NORINCO Intl Thatta Power

北方国际萨塔电力

SCHEDULE I
(Regulation 3(1)
FORM OF APPLICATION

The Registrar
National Electric Power Regulatory Authority,
Islamabad.

Subject:

Application for a Generation License for
Norinco International Thatta Phase –II 50MW Wind Power Project (Norinco -2)

I, Asad Alam Niazi, Chief Operation Officer (COO), being the duly authorized representative of Norinco International Thatta Power (Private) Limited by virtue of BOARD RESOLUTION dated 05 -05-2017, hereby apply to the National Electric Power Regulatory Authority for the grant of a GENERATION LICENCE to the Norinco International Thatta Power (Private) Limited -2 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 the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of the 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.

It is to be noted that the company had applied for (2x50MW) wind farm project and LOI have been issued with proper segregation. We have received generation license for 1st phase of 50MW wind power and now we are applying Generation License for Norinco International Thatta Phase –II the 2nd 50MW wind power project ("Norinco-2"). This generation license for 2nd 50MW Project may please be read as "NORINCO-2".

A Bank Draft No. 6831 Dated 04-05-2017 in the sum of Rs. 300336/- (Rupees Three Hundred Thousand Three Hundred Thirty Six Only), being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999 is also attached herewith.

May 22, 2017
Dated

NITPPL

Asad Alam Niazi
Director & COO

NORINCO International Thatta Power (PVT.) Limited 北方国际萨塔电力有限公司
Suite No. 201, 2nd Floor, Horizon Vista, Block 4, Clifton, Karachi, Pakistan
UAN: +92-21-111-111-275 PABX: +92-21-35371833-34 Fax: +92-21-35371836 Email: norinco-power@qq.com

NORINCO Intl Thatta Power

北方国际萨塔电力

EXTRACTS OF THE MEETING OF THE BOARD OF DIRECTORS OF NORINCO INTERNATIONAL THATTA POWER (PRIVATE) LIMITED (THE "COMPANY") HELD ON MAY 5, 2017 AT THE REGISTERED OFFICE OF THE COMPANY

Ref: NOR-THA-BOARD-08

It is RESOLVED THAT Mr. Asad Alam Niazi, COO of the Company, is hereby appointed as Authorized Person to apply to National Electric Power Regulatory Authority (NEPRA) for Generation License of Norinco International Thatta Phase-II 50 MW Wind Power Project and to undertake the following steps on behalf of the Company:

(a) to file/sign all the required documents,

(b) to comply with any of the NEPRA objections / instructions in this regard, and

(c) to make necessary changes/modifications to the documents submitted for Generation License to ensure compliance with NEPRA requirements as per related Rules/Regulations.

Certified that the abovementioned is a true and valid extract from the Meeting of the Board of Directors of NORINCO INTERNATIONAL THATTA (PRIVATE) LIMITED held on May 5, 2017.

NORINCO INTL THATTA
POWER PVT LTD

COMPANY SECRETARY

Mr. Ge Lingxing
Company Secretary

DATED: May 5, 2017

NORINCO International Thatta Power (PVT.) Limited 北方国际萨塔电力有限公司
Suite No. 201, 2nd Floor, Horizon Vista, Block 4, Clifton, Karachi, Pakistan
UAN:+92-21-111-111-275 PABX: +92-21-35371833-34 Fax: +92-21-35371836 Email: norinco-power@qq.com

A008211

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. 0097671

I hereby certify that NORINCO INTERNATIONAL THATTA POWER (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 fourth day of February, Two Thousand and Sixteen

Incorporation fee Rs. 62,000/= only

(Muhammad Naeem Khan)
Joint Registrar / Acting In charge
Karachi

Company Registration Office Karachi Securities and Exchange Commission of Pakistan

Certified to be True Copy

Deputy Registrar of Companies

21/4/17

THE COMPANIES ORDINANCE, 1984

(Private Company Limited by Shares)

MEMORANDUM OF ASSOCIATION

OF

NORINCO INTERNATIONAL THATTA POWER (PRIVATE) LIMITED

I. The name of the Company is "**Norinco International Thatta Power (Private) Limited**"

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

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

1. To carry on all or any of the business of producers, manufacturers, generators, suppliers, distributors, transformers, converters, transmitters, processors, developers, storers, procurers, carriers and dealers of electricity and energy generation and any and all products and by-products thereof of every kind whatsoever derived from or in connection with any of the foregoing activities and to perform any and all other acts which are necessary or incidental to the business of and to do any and all ancillary, related or connected activities as may be considered necessary or beneficial or desirable for or in connection with any or all of the aforesaid purposes subject to permission from NEPRA and other regulatory authorities.

2. To locate, invent, design, develop, set-up, establish, build, construct, install, provide, repair, maintain and manage, improve, alter, own, use, operate, purchase, acquire, sell or otherwise dispose of, lease or sublease, take on hire, give on hire, or otherwise deal in or turn to account, work, manage operate and control power plants and energy projects systems and facilities and works of every kind and description whatsoever including but not limited to thermal, coal fired, coal-gasification, diesel and biofuel, steam, gas and combined cycle, hydro, solar, wind, geothermal, waste-to-energy, co-generation or integrated power plants, energy projects systems and facilities and works for and in connection with the distribution and supply of electricity to customers, both public and private, including but not limited to cities, towns, streets, docks, markets, theatres, buildings, industries, utilities and places, both public and private, and for all or any other purposes for which electric energy can be employed subject to permission from NEPRA and other regulatory authorities.

3. To carry on all or any of the business of retailing, trading, importing and exporting, supplying, distributing, designing, developing, manufacturing and assembling, installing and testing, transforming, switching, converting, repairing, maintaining, contracting, constructing, operating, using, inspecting and reconditioning, altering, removing and hiring products and services of any kind and description in connection with power plants, energy projects, systems and facilities including but not limited to cables, wires, lines, meters, pylons, tracks, rails, pipelines , transmission facilities and systems, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, dry cells and any other plant, apparatus, equipment, and engineering goods of any kind and description whatsoever for any of the aforesaid purposes.

4. To import, purchase, or otherwise acquire, prospect, explore for, produce, exploit, refine, compound, treat, process, manufacture, purify, blend, reduce, distil, store, transport, market, distribute, supply, buy, sell, transfer and otherwise deal in raw and other materials and their by-products of every kind and description for, or in connection with any of the aforesaid activities, including but not limited to coal, coal-bed methane, petroleum, petroleum products, oil, gas, hydrocarbons, petrochemicals, bituminous substances and any other similar materials of any kind whatsoever.

5. To obtain, procure, purchase, take on lease or sublease, exchange or otherwise howsoever acquire in any part of the world any concessions, grants, claims, licences, leases, option, rights or privileges for any mining objects or purpose or any mines, mining rights or concessions, or any metalliferous lands, gravels of rivers, or any lands containing or believed to contain any metals or minerals (including fossilised minerals), mineral ores or products and to explore, work, exercise, develop let lease sublease out or otherwise howsoever turn to account, deal with or dispose of any such concessions, grants, claims, license, lease, mines, lands, option, rights or privileges and the produce thereof.

6. To carry on the business of electricians, electrical engineers and mechanical engineers and of manufacturers, designers, workers, repairers of, and dealers in, electrical and electronic apparatus, machinery and goods of every kind and description.

7. To carry on all or any of the business of electrical, mechanical, motor and general engineers, manufacturers and merchants of, agents for, and dealers in engineering specialities of every description.

8. To purchase or otherwise acquire offices, workshops, buildings, and premises and any fixed and movable machinery, tools, engines boilers, plant implements, patterns and other tooling, stock-in-trade, patents and patent rights, drawings, designs and copyrights convenient or necessary for any of the above activities.

9. To manufacture, produce, process, refine, develop, buy, sell, distribute and otherwise deal in all kinds of chemicals, fine chemicals, industrial and pure chemicals, organic and inorganic chemicals and allied products, formulations and articles.

10. To carry on research and development work and experiments relating to any new material and/or substance or the application of any chemical, organic or other process to any material or substance and to undertake, establish, provide and conduct scientific technical and industrial research or otherwise sponsor or subsidise such laboratories and experimental workshops or projects for such research on a commercial scale.

11. To carry out investigations, and to carry on and undertake basic, fundamental and advanced research, in all branches of science, engineering and technology including without limiting the generality of the foregoing, bio-technology waste treatment technology environmental technology, mining, geophysical and geological methods and techniques and other allied and related fields of study and to discover, invent, invest, produce, manufacture, make improvements, modify and scale up plants, machinery, equipment, appliances, apparatus', processes, chemical substances, goods, articles and things of every kind and description.

12. To own, establish, construct, set up, run, operate, manage, administer, promote, invest in or support training and research centres for providing education and training, whether general, professional, technical or vocational, in any and all fields related to or associated with or connected to electric and power generation and allied industries, including without limiting, the generality of the foregoing production generation and distribution activities, operations and services and the administration and management thereof.

13. To carry on the business of commercial, industrial, business, manufacturing, technical, financial, marketing, distribution, supply chain, logistics, transportation, managerial, personnel, organizational, administrative, information technology and software consultants and advisers and in connection therewith or in relation thereto to provide advice, training, services and assistance of all kinds and every description and for or in connection with any of the forgoing.

14. To carry on the business as advisors, consultants, engineers and technical experts for any trade or industry and to render such advice and services as are usually rendered by technicians, engineers, commercial, economical, industrial and business consultants, and to prepare, plan, explore, conduct tests and market research, collect data or otherwise assist in the execution of such schemes as may be thought desirable in conjunction with the business of the Company.

15. To own, purchase, acquire, build, construct, alter, establish, install, lay out, improve, maintain, work, manage, operate, carry out, control, or aid in, contribute or subscribe to the construction, erection, maintenance and/or improvement or working of, any roads, ways, tramways, railways, aerodromes and landing fields, docks, wharves, piers, bridges, jetties, breakwaters, dredging facilities, moorings, harbour abutments, viaducts, aqueducts, canals, water courses, wells, tanks, storage installations, refineries, pipes, pipelines, conveyors, telegraphs, telephone, communication apparatus and systems, wireless, gas works, steam works, electric lighting and power works, power houses, hydroelectric plants, laboratories, factories, mills, foundries, workshops boilers, machine shops, warehouses, shops, stores, fuel stores, hangers, garages, guard towers, machinery equipment and other appliances, hotels, clubs, restaurants, lodging houses, baths, places of workshop, hospitals, dispensaries, places of amusement, pleasure grounds, parks, gardens, reading rooms, dwelling houses, offices and other buildings, works and conveniences which may be calculated, directly or indirectly, to advance the Company's interests and to contribute to, subsidise or otherwise assist or take part in, the construction, improvement, maintenance, working, management, carrying out of control thereof, and to take any lease and enter into any working agreement in respect thereof.

16. To purchase, build, charter, affreight, hire and let out for hire, or for chartering and affreightment and otherwise to obtain the possession of, and use, operate and dispose of, and employ or turn to account ships, lighters, barges, tugs, launches, boats and vessels of all kinds, automobiles, lorries, motor trucks and tractors, airplanes, helicopters, locomotives, wagons, tank cars, and other forms of transport and rolling stock, and otherwise to provide for and employ the same in the conveyance of property and merchandise of all kinds and the transportation of personnel, employees, customers and visitors and to purchase or otherwise to acquire any ship, lighter, barge, tug, launch, boat or vessel of any kind, automobile, lorry, motor truck or tractor, airplane, helicopter, locomotive, wagon, tank car, and other form of transport.

17. To buy, sell, manufacture, make up, prepare, repair, alter, exchange, let on hire, import, export and deal in all kinds of articles and things which may be required for the purposes of any of the businesses aforesaid or commonly supplied or dealt in by persons engaged in any such business or which may seem capable of being profitably dealt with by the Company.

18. To receive goods on consignment, from any company, firm, association of persons, body, individuals, government, semi-government or any local authority and sell the same as agents or as principal.

19. To carry on any other business, connected with trading which may seem to the Company capable of being conveniently carried on in connection with the above, calculated directly or indirectly to enhance the value of the Company or render profitable any of the Company' property or rights and to acquire and undertake the whole or any part of the business, property, and liabilities of any person or company carrying on or proposing to carry on any business which the Company is authorized to carry on.

20. To buy, sell, dispose of, import, export, modify, manufacture, produce, plant, cultivate, prepare, process, treat, repair, alter, manipulate, exchange, hire, let on hire and deal in all kinds of materials, substances, commodities, things, products, goods, merchandise, plant, machinery, equipments, apparatuses, appliances, tools, implements and other articles and things connected with and necessary for carrying on all or any of the Company's business.

21. To carry on in or outside Pakistan the business of manufacturers, importers, exporters, retailers, indenters, transporters, dealers in all articles and commodities akin to or connected with any of the business of the Company capable of being conveniently carried on or necessary for the promotion of the objects herein contained, as permissible, under law.

22. To carry on agency business (except managing agency) and to acquire and hold selling agencies and to act as selling agents, commission agents, manufacturers' representatives and distributing agents of and for the distribution of all kinds of merchandise, goods, commodities, products, materials, substances, articles and things whether finished, semi-finished, raw, under process, refined, treated or otherwise pertaining to trade and commerce and for that purpose to remunerate them and to open and maintain and maintain branches, receiving offices, marketing, sales and distribution centres, depots, display centres, service centres.

23. To purchase, take on lease or in exchange, hire, apply for or otherwise acquire and hold for any interest, any rights, privileges, lands, building, easements, trade marks, patents, patent right, copyrights, licenses, machinery, plants, stock-in-trade, and any movable and immovable property of any kind necessary or convenient for the purposes of or in connection with the Company's business or any branch or department thereof and to use, exercise, develop, grant licenses in respect of or otherwise turn to account any property, rights, and information so acquired, subject to any permission required under the law, property of any description which the Company may deem necessary or which may seem to the Company capable of being turned to account, subject to any permission as required under the law.

24. To act as representatives, for any person, firm or company and to undertake and perform sub-contracts, and also act in the business of the Company through or by means of agents, sub-contractors and to do all or any of the things mentioned

herein in any part of the world and either alone or in collaboration with others and by or through agents, sub- contractors, or otherwise.

25. To go in for, buy or otherwise acquire and use any patent design, copyright, licenses, concession, convenience, innovation, invention, trade marks, or process, rights, or privileges, plants, tools or machinery and the like in Pakistan or elsewhere, which may for the time being appear to be useful or valuable for adding to the efficiency or productivity of the Company's work or business, as is permissible under the law.

26. To acquire and carry on all or any part of the business or property and to undertake any liabilities of any person, firm, association or company's possession of property suitable for any of the purposes of the Company or carrying on any business which this Company is authorised to carry on and in consideration for the same, to pay cash or to issue shares of the Company.

27. 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.

28. To enter into partnership, amalgamate, or merge movable and immovable and/or to buy on all interests, assets, liabilities, stocks, or to make any arrangement for sharing profits, union of interests, co-operation, joint-venture, reciprocal concession or otherwise with any person, firm or company carrying on or proposing to carry on any business which this Company is authorised to carry on or which is capable of being conducted so as to directly or indirectly benefit this Company and to have foreign collaborations and to pay royalties/technical fees to collaborators subject to the provisions of the Companies Ordinance, 1984.

29. To establish, promote or assist in establishing or promoting and subscribe to or become a member of any other company, association or club whose objects are similar or in part similar to the objects of this Company or the establishment or promotion of which may be beneficial to the Company, as permissible under the law.

30. To open accounts with any bank or banks and to draw, make, accept, endorse, execute, issue, negotiate and discount cheques, promissory notes, bills of exchange, bills of lading, warrants, deposit notes, debentures, letter of credit and other negotiable instruments and securities.

31. To arrange local and foreign currency loans from scheduled banks, industrial banks and financial institutions for the purpose of purchase, manufacture, market, supply, export and import of machinery, construction of factory, building and for the purpose of working capital or for any other purpose as required by the Company.

32. To sell or otherwise dispose of the whole or any part of the undertaking of the Company, either together or in portions for such consideration as the Company may think fit and in particular, for shares, debenture-stock or securities of any Company purchasing the same.

33. To pay all costs, charges, and expenses preliminary or incidental incurred in formation or about the promotion and establishment of the Company and to remunerate any person, firm or company for services rendered or to be rendered in or about the formation or promotion of the Company or the conduct of its business.

34. To give any servant or employee of the Company commission in the profits of the Company's business or any branch thereof and for the purpose to enter into any agreement or scheme of arrangement as the Company may deem fit and to procure any servants or employees of the Company to be insured against risk of accident in the course of their employment by the Company.

35. To establish and support or aid in the establishment and support of associations, institutions, funds, and conveniences calculated to benefit persons who are or have been directors of or who have been employed by or who are serving or have served the Company or any other company which is a subsidiary or associate of the Company or the dependents or connection of such persons and to grant pensions, gratuities, allowances, relieves and payments in any other manner calculated to benefit the persons described herein.

36. To distribute any of the Company's property and assets among the members in specie or in any manner whatsoever in case of winding up of the Company.

37. To guarantee the performance of any contract or any other obligation of the Company or any other company in relation to the payment of any loan, debenture-stock, bonds, obligations or securities issued by or in favour of the Company or any other company and to guarantee the payment or return on such investments.

38. To carry out joint venture agreements with other companies or countries within the scope of the objects of the Company.

39. To cause the Company to be registered or recognized in any foreign country.

40. To do and perform all other acts and things as are incidental or conducive to the attainment of the objectives of the Company.

41. To apply for and obtain necessary consents, permissions and licences from any government, state, local and other authorities for enabling the Company to carry on any of its objects into effect as and when required by law.

42. The objects specified in each of the paragraph of this Memorandum of Association shall be regarded as independent objects and accordingly shall in no way be limited or restrict (except where otherwise expressed in such paragraphs) by reference to or inference from the terms of any other paragraph, but may be carried out in as full and ample a manner and construed in as wide a sense as if each of the said paragraphs defined the objects of a separate and distinct company.

43. It is hereby declared and undertaken that the Company shall not engage in banking business, business of dealing in foreign exchange, illegal brokerage or business of an investment company, non-banking finance company, leasing, business of managing agency, investment, payment sales receipt scheme and insurance business directly or indirectly as restricted under the law or in any unlawful business or operations and that nothing contained in the object clauses

Company Registration Office Karachi

shall be so construed to entitle it to engage in such businesses directly or indirectly and the Company shall not launch multilevel marketing (MLM), pyramid and ponzi schemes.

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

IV. The liability of the members is limited.

V. The authorised capital of the Company is PKR 10,000,000/- (Pak Rupees Ten Million divided into 1,000,000 (One Million) ordinary shares of PKR 10/- (Pak Rupees Ten) each with powers to the Company, to increase or reduce, consolidate, sub-divide or otherwise reorganize the share capital of the Company in accordance with the provisions of the Companies Ordinance, 1984 and subject to any permission required under the law.

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

Name and surname	CNIC No /NICOP No/Passport No.	Father's/ Husband's Name in full	Nationality	Occupation	Residential Address	Number of shares taken by each subscriber	Signatures
NORINCO INTERNATIONAL COOPERATION LIMITED through its authorised representative Wang Xinqing, holder of Passport No. PE0575302	-		Chinese	-	Room 301-302, Floor 3, Building 47, Block 12, No.188 South-Fourth-Ring West Road, Fengtai District, Beijing, Peoples Republic of China	89,997 (Eighty Nine Thousand Nine Hundred Ninety Seven) ordinary shares of PKR 10/- (Pak Rupees Ten) each	
AN ENERGY (PRIVATE) LIMITED through its authorised representative Asad Alam Niazi, holder of CNIC No. 61101-3375696-9	-		Pakistani		Suite # 201, 2nd Floor, Horizon Vista, Plot Number Commercial-10, Scheme 05, Block 04, Clifton, Karachi, Pakistan	9,999 (Nine Thousand Nine Hundred Ninety Nine) ordinary shares of PKR 10/- (Pak Rupees Ten) each	
WU XIAOCHUAN	PE 0026777	Wu Mingshun	Chinese	Engineer	Floor 22, Fanglinyuan, No. 5, Zifang Road, Chaoyang District, Beijing, Peoples	1 (One) ordinary share of PKR 10/- (Pak Rupees Ten) each	

Name and surname	CNIC No /NICOP No/Passport No.	Father's/ Husband's Name in full	Nationality	Occupation	Residential Address	Number of shares taken by each subscriber	Signatures
					Republic of China		
LIU ZHEN	PE0023582	Liu Yusong	Chinese	Project Manager	Norinco International Plaza. No. 6. Zhengda Road. Shijingshan District. Beijing. Peoples Republic of China	1 (One) ordinary share of PKR 10 - (Pak Rupees Ten) each	
WANG XINQING	PE0575302	Wang Xiaowu	Chinese	Vice President. Norinco International Cooperation Limited.	Norinco International Plaza. No. 6. Zhengda Road. Shijingshan District. Beijing. Peoples Republic of China	1 (One) ordinary share of PKR 10 - (Pak Rupees Ten) each	
ASAD ALAM NIAZI	61101-3375696-9	Tassaduq Hussain Niazi	Pakistani	Businessman	House No. 331. Street No. 68. Sector F-11/1. Islamabad	1 (One) ordinary share of PKR 10 - (Pak Rupees Ten) each	
			Total number of shares to be taken			100,000 (One Hundred Thousand) ordinary shares of PKR 10 - (Pak Rupees Ten) each	

Dated: The 25th the day of January. 2016.

Witness to the above signatures:

NIFT (Address: 5TH FLOOR AWT PLAZA. I.I. CHUNDRIGAR ROAD. KARACHI 74000)

Company Registration Office Karachi
Securities and Exchange Commission

Certified to be True Copy

~~Deputy Registrar~~ of Companies

21/4/

THE COMPANIES ORDINANCE, 1984

(Private Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF

NORINCO INTERNATIONAL THATTA POWER (PRIVATE) LIMITED

INTERPRETATION

1 In these Articles, unless there is something in the subject or context inconsistent therewith:-

"Affiliate" means in relation to any person, a person which is (a) the direct or indirect holding company of that person, (b) a subsidiary of that person, or (c) the subsidiary of that person's holding company, where (i) a person is a holding company of another person if such person directly or indirectly controls that other person, with "control" meaning the power to direct the management and policies of that other person, or the ownership of more than fifty percent (50%) of the voting rights in that other person, as applicable; and (ii) a person is a subsidiary of another person if that other person is its holding company

"Auditors" means the auditors of the Company who shall be appointed by the Company, having offices or representative member firms in Pakistan.

"NORINCO" means **NORINCO INTERNATIONAL COOPERATION LIMITED**, a company incorporated under the laws of PRC, with company number

110000010706353 and having its registered address at Room 301-302, Floor 3, Building 47, Block 12, No.188 South-Fourth-Ring West Road, Fengtai District, Beijing, Beijing, PRC.

"AN" means **AN ENERGY (PRIVATE) LIMITED**, a company incorporated under the laws of Pakistan, with CUIN Number 0092884 and having its registered office at Suite # 201, 2nd Floor, Horizon Vista, Plot Number Commercial-10, Scheme 05, Block 04, Clifton, Karachi, Pakistan.

"Articles" means the Articles of Association of the Company.

"Board" means the Board of Directors of the Company.

"Business Plan" means the annual plan of the Company prepared in accordance with Clause 10.4 of the JV Agreement describing the business which the Company will undertake during the relevant financial year.

"Chairman" means the Chairman of the Company for the time being.

"Company" means Norinco International Thatta Power (Private) Limited.

"Deed of Adherence" means the deed of adherence in substantially the same form as set out in the JV Agreement;

"Development Costs" means the development costs and expenses incurred or to be incurred for the Project, including all amounts in relation to the Project, without duplication, paid by NORINCO, AN and the Company until Financial Close;

"Development Costs Budget" means the budget that is approved by the Board from time to time in respect of the Development Costs;

"Directors" mean the Directors of the Company.

"Encumbrance" includes any encumbrance or security interest of any kind whatsoever (including without limitation a mortgage, charge, pledge, lien, restriction, right to acquire, right of pre-emption, option, conversion right, third party right or interest, right of set-off or counterclaim, equities, trust arrangement or any other type of preferential agreement (such as a retention of title arrangement) having similar effect) or any other rights exercisable by or claims by third parties.

"Extraordinary General Meeting" shall have the same meaning as provided under Article [•] below;

"Financial Close" means the date on which all material Project Documents and the Financing Documents have been executed and all of the conditions precedent therein have been fulfilled (or waived as the case maybe) to such extent to give an immediate right to draw down funds under these Financing Documents (subject only to giving the notice of draw down required by those Financing Documents). For the avoidance of doubt Financial Close shall be deemed to have been achieved when a drawdown request is issued to the Financing Parties under the Financing Documents.

"Financing Documents" means the financing and security agreements to be entered into between the Company and the Financing Parties for the purpose of financing the Project

"Financing Parties" means other financial institutions that will provide limited recourse project financing to the Company pursuant to the Financing Documents;

"JV Agreement" means the Joint Venture Agreement dated [•], 2015 entered into by and between NORINCO and AN.

"Member" shall have the meaning assigned thereto in Section 2(1) (21) of the Ordinance.

"Memorandum" means the Memorandum of Association of the Company.

"Month" means a calendar month.

"Office" means the registered office of the Company

"Ordinance" means the Companies Ordinance, 1984 or any statutory modification thereof for the time being in force.

"Organizational Documents" means Memorandum and the Articles.

"Project" means the development, construction, financing, ownership and operation of the 100 MW Thatta Wind Power Project on a build and operate basis and the sale of the electricity generated therefrom, all pursuant to the Project Documents;

"Project Documents" means the following contractual arrangements that the Company will enter into for the Project:

(a) the Implementation Agreement;

(b) the Energy Purchase Agreement;

(c) the Financing Documents;

(d) the EPC Contract; and

(e) the Sale Deed;

Each as defined in the JV Agreement and any other Project Document under the JV Agreement.

"Proxy" shall have the meaning assigned thereto in the Ordinance and shall include attorney duly appointed under a power of attorney.

"Register" shall have the meaning assigned thereto by Section 2(1) (30B) of the Ordinance.

"Seal" means the common seal of the Company.

"Secretary" means the Secretary of the Company and the expression **"Secretary"** shall include a temporary or assistant Secretary and any person appointed by the Directors to perform any of the duties of the Secretary.

"Special Resolution" shall have the meaning assigned thereto by Section 2(1) (36) of the Ordinance.

"Writing" shall include printing, lithography and any other mode or modes of representing or reproducing words in a visible form.

"Year" means a calendar year.

Words importing a singular number only shall include a plural number and vice versa.

Words importing the masculine gender only shall include the feminine gender.

Words importing persons shall include bodies corporate.

Reference in these Articles to any provision of the Ordinance shall, where the context so admits, be constructed as a reference to such provision as specified or re-enacted by any statement for the time being in force.

2. The regulations contained in Table "A" in the First Schedule to the Ordinance shall not apply to the Company except in so far as the same may be expressly incorporated or deemed to be incorporated in these Articles or are made expressly applicable by the said Ordinance or any statutory modification thereof.

PRIVATE COMPANY

3. The Company is a private company within the meaning of Section 2 (1) (28) of the Ordinance and accordingly:

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

(b) The number of Members of the Company (exclusive of persons in the employment of the Company) shall be limited to a minimum of 2 (two), provided that, for the purpose of this provision, when 2 (two) or more persons hold 1 (one) or more shares in the Company jointly they shall be treated as a single Member.

(c) No invitation shall be issued to the public to subscribe for the shares, debentures or debenture stock of the Company.

BUSINESS OF THE COMPANY

4. (a) The business of the Company shall include all or any of the objects enumerated in the Memorandum and can be commenced immediately after the incorporation of the Company as may be decided by the Directors from time to time, notwithstanding that only a part of the capital has been subscribed.

(b) The business of the Company shall be carried on at such place or places in the whole of Pakistan or elsewhere as the Directors may deem proper or advisable from time to time.

SHARE CAPITAL

5. The authorised capital of the company is PKR 10,000,000/- (Pak Rupees Ten Million) divided into 1,000,000 (One Million) ordinary shares of PKR 10/- (Pak Rupees Ten) each. Such capital shall be issued as permitted by law, with the power to increase, consolidate, subdivide, reduce or otherwise reorganize the share capital of the Company subject to the provisions of Sections 90 to 106 of the Ordinance.

6. None of the funds of the Company shall be employed directly or indirectly in the purchase or lent on the security of shares of the Company and the Company shall not, except as authorized by Section 95 of the Ordinance, give any financial assistance for the purpose of or in connection with the purchase of shares in the Company.

7. Subject to the provisions of the Articles, the shares shall be under the control of the Board of Directors, who may allot or otherwise dispose off the same to such persons, firm or corporation on such terms and conditions and at such time as may be thought fit.

8. Without prejudice to any special rights previously conferred on the holders of any existing shares or class of shares, any share in the Company may be issued with such special rights or such restrictions, as the Company may from time to time by ordinary resolution, determine.

TRANSFER OF SHARES

9. Subject to Article 11, the instrument of transfer of any share in the Company shall be executed by both the transferor and the transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the Register in respect thereof.

10. The instrument of transfer of any share shall be in writing in the following form or in any usual or common form which the Directors shall approve:

"I/We, [•] of [•] in consideration of the sum of PKR [•] /- paid to me/us/company by [•] of [•] (hereinafter called "the said transferee") do hereby transfer to the said transferee [•] shares numbered [•] in the undertaking called Norinco International Thatta Power (Private) Limited to hold unto the said transferee, his legal personal representatives and assigns, subject to the several conditions on which I/We held the same at the time of the execution hereof, and I/We, the said transferee, do hereby agree to take the said share (or shares) subject to the conditions aforesaid. As witness our hands this [•] day of [•] 20[•] witness to the signature of, etc."

11. No Member shall, except in accordance with the following provisions of this Article 11 sell, transfer or otherwise dispose of any of such shares held by him, or any legal or beneficial interest therein.

Each Member undertakes to the other that it shall:-

A. not directly or indirectly sell, transfer or otherwise dispose of all or any of its shares or any legal or beneficial interest in its shares or assign or otherwise purport to deal with its shares or with any interest therein if that would contravene any Project Document;

B. procure that any of its Affiliates not sell, transfer or otherwise dispose its benefits and interests in such shares if such sale, transfer, or disposal would contravene any Project Document or Financing Documents;

C. not create any Encumbrance over any of its shares or any legal or beneficial interest therein if that would contravene any Project Document or Financing Documents; and

D. not enter into any agreement with respect to the voting rights attached to all or any of its shares.

12. Subject to Article 11, a Member may at any time and subject to the Financing Documents, transfer its shares to any of its Affiliates (a "**Permitted Transferee**"). In order to verify that a transfer of Shares is to a Permitted Transferee, the Members shall, upon request, provide the Company with such information and evidence as the Company reasonably requires and the Directors may refuse to register a relevant transfer until the information is provided in a form reasonably satisfactory to them. A share may also be transferred by any Member to Directors representing such Member's interests in the Company as may be required to make them Members of the Company and as such eligible for appointment as Directors, or by such nominee Directors to the Member or any other nominee of such Member. Further, a Member may:

(a) pledge, mortgage (whether by way of fixed of floating charge) or otherwise encumber its legal or beneficial interest in its shares to the Financing Parties for the purposes Financing Documents; and

(b) sell, transfer or otherwise dispose of any of such shares (or any legal or beneficial interest thereinas part of the enforcement of the pledge, mortgage (whether by way of fixed of floating charge) or other encumbrance granted to the Financing Parties for the purposes Financing Documents.

13. The Directors shall not refuse to transfer any shares as permitted in accordance with these Articles unless the transfer deed is, for any reason, defective or invalid, provided that the Company shall, within 30 (thirty) days from the date on which the instrument of transfer was lodged with it, notify the defect or invalidity to the transferee who shall, after the removal of such defect or invalidity, be entitled to relodge the transfer deed with the Company. The Directors may suspend the registration of shares during such period or periods as may be permitted by law. The Directors may decline to recognize any instrument of transfer unless the

instrument of transfer is accompanied by the certificate of the shares to which it relates, and such other evidence as the Directors may reasonably require to show the right of the transferor to make the transfer.

14. If at any time any Member (the "**Seller**") receives from a third party a bona fide offer in writing to purchase any or all of the shares held by the Seller for a consideration payable in cash and is prepared to accept the offer, the Seller shall first deliver to the other Member (the "**Continuing Member**") a true copy thereof and shall concurrently offer to sell its shares to the Continuing Member at the same price and on the same terms as are contained in the bona fide offer and the Continuing Member shall then have ninety (90) days within which to accept the offer made to it. If within the period of ninety (90) days mentioned above, the Continuing Member accepts the offer made to it, the Members will complete the sale of the shares within a further period of ninety (90) days. If within the period of ninety (90) days mentioned above, the Continuing Member does not accept the offer made to it, and provided the restrictions in Article 11 are complied with, the Seller shall be free to accept the offer made to it by the third party and to complete the sale of its shares within a further period of ninety (90) days but subject to the condition precedent that where the shares to be sold by the Seller, the third party shall first have executed and delivered a Deed of Adherence under which the third party transferee shall agree to be bound by and shall be entitled to the benefit of the JV Agreement as if such party was the Seller and (b) in case the shares sold constitute only part of the shares owned by the Seller the Members hereto enter into an amendment to the JV Agreement (if required) to include such third party. If the Seller fails to complete the sale to the third party within the ninety (90) day period, its shares shall again become subject to the provisions of this Article 14. If an offer described in this Article 14 is for consideration other than cash, then the Auditors of the Company shall review the offer and determine, according to generally accepted accounting principles, the cash equivalent of the consideration and such cash value shall be used in accordance with Article 14 for the transfer if the pre emption right is exercised. The decision of the Auditors as to the cash equivalent value for the consideration shall be final and binding, and each Member shall provide the Auditors with such information and assistance as the Auditors may request.

15. The Directors may in their absolute and uncontrolled discretion refuse to sanction or register the transfer of any share to any person not already a member and may, for good and sufficient cause, refuse to sanction or register the transfer of any share to any non- member of the Company.

16. Except as permitted under Article 12, no shares shall be transferred by any Member to any person by way of gift or otherwise unless such shares are first offered to the other Members in terms of Article 14 above. In any case no shares shall be transferred to an insolvent or a person of unsound mind.

17. No share shall be transferred unless a proper instrument of transfer has been delivered to the Company. The transferor shall be deemed to remain the holders of such shares until the name of the transferee is entered in the Register in respect thereof. Each signature to such transfer shall be duly attested by the signature of two credible witnesses who shall add their address and occupation.

18. Every instrument of transfer shall be left at the Office for registration accompanied by the certificate of shares to be transferred, and such other evidence as the Company may require to prove the title of the holder. Registered instruments of transfer shall be retained by the Company but any instrument of transfer which the Directors may decline to register, shall on demand, be returned to the person depositing the same.

19. The Directors may, on giving 7 (seven) days previous notice, close the transfer book and Registers of Members and debenture holders for any time as the Directors think fit.

20. A person entitled to a share by transmission shall, subject to the right of the Directors to retain such dividends or money as is provided in these Articles, be entitled to receive and may give a discharge for any dividends or other moneys payable in respect of the share(s). The provisions of the Ordinance in this respect shall apply.

21. Save as herein otherwise provided the Company shall be entitled to treat the person whose name appears on the Register as the holder of any share as the absolute owner thereof, and accordingly shall not (except as ordered by a court of competent jurisdiction or as by law required) be bound to recognize any trust or equitable, contingent or other claim to interest in such shares on the part of any other person whether or not it shall have express or implied notice thereof.

TRANSMISSION OF SHARES

22. In case of the death of a Member the survivor / survivors where the deceased was a joint holder, and the legal personal representatives or the nominees, if any,

appointed under Section 80 of the Ordinance as the case may be, of the deceased where it was a sole holder, shall be the only persons whom the Company will be bound to recognise as having any title to its interest in the shares; but nothing herein contained shall release the estate of a deceased joint holder from any liability in respect of any share which had been jointly held by it with other persons. Before recognising any legal personal representative the Directors may require it to obtain a Grant of Probate or Letters of Administration or a Succession Certificate as the case may be, from a competent court in Pakistan. Provided nevertheless in any case it shall be lawful for the Directors to dispense with the production of Probate or Letter of Administration or Succession Certificate or such other legal representation upon such terms as to indemnity or otherwise as the Directors in their absolute discretion may deem fit.

23. Any person becoming entitled to a share in consequence of the death or insolvency of a Member may upon such evidence being produced as may from time to time properly be required by the Directors and subject as hereinafter provided, elect either to be registered itself as the holder of the share or instead of being registered itself, to make such transfer of the shares 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 a transfer of the share by that Member before his death or insolvency as the case may be.

24. If the person so becoming entitled shall elect to be registered itself, it shall deliver or send to the Company a notice in writing signed by him stating that it so elects. If it shall elect to have another person registered it shall testify his election by executing to that person a transfer of the share. All the limitations, restrictions and provisions of these Articles relating to the right to transfer and the registration of transfers of shares shall be applicable to any such notice or transfer as aforesaid as if the death or insolvency of the Member had not occurred and the notice or transfer were a transfer signed by the Member.

25. A 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 it would be entitled if it were the registered holder of the share except that it shall not before being registered as a member in respect the share be entitled in respect of it to exercise any right conferred by membership in relation to meetings of the Company.

ALTERATION OF CAPITAL

26. The Directors may, with the approval of the Members of the Company in the general meeting, increase the share capital by such sum, to be divided into shares of such amount, as the resolution shall prescribe.

27. Subject to the provisions of Sections 84 and 86 of the Ordinance and to any special rights or privileges for the time being attached to any issued shares the new shares shall be issued upon such terms and conditions, and with such rights and privileges annexed thereto as the resolution creating the same shall direct, and if no direction be given as the Directors shall determine.

28. Subject to any direction to the contrary that may be given by the resolution sanctioning the increase of share capital, all new shares shall, before issue, be offered to the Members of the Company in proportion, as nearly as the circumstances admit, to the amount of the existing shares held by each Member (irrespective of class). The offer shall be made by notice specifying the number of shares offered, and limiting a time within which the offer, if not accepted, will be deemed to be declined, and after the expiration of that time, or on the receipt of an intimation from the person to whom the offer is made, that he declines to accept the shares offered, the Directors may subject to the provisions of sub-section (7) of Section 86 of the Ordinance, dispose of the same in such manner as they think most beneficial to the Company. The Directors may likewise so dispose of any new shares which (by reason of the ratio which the new shares bear to shares held by persons entitled to an offer of new shares) cannot, in the opinion of the Directors, be conveniently offered under this Article.

POWERS TO BE EXERCISE IN A GENERAL MEETING

29. (a) The Shareholders shall at all times regulate the authorized business of the Company by exercising control, supervision and direction in the manner deemed appropriate by them and by delegating such powers, from time to time, to the Board as the shareholders shall deem appropriate.

(b) The functional powers and responsibilities of the Company to be exercised in a general meeting shall include, but not be limited to the matters as provided under this Article 29(b) Whenever the Company, through a general meeting, exercises its powers the conduct of the shareholders and their responsibilities shall be in line with the resolution passed by the shareholders pursuant to these Articles, the JV Agreement and Organizational Documents:-

(i) To make any decision on any amendments to the Organizational Documents.

(ii) To make any decision on establishing or modifying the fundamental accounting policies of the Company, including any approval of a budget and any approval of the annual financial statements of the Company.

(iii) To appoint and/or remove general managers, consultants, advisors, technicians, assistants, independent auditors and other employees.

(iv) To make decisions on approval and execution or modification for contracts and agreements of the Company in excess of USD 1,000,000 (United States Dollars One Million).

(v) To arrange and approve for all documents relating to project finance or the financial transactions of the Company to be duly signed by a person or persons designated by the shareholders.

(vi) To make decisions for the Company to incur indebtedness for borrowed money other than as required by or in connection with the Financing Documents, and for any prepayment by the Company of indebtedness to the Financing Parties incurred pursuant to the Financing Documents.

(vii) To supervise all functions and operations of the Company and to make all necessary arrangements for smoothly running the business of the Company including but not limited to taking and giving loans and advances.

(viii) To make decisions for and on behalf and in the name of the Company, with respect to grant of authority to operate bank accounts and issue or endorse bills of exchange, promissory notes, etc., and buy or sell bonds, to accept, sign and deal in bills of exchange, cheques, drafts and securities and issue debentures for and on behalf and in the name of the Company.

(ix) To make decision on the increase or decrease of the authorised capital and seek for approval of the Government of the Islamic Republic of Pakistan and Government of the People's Republic of China if needed, and issue any new shares.

(x) To make a decision on any merger, consolidation of similar amalgamation of the Company, and/or transfer all or a substantial part of the Company's assets, and/or dissolve or terminate the Company and take any liquidation/insolvency/bankruptcy action.

(xi) To approve distribution of dividends to the shareholders, provided that (i) no decision in respect of the amount of dividend to be distributed shall be made exceeding the rate of dividend as recommended by the Board and (ii) all shareholders receive the dividend in their respective share ratio's.

(xii) To make any decision for the Company to institute litigation or arbitration proceedings with respect to any third party involving a claim of, or in relation to a value in excess of, USD 1,000,000/- (United States Dollars One Million).

(xiii) To exercise powers and fulfill the duties prescribed by the Ordinance, applicable laws and the Organizational Documents as prevailing from time to time.

(xiv) Proceedings of the general meeting shall be conducted in English and the minutes of the meeting shall be formed and finalized each time with the signature of representative of shareholders or its proxy and maintained in English.

DECISION AND RESOLUTION OF SHAREHOLDERS IN GENERAL MEETNIGS

30. All matters to be discussed at a general meeting shall be presented in the form of resolutions. Except as provided below, all other resolutions presented at the meeting shall be deemed to have been passed if the shareholders present at the meeting, whether in person or by proxy, representing a simple majority of the total value of the issued and paid up ordinary shares of the Company except for the Special Resolutions which required a higher vote to pass the resolutions.

(a) Each ordinary share shall entitle its subscribed shareholder to one vote. These votes shall rank pari passu inter se.

(b) Votes shall be cast by show of hands, provided that, upon the demand of the shareholders (or their representatives/proxy) representing at least 5% of the issued and paid up shares of the Company, balloting in writing/poll shall be obligatory.

31. Notwithstanding anything contained in Article 29 and 30 above, the decisions on the matters listed below shall require vote of shareholders representing fifty-one percent (51%) of the total value of all issued and paid up shares of the Company unless a Special Resolutions is mandatory under applicable laws.

(a) Any change in the general nature of the business of the Company or any subsidiary and any disposal of the undertaking or assets of the Company or of any of its subsidiaries or any substantial part thereof other than in the ordinary course of business.

(b) Additional shares or loan certificates caused to be issued by the Company to each contributing or lending party upon the providing of its portion of the equity or loan funding amount, as the case may be.

(c) Approval of remuneration for the Board and or executives of the Company.

(d) Any transaction, arrangement or agreement with a related party or for the benefit of any Director of the Company or his close relatives.

(e) Making of any loan, financial assistance or guarantee to any Director of the Company or his close relatives and any Shareholder of the Company.

(f) Acquisition or formation of any subsidiary company and acquisition of the undertaking or the whole or part of the assets of any other company or business which in relation to the Company's business is substantial.

(g) Conduct of any business by the Company other than as contemplated under the Organizational Documents or other governing documents of the Company.

(h) Incurrence of any indebtedness for borrowed money in excess of US Dollar 1,000,000/- (United States Dollars One Million)(including, without limitation, approval of all development, construction and permanent financing arrangements for the Company's projects.

(i) Increase, other than by way of bonus issue, or reduction, or other alteration whatsoever in the issued share capital of the Company or any of its subsidiaries, or any variation of the right attached to any of the shares for the time being in the capital of the Company or any of its subsidiaries, or the granting of any new options to subscribe for shares or issue of any securities convertible into shares of the Company or any of its subsidiaries, or entering into any agreement for the same.

(j) Any issuance of any voting securities of the Company or the securities of the Company which are exercisable or convertible into shares or other voting securities of the Company or the sale of shares of its subsidiaries.

(k) Any issuance of any securities of the Company having a preference right to dividends or distributions whether during the life of the Company or under dissolution liquidation or winding up.

(l) Any reorganization, consolidation, merger, or other restructuring/business combination of the Company or any subsidiary with or into any other company/body corporate/corporation which is not the Company or a wholly-owned subsidiary of the Company.

(m) Sale, lease or exchange of all or substantially all of the assets of the Company.

(n) Any amendments or restatement of the Organizational Documents or other governing documents of the company.

(o) Any recapitalization of the Company.

(p) Dissolution, liquidation or winding up of the Company.

(q) Any change in the status of the Company.

(r) Any public offering of securities of the Company.

(s) Any transaction by the Company with any Party to the JV Agreement, or any Affiliate of any of them.

(t) Encumbrance or change of any part of the Company's assets.

(u) Acquisition or disposal by the Company of any asset or giving or receiving of any service otherwise than at market value.

(v) Admission of any new shareholder to the Company with or without it's representation in the Board of Directors.

(w) Appointment and removal of auditors of the Company and approval of their remuneration.

(x) Payment or making of any interim or final dividend or any other distribution to the shareholders as recommended by the Board of Directors provided it is in accordance with the JV Agreement and these Articles.

(y) Except as otherwise required under applicable law, resolutions, actions and decisions and resolution of the shareholders shall be adopted, taken or made at a general meeting by the affirmative vote of the shareholders (or their representatives) representing a simple majority of all outstanding issued and paid up shares (not just those shares that are present or represented by proxy) .

DELEGATION TO BOARD

32. The Company, through a general meeting, to the extent permitted by applicable law may delegate its functions and powers from time to time to the Board of Directors.

GENERAL MEETING

33. The Company shall hold in addition to any other meeting a general meeting as its annual general meeting within eighteen (18) months from the date of its incorporation and thereafter once at least in every calendar year within a period of four (4) months following the close of the financial year and not more than fifteen (15) months after the holding of its last preceding annual general meeting.

34. All general meetings of the Company other than the annual general meeting referred to in Section 158 and the statutory meeting mentioned in Section 159 of the Ordinance shall be called extraordinary general meetings.

35. The Directors may at any time 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 on the requisition of the Members representing not less

than one tenth (1/10th) of the voting power on the date of the deposit of the requisition forthwith proceed to call an Extraordinary General Meeting.

NOTICE OF MEETINGS

36. 21 (twenty one) days' notice at the least (exclusive of the day on which the notice is served or deemed to be served but inclusive of the day for which notice is given) specifying the place the day and the hour of meeting, and in case of special business the general nature of that business, shall be given in manner provided by the Ordinance for the general meeting to such persons as are under the Ordinance or the regulations of the Company entitled to receive such notices from the Company but the accidental omission to give notice to or the non-receipt of notice by any member shall not invalidate the proceedings at any general meeting.

PROCEEDINGS AT GENERAL MEETINGS

37. All business shall be deemed special that is transacted at any Extraordinary General Meeting and all that is transacted at an annual general meeting, with the exception of declaring a dividend, the consideration of the accounts, balance sheet and the report of the Directors and auditors, the election of Directors, auditors and legal advisors

38. No business shall be transacted at any general meeting unless a quorum of Members is present at that time when the meeting proceeds to business. 2 (two) Members present personally or by Proxy representing at least 25% (twenty five percent) of the voting powers of the Company either on their own account or as Proxies shall be a quorum of general meeting.

39. If within half an hour from the time appointed for the meeting a quorum is not present the meeting if called upon the requisition of Members shall be dissolved; in any other case it shall stand adjourned to the same day in the next week at the same time and place and if at the adjourned meeting a quorum is not present within half an hour from the time appointed for the meeting the Members present, being not less than 2 (two) shall be quorum and may transact the business for which the meeting was called.

40. The Chairman, if any, of the Board of Directors shall preside as the Chairman at every general meeting of the Company but if at any meeting he is not present or is unwilling to act as the Chairman of the meeting the Members present may elect the Chief Executive or any Director to be the Chairman, or if no Director is present, or if all the Directors present decline to take the chair, the Members present shall choose from amongst them any person to be the Chairman.

41. The Chairman may, with the consent of any meeting at which a quorum is present (and shall if so directed by the meeting), adjourn the meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place. When a meeting is adjourned for 21 (twenty-one) days or more, 7 (seven) clear days' notice at the least of the adjourned meeting shall be given specifying the place and the time of the meeting as in the case of an original meeting, but it shall not be necessary to specify in such notice the nature of the business to be transacted at an adjourned meeting. Save as aforesaid it shall not be necessary to give any notice of an adjournment of the business.

42. Subject to Article 34, at a general meeting a resolution put to the vote of the meeting shall be decided on a poll.

43. A poll demanded on the election of a Chairman or on a question of adjournment shall be taken forthwith and poll demanded on any other question shall be taken at such time not more than 14 (fourteen) days on which it is demanded or as the Chairman of the meeting may direct. The demand of a poll shall not prevent the continuance of the meeting for the transaction of any business other than the question on which a poll has been demanded.

44. In case of an equality of votes on a poll, the Chairman of the meeting shall be entitled to a second or casting vote.

45. If a poll is duly demanded, it shall be taken in such manner as the Chairman directs, and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded.

VOTES OF MEMBERS

46. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a poll every Member present in person or by proxy shall have 1 (one) vote in respect of each share.

47. On a poll a Member entitled to more than 1 (one) vote need not, if it votes, use all his votes or cast all the votes it uses in the same way.

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

49. A Member of unsound mind, or in respect of whom an order has been made by any court having jurisdiction in lunacy may vote, by his committee or other legal guardian and any such committee or guardian may, on a poll, vote by Proxy.

50. No objection shall be raised to the qualification of any voter except at the meeting or adjourned meeting at which the vote objected to is given or tendered, and every vote not disallowed at such meeting shall be valid for all purposes. Any such objection made in due time shall be referred to the Chairman of the meeting, whose decision shall be final and conclusive.

51. The instrument appointing a Proxy shall be in writing under the hand of the appointee or of his attorney duly authorised in writing, or, if the appointee is a corporation, either under seal, or under the hand of an officer or attorney duly authorised. A Proxy need not be a Member of the Company.

52. The instrument appointing a Proxy, or power of attorney or other authority (if any), under which it is signed or a notarially certified copy of that power or authority, shall be deposited at the Office not less than 48 (forty-eight) hours before the time for holding the meeting at which the person named in the instrument proposes to vote, and in default the instrument of proxy shall not be treated as valid.

53. An instrument appointing a proxy may be in the following form, or in any other form which the Directors shall approve:-

"I/We [•] of [•] in the district of [•] being a member of Norinco International Thatta Power (Private) Limited, hereby appoint [•] of [•] as my/our proxy to vote for me/us and on my/our behalf at the (ordinary or extraordinary, as the case may be) general meeting of the Company to be held on the [•] day of [•], 20[•] and at any adjournment thereof.

Signed this [•] day of [•], 20[•]."

54. The instrument appointing a Proxy shall be deemed to confer authority to demand or join in demanding a poll.

55. A vote given in accordance with the terms of an instrument of proxy shall be valid notwithstanding the previous death or insanity of the principal or revocation of the proxy or of the authority under which the proxy was executed, or the transfer of the shares in respect of which the proxy is given, provided that no intimation in writing of such death, insanity, revocation or transfer as aforesaid shall have been received by the Company at the Office before the commencement of the meeting or adjourned meeting at which the proxy is used.

56. Any corporation which is a Member of the Company may by resolution of its directors or other governing body authorise such person as it thinks fit to act as its representative at any meeting of the Company or of any class of Members, and the person so authorised shall be entitled to exercise the same powers on behalf of the corporation which he represents as that corporation could exercise if it were an individual Member, present in person.

DIRECTORS

57. The number of Directors of the Company shall be 4 (Four). Norinco shall have the right to nominate 3 (three) Directors and AN shall have the right to nominate 1 (one) Director. A Director nominated by Norinco will act as the Chairman of the Company and Norinco shall have the right to replace the Chairman.

The following first Directors will be the subscribers to the Memorandum and the Articles of the Company viz:-

1. Mr. Wang Xinqing;
2. Mr. Liu Zhen ;
3. Mr. Wu Xiaochuan; and
4. Mr. Asad Alam Niazi.

58. Save as provided in Section 187 of the Ordinance, no person shall be appointed as a Director unless he/she is a Member of the Company.

59. The remuneration of the Directors shall from time to time for services rendered to the Company and for attending the meetings may be determined by the Company in the general meeting. A Director who is an executive of the Company or of any of its

affiliates shall not be entitled to any remuneration for attending meetings of the Board. The Directors may also be paid all travelling, hotel and other expenses, properly incurred by them in attending and returning from meetings of the Directors or any committee of the Directors or general meetings of the Company or in connection with the business of the Company. Where a Director or a firm of which such Director is a partner or a private company of which such Director is a director holds an office of profit under the Company other than the office of Chief Executive or an office as legal or technical adviser or banker, the terms of remuneration for such office shall be sanctioned by an ordinary resolution passed by the Members of the Company.

60. If any Director being willing shall be called upon to perform extra services as Director or otherwise for any of the purposes of the Company, the Company shall remunerate such Director either by a fixed sum or by a percentage of profit or by both as determined by the Directors and such remuneration shall be in addition to profit on his shares in the Company.

ALTERNATE DIRECTORS

61. Subject to the approval of the Directors, each Director shall have the power from time to time to nominate another Director to act as an alternate Director upon such terms and with such power in his place during his absence from Pakistan of not less than 3 (three) months. Each such Director will have full discretion to remove such alternate Director. The alternate Directors shall be subject in all respects to the terms and conditions existing with reference to the other Directors of the Company and such alternate Director while acting in the place of any absent Director shall exercise and discharge all rights and duties of the Director he represents but shall look solely to such Director for his remuneration and shall not be entitled to claim any remuneration from the Company. Any Director of the Company, who is so appointed as an alternate Director, shall be entitled to vote at a meeting of the Directors on behalf of the Director who appointed him as distinct from the vote to which he is entitled in his own capacity as a Director for the purpose of making quorum of Directors. If the Director appointing the alternate Director ceases to be a Director, then such person appointed as an alternate Director shall also cease to act as a Director. The alternate Director shall *ipso facto* vacate office if and when the

Director appointing him returns to Pakistan alternate Director shall also cease to act as a Director.

POWERS & DUTIES OF DIRECTORS

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

63. The Directors may from time to time and at any time by power of attorney appoint any company, firm or person or body of persons, whether nominated directly or indirectly by the Directors, to be the attorney or attorneys of the Company for such purposes and with such powers, authorities and discretions (not exceeding those vested in or exercisable by the Directors under these Articles) and for such period and subject to such conditions as they may think fit, and any such powers of attorney may contain such provisions for the protection and convenience of persons dealing with any such attorney as the Directors may think fit and may also authorise any such attorney to delegate all or any of the powers, authorities and discretions vested in him.

64. The Company may exercise the powers conferred by Section 213 of the Ordinance with regard to having an official Seal for use abroad, and such powers shall be vested in the Directors.

65. A Director of the Company or a firm of which such Director is a partner or a private company of which such Director is a director may with the consent of the Company in general meeting hold any office of profit under the Company provided that no such consent is required where the office held is that of chief executive or a legal or technical adviser or banker.

66. Subject to the provisions of Section 196 of the Ordinance, the Directors shall not be disqualified from contracting with the Company either as vendor, purchaser or otherwise, nor shall any such contract or arrangement entered into by or on behalf of the Company with any company, or partnership of or in which any Director of the Company shall be a member or otherwise interested be avoided nor shall any such Director so contracting or being such member or so interested be liable to account to the Company for any profit realized by any such contract or arrangement by reason of such Director holding that office or of the fiduciary relation thereby established, but the nature of his interest must be disclosed by him at the time specified in sub-section (2) of Section 214 of the Ordinance. A general notice that any Director of the Company is a director or a member of any other named company or is a member of any named firm and is to be regarded as interested in any subsequent transaction with such company or firm shall as regards any such transaction be sufficient disclosure under the Articles until the end of the financial year in which it was given and after such general notice it shall not be necessary to give any special notice relating to any particular transaction with such firm or company.

67. In accordance with the provisions of Section 219 of the Ordinance, a Register shall be kept by the Directors in which shall be entered particulars of all contracts or arrangements and which shall be open to inspection by any Member at the Office during business hours.

68. A Director of the Company may be or become a director of any other company promoted by the Company or in which the Company may be interested as a vendor, vendee, Member or otherwise and no such Director shall be accountable for any benefits received as director or member of such other company.

69. All cheques, promissory notes, drafts, bills of exchange and other negotiable instruments, and all receipts for moneys paid to the Company, shall be signed, drawn, accepted, endorsed, or otherwise executed, as the case may be, in such manner as the Directors shall from time to time by resolution determine.

70. The Directors shall duly comply with the provisions of the Ordinance or any statutory modification thereof for the time being in force, and in particular with the provisions in regard to the registration of the particulars of mortgages and charges affecting the property of the Company or created by it, and to keeping a register of the Directors and to sending to the Registrar an annual list of Members, and a summary of particulars relating thereto and notice of any consolidation or increase of share capital, or conversion of shares into stock and copies of the Special

Resolutions and a copy of the Register of Directors and notifications of any changes therein.

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

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

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

(c) of all resolutions and proceedings at all meetings of the Company, and of the Directors, and of committees of Directors;

and every Director present at any meeting of Directors or committee of Directors shall sign his name in a book to be kept for that purpose and any such minute of such a meeting if purporting to be signed by the Chairman thereof, or by the Chairman of the next succeeding meeting of the same body, shall be sufficient evidence without any further proof of the facts therein stated.

72. The Directors on behalf of the Company may pay a gratuity or pension or allowance on retirement to any Director who has held any other salaried office or place of profit with the Company or to his widow or dependents and may make contributions to any fund and pay premiums for the purchase or provisions of any such gratuity, pension or allowance.

BORROWING POWERS

73. Subject to the provisions of the Ordinance the Directors may borrow or otherwise acquire finance, loans, facilities whether fund based or contingent in nature and whether secured or unsecured, any sum or sums of money as they think fit for the purposes of the Company's business, or obtain any banking or financial facilities from any bank, financial institution, modaraba or any person on such terms and conditions as the Directors may agree, including but not limited to raising funds by way of issue of securities and redeemable capital and to secure such borrowings, finance and/or facilities by mortgaging / pledging / hypothecating / charging the assets of the Company and to guarantee and secure repayment of facilities, finance, borrowings of other companies, firms, persons.

DISQUALIFICATION AND REMOVAL OF DIRECTORS

74. The office of a Director shall be vacated if:-

(a) he/she is found to be of unsound mind by a court of competent jurisdiction, or

(b) he/she is adjudged an insolvent, or

(c) he/she or any firm of which he is a partner or any private company of which he is a director without the sanction of the Company in general meeting accepts or holds any office of profit under the Company other than that of a chief executive or a legal or technical adviser or a banker, or

(d) he/she absents himself from three consecutive meetings of the Directors or from all meetings of the Directors for a continuous period of three months whichever is the longer without leave of absence from the Board of Directors, or

(e) he/she or any firm of which he is a partner or any private company of which he is a director accepts a loan or guarantee from the Company in contravention of Section 195 of the Ordinance, or

(f) he/she or any firm of which he is a partner or any partner of such firm or any private company of which he is a member or director, without the sanction of the Directors in the form of a resolution passed at their meeting, enters into any contract with the Company for making sale, purchase or supply of goods or rendering services to the Company, or

(g) he/she resigns his office by notice in writing to the Company.

75. At any time the Company may by resolution in the general meeting remove the Chief Executive of the Company appointed under Article 89: Provided that the resolution for removing a Director / Chief Executive shall not be deemed to have been passed unless the number of votes cast in favour of such a resolution is not less than:-

(a) the minimum number of votes that were cast for the election of a Director/ Chief Executive at the immediately preceding election of Directors, if the resolution relates to removal of a Director elected in the manner provided in Article 89, or

(b) the total number of votes for the time being computed in the manner laid down in Article 80 divided by the number of Directors for the time-being if the resolution relates to removal of a Director appointed under Article 76 to Article 81 of these Articles.

RETIREMENT & ELECTION OF DIRECTORS

76. At the first annual general meeting of the Company all the Directors shall stand retired from office and Directors shall be elected in their place in accordance with Section 178 of the Ordinance for a term of 3 (three) years.

77. A retiring Director shall be eligible for re- election.

78. The Directors of the Company shall, subject to Section 174 of the Ordinance, fix the number of elected Directors of the Company not later than 35 (thirty-five) days before the convening of the general meeting at which the Directors are to be elected and the number so fixed shall not be changed except with the prior approval of the Members in a general meeting of the Company

79. In respect of any vacancy occurring, the Directors shall have powers from time to time and at any time to appoint any other qualified person to be a Director of the Company to hold office till expiry of the term of office of the outgoing Director.

80. The Directors shall unless the number of persons who offer themselves to be elected is not more than the number of Directors fixed under Article 78 be elected by the Members of the Company in the general meeting in the following manner, namely:-

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

(b) 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

(c) the candidate who gets the highest number of votes shall be declared elected as the 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 elected.

81. If at any meeting at which an election of Directors ought to take place, the places of the vacating Directors are not filled up, the meeting shall stand adjourned till the same day in the next week at the same time and place, and, if at the adjourned

meeting the places of the vacating Directors are not filled up, the vacating Directors or such of them as have not had their places filled up shall be deemed to have been re-elected at the adjourned meeting.

PROCEEDINGS OF DIRECTORS

82. The Directors may meet together for the despatch of business or undertake the same via video or telephonic conferencing, adjourn or otherwise regulate their meetings, as they think fit. Questions arising at any meeting shall be decided by a majority of votes. In case of an equality of votes, the Chairman shall have a second or casting vote. A Director may, and the Secretary on the requisition of a Director shall, at any time, summon a meeting of the Directors.

83. The quorum necessary for the transaction of the business of the Directors shall, unless otherwise determined by the Directors from time to time, be 3 (three) Directors.

84. The continuing Directors may act notwithstanding any vacancy in their body, but, if and so long as their number is reduced below the number fixed by or pursuant to the regulations of the Company as the necessary quorum of Directors, the continuing Directors may act for the purpose of filling a casual vacancy or summoning a general meeting of the Company, but for no other purpose.

85. The Directors shall elect a Chairman of their meetings from amongst the nominee Directors of Norinco and determine the period for which he is to hold office and the first Chairman shall be Mr. Wang Xinqing; but if no such Chairman is elected, or if at any meeting the Chairman is not present within 15 (fifteen) minutes after the time appointed for holding the same, the Directors present may choose one of the Norinco nominee Directors present to be the Chairman of the meeting.

86. The Directors may delegate any of their powers to committees consisting of such Member or Members of their body as they think fit. Any committee so formed shall in the exercise of the powers so delegated conform to any regulations that may be imposed on it by the Directors.

87. All acts done at any meeting of the Directors, or of a committee of Directors, or by any person acting as a Director, shall notwithstanding that it shall afterwards be discovered that there was some defect in the appointment or continuance in office of any such Directors or person acting as aforesaid, or that they or any of them were

disqualified or had vacated office, or were not entitled to vote, be as valid as if every such person had been duly appointed or had duly continued in office and was qualified and had continued to be a Director and had been entitled to be a Director.

88. Subject to the provisions of sub-section (2) of Section 196 of the Ordinance any resolution of the Directors or of a committee of Directors which is circulated in writing to all Directors or all members of the committee (as applicable) and evidenced by writing under the hands of majority of the Directors or members of the committee (as the case may be) shall be as valid and effectual as a resolution duly passed at a meeting of the Directors or of such committee, called and held in accordance with the provisions of these Articles. Such resolution may be contained in one document or in several documents in like form each signed by one or more of the Directors or Members of the committee concerned.

89. Subject to the provisions of Sections 199 to 201 of the Ordinance the Directors may from time to time appoint one of the Norinco nominee Directors to the office of the Chief Executive for such period and on such terms as they think fit, and, subject to the terms of any agreement entered into in any particular case, and to the provisions of Section 202 of the Ordinance, may revoke such appointment. The first Chief Executive of the Company till the first annual general meeting shall be Mr. Liu Zhen.

90. The Directors may entrust to and confer upon the Chief Executive any of the powers exercisable by them 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, and may from time to time revoke, withdraw, alter or vary all or any of such powers.

THE SEAL

91. The Directors shall provide for the safe custody of the Seal which shall only be used by the authority of the Directors or of a committee of the Directors authorized by the Directors in that behalf and every instrument to which the Seal shall be affixed shall either be signed by one Director and countersigned by the Secretary or by a second Director or by some other person appointed by the Directors for the purpose or be signed by the Chief Executive alone, but so that the Director, may by resolution determine, either generally or in any particular case, that the signature of any

Director and/or Secretary may be affixed by some mechanical means to be specified in such resolution.

DIVIDENDS AND RESERVES

92. Subject to Article 38, the Company in the general meeting may declare dividends but no dividend shall exceed the amount recommended by the Directors. However the Directors may also from time to time pay to the Members such interim dividends as appear to them justified by the reserves and profits of the Company.

93. Unless otherwise directed, dividend may be paid by cheque or warrant sent through the post at the registered address of the Members or person entitled, or in the case of joint holders, to the registered address of that whose name stands first in the register in respect of joint holding. And every cheque or warrant so sent shall be made payable to the order of the person to whom it is sent.

94. No dividends shall be paid otherwise than out of profits of the year or any other undistributed profits.

95. The Directors may before recommending any dividend set aside out of the profits of the Company such sums as they think proper as a reserve or reserves which shall, at the discretion of the Directors, be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the Company may be properly applied, and pending such application may, at 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 Directors may from time to time think fit.

96. A transfer of shares shall not pass the right to any dividend declared thereon after such transfer and before the registration of the transfer.

97. No dividend or other moneys payable on or in respect of a share shall bear interest against the Company. Dividends unclaimed after having been declared may be invested or otherwise used by the Directors for the benefit of the Company until claimed and all dividends unclaimed for three years after having been declared may be forfeited by the Directors for the benefit of the Company provided however the Directors may at any time annul such forfeiture and pay such dividends.

98. Any general meeting sanctioning or declaring a dividend in terms of these Articles may direct payment of such dividend wholly or in part, by the distribution of

specific assets, and in particular of paid-up shares, debentures or debenture stock, of the Company or in any one or more of such ways, and such directions shall be given effect to and where any difficulty arises in regard to the distribution the Directors may settle the same as they think expedient and in particular may issue fractional certificates and may determine that cash payment shall be made to any Member or Members upon the footing of the value so fixed in order to adjust the rights of all parties and may vest any such specific assets in trustees upon such trusts for the persons entitled to the dividends as may seem expedient to the Directors. Where requisite the Directors shall comply with Section 73 of the Ordinance and may appoint any person to sign any contract thereby required on behalf of the person entitled to the dividend and such appointment shall be effective.

CAPITALIZATION OF PROFITS

99. The Company in the general meeting may upon the recommendation of the Directors resolve that it is desirable to capitalize any part of the amount for the time being standing to the credit of any of the Company's reserve accounts or to the credit of the profit and loss account or otherwise available for distribution, and accordingly that such sum be set free for distribution amongst the Members who would be entitled thereto if distributed by way of dividend and in the same proportions on condition that the same be not paid in cash but be applied in or towards paying up in full unissued shares or debentures of the Company to be allotted and distributed credited as fully paid up to and amongst such Members in the proportion aforesaid, and the Directors shall give effect to such resolution.

100. Whenever such a resolution as aforesaid shall have been passed the Directors shall make all appropriations and application of the undivided profits resolved to be capitalized thereby, and all allotments and issues of fully paid shares or debentures, if any, and generally shall do all acts and things required to give effect thereto, with full power to the Directors to make such provision by the issue of fractional certificates or by payment in cash or otherwise as they think fit for the case of shares or debentures becoming distributable in fractions and also to authorise any person to enter on behalf of all the Members entitled thereto into an agreement with the Company providing for the allotment to them respectively, credited as fully paid up, of any further shares or debentures to which they may be entitled upon such

capitalisation, and any agreement made under such authority shall be effective and binding on all such Members.

ACCOUNTS

101. The Directors shall cause to be kept proper books of accounts as required under Section 230 and the books of accounts shall be kept at the registered Office of the Company or at such other places as the Directors shall think fit and shall be open to inspection by the Directors during business hours. The Directors shall, from time to time, determine whether and to what extent and at what time and places and under what conditions or regulations the accounts and books or papers of the Company or any of them shall be open to inspection of the Members not being Directors and Member or Members (not being Director(s)) shall not have any right of inspecting any account and books or papers of the Company except as conferred by law or authorized by the Directors or by the Company in the general meeting.

102. The Directors shall, as required by Sections 233 and 236, cause to be prepared and to be held before the Company in the general meeting such profit and loss accounts or income and expenditure accounts and balance sheets duly audited and reports as are referred to in those sections. A balance sheet, profit and loss account, income and expenditure account and other reports referred to above shall be made out every year and laid before the Company in the annual general meeting made upto a date not more than four months before such meeting. The balance sheet and profit and loss account or income and expenditure account shall be accompanied by a report of the auditors of the Company and the report of the Directors. A copy of the balance sheet and profit and loss account or income and expenditure account and reports of the Directors and auditors shall, at least 21 (twenty-one) days preceding the meeting, be sent to the persons entitled to receive notices of general meetings in the manner in which notices are to be given. The Directors shall comply with the provisions of Sections 230 and 236.

AUDITORS

103. Auditors shall be appointed and their duties, regulated in accordance with Sections 252 and 255 of the Ordinance. The Company shall at each annual general meeting

appoint an auditor to hold office from the conclusion of that meeting until the conclusion of the next annual general meeting.

NOTICE

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

105. (1) Notice of every general meeting shall be given in some manner hereinbefore authorised to (a) every Member except those Members who (having no registered address within Pakistan) have not supplied to the Company an address within Pakistan for the giving of notices to them, (b) every person entitled to a share in consequence of the death or insolvency of a Member, who but for his death or insolvency would be entitled to receive, notice of the meeting, and (c) the auditors of the Company.

(2) If a Member has no registered address in Pakistan, and has not supplied to the Company an address within Pakistan for the giving of notices to him, a notice addressed to him or to the Members generally and advertised in a newspaper circulating in the neighbourhood of the registered office of the Company shall be deemed to be duly given to him on the day on which the advertisement appears.

(3) 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.

(4) A notice may be given by the Company to persons entitled to a share in consequence of the death or insolvency of a Member by sending it through the post in a prepaid letter addressed to them by name, or by the title of representatives of the deceased, or assignee of the insolvent or by any like description, at the address (if any) in Pakistan supplied for the purpose by the person claiming to be so entitled, or (until such an address has been so supplied) by giving the notice in any manner in which the same might have been given if the death or insolvency had not occurred.

WINDING UP

106. If the Company is wound up, the liquidator may, with the sanction of a Special Resolution of the Company 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.

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

108. The liquidator may, with the like sanction, vest the whole or any part of such assets in trustees upon such trusts for the benefit of the contributories as the liquidator, with the like sanction, thinks fit, but so that no Member shall be compelled to accept any shares or other securities where-on there is any liability.

SECRECY

109. Save as otherwise provided in the Ordinance no Member or other person (not being a Director) shall be entitled to visit and inspect any of the Company's premises or properties of the Company without the permission of the Directors of the Company for the time being or any person authorised in this behalf by the Directors or to require discovery of or 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 process or of any matter whatsoever which may relate to the conduct of the business of the Company and which in the opinion of the Directors will be inexpedient in the interest of the Members of the Company to communicate to the public.

INDEMNITY

110. The Chief Executive, Directors, Auditor, Secretary, Chief Accountant, Legal Advisor or other officer of the Company for the time being shall be indemnified out of the funds of the Company from all suits, proceedings, cost charges, losses,

damages and expenses which any one may incur by reason of any act done or committed to be done for and on behalf of the Company.

DISPUTE RESOLUTION

111. In the event that a dispute, claim or controversy arises between the Company, it's management or its shareholders, or between the shareholders inter se, or the directors inter se, all steps may be taken to settle the dispute and resolve the issue through mediation by an accredited mediator before taking recourse to formal dispute resolution such as arbitration or litigation.

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

Name and surname	CNIC No / NICOP No / Passport No.	Father's / Husband's Name in full	Nationality	Occupation	Residential Address	Number of shares taken by each subscriber	Signatures
NORINCO INTERNATIONAL COOPERATION LIMITED through its authorised representative Wang Xinqing, holder of Passport No. PE0575302	-		Chinese	-	Room 301-302, Floor 3, Building 47, Block 12, No.188 South-Fourth-Ring West Road, Fengtai District, Beijing, Peoples Republic of China	89,997 (Eighty Nine Thousand Nine Hundred Ninety Seven) ordinary shares of PKR 10/- (Pak Rupees Ten) each	
AN ENERGY (PRIVATE) LIMITED through its authorised representative Asad Alam Niazi, holder of CNIC No. 61101-3375696-9	-		Pakistani		Suite # 201, 2nd Floor, Horizon Vista, Plot Number Commercial-10, Scheme 05, Block 04, Clifton, Karachi, Pakistan	9,999 (Nine Thousand Nine Hundred Ninety Nine) ordinary shares of PKR 10/- (Pak Rupees Ten) each	
WANG XINQING	PE0575302	Wang Xiaowu	Chinese	Vice President, Norinco Intl Cooperation Limited.	Norinco International Plaza, No. 6, Zhengda Road, Shijingshan District, Beijing, Peoples Republic of China	1 (One) ordinary share of PKR 10/- (Pak Rupees Ten) each	
WU XIAOCHUAN	PE0026777	Wu Mingshun	Chinese	Engineer	Floor 22, Fanglinyuan, No. 5, Zifang Road, Chaoyang District, Beijing, Peoples Republic of China	1 (One) ordinary share of PKR 10/- (Pak Rupees Ten) each	
LIU ZHEN	PE0023582	Liu Yusong	Chinese	Project Manager	Norinco International Plaza, No. 6, Zhengda Road, Shijingshan District, Beijing, Peoples Republic of China	1 (One) ordinary share of PKR 10/- (Pak Rupees Ten) each	

ASAD ALAM NIAZI	61101-3375696-9	Tassaduq Hussain Niazi	Pakistani	Businessman	House No. 331, Street No. 68, Sector F-11/1, Islamabad.	1 (One) ordinary share of PKR 10/- (Pak Rupees Ten) each	
			Total number of shares to be taken			100,000 (One Hundred Thousand) ordinary shares of PKR 10/- (Pak Rupees Ten) each	

Dated: The 25th day of January, 2016

Witness to the above signatures:

NIFT (Address: 5TH FLOOR AWT PLAZA, I.I. CHUNDRIGAR ROAD, KARACHI 74000)

Certified to be True Copy

Deputy Registrar of Companies

21/4/17

NORINCO Intl Thatta Power
北方国际萨塔电力

5th MAY 2017

To,
Registrar,
National Electric Regulatory Authority (NEPRA)
Islamabad.

Subject: Submission of Application.

Dear Sir,

With reference to Generation License application and Schedule iii point No. 8

1. Project Cost USD$ 119,630,548.47
2. Sources and amount of equity and debt. The Export-Import Bank of China ("EXIM BANK")
   Industrial and Commercial Bank of China ("ICBC")
   Bank of China ("BOC")
   USD$ 35,889,164.54(Equity)
   USD$ 83,741,383.93(Debt)

Your kind consideration in this regards will be highly appreciated

Warm Regards

Asad Alam Niazi
Director & COO

NITPPL
Norinco International Thatta Power (Private) Limited

NORINCO International Thatta Power (PVT.) Limited 北方国际萨塔电力有限公司
Suite No. 201, 2nd Floor, Horizon Vista, Block 4, Clifton, Karachi, Pakistan
UAN: +92-21-111-111-275 PABX: +92-21-35371833-34 Fax: +92-21-35371836 Email: norinco-power@qq.com

NO. DAE/Wind/77-B/2015
GOVERNMENT OF SINDH
Directorate of Alternative Energy
ENERGY DEPARTMENT
Karachi, dated 20th April, 2015

Ph: 021-99206449

Mr. Wang YueTao,
President ,
Norinco International Cooperation Ltd.
C/O Mr. Asad Alam Khan
101,Horizon Vista, Plot # Commercial -10
Block-4 scheme 5, Clifton Karachi.

Subject: **LETTER OF INTENT (LOI) FOR 50 MW THATTA WIND FARM-II PROJECT**

Reference: your letter/proposal dated nil.

In pursuance of the Policy for Development of Renewable Energy for Power Generation 2006 ("Policy"), implemented by Govt. of Sindh under clause 32 of schedule II, Sindh Govt. Rules of Business 1986, the Directorate of Alternative Energy, Energy Department Govt. of Sindh, (DAE, GoS) hereby confirm its interest in your proposal for establishing an approximately 50MW Wind Power Generation Project in wind corridor Thatta. The sponsors may approach the Land Utilization (LU) Department, through Energy Department Government of Sindh for acquisition of land. DAE GoS shall facilitate the sponsors for acquisition of land for project development. DAE GoS acknowledges receipt of Bank Guarantee NO. **LG288011500099** issued on dated 17th April,2015, in the sum of USD25,000/(USD Twenty Five thousand only) from Industrial Commercial Bank of China, Karachi, Branch for the issuance of Letter of Intent ("LOI") **NO.DAE/Wind/77-B/2015/11**.

2. The Sponsor(s) is required to complete the feasibility study and achieve the milestones listed at the Annex-I to this LOI ("LOI Milestones") for the subject project, at no risk and at no cost to, and without any obligation on the part of the DAE Energy Department Government of Sindh or any other Provincial (Sindh) agency, within a period of 18 Months from the date of issuance of this LOI.

3. The Sponsor(s) is required to carry out and complete the feasibility study in accordance with internationally acceptable standards and in accordance with the terms and conditions stipulated in the Policy and this LOI. The feasibility study must include, inter alia, micro-siting details, detailed power production estimates based on wind speed benchmarks set by DAE GoS/GoP , soil tests reports, technical details pertaining to wind turbines to be used in the wind farm, electrical studies (including but not limited to short-circuit study, power quality study, load flow study and stability study), environmental study, project costing, financing plan, carbon credits, financing terms, tariff calculations and assumptions for financial calculations including economic/financial analysis. The Sponsor is also advised to liaise with Panel of Expert (POE), constituted by DAE,GoS. and the power purchaser while determining the site, project layout, sub-station design and layout, the transmission line, interconnection arrangements and other related matters.

EXTENTION LETTER Encls

Verified 3 Pages
NORINCO INT. THATTA POWER (PVT) LTD.

4. The validity of this LOI is Eighteen (18) calendar months from the date of its issue, where after it will automatically lapse immediately (unless extended pursuant to clause 5 or 6), being the **19th October,2016** (the "**Expiry Date**"). Issuance of this LOI or the lapsing of its validity, or your conducting a feasibility study there under, cannot form the basis of any claim for compensation or damages by the Sponsor(s) or the project company or any party claiming through or under them against the Government of Sindh or any of its allied department, employees or consultants on any grounds whatsoever, during or after the expiry of the validity of the LOI.

5. The Sponsor(s) is therefore required to complete the feasibility study and achieve the LOI Milestones for the subject project within the validity of this LOI. The Sponsor(s) is also required to submit quarterly progress reports to be reviewed by Panel of Experts (POE). Provided the Sponsor(s) meets the LOI Milestones on the stated dates, the expiry date of this LOI shall be extended on a day-to-day basis for the number of days of delay by which the approval or review by the relevant public sector entity listed in the LOI Milestones is delayed beyond the corresponding period stated in the LOI Milestones. In case there is a delay in completion of the feasibility study within the validity of this LOI for reasons not attributable to a public sector entity, a one-time extension may be granted up to a maximum period of 180 days, provided that DAE GoS is satisfied that the feasibility study is being conducted in a satisfactory manner and is likely to be completed shortly, and provided the Sponsor(s) enhance the amount of the bank guarantee to twice its original amount and extend its validity for a period six (6) months beyond the extended date of the LOI. Furthermore, if the said feasibility study is technically approved by the Panel of Experts and later the tariff awarded by NEPRA is not agreed by the Sponsor(s) (such decision to be made within 30 days of the award of the tariff, and in any event within the validity of the LOI), the bank guarantee less 10% deduction for administrative and ancillary charges, would be returned to the Sponsor(s).

6. The Sponsor(s) shall apply to NEPRA for award of tariff within the period of validity of this LOI. Upon tariff being given, the Sponsor(s) shall forthwith submit a new Performance Guarantee in the sum of **USD125,000/** (One Hundred Twenty Five thousand US dollars) (subject to revision from time to time) and obtain the Letter of Support (Tripartite i.e. AEDB for GoP, Energy Department for GoS and Project Company) from DAE GoS within the validity period of this LOI, provided, if the award of the tariff is delayed beyond the initial validity of the LOI, the Sponsor(s) shall extend the bank guarantee for a further period of six (6) months (or such period as may be determined by DAE GoS in the circumstances) and the validity of this LOI shall be extended *ipso facto* for a further period of six (6) months, and the Sponsor(s) shall obtain the Letter of Support and submit the Performance Guarantee within the extended period afore-said. For avoidance of doubt, the afore-said extension process may be repeated if the tariff is not announced (including any review petition filed by the Sponsor(s), such review (if any) to be filed within the period prescribed in the NEPRA (Tariff Procedures and Standards) Rules up to fifteen (15) days before the then prevailing Expiry Date.

7. In case the Sponsor(s) fails to meet the LOI Milestones or perform any other obligations set forth in the Policy and this LOI, including the extension of the date of expiry of bank guarantee as provided herein, DAE GoS will terminate this LOI and encash the bank guarantee.

Verified

NORINCO INT THATTA POWER (PVT.) LTD.

8. (A) Pending the nomination of the Main Sponsor per sub-clause (B), the **M/S Norinco International Cooperation Ltd.** *(being the individual or group holding at least 20% equity or participatory interest in the IPP project)* is liable for all obligations and liabilities of and on behalf of all other shareholders/ Sponsor(s) (without relieving the other shareholders/Sponsor(s) of their obligations and liabilities under this LOI). It is emphasized that the financial and other relevant credentials of **M/S Norinco International Cooperation Ltd.** were a fundamental consideration for exercise of its shareholding (or other participatory interest, if the project company is not formed by the date of issue of the LOI) in the project or the project company without the prior written approval of DAE, Energy Department GoS, which approval may be declined by DAE, Energy Department GoS in its discretion if the proposed transferee's financial and other relevant credentials are found unsatisfactory.

(B) The Sponsor(s) is advised to nominate the Main Sponsor (being the individual or group holding at least 20% equity or participatory interest in the IPP project) no later than the Expiry Date of the LOI. In default of nomination as aforesaid, the **M/S Norinco International Cooperation Ltd** will be deemed the Main Sponsor for all intents and purposes. The Main Sponsor together with other initial project shareholders/Sponsor(s) (which shall, subject in each case to sub-clause (A) above, by firmly settled and announced to DAE GoS by the Expiry Date of the LOI), must hold 51% of the project equity for a period up to the project's Commercial Operations Date (COD).

(C) Any actual or purported transfer or assignment of the shares or other participatory interests by the Sponsor(s) / shareholders in contravention of the foregoing restrictions without prior written consent of the DAE GoS shall render this LOI void and the bank guarantee will be encashed in such case by DAE GoS.

9. This LOI is not assignable and non-transferable. This LOI shall be void upon any actual or purported assignment or transfer hereof without the prior written consent of DAE GoS.

10. This LOI is issued in duplicate on the date hereof, and it shall come into effect when one copy is received by DAE, Energy Department GoS. after being duly countersigned by you. Nevertheless, this LOI shall lapse if the countersigned copy is not received at DAE within 15 days of its issuance.

Agreed & Accepted for and on behalf
M/S Norinco International Cooperation Ltd

20-04-2015

Engr. Mehfooz Ahmed Qazi)
Director Alternative Energy
DAE, Energy Department
Government of Sindh

DIRECTOR
Directorate of Alternative Energy
Energy Department, Govt. of Sindh

Verified
NORINCO INT. THATTA POWER (PVT) LTD.

Ph: 021-99206449

NO. DAE/Wind/77/2015
GOVERNMENT OF SINDH
Directorate of Alternative Energy
ENERGY DEPARTMENT
Karachi, dated December 2, 2016

SAY NO TO CORRUPTION

Mr. Wang YueTao,
President ,
Norinco International Cooperation Ltd.
C/o Mr. Asad Alam Khan
101, Horizon Vista, Plot # Commercial-10
Block-4, Scheme-5, Clifton Karachi

SUB: **EXTENSION IN THE VALIDITY PERIOD OF LETTER OF INTENT (LOI NO.DAE/WIND/77-B/2015/10 DATED 20TH APRIL 2015) ISSUED TO M/S NORINCO INTERNATIONAL THATTA POWER (PVT.) LIMITED (NITPPL) FOR THE DEVELOPMENT OF 50MW WIND POWER PROJECT** .

Reference is made to your request vide letter No. Nil dated 18th October 2016 regarding subject matter.

2. Directorate of Alternative Energy, Energy Department, Govt. of Sindh is pleased to convey the extension in the validity period of LOI No.DAE/Wind/77-B/2015/10 dated 20th April 2015 for the development of 50MW Wind Power Project at Jhimpir wind corridor Thatta, Sindh upto **10-07-2017**.

3. All other terms and conditions of LOI No.DAE/Wind/77-B/2015/10 dated 20th April 2015 shall remain same.

(ENGR. MEHFOOZ AHMED QAZI)
Director (Alternative Energy)

Copy for information to:

i) Secretary, Land Utilization Department, Govt. of Sindh
ii) Registrar, NEPRA, Islamabad
iii) CEO, Alternative Energy Development Board, Islamabad
iv) CEO, CPPA, Islamabad
v) GM Planning (Power), NTDC, Lahore
vi) PS to Secretary, Energy Department, Govt. of Sindh

Verified
NORINCO INT. THATTA POWER (PVT) LTD.

15age

Part 9

Prospectus

Introduction of Norinco International Thatta Power (PVT.) Limited

1 Norinco International Thatta Power (PVT.) Limited ("Norinco -2" or "Project Company") is a Pakistan based company with the sole objective of developing, financing, building and operating Norinco International 50MW Wind Power Project in Jhampir, Karachi, Pakistan (the "Project"). The Project is being pursued under the terms of a Letter of Intent ("LOI") issued by DAE in 2015.

2 Sponsor

The Sponsor for Norinco International 2x50MW Wind Power Project is two shareholder of the Project Company, NORINCO INTERNATIONAL COOPERATION LTD, a company incorporated under the laws of PRC, with company number 110000010706353 and having its registered address at Room 301 & 302, 3/F, Building 47, Block 12, No.188, South Sihuan West Road Fengtai District, Beijing, PRC and AN ENERGY (PYT.) LIMITED, a company incorporated under the laws of Pakistan, with company number 0092884 and having its registered office at Suit # 201, 2nd Floor, Horizon Vista, Plot Number Commercial-10, Scheme 05, Block 04, Clifton, Karachi, Pakistan ("AEPT"). The Equity of the total investment will be financed by the two shareholders. And the Debt of the total investment will be financed by commercial Bank, ie. ICBC Karachi, Bank of China (BOC) or China Exim Bank.

It is to be noted that the company had applied for (2x50) wind form project and LOIs have been issued with proper segregation. We have review generation license for 1st phase of 50MW wind power and now we are applying for the 2X50MW project. This project may generation license for Please be read as NORINCO-2.

3 The Site

Norinco International Thatta Power (PVT.) Limited has acquired land around 2500 acres for the Project Company's Norinco International 50MW Wind Power Project, located at Jhampir in Sindh Province of Pakistan, about 110km northeast away from Karachi and 80km northeast away from Port Qasim, with geographical coordinates of 68°0'4"~68°3'55" E and 25°5'23"~25°8'4" N. The project area stretches in nearly northwest-southeast direction, with a length of about 6.7km and a width of 1.6km. The elevation of the project area is 40m~60m. The site was selected after going through various technical studies of terrain and assessment of wind.

[redacted]

Geo-technical study has been carried out on the Project Site. Soil conditions were found to be favorable for road construction and for installing underground facilities such as wind turbine foundations etc. The bearing capacity is high and stable. A comprehensive Geo-technical study will be conducted under the supervision of EPC Contractor.

4 Onshore and Offshore Contractor, O&M Contractor

M/S Norinco International Cooperation Limited, a company incorporated under thelaws of the People's Republic of China, as the onshore Contractor, shall execute the Onshore Works of civil construction for Norinco International Thatta 50MW Wind Power

M/S GLORY TOWN HOLDINGS LIMITED, a company incorporated under the laws of Hong Kong, the People's Republic of China, as the offshore Contractor, shall execute the offshore work of procuring and suppling the Equipment and materials for the execution of Norinco International Thatta50MW Wind Power Project.

Norinco International Thatta Power (PVT.) Limited will establish its own O &M team after the commercial operation.

The key features of WTG procured by M/S GLORY TOWN HOLDINGS LIMITED fromM/SGold Wind Tech. are shown in the following table.

Type of WTG	GW121-2.5MW
Height of Hub	90m
Diameter of blade	121m
Number of blade	3
Capacity	2.5MW

5 Wind Assessment

Based on the calculation and analysis of wind resource, the main wind direction of

Thatta wind farm is basically consistent with that of the main wind energy, and west-southwest (WSW) and west (S) winds have the maximum speed, power and frequency, with the prevailing wind in a direction stable. There is no destructive wind speed in Thatta wind farm, the wind quality is good, the prevailing wind direction is stable, enjoying good wind energy resources. Therefore, Thatta wind farm boasts a desirable site for wind power development.

6 Environmental Studies

As per the requirements of Section 12 of Pakistan Environmental Protection Act (PEPA), 1997, Project Company has completed the Initial Environmental Examination ("IEE") report for the Project. The Project is not likely to have any significant adverse environmental impacts, which could be irreversible or could affect sensitive eco-system, requires involuntary resettlement, or has an unprecedented impact. The Project has no gaseous and other emissions. Sewerage will be treated and reused at the Project Site for sprinkling on the unpaved site to reduce fugitive dust. The Project is also not located in the vicinity of sensitive location of national importance. Therefore Project falls under Category "B" according to "Pakistan Environmental Protection Agency, Review ofIEE & EIA Regulations 1997/2000 (revised)". Sindh Environmental Protection Agency has issuedNo Objection Certificate ("NOC") to the Project Company on March 4, 2016.

7 Social Responsibility

The Sponsors of Project Company always regard corporate social responsibility as an important force in building a harmonious society. They also believe in paying full attention to human factors, exercising environmental protections and conservation, increasing employment, and helping build the community. Every year they support numerous educational, sporting, and charity programs designed to help a wide range of people. Operations of the Plant will provide job opportunities especially to the local people. Poverty alleviation, though at minor scale, will be another benefit besides meeting power shortage in Pakistan.

8 Project Agreements

Project Company will sign;

(1). Implementation Agreement with the Government of Pakistan through Alternative Energy Development Board

(2)Energy Purchase Agreement with National Transmission And Dispatch Company Limited (through its Central Power Purchasing Agency on behalf of ex-WAPDA Distribution Companies)

9 Financing

Total Project Cost, expressed in United States Dollars, has been calculated after thorough analyses,evaluation, and understanding of the dynamics that affects the development, construction, andoperations of a wind farm in Pakistan.

The Project cost will be financed by a combination of loan and equity. Maximum Loan Equity ratiofor the Project is assumed as 70%:30%.

Equity: Sponsorhave lined up the required equity for the Project. Norinco International and AN Energy (Pvt.) Ltd will contributed 100% of the required equity.

Loan: Project Company is negotiating loan for the Project with ICBC Karachi, Bank of China and China Exim Bank and will arrange 100% financing for the Project.

10 Tariff

Project Company is filing Upfront Tariff petition with NEPRA separately.

11 Timeline

Tentative financial close date of the Project is August 31st, 2018 and construction will start 31st December 2017 Under the terms of the Contract, construction will be completed in 18 months andCommercial Operations Date ("COD") is June 30, 2019.

12 Contact Details

Asad Alam Niazi
Director and COO
Norinco International Thatta Power (PVT.) Limited
Suite No. 201, 2nd Floor, Horizon Vista, Block 4, Clifton, Karachi, Pakistan.
Direct: +92 2135371189
Fax: +92 2135371836

Part 10
Summary of Plant Details

NORINCO INTERNATIONAL THATTA POWER (PRIVATE) LIMITED
Suite No. 201, 2nd Floor, Horizon Vista, Block 4, Clifton, Karachi, Pakistan
Direct: +92-2-35371189 Fax:+92-21-35371836 Email: norinco-power@qq.com

Summary of Plant details

Regulations 3(5), 3(6), and Schedule III of the National Electric Power RegulatoryAuthority Licensing (Application and Modification Procedure) Regulations, 1999.

Name of Applicant:	Norinco International Thatta Power (PVT.) Limited
Registered Office	Suite No. 201, 2nd Floor, Horizon Vista, Block 4, Clifton, Karachi, Pakistan Director: +92-2-35371189 Fax:+92-21-35371836
Business Office:	Suite No. 201, 2nd Floor, Horizon Vista, Block 4, Clifton, Karachi, Pakistan Director: +92-2-35371189 Fax:+92-21-35371836
Plants Location:	Jhampir, Thatta District, Karachi, Sindh, Pakistan
Type of Facility	Wind
Proposed Buyer	National Transmission And Dispatch Company Limited (through its Central Power Purchasing Agency on behalf of ex-WAPDA Distribution Companies)
Plant Configuration a) Plant Size b) De-rated Capacity(on account of Air density, humidity, temperature, wake effect, wind direction, rain etc) c) Auxiliary Consumption d) Total Net Capacity e) Type of Technology f) Number of Unit g) Unit Size h) Unit Make and Model i) Commissioning Date j) Expected life of the Projectfrom COD	 50WM 46MW 1MW 45MW Wind 20 2.5MW each Gold Wind Tech. GW121/2.5MW April 30,2019 25-year
Plant Characteristics	
a) Generation Voltage	690V at generator terminal and 132kV at the point of interconnection with the grid
b) Power Factor	0.95 lagging/leading at turbine output. 0.95 lagging/ leading at interconnection point.
c) AGC (Automatic Generation Control/ AVR (Automatic Voltage)	Not applicable
d) Ramping Rate	Not applicable
e) Alternate Fuel	Not applicable
f) Auxiliary Consumption	1MW
g) Time to Synchronize	As per NTDC's approved specifications
Proposed Tariff	Upfront Tariff

Note: All the above figures are indicative. The Net Capacity available to NTC for dispatch and provision to purchase will be determined through procedures contained in the Agreements or Grid Code.

NORINCO INTERNATIONAL THATTA POWER (PRIVATE) LIMITED
Suite No. 201, 2nd Floor, Horizon Vista, Block 4, Clifton, Karachi, Pakistan
Direct: +92-2-35371189 Fax:+92-21-35371836 Email: norinco-power@qq.com

NATIONAL TRANSMISSION & DESPATCH CO. LTD (NTDC)

General Manager Planning Power, NTDC

No. GMPP/CEMP/TRP-380/1702-06 Dated: 03-04-2017

Chief Executive Officer CPPA(G) Ltd.
Shaheed-e-Millat Secretariat,
6th Floor, Jinnah Avenue,
Blue Area, Islamabad.
Fax#:051-9213616

Sub: **Approval of Grid Interconnection Study Report of 50 MW Norinco-2 Wind Power Project by M/s Norinco International Thatta Power (Pvt) Limited-2 (NITPPL-2) at Jhimpir Thatta Sindh**

Ref: CPPA-G letter No. CPPA(G)L/CEO/DGMT-II/MT-V/NITPPL-2/18105-06 dated 21-03-2017.

This office has received the final grid interconnection study report of the subject Norinco-2 WPP vide above referred letter. After review of the report, it was found that most of our comments communicated previously vide our letter No. GMPP/CEMP/TRP-380/5177-82 dated 02-12-2016 had been incorporated in the subject report. Therefore, the grid interconnection study report of Norinco-2 WPP is approved at NTDC end as per assumptions and study results presented in the report.

It is intimated that the Grid Code Addendum for Wind Power Projects is being updated at present and after its approval from NEPRA, the developers of the subject wind power project will be required to follow/implement the requirements/recommendations as given in the Grid Code Addendum for Wind Power Projects. It is added that during EPA, if there is any major change in the parameters of the subject Norinco-2 WPP as used in the subject grid interconnection study, then relevant studies will have to be revised.

It is also important to intimate that the subject report has been approved only for power evacuation/ interconnectivity aspects of the subject Norinco-2 WPP. Moreover, there may be some modification in the interconnection arrangement of the subject WPP depending on variation in its COD as well as other power plants in the area. Any commitment regarding project execution or for any other purpose should be discussed with CPPA(G) and relevant departments of NTDC/HESCO. Moreover, the comments of HESCO on the subject report may be obtained.

3/4/17

(Maqsood Ahmad Qureshi)
General Manager Planning Power

cc:
- Chief Executive Officer, HESCO
- General Manager (Services Division) NTDC
- Director & COO Norinco International Thatta Power (Pvt) Limted-2 (NITPPL-2), Suit No 201, 2nd Floor, Horizon Vista Block 4,, Clifton, Karachi, Pakistan.
- M/s PPI, 64-F/1 Wapda Town, Lahore.
- *Master File (MP)*

Total Pages 339

Verified
NORINCO INT. THATTA POWER (PVT) LTD.

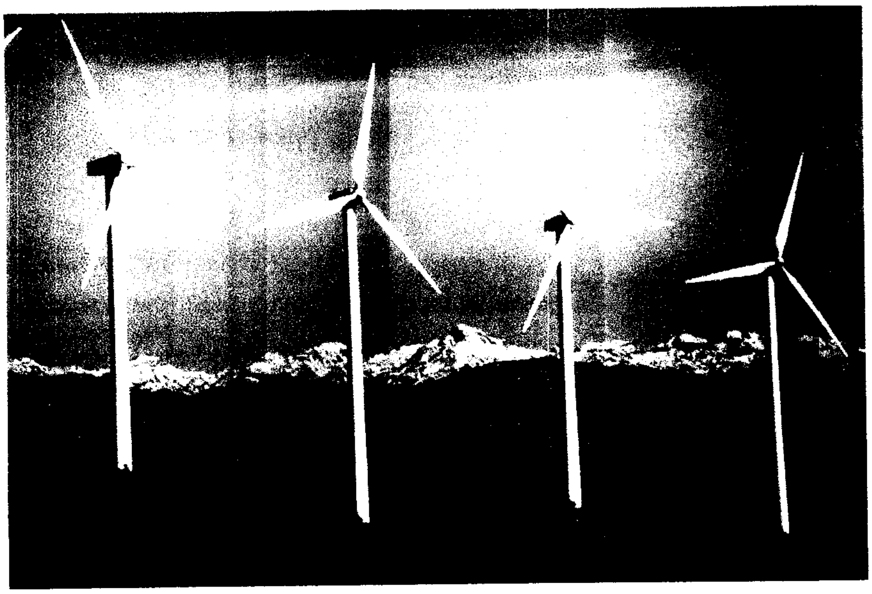
4th Floor, PIA Tower, Egerton Road, Lahore| TEL:+92-42 99202613, Fax: +92 42 36307738 gmpp@ntdc.com.pk

Report No. PPI-217.2-Final-Norinco-2/17

ELECTRICAL GRID STUDIES

For

50 MW Wind Power Plant by Norinco International Thatta Power (Pvt.) Limited



Final Report
(March 2017)

UK OFFICE

3- Sylvester Road,
Sudbury Town, Middlesex
HAO 3AQ U.K.
Ph. No. +44-208-9223219
Fax +44-208-9220657

PAKISTAN OFFICE

64-F1, Wapda Town, Lahore
Ph. Nos. +92-42-35182835
+92-42-35224247
Fax +92-42-35183166

Email: info@powerplannersint.com
Website: www.powerplannersint.com

Executive Summary

- The study objective, approach and methodology have been described and the plant's data received from the client Norinco International Thatta Power (Pvt.) Limited has been validated.
- The wind project by Norinco International Thatta Power (Pvt.) Limited, referred to as Norinco-2 WPP in the remainder of the report, is expected to start commercial operation by summer 2019. Therefore, the scenario of August/September 2019 has been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load forecast provided by NTDC has been used for the study, attached in Appendix – 2, vide data permission letter no. GMPP/CEMP/TRP-380/3416-18 dated 17-08-2016.
- Recently a study of 10 WPPs was carried out by NTDCL planning department to fill the power capacity vacated by NBT Wind Power Pakistan II & III. A new 220kV grid station with the name of Jhimpir-2 was proposed which was connected by loop in-loop out configuration of Jamshoro – KDA 220kV single circuit and Jhimpir-1 – Gharo 220kV single circuit. This study is carried out for 15 new WPPs in integration with the already planned WPPs and other upcoming WPPs in its vicinity.
- Out of these 15 WPPs, 9 plants which lie in the southern part of Jhimpir namely Indus, Lakeside, DHA City, Noor, Metro-2, Iran Pak, Nasda, Uni-energy and Shafi Energy WPPs, are proposed to be connected to the newly proposed Jhimpir-2 220/132kV Grid station. Since the site of Jhimpir-2 220/132kV grid station has recently been finalized hence a site visit was carried out on 25th January 2017 along with NTDC official to verify the distances of the upcoming 220kV circuits emanating from this grid station. Moreover sites of the above mentioned 9 WPPs were also visited to develop technically correct as well as least cost scheme for evacuation of power from these WPPs. Based on the location of the WPPs, two loops (each having 8 WPPs) were proposed at Jhimpir-2 grid station.

The configuration of the new loops is shown in Appendix-4 and the list of WPPs in each loop is provided below:

First Loop: Lakeside, Nasda, Trans-Atlantic, Uni-Energy, Iran Pak, Artistic, Act-2 and Cacho WPPs

Second Loop: Indus, Gul Ahmed, Metro-2, Zulaikha, Din Energy, Noor, Shafi Energy and DHA-City WPPs

- Sites of 3 plants out of these 15 WPPs which lie in the northern part of Jhimpir namely Norinco-2, Sinowell and Tricom WPPs were also visited and they are proposed to be connected via loop in-loop out of upcoming Jhimpir-1 - T.M Khan 132kV single circuit. Similarly Burj WPP is proposed to be connected via loop in-loop out of Thatta – FWEL-I 132kV S/C and Master Green WPP which is located in Jamshoro district is proposed to be connected by loop in-loop out configuration of the newly proposed Nooriabad - Jamshoro old 132kV single circuit. Lastly, Lootah Energy WPP is proposed to be connected via loop in-loop out of upcoming Jhimpir-1 – Tricon-A 132kV S/C
- Norinco-2 WPP which is the plant under study, has been placed in the loop at 220/132kV Jhimpir-1 grid station. Norinco-2 Wind Power Plant would be connected by a double circuit of 132 kV by looping in-out configuration of the one circuit of Jhimpir-1 – T.M.Khan along with Tricom WPP and Sinowell WPP. It should be noted that the length of circuits used for the simulations are confirmed from site visit and agreed with NTDC official. They may change slightly during the implementation of the project. In addition, the connectivity of Norinco-2 WPP with neighboring wind power plants may change, depending upon the COD of the project.
- The scheme of interconnection of these 15 new WPPs including Norinco-2 WPP proposes the following reinforcements in place at Jhimpir cluster.
  - 220 kV D/C transmission line approx. 5km long on twin bundled Greeley conductor looping In/out of second circuit of existing Jamshoro – KDA-33 D/C transmission line at the proposed Jhimpir-2 220/132 kV substation

- Addition of 4th 220/132 kV transformer at the newly proposed Jhimpir-2 220/132 kV substation.
- 132kV double circuit transmission line approx. 135 km long on twin bundled Greeley conductor for connecting 8 WPPs in the first loop to Jhimpir-2 220/132 newly proposed substation.
- 132kV double circuit transmission line approx. 168 km long on twin bundled Greeley conductor for connecting 8 WPPs in the second loop to Jhimpir-2 220/132 newly proposed substation.
- In this Integrated study, the interconnection of Norinco-2 WPP includes 132 kV D/C transmission line approx. 1 km long, on Greeley conductor for looping in/out on the 132kV single circuit from Jhimpir-1 to TRICOM WPP grid station.

➢ The existing grid system of HESCO and NTDC in the vicinity of Norinco-2 WPP has been studied in detail by performing load flow, short circuit and dynamic analysis for the conditions prior to commissioning of Norinco-2 WPP and no bottlenecks or constraints have been found in the grid system.

➢ Wind Farm of Norinco-2 WPP has been modeled considering Type-4 WTGs. The terminal voltage is 0.69 kV. The medium voltage level of wind farm has been selected as 33 kV for unit step-up transformers, for collector circuits and step-up from MV to HV (132 kV) at Farm substation to connect to the Jhimpir-2 220/132 kV grid station of NTDC.

➢ The design of scheme of 132/33 kV substation of Norinco-2 Wind Farm has been provided by the Client and is attached in Appendix – 2.

➢ Load flow analysis has been carried out for peak and Off Peak scenarios of August/September 2019 considering the COD targeted by Norinco-2 WPP and a future scenario of 2022, for the dispersal of power from Norinco-2 WPP into NTDC system using the latest load forecast, generation and transmission expansion plans of NTDC and HESCO. The above mentioned interconnection scheme 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. All the scenarios have been studied by considering maximum dispatch from all the existing/planned WPPs in the Jhimpir and Gharo Clusters.

- For the base case of summer 2019, capacity constraint was observed in 500kV network emanating from Jamshoro and upwards in case of some critical outages of 500kV circuits. Due to this capacity constraint, partial curtailment in the output of all WPPs under study was proposed to bring the loading on the 500kV network within limit. Hence output of Norinco-2 WPP is curtailed to 7 MW in case of some contingency events. For the future scenario of 2022, this issue of capacity constraint is resolved due to the following major reinforcements:
  - 660kV HVDC from Matiari to Lahore
  - 660kV HVDC from Port Qasim to Faisalabad West
- With the proposed reinforcements highlighted earlier and the curtailment process for the base year of 2019 under special circumstances, the load flow results for peak and Off Peak scenarios establish that the proposed scheme of interconnection of Norinco-2 WPP shows no bottlenecks or capacity constraints in the adjoining 500 kV, 220 kV and 132 kV network in terms of absorbing all the output of Norinco-2 WPP and other proposed WPPs under normal as well as the contingency conditions.
- Maximum and minimum short circuit levels for three-phase faults and single-phase faults have been evaluated. The maximum SC levels have been evaluated for the year 2022 and minimum short circuit level for the year 2019 for the most stringent conditions. The fault levels of Norinco-2 132 kV are 9.28 kA and 8.01 kA for 3-phase and single phase faults respectively for 2022. This is much less than the switchgear rating of 40 kA recommended for Norinco-2 Farm Substation as per NTDC requirements for 132 kV. The fault levels for Norinco-2 MV 33 kV are 12.94 kA and 13.73 kA for 3-phase and single-phase faults respectively for year 2022.

Therefore the short circuit rating for 33 kV switchgear is recommended as 25 kA. It has been found that the proposed scheme provides maximum SC strength for the evacuation of Norinco-2 WPP power to the grid.

The switchgear ratings for Norinco-2 WPP substation are as follows:

132 kV:

Short circuit rating = 40 kA (3 sec.)

Continuous rating = 2500 A

33 kV:

Short circuit rating = 25 kA (3 sec.)

Continuous rating = 2500 A

- Transient Stability analysis has been carried out for Norinco-2 WPP based on their selection of Type-4 WTGs, with connectivity of 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 Norinco-2 WTG unit's dynamic characteristics and the grid connectivity is strong enough to maintain stability under all disturbances. In turn, any disturbance from Norinco-2 WPP side did not cause any stress on the main grid or the power plants nearby and in the HESCO area such that the whole system remained stable under all events.
- 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.
- The issues of power quality like flicker, unbalance and harmonic resonance have been studied in detail. The results have indicated that the levels of flicker and unbalance are within the permissible limits of IEC and other International Standards.
- There are no technical constraints whatsoever in the way of bringing in the 50 MW of Norinco-2 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 50,000 MW. There are many entrepreneurs coming forward to tap this huge natural resource of power.

Study of 10 WPPs was recently carried out by NTDCL Planning Department after cancellation of LOIs of NBT-II and NBT-III. New Jhimpir-2 220/132 kV substation was proposed to evacuate power from these WPPs. For further evacuation of power from Jhimpir area, an integrated study was required depicting optimal utilization of resources. Hence a study of 15 new WPPs was carried out in integration with the already planned / existing WPPs. Norinco International Thatta Power (Pvt.) Limited is amongst those entrepreneurs who have come forward with a Wind Power Plant within this cluster at Jhimpir.

The proposed wind farm shall have the installed capacity of about 50 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 Norinco-2 Wind Power Plant on the System
2. Impact of the System on Norinco-2 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 for the spot year of study i.e. 2019. A future scenario of 2022 is also studied.

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 Norinco-2 Wind Power Plant (WPP) with HESCO/NTDC network at 132 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 Norinco-2 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. 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 220 kV and 132 kV voltage levels to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the Medium Voltage substation of collector system of Norinco-2 Wind Farm and the NTDC/HESCO substations of 132 kV connecting with the Norinco-2 Wind Farm.

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 Norinco-2 WPP in response to Grid disturbances and vice versa the dynamic impact of disturbances in Norinco-2 WPP on the Grid.
9. To check the ability of the wind turbine generators of Norinco-2 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
	49.4 - 50.5 Hz, Under Contingency

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.

3. LVRT of 100 ms for normal fault clearing and 180 ms for the case of failure of primary protection (stuck breaker case).

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 Norinco-2 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 input data of HESCO / NTDC has been used in this study as per letter no. GMPP/CEMP/TRP-380/3416-18 dated 17-08-2016. The load forecast and the generation expansion plan of NTDC provided vide this letter has been used as shown in Appendix 2.

The input data regarding Norinco-2 Wind Farm has been provided by the client who has indicated to use 2.5 MW Goldwind GW121/2500 Type-4 WTG. The main parameters of the WTGs have been attached in Appendix-2.

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 required to 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 Power Plants. Next to them is Hub with 1200 MW and Lakhra with 150 MW installed capacities respectively. Apparently this amount of generation in Southern grid seems strong enough to absorb the penetration of wind power. 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 Norinco-2 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. Norinco International Thatta Wind Power (Pvt.) Limited is considering using 2.5 MW Goldwind GW121/2500 Type-4 WTG.

2.2 Approach to the problem

We will apply the following approaches to the problem:

- According to the COD of Norinco-2 WPP as provided by the Client Client Norinco International Thatta Wind Power (Pvt.) Limited, we have decided to perform our analysis for the scenario of August/September 2019 to judge the maximum impact of the plant after the COD of the plant when the 220/132 kV Substation of Jhimpir-2 is commissioned.
- The base case for the year 2019 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 all the proposed and existing Wind Power Plants which have been developed or are going to be developed on a fast track basis and are expected to be commissioned by 2019 as per the latest schedule of AEDB.

- Interconnection scheme 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 load conditions of high wind seasons' power dispatches, to confirm technical feasibility of the interconnections.
- The proposed interconnection scheme will be subjected to steady state analysis (load flow), short circuit and transient stability to test the robustness of the scheme 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 HESCO/NTDC Grid. This sensitivity check can be performed for the ultimate planned number of Wind Power Plants in the neighborhood of Norinco International Thatta Wind Power (Pvt.) Limited.

3. Analysis of Network Prior to Norinco-2 WPP Interconnection

3.1 Description of the Network

The electrical grid, which is relevant for interconnection of Norinco-2 Wind PP, is the 500, 220 and 132 kV network that stretches through South of Hyderabad and Jamshoro up to coastal areas of Southern Sindh. The sketch of this network for the spot year 2019 after the addition of reinforcements in the area is shown in Appendix-4.

In this sketch, all the existing and proposed WPPs in the Jhimpir and Gharo clusters are modeled. Newly proposed 220/132kV substation of Jhimpir-2 is shown connected in loop In-out of the 220 kV Jamshoro – KDA double circuit and Jhimpir-1 – Gharo-New 220 kV single circuit. On 25th January 2017 a site visit was carried out to develop technically correct as well as least cost scheme for evacuation of power from these WPPs. Based on the location of the WPPs, two loops (each having 8 WPPs) were proposed at Jhimpir-2 grid station. The list of WPPs in each loop is provided below:

First Loop:

- Lakeside (50 MW)
- Nasda (50 MW)
- Trans-Atlantic (50 MW)
- Uni-Energy (50 MW)
- Iran Pak (50 MW)
- Artistic (50 MW)
- Act-2 (50 MW)
- Cacho (50 MW)

Second Loop:

- Indus (50 MW)
- Gul Ahmed (50 MW)
- Metro-2 (60 MW)
- Zulaikha (50 MW)

- Din Energy (50 MW)
- Noor (50 MW)
- Shafi Energy (50 MW)
- DHA-City (50 MW)

The details of the other 6 newly proposed WPPs is provided below:

- 14 MW Burj WPP connected via loop In-Out of 132 kV Thatta – FWEL-I single circuit
- Norinco-2 (50 MW), Sino Well (50 MW) and Tricom (50 MW) connected via loop In-out of the 132kV Jhimpir-1 – T.M.Khan 132kV single circuit
- Master Green (50 MW) connected via loop In-out of the proposed Nooriabad – Jamshoro Old 132kV single circuit
- Lootah Energy (50 MW) connected via loop In-out of the upcoming Jhimpir-1 – Tricon-A 132kV single circuit

We have carried out the studies of the case "without" Norinco-2 WPP but including all the other planned and existing WPPs which have COD by 2019 to ascertain if there are any constraints in the system prior to Norinco-2 WPP's commissioning.

3.1.1 Load Forecast

The load forecast of NTDC attached in Appendix-2 has been used for the preparation of all the study scenarios.

3.1.2 Generation and Transmission Expansion Plan

There is a sizable addition of generation in the Southern part of the country. The latest generation and transmission expansion plan provided by NTDCL has been used and is attached in Appendix-2.

3.2 Load Flow Analysis

Load flow analysis has been carried out for the NTDC / HESCO network including all the existing and planned wind power plants at Jhimpir and Gharo clusters but without including Norinco-2 WPP to see if the network was adequate for dispersal of wind power without it. The case has been studied for the system conditions of

August/September 2019. The month has been selected so that the Jhimpir-2 220/132 kV substation is completed before the commissioning of the said WPPs. In order to ensure proper economic dispatch in the southern area for this High Wind High Water Season, it was essential to have a reasonable energy mix with contributions from both thermal and wind power plants. We kept the dispatch of the nearby power plants such as Thatta, Nooriabad and Kotri-Site at its maximum. Kotri GTPS was operated at 50% capacity. Output from all the existing/ under construction/ planned Wind Plants was kept at maximum. The results are shown plotted in Exhibit 3.0 in Appendix-3 which indicates that no circuit is loaded more than its rated power carrying capacity and the voltage profile at all the bus bars of 132 kV, 220 kV and 500 kV is within the permissible range. All power plants are running at lagging power factor within their rated range.

The N-1 contingency check has also been applied and the results are attached in Appendix-3 as below:

Exhibit 3.1	Jhimpir-1 to Tricom 132 kV Single Circuit Out
Exhibit 3.2	Lake Side to Jhimpir-2 132 kV Single Circuit Out
Exhibit 3.3	Gul Ahmed-E to Jhimpir-2 132 kV Single Circuit Out
Exhibit 3.4	Jhimpir-2 220/132 kV Single Transformer Out
Exhibit 3.5	Jhimpir-1 to T.M. Khan 132 kV Single Circuit Out
Exhibit 3.6	Jhimpir to Kotri GTPS 132 kV Single Circuit Out
Exhibit 3.7	Kotri GTPS to Jamshoro Old 132 kV Single Circuit Out
Exhibit 3.8	Jhimpir-1 to TM Khan Road 220 kV Single Circuit Out
Exhibit 3.9	Jhimpir-1 to Jhimpir-2 220 kV Single Circuit Out
Exhibit 3.10	Jhimpir-2 to KDA-33 220 kV Single Circuit Out
Exhibit 3.11	Jhimpir-2 to Jamshoro 220 kV Single Circuit Out
Exhibit 3.12	Jamshoro 500/220 kV Single Transformer Out
Exhibit 3.13	Matiari to Dadu 500 kV Single Circuit Out
Exhibit 3.13a	Matiari to Dadu 500 kV Single Circuit Out - Curtailment of Wind Generation by 600 MW

Exhibit 3.14	Jamshoro to Dadu 500 kV Single Circuit Out
Exhibit 3.14a	Jamshoro to Dadu 500 kV Single Circuit Out - Curtailment of Wind Generation by 600 MW

The load flow results of the network in the close vicinity of Norinco-2 WPP shown plotted in Exhibits 3.1 to 3.12 indicate that all the power flows on the lines are within the rated limits of this network.

For some critical outages of 500kV circuits shown in Exhibit 3.13 and 3.14, capacity constraint was observed in 500kV network emanating from Jamshoro and upwards. Due to this capacity constraint, partial curtailment in the output of all WPPs under study was proposed to bring the loading on the 500kV network within limit. Results are shown in Exhibit 3.13(a) and 3.14(a). The details of the curtailment of WPPs are provided below:

Plant Name	Gross output	Curtailed Output
Nasda	50 MW	7 MW
Uni-Energy	50 MW	7 MW
Indus	50 MW	7 MW
Noor	50 MW	7 MW
Sino Well	50 MW	7 MW
Lootah	50 MW	7 MW
Shafi Energy	50 MW	7 MW
Master Green	50 MW	7 MW
Iran Pak	50 MW	7 MW
Metro-2	60 MW	9 MW
Norinco-2	50 MW	7 MW
DHA City	50 MW	7 MW
Tricom	50 MW	7 MW

With the curtailment process described above, it is established with Load flow results that the network existing before Norinco-2 WPP in the same vicinity in Jhimpir cluster including the Jhimpir-2 220/132 kV collector substation is enough to absorb their power, and has no limitations in terms of power transfer capacity under normal as well as N-1 contingency, prior to connection of Norinco-2 WPP. We will check the adequacy of network after adding Norinco-2 WPP in Chapter 6.

4. Development of Interconnection Scheme

4.1 Interconnection of Norinco-2 50 MW WPP

To connect the wind farms to the main grid of NTDC / HESCO, one may think of connecting each Farm with any nearby available 132 kV substation by laying a direct 132 kV circuit from the gantry of each Farm's substation. But it is important to first see if the nearby substation has enough short circuit strength to connect to a Wind farm having characteristics of time-varying output because flicker and harmonics' resonance are a function of short circuit MVA of that node where this variation would be occurring.

In case there is a potential of developing of several Wind Farms in the same area, then a better interface or common coupling point may be a collector substation where each Wind Farm is connected and then this collector substation is connected to suitable node or nodes of the main national grid system. From suitable node or nodes we mean the nodes (bus bars) having relatively higher short circuit levels to mitigate the impact of time-variant generation from WTG.

In case of Norinco-2 WPP, the nearest substation is the collector substation of Jhimpir-1 220/132 kV for evacuation of power from said power plant.

4.2 Proposed Interconnection Scheme

The scheme of interconnection of these 15 new WPPs including Norinco-2 WPP proposes the following reinforcements in place at Jhimpir cluster.

- 220 kV D/C transmission line approx. 5km long on twin bundled Greeley conductor looping In/out of second circuit of existing Jamshoro – KDA-33 D/C transmission line at the proposed Jhimpir-2 220/132 kV substation
- Addition of 4th 220/132 kV transformer at the newly proposed Jhimpir-2 220/132 kV substation.
- 132kV double circuit transmission line approx. 135 km long on twin bundled Greeley conductor for connecting 8 WPPs in the first loop to Jhimpir-2 220/132 newly proposed substation.

- 132kV double circuit transmission line approx. 168 km long on twin bundled Greeley conductor for connecting 8 WPPs in the second loop to Jhimpir-2 220/132 newly proposed substation.
- In this Integrated study, the interconnection of Norinco-2 WPP includes 132 kV D/C transmission line approx. 1 km long, on Greeley conductor for looping in/out on the 132kV single circuit from Jhimpir-1 to TRICOM WPP grid station.

The connection scheme of Norinco-2 WPP for the scenario of August/September 2019 as shown in Appendix - 4 is by interconnecting Norinco-2 in the double circuit going from Jhmipir-1 to T.M.Khan Road placed along with Tricom and Sinowell WPP. It should be noted that the length of circuits used for the simulations are confirmed from site visit and agreed with NTDC official. They may change slightly during the implementation of the project. In addition, the connectivity of Norinco-2 WPP with neighboring wind power plants may change, depending upon the COD of the project.

5. Modeling of Norinco-2 Wind Farm

5.1 Electrical Layout of Wind Farm

5.1.1 Norinco-2 WPP Energy Selection

Norinco-2 has selected 2.5 MW Goldwind GW121/2500 Type-4 WTG which they are considering to install on their Wind Farm. Each WTG would step up from its terminal LV voltage of 0.69 kV to a medium voltage (MV) that will be 33 kV.

5.1.2 Electrical Layout

The WTGs would be connected to MV collector cables of 33 kV laid down in the Farm connecting each line (row) of the WTGs to the Farm substation. The layout is shown in **Sketch – 3** (Appendix-5), briefly described as follows;

Line – 1	WTGs 1-10	(10 x 2.5 = 25 MW)
Line – 2	WTGs 11-20	(10 x 2.5 = 25 MW)

The average length of cable between the two WTGs has to be enough to completely outdo the wake effect from the adjoining WTG based on thumb rule to leave 4xD (rotor diameter) between the WTGs to take care of wake effect. In actual micro-siting the distances between WTGs might be slightly different due to many other factors. We have taken about 400 meters distances between the WTGs.

The Farm Substation has been assumed to be located somewhere in the middle of the Farm.

The three collector circuits of 33 kV would thus be laid as shown in Sketch-3 and explained as follows;

Collector Line-1	from WTG-1 to Farm Substation
Collector Line-2	from WTG-11 to Farm Substation

Since each collector would carry a max of approximately 25 MW at normal rating, the 33 kV collector circuits loading capacity should be in the range of 27.7 MVA each, giving some margin for reactive power at 0.95 Power Factor and some losses in the circuits with certain overload capacity as well.

5.1.3 33 kV Collector Circuits

The MV voltage level selected by Norinco-2 for interconnection of collector groups of WTGs in the Farm is 33 kV. Underground cables will be used with length of approx. 6.4 km and 7.8 km for two different collector Cables as shown in sketch-3 of Appendix - 5. Further details regarding the type of cable is provided in Appendix - 2.

5.2 Wind Farm Substation 132/33 kV

A substation would be built in the middle of the Farm to collect all the power from the WTGs, spread out in the Farm, at medium voltage (MV) level of 33 kV and step-up this power to high voltage (HV) level of 132 kV so that the Farm's output may be evacuated to the main grid of NTDC. The single line diagrams of the substation are briefly shown in Sketch-1 and 2 in Appendix-5 for 33 kV and 132 kV respectively.

Keeping in view the data provided by the Client, the bus bar scheme for 132 kV level is double bus with a coupler i.e. double bus-single-breaker scheme. Keeping in view the NTDC/DISCOs practice, we propose to provide good reliability to a power plant as follows:

- Single bus scheme with a sectionalizer to enable to have two bus sections at 33 kV.
- Double-bus single-breaker scheme with a Bus Coupler at 132 kV

The schemes are shown in Sketch-1 and 2 respectively and described as follows.

5.2.1 Conceptual Design of 33 kV

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

- Two single bus-sections of 33 kV with a bus sectionalizer
- Four breaker bays to connect four collector double circuits of WTG Lines 1-2
- Two breaker bays to connect two transformers of 132/33 kV
- Two breaker bays for connecting two auxiliary transformers of 33/0.4 kV
- Two breaker bays to connect SVCs

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity = 25 kA

Normal continuous current = 1250 A for line breakers

= 2500A for Bus Sectionalizer and Power TF

5.2.2 Conceptual Design of 132 kV

Single-line-diagram SLD–2 (Appendix–5) shows 132 kV bus bars of the Farm substation, which would comprise as follows:

- Double bus bars with a Bus Coupler
- Two breaker bays to connect two transformers 132/33 kV
- Two breaker bays to connect two circuits of 132 kV i.e. double circuit on single tower overhead line to connect to the grid system.

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity = 40 kA

Normal continuous current = 1250 A for line and TF breakers

= 2500 A for Bus Sectionalizer

The other equipment of the substation consists of:

- Two 132/33 kV, 31.5/40/50 MVA ONAN/ONAF1/ONAF2 OLTC transformers, 132±8×1%/33kV, to fulfill N-1 criteria of Grid Code
- Two station auxiliary transformers 33/0.4 kV
- Two static VAR generator each of the size of 10 MVAR with contactors and PLC (Programmable Logic Controller).
- Energy meters would be installed on HV side (132 kV) of the 132/33 kV transformers.

6. Load Flow Analysis

Load flow analysis has been carried out for the proposed scheme of interconnection of Norinco-2 WPP with NTDC grid for the base scenario of September 2019.

6.1 Modeling of Wind Farm in 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. Though simulations of bulk system dynamics using a single machine equivalent are adequate for most planning studies, we have adopted a rather more detailed level of modeling by using an equivalent machine just for one group of WTGs connected to one collector feeder. Since we have two collector feeders connecting to two groups of WTGs, therefore there are two equivalent WTGs assumed for each collector group in this study report.

The Farm Substation is represented by two bus bars as Norinco-2 medium voltage bus named Norinco-2 -MV 33 kV and Norinco-2 132 kV, with two inter-bus transformers of 31.5/40/50 MVA each. These transformers have an overload capacity of 50 MVA for a limited time to cover N-1 contingency criteria of Grid Code i.e. in case of outage of one transformer, the other can take up the full output of Farm i.e. 50 MVA.

6.2 Reactive Power Requirements

Norinco-2 is considering using 2.5 MW Goldwind GW121/2500 Type-4 WTG, in their WPP. Its power factor is 0.95 lagging (capacitive/generating) and 0.95 leading (inductive/absorbing). The maximum reactive power output that can be available at the 0.69 kV terminal is 0.66 MVAR for each WTG. Part of this reactive power will be consumed by the 0.69/33 kV step-up (GSU) transformer and the rest may be consumed in the MV collector cables of the wind farm. However some reactive power might reach the MV bus bar 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/HESCO grid at 132 kV (point of common coupling). Therefore a Farm of 50 MW generating capacity is required to pump 16.4 MVAR to the grid at full output of 50 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 i.e. 132/33 kV transformers at the Farm substation. In order to meet the Grid Code criteria, we need to install SVC at 33 kV bus of the Farm substation of sufficient size capable of delivering approx. 16.4 MVAR at 132 kV bus after VAR loss across 132/33 kV transformers.

6.3 Load Flow Analysis for Peak Load Scenario of August/September 2019

Load flow analysis has been carried out for the NTDC / HESCO network to see the steady state impact of adding the generation of Norinco-2 WPP on the network including the existing/under-construction/planned WPPs in the Jhimpir and Gharo Cluster. The network configuration is same for Jhimpir and Gharo clusters as indicated in Appendix-4 and discussed in Ch. 3.

The integrated case has been studied for the system conditions of summer 2019, the time line associated with the COD of Norinco-2 WPP and after the commissioning of the newly proposed 220/132 kV substation in the southern part of Jhimpir. In order to ensure proper economic dispatch in the southern area for this High Wind High Water Season, it was essential to have a reasonable energy mix with contributions from both thermal and wind power plants. We kept the dispatch of the nearby power plants such as Thatta, Nooriabad and Kotri-Site at its maximum. Kotri GTPS was operated at 50% capacity. Output from all the existing/ under construction/ planned Wind Plants was kept at maximum.
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 6.1.0 shows the normal case under the system conditions of summer 2019. All the wind farms in Jhimpir and Gharo clusters with installed capacity of 50 MW or 49.5 MW have been assumed after deducting Farm losses and given some diversity in the maximum output of all the Wind Power Plants at one time. For Norinco-2 WPP, 47.5 MW is assumed to be delivered at the point of delivery to grid at 132 kV. 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.
We see that all the WTGs are running at a power factor above its rated value of 0.90 not using full reactive power capability leaving enough margin to cover contingencies. The SVC of 20 MVAR at 33 kV bus bar is supplying 20.00 MVAR at (32.99 kV) voltage and, after VAR loss across 132/33 kV transformers, supplying about 15.24 MVAR (nearly 0.95 PF) at 132 kV bus i.e. fulfilling the Grid Code criteria at the point of interconnection. The 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.

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 6.1.1	Norinco 2 132/33 kV Single Transformer Out
Exhibit 6.1.2	Norinco 2 to Tricom 132 kV Single Circuit Out
Exhibit 6.1.3	Norinco 2 to Jhimpir-1 132 kV Single Circuit Out
Exhibit 6.1.4	Lake Side to Jhimpir-2 132 kV Single Circuit Out
Exhibit 6.1.5	Gul Ahmed-E to Jhimpir-2 132 kV Single Circuit Out
Exhibit 6.1.6	Jhimpir-2 220/132 kV Single Transformer Out
Exhibit 6.1.7	Jhimpir-1 to T.M. Khan 132 kV Single Circuit Out
Exhibit 6.1.8	Jhimpir to Kotri GTPS 132 kV Single Circuit Out
Exhibit 6.1.9	Kotri GTPS to Jamshoro Old 132 kV Single Circuit Out
Exhibit 6.1.10	Jhimpir-1 to TM Khan Road 220 kV Single Circuit Out
Exhibit 6.1.11	Jhimpir-1 to Jhimpir-2 220 kV Single Circuit Out
Exhibit 6.1.12	Jhimpir-2 to KDA-33 220 kV Single Circuit Out
Exhibit 6.1.13	Jhimpir-2 to Jamshoro 220 kV Single Circuit Out
Exhibit 6.1.14	Jamshoro 500/220 kV Single Transformer
Exhibit 6.1.15a	Matiari to Dadu 500 kV Single Circuit Out - Curtailment of Wind Generation by 600 MW
Exhibit 6.1.16	Jamshoro to Dadu 500 kV Single Circuit Out
Exhibit 6.1.16a	Jamshoro to Dadu 500 kV Single Circuit Out - Curtailment of Wind Generation by 600 MW

The load flow results of the network in the close vicinity of Norinco-2 WPP shown plotted in Exhibits 6.1.1 to 6.1.14 indicate that all the power flows on the lines are within the rated limits of this network.

For some critical outages of 500kV circuits shown in Exhibit 6.1.15 and 6.1.16, capacity constraint was observed in 500kV network emanating from Jamshoro and upwards. Due to this capacity constraint, partial curtailment in the output of all WPPs under study was proposed to bring the loading on the 500kV network within limit. Hence output of Norinco-2 WPP is curtailed to 7MW in case of these contingency events. Results are shown in Exhibit 6.1.15(a) and 6.1.16(a). The details of the curtailment of WPPs are provided below:

Plant Name	Gross output	Curtailed Output
Lake Side	50 MW	7 MW
Nasda	50 MW	7 MW
Uni-Energy	50 MW	7 MW
Indus	50 MW	7 MW
Noor	50 MW	7 MW
Sino Well	50 MW	7 MW
Lootah	50 MW	7 MW
Shafi Energy	50 MW	7 MW
Master Green	50 MW	7 MW
Iran Pak	50 MW	7 MW
Metro-2	60 MW	9 MW
Norinco-2	50 MW	7 MW
DHA City	50 MW	7 MW
Tricom	50 MW	7 MW

Total Wind Capacity: 724 MW
Wind Capacity after curtailment: 113 MW

The results also show that under all events of outages the switched shunt capacitor banks at 33 kV bus regulates the voltage under all events. The reactive power being supplied by the 20 MVAR SVC as proposed by the client connected at 33 kV bus, maintains the supply of VARS to the grid under all contingencies adjusting its output according to the system requirement.

In addition, Greeley conductor (184 MVA) is used for the interconnection of Norinco-2 WPP. In the load flow simulation, however, the MVA capacity is assumed to be 202 MVA taking into account the increase in MVA capacity of the conductors at high wind speed during high wind season. This is true for all the conductors in the area, whether lynx or rail, a 10% increase in the thermal rating is assumed.

6.4 Load Flow Analysis for Off-Peak Load Scenario of August/September 2019

Load flow analysis has been carried out for the off-peak conditions of August/September 2019 for the NTDC / HESCO network to see the steady state impact of reduced loads and generations as a higher loading on the circuits is expected during the off-peak conditions.

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

Exhibit 6.2.0 shows the normal case under the off-peak system conditions of August/September 2019. 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 N-1 contingency cases have been run and the results have been shown plotted as under:

Exhibit 6.2.1	Norinco 2 132/33 kV Single Transformer Out
Exhibit 6.2.2	Norinco 2 to Tricom 132 kV Single Circuit Out
Exhibit 6.2.3	Norinco 2 to Jhimpir-1 132 kV Single Circuit Out
Exhibit 6.2.4	Lake Side to Jhimpir-2 132 kV Single Circuit Out
Exhibit 6.2.5	Gul Ahmed-E to Jhimpir-2 132 kV Single Circuit Out
Exhibit 6.2.6	Jhimpir-2 220/132 kV Single Transformer Out
Exhibit 6.2.7	Jhimpir-1 to T.M. Khan 132 kV Single Circuit Out
Exhibit 6.2.8	Jhimpir to Kotri GTPS 132 kV Single Circuit Out
Exhibit 6.2.9	Kotri GTPS to Jamshoro Old 132 kV Single Circuit Out

Exhibit 6.2.10	Jhimpir-1 to TM Khan Road 220 kV Single Circuit Out
Exhibit 6.2.11	Jhimpir-1 to Jhimpir-2 220 kV Single Circuit Out
Exhibit 6.2.12	Jhimpir-2 to KDA-33 220 kV Single Circuit Out
Exhibit 6.2.13	Jhimpir-2 to Jamshoro 220 kV Single Circuit Out
Exhibit 6.2.14	Jamshoro 500/220 kV Single Transformer
Exhibit 6.2.15a	Matiari to Dadu 500 kV Single Circuit Out - Curtailment of Wind Generation by 600 MW
Exhibit 6.2.16	Jamshoro to Dadu 500 kV Single Circuit Out
Exhibit 6.2.16a	Jamshoro to Dadu 500 kV Single Circuit Out - Curtailment of Wind Generation by 600 MW

The load flow results of the network in the close vicinity of Norinco-2 WPP shown plotted in Exhibits 6.2.1 to 6.2.14 indicate that all the power flows on the lines are within the rated limits of this network.

For some critical outages of 500kV circuits shown in Exhibit 6.2.15 and 6.2.16, capacity constraint was observed in 500kV network similar to the peak scenario discussed above. Hence curtailment of WPPs as discussed above was carried out in this off-peak scenario as well. Results after curtailment are shown in Exhibit 6.2.15(a) and 6.2.16(a).

6.5 Load Flow Analysis for Future Scenario of 2022

Load flow analysis has been carried out for the peak conditions for future scenario of 2022 for the NTDC / HESCO network. All the future reinforcements that were proposed till 2022 are modeled in the case.

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

Exhibit 6.3.0 shows the normal case under the peak system conditions of future year 2022. 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 N-1 contingency cases have been run and the results have been shown plotted as under:

Exhibit 6.3.1	Norinco 2 132/33 kV Single Transformer Out
Exhibit 6.3.2	Norinco 2 to Tricom 132 kV Single Circuit Out
Exhibit 6.3.3	Norinco 2 to Jhimpir-1 132 kV Single Circuit Out
Exhibit 6.3.4	Lake Side to Jhimpir-2 132 kV Single Circuit Out
Exhibit 6.3.5	Gul Ahmed-E to Jhimpir-2 132 kV Single Circuit Out
Exhibit 6.3.6	Jhimpir-2 220/132 kV Single Transformer Out
Exhibit 6.3.7	Jhimpir-1 to T.M. Khan 132 kV Single Circuit Out
Exhibit 6.3.8	Jhimpir to Kotri GTPS 132 kV Single Circuit Out
Exhibit 6.3.9	Kotri GTPS to Jamshoro Old 132 kV Single Circuit Out
Exhibit 6.3.10	Jhimpir-1 to TM Khan Road 220 kV Single Circuit Out
Exhibit 6.3.11	Jhimpir-1 to Jhimpir-2 220 kV Single Circuit Out
Exhibit 6.3.12	Jhimpir-2 to KDA-33 220 kV Single Circuit Out
Exhibit 6.3.13	Jhimpir-2 to Jamshoro 220 kV Single Circuit Out
Exhibit 6.3.14	Jamshoro 500/220 kV Single Transformer Out
Exhibit 6.3.15	Matiari to Dadu 500 kV Single Circuit Out
Exhibit 6.3.16	Jamshoro to Dadu 500 kV Single Circuit Out

The results show that power flows on intact 132 kV circuits remain within their rated limits. For this future scenario of 2022, the issue of capacity constraint that was observed in the base case of 2019 is resolved due to the following major reinforcements in the system:

- 660kV HVDC from Matiari to Lahore
- 660kV HVDC from Port Qasim to Faisalabad West

6.6 Conclusion of Load Flow Results

With the proposed reinforcements and the curtailment process for the base year of 2019 under special circumstances, the load flow results of the proposed scheme of interconnection of Norinco-2 WPP shows no bottlenecks or capacity constraints in the adjoining 500 kV, 220 kV and 132 kV network in terms of absorbing all the output of Norinco-2 WPP under normal as well as the contingency conditions for all the scenarios studied.

Norinco-2 Wind Power Plant would be connected by a double circuit of 132 kV by looping in-out configuration of the Jhimpir-1 to T.M.Khan 132kV single circuit. Greeley conductor with the capacity of 184 MVA per circuit is assumed to have a thermal limit of 202 MVA taking into account the increase in MVA capacity of the conductors at high wind speed during high wind season.

7. Short Circuit Analysis

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 1.1 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 equipment.

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 future year of 2022 to assess the maximum impact of Norinco-2 WPP.

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 of 220 kV and 132 kV in the electrical vicinity of Norinco-2 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.

To assess the minimum short circuit levels we have considered conditions of 2019 to simulate the minimum short circuit strength of southern grid. For Norinco-2 WPP we have assumed a smaller percentage of dispatch of its capacity for the minimum short circuit calculations i.e. just one collector group with partial output of approx. 25 MW is on bar.

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

7.2.1 Maximum Short Circuit Levels for the Year 2022

The short circuit levels have been calculated and plotted on the bus bars of 500 kV, 220 kV and 132 kV of substations lying in the electrical vicinity of our area of interest i.e. Jhimpir, T.M.Khan Road, Jamshoro and Gharo area, and are shown plotted in the Exhibit 7.2 for the scenario of 2022 and 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 the 500 kV, 220 kV and 132 kV bus bars of our interest i.e. the substations connecting in the three branches of 132 kV running South of Hyderabad up to Southern Sind coast line. 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. For Jamshoro 220kV substation whose fault level exceed 40kA, this is due to the reinforcements in the NTDC system hence NTDC should take mitigation measures to reduce these fault levels.

The fault levels of Norinco-2 132 kV are 9.28 kA and 8.01 kA for 3-phase and single phase faults respectively for 2022. This is much less than the switchgear rating of 40 kA recommended for Norinco-2 Farm Substation as per NTDC requirements for 132 kV.

The fault levels for Norinco-2 33 kV are 12.94 kA and 13.73 kA for 3-phase and single-phase faults respectively for 2022. Therefore the short circuit rating recommended for 33 kV switchgear is recommended as 25 kA.

Table-7.1

Maximum Short Circuit Levels with Norinco-2 WPP – 2022

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Norinco-2 132 kV	9.28	8.01
Norinco-2 MV 33 kV	12.94	13.73
Nooriabad 132 kV	11.92	13.16
Thatta 132 kV	6.62	6.50
Jamshoro Old 132 kV	23.84	22.86
Jamshoro New 132 kV	25.25	24.90
Kotri GTPS 132 kV	19.73	19.01
Hala Road 132 kV	22.36	21.44
T.M.KHAN 132 kV	14.80	14.24
Jhimpir 132 kV	11.45	10.49
Jhimpir-1 132 kV	30.36	26.69
Jhimpir-2 132 kV	24.21	22.22
Gharo-New 132 kV	10.37	9.81
Gharo-New 220 kV	10.17	8.00
Jhimpir-1 220 kV	23.18	18.06
Jhmipir-2 220 kV	29.86	21.96

Jamshoro 220 kV	45.00	45.78
Hala Road 220 kV	29.68	22.90
TM.KH.RD 220 kV	22.56	18.46
Jamshoro 500 kV	40.62	34.94
Matiari-CS 500 kV	43.09	30.36

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 the 132 kV bus bars of our interest.

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 Norinco-2 WPP 2019

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Norinco-2 132 kV	6.49	5.67
Norinco-2 MV 33 kV	10.49	10.51
Nooriabad 132 kV	7.88	8.41
Thatta 132 kV	4.74	4.70
Jamshoro Old 132 kV	15.93	15.61
Jamshoro New 132 kV	16.89	16.90
Kotri GTPS 132 kV	13.25	12.28
Hala Road 132 kV	15.58	15.20
T.M.KHAN 132 kV	10.92	10.63
Jhimpir 132 kV	7.31	6.89
Jhimpir-1 132 kV	18.25	18.96
Jhimpir-2 132 kV	16.98	16.54
Gharo-New 132 kV	7.44	7.53
Gharo-New 220 kV	7.42	6.31
Jhimpir-1 220 kV	14.88	13.40
Jhmipir-2 220 kV	19.00	15.84
Jamshoro 220 kV	23.86	23.61

Hala Road 220 kV	18.13	14.89
TM.KH.RD 220 kV	14.89	12.92
Jamshoro 500 kV	13.12	11.18
Matiari 500 kV	12.76	10.52

7.3 Conclusions of Short Circuit Analysis

As a whole for the peak scenario of 2022, the fault levels at all the 132 kV bus bars are well below the short circuit rating of the equipment at these substations.

The fault levels of Norinco-2 132 kV are 9.28 kA and 8.01 kA for 3-phase and single phase faults respectively for 2022. This is much less than the switchgear rating of 40 kA recommended for Norinco-2 Farm Substation as per NTDC requirements for 132 kV.

The fault levels for Norinco-2 33 kV are 12.94 kA and 13.73 kA for 3-phase and single-phase faults respectively for 2022. Therefore the short circuit rating recommended for 33 kV switchgear is 25 kA.

Similarly for minimum short circuit case for the year 2019, the fault levels are also well below the short circuit rating of the equipment at these substations.

The short circuit strength is very important for Power Quality issues like flicker, harmonics and voltage unbalance. Exhibit 7.1.1 and 7.1.2 show the results of minimum fault levels in MVA to be used in Power Quality analysis carried out in Ch.9.

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 well on the basis of short circuit analysis as well.

8. Transient Stability Analysis

The objective of transient stability study is to see:

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

8.1 Assumptions & Methodology

8.1.1 Type-4 WTG Dynamic Model

Norinco-2 is considering using Type-4 WTG in their Wind Power Plant. We have used the generic Type-4 wind turbine-generator model, which has been developed and has been made available by Siemens–PTI to their users of PSS/E software. Only the main parameters have been incorporated in this model, whereas other 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 System Disturbances

8.2.1

<table>
<tr><td colspan="4">Fault Type: 3-Phase</td></tr>
<tr><td colspan="4">Fault Location: Norinco-2 132 kV bus bar</td></tr>
<tr><td colspan="4">Fault Duration: 5 cycles (100 ms)</td></tr>
<tr><td colspan="4">Line Tripping: Norinco-2 to Tricom 132 kV Single Circuit</td></tr>
<tr><th>Variable</th><th>Bus/Line</th><th>Response</th><th>Figure No.</th></tr>
<tr><td>Voltage</td><td>1. Norinco-2 132 kV
2. Norinco-2 MV 33 kV
3. Tricom 132 kV
4. Sinowell 132 kV
5. Jhimpir-1 132 kV
6. Jhimpir-1 220 kV</td><td>The voltages of all the bus bars recover after fault clearance</td><td>1.1</td></tr>
<tr><td>Frequency</td><td>Norinco-2 132 kV</td><td>Recovers after fault clearance</td><td>1.2</td></tr>
</table>

• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	1.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	1.4
• **MW Line Flow** • **MVAR Line Flow**	Norinco-2 to Jhmipir-1 132 kV intact single circuit	Attains steady state value after damping of oscillations	1.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	1.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	1.7

8.2.2

Fault Type: 1-Phase			
Fault Location: Norinco-2 132 kV bus bar			
Fault Duration: 9 cycles (180 ms)			
Line Tripping: Norinco-2 to Tricom 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Norinco-2 132 kV 2. Norinco-2 MV 33 kV 3. Tricom 132 kV 4. Sinowell 132 kV 5. Jhimpir-1 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	2.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	2.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	2.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	2.4

• **MW Line Flow** • **MVAR Line Flow**	Norinco-2 to Jhmipir-1 132 kV intact single circuit	Attains steady state value after damping of oscillations	2.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	2.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	2.7

8.2.3

Fault Type: 3-Phase			
Fault Location: Norinco-2 132 kV bus bar			
Fault Duration: 5 cycles (100 ms)			
Line Tripping: Norinco-2 to Jhmipir-1 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Norinco-2 132 kV 2. Norinco-2 MV 33 kV 3. Tricom 132 kV 4. Sinowell 132 kV 5. Jhimpir-1 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	3.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	3.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	3.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	3.4
• **MW Line Flow** • **MVAR Line Flow**	Norinco-2 to Tricom132 kV intact single circuit	Attains steady state value after damping of oscillations	3.5

• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	3.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	3.7

8.2.4

Fault Type: 1-Phase

Fault Location: Norinco-2 132 kV bus bar

Fault Duration: 9 cycles (180 ms)

Line Tripping: Norinco-2 to Jhmipir-1 132 kV Single Circuit

Variable	Bus/Line	Response	Figure No.
Voltage	1. Norinco-2 132 kV 2. Norinco-2 MV 33 kV 3. Tricom 132 kV 4. Sinowell 132 kV 5. Jhimpir-1 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	4.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	4.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	4.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	4.4
• **MW Line Flow** • **MVAR Line Flow**	Norinco-2 to Tricom132 kV intact single circuit	Attains steady state value after damping of oscillations	4.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	4.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV	Damps down quickly and attain a steady state value	4.7

	6. Guddu-New (Reference)		

8.2.5

Variable	**Bus/Line**	**Response**	**Figure No.**
Fault Type: 3-Phase			
Fault Location: Norinco-2 33 kV bus bar			
Fault Duration: 9 cycles (180 ms)			
Line Tripping: Norinco-2 132/33 kV Transformer			
Voltage	1. Norinco-2 MV 33 kV 2. Norinco-2 132 kV 3. Tricom 132 kV 4. Sinowell 132 kV 5. Jhimpir-1 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	5.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	5.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	5.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	5.4
• **MW Line Flow** • **MVAR Line Flow**	Norinco-2 132/33 kV intact single transformer	Attains steady state value after damping of oscillations	5.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	5.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	5.7

8.2.6

Fault Type: 3-Phase			
Fault Location: Norinco-2 33 kV bus bar			
Fault Duration: 9 cycles (180 ms)			
Line Tripping: Norinco-2 One collector group of 25 MW			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Norinco-2 MV 33 kV 2. Norinco-2 132 kV 3. Tricom 132 kV 4. Sinowell 132 kV 5. Jhimpir-1 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	6.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	6.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	6.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	6.4
• **MW Line Flow** • **MVAR Line Flow**	Norinco-2 132/33 kV intact single transformer	Attains steady state value after damping of oscillations	6.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	6.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	6.7

8.2.7

Fault Type: 3-Phase
Fault Location: Tricom 132 kV bus bar
Fault Duration: 5 cycles (100 ms)

Line Tripping: Tricom to Norinco-2 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Tricom132 kV 2. Norinco-2 132 kV 3. Norinco-2-MV 33 kV 4. Sinowell 132 kV 5. Jhimpir-1 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	7.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	7.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	7.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	7.4
• **MW Line Flow** • **MVAR Line Flow**	Tricom to Sinowell 132 kV intact single circuit	Attains steady state value after damping of oscillations	7.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	7.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	7.7

8.2.8

Fault Type: 1-Phase			
Fault Location: Tricom 132 kV bus bar			
Fault Duration: 9 cycles (180 ms)			
Line Tripping: Tricom to Norinco-2 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**

Voltage	1. Tricom132 kV 2. Norinco-2 132 kV 3. Norinco-2-MV 33 kV 4. Sinowell 132 kV 5. Jhimpir-1 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	8.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	8.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	8.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	8.4
• **MW Line Flow** • **MVAR Line Flow**	Tricom to Sinowell 132 kV intact single circuit	Attains steady state value after damping of oscillations	8.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	8.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	8.7

8.2.9

Fault Type: 3-Phase			
Fault Location: Jhimpir-1 132 kV bus bar			
Fault Duration: 5 cycles (100 ms)			
Line Tripping: Jhimpir-1 to Norinco-2 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Jhimpir-1 132 kV 2. Norinco-2 132 kV 3. Norinco-2 MV 33 kV 4. Tricom 132 kV 5. Sinowell 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	9.1
Frequency	Norinco-2 132 kV	Recovers after	9.2

		fault clearance	
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	9.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	9.4
• **MW Line Flow** • **MVAR Line Flow**	Jhimpir-1 to T.M.Khan Road 132 kV Single Circuit	Attains steady state value after damping of	9.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	9.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 500 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	9.7

8.2.10

Fault Type: 1-Phase			
Fault Location: Jhimpir-1 132 kV bus bar			
Fault Duration: 9 cycles (180 ms)			
Line Tripping: Jhimpir-1 to Norinco-2 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Jhimpir-1 132 kV 2. Norinco-2 132 kV 3. Norinco-2 MV 33 kV 4. Tricom 132 kV 5. Sinowell 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	10.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	10.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	10.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	10.4

• **MW Line Flow** • **MVAR Line Flow**	Jhimpir-1 to T.M.Khan Road 132 kV Single Circuit	Attains steady state value after damping of	10.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	10.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 500 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	10.7

8.2.11

Fault Type: 3-Phase			
Fault Location: Jhimpir-2 220 kV bus bar			
Fault Duration: 5 cycles (100 ms)			
Line Tripping: Jhimpir-2 to KDA-33 220 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Jhimpir-2 220 kV 2. KDA-33 220 kV 3. TM.Khan.RD 220 kV 4. Norinco-2 132 kV 5. Gharo-New 220 kV 6. Jamshoro 220 kV	The voltages of all the bus bars recover after fault clearance	11.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	11.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	11.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	11.4
• **MW Line Flow** • **MVAR Line Flow**	Jhimpir-2 to KDA-33 220 kV intact single circuit	Recovers after damping down oscillations	11.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Attains steady state value after damping of oscillations	11.6
Rotor Angles	1. Kotri GTPS 132 kV	Damps down	11.7

	2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	quickly and attain a steady state value	

8.2.12

Fault Type: 1-Phase			
Fault Location: Jhimpir-2 220 kV bus bar			
Fault Duration: 9 cycles (180 ms)			
Line Tripping: Jhimpir-2 to KDA-33 220 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Jhimpir-2 220 kV 2. KDA-33 220 kV 3. TM.Khan.RD 220 kV 4. Norinco-2 132 kV 5. Gharo-New 220 kV 6. Jamshoro 220 kV	The voltages of all the bus bars recover after fault clearance	12.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	12.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	12.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	12.4
• **MW Line Flow** • **MVAR Line Flow**	Jhimpir-2 to KDA-33 220 kV intact single circuit	Recovers after damping down oscillations	12.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Attains steady state value after damping of oscillations	12.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	12.7

8.2.13

Fault Type: 3-Phase			
Fault Location: Jhimpir-1 220 kV bus bar			
Fault Duration: 5 cycles (100 ms)			
Line Tripping: Jhimpir-1 to T.M.Khan Road 220 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Jhimpir-1 220 kV 2. Jhimpir-2 220 kV 3. TM.Khan.RD 220 kV 4. Jhimpir-2 132 kV 5. Norinco-2 132 kV 6. Jamshoro 220 kV	The voltages of all the bus bars recover after fault clearance	13.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	13.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	13.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	13.4
• **MW Line Flow** • **MVAR Line Flow**	Jhimpir-1 to T.M.Khan Road 220 kV intact single circuit	Recovers after damping down oscillations	13.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Attains steady state value after damping of oscillations	13.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	13.7

8.2.14

Fault Type: 1-Phase
Fault Location: Jhimpir-1 220 kV bus bar
Fault Duration: 9 cycles (180 ms)

Line Tripping: Jhimpir-1 to T.M.Khan Road 220 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Jhimpir-1 220 kV 2. Jhimpir-2 220 kV 3. TM.Khan.RD 220 kV 4. Jhimpir-2 132 kV 5. Norinco-2 132 kV 6. Jamshoro 220 kV	The voltages of all the bus bars recover after fault clearance	14.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	14.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	14.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	14.4
• **MW Line Flow** • **MVAR Line Flow**	Jhimpir-1 to T.M.Khan Road 220 kV intact single circuit	Recovers after damping down oscillations	14.5
• **MW Output** • **MVAR Output**	Tricom 132 kV	Attains steady state value after damping of oscillations	14.6
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 220 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	14.7

8.2.15

Fault Type: 3-Phase			
Fault Location: Jhimpir-1 132 kV bus bar			
Fault Duration: 5 cycles (100 ms)			
Line Tripping: Jhimpir-1 to T.M.Khan Road 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Jhimpir-1 132 kV 2. T.M.Khan Road 132 kV 3. Norinco-2 132 kV 4. Sinowell 132 kV 5. Tricom 132 kV	The voltages of all the bus bars recover after fault clearance	15.1

	6. Jhimpir-1 220 kV		
Frequency	Norinco-2 132 kV	Recovers after fault clearance	15.2
• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	15.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	15.4
• **MW Line Flow** • **MVAR Line Flow**	Jhimpir-1 to Norinco-2 132 kV Single Circuit	Attains steady state value after damping of	15.5
• **MW Line Flow** • **MVAR Line Flow**	Sinowell to T.M.Khan Road 132 kV Single Circuit	Attains steady state value after damping of	15.6
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	15.7
• **MW Output** • **MVAR Output**	Sinowell Collector Group-1 0.69 kV	Recovers after damping down oscillations	15.8
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 500 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	15.9

8.2.16

Fault Type: 1-Phase			
Fault Location: Jhimpir-1 132 kV bus bar			
Fault Duration: 9 cycles (180 ms)			
Line Tripping: Jhimpir-1 to T.M.Khan Road 132 kV Single Circuit			
Variable	**Bus/Line**	**Response**	**Figure No.**
Voltage	1. Jhimpir-1 132 kV 2. T.M.Khan Road 132 kV 3. Norinco-2 132 kV 4. Sinowell 132 kV 5. Tricom 132 kV 6. Jhimpir-1 220 kV	The voltages of all the bus bars recover after fault clearance	16.1
Frequency	Norinco-2 132 kV	Recovers after fault clearance	16.2

• **Plant MW Output** • **Plant MVAR Output**	Norinco-2 Collector Group-1 0.7 kV	Recovers after damping down oscillations	16.3
• **Voltage Sensor for LVACR**	Norinco-2 Collector Group-1 0.7 kV	Recovers after fault clearance	16.4
• **MW Line Flow** • **MVAR Line Flow**	Jhimpir-1 to Norinco-2 132 kV Single Circuit	Attains steady state value after damping of	16.5
• **MW Line Flow** • **MVAR Line Flow**	Sinowell to T.M.Khan Road 132 kV Single Circuit	Attains steady state value after damping of	16.6
• **MW Output** • **MVAR Output**	Tricom 132 kV	Recovers after damping down oscillations	16.7
• **MW Output** • **MVAR Output**	Sinowell Collector Group-1 0.69 kV	Recovers after damping down oscillations	16.8
Rotor Angles	1. Kotri GTPS 132 kV 2. Thatta132 kV 3. Lakhra 132 kV 4. Nooriabad 132 kV 5. Atlas 500 kV 6. Guddu-New (Reference)	Damps down quickly and attain a steady state value	16.9

8.5 Conclusion of Stability Study

The transient stability analysis performed as discussed above indicates that the NTDC system connecting to Norinco-2 WPP through the proposed scheme of interconnection is strong enough to absorb the worst disturbances on either side i.e. on Norinco-2 WPP side or the Grid side.

There are no constraints of connecting Norinco-2 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 2019 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 Exhibits 7.1.1 and 7.1.2 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

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

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 MV bus of Norinco-2 Farm substation.

For minimum short circuit case we have assumed the same case as discussed in paragraph 7.1.1.2 of Chapter 7 in which output of Norinco-2 Wind farm reduced from full rated capacity. Therefore taking one collector group as one equivalent generator of 10 x 2.5 = 25 MW we have calculated as follows;

S_n= 2.78 MVA at 0.90 PF (For 1 WTG)

N_{WT} = 10

S_k for MV bus = 600 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

$P_{st\Sigma} = P_{lt\Sigma}$= 0.014652= 1.4652 %

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 Norinco-2 Wind farm would not cause any flicker problem during steady state operation even in the weakest system conditions of minimum short circuit level.

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	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 $k_{f,i}$ (ψk) 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;

$P_{st\Sigma} = 0.308755$

$P_{lt\Sigma} = 0.296468$

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 evaluated above are less than the values recommended in the references of above standards.

9.2 Voltage Unbalance

9.2.1 Voltage Step-Change

The voltage step change would occur when a WTG will be energized, assuming just one WTG in the collector for the minimum No. of units in the collector being energized.

The limit on the voltage change is based on the impedance of the circuit between the point of connection and the MV transformer bus bar together with the apparent power of the wind turbine generators. The following equation needs to be satisfied [2];

$$\Delta V = \sum S_{WKA} [(1/S_{KE}) - (1/S_{KSS})] \leq 1/33 \text{ or } 3\ \%$$

Where

S_{WKA} = MVA rating of the WTG

S_{KE} = Short circuit MVA at connection point

S_{KSS} = Short circuit MVA at MV bus of the wind farm substation

For the minimum short circuit case, we have calculated minimum fault levels in MVA as shown in Exhibit 7.1.2

S_{WKA} = 2.78 MVA for the equivalent WTG of a collector group for the minimum case

S_{KE1} for one WTG in collector group = 310 MVA (Exhibit 7.1.2)

S_{KSS} = 590 MVA (Exhibit 7.1.2)

Substituting these values we get

$$\Delta V = 0.004255878 = 0.4255878\ \%$$

Which is much less than the limit of 3 %

9.2.2 Voltage Fluctuation

For the limits of voltage fluctuation, we need to satisfy the following equation [2].

$$\sqrt{\sum (P_{WKA}/S_{KE})^2} \leq 1/25 \text{ or } 4\ \%$$

Where

P_{WKA} = MW rating of the WTG

S_{KE} = Short circuit MVA at connection point

Punching all the numbers in this equation, we get

Voltage Fluctuation = 0.008064516 = 0.80645 %

Which is less than the maximum permissible specified as 4 %.

10- Conclusions & Recommendations

- Interconnection Study has been carried out for 50 MW Norinco-2 WPP which is proposed to be placed in the loop at Jhimpir-1 220/132 kV collector substation. The scheme of interconnection of these 15 new WPPs including Norinco-2 WPP proposes the following reinforcements in place at Jhimpir cluster.
    - 220 kV D/C transmission line approx. 5km long on twin bundled Greeley conductor looping In/out of second circuit of existing Jamshoro – KDA-33 D/C transmission line at the proposed Jhimpir-2 220/132 kV substation
    - Addition of 4^{th} 220/132 kV transformer at the newly proposed Jhimpir-2 220/132 kV substation.
    - 132kV double circuit transmission line approx. 135 km long on twin bundled Greeley conductor for connecting 8 WPPs in the first loop to Jhimpir-2 220/132 newly proposed substation.
    - 132kV double circuit transmission line approx. 168 km long on twin bundled Greeley conductor for connecting 8 WPPs in the second loop to Jhimpir-2 220/132 newly proposed substation.
    - In this Integrated study, the interconnection of Norinco-2 WPP includes 132 kV D/C transmission line approx. 1 km long, on Greeley conductor for looping in/out on the 132kV single circuit from Jhimpir-1 to TRICOM WPP grid station.
- The existing grid system of HESCO and NTDC in the vicinity of Norinco-2 WPP has been studied in detail by performing load flow, short circuit and dynamic analysis for the conditions prior to commissioning of Norinco-2 WPP and no bottlenecks or constraints have been found in the grid system.
- Wind Farm of Norinco-2 has been modeled considering Type-4 WTGs. The terminal voltage is 0.69 kV. The medium voltage level of wind farm has been selected as 33 kV for unit step-up transformers, for collector circuits and step-up from MV to HV (132 kV) at Farm substation to connect to the Jhimpir-1 220/132 kV grid station of NTDC.

- The design of scheme of 132/33 kV substation of Norinco-2 Wind Farm has been provided by the Client and is attached in Appendix – 2.
- Load flow analysis has been carried out for peak and Off Peak scenarios of August/September 2019 considering the COD targeted by Norinco-2 WPP and a future scenario of 2022, for the dispersal of power from Norinco-2 WPP into NTDC system using the latest load forecast, generation and transmission expansion plans of NTDC and HESCO. The above mentioned interconnection scheme 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. All the scenarios have been studied by considering maximum dispatch from all the existing/planned WPPs in the Jhimpir and Gharo Clusters.
- For the base case of summer 2019, capacity constraint was observed in 500kV network emanating from Jamshoro and upwards in case of some critical outages of 500kV circuits. Due to this capacity constraint, partial curtailment in the output of all WPPs under study was proposed to bring the loading on the 500kV network within limit. Hence output of Norinco-2 WPP is curtailed to 7MW in case of some contingency events. For the future scenario of 2022, this issue of capacity constraint is resolved due to the following major reinforcements:
    - 660kV HVDC from Matiari to Lahore
    - 660kV HVDC from Port Qasim to Faisalabad West
- With the proposed reinforcements highlighted earlier and the curtailment process for the base year of 2019 under special circumstances, the load flow results for peak and Off Peak scenarios establish that the proposed scheme of interconnection of Norinco-2 WPP shows no bottlenecks or capacity constraints in the adjoining 500 kV, 220 kV and 132 kV network in terms of absorbing all the output of Norinco-2 WPP and other proposed WPPs under normal as well as the contingency conditions.

- Maximum and minimum short circuit levels for three-phase faults and single-phase faults have been evaluated. The maximum SC levels have been evaluated for the year 2022 and minimum short circuit level for the year 2019 for the most stringent conditions. The fault levels of Norinco-2 132 kV are 9.28 kA and 8.01 kA for 3-phase and single phase faults respectively for 2022. This is much less than the switchgear rating of 40 kA recommended for Norinco-2 Farm Substation as per NTDC requirements for 132 kV. The fault levels for Norinco-2 33 kV are 12.94 kA and 13.73 kA for 3-phase and single-phase faults respectively for year 2022. Therefore the short circuit rating for 33 kV switchgear is recommended as 25 kA. It has been found that the proposed scheme provides maximum SC strength for the evacuation of Norinco-2 WPP power to the grid.

  The switchgear ratings for Norinco-2 WPP substation are as follows:

  132 kV:

  Short circuit rating = 40 kA (3 sec.)

  Continuous rating = 2500 A

  33 kV:

  Short circuit rating = 25 kA (3 sec.)

  Continuous rating = 2500 A

- Transient Stability analysis has been carried out for Norinco-2 WPP based on their selection of Type-4 WTGs, with connectivity of 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 Norinco-2 WTG unit's dynamic characteristics and the grid connectivity is strong enough to maintain stability under all disturbances. In turn, any disturbance from Norinco-2 WPP side did not cause any stress on the main grid or the power plants nearby and in the HESCO area such that the whole system remained stable under all events.
- 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.

- The issues of power quality like flicker, unbalance and harmonic resonance have been studied in detail. The results have indicated that the levels of flicker and unbalance are within the permissible limits of IEC and other International Standards.
- There are no technical constraints whatsoever in the way of bringing in the 50 MW of Norinco-2 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.

Reference No: EPA/2016/02/03/IEE/11
ENVIRONMENTAL PROTECTION AGENCY
GOVERNMENT OF SINDH
Plot # ST – 2/1, Sector 23, Korangi
Industrial Area, Karachi – 74900
Ph: 021 – 35065950, 35065621,
35065946
epasindh@cyber.net.pk
Fax No: 021 - 35065940

Dated: 04[th] March 2016

SUBJECT: DECISION ON INITIAL ENVIRONMENTAL EXAMINATION (IEE)

1. **Name & Address of Proponent:** Mr. Asad Alam Niazi
Director & COO
Norinco International Thatta Power Pvt. Ltd
Suite No. 201, 2[nd] Floor, Horizon Vista, Block -4,
Clifton, Karachi
2. **Description of Project:** Establishment of 100 MW Wind Farm in Jhimpir
3. **Location of Project:** Project site is located in Jhimpir about 110 km Northeast of Karachi and 80km Northeast of PQ, with geographical coordinates: 68°0'4"~68°3'55"E and 25°5'23"~25°8'4"N.
4. **Date of Filing of IEE:** 03-02-2016

5. After careful review and analysis of the Initial Environmental Examination (IEE) report, the Sindh Environmental Protection Agency (SEPA) accords its approval subject to the following conditions:
   i) All mitigation measures recommended in IEE report should be complied with, for achieving negligible impacts on physical, biological, environmental and socio-economic resources of the area. Sindh Environmental Quality Standards (SEQS) 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. Environmental management system shall be made in place during the operation of the project needing towards third party environmental audit and for achievement of ISO14000 standards.
   iii) The proponent shall also appoint a reputable research institute or organization to conduct a detailed noise mapping/modeling study & Avian Risk Assessment and

Total pages 280

Verified
NORINCO INT. THATTA POWER (PVT) LTD.

Reference No: EPA/2016/02/03/IEE/11
ENVIRONMENTAL PROTECTION AGENCY
GOVERNMENT OF SINDH
Plot # ST - 2/1, Sector 23, Korangi
Industrial Area, Karachi - 74900
Ph: 021 - 35065950, 35065621,
35065946
epasindh@cyber.net.pk
Fax No: 021 - 35065940

Management Study. The noise modeling report and Avian Risk Assessment and Management Study must be submitted to SEPA within 04 weeks from the date of issuance of this approval.

iv) The proponent shall be under obligation to compensate for any significant adverse short term, long term and irreversible impact occurred due to windfarm operations. 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
- 500m from archaeological / cultural site / monument
- Distance will be measured from the tip blade of turbines or / and transmission power lines associated.
- Project activity will not be carried out within buffer zone of any projected area designated under Sindh wildlife protection act.

v) 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.

vi) 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.

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

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

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

Reference No: EPA/2016/02/03/IEE/11

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

x) 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.

xi) Compensation will be provided to the inhabitants in case of loss of agriculture land, crop property, etc., in accordance with the rates, that are agreed upon.

xii) 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.

xiii) 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 IEE. 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. The proponent shall be liable to submit monthly environmental monitoring reports to EPA Sindh.

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

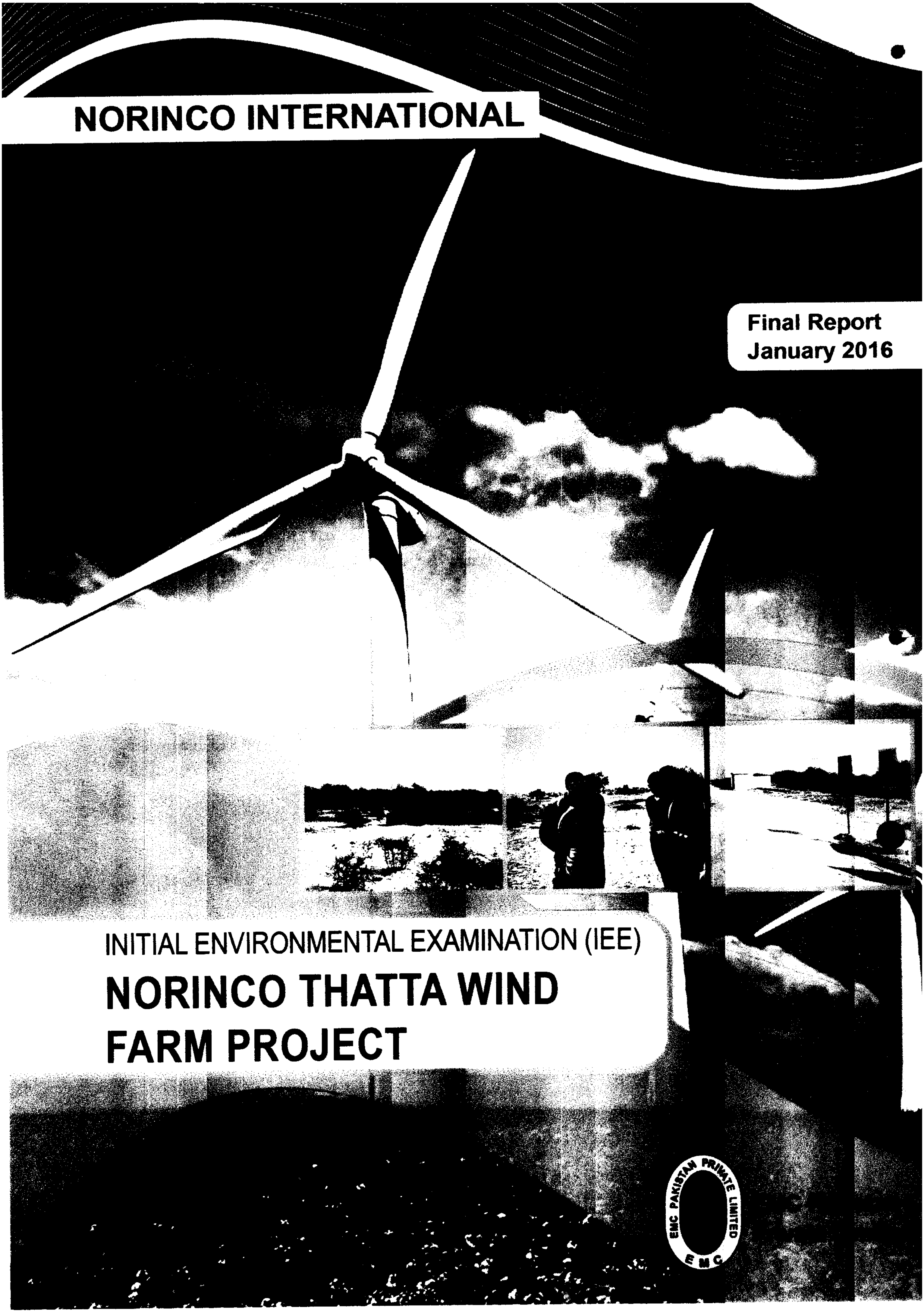
7. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any other law in force.

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

Muhammad Imran Sabir
Deputy Director (Technical)

NORINCO INTERNATIONAL

Final Report
January 2016



INITIAL ENVIRONMENTAL EXAMINATION (IEE)

NORINCO THATTA WIND FARM PROJECT

EMC PAKISTAN PRIVATE LIMITED
EMC

NORINCO INTERNATIONAL

Initial Environmental Examination (IEE) Study
Norinco Thatta Wind Farm Project

Final Report
January 2016
Ref: IEE-01/01/16

EMC PAKISTAN PVT. LTD.
503, Anum Estate, Opp. Duty Free Shop, Main Shahrah-e-Faisal, Karachi.
Phones(+) 9221- 34311466, 34382860, Fax: (+) 9221-34311467.
E-mail: mail@emc.com.pk, nadeem@emc.com.pk
Website: www.emc.com.pk

Executive Summary

The Initial Environmental Examination (IEE) Study for "Norinco Thatta Wind Farm Project" has been conducted by EMC Pakistan Pvt. Ltd. The IEE has been prepared in compliance with the requirement under section 17 of Sindh Environmental Protection Act, 2014 and SEPA IEE/EIA Regulations 2014 for scheduled development projects.

The proposed project is the establishment a 100 MW Wind Farm in Jhampir in Thatta District. The project site is about 2500 acres acquired by the proponent for this project. NTWFP has an installation capacity of 100MW, 40 sets of GW121-2500-90m wind turbines will be installed.

Sindh Environmental Protection Act 2014 empowers the Sindh Environmental Protection Agency (SEPA) as the principal authority for environmental management in Sindh. It has also established the requirement of environmental assessment of any project in place prior to commencement of work.

According to Sindh Environmental Protection Agency Regulation, 2014, a project falling in any category listed in Schedule I shall file an IEE with the Sindh Environmental Protection Agency (SEPA). **Wind project** are placed in Schedule I: B(7) thus requiring an IEE.

Entrusted by NORINCO INTERNATIONAL (Project Proponent), POWERCHINA Northwest Engineering Corporation Limited is the Design Consultant. The design in the feasibility study stage mainly involves engineering geology, wind resources, WTG (wind turbine generator) type selection and electric power generation estimate, electrical engineering, civil works, environmental protection and water & soil conservation, design budget estimate, financial evaluation and social effect analysis, etc.

The long-term friendly relationship between China and Pakistan and relevant policies of Pakistan encouraging foreign investment to enter the electric power sector, provide a good basis and facilitate the cooperation of both parties in the power sector. Currently, China and Pakistan have worked together on development of many power projects, establishing a solid foundation for further cooperation. The construction of Thatta wind farm will promote the sustainable growth of local economy, improve the living standard of local residents, facilitate the development of local electric power industry, and meet the demand of sustainable development of Chinese enterprises in the international market. Therefore, the construction of the project is necessary.

The main objectives of the NTWF 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.

Thatta wind farm project (100MW) is located at Jhimpir in Sindh Province of Pakistan, about 110km northeast away from Karachi and 80km northeast away from Port Qasim, with geographical coordinates of 68°0'4"~68°3'55" E and 25°5'23"~25°8'4" N. The project area stretches in nearly northwest-southeast direction, with a length of about 6.7km and a width of 1.6km. The elevation of the project area is 40m~60m. The project area can be reached through M9 Highway from Karachi to Nooriabad.

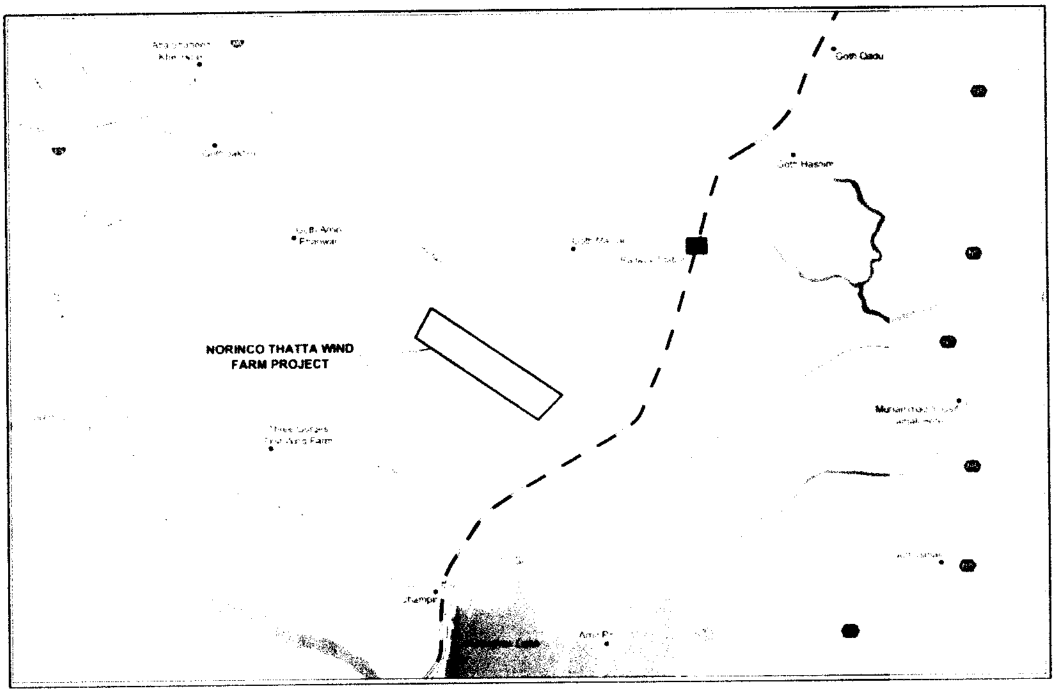


Figure ES1: Location of Project Site

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 IEE Study for assessment of impact of different activities for establishment of NTWF Project. The review process finds that:

- The impacts from NTWF 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 NTWF 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 NTWF Project would be economically viable and environment friendly.

Executive Summary

The Initial Environmental Examination (IEE) Study for "Norinco Thatta Wind Farm Project" has been conducted by EMC Pakistan Pvt. Ltd. The IEE has been prepared in compliance with the requirement under section 17 of Sindh Environmental Protection Act, 2014 and SEPA IEE/EIA Regulations 2014 for scheduled development projects.

The proposed project is the establishment a 100 MW Wind Farm in Jhampir in Thatta District. The project site is about 2500 acres acquired by the proponent for this project. NTWFP has an installation capacity of 100MW, 40 sets of GW121-2500-90m wind turbines will be installed.

Sindh Environmental Protection Act 2014 empowers the Sindh Environmental Protection Agency (SEPA) as the principal authority for environmental management in Sindh. It has also established the requirement of environmental assessment of any project in place prior to commencement of work.

According to Sindh Environmental Protection Agency Regulation, 2014, a project falling in any category listed in Schedule I shall file an IEE with the Sindh Environmental Protection Agency (SEPA). **Wind project** are placed in Schedule I: B(7) thus requiring an IEE.

Entrusted by NORINCO INTERNATIONAL (Project Proponent), POWERCHINA Northwest Engineering Corporation Limited is the Design Consultant. The design in the feasibility study stage mainly involves engineering geology, wind resources, WTG (wind turbine generator) type selection and electric power generation estimate, electrical engineering, civil works, environmental protection and water & soil conservation, design budget estimate, financial evaluation and social effect analysis, etc.

The long-term friendly relationship between China and Pakistan and relevant policies of Pakistan encouraging foreign investment to enter the electric power sector, provide a good basis and facilitate the cooperation of both parties in the power sector. Currently, China and Pakistan have worked together on development of many power projects, establishing a solid foundation for further cooperation. The construction of Thatta wind farm will promote the sustainable growth of local economy, improve the living standard of local residents, facilitate the development of local electric power industry, and meet the demand of sustainable development of Chinese enterprises in the international market. Therefore, the construction of the project is necessary.

The main objectives of the NTWF 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.

Thatta wind farm project (100MW) is located at Jhimpir in Sindh Province of Pakistan, about 110km northeast away from Karachi and 80km northeast away from Port Qasim, with geographical coordinates of 68°0′4"~68°3′55" E and 25°5′23"~25°8′4" N. The project area stretches in nearly northwest-southeast direction, with a length of about 6.7km and a width of 1.6km. The elevation of the project area is 40m~60m. The project area can be reached through M9 Highway from Karachi to Nooriabad.

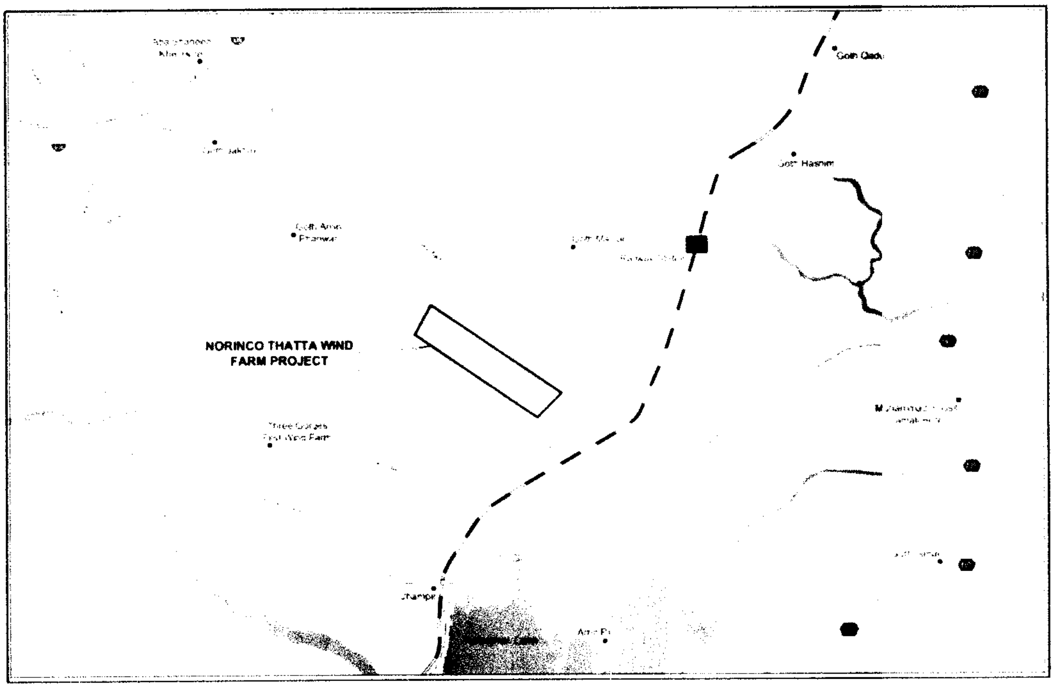


Figure ES1: Location of Project Site

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 IEE Study for assessment of impact of different activities for establishment of NTWF Project. The review process finds that:

- The impacts from NTWF 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 NTWF 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 NTWF Project would be economically viable and environment friendly.

- No untreated wastewater would be discharged from the NTWF 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 NTWF 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 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 NTWF Project operations will have no significant impact either on its microenvironment that includes the proposed site for NTWF Project, or on its macroenvironment.

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 NTWF Project has remained an isolated component of the ecosystem of Lower Sindh for a long time. Location of NTWF 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 Jhimpir.
- On the Other hand, the site is already designated for Wind Power projects and 11 wind farms are constructed or planned near the NTWF site (as described in figure 4.10).
- Visual effect, noise effect, EMI effect, flicker effect induced by operation of the wind turbines may have an impact on the living area, located 500 m from the NTWF Project. Therefore as a mitigation measure, it is proposed that wile siting the WTGs, a distance of 1 km should be maintained from Haji Suleman Brohi Village. 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.
- Results from Stakeholder consultation with key informants of Haji Suleman Brohi Village suggests that the expectations of villagers should be met e.g. priority in unskilled Jobs during construction, provision of healthcare facility, installation of WTGs not too close to their village.
- 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. Kinjhar Lake is located far at a distance of 10 km away from the project.
- Finding of archaeological artifacts during the construction phase will be immediately reported to the Department of Archaeology, Sindh.
- The proposed NTWF Project, when commissioned, would become integral part of microenvironment of already developed wind farm area.

This IEE Study finds that the value-addition characteristics of NTWF 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".

It is therefore concluded that if the field activities, including the implementation of all mitigation measures, are carried out in line with recommendations suggested in the report, the impacts from project's construction and operations will not be adverse so as to deteriorate the environmental quality of the project area and a more detailed report will not be required in the form of an EIA. Additionally careful implementation of the EMP will ensure that environmental impacts are managed and minimized and the project proponent meets all statutory requirements.

There are two essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. The Proponent shall ensure that:

- All mitigation, compensation and enhancement measures proposed in this IEE report are implemented in full, as described in the document;
- The Environmental Management and Monitoring Plan will be implemented in letter and spirit.

Screening of potential impact suggests that the Construction & O&M of Norinco Thatta Wind Farm Project will, on adoption of the suggested mitigation measures, be an environmentally acceptable proposition and provide clean and renewable energy. It is recommended that the IEE be approved with the condition that recommendations given in the IEE and NOC will be duly followed by the proponent.

Table of Contents

ANNEXURES

List of Tables

List of Figures

Abbreviations

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
GoP	Government of Pakistan
GOS	Government of Sindh
IEE	Initial Environmental Examination
IMC	Independent Management Consultant
NEQS	National Environmental Quality Standards
NOC	No Objection Certificate
NTDC	National Transmission and Dispatch Company
PGA	Peak Ground Acceleration
PMD	Pakistan Meteorological Department
SEPA	Sindh Environmental Protection Agency
TDS	Total dissolved solids
TSS	Total Suspended Solids
WB	World Bank
WHO	World Health Organization

Chapter 1 Introduction

This report presents the findings of the Initial Environmental Examination (IEE) Study conducted by EMC Pakistan Pvt. Ltd for proposed "100 MW Norinco Thatta Wind Farm Project (hereinafter referred to as NTWFP)" located at Jhimpir in Thatta District being undertaken Norinco International. (hereinafter referred as Project Proponent).

The proposed project is the establishment a 100 MW Wind Farm in Jhampir in Thatta District. The project site is about 2500 acres acquired by the proponent for this project. NTWFP has an installation capacity of 100MW, 40 sets of GW121-2500-90m wind turbines will be installed.

This Environmental & Social Impact Assessment (ESIA) Report presents the assessment of environmental and social impacts of the proposed project. This document has been prepared in compliance with the mandatory requirements of **Section 17 of Sindh Environmental Protection Act (SEPA) 2014**. Compliance with the Provisions of SEPA 2014, Section 17 requires that:

"No proponent of a project will commence construction or operation unless he has filed with the Agency an environmental impact assessment, and has obtained from the Agency approval in respect there of".

EMC Pakistan Pvt. Ltd has been commissioned by the Project Proponent to conduct the Initial Environmental Examination (IEE) Study of proposed NTWFP for local regulatory approval from the Environmental Protection Agency of Sindh Province, & to meet the requirements of the specified reference framework as follow:

- Applicable national laws and regulations in Pakistan;
- Sindh Environmental Protection Act, 2014;
- Sindh Environmental Protection Agency (SEPA) Review of IEE/EIA regulations 2014;
- Other applicable laws, regulations and guidelines for environmental & social safeguard.

Not only to meet the regulatory requirements, the purpose of this IEE is also to assess the project's environmental and social viability through various environmental and social components like air, water, noise, including land, ecology, human settlements, land acquisition along with the parameters of human interest and to prepare Environmental Management Plan (EMP) for mitigation of adverse impacts along with chalking out of post project environmental monitoring programme. This report presents baseline data collected for air, water, noise including land, ecology and socio-economic components of environment, identification, prediction and evaluation of impacts and preparation of environmental management plan for mitigation of adverse impacts that may arise due to the proposed project.

1.1. Need and Justification of the Project

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 government of Pakistan decided to develop wind power energy sources due to problems supplying energy to the southern coastal regions of Sindh and Balochistan. Gharo Wind Corridor (Figure 1.1) has coverage of 9,700 sq. km in Sindh and having a gross wind power potential of 43,000 MW. Keeping in view the area utilization constrains etc. the exploitable electric power potential of this area in Sindh is about 11,000 MW. Therefore to exploit this resource of renewable energy, Project proponent is undertaking this project of 100 MW capacity.

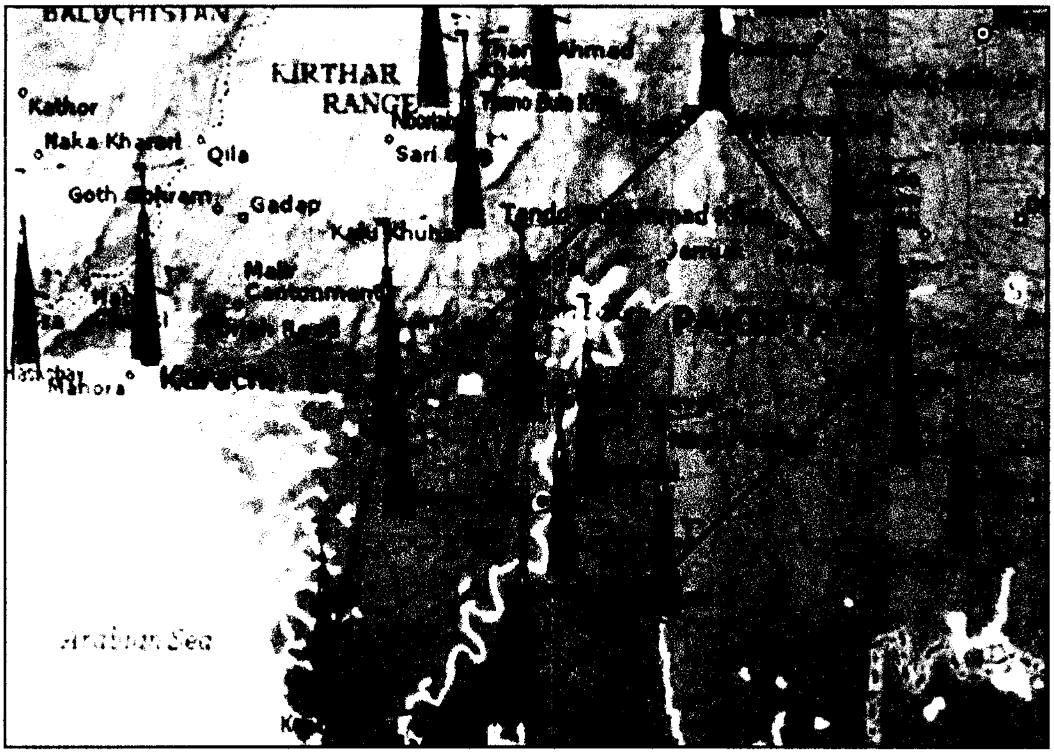
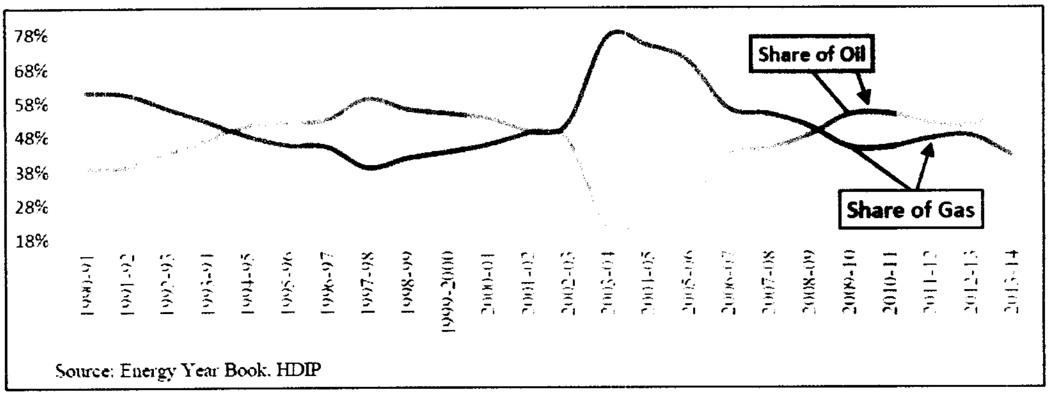


Figure 1.1: [illegible] Wind Corridor (Source: Pakistan Meteo[illegible])

1.1.1. Energy Overview

Electricity although the secondary source of energy has become indispensable not only for household but for all other sphere like industry, transport etc. Power shortages have become the most influential economic challenge not only causing social disruption but also hitting the real GDP growth rate. In NEPRA State of Industry Report 2013, NEPRA estimated, "the power sector is responsible for 2 to 3 percent reduction in the annual GDP of the country." However, exact cost including direct and indirect cost of power shortage and its directional relationship with growth is still unfold for developing economies especially for Pakistan. In this era of modernization, there is continuous increase in consumption of electricity within household as innovation has introduced more electrical-usage appliances to household. With respect to industry, the behavior is little bit different as due to power shortage the large manufacturers have got their own captive plants to generate electricity and thus became Independent Power Producers (IPPs) under the Power Policy 2002. Nishat, Gul Ahmed, Orient, etc. are some of the examples. All IPPs under the 1994 policy were thermal power plants often using furnace oil as a fuel. Thus the share of oil in thermal power generation remained high which also created a heavy dependence on oil prices.



[illegible] 2 Share of Oil a[illegible]ation

At present, the people are facing severe load shedding/blackout problems due to shortage of 5-7 GW power supply. The natural gas demand grows beyond the transmission/supply capacity and large users mainly industries, power plants, cement industries and transport sector (CNG stations) are curtailed specially during winter months to ensure supplies to domestic, commercial and small industries or fertilizer. The energy crisis in the country has forced thousands of industries to shut down operations, affecting industrial production and the livelihoods of thousands of families. It has been a major drag on the economy and a serious impediment to growth with an estimated cost of 10% of the GDP over the past 5 years. Pakistan's energy crisis, if not tackled at both operating and strategic level in the immediate future, might become a national security threat.

Table 1.1 shows the projections of power supply and demand in the NTDC's systems indicating that the gap between supply and demand is likely to persist over next few years. The gap represents about one-third of the total demand in National Transmission and Dispatch Company (NTDC) system resulting in as much as 12 hours of load shedding in urban areas and at times more than 18 hours of load shedding in rural areas. Any slippage in the addition of new generation capacity or fuel availability will further widen the gap between supply and demand.

Chronic power shortages in Pakistan are the most serious constraints to the country's economic growth and job creation. The energy crisis continues to drag down the country's economic performance and spark social instability. Increasing an unpredictable load shedding is estimated to constrain annual gross domestic product (GDP) growth by at least 2%. Hardest hit are the small- and medium-sized enterprises that employ the most number of people but cannot afford back-up electricity generators and fuel. In addition to the economic impact, the shortage has environmental and social consequences as well. Other than complaints of general discomfort, students have complained of effects of the load shedding on their studies. It has resulted in deterioration of health care services. The environmental impact of the shortage has not been studied but potential impacts include increased use of firewood, kerosene, biomass and their effects on deforestation and air quality. As there are no regulatory control over the emission from these small generators, widespread use of generators in the cities results in emissions of nitrogen oxides, particulate matter and sulfur dioxide (from diesel generators) from generator exhaust and hence contributing to the urban air pollution. These generators are also a major source of noise.

Table 1.1: Projected Supply and Demand in NTDC Systems				
Financial Year ending 30th June	**Planned Generation Capability as per NTDC (MW)**	**NTDC Projected Demand Growth Rate**	**NTDC Projected Demand during peak hours (MW)**	**Surplus/ (Deficit) (MW)**
NTDC				
2012 (actual)	13,733	-	20,058	-6,325
2013	21,299	7.4%	24,126	-2,827
2014	21,668	7.4%	25,918	-4,250
2015	30,510	7.7%	28,029	2,481
2016	20,352	5.5%	24,018	-3,666
2017	24,075	5.5%	25,352	-1,277
Source: NEPRA's State of Industry Report, 2012				

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 1.3.

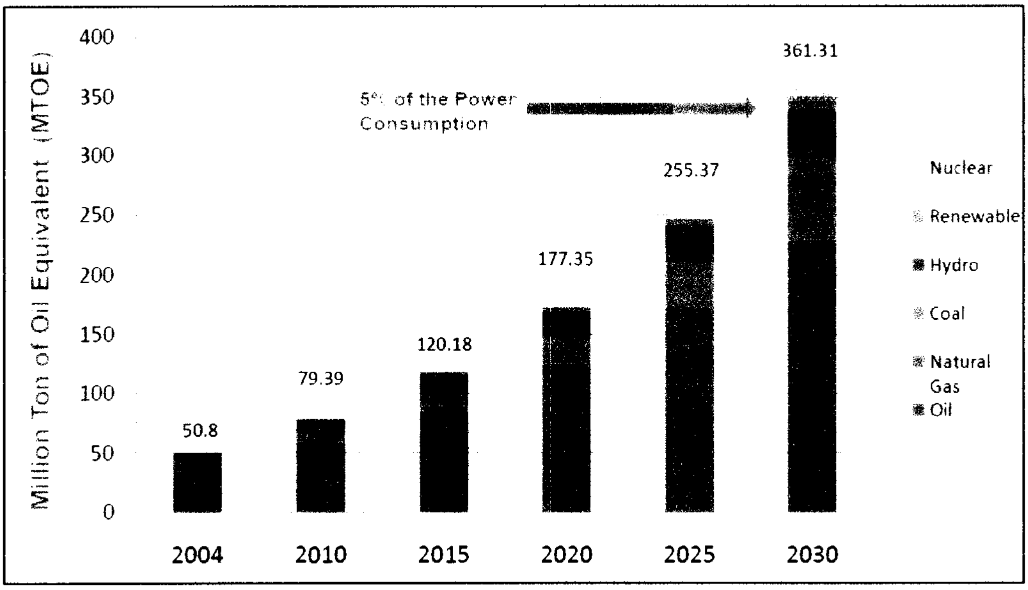


Figure [illegible] Energy Mix Plan Projection (Source [illegible])

The Government considers Thar coal development as a flagship project and believes in it as a means to Energy Security. Thar Coal Projects have been enlisted as early harvest projects by the CPEC (China-Pakistan Economic Corridor), Sindh Engro Coal Mining Company (SECMS) and Sino Sindh Resources (Pvt.) Limited (SSRL) has been prioritized as top priority projects to be financed by Chinese institutions. There is a complete synergy between the Federal and the Provincial Government of Sindh. Total power generation anticipated from these three projects is 2400 MW by 2018.

In addition to Thar Coal resources, 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.

1.1.2. Preliminary analysis of power market

According to WAPDA's data, the maximum loads of Pakistan's power grid will be 27840 MW and 31900 MW in 2017 and 2020, respectively. Considering appropriate load reserve, the installed capacities are required to be about 36190 MW and 41470 MW respectively, to meet the Pakistan's power demand by 2017 and 2020. As of 2013, the existing thermal power capacity of Pakistan reached 16000MW, the hydropower capacity 6872MW, and according to the power construction planned in the schedule, 3765MW and 7425MW new power sources will be commissioned respectively in 2017 and 2030, but there would be still a big supply-demand gap by 14777MW and 17220MW respectively in 2017 and 2030.

As a clean energy, wind power has bright future, but due to its instability, wind power share in the grid should not be too large. It is commonly believed that in case of wind power capacity not more than 10% of the total installed capacity, the grid operation should be economical and safe, but given different power source structures and different grid compositions, some countries, such as like Germany, Denmark, France and Spain, have higher proportions of wind power in their national grids. The power supply structure of Pakistan is not so rational, mainly depending on thermal power, and with poor stability. Therefore, the power market analysis is made based on two scenarios separately with lower and higher shares, i.e. Scenario 1 (wind power capacity accounting for 10% of the total installed capacity) and Scenario 2 (wind power capacity accounting for 5% of the total installed capacity). The preliminary analysis of wind power market is shown in Table 1.2.

Table 1.2: Preliminary analysis of wind power market in Pakistan

Designation		2017	2020
Maximum load (MW)		27840	31900
Total installed capacity (MW)		36190	41470
Wind power capacity of electric system (MW)	Scenario 1 (10%)	3619	4147
	Scenario 2 (5%)	1810	2074
Wind power capacity of existing, under-construction & planned wind farms (MW)		750	750
Required additional wind power capacity (MW)	Scenario 1 (10%)	2869	3397
	Scenario 2 (5%)	1060	1324

Based on Scenario 1, it is preliminarily estimated that, besides the capacities of the existing and planned wind farms, additional wind power capacities will be required by 2869 MW as of 2017 and 3397 MW as of 2020, respectively; based on Scenario 2, additional wind power capacities will be required by 1060MW as of 2017 and 1324MW as of 2020, respectively. Wind power has big potential to enlarge in capacity.

Due to the oil and coal shortage problem, as well as the long-term of hydropower construction, its near-term power demand cannot be satisfied at earlier time. However, the ideal endowment of wind energy resources and the short construction cycles make the wind power as the best power source option to satisfy the power market demand, and also as one of sustainable energies to meet the increasing power demand in Pakistan.

The present energy consumption structure is quite unbalanced, as the dependency degree on petroleum and natural gas products is higher than 79%, and their annual demands increase by 5.7% and 7.5%. To satisfy the ever-increasing energy demand, the government of Pakistan has to spend large amounts of foreign exchanges to import crude oil and associated products, which brings about a great pressure on Pakistani finance, national economy and environment. As a clean energy form, wind energy features low-energy consumption and short construction period, which can suit Pakistani power development well. Preliminary analysis of wind energy potential shows that wind power still has a great development space in Pakistan. However, it should be noted that with the fast development pace and flocking investors, the grid interconnection permit for the project should be applied for and obtained as earlier as possible, in order to get one favourable electricity tariff, and speed up the project construction.

1.1.3. 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 1.4 and 1.5:

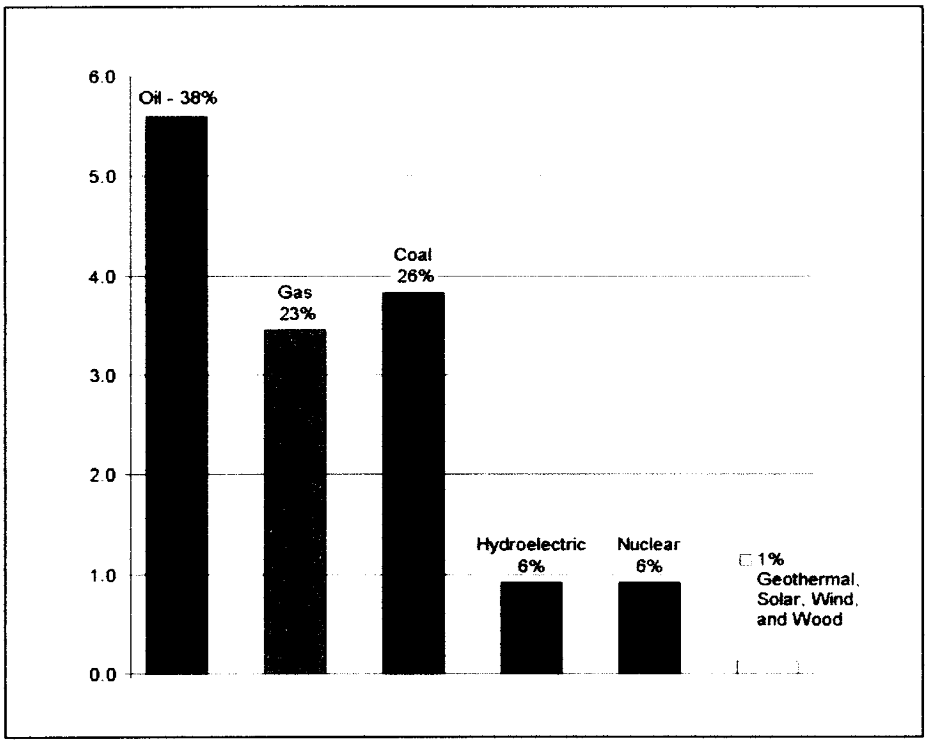
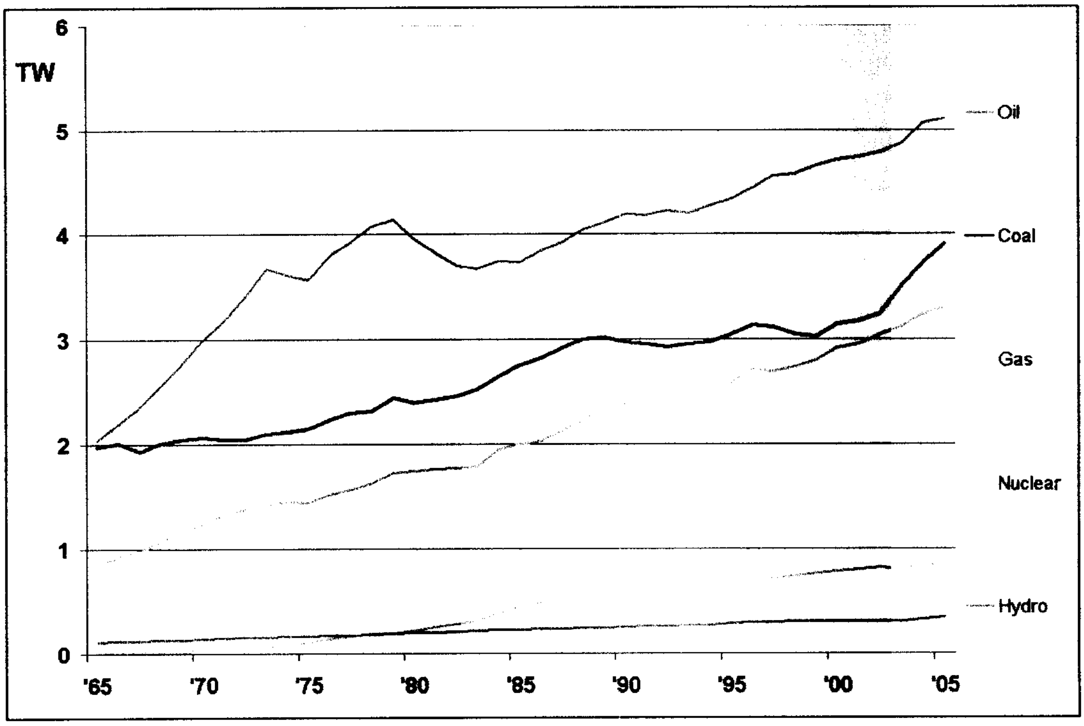


Figure 1.4: Worldwide Energy Supply in [illegible]



World E ... 2005

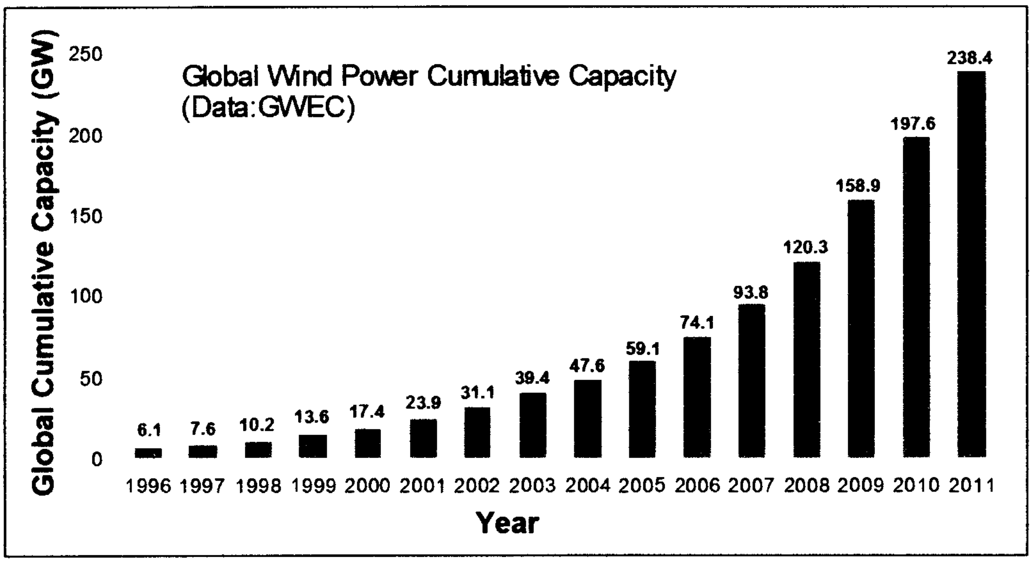
According to estimates on Global Demand Forecast:

- 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.

1.1.4. 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.



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 km2 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.
- Pakistan has about 1000 MW of wind power plants at various stages of 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.

1.1.5. 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 1.3 shows that requirement of land area per unit of energy produced from different sources is highest for wind power. Project proponent 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 1.3: 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.

1.1.5.1. 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:
- CO2 (a major contributor to the "greenhouse effect") 0.775 million tonnes/year.
- H2O vapour: 0.634 million tones/year
- SO2 (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.

1.1.5.2. 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 CO2 emissions range from 0.33 to 0.59 tonnes of CO2 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.

1.1.5.3. 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.

1.1.6. Necessity of project construction

(1) Complying with the industrial development policy for renewable energy sources in Pakistan

In the 2030 Energy Strategy Plan, the government of Pakistan puts the renewable energy generation at an important strategy position. In accordance with the Pakistan Vision 2030, the government makes a definite plan on renewable energy development, and the installed capacity of renewable energy shall reach 800MW by 2015 and 970MW by 2030, accounting for 5% of the total installed capacity. The government encourages investment and utilization of renewable energy, constitutes policies and strategies for renewable energy, including mini hydropower (not exceeding 100MW), wind power and solar power. The project construction complies with the industrial development policy of renewable energy sources in Pakistan, and will also promote the local wind power industry development.

(2) Meeting the demand for energy structure improvement

Currently, the energy structure of Pakistan is dominated by thermal power, depending highly on oil and natural gas. In recent years, the continuous price rising of oil and gas in the international market has brought huge economic pressure to Pakistan. Based on the long-term strategy of ensuring energy dominion and in order to reduce the dependence on oil, the Pakistan government constitutes a series of energy development plans to encourage renewable energy development so as to promote the energy consumption restructuring. As a clean energy form, the implementation of this wind farm project shall improve the energy structure to some extent, and be favorable to increase the proportion of renewable energy in the power system.

(3) Rational exploitation of wind energy resources to ease power shortage problem

Pakistan suffers serious power shortage problem. It is reported that, in the peak time of electric shortage, power cut would be 6 hours per day in Islamabad, 9 hours in Karachi, and more than 12 hours or even 16 hours in other cities or surrounding areas. In the end of December 2008, blackout time in most middle and small cities last 20 hours to 22 hours, and exceeded 18 hours even in the metropolis like Karachi.

Sindh province where Thatta wind farm is proposed to be located is one of regions where wind energy can be utilized. With appropriate wind speed, better wind quality and steady prevailing wind direction, the wind energy resource is better, having better development prospect. Upon completion, the wind farm would partly increase the system power supply and mitigate power shortage problem in the country.

(4) Meeting the demand for sustainable development of local and national economy

Power shortage in Pakistan has imposed increasing restriction on the national economic development. Along with economic growth, the power shortage would be more serious. Some enterprises have to close due to shortage of power, which would result in the unemployment rate growth. Construction and operation of this project would promote the development of related local industries such as building materials, transportation, equipment manufacturing, benefit employment increase, tax revenue increment and third industries development, and promote the national economy development and social progress.

(5) Meeting the demand for improving and protecting ecological environment

It is a common aspiration of the world people to protect and improve the environment the human being depends on so as to realize sustainable development. The effective approaches to improve and protect ecological environment include developing and utilizing natural resources reasonably, improving the way of resource utilization, adjusting the structural configuration of resource, raising the utilization rate of resource, etc. Wind energy is clean and renewable, the development and construction of wind farms can effectively reduce the consumption of conventional energy and protect ecological environment. Currently due to the electricity shortage, some enterprises in Pakistan can only depend on thermal power, which results in large amounts of pollutions such as sulfur dioxide emission. The construction of Thatta wind farm will reduce the emission of pollutions to some extent and therefore benefit ecological environment protection in Pakistan.

(6) Meeting the demand for sustainable development of going-global strategy of Chinese enterprises

In the trend of economic globalization, the Chinese enterprises must face the international competition and go globally to seek survival and growth in the international market.

According to relevant polices issued by Chinese government, Chinese enterprises are encouraged to invest overseas in accordance with international practices, conduct overseas project contracting and labor export service, enhance cooperation and development under mutual benefit, and develop technical and economic cooperation with neighboring countries.

In recent years, China strengthens the strategy of "going global", encourages and supports the competent enterprises to invest overseas. Construction of Thatta wind farm would meet the demand of sustainable global development of Chinese enterprises.

(7) Providing investment opportunity to Chinese enterprises on the basis of good cooperation between China and Pakistan

The long-term friendly relationship between China and Pakistan and relevant policies of Pakistan encouraging foreign investment to enter the electric power sector, provide a good basis and facilitate the cooperation of both parties in the power sector. Currently, China and Pakistan have worked together on development of many power projects, establishing a solid foundation for further cooperation.

Above all, the construction of Thatta wind farm will promote the sustainable growth of local economy, improve the living standard of local residents, facilitate the development of local electric power industry, and meet the demand of sustainable development of Chinese enterprises in the international market. Therefore, the construction of the project is necessary.

1.2. Project Proponent

Entrusted by NORINCO INTERNATIONAL (Project Proponent), POWERCHINA Northwest Engineering Corporation Limited conducted the feasibility study of Thatta wind farm. The design in the feasibility study stage mainly involves engineering geology, wind resources, WTG (wind turbine generator) type selection and electric power generation estimate, electrical engineering, civil works, environmental protection and water & soil conservation, design budget estimate, financial evaluation and social effect analysis, etc.

1.3. Brief Description of Project

The proposed project is the establishment a 100 MW Wind Farm in Jhampir in Thatta District. The project site is about 2500 acres acquired by the proponent for this project. NTWFP has an installation capacity of 100MW, 40 sets of GW121-2500-90m wind turbines will be installed.

The project components include:

- Wind resource use assessment for macro-siting the Wind Farm in the Jhimpir Wind Corridor.
- Acquisition of data from Karachi Meteorological Station.
- Geological survey.
- Finalizing the layout plan for siting the selected wind turbines.

- Construction of access road linking the wind turbines and for transportation of other equipment.
- Installation of selected wind turbines with generation capacity of 2 MW and 2.5 MW.
- 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 substation.
- Construction of operations and control buildings.
- O&M of Wind Farm and decommissioning.

1.3.1. Objectives of the Project

The main objectives of the NTWF Project are to:

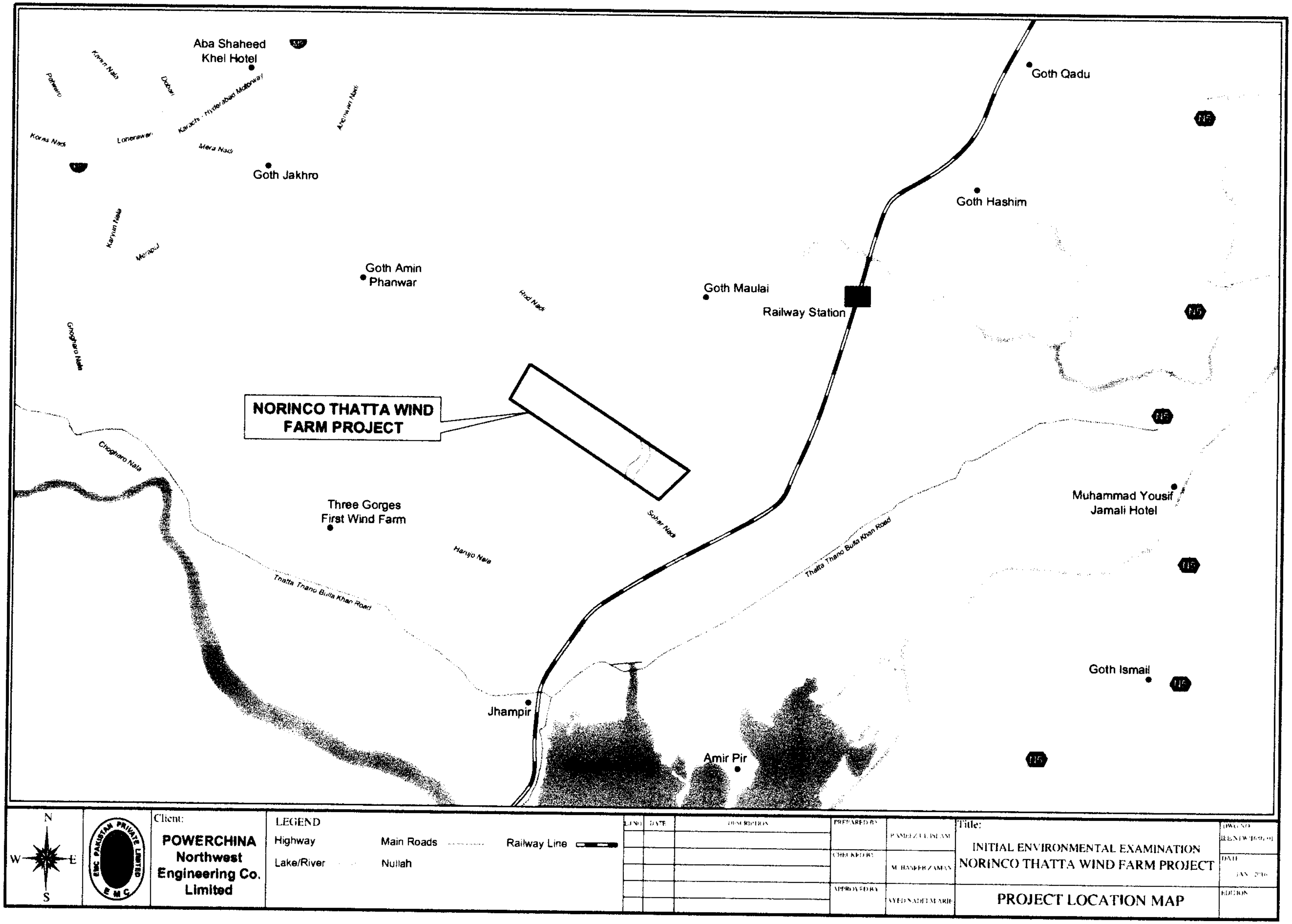
- Respond to the national need to produce power from alternative or renewable energy sources that are alternative to thermal and hydro power production systems;
- Establish a wind power generation facility in accordance with GOP's policy and guidelines on development and generation of alternative or 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.

1.3.2. Location of the Project

Thatta wind farm project (100MW) is located at Jhimpir in Sindh Province of Pakistan, about 110km northeast away from Karachi and 80km northeast away from Port Qasim, with geographical coordinates of 68°0'4"~68°3'55" E and 25°5'23"~25°8'4" N. The project area stretches in nearly northwest-southeast direction, with a length of about 6.7km and a width of 1.6km. The elevation of the project area is 40m~60m. The project area can be reached through M9 Highway from Karachi to Nooriabad. The location map is proposed Project is presented in Figure 1.7. The coordinates of project site boundaries are listed in Table 1.4.

Table 1.4: Project Site Boundaries

S. No.	Longitude	Latitude
1	25°07'19.17"N	68°0'3.89"E
2	25°08'3.98"N	68°00'31.41"E
3	25°5'23.28"N	68°03'14.82"E
4	25°6'0.54"N	68°3'54.69"E


Aba Shaheed Khel Hotel
Goth Qadu
Goth Jakhro
Goth Hashim
Goth Amin Phanwar
Goth Maulai
Railway Station
NORINCO THATTA WIND FARM PROJECT
Choghiaro Nala
Muhammad Yousif Jamali Hotel
Three Gorges First Wind Farm
Thatta Thano Bulla Khan Road
Thatta Thano Bulla Khan Road
Goth Ismail
Jhampir
Amir Pir
N
W
E
S
EMC PAKISTAN PRIVATE LIMITED
EMC
Client:
POWERCHINA Northwest Engineering Co. Limited
LEGEND
Highway
Main Roads
Railway Line
Lake/River
Nullah
Title:
INITIAL ENVIRONMENTAL EXAMINATION
NORINCO THATTA WIND FARM PROJECT
PROJECT LOCATION MAP

1.4. Initial Environmental Examination (IEE)

The IEE study aims to assess the environmental and social impacts likely to result from the activities proposed under the context of Norinco Thatta Wind Farm Project and propose suitable and practicable mitigation measures for the identified social and environmental impacts. The study will be undertaken to fulfill the legislative requirements stipulated in Sindh Environmental Protection Act (SEPA), 2014 and rules and regulations framed there under.

The IEE shall cover following key aspects during its course of execution:

- Collection of baseline data for physical, biological and socio-economic components for assessment of potential impacts of project activity
- To assess all the major and minor environmental and socio-economic aspects due to project activities in the area in accordance with the national and international environmental legislations, especially the Sindh Environmental Protection Act (SEPA) 2014 and IEE/EIA review guidelines.
- To propose appropriate mitigation and monitoring measures that can be included into the design of the project to minimize or prevent any potential adverse effects identified by the assessment.
- To develop a detailed Environmental Management Plan (EMP) for the sustainable implementation mechanism of mitigation measures identified during the study.

1.4.1 Categorization of the Project

The Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2000 define Schedules (I & II) of projects falling under the requirement of IEE or EIA. This IEE Study has, for environmental classification of the Project into Category A or B, taken account of the requirements of the Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2014 which define Schedules (I & II) as follows:

Schedule I: A project falls in Schedule I if it is likely to have adverse environmental impacts, but of lesser degree or significance than those for category 'A' and all the mitigation measures to handle the impact is manageable. Such types of projects need IEE report including EMP.

Schedule II: Projects are categorized in Schedule II if they generate significant adverse environmental impacts that require a comprehensive management plan, or if the project is located within or passes through: a) Areas declared by the Government of Pakistan as environmentally sensitive (National Parks/Sanctuaries/Game Reserve), b) Areas of international significance (e.g. protected wetland as designated by the RAMSAR Convention), or c) Areas designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as cultural heritage sites.

According to Sindh Environmental Protection Agency Regulation, 2014, a project falling in any category listed in Schedule I shall file an IEE with the Sindh Environmental Protection Agency (SEPA). **Wind project** are placed in Schedule I: B (7) thus requiring an IEE.

1.5. Adopted Methodology for IEE Study

Various steps were undertaken in order to conduct, prepare and present this IEE report. Brief details on those steps are given below while description is documented in the subsequent sections of this report.

1.5.1. Understanding of the Proposed Operation

This step required collection of information from the proponent on the proposed project and understanding the activities to identify potential impacts from them.

1.5.2. Review of Legislation and Guidelines

National legislation and environmental guidelines were reviewed to set environmental standards that the proponent of the proposed project will be required to adhere to, during the different stages of the project.

1.5.3. Secondary Data Collection

All available published and unpublished information pertaining to the background environment was obtained and reviewed. It included previous environmental studies and environmental baselines conducted by EMC Pakistan Pvt. Ltd. and associated consultants in the past, in the project area and/or its surroundings. All data sources were carefully reviewed to collect project area's related information with regard to physical, biological and socio-economic environment.

1.5.4. Field Data Collection

Detailed environmental baseline survey was conducted to collect primary data on the Project corridor to help identify sensitive receptors. The primary data were examined and compared with secondary data available from earlier environmental studies in the region. The scope of survey included collection of information on following key aspects:

(1) To confirm baseline data including Biophysical of the Project Area including the following items with their seasonal variability:

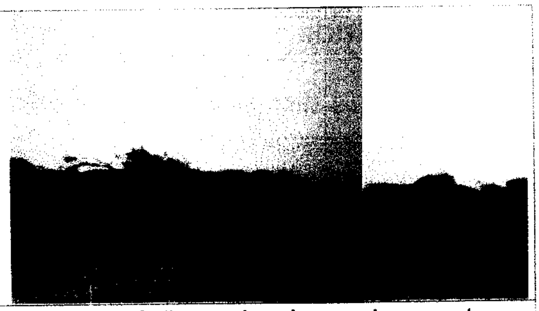
- Climate and Rainfal
- Air Quality
- Noise Quality
- Wind project phy
- Soil
- Geology
- Hydrology
- Vegetation
- Fauna
- Geomorphology

(2) To confirm baseline data including Socio Economic Environment of the Project Area including the following items with their seasonal variability

- Administrative Division
- Nearby village settlement

- Socio-Economic Activities
- Land use
- Existing Infrastructure and Social Services
- Current Resettlement Issues


Ecological Survey


View of villages in microenvironment


Consultation with Locals


Reconnaissance Survey

1.5.5 Consultation with Stakeholders

Stakeholder consultation: A stakeholder consultation was undertaken to document the concerns of the local village communities and other relevant stakeholders, and to identify issues that may require additional assessment in order to address these concerns. Stakeholder consultation was conducted during the survey with following objectives:

- To inform the Stakeholders and village Communities about the project
- To gather feedback from primary and secondary stakeholders of project
- To identify relevant potential issues, including the socioeconomic impact of the project, and corresponding mitigation measures.

During the stakeholder consultation process for the project, following key considerations were focused:

- Identification of sensitive receptors in the area
- Identification of nearby villages
- Concerns of the village members near the project alignment
- Concerns of other stakeholders about the negative and positive impacts of the project

1.5.6. Identification of Aspects

Identification of environmental aspects and their significance is fundamentally important for determination of severity of incidence of impacts at different stages of the project. This step is aimed at obtaining an inventory of the aspects. The aspects identified during this step cover all activities in order to determine those which have or can have significant impact on the environment.

1.5.7. Impact Assessment & EMP

Environmental experts at EMC analyzed and assessed the anticipated impacts that are likely to arise due to the identified aspects. Each of the potential impacts identified during the consultation session was evaluated using the environmental, socioeconomic, and project information collected. Air quality monitoring was undertaken to oversee the impact of gaseous emissions. In general, the impact assessment discussion covers the following aspects:

- Present baseline conditions
- Potential change in environmental parameters due to project
- Prediction of potential impacts
- Evaluation of the potential impacts
- Defining of mitigation measures to reduce impacts to as low as practicable
- Monitoring of residual impacts.

An environmental management plan (EMP) was developed to oversee the environmental performance of the project and adoption of proposed mitigation measures. A monitoring plan has also been incorporated in the EMP to monitor impact of all activities and performance of mitigation measures and to identify the residual impact if any, and also the positive/negative changes in the physical, and socioeconomic environment.

1.5.8. Documentation & Review

This is the final step of the IEE study. The data generated during and for the study are compiled and examined by experts of the respective field. Sections of this report were prepared as the study progressed, by EMC office staff in consultation with experts. The report was finally reviewed by Team Leader, who analyzed the information, assessed the potential environmental impacts in the light of national and international guidelines, and examined the alternatives in the light of observations on the field as well as meetings with the stakeholders, before organizing the Report in the present form.

1.5.9. Report Structure

This report locates the IEE process in the context of the current EIA/IEE legislation, describes in broad terms the important aspects of the proposed development, and the biophysical and social environments in which it will exist, and identifies possible issues relating to these environments that will be assessed in the IEE study. The structure of the report is as follows:

Section 1 Introduction

Section 2 Describes the proposed project and its associated activities;

Section 3 Contains an overview of applicable national regulatory requirements as well as international conventions, guidelines which are relevant to construction of the reverse osmosis plant and conservation of environment.

Section 4 Describes baseline of project area, which includes existing environmental conditions.

Section 5 Describes assessment of potential impacts of project along with appropriate mitigation measures for reducing these impacts.

Section 6 Defines the change management criterion for the environmental assessment and identifies the steps that need to be taken if there is a change in project activities or in the area where the project activities will be undertaken.

Section 7 The final section presents the conclusion of the IEE study.

The IEE report has been structured on the standard format, prescribed by the Federal EPA. The main text of the report is supported by a series of Annexures which provide auxiliary information including: Respective sections of prominent National and International Environmental Laws and Guidelines which form part of the environmental study are provided in the Annexures.

1.6 IEE Study Team

EMC composed the following team of experts and all experts were assigned specific tasks relevant to their expertise.

Table 1.5: IEE team members

S. No.	Name of Expert	Position in IEE Team
1.	Mr. Syed Nadeem Arif	Project Manager / Team Leader
2.	Muhammad Haseeb	Environmental Specialist/Project Coordinator
3.	Mr. Khurram Shams	Socioeconomic Expert
4.	Mr. Shahzad Rizvi	Sociologist
5.	Mr. Sultan Mehmood Zaman	Soil Scientist / Field Survey Supervisor
6.	Mr. Jalal Abbas	Environmental Scientist
7.	Mr. Saad Qudrat	Environmental Scientist
8.	Mr. Agha Sawood	Environmental Scientist / Field Surveyor
9.	Mr. Irfan Ali	Environmental Scientist / Field Surveyor

Chapter 2 DESCRIPTION OF PROJECT

This section describes the description of the project including the technical specifications, methodology for undertaking the Transmission Lines laying works and the necessary procedures to be followed per applicable national / international guidelines and standards.

Entrusted by NORINCO INTERNATIONAL, Powerchina Northwest Engineering Corporation Limited conducted the feasibility study of Thatta wind farm. The design in the feasibility study stage mainly involves engineering geology, wind resources, WTG (wind turbine generator) type selection and electric power generation estimate, electrical engineering, civil works, environmental protection and water & soil conservation, design budget estimate, financial evaluation and social effect analysis, etc.

2.1. Outline of the Project

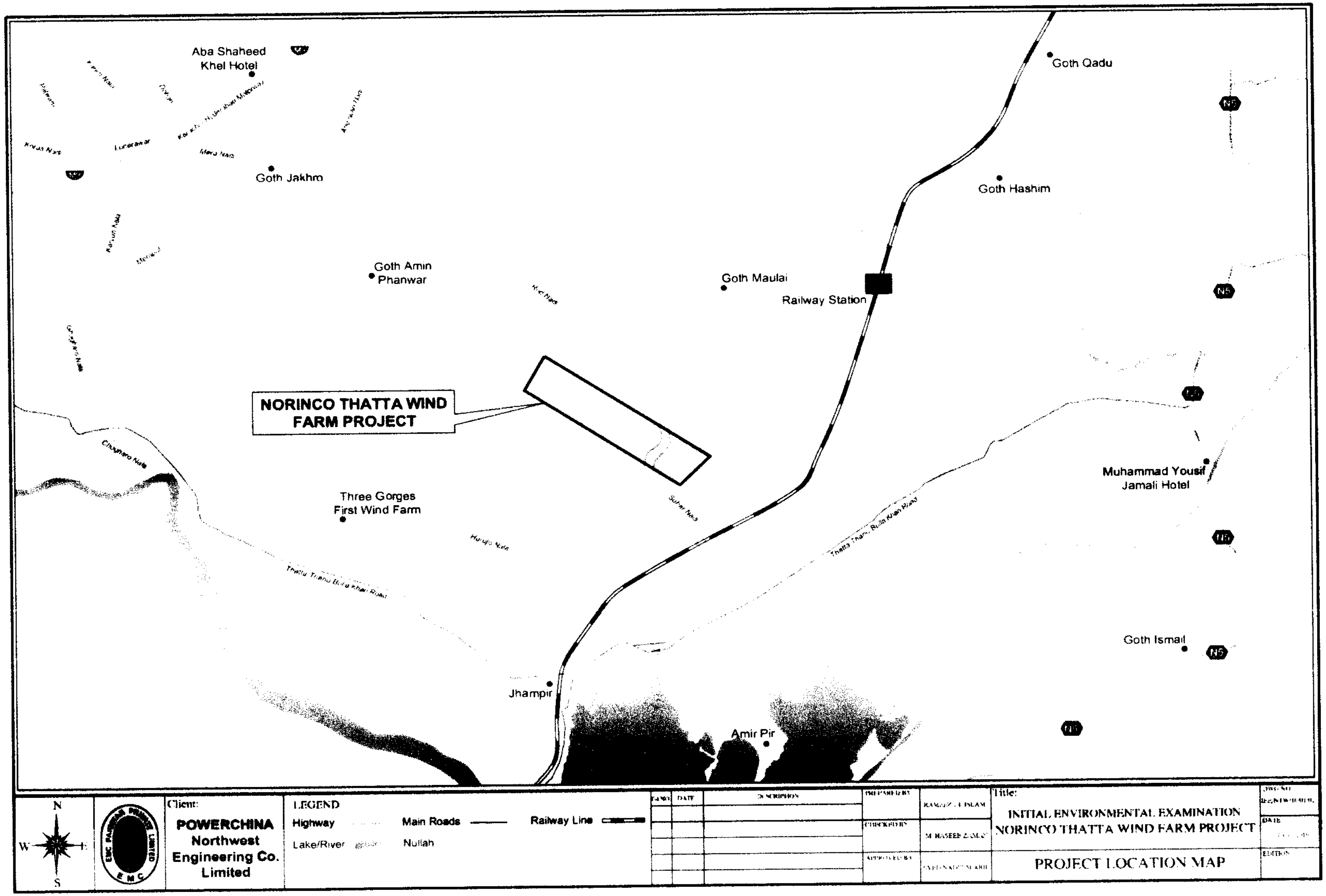
The proposed project is the establishment a 100 MW Wind Farm in Jhampir in Thatta District. The project site is about 2,500 acres acquired by the proponent for this project. NTWFP has an installation capacity of 100MW, 40 sets of GW121-2500-90m wind turbines will be installed.

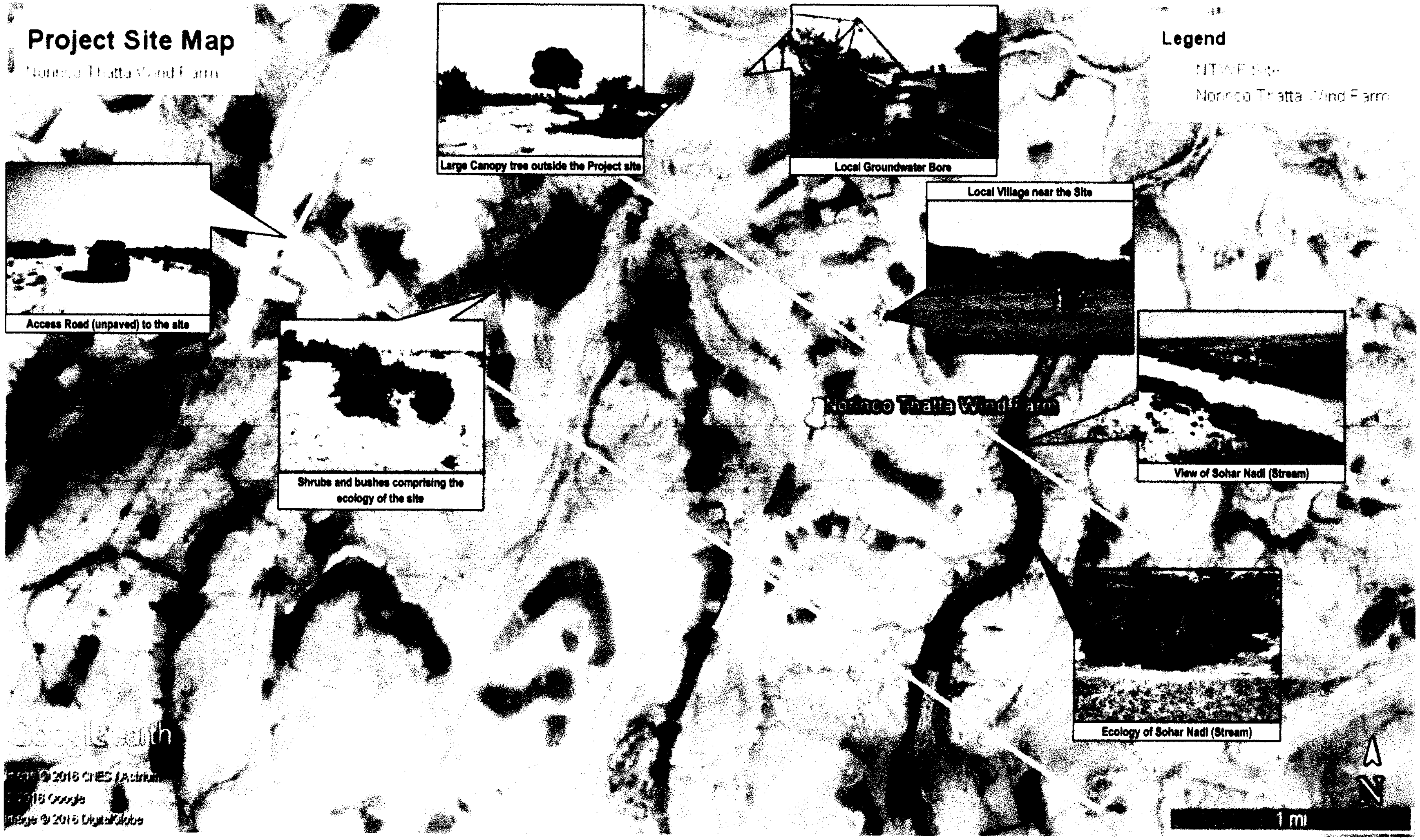
The project components include:

- Wind resource use assessment for macro-siting the Wind Farm in the Jhimpir Wind Corridor.
- Acquisition of data from Karachi Meteorological Station.
- Geological survey.
- Finalizing the layout plan for siting the selected wind turbines.
- Construction of access road linking the wind turbines and for transportation of other equipment.
- Installation of selected wind turbines with generation capacity of 2 MW and 2.5 MW.
- 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 substation.
- Construction of operations and control buildings.
- O&M of Wind Farm and decommissioning.

2.1.1. Location of the Project

Thatta wind farm project (100MW) is located at Jhimpir in Sindh Province of Pakistan, about 110km northeast away from Karachi and 80km northeast away from Port Qasim, with geographical coordinates of 68°0′4"~68°3′55" E and 25°5′23"~25°8′4" N. The project area stretches in nearly northwest-southeast direction, with a length of about 6.7km and a width of 1.6km. The elevation of the project area is 40m~60m. The project area can be reached through M9 Highway from Karachi to Nooriabad. The location map is proposed Project is presented in Figure 2.1.

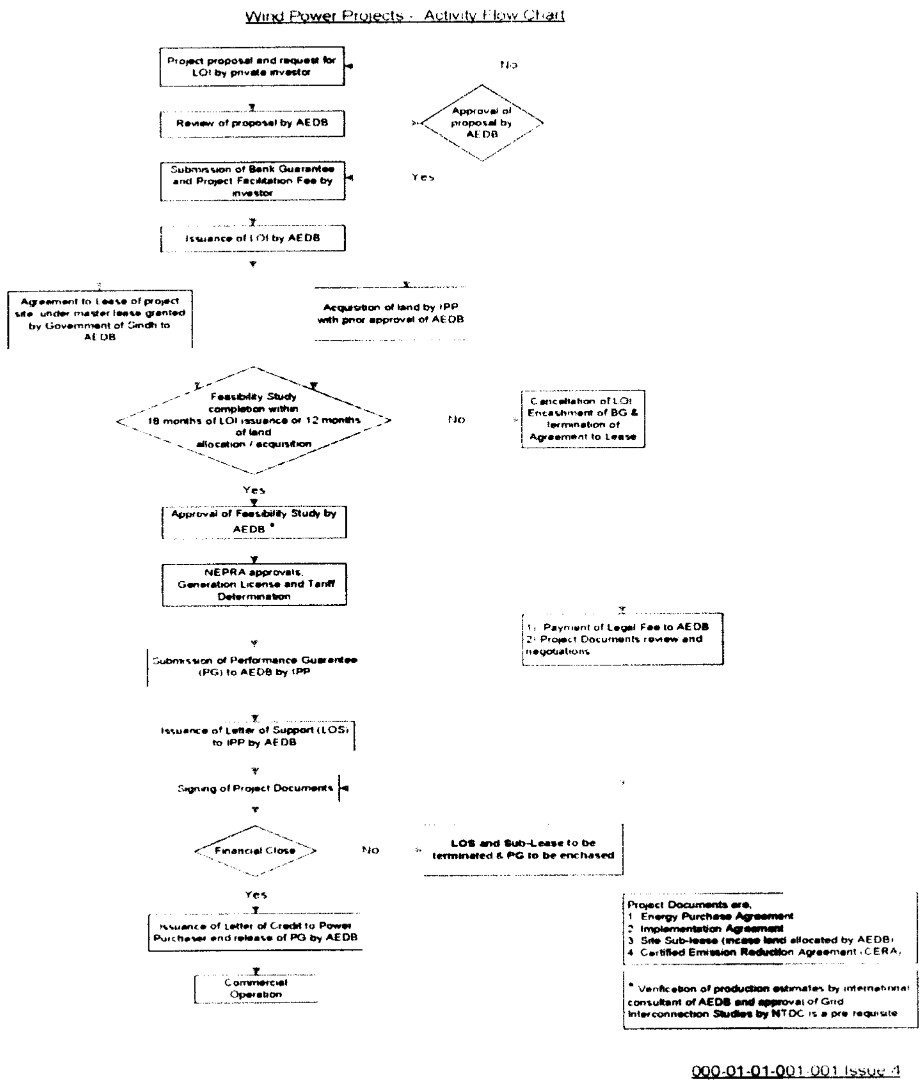

Aba Shaheed
Khel Hotel
Goth Qadu
Goth Jakhro
Goth Hashim
Goth Amin
Phanwar
Goth Maulai
Railway Station
NORINCO THATTA WIND
FARM PROJECT
Three Gorges
First Wind Farm
Muhammad Yousif
Jamali Hotel
Goth Ismail
Jhampir
Amir Pir
N
W
E
S
Client:
POWERCHINA
Northwest
Engineering Co.
Limited
LEGEND
Highway
Main Roads
Railway Line
Lake/River
Nullah
Title:
INITIAL ENVIRONMENTAL EXAMINATION
NORINCO THATTA WIND FARM PROJECT
PROJECT LOCATION MAP


Project Site Map
Legend
Large Canopy tree outside the Project site
Local Groundwater Bore
Local Village near the Site
Access Road (unpaved) to the site
Shrubs and bushes comprising the ecology of the site
Norinco Thatta Wind Farm
View of Sohar Nadi (Stream)
Ecology of Sohar Nadi (Stream)
1 mi

2.2. Technical Details of Project

2.2.1. Macro-Site Selection

Wind Power Potential of the Jhimpir Wind Corridor, the macro-site of Norinco Thatta Wind Farm Project was established after detailed survey by Karachi Meteorological Station. The AEDB has thereafter stated the activity flow chart of the project in Figure 2.3.



Activit

2.2.2. Determination of Wind Energy Potential For Micro-siting

2.2.2.1. *Basic Wind Data*

Wind data measured by two anemometer towers (Lucky and FFC) near Thatta wind farm have been collected. Lucky anemometer tower is 4km away from the center of the wind farm site in crow flight distance and FFC anemometer tower 7km. Wind data of both anemometer towers over a whole year are available and the integrity rate of valid data is relatively high.

To verify the representativeness of the anemometer towers, 3TIER numerical weather predication model of U.S. is used to conduct a simulating calculation on the wind resource situation over the past 30 years of this region, the result is shown in Figure 2.4, and the area pointed by arrow is the center of Thatta wind farm.

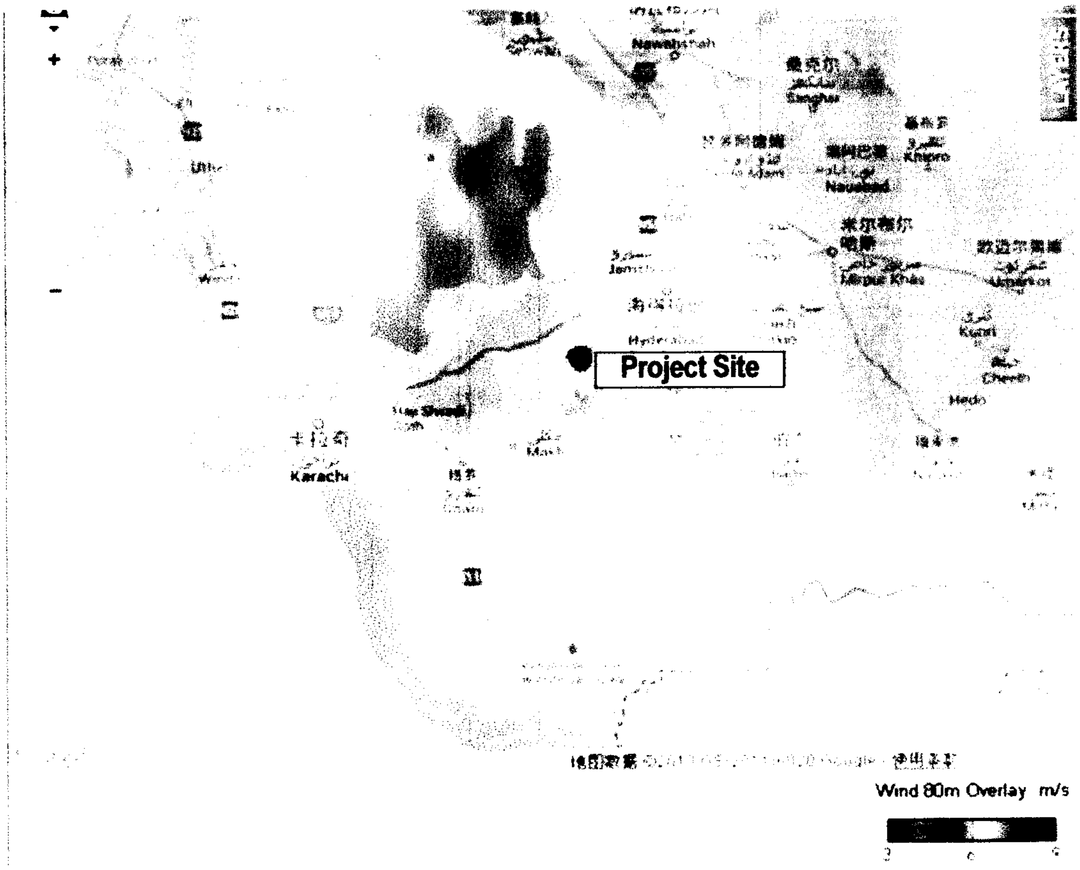


Figure 2.4: Simulated Wind [illegible] Distribution Map for Thatta Wind [illegible] Height by [illegible] Database

In accordance with the annual average wind speed at 80m height in Thatta wind farm area simulated with 3TIER database statistics is 8.1±1.1m/s, and the annual average wind speed at 80m height for both Lucky and FFC anemometer towers is 7.8±1.0m/s, it can be seen that the annual average wind speeds in the two areas have a little difference, indicating Lucky and FFC anemometer towers have a better representation with regard to Thatta wind farm. Lucky anemometer tower is only 4km away from the center of the wind farm and has a completed measured data of three years, thereby, the wind data of three years (January 1, 2009 ~ December 31, 2011) of Lucky anemometer tower is used as the basis of this wind resource analysis and calculation, and FFC anemometer tower is used as the reference.

The basic information of the anemometer towers is given in Table 2.1. The locations of the anemometer towers are shown in Figure 2.5.

Table 2.1: Basic Information of the Anemometer Towers in Thatta Wind Farm Area

Tower	Height	Wind measurement cycle	Coordinate	Elevation	Anemometer tower configuration
Lucky	85m	2009.01.07 ~	N 25° 8'08"	85m	Anemograph 10m\30m\60m\85

Table 2.1: Basic Information of the Anemometer Towers in Thatta Wind Farm Area

Tower	Height	Wind measurement cycle	Coordinate	Elevation	Anemometer tower configuration
		2011.12.31	E 67°59'46.9"		Wind vane 28.5m\83.5 Temperature and air pressure
FFC	80m	2007.06.01 ~ 2010.04.31	N 25° 4'33.20" E 67°58'22.20"	50m	Anemograph 10m\30m\、60m\80m(1)\80m(2) Wind vane 28m\78m Temperature and air pressure

ation meter Tow

2.2.2.2. *Validation and Analysis of Wind Measurement Data*

To effectively evaluate the wind energy resources of the wind farm, all the original wind measurement data have been respectively verified and the discretion on the data integrality and rationality has been made, thus to find out the irrational data and absent data.

According to the Methodology of Wind Energy Resource Assessment for Wind Farm (GB/T18710-2002), Wind Data Validation & Evaluation Software for Wind Farm Design (2.0 version) developed by Beijing Millennium Engineering Software Co., Ltd has been applied for validation of integrity, range, relativity and wind speed variation trend on the measured data of each anemometer tower, including the following items:

(1) Hourly average wind speed range: 0m/s~40m/s;

(2) Wind direction range: 0°~360°;

(3) When the cut-in wind speed is over 5.0m/s, the wind speed and wind direction remain unchanged for continuous 6 hours;

(4) Hourly average wind speed variation is less than 6.0m/s;

(5) Under height difference of 1m~20m, the average wind speed difference is less than 2.0m/s;

(6) Under height difference of 21m~40m, the average wind speed difference is less than 4.0m /s;

(7) When the cut-in wind speed is over 5.0m/s, the standard deviation of wind speed is less than 10.

After validation, all irrational data and absent data as well as the corresponding duration have been listed out. The irrational data have been checked again so as to find out the valid data and insert the data back to the original data group. For check result of each anemometer tower, please refer to Table 2.2. For measured wind speed of each anemometer tower, please refer to Table 2.3.

Table 2.2: Check of Wind Data of Anemometer Towers

Tower	Check duration	Supposed data	Absent data	Irrational data	Valid data	Integrity rate of valid data
FFC	2007.06.01 ~ 2010.04.31	153361	11586	0	141775	92.4%
Lucky	2009.01.01 ~ 2011.12.31	157680	5177	0	152503	96.7%

Table 2.3: Monthly Average Wind Speed at Each Height Measured by Each Anemometer Tower (Unit: m/s) [Note: () means incomplete statistics]

Tower		Height	1	2	3	4	5	6	7	8	9	10	11	12	Annual average
Lucky	2009	85m	8.0	6.1	6.2	7.0	8.9	8.8	9.3	9.3	8.5	5.7	6.9	7.1	7.66
		60m	7.5	5.7	5.8	6.7	8.7	8.6	9.0	9.1	8.1	5.3	6.4	6.6	7.30
		30m	6.3	4.9	5.2	5.9	8.0	8.0	8.4	8.5	7.3	4.6	5.2	5.3	6.49
		10m	5.2	4.0	4.3	5.0	7.1	7.2	7.5	7.5	6.3	3.7	4.0	4.0	5.49
	2010	85m	6.5	6.2	6.6	8.0	9.9	9.6	8.1	7.1	6.6	6.0	6.7	7.3	7.39
		60m	6.1	5.8	6.3	7.7	9.6	9.3	7.9	6.7	6.3	5.5	6.3	6.7	7.02
		30m	5.1	5.0	5.5	6.9	8.8	8.6	7.3	6.1	5.6	4.7	5.3	5.5	6.21
		10m	4.0	4.0	4.6	6.0	7.7	7.7	6.4	5.2	4.7	3.8	4.1	4.3	5.22
	2011	85m	6.7	6.3	6.7	6.5	10.0	10.7	9.5	8.3	7.7	6.0	5.9	7.1	7.63
		60m	6.2	5.9	6.3	6.2	9.8	10.4	9.2	8.0	7.2	5.6	5.6	6.6	7.28
		30m	5.2	5.0	5.5	5.6	9.1	9.7	8.6	7.4	6.3	4.8	4.6	5.4	6.45
		10m	4.1	4.0	4.6	4.7	8.0	8.6	7.7	6.5	5.3	3.8	3.5	4.1	5.42
FFC	2007	80m						8.9	8.8	9	8.5	6.1	5.2	7.1	(7.62)
		_80m						9	8.7	8.8	8.3	6.1	5.2	7.2	(7.56)
		60m						8.7	8.6	8.7	8.2	5.8	4.9	6.7	(7.33)
		30m						8.1	8	8.1	7.6	4.9	4.1	5.5	(6.55)
		10m						7.1	7	7.2	6.6	3.7	3	4.2	(5.47)
	2008	80m	7.1	5.2	6.6	7.4	11.9	9	10.2	9.5	8.2	6.8	7.4	6.5	8.11
		_80m	7.1	5.2	6.6	7.3	11.5	8.9	9.9	9.1	7.9	6.7	7.4	6.5	7.97
		60m	6.7	5	6.3	7.1	11.6	8.9	10.1	9.3	7.9	6.5	6.9	6.2	7.84
		30m	5.6	4.3	5.6	6.5	10.9	8.4	9.5	8.7	7.2	5.6	5.7	5.2	7.09
		10m	4.3	3.3	4.6	5.5	9.7	7.4	8.5	7.8	6.3	4.5	4.4	4.2	6.03
	2009	80m	7.9	6.1	6.5	7.2	9.2	9.2	8.8	9.2	8.5	5.5	6.7	6.8	7.55
		_80m	7.9	6.1	6.4	7.1	9.0	9.0	8.6	8.8	8.2	5.5	6.8	6.8	7.45

Table 2.3: Monthly Average Wind Speed at Each Height Measured by Each Anemometer Tower (Unit: m/s) [Note: () means incomplete statistics]

Tower		Height	1	2	3	4	5	6	7	8	9	10	11	12	Annual average
		60m	7.4	5.8	6.2	6.9	9.0	9.1	8.6	8.9	6.3	5.2	6.3	6.3	7.07
		30m	6.3	5.0	5.5	6.2	8.4	8.5	8.1	7.6	7.4	4.4	5.2	5.2	6.40
		10m	5.2	4.0	4.6	5.2	7.4	7.6	7.2	7.5	6.4	3.5	3.8	3.9	5.40
		80m	6.4	6.2	6.8	8.2									(6.9)
		_80m	6.4	6.3	6.7	8.1									(6.85)
	2010	60m	6	5.9	6.4	7.9									(6.54)
		30m	5	5	5.8	7.3									(5.75)
		10m	3.8	3.9	4.7	6.3									(4.69)

2.2.2.3. *Analysis of Representativeness of Long Series Data*

To obtain a set of data representing long-term average wind speed at the wind farm, the long-term wind data recorded at Karachi meteorological station shall be used for revision and amendment of the data collected by Lucky anemometer tower. Annual average wind speed of Karachi station in the past 30 years (January 1981 ~ December 2010) is 4.63m/s; in the past 20 years (January 1991 ~ December 2010) is 4.78m/s; in the past 10 years (January 2001 ~ December 2010) is 5.07m/s. According to investigation, the wind data of Karachi station have been obtained through manual observation at 05:00, 08:00 and 17:00 every day and the data are of poor accuracy. Therefore, during this wind energy resource analysis, the hourly wind speed and wind direction data collected by Lucky anemometer tower at 85m height from January 1991 to December 2010 are revised and analyzed additionally with the long series data of MERRA database.

MERRA, a reanalysis data product established by "Model Analysis and Forecasting" project of NASA, is developed on the basis of GEOS-5, which includes various modern climate observation systems such as EOS, with normal accuracy of 5km per pixel and highest accuracy of 3.5km per pixel. MERRY covers all the remote sensing data from 1979 to the present.

In this study, the hourly wind data measured at 80m height in nearly 30 years (January 1981 ~ December 2014) at the location of Lucky tower in MERRY database is collected. According to statistics of MERRA' data, the average wind speed in the time period of nearly 30 years is 7.78m/s, the average wind speed in the time period of nearly 20 years is 7.66m/s, and the average wind speed in the time period of nearly 10 years is 7.43m/s. While the contemporary record (January 2009 ~ December 2011) of average wind speed at the location of Lucky anemometer tower in MERRY database is 7.35m/s. Considering the global climate change, the time period for representative characteristic analysis of long series shall not be too long, so the average wind speed in the time period of nearly 10 years in MERRY database is taken as analysis base. The contemporary record at the location of Lucky anemometer tower is 1.09% smaller than the MERRY's data, and is close to the average in nearly 10 years of the meteorological station, showing a good long series representation.

2.2.2.4. *Calculation of Wind Resources*

For Lucky anemometer tower, the average air temperature measured is 32.49°C, average air pressure is 999.70hPa, substituting the values into the formula, the air density at the hub height is worked out as 1.131kg/m³. For FFC anemometer tower, the average air temperature measured is 26.67°C, average air pressure is 1002.29hPa, substituting the values into the formula, the air density at the hub height is worked out as 1.155kg/m³.

Considering that Lucky anemometer tower with same altitude as the wind farm is only 4km away from the center of the wind farm, and temperature and air pressure data of three years are available at the anemometer tower. Based on comprehensive analysis, the air density of Thatta wind farm site is estimated as 1.131kg/m³.

2.2.2.5. *Calculation of Wind Energy*

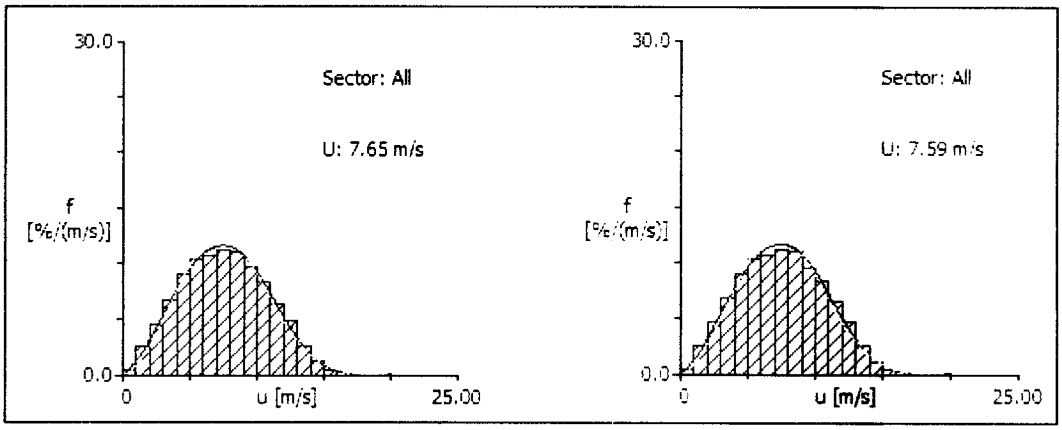
Average Wind Speed and Wind Power Density

According to the statistics of data obtained from Lucky anemometer tower from January 1, 2009 to December 31, 2011, annual average wind speed at height of 90m (calculated based on 85m with shear index of 0.14) is 7.62 m/s, annual average wind power density is 382 W/m2, utilization hour at annual effective wind speed (3.0m/s~20.0m/s) is 7357; annual average wind speed at height of 85m is 7.65 m/s, annual average wind power density is 372 W/m², utilization hour at annual effective wind speed (3.0m/s~20.0m/s) is 7339; annual average wind speed at height of 60m is 7.2 m/s, annual average wind power density is 331 W/m², utilization hour at annual effective wind speed (3.0m/s~20.0m/s) is 7311. Monthly average wind speed and wind power density statistical results of Lucky anemometer tower at various heights are shown in Table 2.4.

Table 2.4: Wind Frequency Curve and Weibull Parameters

Height	Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
90m	Wind speed	7.13	6.24	6.53	7.25	9.7	9.77	9.03	8.26	7.65	5.91	6.54	7.23	7.62
	Wind power density	320	226	240	322	657	665	580	433	319	175	264	348	382
85m	Wind speed	7.07	6.19	6.48	7.19	9.62	9.69	8.96	8.20	7.59	5.86	6.48	7.17	7.56
	Wind power density	313	221	235	315	641	650	566	423	311	171	258	339	372
60m	Wind speed	6.6	5.81	6.13	6.84	9.33	9.45	8.72	7.92	7.2	5.49	6.06	6.62	7.2
	Wind power density	248	179	204	281	604	619	536	394	276	141	205	254	331
30m	Wind speed	5.55	4.98	5.41	6.13	8.63	8.79	8.09	7.28	6.42	4.71	5.04	5.38	6.39
	Wind power density	147	111	144	211	487	502	431	311	204	89	116	131	242
10m	Wind speed	4.4	3.99	4.51	5.23	7.62	7.81	7.18	6.37	5.46	3.73	3.87	4.13	5.38
	Wind power density	83	63	91	141	342	355	301	213	134	51	61	67	160

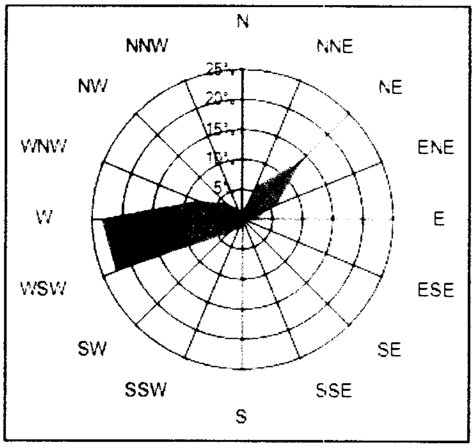
Curve fitting calculation is conducted by using WASP10.0 program, annual average wind speed measured by Lucky anemometer tower at height of 90m is 7.65m/s, average wind power density is 387W/m^2, Weibull parameters A = 8.7, k = 2.69; annual average wind speed measured by Lucky anemometer tower at height of 85m is 7.59m/s, average wind power density is 379W/m^2, Weibull parameters A = 8.6, k = 2.69; annual average wind speed measured by Lucky anemometer tower at height of 60m is 7.23m/s, average wind power density is 330W/m^2, Weibull parameters A = 8.2, k = 2.62. The Weibull distribution of wind speed measured by Lucky anemometer tower at height of 90m and 85m is shown in Figure 2.6. The Weibull distribution curve fitting is good in general.



Wind Sp... ...cky Anemo...

2.2.2.6. *Wind Direction and Wind Speed*

Annual wind direction and wind energy rose diagram plotted based on data measured by Lucky anemometer tower at height of 90m are shown in Figures 2.7 and 2.8, respectively. Figures show that the main wind direction for Thatta wind farm is west-southwest (WSW) wind and west (W) wind, accounting for 31.62%, 30.99% of all year's wind, respectively; prevailing wind energy direction is also west (W) wind and west-southwest (WSW) wind, accounting for 23.54% and 22.79% of all year's wind, respectively, the prevailing wind direction is consistent with prevailing wind energy direction. The statistics for wind direction and wind energy proportion of various sectors at height of 90m in Thatta wind farm are shown in Table 2.5.



Wind Dire... ...Anemometer...

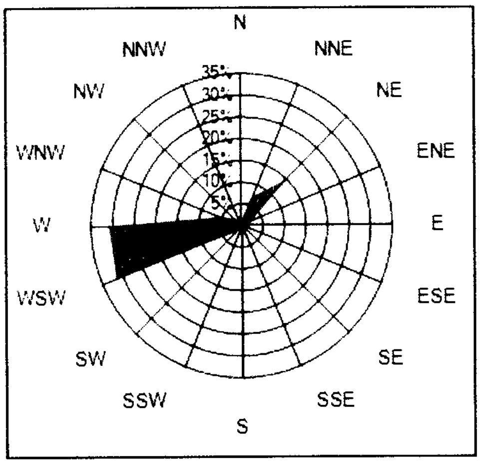
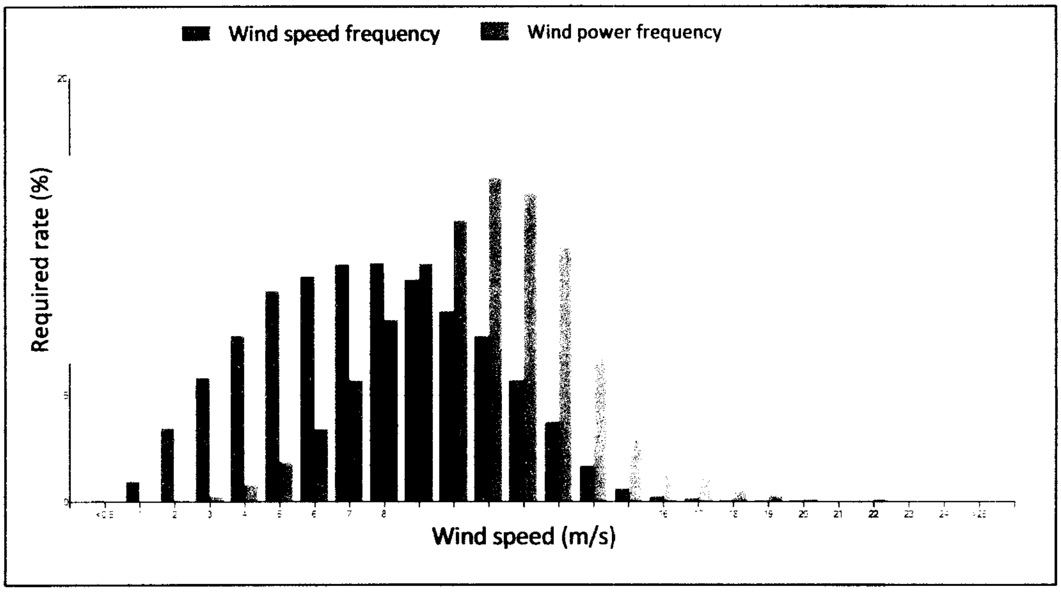


Figure 2.8: Rose Diagram of Wind Energy at Height of 90 m for Lucky Anemometer Tower

Table 2.5: Annual Wind Direction and Wind Energy Proportion of Various Sectors at Height of 90 m for Lucky Anemometer Tower								
Sector	**N**	**NNE**	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**
Wind direction	0.32	7.46	15.64	2.37	0.42	0.13	0.07	0.08
Wind power	1.34	6.19	14.84	6.23	2.23	0.82	0.66	0.56
Sector	**S**	**SSW**	**SW**	**WSW**	**W**	**WNW**	**NW**	**NNW**
Wind direction	0.24	0.37	2.26	31.62	30.99	5.23	2.13	0.67
Wind power	1.34	1.67	3.72	22.79	23.54	8.17	3.93	1.97

The histogram of wind speed and wind energy distribution plotted based on data measured by Lucky anemometer tower at height of 90m is shown in Figure 2.9. Wind speed distribution shows that the wind speed mainly varies from 3.0m/s to 12.0m/s, accounting for 89.09% of the year's wind; wind energy mainly varies from 7.0m/s to 14.0m/s, accounting for 87.11% of the year's wind, this wind speed distribution is favorable to annual power generation. The wind speed and wind energy distribution plotted based on data measured by Lucky anemometer tower at height of 90m are given in Table 2.6.

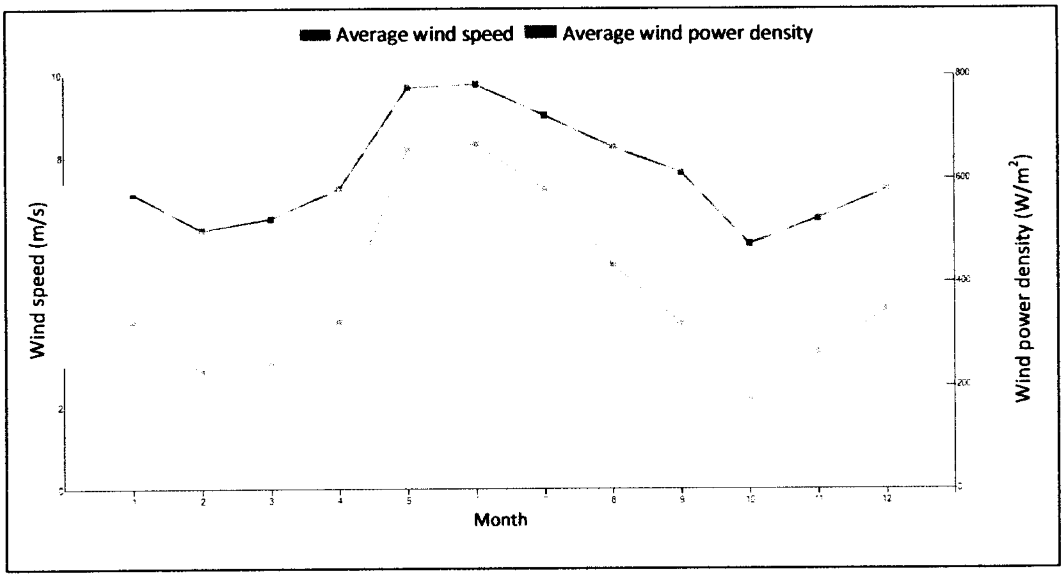


Wind Speed ... for Lucky A

Table 2.6: Wind Speed and Wind Energy Distribution at 90 m of Lucky Anemometer Tower					
Sector (m/s)	Wind speed frequency (%)	Wind power frequency (%)	Sector (m/s)	Wind speed frequency (%)	Wind power frequency (%)
<0.5	0.02	0	12	5.7	14.52
1	0.92	0	13	3.72	11.99
2	3.44	0.05	14	1.7	6.79
3	5.81	0.24	15	0.61	2.99
4	7.78	0.76	16	0.24	1.43
5	9.86	1.85	17	0.17	1.2
6	10.57	3.39	18	0.06	0.53
7	11.13	5.67	19	0.03	0.29
8	11.18	8.52	20	0.01	0.09
9	10.39	11.16	21	0	0
10	8.91	13.2	22	0	0.06
11	7.76	15.26	Total	100%	100%

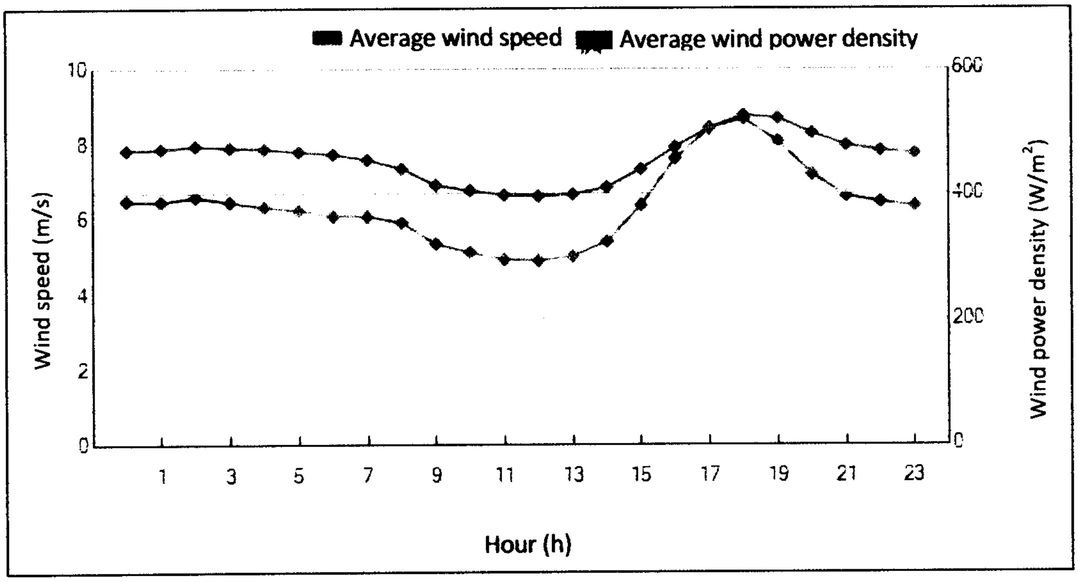
2.2.2.7. *Wind Speed Variation within a Year*

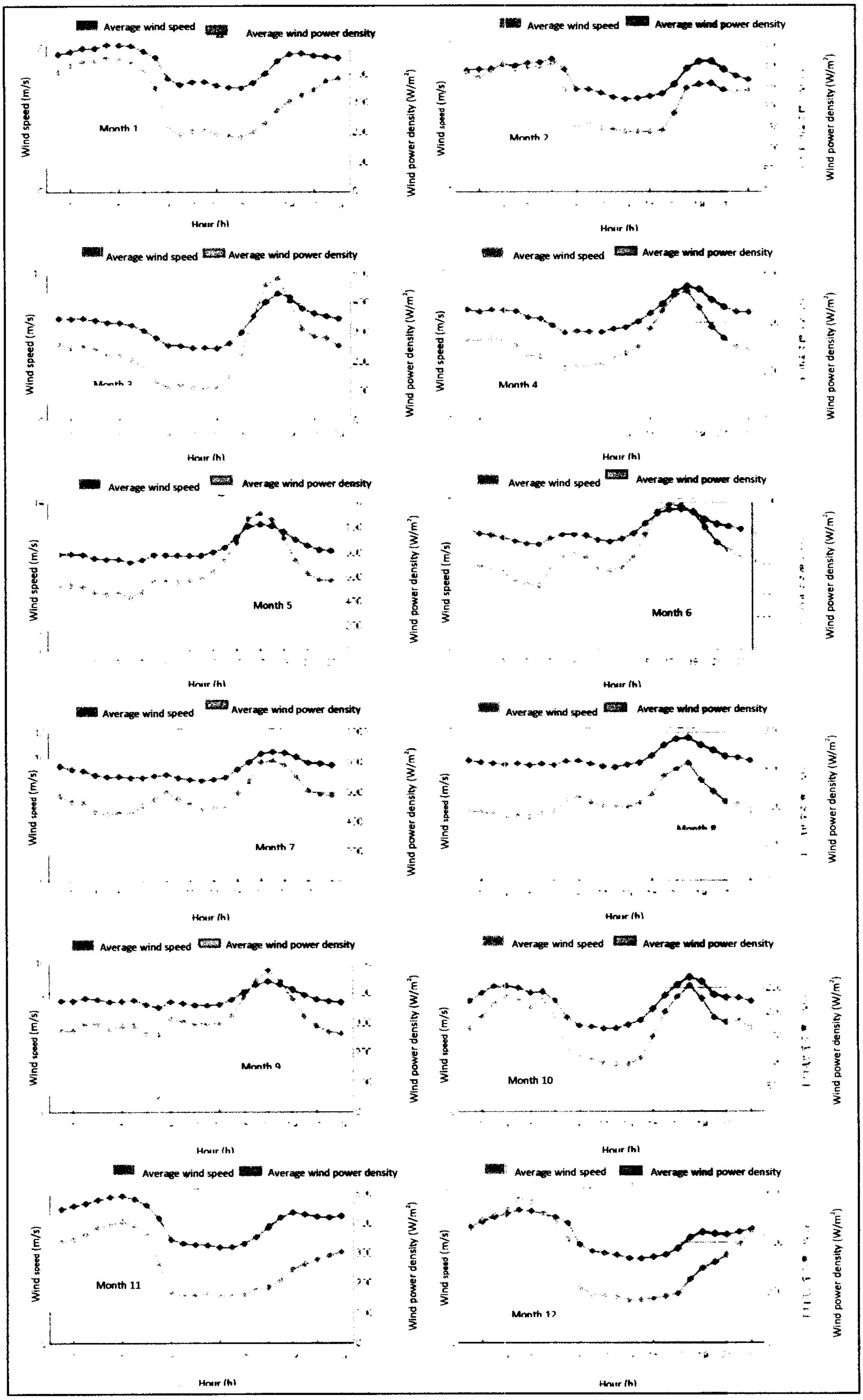
Normally, the wind speed within the period from May to September is relatively higher; the wind speed of the rest seven months is relatively lower. The variation curve of wind speed and wind power density of Lucky anemometer tower at height of 90m within a year is indicated in Figure 2.10.



2.2.2.8. *Daily Variation of Wind Speed*

The wind speed variation within a day is very complex; it's difficult to be expressed by a curve. The daily variation curve of wind speed and wind power density based on wind measurement statistics of Lucky anemometer tower at height of 90m is shown in Figure 2.11; the monthly daily variation curve of wind speed and wind power density based on wind measurement statistics of Lucky anemometer tower at height of 90m is shown in Figure 2.12. It can be seen from the above figures that the wind speed decreases from dawn and reaches the minimum at 2:00 pm, then quickly increases and reaches the maximum at 6:00 pm, after which, it slowly decreases until dawn, showing an "M" shaped variation.





Speed … Lucky An

2.2.2.9. *Wind Shear Indices*

The wind shear indices of each anemometer tower in the Thatta wind farm at various heights are shown in Table 2.7.

Table 2.7: Wind Shear Indices of Each Anemometer Tower in the Thatta Wind Farm at Various Heights

	Height	10m	30m	50m	60m
Lucky	30m	0.157			
	60m	0.163	0.172		
	85m	0.159	0.161		0.140
FFC	30m	0.157			
	60m	0.155	0.143		
	80m(1)	0.150	0.156		0.117
	80m(2)	0.156	0.154		0.162

According to the wind measurement data of Lucky anemometer tower at various heights, the equation of correlation between different heights and corresponding wind speeds is fitted, the fitting equation: Y=6.410X0.155, the correlation coefficient is 0.996, the shear index is 0.155, the fitting curve is shown in Figure 2.13. According to the wind measurement data of FFC anemometer tower at various heights , the equation of correlation between different heights and corresponding wind speeds is fitted, the fitting equation: Y=6.615X0.140, the correlation coefficient is 0.997, the shear index is 0.140, and the fitting curve is shown in Figure 2.14.

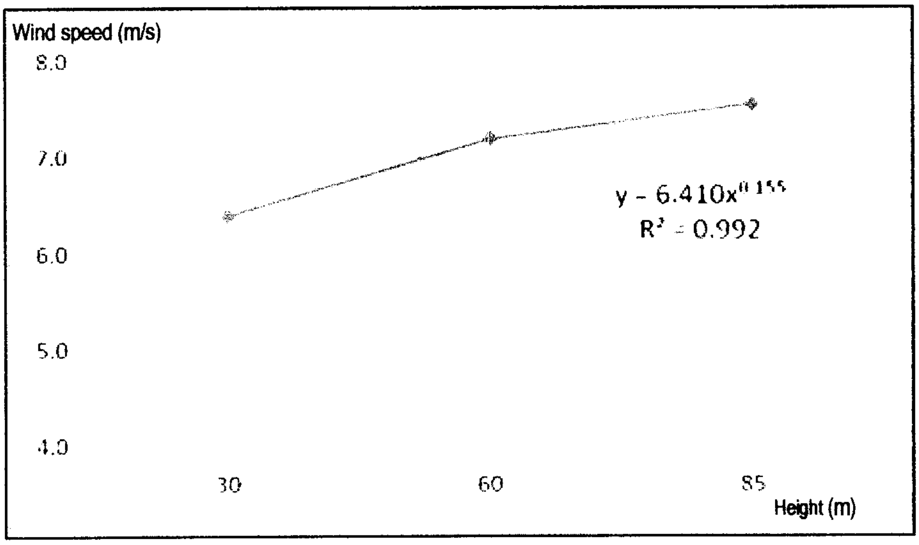
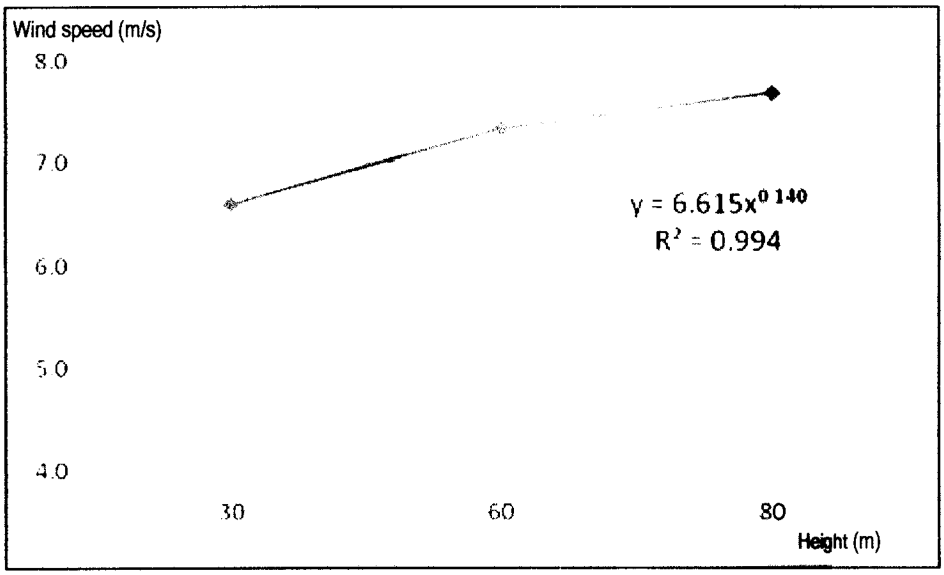


Figure [illegible] Fitting Curve of Wind Shear Index for Lucky [illegible] Tower



... ve of W... ... ter Tower

According to the above calculation results, the wind shear indices of various heights for Lucky anemometer tower vary from 0.140 to 0.172, the wind shear indices of various heights for FFC anemometer tower vary from 0.117 to 0.162, and the wind shear values of the two anemometer towers at various heights are consistent with that obtained from the fitting equation. Consulting assessment of other nearby wind farms, the wind shear index is taken as 0.14.

Turbulence Intensity

The turbulence intensity of 15m/s wind speed section is calculated by the following formula:

$$I_T = \sigma / V$$

Where,

V - average wind speed of 15.5m/s> V> 14.5m/s;

σ - standard deviation of corresponding wind speed.

The average turbulence intensity of the anemometer towers at different heights under wind speed sector of 15m/s are shown in Table 2.8.

Table 2.8: Average Turbulence Intensity of the Anemometer Towers at Different Heights

Tower	85m	80m (1)	80m (2)	60m	30m	10m
Lucky	0.076			0.088	0.109	0.132
FFC		0.069	0.075	0.077	0.101	0.104

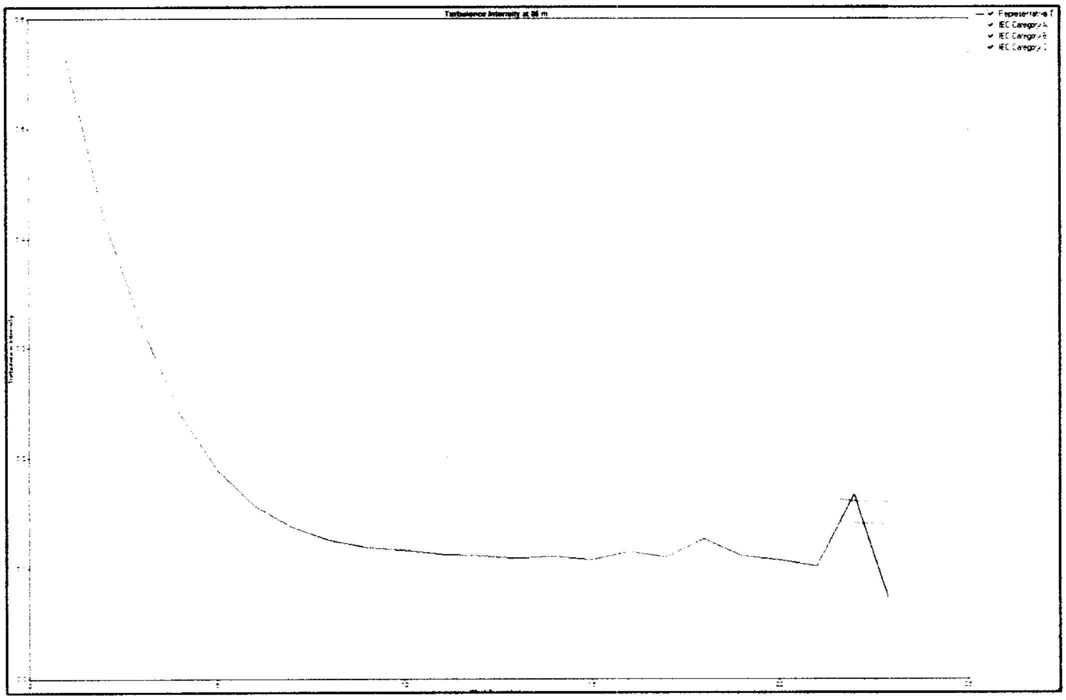
From Table 11, turbulence intensity of both anemometer towers decreases with the increase of height, the turbulence intensity is relatively small. The average turbulence intensity and representative turbulence intensity of the two anemometer towers at 90m height under different wind speed sectors are shown in Table 2.9 and Table 2.10, and the turbulence intensity variation under different wind speed sectors are shown in Figure 2.15 and Figure 2.16.

Table 2.9: Calculation Result of Turbulence Intensity of Lucky Anemometer Tower at 90 m Height under Different Wind Speed Sectors

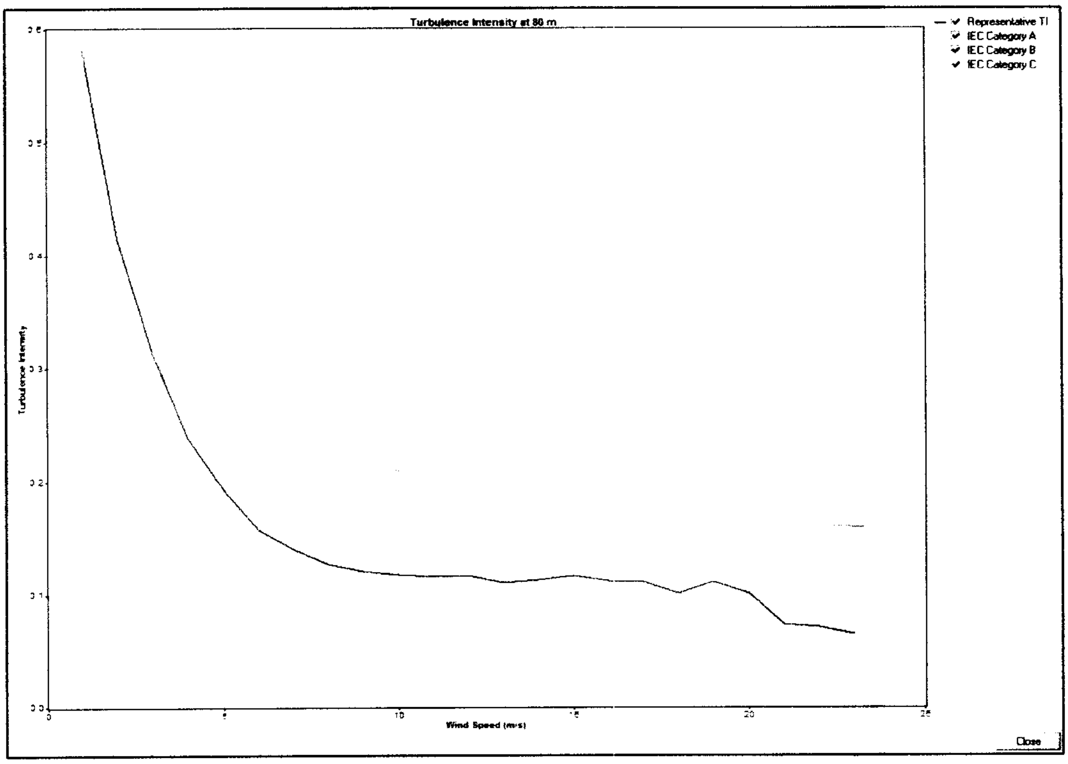
Wind speed sector (m/s)	Record number	Average turbulence intensity	Standard deviation of turbulence intensity	Representative turbulence intensity	Maximum turbulence intensity
3	8612	0.179	0.11	0.32	1.067
4	11892	0.132	0.086	0.241	0.86
5	14878	0.103	0.067	0.189	0.783
6	16002	0.086	0.055	0.156	0.729
7	16739	0.077	0.047	0.137	0.746
8	17078	0.074	0.04	0.125	0.468
9	15784	0.073	0.036	0.119	0.495
10	13594	0.074	0.033	0.116	0.536
11	11783	0.072	0.031	0.112	0.481
12	8520	0.072	0.031	0.111	0.412
13	5760	0.07	0.031	0.109	0.267
14	2563	0.076	0.027	0.11	0.36
15	1047	0.076	0.024	0.107	0.311
16	438	0.081	0.027	0.115	0.387
17	213	0.084	0.02	0.11	0.173
18	106	0.087	0.031	0.127	0.253
19	49	0.082	0.023	0.111	0.148
20	16	0.071	0.029	0.107	0.17
21	12	0.067	0.026	0.101	0.139
22	5	0.1	0.052	0.166	0.192
23	1	0.061	0	0.061	0.061

Table 2.10: Calculation Result of Turbulence Intensity of FFC Anemometer Tower at 90m Height under Different Wind Speed Sectors.

Wind speed sector (m/s)	Record number	Average turbulence intensity	Standard deviation of turbulence intensity	Representative turbulence intensity	Maximum turbulence intensity
3	2832	0.173	0.109	0.313	0.769
4	3778	0.131	0.084	0.239	0.649
5	4768	0.107	0.067	0.192	0.660
6	5297	0.090	0.053	0.157	0.458
7	5835	0.083	0.044	0.139	0.557
8	6250	0.077	0.038	0.126	0.487
9	5657	0.075	0.035	0.120	0.660
10	4929	0.075	0.033	0.117	0.268
11	3811	0.075	0.031	0.115	0.189
12	2806	0.076	0.032	0.116	0.355
13	1860	0.066	0.034	0.110	0.156
14	915	0.070	0.033	0.112	0.186
15	533	0.076	0.031	0.116	0.289
16	302	0.083	0.022	0.111	0.139
17	170	0.087	0.018	0.110	0.132
18	97	0.082	0.014	0.101	0.115
19	36	0.085	0.020	0.110	0.150
20	10	0.076	0.019	0.101	0.108
21	4	0.068	0.003	0.073	0.072
22	7	0.060	0.008	0.070	0.074
23	2	0.060	0.004	0.064	0.062



... of Luck ... under Dif ...



... of FF ... under Dif ...

50-Year Extreme High Wind Speed

As the hourly wind data of Karachi weather station and anemometer tower over the same period cannot be collected, so the correlation cannot be established to calculate the 50-year maximum wind speed of the wind farm. Therefore, the following calculation methods are used in this report to determine the 50-year maximum wind speed of the wind farm:

7-Day Wind Speed Extremum Method

In this method, 10 minutes of observation data of anemometer tower is used in the wind farm, a maximum value is selected within 7 days, based on this 7-day wind speed extremum, 50-year maximum wind speed of the wind farm is estimated using I-type extremum probability distribution.

Based on the measured data of Lucky and FFC anemometer towers, the 50-year extreme wind speeds at the wind turbine hub heights of 90m calculated using the above method are 34.2m/s and 35.9m/s, respectively (shear index is 0.14). The advantage of this method is that the data of anemometer towers can be directly used, the disadvantage is that the representation of the results is slightly worse due to relatively short time series.

2.2.2.10. Measured Data of Wind Farm

The maximum and extreme wind speeds at different heights of each anemometer tower are obtained based on the measured data of five anemometer towers around the wind farm, as shown in Table 2.11.

Table 2.11: Maximum and Extreme Wind Speeds at Different Heights of the Anemometer Towers (Wind Speed Unit: m/s)

			Baburband		
Measurement period	2008-05-26 ~ 2011-11-30				
Height (m)	81.5	80	60	30	10
Maximum wind speed	27.7	27.7	25.5	22.7	18.7
Extreme wind speed	33.7	34.4	33.1	31.7	31.5
			Lucky		
Measurement period	2009-01-01 ~ 2011-12-31				
Height (m)	85	85	60	30	10
Maximum wind speed	23	23	21.8	19.6	16.8
Extreme wind speed	29.5	29.4	30.2	29.9	30.1
			FFC		
Measurement period	2009.01.01 ~ 2009.12.31				
Height (m)	80	80	60	30	10
Maximum wind speed	37.9	38.4	37.1	32.8	27.4
Extreme wind speed	51.6	52.3	52.4	48.9	44.1
			Zorlu A		
Measurement period	2007.04.01 ~ 2009.03.31				
Maximum wind speed	37.13				
Extreme wind speed	54.5				
			Master		
Measurement period	2007.04.01 ~ 2009.03.31				
Maximum wind speed	38.22				
Extreme wind speed	48.1				

No measured data is available at Zorlu A and Master anemometer towers; and the data in the above table has consulted the Feasibility Study Report of one wind power farm project in Karachi. The statistic table shows that, with regard to the measured wind date from 2007 to 2009 of FFC and Master anemometer towers, the 10-minute maximum wind speed reached 37.5m/s, 3-second extreme wind speed of Zorlu A is greater than 52.5m/s, exceeding the standard of wind farm of Grade IEC III.

Estimation Using Empirical Formula of Average Wind Speed

The measured average wind speeds at the height of 85m data of Lucky anemometer tower is 7.56m/s, the measured average wind speeds at the height of 80m data of FFC anemometer tower is 7.55m/s. The empirical formula of average wind speed of IEC 61400-1(2005) standard is used to estimate the maximum wind speeds of the two anemometer towers in Thatta wind farm, the results are 37.8m/s and 37.75m/s, respectively, and is 36.32m/s and 36.27m/s after corrected to the standard air density. The calculation results of Lucky and FFC anemometer towers reach the 50-year extreme wind speed standard of IEC II.

2.2.2.11. Conclusion

Thatta wind farm is located in Jhimpir, according to the calculation results of FFC, Zorlu A and Master anemometer towers, it's determined tentatively to adopt the wind turbine with IEC II safety standard or above for Thatta wind farm. After long series wind speed data of the weather station is available, further analysis and calculation will be conducted.

2.2.2.12. Evaluation of Wind Resources

Based on the above analysis, the main wind direction of Thatta wind farm is basically consistent with that of the main wind energy, and west-southwest (WSW) and west (S) winds have the maximum speed, power and frequency, with the prevailing wind in a direction stable.

According to the measured data by Lucky anemometer tower from January 1 2009 ~ December 21, 2011, the annual average wind speed at height of 90m is 7.62m/s, annual average wind power density is 382W/m^2, utilization hours with annual effective wind speed (3.0m/s-20.0m/s) are 7357; the annual average wind speed at height of 85m is 7.56m/s, annual average wind power density is 372W/m2, utilization hours with annual effective wind speed (3.0m/s-20.0m/s) are 7339; the annual average wind speed at height of 60m is 7.2m/s, annual average wind power density is 331W/m2, utilization hours with annual effective wind speed (3.0m/s-20.0m/s) are 7311. Curve fitting calculation is conducted by using WASP10.0 program, annual average wind speed measured by Lucky anemometer tower at height of 90m is 7.65m/s, average wind power density is 387W/m2, Weibull parameters A=8.7, k=2.69; annual average wind speed measured by Lucky anemometer tower at height of 85m is 7.59m/s, average wind power density is 379W/m^2, Weibull parameters A=8.7, k=2.69; annual average wind speed measured by Lucky anemometer tower at height of 60m is 7.23m/s, average wind power density is 330W/m^2, Weibull parameters A=8.2, k=2.62. According to Technical Regulations for Wind Energy Resource Measurement and Assessment of Wind Farm, the wind power density standard of the wind farm is determined to be Grade III, indicating that the wind energy resources are relatively abundant.

The calculated based on wind speed data measured by Lucky anemometer tower at various heights under wind speed of 15m/s, turbulence intensity varies between 0.069~0.104, the calculated based on wind speed data measured by FFC anemometer tower at various heights under wind speed of 15m/s, turbulence intensity varies between 0.076~0.132, indicating that turbulence intensity is smaller. According to the results of a variety of calculation methods, it's proposed to tentatively adopt the wind turbine with IEC II safety standard or above for Thatta wind farm.

In summary, there is no destructive wind speed in Thatta wind farm, the wind quality is good, the prevailing wind direction is stable, enjoying good wind energy resources. Therefore, Thatta wind farm boasts a desirable site for wind power development.

2.2.3 Type Selection & Arrangement of Wind Turbines and Power Generation Estimation

2.2.3.1. Selection of WTG type

In the construction of wind farms, the selection of wind turbines is restricted by natural environmental conditions, transport conditions, as well as lifting and erection conditions, etc. Meanwhile, under the prerequisite of advanced technology and reliable operation, selection of WTGs shall be economically feasible. In selection of WTGs, the following main factors shall be considered:

Air temperature

Mean monthly temperature data of nearly 40 years from 1971 to 2010 in Karachi weather station indicate that the mean annual air temperature in Karachi is 26°C; extreme maximum air temperature is 47°C; extreme minimum air temperature is 1.3°C. And according to the wind data of the Lucky anemometer tower, the time duration of air temperature higher than 40°C is 59160min, accounting for 38.8%; according to the wind data of FFC anemometer tower, the time duration of air temperature higher than 40°C is 40min, accounting for no more than 1%; the time duration of air temperature higher than 30°C is 64000min, accounting for 12.2%.

The above analysis indicates that the wind farm is in the subtropical climate zone and the temperature may bring great threat to the safe operation of the wind turbines. Therefore, high-temperature type wind turbines should be selected to meet ambient temperature requirements.

Wind energy resources condition

As long-term wind speed series data of the regional weather stations are not available, only the measured wind speed data of anemometer tower can be used to determine the 50-year frequency extreme wind speed. According to the wind data measured by Zorlu A, Master and FCC anemometer towers, the extreme wind speed in this wind farm would exceed the 50-year extreme wind speed, and estimated with different methods, the wind turbines with safety standard of IEC Class II or above may be selected for this wind farm. The turbulence intensities at different heights of Lucky anemometer tower within the wind speed range of

15m/s are 0.069~0.104; the turbulence intensities at different heights of FCC anemometer tower within the wind speed range of 15m/s are 0.076~0.132, suggesting small turbulence at the wind farm. According to IEC 61400-1 (2005) standard, the wind turbines with safety standard of IEC Class II or above can be selected for this wind farm.

Selection of Wind Turbine Manufacturer

The Manufacturers to be chosen should have certain technical strength and possess mass production capability to meet the work progress requirement of this project. Meantime, the Manufacturers are required to guide handling, erection and debugging independently, and assist other parties in the auxiliary constructions such as civil and electrical works, and ensure the work progress of this wind farm. Moreover, in the case of selecting WTGs, the reliable operation of the wind farm shall be fully considered, mainly involving the operation environment adaptation and availability assurance.

In light of the actual situation of the project and the current status of wind turbines manufacturing industry, the following four wind turbine models are selected at this stage for technical and economical comparisons of electric energy production: GW121/2.5MW, MY104/2.0MW, G114/2.0MW and SE87/1.5MW. The results are listed in Table 2.12.

Table 2.12: Economical Comparison of Preliminary Selected Models

Designation	Unit	Scheme 1	Scheme 2	Scheme 3	Scheme 4
		GW121/2500	MY104/2000	G114/2000	SE8715
Total installed capacity	MW	100	100	100	99
Single capacity	kW	2500	2000	2000	1500
Number of units	set	40	50	50	66
Wheel diameter	m	121	104	114	87
Hub height	m	90	80	90	70
Annual on-grid energy	10^4 kW·h	34682	33950	35373	31859
Annual equivalent full load hours	h	3468	3395	3537	3186

Table 2.12 shows that the grid annual equivalent full load hours of the wind farm range from 3186h to 3537h. According to the calculation results of various schemes, Scheme 1 would result in larger energy yield and have the lowest investment per kWh. Taking into account the project progress and the manufacturers' supply capacity and after-sales service, preferential financing policy, high temperature climatic condition, market performance and the Employer's intention, Scheme 1 (GW121/2.5MW) is proposed at this stage.

2.2.3.2. *Comparison of technical parameters of WTGs*

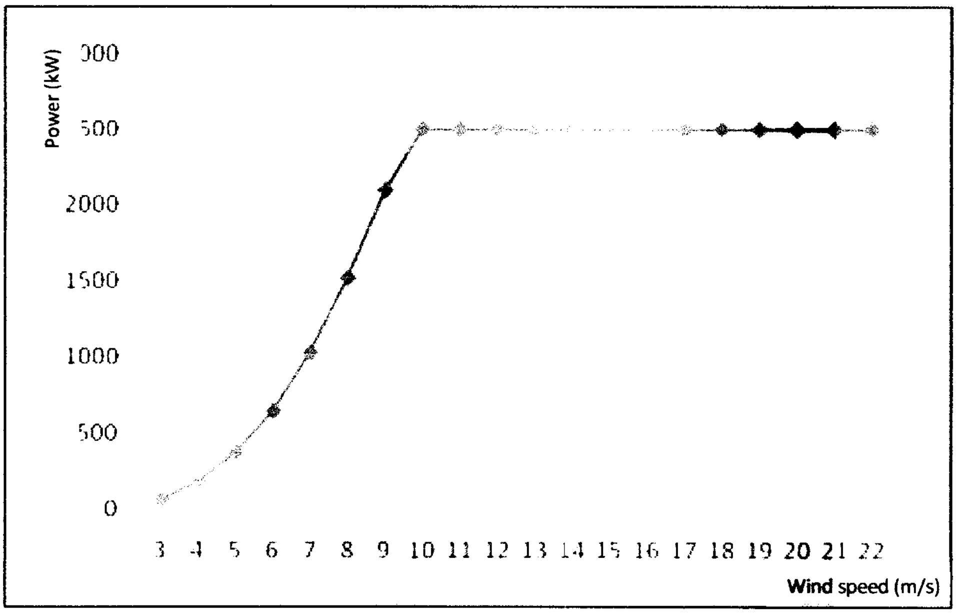
The main technical parameters of the proposed wind turbine models are shown in Table 2.13, and the power curve of standard air density (1.131kg/m3) and the thrust coefficient curve are shown in Table 2.14. The power curve of the proposed wind turbine is shown in Figure 2.17, and the thrust coefficient curve is shown in Figure 2.18.

Table 2.13: Comparison of Main Technical Parameters of Proposed WTG Models

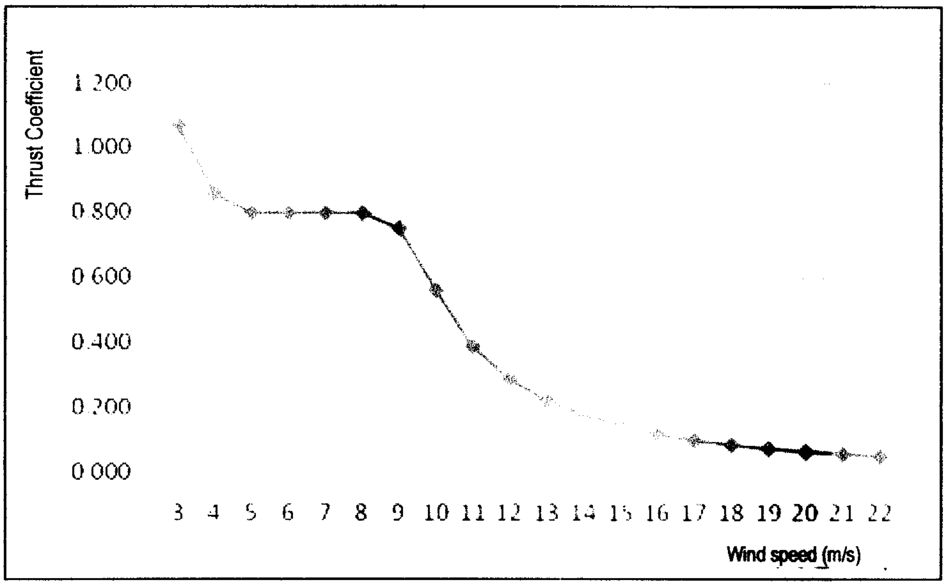
Model	GW121/2500
Wind turbine	
Rated power (kW)	2500
Power regulation mode	Variable speed and variable pitch
Wheel diameter (m)	121.5
Cut-in wind speed (m/s)	3
Rated wind speed (m/s)	9.3
Cut-out wind speed (m/s)	22
Extreme wind speed (m/s)	52.5
Operation temperature scope	-30°C～+40°C
Direction facing wind	Upwind direction
Blade	
Number of blades	3
Speed at blade tip line (m/s)	85.8
Swept area (m^2)	11595
Generator	
Model	Goldwind/GW2.5MW-TFY
Rated power (kW)	2600
Rated voltage(V)	690
Rated rotating speed (r.p.m)	
Protection class	IP54
Nacelle and tower	
Nacelle (t)	84.4
Blade (t)	43.5
Hub (t)	28.57
Tower height (m)	90
Tower weight (t)	278.9

Table 2.14: Local Air Coefficient Curve of Proposed Power Curve and Thrust Model under Density (1.131 kg/m³)

Wind speed (m/s)	Power (kW)	Thrust coefficient
3	59	1.068
4	185	0.855
5	372	0.797
6	645	0.797
7	1024	0.797
8	1516	0.797
9	2096	0.750
10	2500	0.560
11	2500	0.387
12	2500	0.288
13	2500	0.223
14	2500	0.177
15	2500	0.144
16	2500	0.119
17	2500	0.099
18	2500	0.084
19	2500	0.073
20	2500	0.063
21	2500	0.055
22	2500	0.049



curves of ... kg/m³)



proposed ... 131kg/m3

2.2.4 Layout of WTGs

2.2.4.1. Principles

Wind turbines should be arranged mainly based on the characteristics of wind energy resources and geological conditions at the wind farm site, and the layout principles are as follows:

(1) Firstly, it should fully consider the surrounding constraints around the wind farm, and arrange wind turbines within the planned area;

(2) According to the distribution characteristics of wind resources, it should make full use of the prevailing wind direction to reasonably locate those wind turbines with proper space;

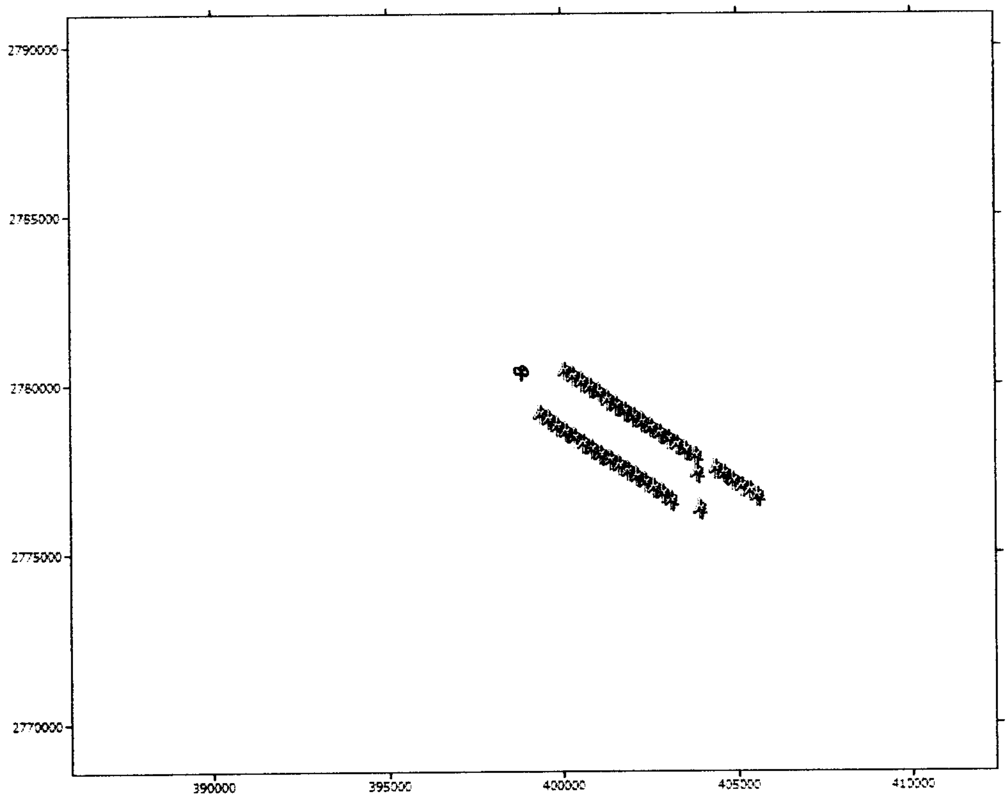
(3) When arranging wind turbines, not only the wake flow influence between wind turbines should be minimized to the least, but also the cable lengths between wind turbines shall be shortened to the least so as to reduce auxiliary works cost and power loss in the transmission and transformation processes;

(4) In consideration of different schemes, energy output capability of the entire wind farm should be optimized to its maximum as well as energy output of individual units.

2.2.4.2. *Layout of WTGs within wind farm*

As the wind direction in Thatta wind farm area is relatively constant and stable, west-southwest (WSW) wind has maximum speed and energy as well as highest frequency; the prevailing wind direction is stable and the availability of wind energy is high. According to the prevailing wind direction and topography condition of this wind farm, the arrangement of wind turbines should take advantage of locations with high wind energy index and greater exploitation value.

Thatta wind farm site takes on a long strip about 6.5km long and 1.6km wide. Taking into account the characteristics of the site area, for optimal utilization of the available ground area, it is proposed to arrange those WTGs of the recommended models perpendicular to the prevailing wind direction in the pattern of 2.5D × 12D. The layout fashions for the two types of WTGs are shown in Fig. 2.19 and Fig. 2.20.



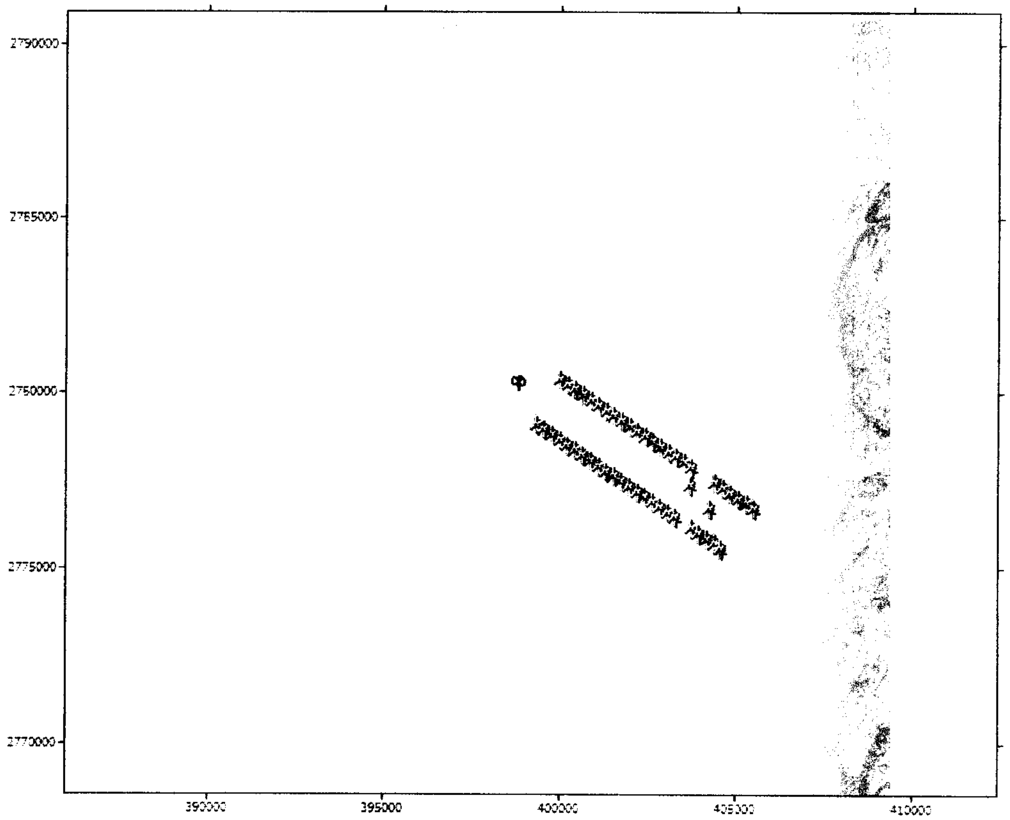


Figure 2.20 La [illegible]

2.2.5. Annual on-grid energy

2.2.5.1. *Calculation of theoretical annual energy yield*

The annual on-grid energy of this wind farm can be estimated based on comprehensive analysis of the wind data measured by Lucky anemometer tower in the representative year, the layout plan for recommended WTGs, and the site 1:50000 topography map. By using the power curve and thrust coefficient curve of the recommended WTG model under the local air density of 1.131kg/m^3, Wasp10.0 software is employed to compute the theoretical annual energy output value and the annual energy yield after taking into account the wake flow effect.

2.2.5.2. *Utilization rate of WTGs*

Taking into account the WTG fault, maintenance and grid fault factors, routine maintenance shall be conducted in the month with smaller wind speeds. According to current wind turbine manufacturing level and the actual conditions of the wind farm, the availability of the wind turbines is determined to be 97%, i.e. the correction factor is taken as 0.97.

2.2.5.3. *Guarantee rate of wind turbine power curve*

In calculating energy output values, the guarantee rate of wind turbine power curve shall be 95%, i.e. the correction factor is 0.95.

2.2.5.4. *Control and turbulence effect reduction*

When wind direction changes, the blade and nacelle of the wind turbine shall change gradually. But in the actual operation, the WTG control always falls behind the wind change. Therefore, this reduction should be considered in energy output calculation. The turbulence intensities at different heights of Lucky anemometer tower within the wind speed range of 15m/s are 0.069~0.104; the turbulence intensities at different heights of FCC anemometer tower within the wind speed range of 15m/s are 0.076~0.132, suggesting small turbulence at the wind farm. The reduction coefficient out of these two factors for this wind farm is taken as 3%.

Reduction due to blade contamination

Contamination on the blade surface may add to its surface roughness and dwindle the aerodynamic characteristics of airfoil. Considering that the industrial pollution impact of this wind farm is small, the blade contamination reduction factor is determined to be 1%, i.e. the correction factor is 0.99.

2.2.5.5. *Shutdown due to weather effect*

The measured extreme maximum temperature for 40 years (1971-2010) at Karachi weather station is 47°C; the measured extreme minimum temperature is 1.3 And according to the wind data of the Lucky anemometer tower, the time duration of air temperature higher than 40°C is 59160min, accounting for 38.8%; according to the wind data of the FFC anemometer tower, the time duration of air temperature higher than 40°C is 40min, accounting for less than 1%; the time duration of air temperature higher than 30°C is 64000min, accounting for 12.2%. By referring to other projects, the shutdown coefficient due to weather effect takes 2%, i.e. the correction factor is 0.98.

2.2.5.6. *Energy loss due to plant service power and line loss*

According to the statistics and analysis of the existing wind farm projects in China and abroad, loss generally includes losses in transmission lines within site, outgoing transmission lines and transformer, as well as service power consumption. The wind farm energy loss coefficient is set to be 2%, i.e. the correction factor is 0.98.

2.2.5.7. *Other influence factors*

The wind farm operation would surely encounter some other influence factors, such as the offset of general software model. The reduction coefficient of 1% will be counted.

2.2.5.8. *Reduction due to wake flow effect of neighboring wind farms*

There have other wind farms situated around Thatta wind farm. According to our engineering experience, the wake flow effect is counted to be 3%.

After counting the above reductions (overall reduction coefficient of 20%), the energy yield indicators of Thatta wind farm with recommended WTGs are given in Table 2.15.

Table 2.15: Energy yield indicators of Thatta wind farm with proposed WTGs

Designation	Unit	GW121/2.5MW
Wheel diameter	m	121
Counted height	m	90
Single unit capacity	kW	2500
Number of units	set	40
Total installed capacity	MW	100
Annual on-grid energy	10^4kW·h	32967
Annual utilization hours	h	3297
Capacity factor		0.376

From Table 2.15, with the recommended scheme for Thatta wind farm, 40 sets of 90m-high WTG model (GW121/2.5MW) are installed with a total installed capacity of 100MW, an annual on-grid energy of 329.67 GWh, an annual utilization hours of 3297h, and a capacity factor of 0.376.

2.3. Construction Method Statement

2.3.1. Construction for Main Works

2.3.1.1. *Foundation of WTG*

Construction Sequence

Construction sequence of the wind turbine foundation: positioning and setting out →mechanical excavation of foundation → manual cleaning and trimming → acceptance of foundation trench → bedding cushion concrete placement → setting out → foundation reinforcement fixing → installation of embedded pipes, parts and bolts → installation of formworks → foundation concrete placement →formworks removal → acceptance →backfill.

Foundation Construction

Excavation and backfill of foundation pit

1) According to coordinate control points at construction site, the foundation axis and excavation line of the foundation pit will be determined; then excavation will begin when no error is found through check.

2) Earth is excavated mainly by machinery and supplemented by manual cooperation. Slope excavation will be conducted according to the requirements of construction drawings; the foundation bottom elevation will be controlled well in excavation; over-excavation is forbidden; excavated soil and stone will be piled according to requirement of water and soil conservation. After foundation excavation of WTG reaches specified elevation and trench is proven qualified by the Engineer and geological professional, then it is allowed to go to next procedure.

3) Earth backfill: after foundation construction is completed and concrete strength meets requirement of specification and design passes acceptance for concealed works, earth backfill will be conducted in time. Earth will be backfilled through auto transportation, layer-

wise manual backfilling and mechanical compaction. In addition, sundries in foundation must be cleaned prior to backfilling.

4) Foundation earthing of WTG will be conducted concurrently with excavation of foundation pit and acceptance of concealed works will be carried out prior to backfilling of the foundation pit.

5) After excavation of the foundation pit is completed, it will be protected prior to placement of bedding cushion concrete.

Placement of bedding cushion concrete

C20 concrete is applied for WTG foundation cushion of the Project; after foundation pit is excavated to proper position and qualified through acceptance, concrete placement of foundation layer will be carried out in time to provide protection for foundation pit; sundries will be cleaned, block surface will be leveled, little water will be sprinkled, compaction and leveling will be conducted prior to concrete placement of the foundation.

Installation of foundation ring and support bracket

1) WTG tower is connected to support bracket with pre-embedded foundation bolts. Foundation ring is directly buried in concrete of foundation and will be subject to fixing of support bracket with foundation bolts in construction.

2) Prior to reinforcement fixing, foundation centerline will be set out on cushion at first, densified control network will be built around foundation to mark out location of foundation centerline, sideline and foundation ring; after it is checked without error, installation of support bracket of foundation ring and reinforcement fixing will begin.

3) Owing to relatively strict requirement put forth for flange installation of foundation ring, the installation will follow these procedures: four 400 × 400 × 20mm steel plates will be embedded in concrete cushion; lower end of support bracket of foundation ring will be connected with embedded foundation slab, and its upper end with adjusting bolt; foundation ring and support bracket will be subject to connection of adjusting bolt which can help adjust smoothness of foundation ring so that elevation of foundation ring can be controlled in accuracy.

4) Reinforcement fixing will begin after installation of foundation ring is accepted as qualified. Bolt support bracket will not be connected with steel bar, formwork, formwork support system, and scaffolds should be in an independent system so as to prevent bolts from influence caused by vibration and deformation of framework in concrete placement.

5) After installation works of support bracket of foundation bolt and foundation ring are completed, overall acceptance and check will be conducted, including acceptance of control axis and foundation centerline and dimension acceptance for embedded parts of foundation. Reinforcement fixing and formwork sealing will begin after mounting bracket of foundation ring is accepted as qualified.

Steel bar works

1) Reinforcement fixing will begin after installation of foundation ring is accepted as qualified. Support bracket of foundation ring will not be connected with steel bars.

2) Main stressed steel bars at parts of foundation like bottom, top, upper pillar etc. are subject to steel bar of common length without overlapping. Connection between steel bars is 100% subject to fixing instead of welding.

3) If structural steel for support bracket of foundation ring and embedded cable conduit are met in arrangement of steel bars, spacing between steel bars will be adjusted to avoid them, while steel bar shall not be cut off to cause damage to stress structure.

4) After reinforcement fixing and installation of foundation ring is completed, foundation ring will be checked and adjusting bolts will be used to adjust error existing in centerline, elevation, smoothness etc. of foundation ring; when each indication is in line with requirement of design and specification, support bracket and foundation ring will be reinforced, adjusting bolts will be fixed through spot welding to assure accuracy for position of foundation ring.

Formworks

Enough strength and rigidity is necessary for formworks, mould and nodes of different members to meet requirement for dimension error; inner surfaces of formworks and moulds shall be kept clean.

Concrete placement of foundation

1) Concrete will be subject to the placement method of centralized mixing through site mixing plant, transportation by mixer trucks, delivered by concrete pumps and vibration by inserted vibrators. During concrete placement, special personnel must be arranged to monitor the displacement of formworks, foundation rings, and bolts and embedded pipes to find any problem and solve them.

2) Construction joint shall not occur in concrete placement and main body concrete shall be placed at a time.

3) Design drawings and supplier's equipment drawings shall be carefully studied and thoroughly understand prior to concrete placement of the foundation, construction will begin only after it is fully understood; absolute accuracy of holes of reserved foundation bolts and integrity of mass concrete foundation must be assured.

4) Much attention must be paid to internal placement for support bracket of foundation bolts in concrete placement. Concrete placement between ends of star steel bars at inner side of support bracket will be carried out through tremie so as to assure that the foundation tower will not displace but kept at center position.

5) Steel bars and anchor bolts must be cleaned prior to placement so as to assure cohesion between concrete and steel bars.

6) Measures shall be taken in concrete placement to assure layer-wise placement from top to bottom; concrete will be controlled to go up evenly to prevent support bracket of bolt from side pressure caused by different heights of concrete.

7) In order to assure that the final installation of foundation ring is correct, measuring instrument shall be used in concrete pouring to strengthen measurement so as to keep smoothness of foundation ring on the support bracket as it is.

8) Construction will be subject to layered placement and vibration, meanwhile good combination between upper and lower layers of concrete must be assured prior to initial setting so that no construction joint will occur.

9) Weather condition shall be learned before concrete construction; rainy day is not suitable for concrete placement and construction in winter will be avoided as much as possible.

Control measures for temperature difference of foundation concrete

1) Prior to concrete placement, calculation for temperature difference between inside and outside of concrete will be carried out according to the annual temperature in determined placement period, cement, aggregate to be used etc. so as to confirm whether the difference between the maximum central temperature of concrete and surface temperature is more than 25°C in that situation; if it is not more than the specified value of 25°C, control measure for temperature difference may not be taken, if it is more than 25°C, control measure for temperature difference must be taken.

2) Temperature monitoring inside concrete

16 temperature measuring points will be set inside concrete, and 2 air temperature measuring points will be set outside concrete, as well as 2 temperature measuring points for thermal insulation materials and 1 temperature measuring point for curing water; 21 working measuring points are arranged in total. The additional 10 stand-by measuring points will be set. Site temperature monitoring data will be automatically collected by data collector and analyzed; temperature of each measuring point and temperature difference between the central and surface measuring points at each measuring position will be printed and output once every two hours; it will be used as basis for study on adjustment of temperature measures to prevent concrete from temperature crack.

Curing of foundation concrete

Concrete curing is to keep it under certain temperature and humidity; special personnel will be arranged to measure concrete temperature regularly during curing so as to assure that temperature difference between inside and outside of concrete will not be more than 25°C and temperature crack will not occur in concrete. Foundation concrete will be covered in time after placement; backfill will be timely carried out at the formwork after it is disassembled so as to reinforce curing of thermal insulation and moisture preservation; concrete will be subject to curing of moisture preservation through spraying after placement.

Crack resistance measures of foundation

1) Slag cement with low heat of hydration will be applied, cement consumption in single cube and cement ash ratio will be reduced, and water reducing agent will be added to reduce heat of hydration in concrete.

2) Concrete will be subject to curing of thermal insulation and moisture preservation immediately after placement so as to make its temperature reduce slowly; concrete surface will be subject to thermal insulation through covering of straw bag with plastic membrane on its top; special personnel will be arranged for curing and the curing period will not be less than 14 days.

3) Time for formwork removal of concrete will be extended; for underground foundation, earth backfill will be conducted immediately after the formwork is removed so as to maintain the situation of thermal insulation and moisture preservation.

4) Mass concrete shall not be placed in season especially hot or cold as possible.

5) Soil content of aggregate shall be controlled well with sediment content for sand not more than 2% and that for gravel not more than 1%.

Foundation sealing

Foundation sealing will be carried out in line with technical requirement provided by the Supplier of WTGs.

2.3.1.2. Installation of WTGs

In recommended scheme of this Project, WTGs with a single capacity of 2500kW is selected. Owing to the difference existing in installation method of WTGs from different manufacturers or of different models, it is largely identical but with minor differences. Therefore, the following installation method description of common WTGs is made for reference. This method features short preparation time, fast lifting and flexible application.

Installation sequence of WTGs: construction preparation –tower lifting– nacelle lifting – blade assembly – blade lifting – installation of control cabinet – cable installation – electrical connection – connection of hydraulic pipelines.

Construction Preparation

Construction plan shall be made before installation of WTGs; the plan shall be consistent with safety production regulations of Chinese codes and be approved by the Engineer.

The following works shall be completed before lifting:

1) Road at WTG installation site shall be flat and smooth and be assured to provide safe access for various kinds of construction vehicles.

2) WTG installation site shall meet lifting requirement and have enough place for storage of parts.

3) Reliable safety measures shall be taken for temporary power supply at construction site.

4) Safety facilities like warning board, fence etc. shall be set at construction site if necessary.

5) Common medical articles shall be prepared at installation site.

6) Before lifting, the personnel must check parts of crane and choose lifting tools correctly.

7) Before lifting, WTG equipment shall be checked carefully to avoid dropping of parts.

8) Dedicated person must be arranged to command at the lifting site. The commander must have a certificate for lifting command and conduct specified command gestures and signals.

9) Crane operator shall be responsible for the whole lifting process. Before lifting, the rigger and crane operator shall be familiar to lifting scheme. The commander shall make the crane operator know his/her works completely.

10) When heavy fog, thunderstorm, insufficient lighting is encountered and the commander cannot see each work position clearly or the crane operator cannot see the commander, lifting must be halted.

11) Only a single person is allowed to climb or work at the same section of ladder within the tower.

Selection of lifting equipment

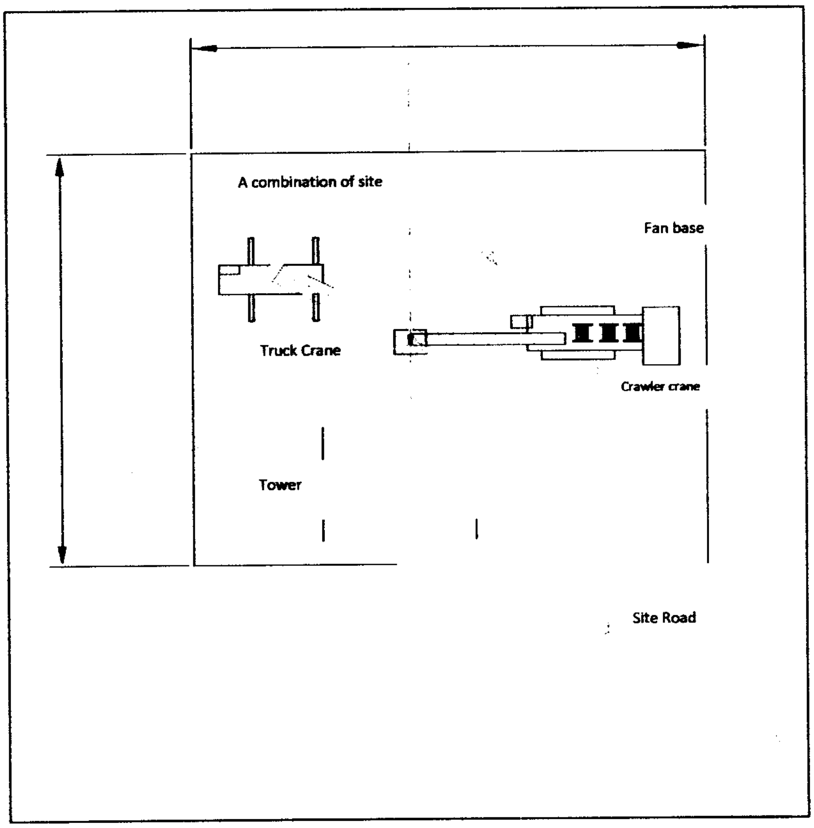
WTG lifting is the key and important step for construction of wind farm project; generally, the heavy-tonnage crawler crane lifting equipment is applied and supplemented by autocrane; crane is used mainly to complete installation of three main components, i.e. nacelle, tower and blades.

Lifting equipment shall be in line with the requirements of DL408, DL409 and the Rules on Work Safety of Power Engineering enacted by the Ministry of Power Industry (DAS [1994] No.227).

Control parameters for selection of huge WTGs crane are hub height and weight of the largest component; for the 2.5 MW WTG in recommended scheme, it is the largest hub at height of 90m and weight of the largest component of 84.4t. Three cranes of 600t, 200t and 75t are applied to perform WTG lifting.

Requirements of lifting site

The installation will be subject to joint operation of two cranes; in order to assure that crane boom will not get contacted with tower in lifting, enough space is required for crane; working space for WTGs shall not be less than 50m × 50m. Enough places are required for storage of parts, fittings or small crane at side of access road. Width of construction road in the farm shall not be less than 6m so as to assure crawler crane can pass smoothly. Figure 2.21 shows WTG lifting plan.



Schemat

Installation of WTG Tower

In this stage, the WTG tower shall be tubular one composed of three parts, and flange plate shall be used for connecting every two parts. These tubular towers shall be transported by sections, and hoisting shall be carried out after the parts in the tower are installed at the site. When stockpiling tower at the site, the tower shall be put onto hardwood and prevented from rolling, and the stockpile area shall be plane and free from slope as possible. Tower and its parts must be inspected at the site to confirm whether they are damaged during transportation, and in order to avoid corrosion, any surface damage shall be repaired immediately and any dirt shall be cleaned.

Base shall be inspected prior to installation, the evenness of base shall be calibrated with leveling instrument, and the allowable error of tower shall be consistent with specification of the manufacturer.

The dust on foundation ring flange and residua of concrete pouring shall be cleaned before installing tower. Especially for flange position, there must be no corrosion. Abrasive paper may be used for polishing if necessary.

Lifting procedures for bottom section of tower

1) Prior to lifting of the bottom section of tower is finished, installation of support and body of tower foundation control cabinet must be completed.

2) Prior to lifting, leveling instrument will be used to check elevation and levelness of foundation ring; sundries like dust, rust, and scrap iron in bolt hole of foundation ring shall be cleaned, as well as lower and upper flanges of foundation ring; sealant shall be applied on upper flange surface of foundation ring.

3) Bolts, nuts and gaskets for connection of the bottom section of tower and foundation ring will be made ready and put in foundation ring;

4) Threads of all bolts shall be applied with special lubricant.

5) Main and auxiliary cranes shall be arranged in place according to requirement of installation scheme, and lifting tools shall be made prepared. Lifting tool of main crane will be connected with upper flange of tower (evenly-distributed connection at four positions), lifting tool of auxiliary crane with one position at lower flange of tower; head of lifting tool will be hung at the main hook of main and auxiliary crane with safety pin fastened.

6) Two pulling ropes will be bound through bolt hole at lower flange of lower section of tower to adjust tower direction.

7) Main and auxiliary cranes will be lifted at the same time; when the tower is lifted away from ground, main crane continues hoisting, auxiliary crane will be used to adjust distance of end of the tower from the ground;

8) When the tower is lifted to a vertical position by main crane, lifting tools of auxiliary crane will be disassembled to make the tower down with bottom accurately in a line with flange surface of foundation ring, pulling rope will be used to adjust direction of the tower; correct position of tower entrance will be found; the tower will be turned to make it in line with bolt hole of foundation ring; then the tower will be put down, when lower section of the tower is 3 ~ 5mm from flange surface of foundation ring, hole pin can be used to fasten.

9) Bolts will be pre-tightened by electric or hydraulic spanner;

10) Then, lifting tools of main crane will be disassembled;

11) Connecting bolts for the tower and foundation ring will be tightened and the tightening torque for bolts must be consistent with requirement;

12) Earth wire connection;

13) Installation of lighting wires in the tower

Lifting of middle and top sections of tower

Lifting of middle and top sections of tower is the same with that for bottom section of tower. Before lifting, upper flange surface and bolt hole of installed tower will be cleaned and bolts for flange connection will be made ready. When mane crane lifts the tower to a vertical position, lower flange surface and bolt hole of tower will be cleaned. Correct position and hole position and reliable connection will be assured in butt joint of tower.

Installation of WTGs and Nacelles

WTG installation will be subject to components lifting; good weather will be chosen for installation which is not allowed in rainy day or day with wind speed more than 12m/s. According to lifting capacity of crawler crane, the nacelle can be lifted by crawler crane directly to tower top and fastened; subgrade boxes shall be laid for the supporting parts of crawler crane to increase ground contact area so that hoisting load can be dispersed and ground settlement can be prevented. When the nacelle is lifted by crane to top of upper flange of tower, pulling rope will be used to adjust direction of the nacelle to make position correct; yaw slide block is used to lead nacelle to required position. When clearance is about 10mm, vertical axis of the nacelle will be adjusted perpendicular to wind direction; tooling will be used to locate the nacelle so as to install fixing bolts; then the nacelle will be put down in place and all bolts will be tightened, ropes will be loosened; bolts will be tightened to specified torque through diagonal method for two times; yaw brake will be installed and hydraulic oil pipe will be connected.

Installation of WTG Blades

Rotor blades will be installed to the hub on the ground according to technical requirements on installation; then lifting can begin. Hub and blades are assembled on the ground and blades will be supported by supports to keep level. Following assembly, special fixtures are used to clamp the hub; meanwhile, two blades will be tied with rope and top of the other one blade is placed on special movable trolley. Prior to rotor blades are installed, cleaning equipment will be used to clean blade flange and hub flange. When the hub is lifted up slowly by crawler crane, blades swing will be controlled by manual pulling of rope on the ground till blades are hoisted to the installation height; then, installation workers will get in the nacelle to finish assembly and connection.

Safety Measures after Lifting

In general, WTGs shall not be subject to commissioning and grid connection immediately following installation. Therefore, measures shall be taken in accordance with requirement of WTGs supplier to assure that performance of WTGs is in good condition in commissioning.

The main issues are as follows:

1) WTGs shall be locked before it is put into operation;

2) Parts of WTGs will be checked regularly for rust which shall be removed if found;

3) Before it is put into operation, stator, rotor and control equipment of WTGs will be checked regularly to determine whether they are affected with damp; if they are affected, measures like heating and dehumidification will be taken to solve such problem;

4) Before it is put into operation, both oil and water circulating systems of WTGs will be started regularly;

5) Inside of control equipment, tower and WTGs will be checked to see whether there is trace of small animals; if there is, prevention measures like blocking and killing will be taken to solve the problem.

Safety Monitoring

Three WTGs of the wind farm shall be selected for safety monitoring which mainly monitors the foundation settlement and incline after WTGs erection and during operation period. Specific monitoring method and practice is as follows: four observation posts shall be arranged on each WTGs foundation along two orthogonal longitudinal directions. Each observation post requires C30 concrete of about 0.207m3. Three reference piers shall be provided about 30m to the WTGs. Each reference pier requires C30 concrete of about 0.675m3. The observation shall adopt gradienter. Observation shall be first made upon completion of the foundation. After application of all loads, observation shall be made again; at least two observations are required during the operating period; observation shall be made in the case of special event such as earthquake or strong wind.

Fire Protection Design for Ventilation and Air Conditioning System

(1) Independent air exhaust system is provided for oil depot, with fans and motors of explosion-proof type.

(2) The oil depot is provided with an emergency ventilation system (combined with normal ventilation system), which will be closed in case of fire. After the confirmation of fire extinguishment, the post-emergency ventilation will be made by the fire control center or through local air exhaust fans.

(3) In case of fire, the operation of ventilation and air conditioning system of relevant parts should be stopped.

(4) For the oil depot, its emergency ventilation system is combined with normal ventilation system and the air exhaust fans are fire-control high-temperature smoke exhaust fans. In case of fire, the ventilation system is closed. After the confirmation of fire extinguishment, the post-emergency smoke exhaust will be made by the fire control center or through local smoke exhaust fans.

2.3.2. Electrical System

According to the Feasibility Study for 100MW Wind Power Project at Nooriabad, Sindh, Pakistan supplied by the Employer, the status of other wind farms in Pakistan and the site condition of Thatta wind farm, to reduce land occupation and shorten installation time, GIS double bus connection is proposed as 132kV power distribution installation (since GIS is technically advanced with appropriate price).

132 kV busbar is designed with double busbar electrical connection; two incoming line bays, two outgoing line bays, two protection bays and one bus-tie bay for main transformers will be provided in total. Single busbar sectional electrical connection is proposed at 35 kV side of the 132 kV collector sub-station, circuit breakers are set between two busbar sections. Direct grounding system is adopted at the 132kV side of the main transformer.

Two 315 kVA service transformers will be adopted for the 132 kV collector sub-station in this stage. One 150 kW diesel generator will be used as backup power source. Substation service power system is equipped with automatic backup switching unit, 0.4kV single busbar sectional electrical connection is adopted, and five GCS-0.4 LV switchgears are proposed.

A total of 40 WTGs with unit capacity of 2500kW will be installed in the wind farm; one WTG will be connected to one box-type transformer. The transformer with a rated capacity of 2750kVA will be installed near the WTG tower.

33kV embedded cable is selected as the power collection line to transmit power. According to layout of WTGs and box-type transformers, capacity of WTGs and route of power collection line, an 8-circuit trunk power collection line is designed; each circuit with respective capacity of 12.5MW will be connected to 5 WTGs. Within each circuit of trunk power collection line, No.1, No.2 and No.3 box-type transformers will be connected by power cables, while No.4 and No.5 box-type transformers will be connected by power cable. All the cables will be embedded and extended outside of the 132kW collector sub-station fencing and connected to 33kV switch cabinet through cable trench.

The 40 WTGs will be divided into 8 groups, and the 40 box-type transformers will be divided into 8 groups accordingly. Each group of WTGs and box-type transformers share one optical fiber cable that is connected to the control equipment in wind farm control center, forming an optical fiber ring network that performs control and monitoring for each WTG and box-type transformer.

The final access mode of the project will subject to the review comment by NTDC.

2.3.2.1. *Box Transformer*

Foundation Construction

Foundation of box transformer will be subject to concrete. At first, the foundation will be subject to excavation of small excavator and supplemented by manual slope excavation of foundation pit; after foundation excavation is completed, foundation pit shall be cleaned and inspected for acceptance. When foundation pit is accepted, foundation will be treated according to geological condition. During foundation concrete placement, a 150mm thick C20 concrete cushion shall be placed at first; when it is set, reinforcement fixing and formwork installation can begin for placement of foundation concrete; then, equipment will be installed following concrete strength gets consistent with that required through 7 days curing.

Installation of Box Transformer

Capacity of box transformer selected in this Project is 2750kVA

Preparation prior to installation

Cables shall be laid before box transformer is in place and be proven without electricity through inspection.

Products shall be checked for damage, deformation and break through opening the box. Completeness of accessories and special tools will be checked in terms of packing list, and they will be installed in line with requirement after no error is found.

There is hook near the box top for assembling and disassembling; degree between wire rope under tensile status and vertical line shall not exceed 30°; if necessary, transverse post will be used to support wire rope to prevent structure of box transformer or lifting hook from deformation. Most of the weight of box transformer is from the transformer in package equipped with iron core, winding and insulation oil; most of the HV and LV terminal box is empty and the weight is relatively low; improper use of hook or crane may cause damage to box transformer or its accessories or bring injury to personnel. After installation, it will be connected to test cable plug and be tested according to relevant test regulations of Chinese codes.

Because specific model and manufacturer of box transformer will be finally determined after bidding in construction period, the installation method will be revised in construction period according to requirement and instruction of the Manufacturer.

2.3.2.2. 132 kV Step-up Substation and Monitoring Center

Construction Technical Requirements and Installation Works Quantity of Electrical Equipment

Construction technical requirements of electrical equipment will be in line with China's relevant standards, details are as follows:

1) Code for Construction and Acceptance of Switchboard Outfit, Complete Cubicle and Secondary Circuit Electric Equipment Installation Engineering (GB50171-2012);

2) Erection Works of Electrical Installations - Code for Construction and Acceptance of Power Transformers, Oil Reactor and Mutual Inductor (GBJ148-90);

3) Code for Construction and Acceptance of Cable System Electric Equipment Installation Engineering (GB50168-2006);

4) Code for Construction and Acceptation of Electric Lighting Device & Electric Equipment Installation Engineering (GB50259-96);

5) Code for Construction and Acceptance of Grounding Connection & Electric Equipment Installation Engineering (GB50169-2006)

Work quantity for installation of main electrical equipment

1) MV power transmission and transformation equipment and installation

2750 kVA box transformer: 40 sets

Earthing of wind farm: 1item

2) HV power transmission and transformation equipment and installation

100MVAvoltage regulation transformer: 2 sets

20MVar reactive compensation device: 2 sets

HV switchgear: 17 panels

Earthing works: 1item

3) LV power transmission and transformation equipment and installation

Station transformer: 2 sets

4) Central monitoring system equipment and installation

Wind farm monitoring system: 1 set

2.3.2.3. *Construction of Main Structures*

Control and complex buildings

It is proposed to apply frame structure to the control building and the complex building, with cast-in-situ reinforced concrete floor, roof plate and the independent foundation under column. Construction sequence of the structures is: construction preparation – foundation pit excavation – foundation concrete placement – foundation pit backfill – concrete placement of column, beam and slab – wall masonry – indoor and outdoor decoration and construction of water supply and drainage system – indoor installation and debugging of electrical equipment.

Floor of the buildings shall all be tiled floor except those in the communication room and central control room with anti-static floors, with colored coating sprayed on the exterior wall surface. External thermal insulation with XPS boards shall be applied to heat insulation of the exterior wall.

Power distribution device area of 132kV step-up substation

Foundation of 132kV power distribution device area is subject to concrete structure; the concrete is processed by site mixing plant and building construction is subject to conventional method. Construction of 132kV power distribution device area: foundation trench soil is subject to mechanical excavation (including underground cable trench between foundations). Reserved 30cm original soil in the trench will be manually excavated; foundation concrete placement, masonry, sealing and earth backfill of underground cable trench wall will start following the trench is proven qualified through inspection. Construction of pipe ducts and embedded pipes will be completed, as well as laying and installation of pipelines; attention shall especially be paid to underground HV and LV cables of the substation and concealed works of pipe ducts so as to fulfill arrangement and passage of various kinds of pipelines. Formwork, support concrete, embedded parts and reserve holes shall be measured in concrete placement to solve any deformation and displacement (if found) in time and assure quality. Concrete shall be subject to curing within 12h after placement; it shall not be tramped and formworks and supports shall not be removed when concrete strength is less than 1.2N/mm^2.

The substation framework will be lifted in place by crane; connection between column base and foundation is subject to cup-inserted type. After the framework is in place, wind rope will be applied to assure its stability, and then fine-aggregate concrete will be placed to fix it. When curing period of concrete ends, temporary fixing facilities will be removed.

2.3.2.4. *Main construction machinery*

The wind farm is designed with 40 WTGs and has an installed capacity of 100MW with a construction term of 18 months. According to decentralization characteristics of the wind farm construction, the construction shall be performed based on centralization and decentralization principle. As the construction term is relatively short, additional construction machinery shall be provided to meet requirement of construction strength. Table 2.16 indicates the main construction machinery.

Table 2.16: Main construction machinery of the proposed scheme

No.	Item	Specification	Unit	Quantity.
1	Crawler crane	650t	set	1
2	Truck crane	200t	set	1
3	Truck crane	75t	set	1
4	Concrete batching plant	HZS60	set	2 (one in use one in standby)
5	Concrete mixing carrier	10m^3	set	7
6	Concrete pump truck	Arm length 30m	set	2
7	Tractor-trailer group	40t		2
8	Tractor-trailer group	60t		2
9	Concrete mixer	400L	set	4
10	Mortar mixer	JI-200	set	6
11	Water truck	8000L		6
12	Internal combustion road roller	15t		1
13	Steel-bar straightener	Not more than φ14	set	2
14	Steel bar cutter	Not more than φ40	set	2
15	Steel bar bender	Not more than φ40	set	2
16	Diesel generator	300kW	set	2
17	Diesel generator	15kW	set	3
18	Backhoe shovel	1.5m^3	set	2
19	Embedded vibrator	CZ-25/35	set	32
20	DC welder		set	4
21	Crawler dozer	165kW	set	1
22	Wheeled loader	3.0m^3	set	2
23	AC welder		set	6
24	Dump truck			5

2.3.2.5. *Firefighting*

Fire protection of this project is designed according to principles of "Putting Prevention First and Combining Prevention & Fire Fighting". Aiming at actual conditions of the project, advanced fire-protection technology shall be actively applied so as to assure safety, convenience and economic feasibility. Contents of fire protection design are mainly the fire-protection design of monitoring center of the wind farm. Meanwhile, design requirements on fire protection for construction are raised.

Through external highway, fire engines can reach the areas where the central control center, WTGs and box-type transformers are built and installed. Fire-protection passages around administration building and service building shall be available. The net width of these passages shall be wider than 4m and the passages shall form looped ones. The passage ways shall be free from overhead barriers and meet relevant specification requirements. Portable and wheeled ammonium phosphate powder extinguishers shall be provided in the control building, garage and operation rooms. In addition, operation building and main transformers shall be equipped with portable and wheeled carbon dioxide fire extinguishers.

Eight sets of outdoor underground fire hydrants (SA100/65-1.0) are provided, and water-supply pipes for outdoor fire protection are arranged in rings.

Fire hazard of the largest building (control building) of this wind farm is of Class IV, the fire protection rating is of Class II and its volume is smaller than 10000m3. In accordance with Code for Fire Protection Design of Building (GB50016-2006), no indoor fire hydrant system is provided to the control building. Water consumption of the outdoor fire hydrants is 20L/s. Based on one fire duration of 2h, water consumption (180m3) is required by the hydrant system for fire extinguishing.

Within the wind farm, one fire water and domestic water tank with effective volume of 180m3 and fire pump house (accommodating both fire pumps and living pumps) will be built. In the pump house, two fire pumps (parameters: Q=25L/s, H=0.5MPa, N=22kW) are provided and these two pumps are mutual standby. Fire water is transported from the outside of the wind farm. Fire water supply system is driven by fire pumps to deliver water from the fire water tank. Normally, water pressure of the firefighting system is kept by the frequency converter set.

Passages around 132kV collector sub-station are free and clear. The fire passages utilize services road, both net width and clearance of roads are greater than 4.0m. All those satisfy requirements on fire-fighting facilities.

2.3.3 Water Drainage System

Separate flow of rainwater and wastewater is employed for water drainage system of the project.

2.3.3.1. *Rainwater drainage system*

Building roof rainwater is drained outside. Outdoor rainwater is drained out of the site along the road slope under gravity.

2.3.3.2. *Wastewater drainage system*

The indoor domestic sewage is drained to outdoor sewage pipe network under gravity and kitchen wastewater is drained to outdoor sewage pipe network after being treated by oil separation tank. One $4m^3$ septic tank, one $4.5m^3$ wastewater adjustment pool, one set of wastewater treatment equipment with a capacity of $0.50m^3/h$ and one wastewater catch basin with a capacity of $50m^3$ are set outside. Wastewater is treated and drained to the $50m^3$ wastewater catch basin before being used for site greening or discharged out of the site.

2.3.3.3. *Pipe Materials and Connection*

PE water supply pipes are used as outdoor water supply pipes, with fusion connection. PVC-U double-wall corrugated water drainage pipes are used as outdoor wastewater pipes, with rubber ring socket connection; steel-plastic composite pipes are used as indoor water supply pipes, with special accessory connection. PVC-U water drainage pipes are used as indoor domestic wastewater pipes, with adhesives connection; and steel-plastic transition joint or special flange joint must be used for connecting PE water supply pipes, metal pipelines, valves and equipment.

2.3.3.4. *Labor Safety and Industrial Health*

Design of labor safety and industrial health is carried out in principles of Safety First and Prevention at Priority as well as follows the safety regulations of that safety facilities of newly-built, rebuilt and extended project shall be designed, constructed and put into operation & production simultaneously with those of main works. In accordance with relevant regulations of laws, factors such as high voltage, flammables, explosives, fire, electromagnetic radiation, noise, corrosion and mechanical injury, etc which directly endangers personnel safety and health shall be identified. Comprehensive prevention and treatment measures satisfying specification requirements and project reality shall be raised to assure the project after putting into operation satisfies requirements on labor safety and industrial health as well as assure safety & health of personnel in the wind farm and safety of structures and equipment themselves.

Concerning main dangers possible occurring during construction, requirements on safety management shall be put forward to the Employer, the Contractor and the Engineer in term of management so as to provide the Employer with reference for tendering management, completion acceptance and management of safety operation of the farm; assure safety of construction personnel lives and properties; minimize property loss, environmental damage and social affects.

2.3.4. Summary of main technical economic indexes

Name	Thatta wind farm (100MW)			
Location	Sindh province, Pakistan			
The Designer	POWERCHINA NORTHWEST ENGINEERING CORPORATION LIMITED			

The Contractor	NORINCO INTERNATIONAL					
Installed capacity	MW	100	Main work quantity	Earth-rock excavation	m^3	160892.0
Capacity of single unit	kW	2500		Backfilling	m^3	148737.00
Annual power generation	10^4 kW·h	32967		Reinforcement	t	2231
Annual utilization hours	h	3297		Concrete	m^3	27607.9
				Tower (including foundation ring)	t	11156
			Required land for construction		Acre	2500
			Planned constructio n period	Construction period for power generation of first batch of wind turbines	Month	
				Total construction period	Month	18
			Fixed number of production staff		Perso n	30

2.3.5. Design of Domestic Water Supply and Drainage

2.3.5.1. Design basis

1) Code for Design of Outdoor Water Supply Engineering (GB 50013-2014);
2) Code for Design of Outdoor Water Supply (GB 50013-2006);
3) Code for Design of Outdoor Water Drainage Engineering (GB 50014-2006) (2014Edition);
4) Code for Design of Building Water Supply and Drainage (GB 50015-2003) (2009 Edition).

2.3.5.2. Domestic water supply and drainage system

1) Water source

Water source: outdoor deep well water is fed for the project.

2) Water consumption

a) Domestic water consumption

The number of water consuming persons is considered as 28, the domestic water quota is 150L/person/d and the maximum daily water consumption is 4.20 m^3/d.

b) Water consumption for greening

The greening area is about 1,450m2 for the project, so the quota for watering is 2.0L/m^2/d and the maximum daily water consumption is 2.90m^3/d.

c) Water consumption for roads and squares

The total area of roads and squares for the project is about 570m2, so the quota for watering is 2.0L/m2/d and the maximum daily water consumption is 1.14m3/d.

d) Water consumption unforeseen and leakage from pipe network

The total amount of water consumption unforeseen and leakage from pipe network is calculated as 10% of the sum of the three kinds of water consumption mentioned above, i.e. 0.82m³/d.

e) Total water consumption

The maximum total daily water consumption is 8.24m³/d for the Project. Table 2.17 summarizes the detailed water consumption.

[illegible] Summary of [illegible] for All Items

S#	Type	Water consumption quota	No. of water consuming units	Hourly variation factor (Kh)	Utilization hours (h)	Water consumption	
						Maximum daily water consumption (m^3/d)	Maximum hourly water consumption (m^3/h)
1	Domestic water	150L / person / d	28 m^2	3	24	4.20	0.53
2	Greening water	2.0L/m^2/d	1450m^2	1	8	2.90	0.36
3	Water for roads and squares	2.0L/m^2/d	570m^2	1	8	1.14	0.14
4	Subtotal					8.24	1.03
5	Water consumption unforeseen and leakage from pipe network	10%				0.82	
6	Total					9.06	1.03

2.3.5.3. *Water supply system*

Secondary pressurized water supply is employed for the project, with the water source from well water. The wind farm is provided with an underground water pool (domestic & firefighting water pool with an effective capacity of 180m³), water pump room (firefighting pump and domestic pump) and water treatment room that accommodates water treatment equipment with a capacity of 1.0m³/h, a 9m³ domestic water tank, a set of domestic constant pressure water supply equipment (including two domestic water supply pumps, mutually standby) and two ultraviolet ray sterilizers. Water in the deep well is lifted by deep-well pump to be stored in the underground water pool (domestic and firefighting water tank with an effective capacity of 180m³), water is drawn by domestic water pump and conveyed to water treatment room. After treatment, the introduced water is stored in the domestic water tank. Water in the tank is supplied to each unit by a frequency conversion domestic water supply set after passing through UV sterilizers. The domestic water tank has parameters of Q = (2.6-3.7-4.4)m³/h, water supply pressure of H= (0.29-0.29-0.26) MPa. The model of frequency conversion domestic water supply set is Q= (10-16-20) m3/h, with water supply capacity of H= (0.405-0.375-0.33) MPa. UV sterilizer has a capacity of 16m3/h. Hot water in the washroom is supplied by the electric water heater.

Chapter 3 POLICY, STATUTORY & INSTITUTIONAL FRAMEWORK

This section describes the current legal responsibilities of the proponent in the context of the environment and sustainable development, and the institutions that exist in the country that may influence the environmental management of the proposed Project.

Project Proponent will comprehensively follow the relevant requirements of the policy documents and legislative framework as well as recommendations as described in the national and international guidelines in relevance to the proposed project. Provisions of many of these guidelines have been incorporated in the mitigation measures and the Environmental Management & Monitoring Plan (EMMP) which have been formulated for the better management of environmental and social impacts.

3.1 Policy Framework

The Pakistan National Conservation Strategy (NCS), which was approved by the Federal Cabinet in March 1992, is the principal policy document for environmental issues in the country. The NCS signifies the country's primary approach towards encouraging sustainable development, conserving natural resources, and improving efficiency in the use and management of resources. The NCS has 68 specific programs in 14 core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment. The core areas that are relevant to the proposed project are biodiversity conservation, restoration of rangelands, pollution prevention and abatement, and the preservation of cultural heritage.

Pakistan is a signatory to the Convention on Biological Diversity, and is thereby obligated to develop a national strategy for the conservation of biodiversity. The Government of Pakistan constituted a Biodiversity Working Group, under the auspices of the Ministry of Environment, to develop a Biodiversity Action Plan for the country, which was completed after an extensive consultative exercise. The plan, which has been designed to complement the NCS and the proposed provincial conservation strategies, identifies the causes of biodiversity loss in Pakistan and suggests a series of proposals for action to conserve biodiversity in the country. The Pakistan Environmental Protection Council (PEPC) has approved the action plan and steering committees at the federal and provincial levels have been formed to implement it.

Mid-term Review of NCS: Key Findings: An overview of the key environmental issues facing Pakistan is as follows:

- Per capita water availability in Pakistan has been decreasing at an alarming rate. In 1951, the per capita availability was 5300 cubic meter which has now decreased to 1105 cubic meter just touching water scarcity level of 1000 cubic meter.
- Almost all fresh water resources are severely polluted due to discharge of untreated industrial and municipal wastes. Pollution of coastal waters due to waste discharges and oil spills coupled with reduced freshwater flows is resulting in declining fish yields.

- About 55 percent of population has access to a relatively safe drinking water source. Potable water quality, assessed against WHO standards, fails to meet all the specified criteria, confirming evidence of extremely high pollutant loads.
- Approximately 35 percent of population has access to adequate sanitation facilities.
- Air pollution is on the rise, especially in urban areas. Recent surveys conducted by Pakistan Environmental Protection Agency revealed presence of very high levels of suspended particulate matter (about 6 times higher than the World Health Organization's guidelines). 'Smog' also seriously affects almost entire Punjab during December and January every year.
- Noise pollution has become a serious issue in major urban centers.
- Of about 54,850 tons of solid waste generated daily in urban areas, less than 60 per cent is collected. No city in Pakistan has proper waste collection and disposal system for municipal, hazardous or healthcare wastes.
- The deforestation rate has been estimated at 0.2-0.5 percent per annum. Forest cover, which was 4.8 percent of total land area in 1992, could hardly be increased substantially despite all efforts.
- Degradation and encroachment of natural forests, rangelands and freshwater and marine ecosystems are resulting in loss of biodiversity. At least four mammal species, including tiger, swamp deer, lion and Indian one-horned rhinoceros, are known to have become extinct from Pakistan while at least 10 ecosystems of particular value for the species richness and uniqueness of their floral and faunal communities are considered to be critically threatened.
- Desertification affects over 43 million hectares of land annually.
- Pakistan is a highly energy in-efficient country. It uses approximately same amount of energy to generate 1 dollar of GNP as the USA.

The situation just mentioned is the result of a number of constraining factors including high population growth rate, prevailing poverty, unplanned urban and industrial expansion, insufficient emphasis on environmental protection in the government policies, lack of public awareness and education and above all the ailing economy which has caused deficiencies in institutional capacity and resources for effective environmental management.

The mid-term review of the NCS led the Government of Pakistan (GOP) and United Nations Development Program (UNDP) to jointly initiate an umbrella support program called the National Environmental Action Plan-Support Program (NEAP-SP) that was signed in October 2001 and implemented in 2002. The development objective supported by NEAP-SP is environmental sustainability and poverty reduction in the context of economic growth. The primary objective of NEAP is to initiate actions and programs for achieving a state of environment that safeguards public health, promotes sustainable livelihood, and enhances the quality of life of the people in Pakistan. The NEAP identifies four primary areas, (1) Clean air (2) Clean water (3) Management of solid waste (4) Ecosystem management. The plan also presents five additional areas of concern (i) Management of fresh water resources (ii) Marine pollution (iii) Toxic and hazardous substances handling and disposal (iv) Energy conservation and management (v) Compliance with international treaties and protocol.

Studies conducted by GOP and Donor Agencies in Pakistan have identified a number of environmental concerns with regard to energy, water and air pollution, waste management, irrigated agriculture, and biodiversity. These studies suggest an overall degradation in the quality and impoverishment of renewable natural resources such as water, forests and other flora as well as key biological habitats. The GOP, private sector and civil society have, with few exceptions, not responded positively to meet the challenges from these concerns.

The Mid-Term Development Framework: 2005-2010 (MTDF 2005-10) of the Planning Commission has been developed in line with the National Environment Action Plan (NEAP) objectives, and the same focuses on four core areas i.e., clean air, clean water; solid waste management, and Ecosystem management. The Plan has been prepared keeping in mind Pakistan's experience with such initiatives in the last decade; the current capacity to undertake planning, implementation and oversight and the identified needs for improvement in such capacity. The MTDF clearly specifies issues in environment which need to be addressed.

3.1.1 National Environmental Policy, 2005

The National Environmental Policy, 2005 aims to protect, conserve and restore Pakistan's environment in order to improve the quality of life for the citizens through sustainable development. It provides an overarching framework for addressing the environmental issues facing Pakistan, particularly pollution of fresh water bodies and coastal waters, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification, natural disasters and climate change. It also gives direction for addressing the cross sectorial issues as well as the underlying causes of environmental degradation and meeting international obligations.

The National Environmental Policy, 2005 while recognizing the goals and objectives of the National Conservation Strategy, National Environmental Action Plan and other existing environment related national policies, strategies and action plans, provide broad guidelines to the Federal Government, Provincial Governments, Federally Administrated Territories and Local Governments for addressing environmental concerns and ensuring effective management of their environmental resources.

The National Environmental Policy, 2005 is agreed for compliance by the proposed project.

3.1.2 Policy for Development of Renewable Energy for Power Generation, GOP 2006

In December 2006 the Government of Pakistan published the first national package of measures aimed at promoting renewable sources of energy. The provisions apply to hydropower plants with a capacity of up to 50MW, solar thermal, photovoltaic's and wind energy. Over the short term, i.e. to mid-2008, technologies that are already in commercial use internationally are to be trialed through the mechanism of attractive power purchase contracts and partial risk coverage. In the medium term, i.e. to 2030, it is hoped to have installed at least 9700 MW of capacity for renewable electricity in this way.

Salient Features of Policy

The Policy invites investment from the private sector for following categories of projects:

1a. Independent power projects of IPPs (for sale of power to the grid only)

1b. Captive cum grid spill over power projects (i.e. for self-use and sale to utility)

1c. Captive power projects (i.e. for self or dedicated use)

1d. Isolated grid power projects (i.e. small, stand-alone)

1. Except for Category (a) above, these projects will not require any LOI, LOS, or IA from the Government.
2. Electricity purchase by NTDC/CPPA from qualifying renewable resources at one location and receive an equivalent amount for own use elsewhere on the grid at the investor's own cost of generation plus transmission charges (wheeling)
3. Net metering and billing allowed enabling a producer to sell surplus electricity at one time and receive electricity from the grid at another time and settle accounts on net basis. This will directly benefit the economics of small scale, dispersed generation and optimize capacity utilization of installed systems.
4. De-licensing and deregulation of small scale power production through renewable resources (up to 5 MW for hydro and 1 MW for net metered sales) to reduce the transaction costs for such investments. This will be particularly beneficial from micro, mini and small hydro as well as solar-based electricity production.
5. Simplified and transparent principles of tariff determination
6. Insulating the investor from resource variability risk, which is allocated to the power purchaser
7. Facilitating project proponents in obtaining carbon credits for avoided greenhouse gas emissions, Helping improve financial retums and reducing per unit costs for the purchaser

These guidelines are in line with the Government's open door policy for inviting private investment into the country.

Policy Goals and Development Strategy

Specific goals of Renewable Energy (RE) Policy are to:

1. Increase the deployment of renewable energy technologies (RETs) in Pakistan so that RE provides a higher targeted proportion of the national energy supply mix, a minimum of 9,700 MW by 2030 as per the Medium Term Development Framework (MTDF), and helps ensure universal access to electricity in all regions of the country.
2. Provide additional power supplies to help meet increasing national demand.
3. Introduce investment-friendly incentives, and facilitate renewable energy markets to attract private sector interest in RE projects, help nurture the nascent industry, and

gradually lower RE costs and prices through competition in an increasingly deregulated power sector.

4. Devise measures to support the private sector in mobilizing financing and enabling public sector investment in promotional, demonstrative, and trend setting RE projects.
5. Optimize impact of RE deployment in underdeveloped areas by integrating energy solutions with provision of other social infrastructure, e.g., educational and medical facilities, clean water supply and sanitation, roads and telecommunications, etc., so as to promote greater social welfare, productivity, trade, and economic well-being amongst deprived communities.
6. Help in broad institutional, technical, and operational capacity building relevant to the renewable energy sector.
7. Facilitate the establishment of a domestic RET manufacturing base in the country that can help lower costs, improve service, create employment, and enhance local technical skills.

3.1.3 The Biodiversity Action Plan

The Biodiversity Action Plan, 2000 has been the most significant direct step towards addressing the issue of loss of biodiversity. It details the current status, trends, direct & indirect causes of loss of biodiversity; its principles, goals and aims; proposals for an action plan including planning & policies, legislation, identification and monitoring, in situ & ex situ conservation, sustainable use, research and training, public education and awareness, Environmental Impact Assessment, information extraction and financial resources etc.

The Wild Birds and Animals Protection Act 1912[1], the West Pakistan Wildlife Protection Ordinance 1959, the Wildlife Protection Rules 1972, provide for the protection of flora and fauna in the territory, including vegetation and protected forests. This IEE study has addressed different aspects of conservation, including wildlife, and forest.

By the perusal of above captioned legislation, it is evident that the Wild Bird and Animal life will not be disturbed due to commissioning and operation of 100 MW Norinco Thatta Wind Farm Project.

3.2 Administrative Framework

Environmental issues are governed by three levels of the government viz. Federal, Provincial and Local Government. The Ministry of Environment and Local Government is the Ministry at the Federal level, which oversees the affairs of the environment in the country. The Government of Sindh (GOS) has designated its Ministry of Environment and Alternative Energy, to administer matters related to the environment in Sindh. The Sindh EPA is directly under the Ministry of Environment and Alternative Energy.

[1] The Wild Birds and Animals Protection Act 1912 (Act No.VIII of 1912 dated 18.09.1912)

3.2.1. Institutional Setup for Environmental Management

The highest environmental body in the country is the Pakistan Environmental Protection Council (PEPC), which is presided over by the Chief Executive of the country. Other bodies include the Pakistan Environmental Protection Agency (Pak-EPA), provincial EPAs (for four provinces, AJK and Northern Areas), and Environmental Tribunals. The roles, responsibilities and authorities of PEPC and the EPA's are defined in the PEPA 1997.

The PEPC has been formed by the Federal Government. Its members include the President of Pakistan, or someone appointed by the President, as the Chairperson; the Minister of the Ministry of Environment, Local Government and Rural Development as the vice-Chairperson; Governors of the Provinces; Ministers in charge of the subject of environment in the Provinces; Secretary to the Federal Government in charge of the Ministry of Environment, Local Government and Rural Development; Director General Federal EPA; heads of other federal and provincial departments; environmentalists and community representatives including scientists. The functions and powers of the Council include formulation of national environmental policy, enforcement of PEPA 1997, approval of the NEQS, incorporation of environmental considerations into national development plans and policies and provide guidelines for the protection and conservation of biodiversity in general and for the conservation of renewable and nonrenewable resources.

The Federal government has also formed the Federal EPA, which is headed by a Director General and has wide-ranging functions given in PEPA 1997. These include the preparation and coordination of national environmental policy for approval by the PEPC, administering and implementing the PEPA 1997 and preparation, revision or establishment of NEQS.

The Provincial Environmental Protection Agencies are formed by the respective Provincial Governments. A Director General who exercises powers delegated to him by the Provincial Government heads each Provincial EPA. IEEs and EIAs are submitted to provincial EPAs for approval.

The proposed project would be located in Sindh Province. Hence this IEE Report will be sent to the EPA Sindh for review and issue of No Objection Certificate (NOC). Coordination of the environmental monitoring activity continues as a provincial subject and is assigned to Provincial EPAs; in this case EPA Sindh has been duly authorized to enforce environmental compliance.

3.3. Statutory Framework

The constitution of Pakistan contains provision for environmental protection and resource conservation. The constitution mentions environmental pollution and the ecology as a subject in the concurrent legislative list, meaning that both the provincial and federal government may initiate and make legislation for the purpose. Article 9 of the Constitution defines the right to life as a "fundamental right" in these words "No person shall be deprived of life or liberty save in accordance with law". The Supreme Court of Pakistan in its judgment in the case Shehla Zia and others vs WAPDA (1994) declared that the right to a clean environment is part of the fundamental constitutional right to life.

Several laws exist for the protection of the environment. Some of these laws are Federal and the rest Provincial in character. The promulgation of the Environmental Protection Ordinance 1983 was the first codifying legislation on the issue of environmental protection. This was indeed a consolidated enactment to plug the gaps and remove defects/deficiencies in the legislation. The promulgation of this ordinance was followed, in 1984, by the establishment of the Pakistan Environmental Protection Agency, the primary government institution dealing with environmental issues. Significant work on developing environmental policy was carried out in the late 1980s, which culminated in the drafting of the Pakistan National Conservation Strategy. Provincial environmental protection agencies were also established at about the same time. The National Environmental Quality Standards were established in 1993.

Prior to the 18th Amendment to the Constitution of Pakistan in 2010, the legislative powers were distributed between the federal and provincial governments through two 'lists' attached to the Constitution as Schedules. The Federal list covered the subjects over which the federal government had exclusive legislative power, while the 'Concurrent List' contained subjects regarding which both the federal and provincial governments could enact laws. The subject of 'environmental pollution and ecology' was included in the Concurrent List and hence allowed both the national and provincial governments to enact laws on the subject.

However, as a result of the 18th Amendment this subject is now in the exclusive domain of the provincial government. The main consequences of this change are as follows: i) The Ministry of Environment at the federal level has been abolished. Its functions related to the national environmental management haves been transferred to the provinces. The international obligations in the context of environment will be managed by various ministries and departments of the federal government, ii) The Pakistan Environmental Protection Act 1997 (PEPA 1997) is technically no longer applicable to the provinces. The provinces are required to enact their own legislation for environmental protection.

3.3.1 Sindh Environmental Protection Act, 2014

Legislative assembly of Sindh province of Pakistan passed the bill on 24th February 2014 to enact Sindh Environmental Protection Act 2014. The Act envisages protection, improvement, conservation and rehabilitation of environment of Sindh with the help of legal action against polluters and green awakening of communities.

It equally lays emphasis for the preservation of the natural resources of Sindh and to adopt ways and means for restoring the balance in its eco-system by avoiding all types of environmental hazards.

Environmental Protection Council (EPC): It has been formed consisting of Chief Minister as Chairman with Minister in charge of Environment Protection Department, Addl. Chief Secretary, Planning & Development Department, Government of Sindh and Secretaries of Environment, Finance, Public Health Engineering, Irrigation, Health, Agriculture, Local Government, Industries, Livestock & Fisheries Forest & Wildlife, Energy, Education Departments Government of Sindh and Divisional Commissioners of Sindh. Non-official members are also included (i.e. representatives of Chamber of Commerce & Industry and from medical or legal professions etc.) along with DG, EPA & two Members of Provincial Assembly also form part of EPC.

The functions and powers of EPC include coordination & supervision of provisions of Act, approving provincial environmental & sustainable development policies & SEQS, provide guidance for protection & conservation, consider annual Sindh Environmental Report, deal with interprovincial and federal provincial issues, provide guidance for bio safety and assist Federal Government in implementation of various provisions of UN Convention on laws on Seas (UNCLOS).

Sindh Environmental Protection Agency (SEPA): SEPA would be headed by Director General (DG) with the aim to exercise the powers and perform the functions assigned to it under the provisions of this Act and the rules and regulations made there under. The Agency shall have technical and legal staff and may form advisory committees.

The Agency shall administer and implement the provisions of this Act and rules and regulations. It shall also prepare environmental policies, take measures for implementation of environmental policies, prepare Sindh Environment Report and prepare or revise Sindh Environmental Quality Standards. SEPA shall also establish systems and procedures for surveys, surveillance, monitoring, measurement, examination, investigation research, inspection and audit to prevent and control pollution and to estimate the costs of cleaning up pollution and rehabilitating the environment and sustainable development. SEPA would also take measures for protection of environment such as to promote research; issues licenses for dealing with hazardous substances, certify laboratories, identify need for or initiate legislation, specify safeguards etc. SEPA would also encourage public awareness and education regarding environmental issues.

SEPA would have powers to enter or inspect under a search warrant issued by Environmental Protection Tribunal or a Court search at any time, any land or building etc. where there are reasonable grounds to believe that an offence under this Act has been or is being or likely to be committed. SEPA may also take samples, arrange for testing or confiscate any article in discharge of their duties.

This act has also provided for Sindh Sustainable Fund derived from various sources such as voluntary contributions or fees generated etc. This fund is utilized for protection, conservation or improvement of environment. It is appendices in this report as **Annex I**.

Salient Features

Section-11: No person shall discharge or emit or allow the discharge or emission of any effluent waste, pollutant, noise or adverse environmental effects in an amount, concentration or level which is in excess to that specified in Sindh Environmental Quality Standards.

Section-12 & 13: No person shall import hazardous waste into Sindh province and handle hazardous substances except under licenses etc.

Section 14: No person shall undertake any action which adversely affects environment or which lead to pollute or impairment of or damage to biodiversity, ecosystem, aesthetics or any damage to environment etc.

Section 15: This section deals with regulation of motor vehicles banning emission of air or noise pollutants being emitted from them in excess of allowable standards.

Section 17: This section states that no proponent of a project shall commence construction or operation unless he has filed with the Agency an initial environmental examination or environmental impact assessment and has obtained from Agency approval in respect thereof. SEPA shall review the IEE & EIA and accord approval subject to such terms and conditions as it may prescribe or require. The agency shall communicate within four (04) months its approval or otherwise from the date EIA is filed failing which the EIA shall deemed to have been approved.

Section 21: Where agency is satisfied that the discharge or emission has occurred in violation of any provision of this act or rules etc. then it may, after giving an opportunity to person responsible, by order direct such person to take such measures within specified period. The agency under this section has been empowered to immediately stop, prevent or minimize emission, disposal etc. for remedying adverse environmental effects.

Section 22: The person who fails to comply with section 11, 17, 18 and 21 shall be punishable with a fine which may extend to five million rupees, to the damage caused to environment and in the case of a continuing contravention or failure, with an additional fine which may extend to one hundred thousand rupees for every day during which such contravention or failure continues. And, where a person convicted under sub-sections 1&2 had been previously convicted for any contravention of this Act, the Environmental Protection Tribunal (EPT) may, in addition to punishment, award imprisonment for a term that may extend up to three years, or order confiscation or closure of facility etc.

Section 23: Where any violation of this Act has been committed by any of employee of any corporate body, then, that employee shall be considered to be guilty of environmental pollution.

Section 25: This section allows for establishment of Environmental Protection Tribunals.

3.3.2 Sindh EPA (Review of IEE/EIA) Regulations 2014

The Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2014 define Schedules (I & II) of projects falling under the requirement of IEE or EIA. This IEE Study has, for environmental classification of the Project into Category A or B, taken account of the requirements of the Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2014 which define Schedules (I & II) as follows:

Schedule I: A project falls in Schedule I if it is likely to have adverse environmental impacts, but of lesser degree or significance than those for category 'A' and all the mitigation measures to handle the impact is manageable. Such types of projects need IEE report including EMP.

Schedule II: Projects are categorized in Schedule II if they generate significant adverse environmental impacts that require a comprehensive management plan, or if the project is located within or passes through: a) Areas declared by the Government of Pakistan as environmentally sensitive (National Parks/Sanctuaries/Game Reserve), b) Areas of international significance (e.g. protected wetland as designated by the RAMSAR Convention), or c) Areas designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as cultural heritage sites.

According to Sindh Environmental Protection Agency Regulation, 2014, a project falling in any category listed in Schedule I shall file an IEE with the Sindh Environmental Protection Agency (SEPA). **Wind project** are placed in Schedule I: B(7) thus requiring an IEE.

Filing: Regulation 9 requires submission of ten hardcopies and two electronic copies accompanied by an application form (schedule-V), copy of receipt of payment of review fee, NOC from relevant departments (where applicable) and environmental checklist (if project falls in schedule III).

Preliminary scrutiny: Regulation 10 states that within 15 days of report submission the agency shall review the report and inform the proponent for submission of any additional information.

Review: The agency shall review the IEE report within 60 days after issuing confirmation of completeness as per Regulation 9. It shall also conduct an experts committee meeting or solicit views from concerned advisory committee.

Validity: Regulation 18 defines the validity period of approval of an IEE or EIA to be three years from date of construction and construction must start within three years of report approval. A three year extension at a time may be granted upon the agency's discretion with or without the submission of a fresh IEE or EIA.

Monitoring: Sub-regulation 20 requires the submission of a report to agency on completion of construction of project and after issue of confirmation of compliance, the submission of annual report summarizing operational performance of the project with reference to conditions of approval and maintenance and mitigation measures adopted by the project.

3.3.3. National Environmental Quality Standards (NEQS)

One of the functions of the Pak EPA under the provision of PEPO of 1983 was to issue NEQS for municipal and liquid industrial effluent, industrial gaseous emissions and motor vehicle exhaust and noise. The Pak EPA issued a statutory regulatory order (S.R.O) in 1994. It required all units coming into production after 1st July 1994 to comply immediately with the new standards. Those already in production at the time of S.R.O were required to comply starting 1st July 1996. The Pak EPA was not able to implement the NEQS effectively for many reasons, including lack of implementation capacity and resistance from industry.

With the PEPA, 1997 the Pak EPA revised the NEQS with full consultation of the private sector, industrialist, trade and business associations and NGOs. The municipal and liquid industrial effluent standards cover 32 parameters. The standards for industrial gaseous emissions specify limits for 16 parameters, and the standards for motor vehicles prescribe maximum permissible limits for smoke, carbon monoxide and noise. Revised standards cover discharges limits of effluents into inland water, sewage treatment plant and the sea. The NEQS are primarily concentration based. Unfortunately, the limits on industrial effluents are neither industry specific nor do they have any relationship with the quantum of production. The NEQS prohibit dilution, but this can be easily circumvented.

Project Proponent is committed to comply with the applicable NEQS in letter and spirit.

The chronological list of NEQS is shown in Table 3.1.

Table 3.1: National Environmental Quality Standards

Date	Number	Scope
1993	742(I)/1993	Liquid Industrial Effluent Industrial Gaseous Emission Vehicle Exhaust and Noise
1995	1023(I)/1995	Industrial Gaseous Emission from Power Plants operating on coal and oil (added)
2000	549(I)/2000	Liquid Industrial Effluent (amended) Industrial Gaseous Emission (amended)
2010	1062(I)/2010	Ambient Air
2010	1063(I)/2010	Drinking Water Quality
2010	1062(I)/2010	Noise

Table 3.2: National Environmental Quality Standard for Ambient Air

Pollutant	Time-weighted average	Concentration in Ambient Air		Method of measurement
		Effective from 1st Jan 2009	Effective from 1st Jan 2012	
Sulfur Dioxide (SO_2)	Annual Average* 24 hours**	80µg/m³ 120µg/m³	80µgm³ 120µgm³	Ultraviolet Fluorescence Method
Oxides of Nitrogen as (NO)	Annual Average* 24 hours**	40µg/m³ 40µgm³	40µgm³ 40µgm³	Gas Phase Chemiluminescence
Oxides of Nitrogen as (NO_2)	Annual Average* 24 hours**	40µgm³ 80µgm³	40µgm³ 80µgm³	Gas Phase Chemiluminescence
O_3	1 hour	180µgm³	130µgm³	Non dispersive UV absorption method
Suspended Particulate Matter (SPM)	Annual Average* 24 hours**	400µgm³ 550µgm³	360µgm³ 500µgm³	High volume Sampling, (Average flow rate not less than 1.1m³/minute)
Respirable Particulate Matter (PM10)	Annual Average* 24 hours**	200µgm³ 250µgm³	120µgm³ 150µgm³	B Ray absorption method
Respirable Particulate Matter (PM2.5)	Annual Average* 24 hours** 1 hour	25µgm³ 40µgm³ 25µgm³	15µgm³ 35µgm³ 15µgm³	B Ray absorption method
Lead (Pb)	Annual Average* 24 hours**	1.5µgm³ 2µgm³	1µgm³ 1.5µgm³	ASS Method after sampling using EPM 2000 or equivalent Filter paper
Carbon Monoxide (CO)	8hours** 1hours	5mg/m³ 10mg/m³	5mg/m³ 10mg/m³	Non Dispersive Infra Red (NDIR) method

***Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.**

****24 hourly / 8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.**

Table 3.3 shows the stan[illegible] motor vehicle noise.

Table 3.3: The Motor Vehicle Ordinance (1965) and Roles (1969)

Parameter	Standards (maximum permissible limit)	Measuring method
Noise	85dB(A)	Sound-meter at 7.5meter from the source

[illegible] 3.4 shows the prop[illegible] [illegible] environmental quality standard [illegible]

Table 3.4: National Environmental Quality Standard for Noise

S. No.	Category of Area / Zone	Effective from 1st January, 2009		Effective from 1st January, 2010	
		Limit it in dB(A) Leq*			
		Day Time	Night Time	Day Time	Night Time
1	Residential area (A)	65	50	55	45
2	Commercial area (B)	70	60	65	55
3	Industrial area (C)	80	75	75	65
4	Silence Zone (D)	55	45	50	45
Note: 1	Day time hours: 6.00 a. m to 10.00 p. m				
2	Night time hours: 10.00 p. m to 6.00p. m				
3	Silence zone; Zone which are declared as such by competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.				
4	Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.				
***dB(A)Leq**	Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.				

[illegible] NEQS for effluents [illegible] Table 3.5

Table 3.5: National Environmental Quality Standard for Municipal & Liquid Industrial Effluents

S. #	**Parameter**	**Into Inland Waters**	**Into Sewage Treatment**	**Into Sea**	**unit**
1	Temperature or Temp. increase	<3	<3	<3	°C
2	pH value (H^+)	6-9	6-9	6-9	
3	Biological Oxygen Demand $(BOD)_5$ at 20°C	80	250	80	mg/l
4	Chemical Oxygen Demand (COD)	150	400	400	mg/l
5	Total Suspended Solids (TSS)	200	400	200	mg/l
6	Total Dissolved Solids (TDS)	3500	3500	3500	mg/l
7	Oil and Grease	10	10	10	mg/l
8	Phenolic Compounds (as Phenol)	0.1	0.3	0.3	mg/l
9	Chloride (as Cl^-)	1000	1000	SC	mg/l
10	Fluoride (as F^-)	10	10	10	mg/l
11	Cyanide (as CN^-)total	1.0	1.0	1.0	mg/l
12	An-ionic detergents (as MBAS)	20	20	20	mg/l
13	Sulphate(SO_4^{2-})	600	1000	SC	mg/l
14	Sulphide (S^{2-})	1.0	1.0	1.0	mg/l
15	Ammonia (NH_3)	40	40	40	mg/l
16	Pesticides	0.15	0.15	0.15	mg/l
17	Cadmium	0.1	0.1	0.1	mg/l
18	Chromium (trivalent and hexavalent)	1.0	1.0	1.0	mg/l
19	Copper	1.0	1.0	1.0	mg/l
20	Lead	0.5	0.5	0.5	mg/l
21	Mercury	0.01	0.01	0.01	mg/l
22	Selenium	0.5	0.5	0.5	mg/l
23	Nickel	1.0	1.0	1.0	mg/l
24	Silver	1.0	1.0	1.0	mg/l
25	Total toxic metals	2.0	2.0	2.0	mg/l
26	Zinc	5.0	5.0	5.0	mg/l
27	Arsenic	1.0	1.0	1.0	mg/l
28	Barium	1.5	1.5	1.5	mg/l

Table 3.5: National Environmental Quality Standard for Municipal & Liquid Industrial Effluents

S. #	Parameter	Into Inland Waters	Into Sewage Treatment	Into Sea	unit
29	Iron	8.0	8.0	8.0	mg/l
30	Manganese	1.5	1.5	1.5	mg/l
31	Boron	6.0	6.0	6.0	mg/l
32	Chlorine	1.0	1.0	1.0	mg/l

3.3.4 Antiquities Act 1975

The Antiquities Act, 1975 ensures the protection of Pakistan's cultural resources. The Act defines "antiquities" as ancient products of human activity, historical sites or sites of anthropological or cultural interest, national monuments, etc. The Act is designed to protect these antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the GoP to prohibit excavation in any area that may contain articles of archaeological significance. Under the Act, the Project proponents are obligated to ensure that no activity is undertaken within 61 m (200 ft) of a protected antiquity, and to report to the GoP's Department of Archaeology any archaeological discovery made during the course of the project.

The federal Department of Archaeology maintains a master register containing basic and vital information on the protected monuments and sites including full measurements of the protected area, description, location and Government Notification number with date of protection. The central directorate general of Archaeology has a separate list which is continuously updated as and when new sites are declared as protected.

The Act is designed to protect the antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the GOP to prohibit excavation in any area that may contain articles of archaeological significance. The project site does not have any cultural sensitivity in the vicinity to require protection. The provisions of this law therefore do not apply on the project.

No protected antiquity/cultural heritage site was identified in the vicinity of the proposed Project.

3.3.5 Sindh Cultural Heritage (Preservation) Act, 1994

The Sindh Cultural Heritage (Preservation) Act, 1994 is the provincial law for the protection of cultural heritage. Its objectives are similar to those of the Antiquity Act, 1975. The Act empowers the Antiquities Department to protect the cultural and heritage sites from any development /improvement work.

None of the sites protected under this law are found in the vicinity of project site. The project will therefore not influence the integrity of cultural heritage in the macro-environment.

3.3.6. Forest Act 1927

The Forest Act deals with the matters related with protection and conservation of natural vegetation/habitats. In that regard it empowers the concerned agency to declare protected and reserved forest areas and maintaining the same. In spite of the fact that it recognizes the right of people for access to the natural resources for their household use, it prohibits unlawful cutting of trees and other vegetation. The permission is required prior to undertaking any tree cutting from the area under the charge of Forest Department of Sindh.

The Project site does not encompass any reserve/protected forest area. However, it is not just the protected forests that the Forest department needs to attend to; it is equally responsible to protect the forest cover, protected or unprotected, to abate rampant desertification. The process of desertification is linked to availability of firewood, which is now in greater demand than ever because of the exhaustion of all fuel resources in the country. This has led to not just felling, lopping and topping of trees, branches anywhere but to extracting the tree by the roots.

3.3.7. 2.9 Cutting of Trees (Prohibition) Act, 1975 and The Protection of Trees and Bush wood Act, 1949

The Cutting of Trees Act prohibits cutting or chopping of trees without prior permission of the Forest Department. Section 3 of this Act states "No person shall, without the prior written approval of the local formation commander or an officer authorized by him in this behalf, cut fell or damage or cause to cut, fell or damage any tree."

Similarly, the Protection of Trees and Bush wood Act, 1949 prohibits cutting of trees and bush wood without permission of the Forest Department. The Act was enforced to prevent unlawful removal /clearing of trees and green areas for any reason without the consent of the Forest Department.

3.3.8. Sindh Wildlife Protection (Second Amendment) Ordinance, 2001

This ordinance provides for the preservation, protection, and conservation of wildlife by the formation and management of protected areas and prohibition of hunting of wildlife species declared protected under the ordinance. The ordinance also specifies three broad classifications of the protected areas: national parks, wildlife sanctuaries and game reserves. Activities such as hunting and breaking of land for mining are prohibited in national parks, as are removing vegetation or polluting water flowing through the park. Wildlife sanctuaries are areas that have been set aside as undisturbed breeding grounds and cultivation and grazing is prohibited in the demarcated areas. Nobody is allowed to reside in a wildlife sanctuary and entrance for the general public is by special dispensation. However, these restrictions may be relaxed for scientific purpose or betterment of the respective area on the discretion of the governing authority in exceptional circumstances. Game reserves are designated as areas where hunting or shooting is not allowed except under special permits.

Wildlife sanctuaries are areas that have been set aside as undisturbed breeding grounds and cultivation and grazing is prohibited in the demarcated areas. Nobody is allowed to reside in a wildlife sanctuary and entrance for the general public is by special dispensation. However, these restrictions may be relaxed for scientific purpose or betterment of the respective area on the discretion of the governing authority in exceptional circumstances. Game reserves are designated as areas where hunting or shooting is not allowed except under special permits.

Two amendments to the Ordinance were issued in January and June 2001 respectively pertaining to oil and gas exploration activities within national parks and wildlife sanctuaries. The first amendment allowed the Government to authorize the laying of an underground pipeline through protected areas. The second amendment allowed exploration and production activities within national parks and wildlife sanctuaries. This amendment is not applicable to other development projects including power generation using wind energy for example.

The Jhimpir ecosystem which includes the Project site does not fall in a protected area or wildlife sanctuary.

Legalization of hunting on disappearing creatures in Pakistan and specifically the hunting of houbara bustard has been allowed as the preservation method for local wild animal habitat. However, because of the lukewarm attitude of the authorities that be, this method of conservation has failed in its mission. The wildlife department is hardly able to monitor the actual number of animal or bird killed as against the legally allowed numbers, and that makes it hard to control the trophy hunters.

Big-game hunting is banned in Pakistan vide the above regulations, except in community-controlled areas with an existing limitation on exact kinds and numbers of species as well as countries they can be exported in. There is decline in such species as cranes, geese, storks, pelicans, and houbara bustards, which are migratory birds. The illegal hunting has led to continuous loss, fragmentation and degradation of natural habitats that include forests, rangelands, and freshwater and marine ecosystem.

Sindh Wildlife Department is responsible for protection of wildlife in the Province. The Department's concerns are limited to areas designated as game reserves, national parks and wildlife sanctuaries and to protecting species afforded protection under the law. So as long as the law is not being contravened they have no artificial interest in activities carried on outside game reserves, national parks and wildlife sanctuaries. The Department nevertheless has the powers to halt illegal activities outside the protected areas.

The project lies in proximity to Kinjhar (Kain) Lake. The distance from this wildlife sanctuary is around 10 km. Protection of measures such as restriction of hunting/poaching of animals, cutting of wood for fuel, and careful transportation etc. will be adopted to ensure the protection of wildlife in the macro environment.

3.3.9 The IUCN Red List

Some animal species are already extinct in Pakistan, and many are internationally threatened. The 1996 IUCN Red List of Threatened Animals classifies 37 species and 14 sub-species of mammals that occur in Pakistan as internationally threatened or near-threatened.

The Red List is based on field data that is more than 10 to 15 years old and needs to be re-assessed. The country also provides critical habitat to 25 internationally threatened bird species and 10 internationally threatened reptiles.

According to the National Avian Research Centre in Abu Dhabi, with houbara's birth rate of 5 per cent a year and if number of houbara keeps decreasing at the same rate with more than 6,000 being bagged by hunting parties and more than 4000 smuggled out of country, the worst scenario is that the houbara bustard would disappear as a species by 2015.

There are a number of organizations that were formed to protest the illegal hunting and preserve the wildlife. This includes National Council for Conservation of Wildlife (NCCW), established in 1974 and supported by the UN, which breaks into three groups: Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Convention on Wetland of International Importance Especially as Waterfowl Habitat (RAMSAR) and Convention on the Conservation of Migratory Species of Wild Animals (CMS).

3.3.10. Land Acquisition Act, 1894

This Act is a colonial legacy which provides law for the acquisition of land needed for public purposes and for companies. The Act provides complete mechanism for determining the amount of compensation for land, trees, horticulture, to be made on account of such acquisitions. The law provides details of various peculiarities involved in acquisition of land such as preliminary investigation, objection to acquisition, declaration of intended acquisition, enquiry into measurements, value & claims, taking possession, reference to court and procedure thereon, apportionment of compensation, payment, temporary occupation of land, acquisition of land for companies, disputes resolutions, penalties and exemptions, etc. This Act has 55 sections addressing different areas. Section 4(2) of the Act mentions that it shall be lawful for any official authorized by the Collector to enter upon and survey, to dig or to do all other acts necessary to ascertain whether the land is suitable for such purpose.

The project site is already acquired by the proponent; the project therefore involved no land acquisition.

3.3.11. Pakistan Penal Code (1860)

The Pakistan Penal Code (1860) authorizes fines, imprisonment or both for voluntary corruption or fouling of public springs or reservoirs so as to make them less fit for ordinary use.

3.3.12. Civil Aviation Rules (1994)

These rules apply to flight operations within Pakistan by aircrafts other than military aircrafts and, except where otherwise prescribed, to flight operations by aircrafts registered, acquired or operating under these rules, wherever they may be. The rules with relevant significance to the activities taking place in Jhimpir Wind Corridor are the following:

- No person shall erect any temporary or permanent structure, nor position a vehicle or other mobile object on or in the vicinity of an aerodrome (airport), that will be within the clearance area, or will protrude through an obstacle limitation surface, at that aerodrome.

- No person shall operate a light in the vicinity of an aerodrome which because of its glare is liable to dazzle pilots of aircraft taking off from or landing at that aerodrome; or which can be mistaken for an aeronautical ground light. If such a light is operated it shall be extinguished or satisfactorily screened immediately upon notice being given to the person or persons operating the light, by the Director General or by the Manager or by a person authorized by him.
- No person or persons shall operate a radio station or electrical equipment in the vicinity of an aerodrome or of a radio aid to navigation serving an airway or an air route in Pakistan which is liable to cause interference with radio communications between aircraft and an Air Traffic Services Unit, or which is liable to disturb the signal from a navigational radio aid.
- A captive balloon or a kite shall not be flown at a height above 200ft within 6km of an aerodrome, and a free balloon shall not be flown at any place, except with the express permission of the Director General and in compliance with the conditions attached to such permission
- An aircraft shall not be flown over congested areas of cities, towns, or settlements or over an open air assembly of persons, except by permission of the Director-General, unless it is at such height as will permit, in the event of an emergency, a landing to be made without undue hazard to persons on the ground, and except when it is taking off or landing, shall not be flown closer than 500ft to any person, vessel, vehicle or structure.

The proposed Wind farm site is neither used by the domestic air traffic, nor does it fall under the flyway of the air traffic. It is therefore unlikely that wind farm construction and operation activities would contravene any of the aforementioned rules. The Proponent will nevertheless submit a promissory note to the Director General Civil Aviation informing the Authority of the construction and operation schedule and install aviation lighting at the top of wind turbine if required by regulations.

3.3.13. Self-Monitoring and Reporting by Industry Rules, 2014

These rules classify the industrial units for monitoring and reporting their liquid effluent and gaseous emissions into three and two categories respectively. According to each category they define the priority parameters to be monitored and reported to SEPA according to a specific frequency based on working conditions. This monitoring and reporting is in addition to the monitoring conditions as required by the conditions of approval of IEE. The sampling for testing must be carried out according to Environmental Samples Rules, 2014 and be sent to SEPA certified environmental testing laboratories.

3.4 Approval and Lease Requirements

- All development activities are now required by law to obtain an Approval/No Objection Certificate (NOC) from the provincial EPA or Federal EPA, as the case may be.
- Power Production Units based on Renewable Energy sources are required to obtain a No Objection Certificate (NOC) from the Alternative Energy Development Board. However, in order to encourage generation through renewable resources, small projects for self-use will not require any permission from the government, and will also be able to sell surplus power to Distribution Companies under the Renewable Energy Policy - 2006.

- The small renewable energy projects also do not require tariff determination from NEPRA. Alternative Energy Development Board has been allowed to handle Wind and solar projects, irrespective of size of the plant (even more than 50 MW), while the power purchaser will bear the wind risk just as well.
- Approvals/leases are required from Local Government, Highway Department, and Irrigation Departments for installation of transmission lines and their crossing of highways, roads, canals and public property. Approvals will also be needed from Civil Aviation Authority as well as Telecommunication Authority in case the project is sited near or under the aircraft flyway zone. Each of these departments has its own set of requirements for grant of approval.

The following departments will be consulted and their consent obtained, if necessary before commencement of work at the Project site:

- Sindh Wildlife and Forest Department.
- National Highway Authority.
- Water and Power Development Authority (WAPDA).
- Pakistan Telecommunication Company Limited (PTCL).
- Civil Aviation Authority
- Telecommunication Authority.

3.5. Environmental and Social Guidelines

3.5.1. Environmental Protection Agency's Environmental and Social Guidelines

The Federal EPA has prepared a set of guidelines for conducting environmental and social assessments. The guidelines derive from much of the existing work done by international donor agencies and NGOs. The package of regulations, of which the environmental and social guidelines form a part, includes the PEPA 1997 and the NEQS. These guidelines are listed below followed by comments on their relevance to proposed project:

- **Policy and Procedures for Filing, Review and Approval of Environmental Assessments, Pakistan Environmental Protection Agency, September 1997:** These guidelines define the policy context and the administrative procedures that govern the environmental assessment process from the project pre-feasibility stage to the approval of the environmental report. The section on administrative procedures has been superseded by the IEE-EIA Regulations, 2000.

The overall flow of obtaining the approval of IEE and EIA is shown in figure 3.1 and 3.2.

- **Guidelines for the Preparation and Review of Environmental Reports, Pakistan Environmental Protection Agency, 1997:** The guidelines on the preparation and review of environmental reports target project proponents and specify:
  - The nature of the information to be included in environmental reports
  - The minimum qualifications of the EIA conductors appointed

- The need to incorporate suitable mitigation measures at every stage of project implementation
- The need to specify monitoring procedures.

- The terms of reference for the reports are to be prepared by the project proponents themselves. The report must contain baseline data on the Study Area, detailed assessment thereof, and mitigation measures.
- **Sectoral guidelines for Environmental Reports – Wind Power Projects:** These Wind Power sectoral guidelines are part of a package of regulations and guidelines. They should be read in the context of the overall EIA Guideline Package. This "Package" has been prepared by the Federal EPA in collaboration with other key stakeholders, including Provincial EPA's and Planning and Development Division from both the Federal Government and the provinces, other Agencies, NGO's representatives of Chambers of Commerce and Industry, and academics and consultants. The Package consists of comprehensive procedures and guidelines for environmental assessment in Pakistan. It is emphasized that the various guidelines should be read as a package; reliance on the sectoral guidelines alone will be inadequate.
- Guidelines for Environmental Impact Assessment of Wind Farms allow for adoption of methods mentioned in the Pakistan Environmental Assessment Procedures 1997.
- **Guidelines for Public Consultation, Pakistan Environmental Protection Agency, May, 1997:** These guidelines support the two guidelines mentioned above. They deal with possible approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures the incorporation of their concerns in any impact assessment study.
- **Guidelines for Sensitive and Critical Areas:** The guidelines identify officially notified protected areas in Pakistan, including critical ecosystems, archaeological sites, etc., and present checklists for environmental assessment procedures to be carried out inside or near such sites. Environmentally sensitive areas include, among others, archaeological sites, biosphere reserves and natural parks, and wildlife sanctuaries and preserves.

3.5.2 IFC- Environmental, Health, and Safety Guidelines

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP). For Wind Energy the EHS Guidelines for wind energy include information relevant to environmental, health, and safety aspects of onshore and offshore wind energy facilities.

Construction activities for wind energy projects typically include land clearing for site preparation and access routes; excavation, blasting, and filling; transportation of supply materials and fuels; construction of foundations involving excavations and placement of concrete; operating cranes for unloading and installation of equipment; and commissioning of new equipment. Decommissioning activities may include removal of project infrastructure and site rehabilitation.

Environmental issues associated with the construction and decommissioning activities may include, among others, noise and vibration, soil erosion, and threats to biodiversity, including habitat alteration and impacts to wildlife. Due to the typically remote location of wind energy conversion facilities, the transport of equipment and materials during construction and decommissioning may present logistical challenges.

Environmental issues specific to the operation of wind energy projects and facilities include the following:

- Visual impacts
- Noise
- Species mortality or injury and disturbance
- Light and illumination issues
- Habitat alteration
- Water quality
- Electric Power Transmission and Distribution

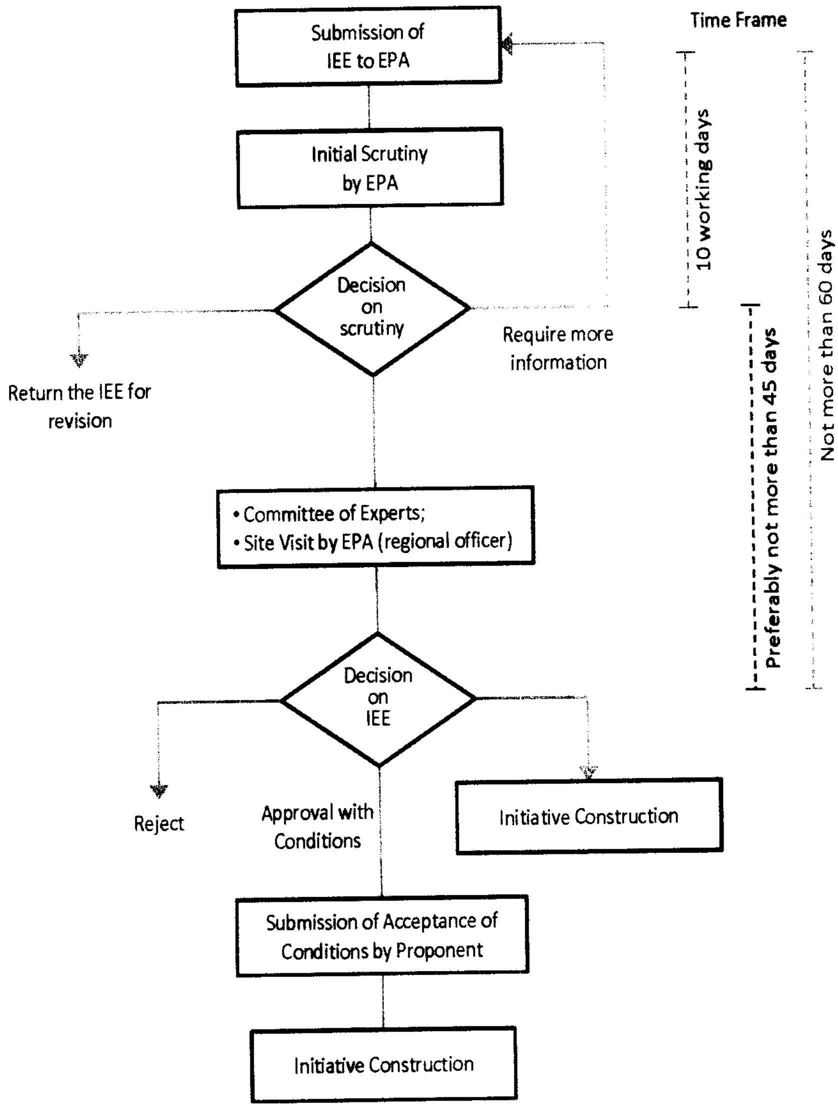
The EHS Guidelines for Electric Power Transmission and Distribution include information relevant to power transmission between a generation facility and a substation located within an electricity grid, in addition to power distribution from a substation to consumers located in residential, commercial, and industrial areas.

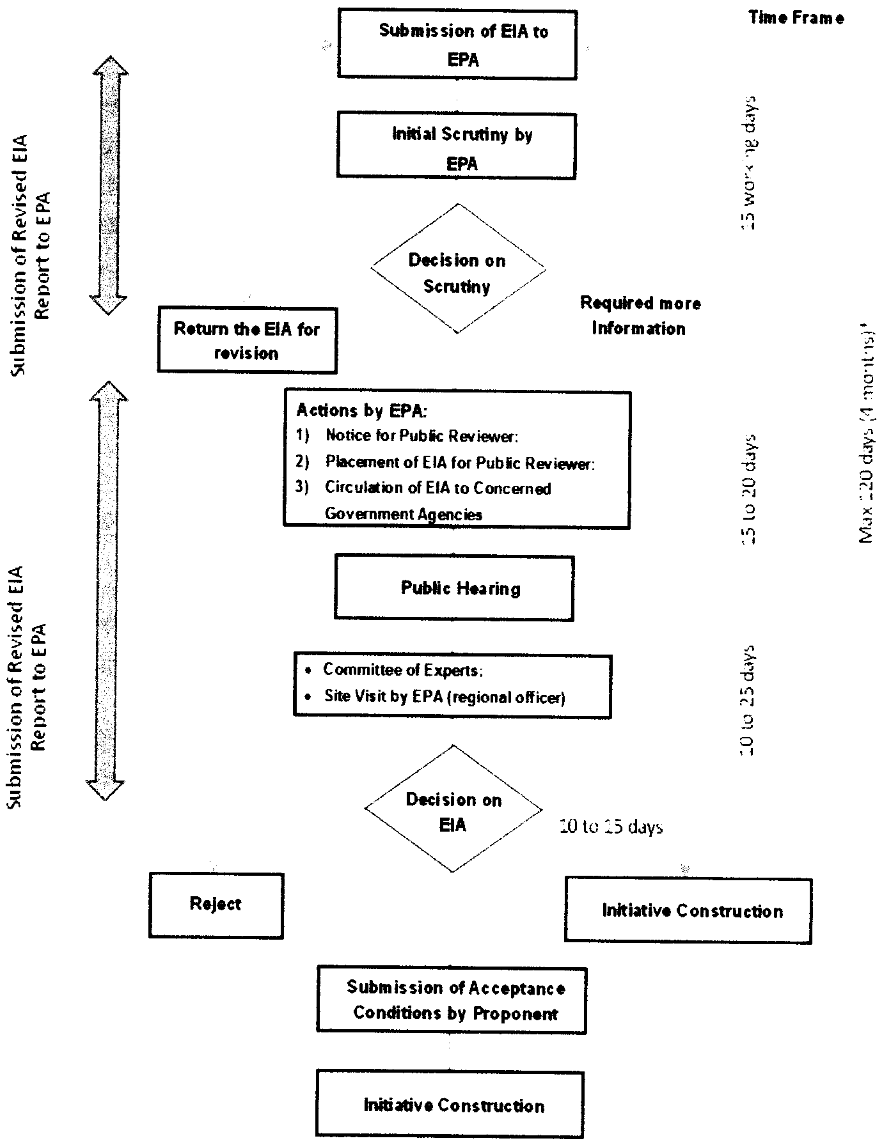
Examples of the impacts addressed in the General EHS Guidelines include:

- Construction site waste generation;
- Soil erosion and sediment control from materials sourcing areas and site preparation activities;
- Fugitive dust and other emissions (e.g. from vehicle traffic, land clearing activities, and materials stockpiles);
- Noise from heavy equipment and truck traffic;
- Potential for hazardous materials and oil spills associated with heavy equipment operation and fuelling activities.

Environmental issues during the construction phase of power transmission and distribution projects specific to this industry sector include the following:

- Terrestrial habitat alteration.
- Aquatic habitat alteration.
- Electric and magnetic fields.
- Hazardous materials.


Submission of IEE to EPA
Time Frame
Initial Scrutiny by EPA
10 working days
Decision on scrutiny
Return the IEE for revision
Require more information
Not more than 60 days
Preferably not more than 45 days
• Committee of Experts;
• Site Visit by EPA (regional officer)
Decision on IEE
Reject
Approval with Conditions
Initiative Construction
Submission of Acceptance of Conditions by Proponent
Initiative Construction


Time Frame
Submission of EIA to EPA
Initial Scrutiny by EPA
Decision on Scrutiny
Required more Information
Return the EIA for revision
Submission of Revised EIA Report to EPA
Actions by EPA:
1) Notice for Public Reviewer;
2) Placement of EIA for Public Reviewer;
3) Circulation of EIA to Concerned Government Agencies
Public Hearing
• Committee of Experts;
• Site Visit by EPA (regional officer)
Submission of Revised EIA Report to EPA
Decision on EIA
10 to 15 days
15 to 20 days
10 to 25 days
Reject
Initiative Construction
Submission of Acceptance Conditions by Proponent
Initiative Construction

Chapter 4 DESCRIPTION OF ENVIRONMENT

4.1 General

This section describes the environmental conditions of the project area. Information for this section was collected from a variety of sources, including published literature, reports of other studies conducted in the area by the EMC Pakistan Pvt. Ltd. and archives of the experts, consultations with institutions, Nongovernment Organizations (NGO's) and field surveys conducted for this study by the team of EMC Pakistan Pvt. Ltd.

Description of the environment of the project requires baseline data on the existing resources of its microenvironment and macro environment, the following in particular:

a. Physical Resources.
b. Ecological Resources.
c. Social, Economic Development and Cultural Resources.

In order to carry out environmental assessment study, it is first necessary to demarcate the existing environmental feature in and around the proposed project, on the existing environment and section describes the environmental setting of the project area.

Baseline data reported here pertain to the physical, biological and socio-economic aspects of the macro-environment as well as the microenvironment of proposed project site. The project is located in Jhimpir- Thatta, Sindh. Information available from electronic/printed literature relevant to baseline of the area, surroundings and Karachi was collected at the outset and reviewed subsequently. This was followed by surveys conducted by experts to investigate and describe the existing status and scenario.

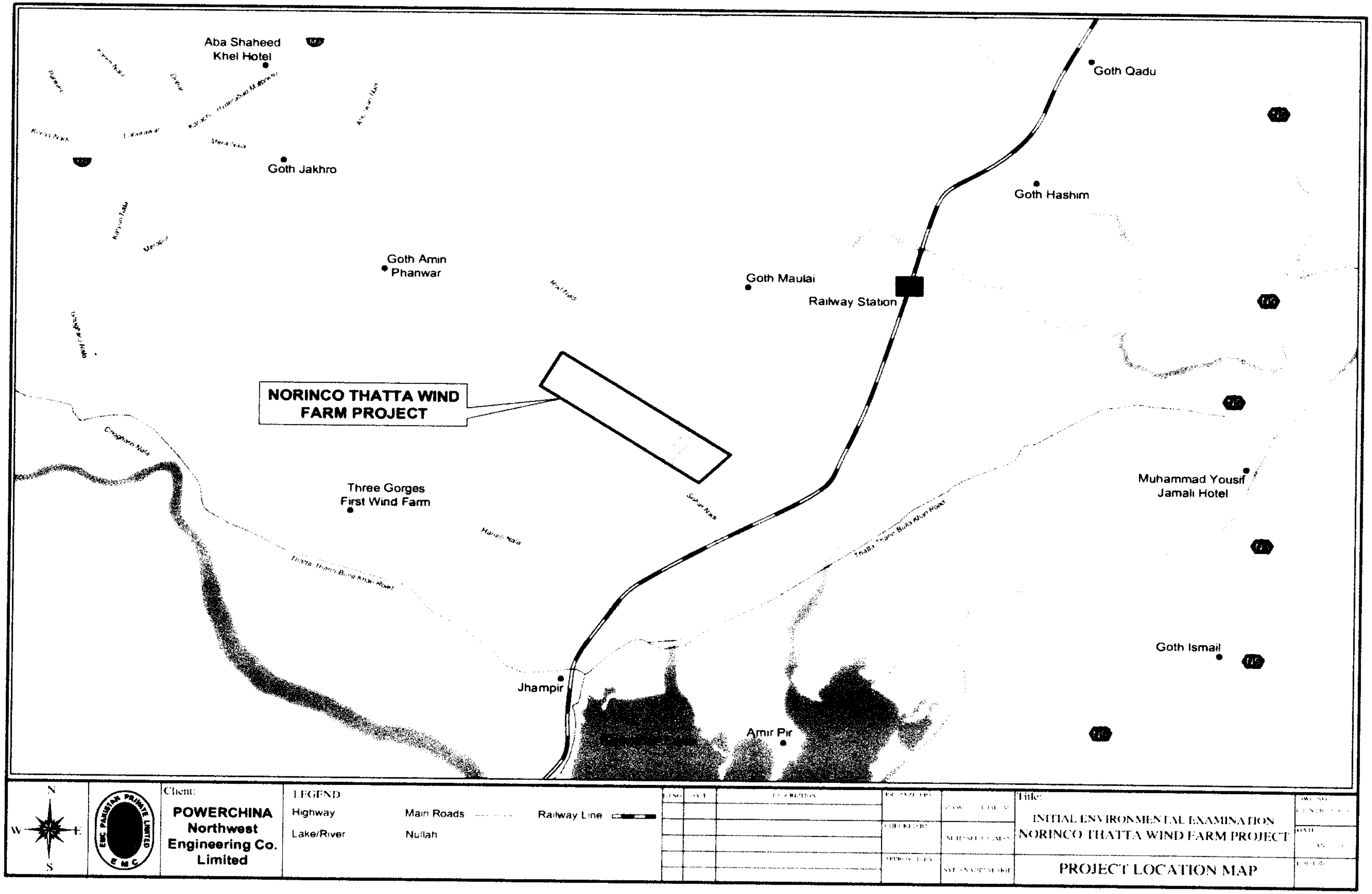
4.2 Physical Baseline of the Macro-Environment

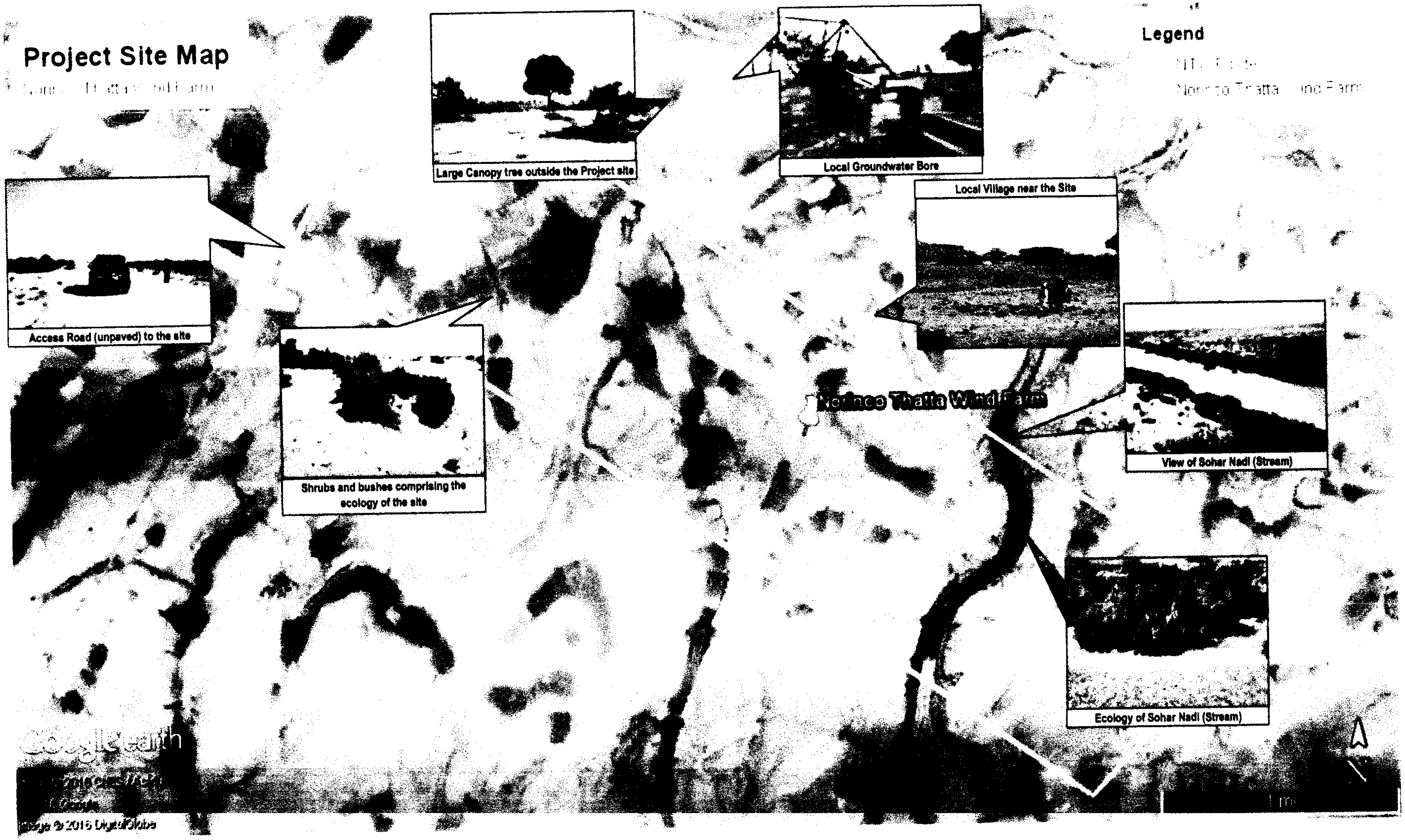
The physical environment of Project has been described here in terms of climate and meteorology, ambient air quality, surface water resources, groundwater resources and quality, geology and seismicity.

4.2.1 Location of the Project

Thatta wind farm project (100MW) is located at Jhimpir in Sindh Province of Pakistan, about 110km northeast away from Karachi and 80km northeast away from Port Qasim, with geographical coordinates of 68°0'4"~68°3'55" E and 25°5'23"~25°8'4" N. The project area stretches in nearly northwest-southeast direction, with a length of about 6.7km and a width of 1.6km. The elevation of the project area is 40m~60m. The project area can be reached through M9 Highway from Karachi to Nooriabad. The location map is proposed Project is presented in Figure 4.1.

Reconnaissance Survey has been conducted to obtain the primary data pertains to the physical environment of the site and microenvironment. The pictorial details are presented in Figure 4.2.


Aba Shaheed Khel Hotel
Goth Jakhro
Goth Qadu
Goth Hashim
Goth Amin Phanwar
Goth Maulai
Railway Station
NORINCO THATTA WIND FARM PROJECT
Three Gorges First Wind Farm
Muhammad Yousif Jamali Hotel
Goth Ismail
Jhampir
Amir Pir
Thatta Thano Bula Khan Road
N
S
W
E
Client:
POWERCHINA Northwest Engineering Co. Limited
LEGEND
Highway
Main Roads
Railway Line
Lake/River
Nullah
Title:
INITIAL ENVIRONMENTAL EXAMINATION
NORINCO THATTA WIND FARM PROJECT
PROJECT LOCATION MAP


Project Site Map
Legend
Large Canopy tree outside the Project site
Local Groundwater Bore
Access Road (unpaved) to the site
Local Village near the Site
Shrubs and bushes comprising the ecology of the site
View of Sohar Nadi (Stream)
Ecology of Sohar Nadi (Stream)
Google earth
Image © 2016 DigitalGlobe

4.3. Macroenvironment of the Project

The macroenvironment of the proposed project is at large scale comprises of Thatta on the whole. Thatta district is spread over 17, 355 sq. km and located between 23° 43' to 25° 26' N and 67° 05' to 68° 45' in Sindh, Pakistan. Thatta district comprises 38.9 % wet areas with Indus River and Keenjhar Lake as the major fresh water resources. Crop irrigated area is around 19.6% and Crop Marginal and irrigated Saline is 3.7% in Thatta district. Forestry includes natural trees and Mangroves consisting of 5.4% in the district and bare areas with sparse natural vegetation comprise 5.9% land. In Thatta district range lands include Natural shrubs and Herbs around 6.1%.

The district is administratively subdived into 7 tehsils (talukas or sub-district): Ghora Bari, Jati, Mirpur Bathoro, Mirpur Sakro, Shah bunder, Sujawal, Thatta, Kharo Chan, and Keti Bunder. These tehsils include 55 Union Councils, 7,200 villages and over 190,000 households with an average size of 6.5 persons per household. Thatta wind farm project would be sited in tehsils Thatta of the district.

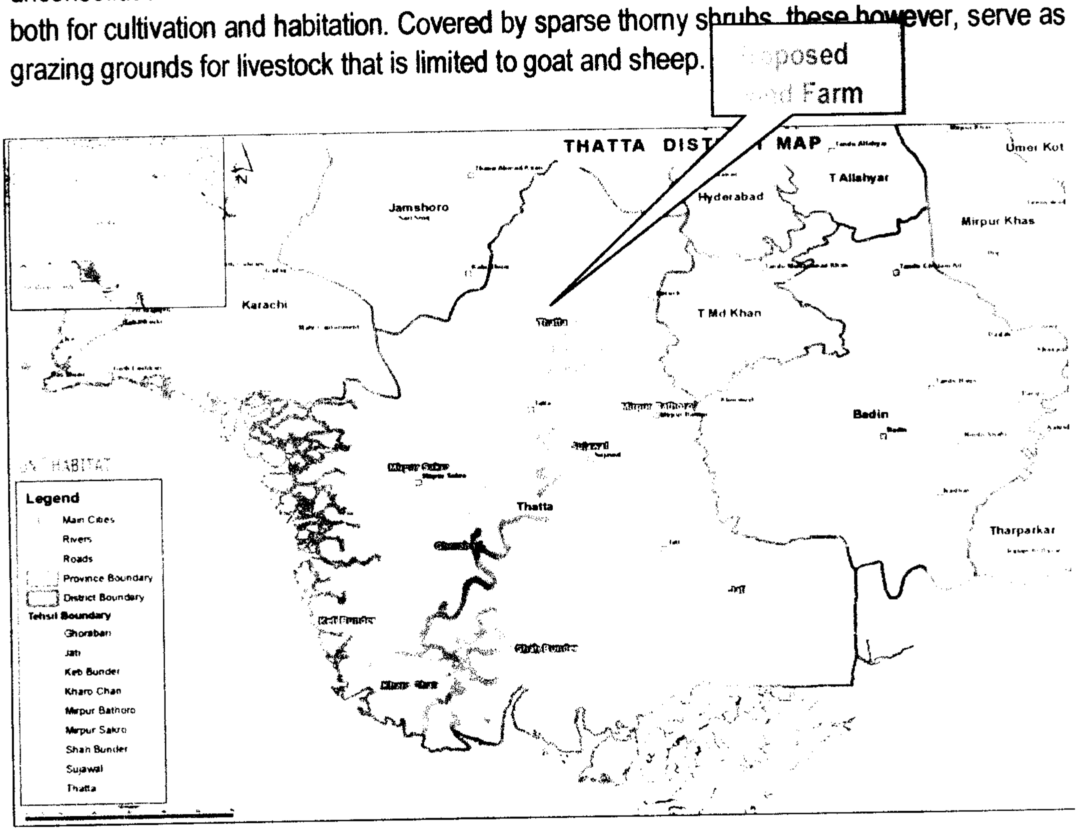
In its physical aspects the Thatta District has very varied features which range from coastal swamps to fresh water marshes and lakes and from river islands to coastal deltas. However, this wide variation has diminished as a result of the lack of water in the Indus River. The current terrain of the district consists of the Makli Hills close by the Thatta Town. These hills are 32 kilometers in length and are well known on account of the ancient tombs which are located here. The nort western part of the district consists of hilly tracts known as Kohistan. The hills are bare and mostly composed of limestone while the valleys are covered with grass or brushwood. Southwards, the area degenerates into sandy wastes, uncultivated and almost devoid of vegetation.

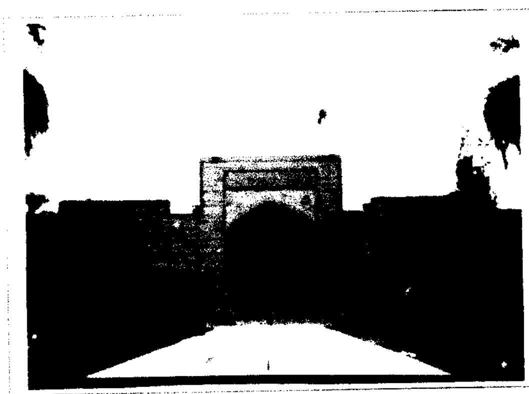
There are short ranges of low stones, hills and intersected by nais or torrent beds which carry the drainage of the Kohistan to the Indus. To the west, wind has blown sand over large tracts of land. In the south eastern quarter of the delta, there is a wide expanse of salt waste, embracing a large part of the Shah Bander and Jatti Talukas. Between Sir and Khori Creeks lie the great Sirganda salt deposits which consist of many square kilometers of solid salt.

There are many lakes in the district. The most famous are Kalri and Haleji.I The Kalri Lake is a reservoir for feeding canals in the Thatta sub-division. During winter it is an ideal spot for fishing and duck-shooting. There have been many ecological changes in the district, which Uhave changed the nature of the delta. The lack of water below Kotri has damaged the ecology of the delta. The old branch of Indus, which used to run past it into the Gharo Creek, has silted up. The district also comprises fierce torrents most important of them is Nai-Barun which rises in the Keerthur Range. The other important Nais in the district are Gagar and Ranpathani.

The climate of the district is moderate. The mean maximum and minimum temperature recorded during this month is about 40°C and 2°C respectively. The winter season starts from November when the dry and cold northeast winds replace the moist sea breeze. As a result there is an immediate fall in temperature. January is the coldest month. The annual average rainfall of the district is about 200 mm.

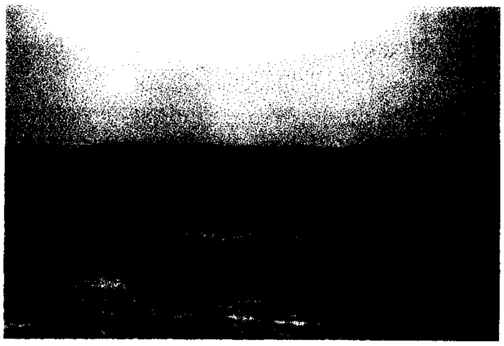
As regards the physiographic features, district Thatta can be characterized as the piedmont colluvial fans. The district is covered with un-differentiated piedmont and sub-piedmont deposits consisting of loosely packed boulders, cobbles, pebbles and coarse to fine stand. In regimen of fluvial erosion, the colluvial fringe has developed by merging of alluvial fans of individual streams depositing the erosional load of coarse sediments at the foot of each hillside. The deposits combined with material brought by sheet wash from hillsides has remained mostly unconsolidated, and under the process of weathering it has developed into good fertile soil where water is available. In dry or semi-arid conditions this shelving deposit of unconsolidated material has created badland topography of deeply scarred earth, unsuitable both for cultivation and habitation. Covered by sparse thorny shrubs, these however, serve as grazing grounds for livestock that is limited to goat and sheep.





Shahjhan Mosque

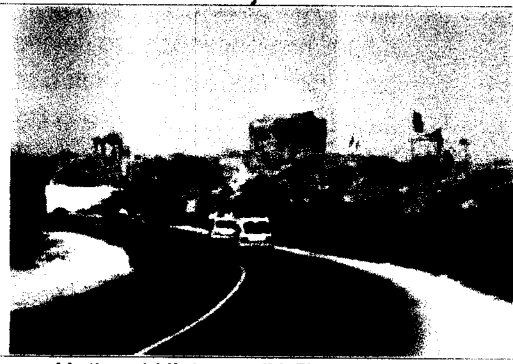
Makli Hills Graveyad



Keenjhar Lake

Haleji Lake

Thatta City



National Highway (N-5) to Thatta city

4.3.1. Geography of Macroenvironment

The Jhimpir Wind corridor lies in the mid-southwestern part of Sindh province. It is in fact bounded by the drainage basin of Baran nai including Darawat Dam site on the north, the Baran nai on the east, the Super Highway on the immediate south and the drainage area of Harolo nai on the west. The Harolo nai drains into Keenjhar Lake beyond the Jhimpir-Meting coal field along the Pakistan Railway Line in the south.

The land here is a barren, flat to mildly hilly tract, consisting of outlying spurs of the Kirthar Range. Cultivation is carried out wherever alluvial soil exists and near or along the numerous depressions where rain water carried by hill streams (nallas) can be stored. Cattle grazing, stone quarrying, gravel and sand collection and transportation, besides wood cutting are the main occupation.

4.3.1.1. Urban Clusters in Macroenvironment of Jhimpir Wind Corridor

It will be observed from the above list that the populated areas are located farther than 10 km from Jhangri. Thano Ahmad Khan and Thano Bula Khan are the main towns on the north of Super Highway M-9. Jhimpir (Population 40,000), Meting (Population 2,000), Nooriabad (Population 4,000) and Jherruck (Population 5,000), the main towns in the Jhimpir Wind Corridor are located on the south of Super Highway.

Jhimpir is an old town of historical significance, rich in minerals and natural resources. The main source of income is fishing in Keenjhar Lake and hunting/catching wintering birds for at least 4 months of the year. Other sources of income are wage labour in coal mines, stone quarries, other menial labour and working at the Jhimpir railway station. Those who have received some education are in jobs at school, offices and industries in Nooriabad.

Nooriabad is 30 km from Jhimpir and is home to the Nooriabad Industrial Area on 5,342 acre area with 522 plots out of 1150 or 30 percent in occupancy. Textile units, light engineering, food processing, and chemicals manufacturing are the major types of industries in the area.

4.3.2. Geology

The prevailing geologic conditions in the region are the results of extensive inundation, depositions, coastal movements, and erosions over a long period of time in the geological ages. The geology of the region is closely related to the formation process of Himalayan ranges resulting in intense deformation with complex folding, high angle strike-slip faults and crust thickening expressed in a series of thrust faults. The important tectonic changes which have had so much influence in the region are feebly visible particularly in the Indus Plain, and it is only by considering the geology on a broader regional scale, as well as in site specific detail, that the effects can be appreciated.

Most parts of Sindh are covered either by recent alluvium or wind-borne sand. The principal features of geological significance are to be found in the hilly portions of the province, towards the west of the Indus. Outlying extensions of this hilly tract occur east of the Indus as well, near Sukkur, Hyderabad and Jerruck. The isolated hills of Nagarparkar on the northern border of the Rann of Kutch belong to quite a different system both geographically and geologically.

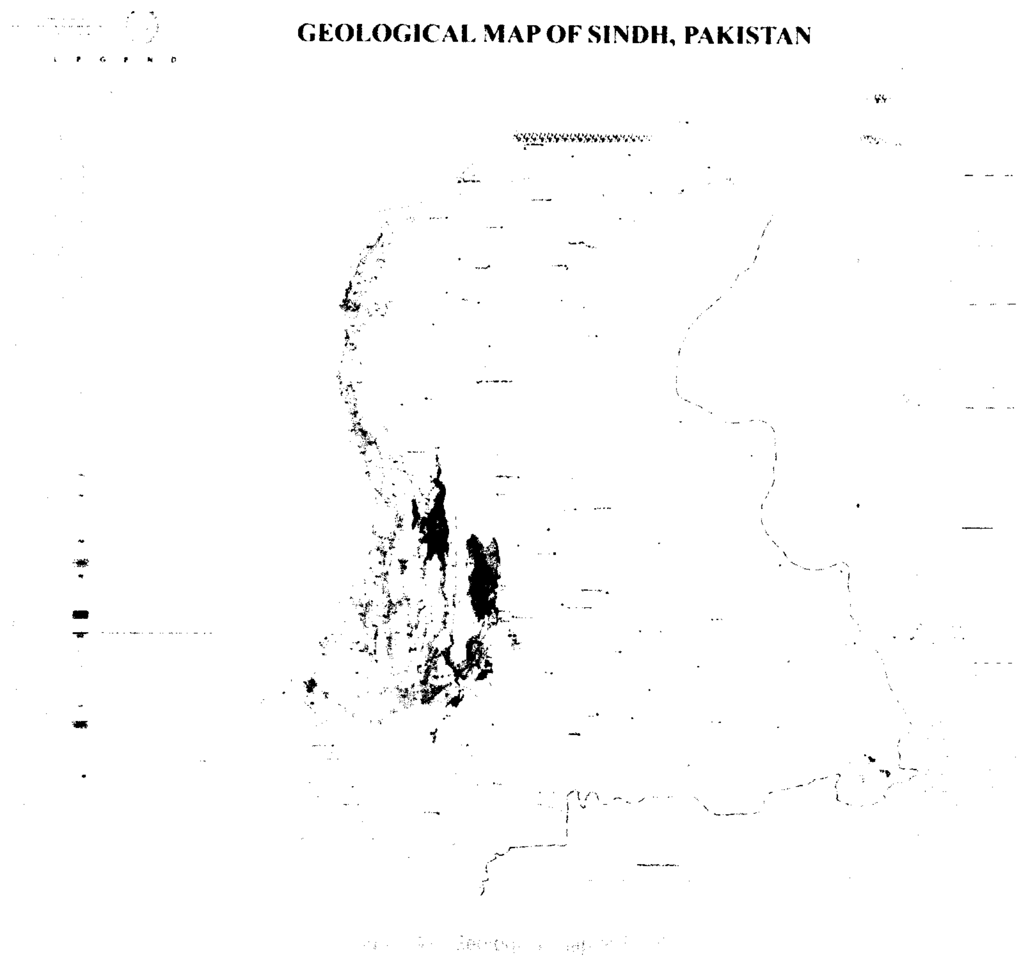
The hilly region of western Sindh consists almost entirely of rocks belonging to the tertiary system of geological nomenclature. It is only along the Laki Range and in its neighborhood that there are some exposures of rocks belonging to the next older system, the Cretaceous. With the exception of some volcanic beds associated with these Cretaceous strata, all the rock formations of western Sindh are of sedimentary origin. All of the more important hill masses consist of limestone. A great majority of these limestone deposits belong to theNummultic period and are largely built up of the accumulated shells of foraminifera, principally those belonging to the genus Nummulites.

Pediments and fluvial terraces at various levels in the landscape indicate that uplift is intermittent, because these surfaces only form during periods of vertical stability. In general the landscape of Kirthar Range is dominated by erosion while the stony plains are dominated by deposition.

The mountains of the Kirthar region have been cut by deep gorges, the Darawat Gorge being one of them. The gorges have passed onto a piedmont that is characterized by the following units: bedrock-cut pediments that are now dissected by alluvial fans which terminate in a plain, and finally a floodplain.

The piedmont plain is subdivided into plains cut in bedrock (pediments) and plains formed of alluvium (alluvial plains). The area contains bedrock-cut pediments that have been dissected by alluvial fans which terminate in a plain and in the floodplain of the Barannai. The dissected plain geomorphological land unit is bounded by bedrock outcrops. The main difference between this land unit and the 'Plain' land unit is the degree of fluvial incision into this surface. Streams like Layari and HaroloNai are deeply entrenched. The 'Dissected plain' surface is higher in the landscape than the 'Plain' surfaces, and the streams have therefore incised it more deeply in an attempt to maintain regular stream long profiles.

While the Sonda area is generally covered by scattered rock outcrops and hills, a large part of the area is covered by few to tens of feet thick alluviam. The soil comprises mainly of silt, sand, and gravel size particles deposited from the erosion of shales and limestone of the Lakhra formation. The soil is brown yellow to dark brown color and is quite fertile in areas where limited agriculture is carried out using rain and river water.



4.3.2.1. *Basic geological conditions of the project area*

Topography and geomorphology

The wind farm is about 6.7km long and 1.6km wide. It is a low and gentle hilly land with flat and open terrain and less fluctuation, higher in the south and lower in the north, forming an inclined platform, with general elevation of 40m~60m. Gullies with drought-enduring shrub are developed in the area.

Stratum and rock type

According to area survey and engineering investigation data of nearby existing wind farms, the project area area is mainly composed of the Quaternary Holocene alluvial and proluvial deposits and the underlying Jurassic limestone. From top to bottom it is divided into two main layers:

Layer ①: Quaternary Holocene alluvial and proluvial rubbles, which is dry, composed of rubbles of 0.5cm~1.5cm in size with less medium ~ coarse sand and clay, limestone is the dominant rock type. The layer is unevenly distributed, generally 0.1m~0.5m thick on the platform surface and 0.2m~1.5m along gentle slope and at the bottom of gullies, of moderate ~ dense structure.

Layer ②: Jurassic limestone, which is hard, grey white in color and widely exposed in the project area. The occurrence of the layer is nearly horizontal, and the thickness of highly weathered rock mass is 3m~5m according to estimation. Karst development can be seen in the layer, mainly appearing as small dissolved pores and karst caves of 0.5cm~7cm in diameter, which are mostly filled.

Hydrogeology

Investigation shows that the groundwater depth is comparatively great, exceeding 10m according to estimation. The corrosive effect of groundwater on structures can be omitted.

Thickness of frozen soil

According to local meteorological data, there is no seasonal frozen soil in the project area.

4.3.3. Soil

The soil in the plains of Sindh is plastic clay that has been deposited by the Indus. Combined with water it develops into a rich mould and without water it degenerates into a desert. Nearly the entire Indus valley has soil which is extremely friable and easily disintegrated by the flow of water. Resultantly, the water always contains a large amount of suspended silt.

4.3.3.1. Soil condition of Project Area

On the basis of geological investigation data and the engineering geological properties of foundation (rock) soil mass in the project area, the physical & mechanical parameters of the foundation (rock) soil mass are proposed as follows:

... mechanica ... soil mass

Rock / soil	Weathering level	Thickness (m)	Gravity density (natural) (kN/m³)	Deformation modulus (MPa)	Cohesion (kPa)	Friction angle (°)	Characteristic value of bearing capacity (kPa)
Layer ①	Loose	<1.5	22.5	10～15	0.0	28	200
Layer ②	Highly weathered	3～5	25.5	200～400	100~300	35	500~800

	Moderately weathered	>10	26.5	400～1000	400~600	45	1200

4.3.3.2. *Classification of foundation and environment*

According to the characteristics of the geological conditions of the project area, and in light of the Code for Investigation of Geotechnical Engineering (GB 50021-2001), the complexity of the project area and the foundation, and the environment form are classified as follows:

(1) According to the scale and the characteristics of the project and considering the consequence of project damage or abnormal operating caused by geotechnical engineering problems, the importance level of the project is defined as Grade II, i.e. the general project with severe consequence.

(2) The seismic fortification intensity of the project area is Grade VII the topography and geomorphology is comparatively complex, and the groundwater has minor effect on the project, so the project area is classified as a moderately complicated area (Grade II) and the foundation is defined as a simple one (Grade III).

(3) The project area belongs to arid region, the foundation soil water content w<20%, so the area environment class is defined as Type III.

4.3.3.3. *Corrosivity of foundation (rock) soil mass and water*

(1) Corrosivity of foundation (rock) soil mass

According to pertinent data, the foundation (rock) soil mass is slightly ~ moderately corrosive to concrete, steel bars in reinforced concrete and steel structure, anti-corrosion measures should be taken accordingly.

(2) Corrosivity of water

Wind turbines are mostly arranged on the top of mountain ridges and peaks, where the buried depth of groundwater is greater than 10m in general, so the influence of groundwater on building foundation can be omitted.

4.3.3.4. *Evaluation on engineering geological characteristics of foundation (rock) soil mass*

Layer ① is dry, composed of rubbles of 0.5cm~1.5cm in size with less medium ~ coarse sand and clay, limestone is the dominant rock type. The layer is mainly of moderate ~ dense structure, the bearing capacity characteristic value of which is 200 kPa ~ 350 kPa. With fair mechanical property, it can be used as natural foundation.

Layer ② is stable in distribution, mainly composed of highly ~ moderately weathered limestone, developed with small dissolved pores and karst cave, the bearing capacity characteristic value of which is 500 kPa~1200 kPa. With better mechanical property, it is proposed to be used as the foundation supporting layer or the underlying layer of wind turbines and ancillary buildings.

4.3.3.5. *Unfavorable geological process and geological hazard*

Area survey shows that despite the surface corrosion of the limestone and the development of solution cracks and pores (the pore is 0.5cm~7cm in diameter with poor connectivity), there is no unfavorable geological phenomenon such as large karst caves in the project area. Nevertheless, the condition of foundation soil for each wind turbine and the step-up substation shall be investigated in the next stage.

The terrain of the project area is comparatively flat and gentle, with undeveloped surface drainage, dense vegetation, great groundwater depth, and nondevelopment of landslide and debris flow. There are no adverse geophysical phenomena such as goaf, ground fissure and large karst caves.

According to investigation, intermittent flood would occur in rainy season in the project area, which is caused by short-time rainstorm in local area. The flood would spread along small gullies in hilly land with gentle slopes, lasting for short time. Design of Thatta wind farm should take into account the effect of the flood in high flow year.

4.3.3.6. *Resistivity of foundation soil*

Foundation (rock) soil mass mainly comprises rubble and highly weathered limestone, the resistivity of foundation soil is proposed as 1000Ω•m~2000Ω•m.

4.3.4 Construction materials

According to investigation of the natural construction materials in the project area and the neighboring area, two quarries are found about 12km in the south of the project area which can supply concrete aggregates for the project with satisfied quality and storage. The quarries are connected with the project area by asphalt road, the traffic condition is convenient.

4.3.5 Seismicity

Seismic Zones are a vestige of the Uniform Building Code (UBC). The Zone number correlates to a level of acceleration expressed as a % of gravity. The maps are intended to represent the likely levels of earthquake ground shaking and, therefore, the potential for structural damage.

The ground accelerations associated with the Zones are probability based and correlate to prescribed levels of ground accelerations with Zone 4 being the highest and 0 being negligible.

According to the seismic zoning map of Pakistan, Sindh falls into medium to low seismicity risk zone of 2A/2B, with about 0.08g to 0.16g value. GSP has publishes seismic data which when in combined and mapped with the data provided by Pakistan Meteorological Department (PMD) become a useful tool to identify the potentially hazardous earthquake zone.

Following faults are located within the province of Sindh:

A. Jhimpir Fault
B. Karachi-Jati Fault
C. Surjani Fault
D. Pab Fault
E. Hab Fault
F. Allah Bund-Rann of Kutch Fault

4.3.5.1. *Jhimpir Fault*

N-W Trending. A number of epicenters are located on the fault. The fault has produced an earthquake of M=5.6 on Ritcher Scale. This fault is developed near the area.

4.3.5.2. *Surjan Fault*

These N-S trending dip-slip or bedding-plane faults are active along the Kirthar Range Front. This fault cuts across the Quaternary deposits on the north of Karachi and west of MirpurSakro. The southern end of this fault is intersected by the northwest trending Surjani Fault on the west of Jhimpir. The interaction of these two faults is characterized by at least four tele-seismic events of shallow focal depth and magnitude 3.6. The maximum magnitude of the earthquake associated with the Surjani Fault is of the order of M ≈ 6.1.

A number of epicenters are located on this N-W trending fault. The fault has produced an earthquake of M ≈ 5.6 on Richter scale.

4.3.5.3. *Pab Fault*

This NNW-SSE trending is 135 km in length and is located in the eastern part of the Pab Range and has dislocated vertically the Quaternary alluvial fans. The maximum magnitude of the earthquake associated with this fault is of the order M ≈ 7.0 on Richter scale.

4.3.5.4. *Hab Fault*

The Hab valley is traversed by this fault.

4.3.5.5. *Rann of Kutch Fault*

This E-W trending fault has produced earthquake of the order of M ~ 7.6 on Richter scale. In 1819 and 1956, this fault was responsible for severe earthquakes in Gujarat, Tharparker and Indus delta. This fault system also known as Allah Bund Fault passes in the proximity of the Steel Mills and Karachi Nuclear Power plant. It is 225 km in length and is responsible for the production of earthquake of considerably high magnitude of up to 7.6 M on Richter scale and of IX to X intensity on the Modified Mercalli, MM scale on June 16, 1819.

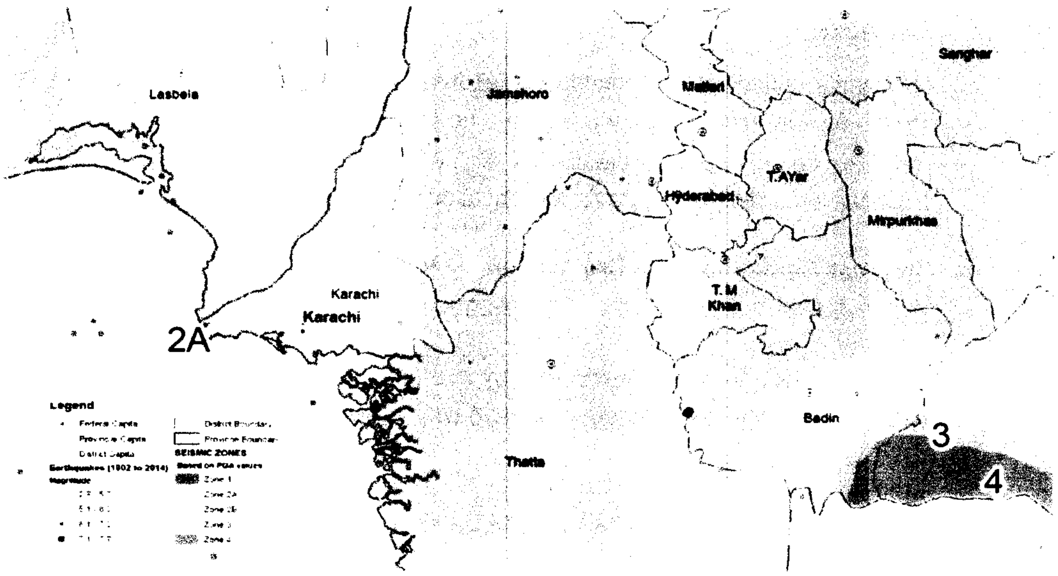
Additionally a complex series of faults generally oriented easterly and slightly concave to the north have been identified through aerial photographs. They are roughly parallel to the inferred zone of rupture for the 1819 earthquake event.

The Table 4.1 shows the earthquake occurrences over the last forty years. The Table does not include the numerous events of magnitude less than 4.0 on Richter scale. Earthquakes of recent occurrence were recorded on July 16, 2005, followed by one on August 6, another on August 13, yet another on October 9 and then again on October 11, 2005. They were all of magnitude between 4 and 5.1 on Richter scale. The epicenter of these earthquakes was away from those listed in table. The epicenter of the most recent tremor of January 2, 2009 was 100 kilometers in the coastal regions of Lower Sindh. It had a shallow depth of 10 kilometers and magnitude of 2.2 M on Richter scale.

...nsity of E...

Year	Coordinates	Depth	Magnitude Richter Scale	Intensity MM	Location
1962	24°70'N66°00E	0	4.50	-	Karachi
1965	25° 03N67°76'E	40	4.50	-	Karachi
1966	25° 0N68°00' E	-	5.0	VI-VII	Jhimpir
1968	24°61N66°42' E	19	4.10	-	Karachi
1970	25°28N66°65' E	33	4.90	V	Karachi
1971	25°00N68°00' E	-	4.50	V	Jhimpir
1972	25°35N66°71' E	33	4.50	V	Karachi
1973	25°00N68°00' E	-	5.00	VI	Jhimpir
1973	25°48N66°33' E	57	4.90	V	Karachi
1975	25°50N66°80' E	-	4.50	V	Gadani
1975	25°22N66°59' E	33	4.90	V	Karachi
1976	24°96N70°38' E	14	4.70	V	Karachi
1984	25°86N66°41' E	33	4.70	VI	Karachi
1985	24°90N67°39' E	33	5.00	VI	Karachi
1986	25°34N66°60' E	33	4.50	V	Karachi
1992	25°25N67°76' E	33	3.60	IV	Karachi
1996	25°06N66°76' E	33	-	-	Karachi
1998	25°69N66°46' E	33	4.40	V	Karachi
1998	24°85N66°35' E	33	4.50	V	Karachi
2009	24°31N67°18' E	10	2.2	IV	Thatta
2013		76	7.9	VIII	Kash / Pak-Iran Border
2013		14.8	7.7	VIII	Awaran

According to a map created by the Pakistan Meteorological Department, the country is divided into 4 zones based on expected ground acceleration. The areas surrounding Quetta, those along the Makran coast and parts of the NWFP, and also along the Afghan border fall in Zone 4. The rest of the NWFP lies in Zone 3, with the exception of southern parts of this province, which lie in Zone 2. The remaining parts of the Pakistani coastline also lie in Zone 3. The remaining parts of the country lie in Zone 2.



Seismic Zones of Thatta

In view of the not too distant location of the Project site to Allah Bund Fault line, it is suggested that this ecosystem that includes the proposed project land should be placed in Zone 2A. Such Seismic Zoning would correspond to Magnitude between V and VII on Modified Mercallis Scale and hence ground Force in terms of Assumed Approximate Acceleration equivalent of 0.08-0.16g should be adopted for siting the Wind Farm for constructions and positioning of towers and WTGs, for operational basis earthquakes (OBE) pertaining to damage due to moderate level earthquakes (MM-V to VII). Therefore, the regional tectonic stability of the area is comparatively low.

The basic seismic intensity of the wind farm area is classified as VII degrees. The area overburden is comparatively thin, mainly composed of highly ~ moderately weathered limestone, with better mechanical property. The construction area is classified as Grade I, belonging to the area that is favorable to seismic design of structures. The area is suitable for construction of the wind farm.

According to the Code for Seismic Design of Buildings (GB50011-2001), there is no seismic liquefaction in the area foundation.

4.3.6. Seismic effect on the project area and foundation

The basic seismic intensity of the wind farm area is classified as VII degrees. The area overburden is comparatively thin, mainly composed of highly ~ moderately weathered limestone, with better mechanical property. The construction area is classified as Grade I, belonging to the area that is favorable to seismic design of structures. The area is suitable for construction of the wind farm.

According to the Code for Seismic Design of Buildings (GB50011-2001), there is no seismic liquefaction in the area foundation.

[2] Map data source(s): PMD, GSP, Pakistan Engineering Council – Prepared by Al hasan Systems Private Limited

4.3.7. Climate

Pakistan's latitudinal and longitudinal extents and its northern rim of lofty mountains, are thetwo factors, which have a great bearing not only on the temperature and rainfall patterns, but also on the general circulation of the atmosphere on the southern Asia.Climate of Pakistan according to Koppen's classification18 falls under the following five types:

Tropical Semi-arid with Dry Winter: This climate type prevails in Karachi, Hyderabad, andsouthern Khairpur Division. The mean annual temperature is above 18°C.

Tropical Arid: This is characterized by average annual temperature of about 18°C with dry winters. This includes southern Kalat and whole of the Indus Plain.

Cold Semi-arid With Dry Summer: This climate type covers central Kashmir, Peshawar, D.I. Khan, Quetta and northern half of Kalat Division.

Snow Forest Climate: This climate type is characterized by average temperature of coldest month below 0 ▯C. Mean temperature of the warmest month is between 10 and 22°C. It includes northern mountainous areas and parts of Kashmir.

Extreme Cold: This climate type is characterized by average temperature of the warmest months between 10 and 0°C. It comprises eastern and northern parts of Kashmir, Chitral, Gilgit and Laddakh. Based upon the above classification, most parts of the proposed project area are included in the Tropical Arid climate zone, while some southern parts of Sindh are located in the Tropical Semi-arid with Dry Winter climate zone.

The project area lies in the Tropical Arid climate zone becuase the mostly area experiences dry winters and with annual average temperature around 18°C. The climate of most parts of the Jhimpir is arid characterized by four distinct seasons in a year, that is, winter from Mid-November to February, spring during March and April summer from May to Mid-September and autumn from Mid-September to Mid-November.

4.3.8 Meteorology

There exist several meteorological stations in Sindh; data recorded at some of these stations is provided in the following sections.

4.3.8.1. Temperature[3]

Atmospheric temperature is generally moderate through the year in Thatta due to the presence of sea. The mean yealry maximum 40°C and minimum around 8°C. The Tables below indicate that the mean monthly maximum temperature in Thatta ranged between 25°C and 40°C, while the mean monthly minimum temperature ranged between 8°C and 27.6°C. The Termperatures start falling from October each year to January and dry and hot weather prevails from April to September.

[3] IEE 50 Gul Ahmed Wind Farm Thatta

Table 4.3: Meteorological Parameters for Jhimpir Area				
Months	Temperature °C		Rainfall mm	Relative Humidity %
	Maximum	Minimum		
January	25.78	8.73	0.96	50.38
February	28.59	11.60	3.60	48.81
March	34.02	16.80	2.30	48.36
April	38.40	21.80	2.49	48.67
May	39.85	25.47	0.69	53.10
June	38.02	27.46	10.76	60.70
July	35.11	27.04	70.49	69.61
August	33.61	26.06	89.88	72.55
September	34.36	24.87	34.43	68.78
October	35.80	21.70	3.72	58.15
November	31.87	15.86	1.67	53.88
December	26.68	10.10	1.11	52.46
Annual	33.48	19.76	221.64	57.56

Due to high temperatures in summer, the plant species with low vigor and shallow root system die away. Maximum temperature is high in these regions, especially in the dry season when there is little cloud or moisture in the atmosphere to absorb solar radiation. Under conditions of high temperatures life and work become difficult. Not only is lack of moisture in the form of rain, the chief factor causing arid conditions, but low air humidity in itself has an adverse effect upon plants and animals, because the rate of evaporation is very high at these temperatures. Loss of moisture from the ground and from vegetation is an indicator of rate of "evapo-transpirtion" which is very high in semi- arid and arid regions of Kohistan, Thatta. The incidence of high temperature causes heat damage. Maximum temperatures are high in Kohistan especially in dry season when there is little cloud or moisture to absorb solar radiation. Accordingly the rate of evapo-transpiration is very high.

4.3.8.2. *Rainfall*

The southwest monsoon brings in humid air from the sea, but the precipitation is generally very low with nearly 80% of the 100 to 200 mm rain falling from June to September. Rainfall, when it does come, it is often torrential causing problems of drainage and erosion of the light and sparsely vegetated land of Jhimpir.

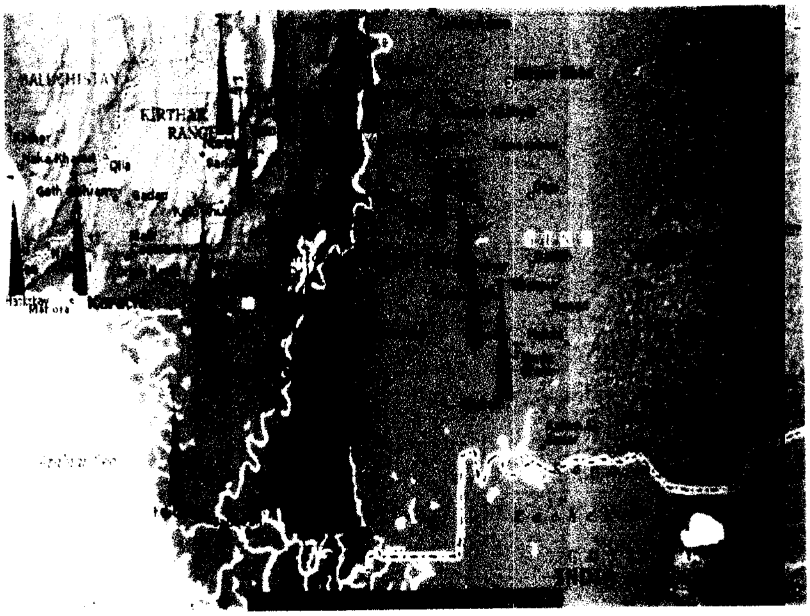
The winters are short and mild from late November to early February with the prevailing wind coming from the North East with very little rainfall. The most important characteristics of the prevailing meteorological conditions are the generally high dust conditions as a result of the aridity of the surrounding area; dust storms occur especially before the onset of monsoon. The higher winds during the southwest monsoon tend to carry air-borne dust inland during the summer months, while in winter they tend to be light to moderate in intensity and carry air borne particulate matter seaward.

Monsoon in the arid area of Kohistan is characterized by low and high variable rainfall both in time and space. The rainfall has a specific trend and pattern that is below medium rainfall, which may come once in three years, whereas drought once in 8- 10 years. Annual rainfall increases from less than 100 mm in the north to 350 mm in the southeast. Nearly 14 per cent of the desert receives 350 mm rainfall, 25 per cent gets 250 mm, and 4.5 per cent receives less than 150 mm, and remaining 52.5 percent receives 150- 25 mm rainfall. Almost all the rain is received during monsoon from mid-June to mid-September, but July and August are the months of heavy rainfall. During remaining period of the year there are drought-like conditions for continuous period of six to nine months. Although, rainfall is in heavy showers yet there is generally little runoff. The rainwater is usually absorbed in the sandy grounds, however the village folks have constructed channels to divert the surface run-off into land area enclosed by dykes for storage in tanks or bandats, and also into fields for irrigation. Removal of vegetation, by overgrazing, or drying up due to continuous drought conditions greatly reduces the effects of rain, because the water runs off the surface of the ground. Within a few minutes, the dry Nai (rain fed channel) such as Layari and Harolo become roaring torrents removing any sign of topsoil and eroding deep gullies into the ravaged landscape. The two nais are dry except after rain. During some years the persistent wind with high velocity the monsoon winds do not reach the region and no rain occurs during such periods. The desertified area is subject to heavy soil erosion. During recent years the annual rainfall has ranged between a the minimum 4.6mm in 2002 and 800mm in 2006 with an annual average of 300mm. The rainy season is spread over the June-September period, with maximum rainfall occurring in September, and average rate of evapotranpiration 218.2mm.

4.3.8.3. Wind Speed and Direction

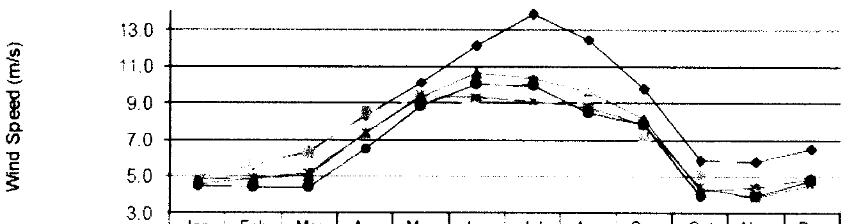
The wind direction in the area is generally west-northwesterly during the summer monsoon and east-northeasterly during the short winter monsoon season. The wind speed at ground level varies between 0 and 2 m/s during the calm months to 4 and 8m/s during the pre-monsoon season.

Pakistan Meteorological Department has conducted a detailed Wind Power Potential Survey of Coastal Areas of Pakistan The list of stations located along Sindh is given below. Badin, Baghan, Chuhar Jamali, DHA Karachi, Gharo, Golarchi, HawksBay, Hyderabad, Jamshoro, Jati, Karachi, Kati Bandar, Matli, MirPurSakro, Nooriabad, Sajawal, Shah Bandar, Talhar, Thano Bula Khan, Thatta, as shown in the Map-1:



[4] An Investigatin on Wind Power potential of Sind, Metrological Department Sindh

Monthly average estimated wind speed at 50m heights at six most windy stations. The graph clearly depicts that the most windy months are April to September in these areas of Sindh region. We can see that Jamshoro is the region of most powerful wind and hence considered very good site to generate electric power potential. Moreover KatiBandar, Nooriabad, Thatta, Gharo, Hyderabad, Sajawal, Jati, Golarchi, Baghan, Talhar, MirPurSakro, Chuhar Jamali are suitable sites for power generation.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jamshoro	5.0	5.6	6.3	8.3	10.1	12.1	13.9	12.5	9.8	5.9	5.8	6.5
KatiBandar	4.9	5.7	6.2	8.4	9.3	9.3	10.2	8.8	7.2	5.1	4.4	5.0
Nooriabad	4.9	4.8	5.0	7.3	9.3	10.6	10.4	9.7	8.1	4.2	4.4	4.9
Thatta	5.2	4.7	5.4	7.2	8.6	9.1	9.8	9.6	7.3	4.1	4.2	5.1
Gharo	4.6	4.9	5.2	7.4	9.4	9.3	9.1	8.8	7.8	4.4	3.8	4.5
Hyderabad	4.4	4.4	4.3	6.5	8.9	10.0	9.9	8.5	7.8	3.9	3.9	4.8

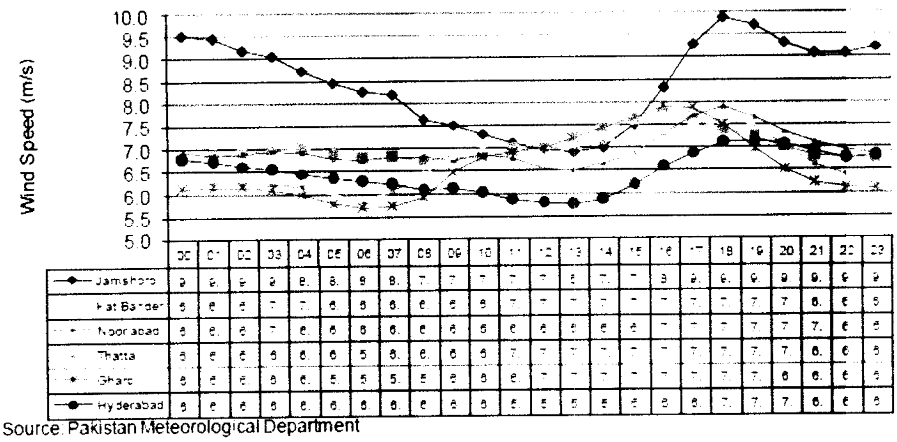
Months

Source: Pakistan Meteorological

The range of variation in wind velocity at 50 m is between a low of 3.7 m in November and a high of 8.3 m in July, while at 30 m it ranges between 3.2 m/sec in November and 7.8 m in July. Thus there are minor differences in velocity between the 30 m and 50 m levels. High velocity winds of 6 to 8 m/sec are, according to the data recorded in the Table dominant from May to August, which are the monsoon months. Monthly average wind velocity decreases from 5.62 m/s at 50 m to 5.12 m/s at 30 m and 4.66 m/s at 20 m level.

The annual diurnal wind speed variations at 50m heights at six most windy stations. We have already mentioned that Jamshoro, Kati Bandar, Nooriabad, Thatta, Gharo, Hyderabad is the region of sustainable wind. At Jamshoro the wind varies from minimum 6.9 m/s to maximum 9.9 m/s, at Kati Bandar it varies from minimum 6.8 m/s to maximum 7.7 m/s, at Nooriabad it varies from minimum 6.7 m/s to maximum 7.9 m/s, at Thatta it varies from minimum 5.8 m/s to maximum 7.6 m/s, at Gharo it varies from minimum 5.7 m/s to maximum 7.9 m/s, and at Hyderabad it varies from minimum 5.8 m/s to maximum 7.1 m/s, We can see that Jamshoro is the region of most powerful wind in the region hence considered very good site to generate electric power potential.

[5] An Investigatin on Wind Power potential of Sind, Metrological Department Sindh



Source: Pakistan Meteorological Department

...Variatio... ...cts[6]

Studies shows the wind velocity recorded at ground level was recorded in the project surrounding

...in the p...

	Wind Speed m/s	Direction (Degree)	Air Temperature °C	Humidity %
Average	2.8	104.5	25.3	20.9
Max	8.0	359.0	32.9	37.6
Min	0.0	0.2	15.9	10.1

According to the data recorded at Project site, the wind speed at ground level varied between ~1.0 m/s to ~8.0 m/s. Occasional gusts were noted at certain points of time when the direction changed, possibly due to whirling. The maximum wind direction turns to 359° and each change in direction was followed by increase in speed or else a slowdown.

4.3.9 Storms

The movement of cyclones and storms in the Arabian Sea. The movement is generally in the west-north-westerly direction. The one that moved into the coastal area on May 12, 1999 changed direction and hit the coastal area of Badin while the coastal area southeast of Karachi was in the periphery and only rain showers of moderate intensity were recorded. This coast is otherwise classified outside the zone of cyclone activity for the Arabian Sea. Thunderstorm frequency is also low and is reported to occur at an average rate of 10 thunderstorms/year. The pattern seems heading towards a change during the last two years. Coastal area of Pakistan has experienced an increase in the frequency of storms in the southern part of Pakistan especially along Baluchistan coast. In the month of June 2007 two tropical cyclonic storms namely Gonu and Yemyin hit the Baluchistan coast. Under their influence, rain /thunder showers associated with gusty winds and thunderstorms occurred at isolated places of Makran Coast, while the sea conditions were very rough along the coast of Sindh. The high heat content of the Arabian Sea that is adjacent to the heat zone of Pakistan had disturbed the heat balance and water balance of the region. This induced the windstorm in late May, followed by the Tropical Cyclone Gonu in the first week of June, then by Tropical

6 An Investigatin on Wind Power potential of Sind, Metrological Department Sindh
7 IEE of 50MW Gul Ahmed Wind Warm at Jhimpir

Cyclone 03A from the south of Mumbai, and thereafter by Tropical Cyclone 04B nicknamed Yemyin. The June 6, 2010 cyclone 03A, nicknamed Phet had landed on the coast of Oman and had lost its intensity. Moving in clockwise direction it poured heavy rains on Gwadar and Pasni. The rain bearing winds moved along the coastline towards Karachi. It touched Karachi only tangentially and brought 100 mm rainfall in Karachi and 50 mm rainfall in Hyderabad two days before it landed south of Thatta District.

4.3.10. The Cyclones

The frequency of cyclonic disturbances has increased during last decade. The Table 4.5 shows the incidence of cyclones during the last two decades:

Table 4.6: Cyclones & Storms during Last 20 Years

No.	Year	Type/ Location of Cyclone	Wind Speed Range (km/h)
1	Nov 1993	Tropical Cyclone/ Northeast Arabian Sea	62 – 88
2.	June 1996	Cyclonic Storm /East Central Arabian Sea	62 – 88
3.	Oct 1996	Tropical Storm /Southeast Arabian Sea	62 – 88
4.	June 1998	Cyclonic Storm /Southeast Arabian Sea	62 – 88
5.	Oct 1998	Cyclonic Storm /East Central Arabian Sea	62 – 88
6.	May 1999	Very Severe Cyclonic Storm /East Central Arabian Sea	> 118
7.	May 2001	Very Severe Cyclonic Storm /East Central Arabian Sea	> 118
8.	Sept 2001	Cyclonic Storm /East Central Arabian Sea	62 – 88
9.	May 2002	Tropical Cyclone /West Central Arabian Sea	62 – 88
10.	May 2004	Very Severe Cyclonic Storm /Southeast Arabian Sea	> 118
11.	Oct 2004	Severe Cyclonic Storm /Northeast Arabian Sea	89 – 117
12.	Sept 2006	Tropical Cyclone /East Central Adjoining Northeast Arabian Sea	62 – 88
13.	02 June 2007	Tropical Cyclone /East Central Arabian Sea	62 – 88
14.	07 June 2007	Very Severe Cyclonic Storm /Northwesterly of East Central Arabian Sea	> 118
15.	21 June 2007	Tropical Cyclone (Deep Depression) /Northeast Arabian Sea	> 50
16	07 June 2010	Tropical Cyclone /Northeast Arabian Sea	> 50
17	06 June	Tropical Cyclone /Northeast Arabian Sea	> 50

The incidence of cyclones was considered as associated with the sun spot cycle. The tropical cyclone frequency was also related to El-Nino Scale Cycle (ENSO) of 2-5 years. Pakistan coast line was considered outside the normal pattern of the cyclone since in several ways it remains protected and has remained unaffected. Manmade interventions and tectonic activities in the region has been found to induce as much stress as to include the coastline in the zone of cyclonic activity.

For reasons stated above, it seems that the Hypothesis on Climate Change more appropriately explains the position. The Theory holds that high evaporation rate induced by high temperatures on the hinterland of the Arabian Sea have led to hyper-salinity of the sea water. The high temperature on vast territory in the Arabian Sea hinterland has (i) turned large territory of Pakistan into an extensive heat zone, and (ii) raised the temperature of the North Arabian Sea by 1oC to 1.5oC, and (iii) evaporated correspondingly larger volumes of seawater. The heat zone formation over land serves as the main heat engine for the monsoon. The significant rise in temperature of the Arabian Sea raises the surface salinity and induces salinity steep gradient on the sea; the impact of the two factors can trigger cyclones in the Arabian Sea, while the correspondingly large volume of water vapour is cause for heavy monsoon rains all over the Indo-Pakistan region.

The cyclones are a coastal activity and their impact remains confined to the coastal belt. They are not likely to have major impact on the site at a distance of 80 km inland. However, cyclones do disturb the atmospheric air current system and hence the Project personnel will be mandated to follow the contingency plan.

4.3.11. Hydrology

In the Sind province 24 percent of the area is irrigated by canals (95 per cent), wells (4 percent) and tube wells and other means. In proposed project area surrounding, the water sources include dug wells, tube wells and lake. The soil sustains moisture for longer period to support the dry-land agriculture. When these sources of water dry up, the herders of surrounding hamlets have to walk 10 to 12 kilometers to watering points, and they were found saying during the consultation meetings that they have to fetch water from very far areas.

4.3.11.1. Surface Water

The major fresh water source in district Thatta is Keenjhar Lake which is at a distance of 10 km from the project site. The sweet water lake kinjhar, also known as Kalri Lake, is located in the dry and stony desert at a distance of about 20 km north and north-west of Thatta. It is 24 km long and 6 km wide and has an area of 14000 ha. The lake is fed by the Kalri Bagar feeder canal from the north-west as well as by small seasonal streams entering it from the north and the west. The feeder is also the conduit for the industrial wastes of Kotri town. The only outlet is the Jam branch canal in the south-east end of the lake. Keenjhar is a wild life sanctuary and a Ramsar site. Jhimpir town, on the northern banks of the lake is the main town on Keenjhar besides twelve large and twenty small villages scattered around it. About 50,000 people are said to bedependent on the lake and in 2005-06 about 800 boats of different size are said to beoperating in it (declining from 2200 in 1988-89 and 1710 in 1998-99). There are four fish landing centres at Chilya, Sonahri, Jhimpir and Khumbo.

4.3.11.2. Ground Water Resources

The Indus Basin was formed by alluvial deposits carried by the Indus and its tributaries. It is underlain by an unconfined aquifer covering about 15 million acres (60,700 km2) in surface area. In Sindh, about 28% of the area is underlain by fresh groundwater. This is mostly used as supplemental irrigation water and pumped through tube-wells. Some groundwater is saline. Water from the saline tube-wells is generally put into drains and, where this is not possible, it is discharged into large canals for use in irrigation, after diluting with the fresh canal water. Before the introduction of widespread irrigation, the groundwater table in the Indus Basin varied from about 12 m in depth in Sindh and Bhawalpur areas to about 30 m in RechnaDoab (the area between Ravi and Chenab Rivers). After the introduction of weir-controlled irrigation, the groundwater table started rising due to poor irrigation management, lack of drainage facilities and the resulting additional recharge from the canals, distributaries, minors, water courses and irrigation fields. At some locations, the water table rose to the ground surface or very close to the surface causing water-logging and soil salinity, reducing productivity.

4.4. Microenvironment of the Project

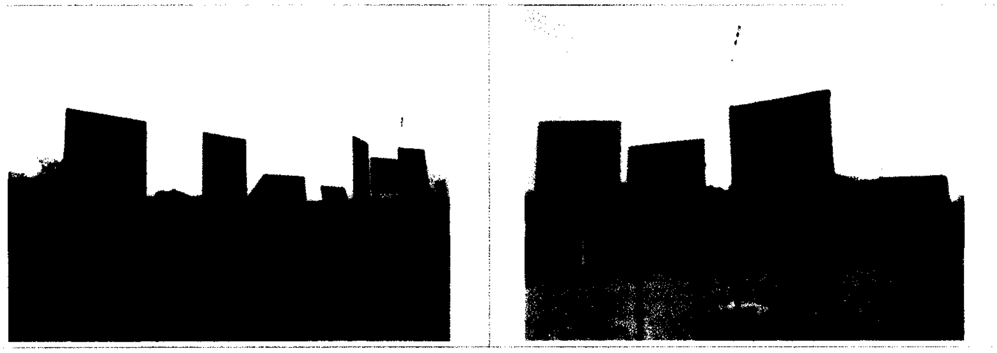
Microenvironment comprises of Jhimpir wind corridor, Cattle grazing, stone quarrying, gravel and sand collection and transportation, and livestock are the main occupation.

Microenvironment land is barren hilly tract, consisting of outlying spurs of the Kirthar Range cultivation is carried out wherever alluvial soil exists and near or along the numerous depressions where rain water carried by hill streams (nallas) can be stored.

Topographic undulation in some parts of district is substantially large with the relative height varying between 65 meters and 105 meters with the differential being 20 to 25 meters. Similarly, in some parts, the differentia is not large; the terrain undulates between 70 and 100m above sea level. There is a small hillock on the north east of the site which is 150m above sea level.

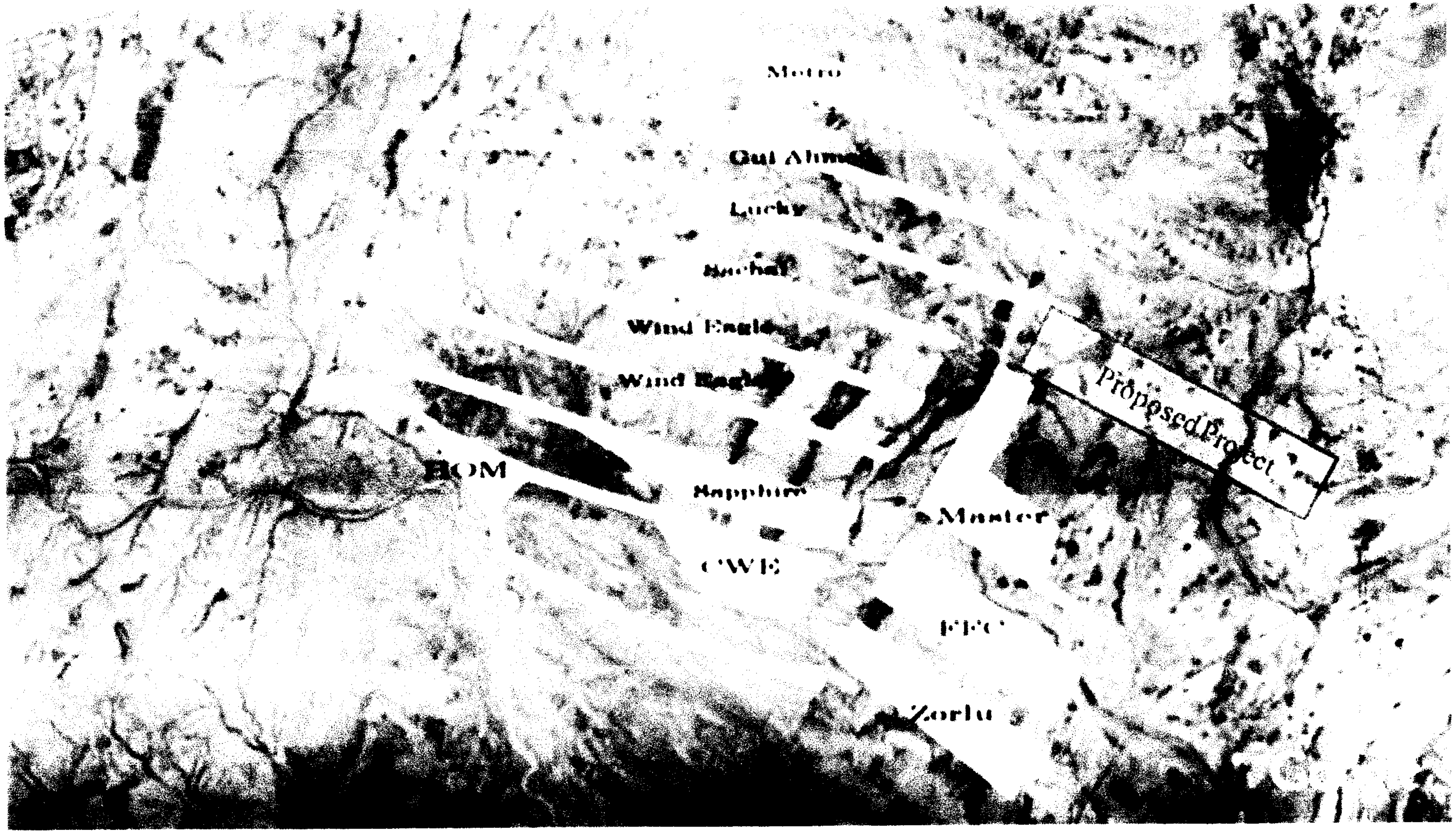
Jhimpir wind corridor has a 50,000 megawatt potential with average wind speeds over 7 meters per second. There are already 12 projects in the corridor and some of them are[8]

- Jhimpir Wind Energy Project (FFCEL) 49.5MW
- Fauji Foundation Wind Energy I Limited and Foundation Wind Energy II (Private) Limited 50MW
- Three Gorges First Wind Farm Pakistan (Pvt) Ltd 50 MW
- Sapphire Wind Power Company's (SWPCL) 52.8MW
- Tapal Wind Farm 30MW
- Metro Power Company Limited 50MW
- Zorlu Enerji Pakistan Wind Power Project
- Master Wind project 50MW
- Sachal Wind Power Plant



Wind farms in Jhimrpir corridor area

[8] Wind Power in Pakistan, Wikipedia


Metro
Lucky
Sachal
Wind Eagle
Wind Eagle
Sapphire
Master
Proposed Project
CWE
FFC
Zorlu

4.4.1. Physical Features of the Project Site

The physical features of the project area consist of hills and outcrops. The project area is surrounded on all sides by unconsolidated gravel. Its physical features portray the distinctive features of desertified arid land. Vegetation is xerophytic and is characterized by dried up thorny scrubs and poor grasses all over the region. The area is studded with rocky spurs and small mounds on barren lands with scant bushes and grasses in low lying areas.

Xerophytic vegetation

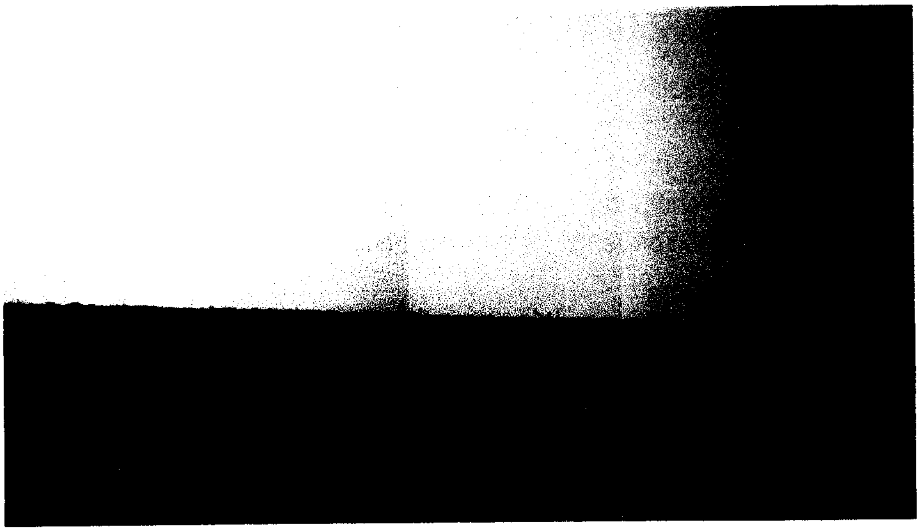
Rocky spurs and small mounds

4.4.2. Land Use

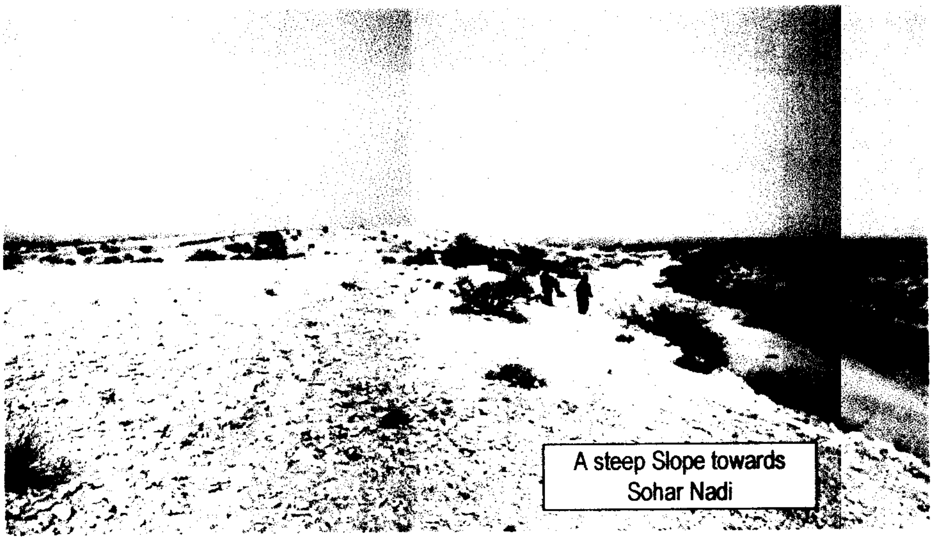
Project area is agriculturally unproductive (rock) land and some poor grazing gravely land. Perennial grazing areas consist of moisture shortage, sandy soils with low to high salinity. This land area in the form of semi-arid/arid sand desert is also present in the upper half of the wind corridor in small patches. The outgrowth in these areas mainly consists of short grasses, shrubs and scrubs along with a few drought resistant trees.

4.4.3. Topography

The general topography of the area is that of valleys and hill ranges with nala cuttings. The sohar Nadi which is a natural torrential stream flooded in the rainy season and brings the hill torrents of Kirthar Ranges to Kinjhar Lake. This stream is a topographic constraint for the installation of WTGs because it traverses perpendicularly from the project site and steep down from its northeast side to 15-20 feet at its bed level. The Stream did not have the flow of water at the time of survey (December 2015).



Topog



Const Drain)

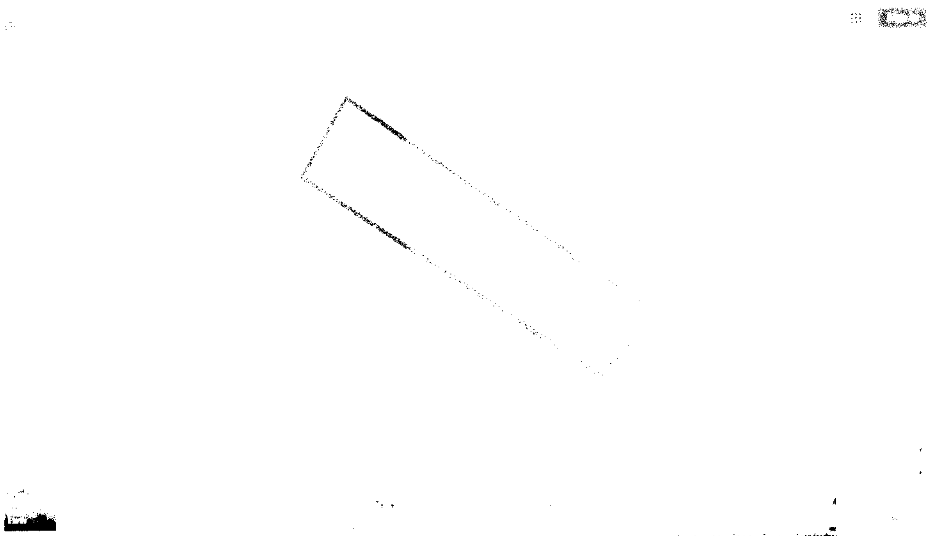


Figure 4.13:

4.4.4. Ambient Air Quality & Noise

The analysis of the air quality and noise at the project has been conducted through an EPA certified Laboratory "Quality Testing Services (QTS). The results of ambient air quality of project area show normal concentrations of parameters and comply the NEQS.

Since the area is a barren land and away from the major roads, therefore there will be no major pollutant sources. The project sites are located very far from the Nooriabad industrial area at distance of around 25km. No kind of any air pollution activity in the surrounding of project area and roads are very far, no vehicular traffic, which causes air pollution. Since the no primary source of air pollution at the site which may deteriorate the air quality on site.

There is no continuous source of noise emission in the proposed Norinco Thatta wind farm site. Occasionally there is some intermittent noise level due to natural wind blowing and noise level fluctuates between 50dB to 60dB in the project site which deviates slightly the NEQS limits for residential areas.

Table 4.7: Monitoring Data Sheet (Time Weighted Average Value)

	SO_2 (µg/m³)	NO_2 (µg/m³)	NO (µg/m³)	CO (mg/m³)	PM_{10} (µg/m³)
Average Time	24 hrs	24hrs	24hrs	8hrs	24 hrs
Near the Start point of Project site (along the access road)	22.7	36.0	11.3	3.2	139
NEQS Limits	120	80	40	5	150

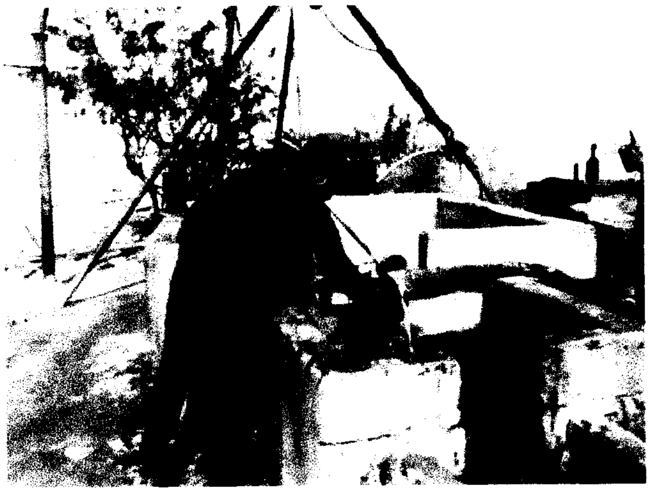
Table 4.8: Average Results of Air & Noise Monitoring in the Microenvironment of the Project

Noise		Nooriabad 1 (Near Al-Mustafa CNG Station)	Nooriabad 2 (Near Palari Hotel)	At Sohar Nadi	At the start point of Project area from the access road	At Haji Suleman Brohi Village
Results	Max	61	67	51	59	56
	Min	56	48	48	55	49
	Avg.	59	53	50	57	53
NEQS		65	55	55	55	55

Source: *Quality Testing Services Team*

4.4.5. Water Quality near the Project Site

During the field survey bore water sample was collected from the dug well situated at a distance of around 2km from the project site. There is only one dug well for the fresh water source in the area and the well was drilled at a depth of 125ft since few years back. Sample is brought back to QTS Laboratory followed by sampling protocols and submitted into the laboratory for the test analysis.



The analytical test results of bore water are mentioned in the table 4.8. No organic matter contamination found in the sample because the chemical oxygen demand in the sample is below the limit detection. The parameters such as TDS, Cl^-, and F^- values are 2080 mg/L, 1100 mg/L & 1.85 mg/L respectively. The parameters which indicate the contamination of waste water such NO^{3-} & NO^{2-} are found satisfactory indicates no intrusion of wastewater or contamination of groundwater.

Table 4.9: Analysis test results of Bore Water

S. No	Parameters	Unit	NSDWQ	Concentration	Method
1	pH Value	---	6.5 – 8.5	7.55	USEPA 150.1
2	Total Dissolved Solids	mg/L	<1000	2080	Hach 8160
3	Chloride	mg/L	<250	1100	Hach 8206
4	Nitrate	mg/L	<50	1.9	Hach 8039
5	Nitrite	mg/L	<3	0.006	Hach 8153
6	Fluoride	mg/L	<1.5	1.85	USEPA 340.1
7	Residual Chlorine	mg/L	0.5	0.03	Hach 8167
8	Chemical Oxygen Demand	mg/L	---	<5	Hach 8000

NSDWQ = National Standard for Drinking Water Quality

4.4.5.1. Seasonal drain

There is a seasonal drain in the cross section of the project area which almost remains dry in the whole year except in rainy month. The drain carries the runoff from upside hills and eventually meets to Keenjhar Lake. The villagers diverted a small part of the drain to their livestock drinking pond. The EMC team has collected the sample of drain water from the upside areas of the nearby village.

Figure 4.15: Dug well sampling by EMC representative

The analytical test results of dug well water are mentioned in the table 4.9. No organic matter contamination found in the sample because the chemical oxygen demand in the sample is below the limit detection. All parameters are in compliance of NSDWQ. The seasonal drain is basically rain water which is stored in rainy season by digging artificial well. Livestock of nearby villages are used to drink water from the seasonal drain.

Table 4.10: Analysis test results of Dug Well Water

S. No	Parameters	Unit	NSDWQ	Concentration	Method
1	pH Value	—	6.5 – 8.5	7.81	USEPA 150.1
2	Total Dissolved Solids	mg/L	<1000	745	Hach 8160
3	Chloride	mg/L	<250	328	Hach 8206
4	Nitrate	mg/L	<50	1.4	Hach 8039
5	Nitrite	mg/L	<3	0.010	Hach 8153
6	Fluoride	mg/L	<1.5	0.02	USEPA 340.1
7	Residual Chlorine	mg/L	0.5	0.08	Hach 8167
8	Chemical Oxygen Demand	mg/L	---	<5	Hach 8000

NSDWQ = National Standard for Drinking Water Quality

4.5. Ecological Baseline

This report covers the field studies undertaken by EMC in respect of the ecology of Project area for which detailed survey was conducted in December 2015. This report also takes into account the data collected during previous surveys conducted by EMC specialists for other projects. The land which is present around the proposed project is sparsely inhabited, has plain sandy, rocky areas and wastelands along its sides. Most of the land is barren with very little vegetation comprising mostly of bushes.

4.5.1. Ecology of Project Area

4.5.1.1. Ecological Habitats in the Project Area

As a result of extensive cultivation and expanding centers as well as rural settlements, most of the natural habitats have now been rendered altered. The main habitats of the project area include ridges, rocky areas, plain/sandy areas, agricultural areas and wastelands. Ridges and ravines are either flat places or soil filled cracks in the rocks.

- Rocky areas having stony plains provide habitat for Desert Hare, Baluchistan Gerbil and House Bunting.

...erview

- Plain / Sandy areas provide for sparse vegetation cover. This is the favorable habitat of Grey Mongoose, Desert Cat, Common Buzzard Ring Dove, Little Brown Dove, Garden Lizard, Fat-Tailed Gecko.

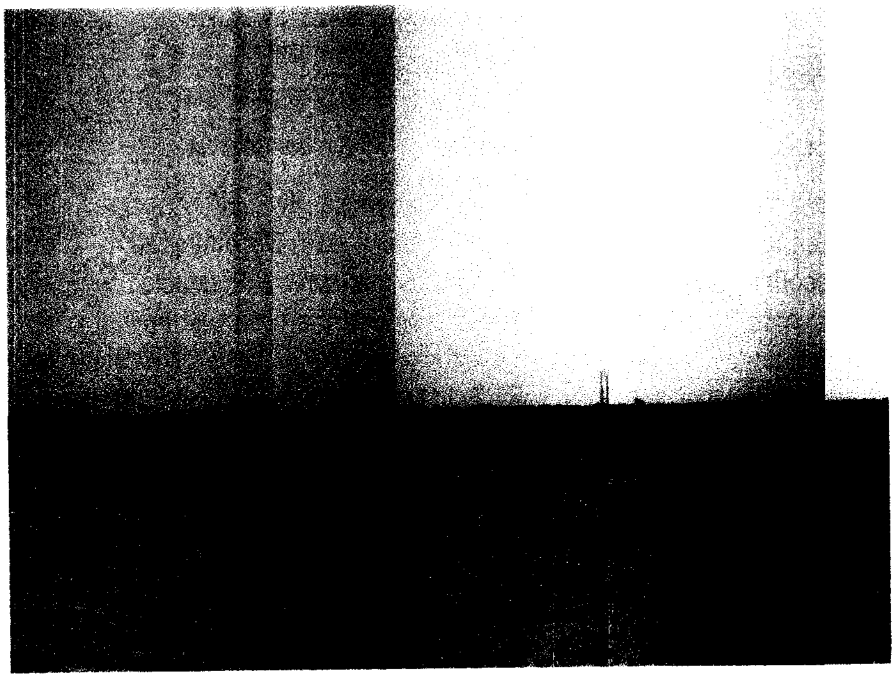


Figure 4.17: Pl...

[illegible] Enduring Shrubs spreading [illegible]

[illegible] 4.1[illegible] Ridges [illegible] Ravines [illegible]

4.5.1.2. *Terrestrial Flora in the Microenvironment*

Grasses

The following grass species have been reported at the site but most of them were found to have succumbed to aridity compounded by overgrazing: Arisdita adscensionis, A. Mutabilis, Cenchrus ciliaris, Cenchrus biflorus, Cenchrus, Cenchrus pennisetformis, Cynodon dacdylan, Cymbopogon jawarancusa, Digitaria sp, Eleucine flagellifera, Lasiarus sindicus, Saccharum spontaneum, Sporobolus marginantus.

Forbs

Aerva tomentosa, Cassia holoserica, Convolvulus glomeratus, Crotolaria bifolia, Fagonia cratica, Helotropium ophioglossum, Indigofera oblongifloia, Rynccosia minima.

Bush

Predominant bush species found in the area include Devi, Chali, Damral and Darathi (local names). No special medicinal value is associated with these bush species by the locals.

Crops

Agricultural activities are constrained by rainfall which has been erratic as well as scant in the microenvironment. Major crops grown on the few fields outside the villages include Indian corn. No crop production was possible during the current season because there was cloud burst which flooded the land area and the soil being largely sandy and gravely could not retain the moisture.

Trees

During the survey, there were no trees found in the Project area except in Sohar Nadi. The few tree species located in the microenvironment include Acacia nilotica (babul) (spotted during survey, low frequency), Acacia senegal (khor) (spotted during survey, low frequency), Calotropis procera (spotted, low frequency), Salvadora oleoides (khabar) (dominant) and Prosopsis senegal (kandi) (dominant but with low frequency), Acacia arabica (kikar) (dominant but with low frequency), Capparis aphylla (reported but not spotted),Commiphora wrighti (spotted during survey, low frequency), Commiphora stocksiana (spotted during survey, low frequency), Prosopis cenraria (spotted during survey, low frequency), Tamarix gallica (lai) (dominant), tamarix aphylla(low frequency), Euphorbia cauducifolia, Lasiurus sindicus ; willo or bahan (populus euphratica), Rhazya stricta (spotted during survey, low frequency), karil (capparis aphyila), and siris (acacia lebbek) (not found during survey), Prosopis cineraria, Eleusine flagelliforia, Salsola foetidia; Baleria acanthoides(spotted during survey, low frequency), Lasiurus sindicus, Aristida sp. Ziziphus nummularia (spotted, low frequency), Cordia gharaf (spotted during survey, low frequency), Grewiavillosa, Leptodenia pyrotecneca, Lyssium depressum (spotted during survey, getting scarce), Pterophyllum oliveri (spotted during survey, low frequency), Tecoma undulate (spotted during survey, (spotted during survey, low frequency).

4.5.1.3. Terrestrial Flora in the Microenvironment

Survey on Fauna was conducted by EMC team to collect the data for the Fauna of the project area. The guidelines for sensitive and critical areas were followed to identify sensitive and critical areas in the project area. Most wildlife species were found to be present or reported quite far away from the project area in relation to the officially notified protected areas which may comprises ecosystems that includes wildlife reserves and forests, archaeological sites, monuments, buildings, antiquities or cultural heritage sites.

Reptiles

Reptiles are also getting rare because of aridity which has in general reduced the biodiversity of the area. The monitor lizard population in the microenvironment of project site is low, while that of spiny-tailed lizard is abundant. Indian Monitor lizard (Varanus bengalensis) Wadhi Go/Gioh (reported but not spotted), and Monitor lizard (Varanus griseus) were neither reported nor spotted. The spiny-tailed lizard (Uromastix hardwickii) Sandho/Sandha was not spotted perhaps because they and the other reptiles were hibernating; their abundance is nevertheless low as suggested by the locals. All sand mounds in the area were found to have their burrows. Other reptiles reported here include: Yellow-headed Agama (Stellio Agama nupta fusca) Batth Kirro/Zard Sar Pahari Girgit (spotted during the survey), Indian Garden Lizard (Calotes versicolor) Wann Kirro/Rang badal Girgit, Long-tailed Desert Lacerta (Eremias guttulata watsonana) Wadhi Puch Kirri/Taweel dum Sandhi (reported but not spotted), Sindh Sand Gecko (Crossobamon orientalis) Thari Kirri/Regi Chhupkali (reported but not spotted).

Snakes

The Indian sand boa (Eryx johni) Bar Matti/Do Muhi (reported but not spotted); Saw-scaled Viper (Echis carinatus) Lundhi Bala/Jalebi Samp (reported to be quite frequent but not spotted), are common in the project area, while the Sindh two-headed snake, Indian common krait, and oxus cobra are rare. All these snakes are front-fanged. The krait, viper, and cobra are deadly but incidence of snake bite, as reported by the locals, is getting low, quite likely because their population has been thinned out.

Birds

The most common birds found in the macroenvironment are sparrows, robins and doves. Characteristic bird species that have adapted to the environment and are still to be found in the area, include the Indian grey partridge (francolinus pondicertanis), chest-nut-bellied sand grouse (pterocles exustus), rock dove (Columbia livia), Indian little button quail (turnix sylvatica) and Eurasian roller (coracias garrulous). Kites and vultures the highflying birds were not spotted during the survey. They were reported by the locals to be only occasional visitors. Other birds found here include Grey Parttridge (Francolinus pondiceranus); Indian Sand grouse (Pterocles exustes); Painted Sand grouse (Pterocles indicus); Partridge (Ammoperdix griseogularis) See See Teetar/Sissi Tittar; Common Quail (Coturnix coturnix) Butair/Bhuntrio; Eurasian Wryneck (Jynx torquilla) Gandam Muroor/Nando Kath-Kulho (not spotted); Sindh Woodpecker (Dendrocopos assimilis) Sindhi Khat-Khat/Kath Kutho (reported but not spotted); Common Hoopoe (Upupa epops) Hud Hud /Hud Hud (spotted); Indian Roller (Coracias benghalensis) Neel Kanth/Sat Rango (spotted); Asian Koel (Eudynamys scolopacea) Koel/Koel (spotted); Rose-ringed Parakeet (Psittacula krameri) Tota, Gulabi Kanth Tota/Mitthu, Chattu (reported but not spotted); Spotted Owlet (Athene brama) Chittidar Ullu/Nandho Chibhro (reported but not spotted); Rock Pigeon (Columba livia) Jhungi Kabutar (reported but not spotted); Indian Collared Dove (Streptopelia decaocto) Bari Fakhta Gero (spotted during survey); Common Crane (Grus grus) Koonj (reported but not spotted this year by locals and also not during the survey); Tawny Eagle (Aquila rapax) Gandoori Okab, Rigger/Par Mar (not spotted), Common Myna (Acridotheres tristis) Myna Ghursal/Kabbri, Myna (spotted during survey); Pale Crag-martin (Hirundo obsoleta) Peeli Chatani Ababeel/Jabal wari Ababeel also as pithee (spotted); House Sparrow (Passer domesticus) Correa, Charelu Chiriya/Jhirki (spotted during survey).

Mammals

Indian Pangolin (Scaly Anteater) (Manis crassicaudata) Safna Shikam, (reported but not spotted by locals and also not during survey) in IUCN Red List as low risk, near threatened; Jackal (Canis aureus) /Geedarr (not spotted during survey), in IUCN Red List as low risk; Ratel (Honey Badger) (Mellivora capensis) Gorrpat/Qabar Ka Bijju (abandoned burrow spotted during survey); Black-naped Hare (Lepus nigricollis dayanus) Saho/Khargosh (abandoned burrow spotted during survey); Grey Spiny Mouse (Mus saxicola) Kandan Waro Kuo/Kharpusht Chooha (reported but not spotted).

Livestock

Local inhabitants in the microenvironment maintain stocks of cows, goats and sheep that were found grazing in the area. Livestock and ruminants include: Domestic Goat (Capra hircus) Bakri/Bakra; Domestic Sheep (Ovis aries) Bhairru/Bhairr; Domestic Cattle (Bos taurus) Gaon/Dhaggo, Dhaggi (male, female); Domestic Donkey (Equus asinus) Gadduh/Gadah.

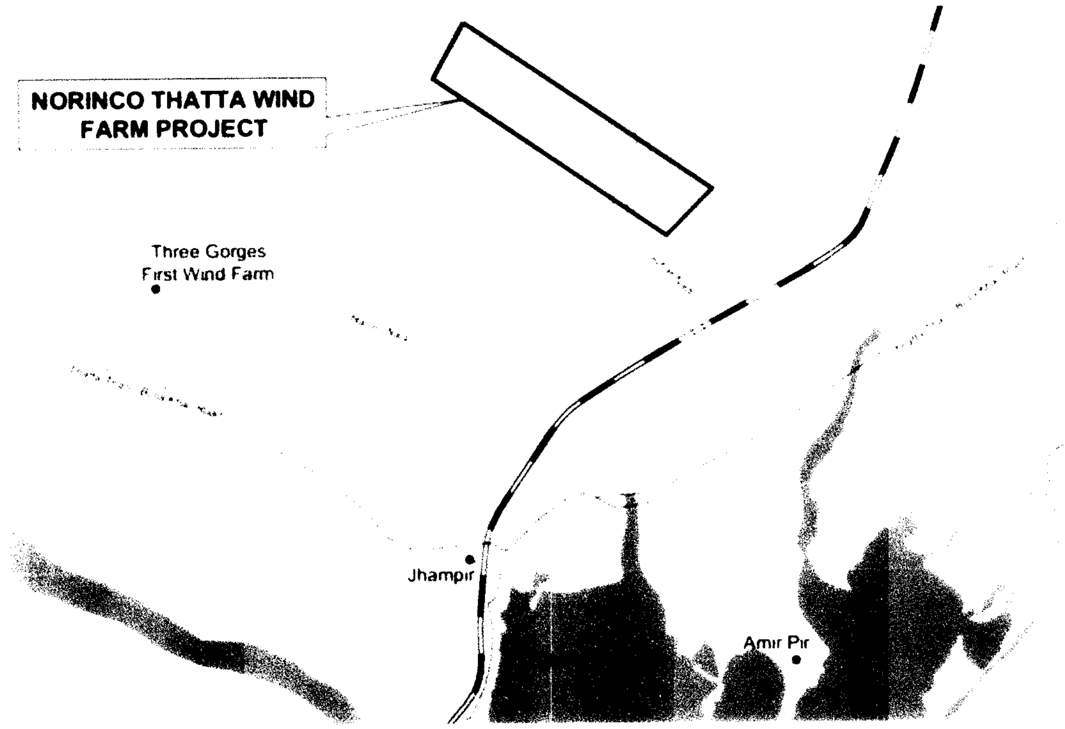
4.5.1.4. Sensitive and Critical Habitats

A number of sensitive and critical habitats exist in Sindh, but only one of them lie near the proposed project site. None of the critical sites will be intercepted though.

Project Site does not lie inside the protected area or buffer zone of protected area. The nearest Wildlife Protected Area is the Kinjhar Lake wildlife sanctuary which lies at a distance of about 10 Km from the proposed project site.

Keenjhar Lake has been declared a ramsar site and a wildlife sanctuary. It provides a favorable habitat of winter migratory birds like ducks, geese, flamingos, cormorants, waders, herons, egrets, ibises, terns, coots and gulls. It has been observed as a breeding area of the black-crowned night heron, the cotton pygmy goose, purple swamphen, and pheasant-tailed jacana.

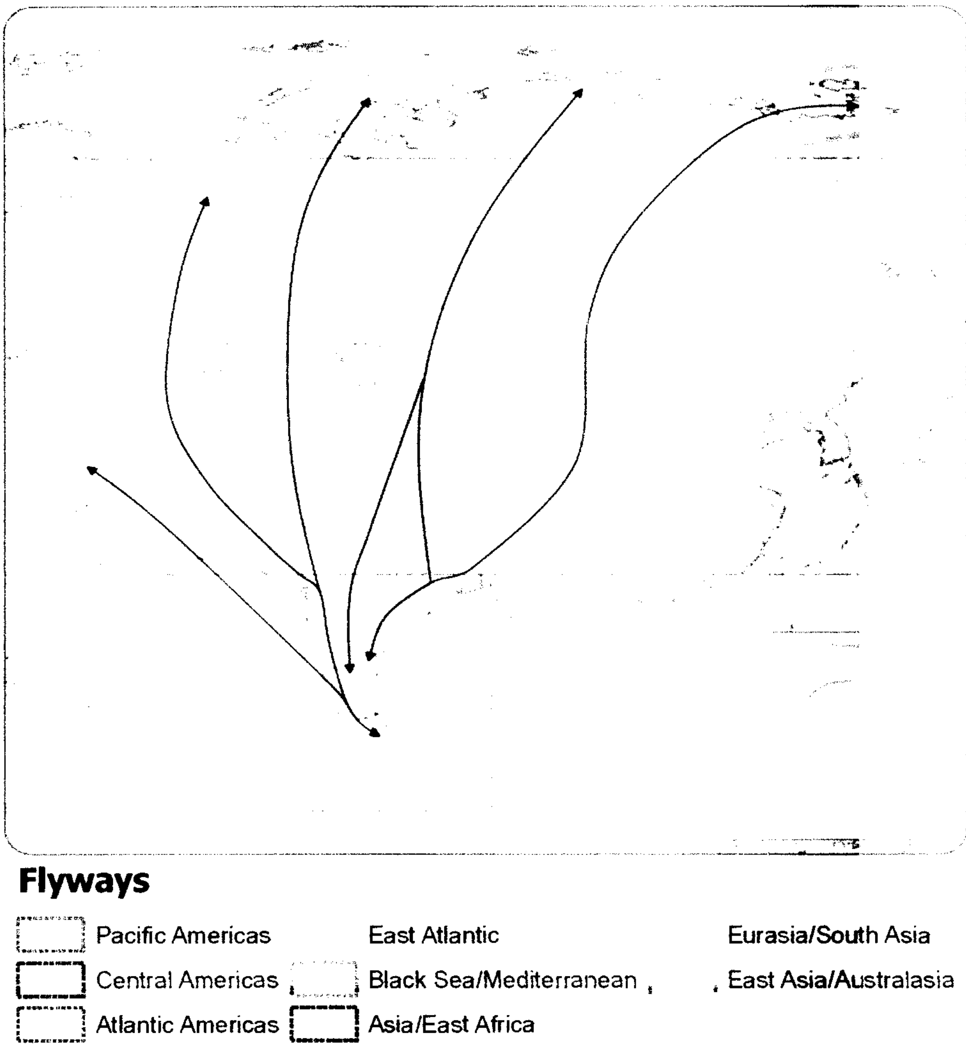
No areas of primary forest are found within or adjacent to ROW of the project road. If some trees need to be cut down, compensatory plantation at a ratio of 1:5 (i.e. 5 trees will be planted on account of cutting of 1 tree) will be done in the open land or after consultation with forest department.



4.5.1.5. *Migratory Birds*

Figure 4.21 shows Indus Flyway. This famous route from Siberia to various destinations in Pakistan over Karakorum, Hindu Kush, and Suleiman Ranges along Indus River down to the delta is known as International Migratory Bird Route Number 4. It is also called as the Green Route or more commonly Indus Flyway, one of the important migratory routes in the Central Asian - Indian Flyway. The birds start on this route in November. February is the peak time and by March they start flying back home. These periods may vary depending upon weather conditions in Siberia and/or Pakistan. As per an estimate based on regular counts at different Pakistani wetlands, between 700,000 and 1,200,000 birds arrive in Pakistan through Indus Flyway every year.

Figure 4.22 shows the Migratory route, breeding range and wintering range of Ferruginous Duck *Aythya nyroca* in Pakistan.


Flyways
Pacific Americas
Central Americas
Atlantic Americas
East Atlantic
Black Sea/Mediterranean
Asia/East Africa
Eurasia/South Asia
East Asia/Australasia

[illegible] Migratory [illegible]

4.6. Socio-Economic Environment

This section presents the socio economic profile of the project area, based on primary and secondary information. Primary data was gathered through an extensive field survey, while various relevant sources were used for secondary data.

Social baseline has been developed by EMC survey team in December 2015 to identify the social settings that may be affected by the siting of proposed Wind farm. It was found that there are no villages / poultry farms / other community structures including mosques and graveyards which are located inside the project site. The closest village named as Haji Suleman Brohi is just touching the project boundaries and a primary school and a Mosque are located atleast 350 meters away from the proposed site.

4.6.1 District Thatta

The macroenvironment include Thatta district having an area of 17,355 km2 and is located between 23°43' to 25°26'N and 67°05' to 68°45'E in Sindh, Pakistan. The district is bordered on the east side by Badin and Hyderabad districts, Dadu district at north, on the southern side by Rann of Kutch and Arabian Sea, and on the west side by Karachi District. The river Indus is divided into tributaries and finally meets the through Thatta district.

The project is situated in Thatta, a taluka of Thatta District which has 9 talukas comprising of 53 union councils (UCs). The table 4.6 below shows the talukas and other Union Councils of the Thatta District.

District That

Talukas	Union Council	Total Ucs
Ghorabari	Garho, Khan., Kotri Allah Rakhio, Mahar, Uddasi	5
Jati	Begna, Gul Muhammad Baraa, Jati, Karamalik, Kothi, Murid Khoso	6
Mirpur Bathoro	Bachal Gugo, Banno, Darro, Darya Khan Suho, Jhoke Sharif, Laikpur, M.Bathoro, Mehar Shah	8
Mirpur Sakro	Bohara, Choubandi, Dhabeji, Gharo., Ghulamullah, Gujjo, Haji Ghirano, Karampur, Mirpur Sakro, Sukhpur	10
Sajawal	Ali Bahar, Bello, Bijora, Jar, Kinjhar, Sujawal	6
Shah Bander	Chuhar Jamali, Doulatpur, Goongani, Jungo Jalbani, Ladiun	5
Thatta	Chatto Chand, Doomani, Jherruck, Jhimpir, Jungshahi, Kalakot, Kalri., Makli, Onger, Sonda, Tando Hafiz Shah, Thatta-I, Thatta-II	13

4.6.2 History

District Thatta with vast cultural history and its glorious past which may not be found now but in monuments, buildings, mosques, graveyards which speak eloquently of its glorious past, Thatta remain capital of Sindh from the 14th century under the rule of Summa Rulers. Since 1592 it was governed by Mughal emperors of Delhi, then in 1739 it falls to Nadir Shah's forces who came from Persia in 1739, which was end of its glorious years and since then it has fallen in to neglect from where it has not yet succumb to.

A tomb at Makli Hills built in 1559 Thatta is known to be the burial place of 125,000 (Sawa Lakh) saints; it also was a place of great learning where eminent scholars from Khurasan, Qandhar, and Heart etc had assembled. Thatta is also famous of being known as Door of Islam to subcontinent which symbolizes the famous entry of Mohammad Bin Qasim to the region.

4.6.3 Population

According to EDO Planning & Development, District Government, Thatta report 2010, the population of Thatta District was in 1.581922 with 837493 males and 74,4430 females. Table 4.11 shows taluka wise total population in 1998 and 2010 of Thatta district and Figure 4.23 also shows Taluka wise percentage of current population.

Table 4.12: Population of District Thatta

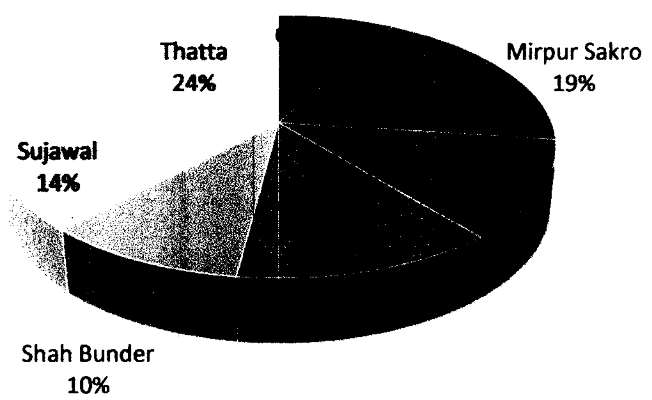
S#	Taluka	*Population 1998*			*Population 2010*		
		Male	*Female*	*Total*	*Male*	*Female*	*Total*
1	Thatta	134200	119548	253748	190707	169886	360593

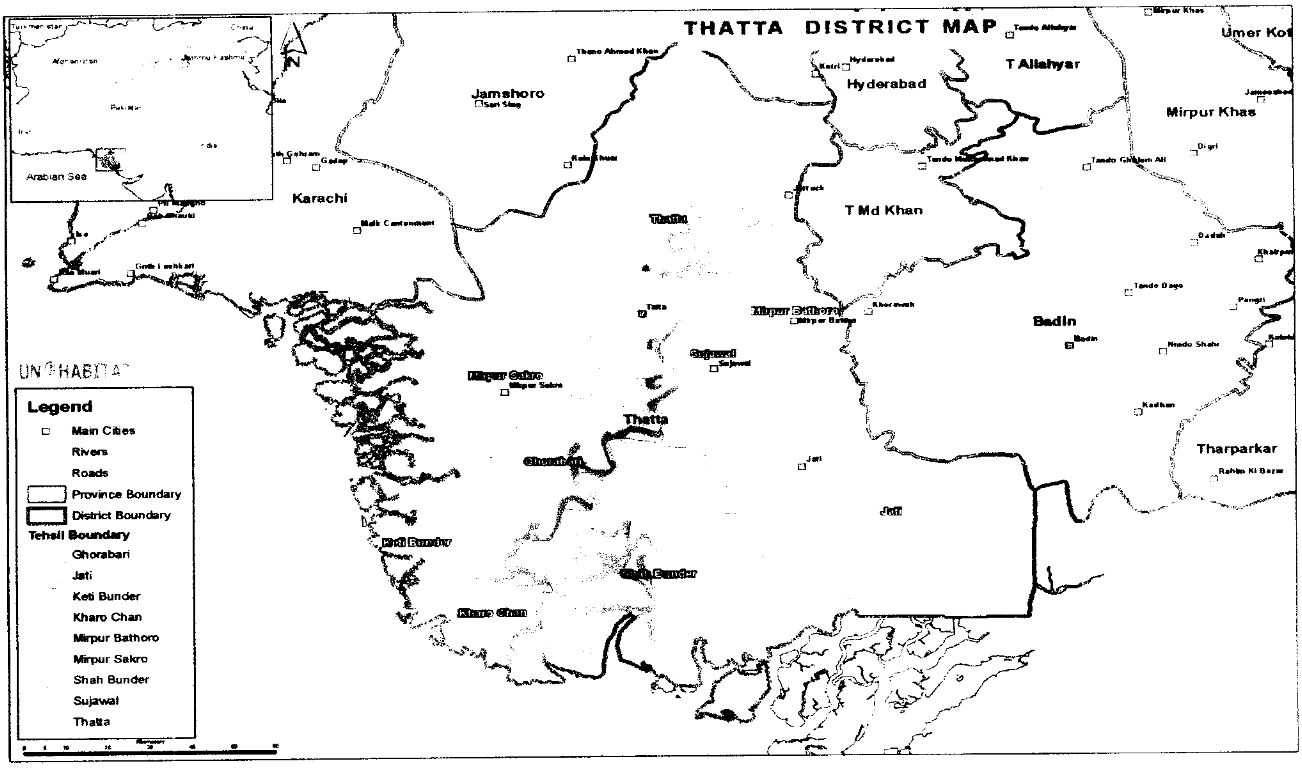
Table 4.12: Population of District Thatta

S #	Taluka	Population 1998			Population 2010		
		Male	Female	Total	Male	Female	Total
2	Mirpur Sakro	105345	93507	198852	149702	132880	282582
3	Keti Bundar	13553	12147	25700	19260	17262	36521
4	Ghorabari	55527	49955	105482	78908	70989	149897
5	Mirpur Bathoro	80753	71162	151915	114755	101126	215881
6	Sujawal	67298	60001	127299	95635	85265	180900
7	Jati	65479	58478	123957	93050	83101	176151
8	Shah Bundar	53392	47183	100575	75874	67050	142924
9	Kharo Chan	13794	11872	25666	19602	16871	36473
10	District Thatta	589341	523853	1113194	837493	744430	1581922

Source: EDO Planning & Development, District Government, Thatta

Taluka Wise Current Population of District




THATTA DISTRICT MAP
Jamshoro
Karachi
Hyderabad
T Allahyar
Umer Kot
Mirpur Khas
T Md Khan
Badin
Tharparkar
Thatta
Arabian Sea
UN-HABITAT
Legend
Main Cities
Rivers
Roads
Province Boundary
District Boundary
Tehsil Boundary
Ghorabari
Jati
Keti Bunder
Kharo Chan
Mirpur Bathoro
Mirpur Sakro
Shah Bunder
Sujawal
Thatta

4.6.4. Taluka Municipal Administration Thatta

TMA Thatta is a Head TMA of District Thatta; it holds a very rich cultural heritage since the beginning of civilization. Thatta remain Capital of Sindh and saw many local rulers beside foreign invaders who invaded this land to fulfil their desire to rule Sindh. Its past glory can be witnessed from the historical monuments that have survived the cruelty of time and are still exist though being in dilapidated condition.

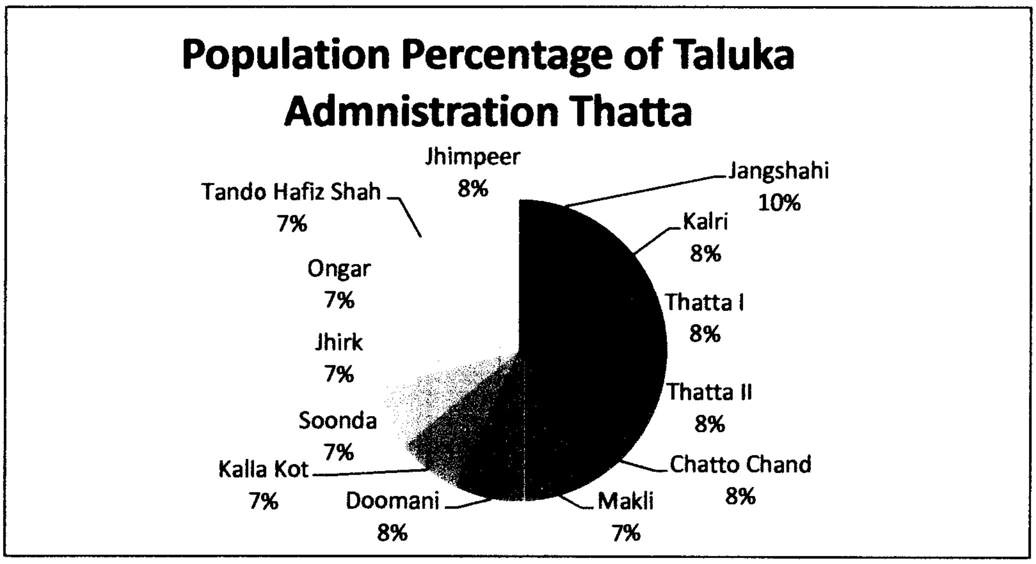
Some monuments worthy to mention here are Badshahi Mosque, Tombs of Jam Nizamuddin (reigned Thatta), tombs of several Turkhan rulers and Mughal officials are can be seen in the famous graveyard of Makli.

TMA Thatta is situated at about 100 kms east of Karachi, it has an area of 1321 Sq. Miles scattered upon 845,219 acres of Land. It is comprised of 13 Union Councils with the total population of 254,056 humans as per the estimates of 1998 census as per.

Table 4.14: UC wise Population of Taluka Thatta

S. No	Name of UC	Population 1998 Census	Estimated Current Population in 2007
1	Thatta-1	20,002	24,456
2	Thatta-2	19,983	24,421
3	Chatto Chand	21,246	25,980
4	Makli	18,742	22,916
5	Doomani	19,658	24,035
6	Kalla Kot	18,568	22,698
7	Soonda	18,192	21,884
8	Jhirk	18,105	21,709
9	Ongar	18,880	23,085
10	Tando Hafiz Shah	18,102	21,890
11	Jhimpeer	20,614	25,205
12	Jungshahi	22,348	27,325
13	Kalri	20,146	24,633

Source: TMA Sindh Devolved Social Services Program (SDSSP)



4.6.5 Administrative setup

District administration in Thatta district was tilled recently governed by the local government system. The District is subdivided into 7 tehsils (talukas or sub-district): Ghora Bari, Jati, Mirpur Bathoro, Mirpur Sakro, Shah Bunder, Sujawal, Thatta, Kharo Chan, and Keti Bunder. These talukas include 55 Union Councils, 7,200 villages and over 190,000 households with an average size of 6.5 persons per household. The seven talukas are governed by their respective Taluka Municipal Administration (TMA), while the 55 UCs of 7 talukas are governed by Union Council Administration (UCA).

4.6.6 Social Infrastructure

Thatta district is considered as a neglected and backward area of Pakistan as most of the villages in Thatta district has not proper physical infrastructure like roads, electricity and other basic necessities. The agricultural activities are suffering due to non-availability of irrigation water since last three years. The underground water is brackish and not fit for irrigation or drinking which resulted in poor agriculture and non-availability of safe drinking water.

4.6.7 Water Supply

District Thatta get the water from River Indus which flows from here till it meets to the great Arabian Sea in the south. The Thatta District is also very poor in terms of the indicator of piped water, which is available to only about 14% of the housing units. About 13% of rural households have hand pumps inside the housing units, while 16% use outside ponds for fetching water and 6% of housing units use dug wells.

Some cases found that the majority of people suffering from water borne diseases and having no option or awareness regarding its control, survey reports said. It said that women fetching canal water from 1-2km meters and sometimes even more. They have no awareness to clean or filter that water in the area. During the water intervals they have small ponds, tanks or ditches to store water and use that water for drinking purposes as that water is contaminated and sometimes animals and birds also drink from these ponds and same is used by the village communities.

4.6.8 Potable Water

Lack of potable water is one of the primary issues of this region. The Union Councils have provided water supply lines to most villages, but these schemes are largely non-functional. Groundwater levels are low and prospecting for water is an expensive proposition.

4.6.9 Sanitary Waste Disposal

The residents of units without proper latrine facility use adjacent rural environs. Majority uses the bushes to answer the call of nature. Only a few households have latrines as part of their bathing area. In the bushes outdoors the toilet area is demarcated; although the women's enclosures are separate, but they are not usually properly concealed.

In the interviews conducted of the locals by EMC team, locals living in the project vicinity revealed that they did have limited facilities for sanitation. There was no sewerage network either so the solid waste from homes is thrown in a demarcated garbage dumping area in the bushes.

Moreover, when the solid waste is in excess it is either lifted via tractor and taken to the lands and dumped in a big hole for bio-degradation into manure, or it is burnt. Conversely, this waste might also be sold to contractors from some other villages, which then have the garbage lifted and removed to cultivable lands where it is used to make manure.

Animal waste is not collected in special ways. Rather it is thrown in the same garbage area and allowed to dry after which if the quantity of animal waste is substantial then it is lifted and taken to the agricultural lands and dumped in a pit to turn it into manure, or else sold to contractors from other villages who have it lifted via tractor and taken to their own lands.

4.6.10. Electricity

Overall the electricity is available only to about one-third of the housing units in Thatta District. There is a wide variation in the availability of electricity in urban and rural areas. It is estimated that about 79 percent in urban areas had access to electricity in contrast to about 21 percent in the entire District. Kerosene oil is used in over 77 percent of the rural dwellings.

4.6.11. Roads

The Thatta District is linked by road with other districts. National Highway from Karachi to Peshawar passes through Thatta for a length of 200 kilometers. All major towns of the district are connected with metaled roads of 1,585 kilometers length. The district is also connected by the main railway line from Karachi to Peshawar. The principal railway stations are Jangshahi, Dhabeji and Jhimpir. The district is also equipped with digital and non-digital telecommunication system besides postage and telegraph. Sindh coastal highway is passes through the macro-environment on the eastern side.

4.6.12. Literacy rate

Literacy rate for Thatta is amongst the lowest in Sindh. Total literacy rate stands at 22%. There are marked urban and rural and male-female differentials in Thatta as 46% urban and 19% rural. The literacy rate in Thatta District was reported to be 22 percent in 1998. The male literacy rate was three times higher than females at 60% compared with the female at 20%. The literacy rate in urban areas was much higher at 46 percent compared to only about 19 percent in rural areas. There is a wider gap between males and females in rural areas where literacy ratio for males is 28 percent compared to only 8 percent for females. Of the total educated persons, 35 percent have passed primary, 13 percent middle and 13 percent matriculation. After matriculation, the percentage falls steeply to 6 percent for intermediates, 3 percent for graduates and less than 2 percent for post graduates. Things have started to change with the emergence of new leadership which has started setting up mosques and madressas in the area of influence.

... school ... way

4.6.13 Health Facilities

Overall, the health infrastructure in Thatta is scant. Three out of the six coastal Talukas do not have any Rural Health Centre or any veterinary dispensary. The BHUs and dispensaries are also in small number. It is estimated that there is one dispensary with one compounder for about 5000 people in the coastal Talukas. A particular problem of access to health services is the scattered nature of the population. Thus many of the people have no access to health services within a convenient location from their homes. This has left room for a lot of untrained people posing as heath care providers who establish camps and thus illegally prescribe medicines.

4.6.14 Enterprise and Industrial Sector

From the industrial point of view Thatta District has progressed considerably. There are about 30 industrial units established in the district. Apart from the sugar mills all the larger industrial units are located in Dhabeji and Gharo adjacent to Karachi. Most of the labour in these units is generally non-local and commutes from Karachi. These include sugar mills (5), textile mills (9), paper mills (2), flour mill (3) salt works, ice factory (2), etc. In addition, stone from the Makli Hills and Kohistan is supplied to the Pakistan Steel Mill and the Thatta Cement Factory. There are also large coal deposits in Thatta Taluka. Recent additions to the industrial units are the car manufacturing plant near Budho Talpur, belonging to the Deevan Group adjacent to the Deevan Sugar Mills. The group also employs non-locals in large numbers; the number of different industries in the district is given in Table 4.14.

Table 4.15: Industries in District Thatta

S #	Type of Industries	No of Factory
1	Sugar Mill	5
2	Textile Mill	9
3	Paper Mill	2
4	Jute Mill	1
5	Salt Works	3
6	Flour Mill	3
7	P.V.C Industries	1

8	Garment Industry	1	
9	Industrial Gases	1	
10	Specialized Textile	1	
11	Ice Factory	2	
Source: District Coordinate Officer District Thatta			

Salt industry: There are numerous sites for salt production in the Bambhore area. Private contractors have leased these lands from the government and local people are working there since the inception of the salt works, under primitive conditions for seven days a week, at an average salary of Rs. 250-350 per day.

Poultry farming: A large number of poultry farms were observed during the site visit for socioeconomic survey in the project area. The climatic condition favors this profitable business in terms of quality and quantity. These farms are major suppliers to urban centers.

Handicrafts: Both men and women in the project area supplement their major income source with handicrafts. Women particularly use their leisure time, albeit minimal, for handmade products like rali, comforters called sour, sagi, agath and embroidery on shirts, bed sheets, pillows, handkerchiefs and table covers.

4.6.15. Agricultural and Livestock

Like in the rest of Pakistan there are two main agricultural seasons in the Thatta District. The main crops grown in the district in the Rabi season are wheat, barley, gram and oil seeds. In Kharif the main crops grown are rice, maize, millet and Jowar. Most common vegetables are grown in all the Talukas in the district. As far as fruits are concerned these include the date palm which only flourishes in Jhimpir in Thatta Taluka. Coconut trees are found in Keti Bunder, Mirpur Sakhro and Thatta Talukas. Bananas are grown in Thatta, Ghorabari and Mirpur Sakro Talukas. Other fruits grown in the district are Papaya, Guava and Mangoes. However, the banana crop exceeds the other fruits in terms of the area and production by far. The district is surplus in rice. Besides, bananas of good quality are exported to Iran and the Middle East. The important items of trade in the district are rice, leather and wool. Good breed of buffalo and cow are found in the district. Sheep, goat, camel, horse, ass and mule are also the main livestock of the district.

4.6.16. Irrigation and Drainage Systems

The hilly areas of the district are cultivated on monsoon water and wells, while the canals and channels irrigate the other lands. The areas within the protective banks of the Indus used to have fertile patches of land which depended upon flood and lift water system from barrage channels at various places for irrigation purposes. However, the pattern of irrigation has been transformed in the district due to lack of water availability.

4.6.17. Occupation

According to the Household Survey Data (Jan 2005), 20 percent of the households relying on fishing as an occupation in the Thatta Districts, Almost 88% of the population resides in rural area and the population base indicates a high level of younger population. Table shows inland and marine fisheries in Thatta District.

Table 4.16: Inland and Marine Fisheries in Thatta District (2009-10) (Metric Tons)

District	Production In Metric Tones	No. of Fisher Man			No. of Boats		
	Fish Production	Full Time	Part Time	Total	Sail	Row	Total
Thatta	11587	10600	780	1180	600	850	1450

Source: Fisheries Department of District Thatta, Government of Sindh

4.6.18. Poverty

According to the Pakistan National Human Development Report 2003, Thatta stands 64th among 91 Districts (UNDP 2003) and one of its Taluka Mirpur Sakro was declared the most poverty ridden Taluka in District Thatta, the 80% of the population living below the poverty line in the district.

A senior member of the nearby community told during an interview that this project could be very promising for the locals as its development can help them earn enough to get out of the vicious trap of crippling poverty.

4.6.19 Employment Opportunities Associated with the Project

The area is backward and limited opportunity of education is available, therefore it is expected that mostly labor force could employed during construction and operation phase. This project will have a relatively short construction period, and will require a relatively small number of skilled and semi-skilled workers, including crane and heavy equipment operators, engineers, electricians, electronic technicians, mechanical technicians, concrete workers and laborers. The project developer should accommodate as much local labor as possible from the local area. Short-term positive economic impacts to area businesses may result from increased expenditures for meals, motels, fuel, etc. However, given the small number of employees involved and the temporary nature of the work, it is not anticipated that there will be significant positive or negative impacts at the community level.

4.6.20. Benefits to women due to the project

When someone thinks of development and physical change in vulnerable area, he must think of the infrastructure and machines moving in it. Weather, it can be a large industry in big/small cities or just bringing electricity in the area. Development can be just lighting in rural areas. What will be the first need that shakes your mind for bringing about immense change in a place; of course it will be availability and significance of energy, which is a basic need and start point of development at grass root level. The inhabitants of far flung areas of Pakistan do not have access to this basic and modern amenity of life. Consequently, such population has minimum opportunity for development. The same is the case for the residents of the area under discussion Like, generally in the third world countries, one of the main drawbacks of this society is that females' home management is not recognized as a productive activity whereas the fact is other way round; women at home are working for very high value cause of society building.

However, during public consultation process, it was noted that females generally work for maintaining livestock, helping male members in agriculture related activities. Some women also work as a labor as well. As for as male members are concerned, some of them who have some education have moved to cities for jobs whereas most of them work as a laborer, maintain their agricultural land and look after their livestock.

Traditionally, women are more skilled and hard workings due to local norms like female have to fetch water and keep themselves busy in other nonproductive activities in community. Another difference made by local cultural between man and woman which force them to wear special dresses that should be different from man and must show specific sign of specific community, so that woman from every community is recognized from their dress.

The women in the area have a lot of potential for development of economic activities that can lead to income generation and improve their livelihood. Migrating activities by men (who are by and large head of the family) for getting economic resources during drought in the area is also necessitated for woman to involve in economic activities to fulfill families' immediate necessities. However they have to be provided with necessary infrastructure including adequate facilities of electricity, access to market, appropriate training, credit facilities etc.

4.7. Stakeholder Consultation

Individuals or groups who have a stake in the Project and their stakes may be directly or indirectly affected by any component of the proposed development project are known as stakeholders. Individuals or groups likely to be directly affected, e.g. local communities, their representatives and the representative organizations are designated as primary stakeholders, while those likely to be indirectly affected, such as line ministries, government departments and national and international non-government organizations (NGOs) are referred to as secondary stakeholders.

The process of stakeholder participation and consultation was endorsed in the United Nations Conference on Environment and Development (UNCED) in 1992 through Agenda 21 that was one of the key documents of the UNCED. Agenda 21 was adopted as a comprehensive strategy for global action on sustainable development to deal with issues regarding human interaction with the environment. It emphasizes the role of public participation in environmental decision-making for achieving the goals of sustainable development.

The participation of project stakeholders in project planning, design and implementation is now universally recognized as an integral part of environmental & social assessment. Local communities, their representatives, government and national and international NGOs may all be able to contribute to, and benefit from, the dialogue directed at identifying and resolving key project-related issues. Stakeholder consultation presents an opportunity for mutual information-sharing and dialogue between the project proponent and stakeholders, specifically aimed at fostering ideas that can help improve project design, resolve conflicts at an early stage, identify management solutions to mitigate potentially adverse consequences and enhance positive impacts, and develop guidelines for effective monitoring and reporting of project activities throughout the project cycle.

The key objectives of stakeholder consultation include the following:

- Provide information related to proposed project activities;

- Facilitate and maintain dialogue;
- Seek participation of all interested parties;
- Identify stakeholder interests and issues;
- Create solutions for addressing these concerns and integrating them into project design, operations, and management; and
- Enhance the project by learning from, and incorporating, the expertise of individuals, professionals, communities and organizations.

4.7.1 Consultation with Villager and Community

Participant: Muhammad Khan

Village: Haji Sulaiman Brohi

Occupation: Descon Driver

Date: 08th January, 2016

Facilitator: M. Anas Khan, EMC Pakistan Pvt. Limited

Coordinates: 25 07 54.2 N 68 01 49.9 E

Discussion

The meeting began with a round of introductions that included the survey team members and participant from the village.

The participants were informed of the purpose of the consultation meeting as under:

a. To identify impacts of NTWF 100MW on the nearby villages
b. To identify suggestions of the villagers to mitigate the expected adverse impacts of the project
c. To identify the existing structure of grievance redress in the community
d. To identify recommendations & expectations of the villagers from the project

The participants were informed of the role of the survey team in the project and assured the participants that their feedback would be shared with relevant authorities without compromising participants' confidentiality.

The facilitator then opened the floor for discussion and used various probes to clarify participants' opinions.

Community Feedback

- There is drinking water well bore (125 feet deep) that is being used by most of villages, although villages are not near this borehole.
- No Surface water body available here.

- Most Common caste in this area is Brohi.
- Basic crops are Guwar and Wheat.
- Villages from this bore hole and far away and they travel great distance just to take water from here.

Figure 4.28: Consultation with Moh[illegible]

<u>Participant: Barkat</u>

Village: Gudh

Occupation: Shepherd

Date: 8th January, 2016

Facilitator: M. Anas Khan, EMC Pakistan Pvt. Limited

Discussion

The meeting began with a round of introductions that included the survey team members and participants from the village.

The participants were informed of the purpose of the consultation meeting as under:

a. To identify impacts of NTWF 100MW on the nearby villages
b. To identify suggestions of the villagers to mitigate the expected adverse impacts of the project
c. To identify the existing structure of grievance redress in the community
d. To identify recommendations & expectations of the villagers from the project

The participants were informed of the role of the survey team in the project and assured the participants that their feedback would be shared with relevant authorities without compromising participants' confidentiality.

The facilitator then opened the floor for discussion and used various probes to clarify participants' opinions.

Community Feedback

- We have 40 to 50 Cows
- We drink water from the nearby water bore and all the other companies also use this same bore hole which is about 200 to 300 ft Borehole
- Agricultural activities are carried out during October.
- They came from Gudh land towards Haji Sulaiman Village to grazing purpose of farm animals.

Participant: Azeem Brohi

Village: Haji Usman Brohi Village

Occupation: Farmer

Date: 08th January, 2016

Facilitator: M. Anas Khan, EMC Pakistan Pvt. Limited

Discussion

The meeting began with a round of introductions that included the survey team members and participants from the village.

The participants were informed of the purpose of the consultation meeting as under:

a. To identify impacts of NTWF on the nearby villages
b. To identify suggestions of the villagers to mitigate the expected adverse impacts of the project
c. To identify the existing structure of grievance redress in the community
d. To identify recommendations & expectations of the villagers from the project

The participants were informed of the role of the survey team in the project and assured the participants that their feedback would be shared with relevant authorities without compromising participants' confidentiality.

The facilitator then opened the floor for discussion and used various probes to clarify participants' opinions.

- The population of the village is around 100 – 400 persons. We have 30 – 40 goats and 5 – 6 cows. There is one primary school and one mosque.
- We use to farming in rain and get coal from railway track
- The common crops that are cultivated here are Johar, Mung and Guwar
- The common diseases here are sugar, cough and fever
- The wind mill installed should not be too close to our houses.
- Employment should be given to villagers
- We use hand pumps (bore water) for drinking but its TDS is very high.
- Hospital is away almost 8 – 9 miles towards Jhimpir.
- We have school and mosque in our village (But when we went to see the school it was abandoned and the building was badly damaged).
- Some of us work in a nearby coal storage area near the railway track.
- We only do farming when it rains.

Figure 4.28: Consultation with Azeem [illegible]

Chapter 5 POTENTIAL ENVIRONMENTAL & SOCIOECONOMIC IMPACTS AND RECOMMENDED MITIGATION MEASURES

This chapter presents the screening of potential environmental and social impacts of different activities of Norinco Thatta Wind Farm Project during its different stages of designing, construction and operation. Using the general guidelines as well as professional judgment, it evaluates the positive and negative impact of emissions and waste discharges on the aesthetics, air shed, watershed, fauna, flora and the living environment at NTWF Project site at Jhimpir, Distr Thatta. The screening process, besides identifying significant environmental impacts and the persistence of residual impact, if any, suggests mitigation measures that may have to be adopted in order to reduce minimize or compensate for the impact.

5.1. Screening of Alternatives

The NTWF Project aims at harnessing the potential of wind energy, the renewable energy source in the Jhimpir Wind Corridor as an alternative to the conventional power plants that depends on fossil fuel, but is unable to meet the entire shortfall in the current energy production system. The alternatives available are:

- No Action, continuation with the existing condition.
- No renewable energy alternative; No new system alternative that involves renewable energy but continuation with the use of fossil fuel.
- Harnessing wind energy potential of the Jhimpir Wind Corridor at NTWF Project Site in Jhimpir.

5.1.1 Selection of Preferred Alternative Site:

Selection of the preferred alternative system and site for establishment of wind farm needs to consider:

- Current status of energy production system,
- Strategic needs of energy production, conservation and environmental protection,
- Urgent need to provide better level of service in power production to meet the current and future demand.

5.1.2. Alternative # 1: No Action Alternative

The "No Action Alternative" does not offer the advantages sought by the Alternative Energy Development Projects. For example, it does not respond to:

- The urgent and strategic needs of enhanced power production to meet the demand of industry, agriculture as well as commercial and domestic consumers of the country; nor does it propose better level of service for improvement of quality of life.

- Flora
- Fauna (Wildlife, Birds)
- Wind Farm Development Advantages (positive effects)
- Recreational and Tourism Issues
- Impact during Construction phase
- Impact during Operational phase

5.2.1. Planning Stage/Siting of Wind farm

5.2.1.1. Land Use

The wasteland at NTWF Project area has remained an isolated component of ecosystem of Lower Sindh for a long time; location of NTWF will comprise value addition to the wasteland and will have positive significant impact on its degraded ecology.

The NTWF Project land currently comprises one segment that is stony wasteland and the other has a few hamlets which are home to land owners who use the land for subsistence farming and rearing livestock. The stony wasteland has been allotted to Project Proponent by AEDB/Sindh Government, while the agricultural land/rangeland will be acquired by AEDB/Sindh Government from the landowners on settlement of their rightful claims as per the Laws on Acquisition of Land (1894) and suitable compensation.

Current land-use in the settlements on the outside of the allocated area is limited to subsistence farming, livestock grazing and cashing on the dead wood, dried up vegetation and sand / gravel / stone.

The NTWF Project has no protected areas such as wildlife/game reserves or national park, or any archaeological, historical or cultural heritage in its immediate neighborhood; as such it would have no visual impact on them.

Mitigation Measures

- Proponent will negotiate for acquisition of land from i) the Revenue Department, Government of Sindh, and ii) landowners strictly in accordance with the Land Acquisition Act 1894.
- NTWF would have its share of water from Deep Groundwater wells and would thus have no significant impact on the current beneficial water uses in the area.

Issue: The airshed of the NTWF Project is, according to the assessment of ambient air quality, unpolluted. The dust fall in the microenvironment as estimated from the ambient air quality measurements at site is high as a result of high aridity in the airshed of the macro environment as well as that of the site itself.

Mitigation Measures

- Deposition of dust on the rotor blades of the WTG may have significant impact on operation of the WTGs. The WTG supplier will take this aspect into account, while

- The need to increase the current power production capacity despite the shortfall in energy availability resulting in load shedding/blackouts of 6 to 12 hours every day.
- The requirement of slowing down on fossil fuel consumption that is adding to global warming on the one hand and depleting its resources on the other hand.
- In view of the above shortcomings, the "No Action Alternative" cannot be considered.

5.1.3 Alternative # 2: No New Renewable Energy Alternative

Alternative#2 also does not respond to:

- The need to increase the current power production capacity despite the shortfall in energy availability resulting in load shedding of 6 to 8 hours in urban areas and 12 to 14 hours every day in rural areas.
- The requirement of slowing down on fossil fuel consumption that is adding to global warming on the one hand and on the other hand depleting the resources.

5.1.4. Alternative # 3: Harnessing Wind Energy Potential of Jhimpir Corridor

This alternative responds to the need to i) augment the current energy production system, and ii) slow down on use of fossil fuel by harnessing the wind energy potential of Jhimpir Wind Corridor criteria just mentioned.

The screening process finds the site of the Project in the Jhimpir Wind Corridor to offer the following additional advantages:

- It is suitable for wind classes 4 to 5
- It is the only alternative site made available to the Proponent for establishment of the NTWF Project.
- It suits to the requirement of accessibility to infrastructure facilities for the establishment of wind farms and for providing energy to NTDC when it goes into operation.

Alternative 3 has, in view of the above findings, been found to be the preferred alternative.

5.2. Screening of Potential Environmental Impacts at different stages of project development

Exploitation of wind energy potential at NTWF Project in Jhimpir will require the following environmental issues to be addressed:

- Land Use
- Visual Effects
- Noise Effect
- EMI Assessment
- Flicker Effects
- Cultural Heritage and Archaeological Issues

environmental monitoring and management plan as well as maintenance staff will address this issue in particular.

Issue: Removal of small patches of vegetation will be needed at 40 locations on the land for construction/ piling for siting the wind turbines.

Mitigation Measures

- Contractors will be committed to minimizing the removal of vegetation, and replanting trees that may have to be removed.

Issue: Soil erosion is likely to be caused by the vehicular traffic on unpaved roads and dirt tracks, land clearing for construction camps and wind turbine towers, construction of roads and excavation for tower foundations.

Soil may be contaminated as a result of fuel/oils/chemicals spillage and leakage, and inappropriate waste (solid as well as liquid) disposal.

Mitigation Measures

Contractors will be committed to strictly follow the EMP as well as IFC's EHS Guidelines on minimizing the soil erosion and contamination.

5.2.1.2. Geology and Land Form

From the already available secondary data of project area it is shown that the water table is deep down and much below 10 m. It is assumed that the strata in the vicinity of water table are dried up.

Wind turbines are mostly arranged on the top of mountain ridges and peaks, where the buried depth of groundwater is greater than 10m in general, so the influence of groundwater on building foundation can be omitted.

According to the Code for Seismic Design of Buildings (GB50011-2001), there is no seismic liquefaction in the area foundation.

The foundation (rock) soil mass in the project area is mainly composed of two layers: Layer ① is composed of rubbles, mainly of moderate ~ dense structure, the bearing capacity characteristic value of which is 200 kPa~350 kPa. With fair mechanical property, it can be used as natural foundation. Layer ② is mainly composed of highly ~ moderately weathered limestone, developed with small dissolved pores and karst cave, the bearing capacity characteristic value of which is 500 kPa~1200 kPa. With better mechanical property, it can be used as the foundation supporting layer or the underlying layer of wind turbine and ancillary buildings.

5.2.1.3. Seismic Hazard

In view of the not too distant location of the Project site to Allah Bund Fault line, it is suggested that this ecosystem that includes the proposed project land should be placed in Zone 2A. Such Seismic Zoning would correspond to Magnitude between V and VII on

Modified Mercallis Scale and hence ground Force in terms of Assumed Approximate Acceleration equivalent of 0.08-0.16g should be adopted for siting the Wind Farm for constructions and positioning of towers and WTGs, for operational basis earthquakes (OBE) pertaining to damage due to moderate level earthquakes (MM-V to VII). Therefore, the regional tectonic stability of the area is comparatively low.

The basic seismic intensity of the wind farm area is classified as VII degrees. The area overburden is comparatively thin, mainly composed of highly ~ moderately weathered limestone, with better mechanical property. The construction area is classified as Grade I, belonging to the area that is favorable to seismic design of structures. The area is suitable for construction of the wind farm.

There is neither seismic liquefaction in the site foundation nor adverse geophysical phenomenon such as goaf, landslide, ground fissure and large karst caves. The possible karst bedrock could be excavated and replaced or treated with consolidation grouting. However, the effect of intermittent flood in high flow year should be paid more attention.

5.2.1.4. *Visual Effects*

Visual impact depends on the visual contrast between turbine structures and visual character against the skyline and landscape, both of which result from color, form and scale. Visual effects are so far a non-issue in the construction of large structures. They have so far not appeared as a major constraint to development of high-rise apartments, towers, minarets and chimneys. There are also no regulations for visual effects while siting wind turbines.

Reflected light can nevertheless be distressing to the eye of persons in living environment in close proximity. The rotor blades will have to have dull finish so as to minimize the visual effects.

Mitigation Measures: Siting of the NTWF Project will give due consideration to its location close to the village, and site the WTGs to maintain a safety distance of about 100 m from this village. The wind turbines would be suitably landscaped so as to make them visually attractive and also matt-finished to make the rotors less glossy.

The wind farm being established near the Jhimpir would be viewed as a curiosity. The cluster of WTG all lined up along the 2 rows in the proximity of Jhimpir City and Kinjhar Lake will create a point of interest in the distantly located rural landscape. This point of interest could be complemented by suitable landscaping and creating a public viewing area to demonstrate the performance of this clean, renewable form of energy generation.

5.2.1.5. *Noise Impact*

Noise created by the wind turbines would range between 90 and 105 dB(A) at a height of about 90 m. This level would attenuate at the ground level to perceptible range of 55 to 65 dB(A), which is almost the same as noted when the surface wind is blowing. With the rotation of blades by class 3-4 winds at 12 to 15 rotations, the noise emission would be at the lower level of 55 to 60 dB(A). At a distance of over 10 km, where Kinjhar Lake is located, the noise emission would be negligible. The average background noise level recorded at site during the reconnaissance survey was 50 to 60 dB(A). The noise level as a result of exposure to wind was 60.0 to 65 dB (A).

Performance of WTGs at a recently installed wind farm in the Jhimpir Wind Corridor has been observed by the residents of Haji Suleman Village. The blades were found rotating at 12 to 15 rounds per minute and were not causing sound disturbance or roaring effect.

Mitigation Measures: In case the wind turbines are noisier than just stated, the impact will be largely on the operators working at the wind farm or the security personnel resident in the accommodation provided to them. It will be mandatory for the workers and officials to wear ear mufflers or earplugs while in the operations area and for the management to adopt mitigation measures during construction to minimize the environmental impact of the wind farm. Regulations/standards relevant to wind farm have not been framed. In addition, the wind turbine manufacturers will provide a maximum noise guarantee level or will be required to repair the wind turbines to meet the guaranteed maximum noise level.

The standards will be applied if the level exceeds the limits for Industrial and commercial sites set at 65 dB(A) at the boundary of the wind farm. Simulation studies indicate that this level would be achieved at the ground level of the wind farm.

The detailed design shall nevertheless take the noise aspect into consideration and site the WTG nearest to Haji Suleman Village.

5.2.1.6. *EMI Impact*

Electro-magnetic Interference (EMI) caused by the development of wind farm is not expected to be significant. Electro-magnetic Interference produced from either WTG placement in the direct line of sight of point-to-point communications, or too close to omni- (all) directional communications or radar equipment, is the main point of interest for communications and radar operators.

- Mitigation Measures: The site is not located under the flyway of commercial aircrafts. The wind turbines would be at the hub height of 90 m, which would necessitate adequate provision of warning lights and signals necessary for elevated structures. This would require obtaining clearance from the Civil Aviation Authority and Telecommunication Authority, which has since been obtained.
- Contact with the Pakistan Telecommunication Authority will be made to establish licensed communications operators in the area. Although no major impact is anticipated, communications operators may need to be contacted, during the initial stages of development. In some cases before and after surveys of signal strength and interference may be required. Typically the following types of owners/operators are contacted:
    - ✧ Television (Some interference to Television signals close to and within the wind farm is possible, however this would probably be possible by rectification with relatively inexpensive aerials or repeaters.)
    - ✧ Radar Systems (Considered an issue on Super Highway for security reasons).
    - ✧ Public Communications Systems (Pakistan Telecommunication Authority)

- Private Communications Systems: Mobile phone coverage is presently being extended to Jhimpir near the Project site.

5.2.1.7. *Flicker Shadow Effect*

Turbines that are east or west of houses can impose fluctuating shadow effects at morning or evening hours when the sun is behind the rotor blades and the alternating shadow flicker is cause for annoyance to residents within one km. The 40 WTGs would be located in 02 rows. The setback distance of 750 m to 1000 m will for most areas exclude the possibility of significant shadow effects at residences beyond 1 km.

Mitigation Measures: This issue will be analyzed in more detail at the designing and siting stage for the final layout.

Visual effect, noise effect, EMI effect, flicker effect induced by operation of the wind turbines may have an impact on the living area, located 500 m from the NTWF Project. Therefore as a mitigation measure, it is proposed that wile siting the WTGs, a distance of 1 km should be maintained from Haji Suleman Brohi Village.

5.2.2 Screening of Potential Environmental Impacts at Construction Stage

Construction activities on NTWF site for the establishment of Wind Farm will include the following main elements:

- Location of campsite and field construction office;
- Quarries, Borrow pits
- Construction of access road, site roads, turn-around areas and crane pads at each wind turbine location;
- Construction of the turbine tower foundations and transformer pads;
- Installation of electrical collection system – underground and some overhead lines;
- Assembly and erection of the wind turbines;
- Construction and installation of the substation;
- Plant commissioning and energizing, and
- Decommissioning.

The above activities will entail the following construction related issues that may have impact on the environment and will require mitigation measures to be adopted during the implementation phase:

- Heavy weight and/or long trucks haulage
- Surface sealing (foundations, roads)
- Topsoil removal
- Compressing of topsoil
- Protection of (natural) drainage of agricultural lands

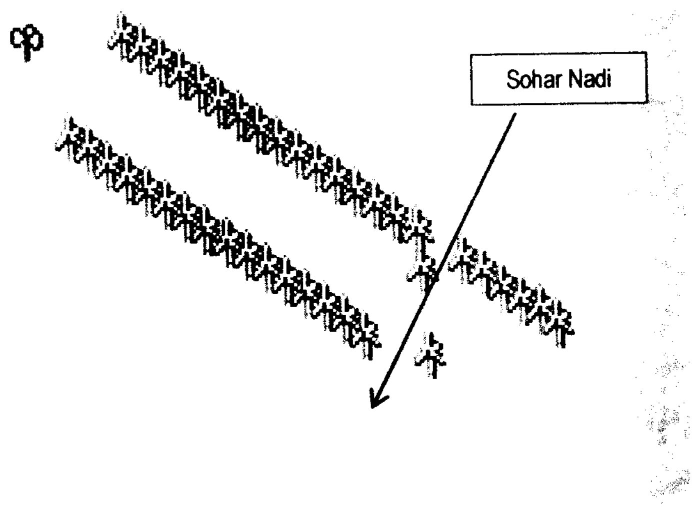
- Fuel storage
- Concrete production
- Ground water levels and watercourses, erosion minimization
- Waste disposal
- Dust emission and control
- Construction related noise
- General conditions of construction site (visual)
- Disturbance of fauna
- Impact on flora
- Emergency response
- Site rehabilitation

5.2.3. Screening of Potential Environmental Impact

- Construction at the proposed site of NTWF Project would not involve extensive land preparation since the stony wasteland at NTWF Project site is almost flat except at the banks of Sohar Nadi which is no be chosen for WTG installation due to topographic constraint. The impact of land preparation on the microenvironment i.e. Haji Suleman Barohi village land with no value addition to its land use, and the living area of Jhimir will be minor and not significant.
- Site preparation activities would include clearing, excavation, earth and fill movement and transportation of wind turbine sets and associated equipment to the site. The said activities will not lead to extensive soil erosion resulting from removal of topsoil at the site, but to improvement of its quality.
- Mitigation Measures: The fugitive dust emission would be controlled by spraying water to keep the soil moist and reduce the dust levels. Dust emission due to other materials of construction will be controlled through appropriate measures to reduce the level of impact to be of minor significance.

Figure [illegible] practices was done on the [illegible]

- Temporary disturbance to the landscape that will occur during 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, including underground and some overhead lines; assembly and erection of the wind turbines, and construction and installation of the substation, will be limited to the footprints of the project site.
- The alignment of Sohar Nadi (Seasonal Stream traversing across the project site) should be be disturbed due to high abundance of trees and faunal species and also the dependence of drinking water for the local cattle. The Sohar Nadi should be barricaded before the construction of the site to avoid the construction workers intrusion and cutting of trees. But access to local and their grazing animals should be provided.



- Mitigation Measures: Environmental Management Plan (EMP) and IFC' HSE Guidelines will be effectively implemented to keep the interventions in the ecosystem well within prescribed limits and contractors will be mandated to adopt the EMP in letter and spirit.
- Vehicles and construction equipment will not be repaired in the field. If unavoidable, impervious sheathing will be used to avoid soil and water contamination.
- For the domestic sewage from the construction camps, appropriate treatment and disposal system, such as septic tanks and soaking pits, will be constructed having adequate capacity, and after determining the soil percolation capacity. The contractor(s) will submit to the proponent the plans for the camp layout and waste disposal system, and obtain approval.
- Waste oils will be collected in drums and sold to the recycling contractors or disposed environmental friendly through a waste contractor.
- The inert recyclable waste from the site (such as card board, drums, broken/used parts, etc.) will be sold to recycling/disposal contractors. The hazardous waste will be kept separate and handled according to the nature of the waste.

- Domestic solid waste from the construction camp will be disposed in a manner that does not cause soil contamination. The waste disposal plan submitted by the contractor(s) will also address the solid waste issues.
- The construction camp will not be established close to the Sohar Nadi and the living areas in particular the Haji Suleman Brohi Village.
- Estimates available from other sites in Jhimpir wind corridor show that 7-10% of the project area is temporarily disturbed for road and crane pad construction. At completion of the project, the turbines, access tracks and associated equipment occupying about 1% of the site area, will meaningfully add value to the wasteland at NTWF area.

5.2.3.1. *Blocked Access*

- There are no settlements at the proposed site. Hence the construction activities at the site will not cause any inconvenience to the nearby population by blocking their access routes. The movement of extra heavy plant equipment along the roads leading to the site may require temporary adjustment and would not block the insignificant local traffic even for short periods of time.

Mitigation Measures

- The IFC's EHS Guidelines will be strictly followed and dedicated EHS manager will be on site
- Movement of extra heavy loads will be carefully planned, in consultation with the communities in the surrounding and relevant authorities.
- Diesel and other petroleum products used for the operation of construction machinery and transportation equipment would cause air pollution besides causing soil pollution through oil spills. The impact from such activity would be of minor significance and would be controlled by good housekeeping practices.
- 9.06 m^3 per day of water required for numerous construction activities would be catered through deep water borehole and will not have significant impact on other beneficial water uses or its reduced availability for downstream users. Conservation practices would nevertheless be adopted during the entire course of construction.
- Noise and visual impact will be limited to the microenvironment. No major operational impact is envisaged at the construction stage from the NTWF.

5.2.3.2. *Temporary Borrow, Disposal Pits & Quarries*

In case there will be a requirement to establish temporary borrow and spoil disposal pits to source materials from quarries, and other contractor's facilities. If not sited or undertaken carefully these activities can result in reductions to air, water quality; and social impacts including social unrest and disease transmission. To mitigate these impacts:

- The locations of temporary borrow and spoil pits will be determined during detailed design in accordance with applicable laws and regulations of SEPA.

Temporary Borrow and Disposal Pits

- Borrow and disposal pits will not be located in environmentally sensitive areas.
- Local community leaders will be consulted regarding the design and location of all borrow and disposal pits so as to ensure the safety of local communities.
- Borrow pits should be properly barricaded to avoid the intrusion of wild and grazing animals.
- Borrow and disposal pits are to be located away from settlements and hill slopes facing settlements so as to minimize visual impacts.
- Spoil disposal pits should be in suitable depressions not adjacent to waterways.

Quarries

- Construction materials for tower foundations and access road works will be sourced only from established quarries which comply with environmental, health and safety and other applicable regulations.

Temporary Facilities including Hot Mix and Batching Plants

- Should be located at least 500m away from settlements.
- Should not be located in environmentally sensitive areas.
- Should have adequate drainage and not be subject to flooding.
- Should not be within 100 m of any domestic or public water sources.

5.2.3.3. *Air Quality Deterioration*

Construction machinery, diesel generators and project vehicles will release exhaust emissions, containing carbon monoxide (CO), sulphur dioxide (SO2), oxides of nitrogen (NOx), and particulate matter (PM), which can deteriorate the ambient air quality in the immediate vicinity of the project site and along the road leading to it. Furthermore, construction activities such as excavation, leveling, filling and vehicular movement on unpaved tracks may cause fugitive dust emissions.

Construction crew and other site staff can be impacted by this air quality deterioration. In addition, the exhaust and dust emissions caused by project related vehicular traffic may impact the communities living along the dirt track leading to the site.

Mitigation Measures

- Environmental Management Plan (EMP) will be effectively implemented to keep the interventions in the ecosystem well within prescribed limits while IFC's HSE Guidelines will be strictly followed and contractors will be mandated to adopt the EMP in letter and spirit.
- Emissions from the generators will be monitored to ensure that the engines are properly tuned and maintained, and generators are so located that emissions are dispersed away from the camp and work areas.

- Noise emission from the vehicles and equipment will exceed 85 dB (A) but the same would be reduced to less than 85 dB (A) at 7.5 m from the source. Workers will be provided ear plugs and other safety equipment as safeguard against the hazards in the 'high noise zones', which will be clearly defined.

Table 5.1: Typical noise levels of construction equipment (noise level in dB (A) at 15 m)

Clearing		Structure Construction	
Bulldozer	80	Crane	75-77
Front end loader	72-84	Welding generator	71-82
Jack hammer	81-98	Concrete mixer	74-88
Crane with ball	75-87	Concrete pump	81-84
		Concrete vibrator	76
Excavation and Earth Moving		Air compressor	74-87
Bulldozer	80	Pneumatic tools	81-98
Backhoe	72-93	Bulldozer	80
Front end loader	72-84	Cement and dump trucks	83-94
Dump truck	83-94	Front end loader	72-84
Jack hammer	81-98	Dump truck	83-94
Scraper	80-93	Paver	86-88
Grading and Compaction		**Landscaping and clean-up**	
Grader	80-93	Bulldozer	80
Roller	73-75	Backhoe	72-93
		Truck	83-94
Paving		Front and end loader	72-84
Paver	86-88	Dump truck	83-94
Truck	83-94	Paver	86-88
Tamper	74-77	Dump truck	83-94

Source: U.S. Environmental Protection Agency, Noise from Construction Equipment and Operations. Building Equipment and Home Appliance. NJID. December 31, 1971

- The liquid effluents generated during the construction phase will include domestic sewage and grey water from the camp operation.
- The sewage will be treated in septic tanks and soaking pits.
- The storm water will be collected in ponds and either disposed of after appropriate treatment, or diverted to fields for vegetation, and rejuvenation of local flora.

5.2.3.4. *Gender and Social Issues*

The construction site and construction camp will be located outside the community settlements of Haji SulemanBrohi Village, thus eliminating any impact on the women of the area. The vehicular traffic on the local roads can potentially pose low level of adverse impact on the women of the area.

Mitigation Measures

- Construction crew will avoid entering villages and settlements.
- Local norms will be respected
- Communities will be informed and consulted before commencing the site works.
- Strict adherence to EMP and IFC's EHS Guidelines as well as code of conduct will be maintained by the construction crew.

- Environmental monitoring during the project execution will ensure compliance with the above mitigation measures and their adequacy, as well as significance of any residual impacts.

5.2.3.5. *Child Labor*

Although the use of child labor is not prevalent in the construction works such as those involved in the proposed project, yet the provisions of the Child Labor Act will be made part of the construction contracts, in order to ensure that no child labor is employed at the project sites or campsites.

5.2.3.6. *Cultural Heritage and Archaeological Issues*

There is no prominent cultural or archaeological feature in or around the NTWF Project site. Jhimpir has some unrecognized sites of historical and religious significance but they are at least 10 km from proposed wind farm site.

Mitigation Measures: The recommended procedure will be followed during site excavation for construction at the site, which requires that if artifacts of significance are found, the finding will be immediately reported to the Department of Archaeology, Sindh.

5.2.3.7. *Flora*

Trees and shrubs (Indigenous Germplasm): One of the main causes of depletion of rangeland and desertification of the land in the microenvironment is the practice of cutting and uprooting trees and shrubs for use as fuel by the rural population because wood is the principal source of available energy, and the dead wood resulting from scarcity of rainfall, is also cash crop.

Mitigation Measures: The trees are a valuable resource and are essential for sustaining the biodiversity of this fast degrading land. The Project will promote the program for protection of the indigenous plants and replant them if necessary.

5.2.3.8. *Fauna*

There is no Wildlife Reserve in close proximity of Project site. Low frequency of visits of a small number of mammals, birds, and reptiles leads to the conclusion that biodiversity of the area has been substantially reduced. Indian Monitor lizard (Varanus bengalensis) Wadhi Go/Gioh (reported but not spotted), and Monitor lizard (Varanus griseus) were neither reported nor spotted during the surveys for this study. The spiny-tailed lizard (Uromastix hardwickii) Sandha is in abundance. All sand mounds in the area have burrows of the sandhas. With extensive wood cutting the mounds are also getting flattened and despite their being protected by the locals they are getting endangered.

Mitigation Measures: The NTWF Project will require land clearance for siting the WTGs. The Project site itself is stony wasteland and has only few mounds at the site that hosts the sandhas. Contractors will be required to commit to protect them and not to disturb the mounds but if necessary, the lizards will not be trapped but scared away. They usually find an alternative hole in the surrounding when scared. Commitment to protection of the lizards and other reptiles will be the mitigation measure employed to save the animals during construction.

The sandhas will soon find other holes and get rehabilitated. These reptile species are scared by movement of mechanical systems or men and animals. Wind turbines and movement of rotors will be at hub height of ~90 m, while movement of personnel would be around the WTGs that would be sited approximately 400 m apart. Thus it is less likely that the sandas will be disturbed if they continue to remain in the microenvironment of the WTGs.

Birds: The impact of establishment of windfarms on birds may be in two broad categories:

- Impact due to construction
- Impact during operation due to bird collision

The first deals with the clearance of vegetation over a small area for each WTG, disturbance due to incoming machinery and installation of the huge wind turbines. It is important to note that high aridity due to drought conditions has since reduced the richness of biodiversity of the site, and is no longer supporting bird or mammalian population. The population of the birds is also quite thin. These birds will migrate and as observed from the field survey, but being accustomed to the area, may return though infrequently.

The second category deals with collision of birds with the Wind Turbine blades. It is important to note here that no bird of importance has been documented for the area in the literature nor identified during the field survey.

Studies undertaken throughout the world have shown that WTGs on land based wind farms do not pose any substantial threat to birds and other wildlife. Risks of birds colliding with WTGs are much lower than with communication towers, high tension wires, vehicles, and are the highest with buildings and windows.

The NTWF Project site does not have habitat of the concerned high flying birds including kites, vultures, and falcons or the Houbara bustard (Tiloor), which is in the IUCN Red List as low risk, near threatened.

Mitigation Measures: NTWF Farm Project site is stony wasteland degraded further by removal of trees, sand, gravel and stone. As such the area offers no attraction to the falcons or other high flying birds for habitation, nor to the migratory birds which do not find an aquatic environment to land. The falcon or other high flying birds found in the microenvironment are those that stray in. The Environmental Management Plan will include monitoring the number of such birds flying in during the pre-construction period and also their mortality in case they fly in.

The possibility of the noise-sensitive falcons flying into the wind turbine structures will be substantially lowered by the siting of seven wind farms in a row at Jhimpir. The cumulative effect of such siting would inhibit the high flying birds from flying into or landing in the Jhimpir Wind Corridor. The wind corridor is not on the fly way of the wintering birds and also not a habitat for the falcon or Houbara bustard. NTWF Project site will not contribute to birds being inhibited in flying in or landing in the wind corridor.

The noise level of about 95 to 105 dB(A) is even otherwise sufficient to scare the high flying birds. The movement of the rotors at 12 to 15 rounds per minute is not so brisk as to entangle a bird easily. The EMP will include monitoring the incidence of such birds straying in and the number of birds killed or injured.

5.2.4 Screening of Potential Environmental Impacts at Operation Stage

Operation of NTWF Project at the proposed site would start as soon as the wind turbines and substations are in place, and the system starts to produce power. Environmental problems identified at the operations stage relate to the following aspects:

- Air quality and noise level changes due to operation of fleet of trucks, container trucks and operation of mechanical equipment.
- Visual Effects
- Noise Effect
- EMI Effects
- Flicker Effects
- Cultural Heritage and Archaeological Issues
- Flora
- Fauna (Wildlife, Birds)
- Recreational and Tourism Issues
- Operation of NTWF Project would not release air pollutants into the airshed, and wastewater will be discharged into soak pits after treatment.
- Diesel and other petroleum products used for the operation of mechanical equipment and transportation vehicles would cause air pollution besides causing soil pollution through oil spills. The impact from such activity would be of minor significance and would be controlled by good housekeeping practices.

Mitigation Measures: The induced impact on operation of the appropriately sited wind turbines on the microenvironment will be monitored through Environmental Management Plan (EMP) and IFC's HSE Guidelines on Wind Energy 2007, and mitigated, if necessary by adoption of suitable measures to minimize the impact of Visual effect, Noise effect and Flicker effect on the microenvironment as well as macroenvironment.

5.2.4.1. Noise Effect

- The rotor blades of the wind turbines are the main source of noise during the operation phase of the wind power plants.
- The study of noise data for a wind power generation plant of similar size and using the same turbines in the same microenvironment shows that the noise levels generated by the wind farm drop down to 35-40 dB(A) range within a distance of about one kilometer from the plant.
- The emergency generator, if installed at the site, will also generate noise of high level. However, much like the noise generated by the wind farm, its impact on the communities will be negligible, in view of the large distance.

- Advances in turbine technology and design have resulted in reduced noise emissions. Aerodynamic refinements that have combined to make turbines quieter include the change from lattice to tubular towers, the use of variable speed operations, and the switch to 3 blade turbine designs. Improvements in gearbox design and the use of anti-vibration techniques in the past ten years have resulted in significant reductions in mechanical noise. The most recent direct drive machines have no high-speed mechanical components and therefore do not produce mechanical noise.

Mitigation Measure

- No mitigation measure is necessary. The staff will be provided with the personnel protective equipment (PPE).
- The proponent may seek evidence that the type(s) of turbines proposed will use best current engineering practice in terms of noise creation and suppression.
- Noise mapping study is recommended at the detailed design stage.

5.2.4.2. Shadow Flicker and Blade Glint

Shadow flicker occurs when the sun passes behind the wind turbine and casts a shadow on the immediate neighborhood. As the rotor blades rotate, shadows pass over the same point causing an effect termed shadow flicker. Shadow flicker may become a problem when residences are located near, or have a specific orientation to, the wind farm. Similar to shadow flicker, blade or tower glint occurs when the sun strikes a rotor blade or the tower at a particular orientation. This can impact a community, as the reflection of sunlight off the rotor blade may be angled toward nearby residences. Blade glint is not a concern for new turbines as matt finish paint is now being used which does not produce the glint effect.

According to the report of Chief Medical Officer of Ontario in May 2010: Shadow flicker occurs when the blades of a turbine rotate in sunny conditions, casting moving shadows on the ground that result in alternating changes in light intensity appearing to flick on and off. About 3 per cent of people with epilepsy are photosensitive, generally to flicker frequencies between 5-30Hz. Most industrial turbines rotate at a speed below these flicker frequencies.

Careful site selection, design and planning, and good use of relevant software, can help avoid the possibility of shadow flicker in the first instance. It is recommended that shadow flicker at neighboring offices and dwellings within 500m should not exceed 30 hours per year or 30 minutes per day. [9]At distances greater than 10 rotor diameters from a turbine, the potential for shadow flicker is very low.

Careful site selection, design and planning, and good use of relevant software, can help avoid the possibility of shadow flicker in the first instance. Proponent will provide calculations (application of Windpro Software) to quantify the effect and where appropriate take measures to prevent or ameliorate the potential effect, such as by turning off a particular turbine at certain times.

[9] The shadow flicker recommendations are based on research by Predac, a European Union sponsored organization promoting best practice in energy use and supply which draws on experience from Belgium, Denmark, France, the Netherlands and Germany.

5.2.4.3. *Wildlife*

The project site and its immediate vicinity do not provide habitat to any terrestrial or avian faunal species, nor is it located along or under the route of migratory birds. The endangered Houbara bustard found in the macro environment, and the highflying falcons are only few in number. The number of the few that visit the site and also their mortality will be recorded during the pre-construction period. High noise levels scare these noise sensitive bird species and the falcons, eagles and high flying birds would be scared off by the scores of WTGs lined up at the NTWF Project site in the Jhimpir Wind Corridor.

Regarding the chances of avian collision with turbines, no such instances have been reported so far. There is a need to study bird behavior and characteristic in these areas which makes it necessary to undertake periodic bird counting and maintaining of records.

Mitigation measures

- Environmental Management Plan (EMP) will be effectively implemented to keep the interventions in the Jhimpir ecosystem well within prescribed limits. Contractors will be mandated to adopt the EMP in letter and spirit and strictly follow IFC's HSE Guidelines.
- The project staff will not be allowed to indulge in any hunting, trapping or harassment activities.
- Turbine arrays will be appropriately configured to avoid potential avian mortality (e.g. group turbines rather than spread them widely or orient rows of turbines parallel to known bird movements);
- EMP will include increasing the visibility of towers and rotor blades to birds by using uniform colors and flashing rotor lights especially during migration;
- A record of bird casualties will be maintained and reviewed at the end of every month.
- The environmental monitoring and strictly following IFC's EHS Guidelines during the project execution will further ensure compliance with the above mitigation measures and their adequacy in dealing with significant residual impacts.

5.3 Economic Assessment of Potential Environmental Impacts

5.3.1 Environmental Benefits of Wind Farm Development

Significant environmental benefits will be gained by establishment of the NTWF Project. Developing the renewable energy resource would, besides proportionately lessening the need to use fossil fuels such as imported fuel oil, or gas, complement the GoP efforts in increasing the power production capacity. Substantial reduction in gaseous emissions from fuel-fired generation will be achieved, although the amount would depend on the wind farm installed capacity.

5.3.2 Saving on Emissions

Utilizing wind power is among the cheapest methods of reducing CO_2 emissions in electricity production. According to a Danish study, a 100 MW offshore wind farm will reduce CO_2

emissions by almost 0.3 million tons per year, when substituting power from conventional coal fired power plants. The costs will be approximately US$ 5 per ton of CO_2 for offshore wind farms situated near the coast.

CO_2 emission is not the only gas of concern in terms of global warming. Others include water vapor (Humidity) NOx, and VOCs have synergistic effects in retaining the thermal component of solar energy. The following indicative figures are based on the estimates that a 100 MW installed capacity power plant using fossil fuel produces 1 kg of CO_2 for generation of each 1 kWh of electricity. Accordingly the 50 MW capacity power plant based on fossil fuel would produce:

- CO_2 (a major contributor to the "greenhouse effect"): 310,000 tonnes/year
- SO_2 (Sulphur Dioxide a constituent of acid rain): 4,750 tonnes/year
- NOx (Nitrous Oxides a constituent of acid rain): 2,300 tonnes/year
- Thus NTWF Wind Power Generation Complex will
  - ✧ Prevent emission of an amount equivalent to 310,000 tonnes CO_2, 4,750 tonnes SO_2, and 2,300 tonnes NOx annually
  - ✧ Add as much value as the saving on CO_2 to the wind whose potential has so far remained neglected in the country.
  - ✧ Help the government environmental initiatives in:
  - ✧ Augmenting the power production capacity in the country, and
  - ✧ Lowering the emission of greenhouse gases.

The following matrix evaluates the severity of impact from different activities:

Actions Affecting Environment Resources & Values	Damage To Environment	Recommended Mitigation Measures	Significance of Impact			
			None	**Small**	**Medium**	**Major**
A. Environmental Problems due to Siting/ Location of Project						
1.Changes in hydrology affecting existing land values	1. Damages to land by erosion and/or accretion	1.Careful design and planning to minimize/offset problem	√			
2. Changes in drainage pattern	2. Damages due to change in flooding, accretion, erosion hazards	2.Careful design to minimize/offset problem	√			
2a. Obstruction in Water Flow	2a Conflicts with other beneficial water uses	2a.Appropriate sharing of water with KWSB Filter Plant	√			
3. Changes in land uses	3. Possible loss in overall regional welfare	3. Careful planning & Implementation of IFC's HSE		√		

Actions Affecting Environment Resources & Values	Damage To Environment	Recommended Mitigation Measures	Significance of Impact			
			None	**Small**	**Medium**	**Major**
		Guidelines				
4. Encroachment into precious ecological zones	4. Loss of precious ecology	4. Careful planning & Implementation of IFC's HSE Guidelines		√		
5. Resettlement	5. Displacement of local population	5. Adequate attention to local problems			√	
6. Historical/monuments/cultural values	6. Loss of precious values	6. Careful planning to minimize/offset problem	√			
7. Environmental aesthetics	7. Loss of environmental aesthetics	7. Careful planning		√		
B. Environmental Problems due to Inadequate Design						
1. Unrealistic assumptions on available O & M skills	1. Unnecessary damages because O&M requirements too high	1. Realistic O&M assumptions & Implementation of IFC's HSE Guidelines		√		
2. Pollution Control Equipment Selection	2. Assumed pollution removals not realized	2. Appropriate equipment selection	√			
3.Environmentalpollution control operations	3. Possible loss in overall regional welfare	3. Careful planning/ designing / monitoring and use of appropriate standards	√			
3a. Surface water	3a. Impairment of downstream beneficial water uses	3a. Careful Management of Resources	√			
3b. Groundwater.	3b Impairment of beneficial water uses	3b. Careful Management of Resources	√			
3c. Air	3c. .Impairment of air quality	3c. Careful Management & monitoring	√			
3d. Noise	3d. Environmental Degradation & Health hazard	3d. Careful planning & monitoring		√		
4. Impacts on adjacent land economic users including recreation/tourism	4. Impairment of land uses	4. Careful planning/O&M		√		
5. Occupational health & Safety hazards	5. Hazards to workers health & safety	5. Effective implementation of EMP & IFC's HSE Guidelines to		√		

Actions Affecting Environment Resources & Values	Damage To Environment	Recommended Mitigation Measures	Significance of Impact			
			None	**Small**	**Medium**	**Major**
		offset problem				
6. Hazards due to Spills/fires/explosions	6. Hazards to workers health & safety	6. Effective implementation of EMP & IFC's HSE Guidelines		√		
7. Area sanitation	7.Sanitation/disease hazards	7. Careful planning/design		√		
8. Hauling routes in/out areas	8. Traffic congestion and nuisances along routes	8. Effective implementation of EMP			√	
C. Environmental Problems During Construction Stage						
1. Problems due to uncontrolled construction practices	1. Problems of Environmental Degradation	1. Careful Planning and Implementation of EMP & IFC's HSE Guidelines		√		
a) runoff erosion	(a) Problems of Environmental Degradation	a) Careful Planning and Implementation of EMP		√		
b) worker accidents	b) Problems of Environmental Degradation	b) Careful Planning and Implementation of EMP		√		
c) sanitation disease hazards	c) Problems of Environmental Degradation	c) Careful Planning and Implementation of EMP		√		
d) insect vector disease hazards	(d) Problems of Environmental Degradation	d) Careful Planning and Implementation of EMP & IFC's HSE Guidelines		√		
e) hazardous material handling	(e) Problems of Environmental Degradation	e) Careful Planning and Implementation of EMP& IFC's HSE Guidelines		√		
f) dust/odors/fume	(f) Problems of Environmental Degradation	f) Careful Planning and Implementation of EMP & IFC's HSE Guidelines			√	
g) explosion/fire hazards/hazardous materials spills	(g) Problems of Environmental Degradation	g) Careful Planning and Implementation of EMP & IFC's HSE		√		

Actions Affecting Environment Resources & Values	Damage To Environment	Recommended Mitigation Measures	None	Small	Medium	Major
		Guidelines				
h) noise/vibration hazards	(h) Problems of Environmental Degradation	h) Careful Planning and Implementation of EMP& IFC's HSE Guidelines		√		
i) traffic congestion	(j) Problems of Environmental Degradation	j) Careful Planning and Implementation of EMP & IFC's HSE Guidelines		√		
k) water pollution hazards	(k) Problems of Environmental Degradation	k) Careful Planning and Implementation of EMP & IFC's HSE Guidelines		√		
l) blockage of wildlife/birds passageways	(l) Problems of Environmental Degradation	l) Careful Planning and Implementation of EMP & IFC's HSE Guidelines			√	
2. Uncovered cut & fill areas	2. Soil erosion & consequent damage to properties & environment	2. Careful Planning and Implementation of EMP & IFC's HSE Guidelines		√		
2. Inadequate construction monitoring	2. Encourages poor construction practices	2. Adequate monitoring during construction and Implementation of EMP & IFC's HSE Guidelines		√		
D. Environmental Hazards Relating to Operations (assuming proper design assumptions on O&M)						
1. Inadequate O & M	1.Varietyof environmental degradation similar to items B.1 to 8	Adequate monitoring during Operation and Implementation of EMP & IFC's HSE Guidelines		√		
2. Inadequate operations phase/environmental monitoring	2. Opportunity loss for feedback connections to project design and	Adequate monitoring during Operation and		√		

Actions Affecting Environment Resources & Values	Damage To Environment	Recommended Mitigation Measures	Significance of Impact			
			None	Small	Medium	Major
	O&M	Implementation of EMP & IFC's HSE Guidelines				
3. Occupational Health & Safety Programmes including accidents	3. Hazards to workers health & safety	Adequate monitoring during Operation and Implementation of EMP & IFC's HSE Guidelines		√		
4. Nuisance from handling & Transportation of fuels on access roads	4. oil drips, spills, dust & noise hazards	Adequate monitoring during Operation & Implementation of EMP		√		
5. Surface run off from plant yard	5. leakage of fuel on ground & oil drips	Adequate monitoring during Operation & Implementation of EMP		√		
E. Critical Environmental Review Criteria						
1. Loss of irreplaceable resources	1. Long-term national environmental and economic losses	1. Planning should be consistent with high-level government policies		√		
2. Accelerated use of resources for short term gain	2. Long-term national environmental and economic losses	2. Planning to be consistent with polices		√		
3. Endangering of species	3.Long-term environmental losses	3. Planning to be consistent with polices 3a. Effective implementation of EMP & IFC's HSE Guidelines		√		
4. Promoting undesirable rural-urban migration	4. Intensification of urban socioeconomic problems	4. Planning to be consistent with polices		√		
5. Increase in affluence/poor income gap	5. Intensification of national socioeconomic imbalances	5. Planning to be consistent with polices			√	
F. Potential Environmental Problems During Operation						
1. Removal or damage to	1. Problem at	1. Careful		√		

Actions Affecting Environment Resources & Values	Damage To Environment	Recommended Mitigation Measures	Significance of Impact			
			None	**Small**	**Medium**	**Major**
vegetative growth	preparation of site & during operation	implementation of EMP & IFC's HSE Guidelines				
2. Land Use Changes	2. Problem at preparation of site & during operation	2. Careful implementation of EMP& IFC's HSE Guidelines		√		
3. Micro level changes in the human settlements	3. Problem at siting & Operation stage	3. Careful implementation of EMP & IFC's HSE Guidelines		√		
4. Industrial & Transportation Activities	4. Problem at Operation Stage	4. Not envisaged Careful implementation of EMP including Traffic Management & IFC's HSE Guidelines	√			
5. Emergence of Slums & Wayside Commercial Activity	5. Problem at Construction & Operation Stage	5. Not envisaged Careful implementation of EMP		√		
G. Impacts from power Transmission facilities						
1 Environmental health hazard due to electromagnetic radiation	1. Unnecessary exposure of workers to environmental hazards.	Careful planning, training of workers		√		
2. Depreciation of environmental aesthetics	2. Loss of values	2. Careful planning & implementation of EMP& IFC's HSE Guidelines		√		
3. Encroachment on ecosystem	2. Loss of precious ecology	2. Careful implementation of EMP& IFC's HSE Guidelines		√		
			11	37	**4**	

Overall Rating of Significance of Impact:

Minor Significance

Impact Confined to Microenvironment

Chapter 6 Environmental Management Plan

This section provides an approach for managing environment related issues and describes the institutional framework for environmental management and resource allocations to be carried out by Project Proponent for mitigating the negative impacts during project execution and operation phases.

Environmental management and monitoring is mandatory activity to be undertaken by the administration over the entire project cycle showing its commitment towards meeting environmental regulations / standards and good house keep practices as well as maintaining health and safety standards. In particular in water treatment projects, it not only requires regular monitoring but also adopting measures for conserving the project affected environment during design, construction as well as operation phase of the project assuring that the quality of the environment is maintained.

EMP is a dynamic and a live document that is under constant review having periodic revisions and may be updated as required. Any amendments in the procedures, information are notified to the concerned personnel after the approval from the competent authority for subsequent implementation.

It is important to remember that the main aim of producing an EMP is to improve environmental outcomes. The EMP needs to be communicated to appropriate staff and implemented.

6.1. Objectives of Environmental Management Plan

The EMP will help Project Proponent / Designer and EPC Contractor in addressing the adverse environmental impact of the Project, enhance project benefits, and introduce standards of good environmental practice. The primary objectives of the EMP are to:

- Facilitate owner/project sponsors corporate policy on environment
- Define the responsibilities of project coordinators, contractors and other role players and effectively communicate environmental issues among them.
- Facilitate the implementation of mitigation measures identified in the IEE by providing the technical details of each project impact, and providing an implementation schedule.
- Define a monitoring mechanism and identify monitoring parameters to ensure that all mitigation measures are completely and effectively implemented.
- Ensure that after completion of Project, restoration of site and rehabilitation work will be carried out
- Required equipment and human resources for environmental monitoring and meeting contingency plan objectives are in place and personnel are trained to meet accidents and emergencies

6.2. Scope of EMP

This Environmental Management Plan has provided detailed strategy to be implemented for achieving improved environmental performance in the following areas:

1. Environmental Management
2. Water Usages and Disposal
3. Recycling and Waste Management
4. Storm Water Management
5. Pollution Prevention/Environmental Risk Assessment
6. Bio-Diversity
7. Energy Management
8. Transport
9. Community Awareness

6.3 Components of EMP

The EMP consists of the following components:

1. Legislation and Guidelines
2. Organizational Structure and Responsibilities
3. Mitigation Plan
4. Environmental Monitoring Plan
5. Emergency Response and Contingency Plan
6. Communication and Documentation
7. Change Management

6.4 Legislation and Guidelines

The IEE for Wind Power Generation has discussed national and international legislation and guidelines that are relevant to the project. Project Proponent will ensure that the key project management officials and staff and all its assigned and associated consultants and contractors are aware of these legislations and guidelines prior to the start of the project activities.

- EIA/IEE Regulation: The project will be conducted in conformance with EIA/IEE regulation and relevant international conventions and that guidance is sought from national and international guidelines. An independent monitoring consultant will be appointed for the project.
- NEQS Requirements: The NEQS for industrial gaseous emissions, Motor Vehicle Emissions and Noise levels, and Industrial and Municipal effluents will be followed throughout the project activities and operation.

- Protection of Wildlife & Endangered Species: The Wind Corridor in Thatta taluka is wasteland having few trees on its area and hence offers no attraction for habitation to the falcons or other highflying birds of concern to the project. As such they are only occasional visitors to Jhimpir Wind Corridor. It will be necessary to monitor the number and type of visiting bird species including the falcons, eagles and black kites during the pre-construction and subsequent stages of the project.

6.5. Organizational Roles and Responsibilities

Project Proponent / EPC Contractor shall have its own Environmental Management System EMS to ensure the implementation of EMP and Health and Safety Issues during construction and maintenance.

The environmental management responsibilities will be assumed by its Project Manager and his team members during construction and operations phase to:

- Coordinate with relevant government departments
- Identify and report changes in activities and services that may create new environmental aspects
- Collect and coordinate information regarding environmental aspects, and maintain records related to environmental aspects and their impacts
- Ensure construction work is carried out in an environmentally sound manner by the Contractor by incorporating environmental compliance by appropriate provision in the construction contract

EPC Contractor will ensure compliance with the environmental management plan by way of training of construction crews in all aspects of implementation of EMP.

6.5.1. Roles and Responsibilities

6.5.1.1. Roles & Responsibilities of the Project Proponent

- Prior to commencing construction, all necessary environmental permits, consents, permissions, reporting obligations to the regulatory entities, and any other authorizations have been obtained. All such documentation shall be available in the site EHS files.
- Submit project environmental management plan to Environment Ministry for approval.
- Provide special training to main contractors / subcontractors on environmental management plan of this project.
- Guarantee necessary legal consult and assistance concerning EHS during the project, and coordinate with Health, Safety and Environment Authority for settlement of EHS business.
- Review and approve EHS plan and relevant files and supervise site work conducted by contractor and subcontractors during the project.
- There should be a smooth communication on EHS business between Proponent and Contractor and assistance to subcontractor(s) if necessary.

6.5.1.2. Roles and Responsibilities of EPC Contractor

- Comply with applicable EHS legal requirements, the rules, regulations of Pakistan, provisions for environment management plan of this project.
- Be responsible for the safety and health of Contractor staff, and provide necessary training and personal protective equipment to them.
- Issuing subcontractors EHS manage orientation, translating the requirements of the site EHS plan into the subcontractors' requirements and monitoring the implementation of these requirements by means of inspections.
- Review any aspect of the subcontractor's EHS program, plans or activities shall not relieve the subcontractors of their obligation to fully meet the requirements of applicable law and these requirements.
- Hold Proponent/EPCC/Subcontractor's weekly EHS meetings, analyze and summarize EHS business of last week, arrange EHS work of next week.
- Coordinate with Contracting Party the entrance and exit from the Site in order to reduce to a reasonable minimum the interruption of the Work and traffic surrounding the area where Work is being performed.
- Conduct site internal Audits and Assessment among subcontractors, in accordance with the contract and environment management plan.
- Organize, implement and maintain an Emergency Response Plan and Organization to ensure a full and proper performance to safeguard their employees and property in case of emergency. Emergency Response Plan should be drilled regularly.
- Stop any work or activity that violates occupational health, safety of employees and surrounding environment until it has been fully corrective.
- Investigate and analyze accidents, incidents and occupational diseases, in order to identify the root causes and take corrective and preventive actions aimed at preventing the occurrence of similar events.

6.5.1.3. Roles and Responsibilities of Contractor/Subcontractor

- All Contractors/subcontractors will be responsible for carrying out all activities in a manner, which minimizes impact to the environment, occupational health and safety, and adherence to all provisions of the site EHS plan and environment management plan. The Principal subcontractors will be responsible for identifying and communicating all requirements to their Subcontractors and employees.
- Comply with applicable legal rule and regulation in the field of EHS of Pakistan and provisions of EHS plan and environment management plan.
- Guarantee the safety and health of their employees, visitors, contractor, subcontractors and other persons entering construction site by issuing high risk job instructors.
- Identify measure, evaluate, prioritize, correct and/or control all risk factors present in the process of the project and design a strategy for the development and implementation of preventive measures.

- Inform workers about risk factors arising in the execution of their work and EHS rules to follow to prevent the occurrence of work accidents or occupational diseases.
- Provide financial resources necessary for the normal performance of preventive and corrective activities to be planned in the organization.
- Attend Proponent/EPCC/Subcontractor's weekly EHS meetings, and analyze and summarize EHS business of last week, formulating recommendations for corrective / preventative actions.
- Ensure that only those workers who are qualified and have received adequate training, have access to high-risk areas.
- Maintain service in good facilities, machines, tools and materials for safe work.
- Provide, without cost to the worker, clothes and appropriate personal protective equipment. Use, care and maintain in good condition all of personal protective equipment provided to them.
- Comply with compulsory of noise level standard established in the environmental legislation of NEQS
- Carry out necessary repairs, reconstructions, corrections and/or replacements of the Work, Works, Equipment and Materials at subcontractors' own costs and expenses if they can't meet the safety, environment and health standard of owner's Provisional Reception after Mechanical Completion
- Subcontractor shall furnish transportation, housing, food, clothing, tools, supplies, furniture and other necessary facilities to its personnel in order to perform this Contract.
- Promote the good conduct of reasonable measures to prevent any disturbances, protests, fights or any similar inappropriate conduct among personnel, and to preserve peace and protection of persons and properties in areas near the Site. Contractor/Subcontractor shall immediately and permanently expel from the Site any such persons who are involved in that kind of activities.
- Subcontractor shall furnish the necessary means for proper protection of their personnel, the Works and the Equipment, including, without limitation:
    a. obligation to use personal protection devices;
    b. organization of any Work performed from heights, or in places containing welding gases, etc.;
    c. order and cleanness during the Work;
    d. security in accesses, roads, service paths, catwalks, railings, scaffolds, etc.;
    e. security in electrical and lighting installations;
    f. security in ancillary facilities, compressed air installations, welding equipment, storage of gas bottles, etc.;
    g. security in hoisting equipment;
    h. first-aid organization and ambulance services.

- In all excavation, fill, and blasting, the Subcontractors shall take precautions to avoid adverse impacts to workers' safety and the property adjacent to site boundary of the work, so as not to disrupt the rights of way, transit, services public and others.

- Subcontractor shall provide all security devices to their Personnel and any visitors entering the Site. Personal protection elements that are obligatory for their Personnel and furnished by subcontractor depending on the workers' location, without being limited to, are the following:
    a. Work clothes;
    b. safety shoes;
    c. hard hats;
    d. headphones;
    e. gloves;
    f. eye protection;
    g. safety belts,
    h. air quality.
- Buy the necessary insurance for their employees and facilities on jobsite, according to requirements of contractual items.
- Maintain a system for recording and reporting of accidents, incidents and occupational diseases and the results of risk assessments and proposed control measures, which have access record to EPCC.
- Within the Site, subcontractor shall adopt and comply with all rules and regulations regarding fire or explosions established in the Applicable Laws and those designated by Contracting Party and duly notified to subcontractor.
- Prohibit or halt the work in which they warn imminent risk of accidents, because it is not possible to use appropriate means to avoid them.
- Apply with necessary risk factors identifying signs or banners at the site.
- All accidents and incidents that occur at the jobsite should be reported to EPCC and the owner at first time, attending accident investigations, analyzing causes, and formulating recommendations for corrective/preventative actions.
- Organize, implement and maintain an Emergency Response Plan and Organization to ensure a full and proper performance to safeguard their employees and property in case of emergency

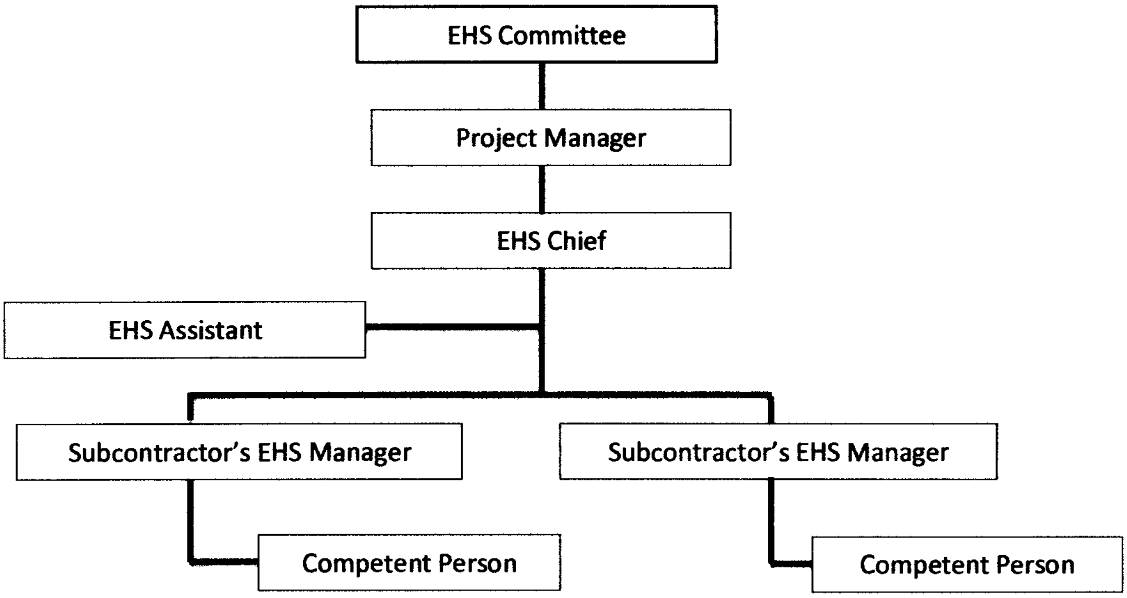
EPCC will ensure compliance with the environmental management plan by way of training of construction crews in all aspects of implementation of EMP.

6.6 EHS Committee

EPCC will establish an EHS committee for the Project as the authority department which settles for safety, occupational health and environment business during the course of project duration period. EHS committee will strive to accomplish project objectives, applicable rules and regulations of Pakistan.

EHS committee is composed of EPCC project manager, EHS Chief. EHS Assistant, chief principals of all subcontractors and specialized departments. Project manager serves as the chairman of committee. EHS responsibilities for specific positions are described in the following subsections.

The EPCC EHS Organizational Framework of the Project is as below:



6.6.1. Roles and Responsibilities

6.6.1.1. Project Manager

- Ensure adequate and suitable resources are allocated to the project to enable the project to be completed, designating qualified persons to cooperate with business unit of the project while complying fully with the requirements of this EHS Plan, and all applicable regulatory requirements.
- Ensure that any subcontractors have received a copy of this EHS plan before they submit a work plan at the jobsite.
- Coordinate all EHS activities with owners and other subcontractor on the project site.
- Issue a work stoppage directive where conditions exist which Immediately Dangerous to Life or Health (IDLH) is damaging to the environment.
- Support or participate in the investigation of all accidents and reportable occurrences.

6.6.1.2. EHS Chief

- The EHS Chief will have overall responsibility for the environmental performance of the project and will ensure that all operations comply with EPCC Environmental Policy and all relevant regulatory requirements.
- Ensuring implementation of this project EHS plan and compliance with rules and regulations of the Project to all personnel of contractor(s)/subcontractor(s) on site.
- Support or participate in the investigation of all accidents and reportable occurrences in order to identify the root causes and take corrective and preventive actions aimed at preventing the occurrence of similar events.

- Ensure adequate facilities, procedures and trained personnel are available for all foreseeable emergencies.
- Where applicable, ensure periodical EHS Inspections are conducted and keep document.
- Attend Owner/Contractor/Subcontractor's weekly EHS meetings, and analyze and summarize EHS business of last week, arrange EHS work of next week.
- Conduct site internal Audits and Assessment among subcontractors, in accordance with the contract and environment management plan.
- Be responsible for the safety and health of EPC Contractor staff, and provide necessary training and personal protective equipment to them.

6.6.1.3. EHS Assistant

- Draft the site EHS plan and assist the EHS Chief in implementing the Site EHS Plan.
- Ensure implementation of the provisions of the project, including training, development and revision of procedures, and periodic auditing of program compliance.
- Attend Owner / Contractor / Subcontractor's weekly EHS meetings, and analyze and summarize EHS business of last week, arrange EHS work of next week, complete memo of meeting for later reference.
- Conduct, or assist with conducting accident investigations, analyzing causes, and formulating recommendations for corrective/preventative actions.
- Liaise with owner, contractor and Subcontractors, health medical services, local fire and police departments, and local regulatory agencies on EHS related matters.
- Verify that all the EHS defects related to subcontractors are rectified and completed according to the owners' requirement.
- Verify that EPCC and each contractor/subcontractor is providing adequate and proper record keeping as required by regulatory agencies and maintaining documentation of EHS training, EHS audits and inspections and occupational safety and health monitoring activities.
- Maintain record keeping for the project and as required by owner and regulatory agencies.
- Conduct site internal Audits and Assessment among subcontractors, in accordance with the contract and environment management plan.

6.6.1.4. EHS Manager of Subcontractors

- The subcontractor's EHS Manager will be responsible for the effective implementation of the mitigation measures during the project by assigning a competent person supervising the execution of this plan.
- Ensuring and documenting adequate environmental training to all personnel. Issuing high risk job instructors, ensuring safety and occupational health of employees, visitors, contractors / subcontractors and other person's entry into the jobsite.
- Supervising execution of financial plan for the normal performance of preventive and corrective activities to be planned in the organization.

- Review qualification and training of workers who have access to high-risk areas.
- Furnish transportation, housing, food, clothing, tools, supplies, furniture, first-aid organization, ambulance services and other necessary facilities to its personnel in order to perform this Contract.
- Keep sufficient first-aid facilities and ambulance services available for its personnel, its Subcontractors' personnel, visitors and other persons at the Site.
- Prohibit or halt the work in which they warn imminent risk of accidents.
- Organize, implement and maintain an Emergency Response Plan and Organization to ensure a full and proper performance to safeguard their employees and property in case of emergency.
- Conduct frequent and regular scheduled safety inspections of construction activities to monitor compliance with applicable rules and regulations and EHS plan.
- Attend Owner / Contractor / Subcontractor's weekly EHS meetings, and analyze and summarize EHS business of last week, arrange EHS work of next week, complete memo of meeting for later reference.
- Conduct, or assist with conducting accident investigations, analyzing causes, and formulating recommendations for corrective/preventative actions.
- Verify that provide adequate and proper record keeping as required by regulatory agencies and maintaining documentation of EHS training, and inspections and occupational safety and health monitoring activities.

6.6.1.5. Competent Person of Subcontractor

- Report to EHS manager unsafe acts/conditions observed on the project site for prompt corrective action to eliminate the unsafe act/condition.
- Ensure all work on site only proceeds when required Job Safety Analysis/Risk assessments have been completed, and reviewed by EHS Chief and communicated to those who can be impacted by the hazards identified.
- Ensure all personnel wear all required personal protective equipment for the environment they are in and the tasks they are performing.
- Attend Owner/Contractor/Subcontractor's weekly EHS meetings, and analyze and summarize EHS business of last week, arrange EHS work of next week.
- Attend accident investigations, analyzing causes, and formulating recommendations for corrective/preventative actions.
- Inform workers about risk factors arising in the execution of their work and EHS rules to follow to prevent the occurrence of work accidents or occupational diseases.
- Maintain a system for recording and reporting of accidents, incidents and occupational diseases and the results of risk assessments and proposed control measures, which have access record to EHS manager.
- Set up necessary risk factors identifying signs or banners at the site.

6.7. Environmentally Sound & Safe Working Procedures

Contractors, sub-contractors and contract workers will be made aware of environmental aspects and Emergency Response Plan prior to commencing the work. Prior to leaving the site contractors, sub-contractors and contract workers will ensure that their work area is in safe position. On emergency call they will report in assembly area. Written procedures or standards will be prepared for all activities, where the absence of such procedures and standards could result in not following HSE policy, the law or the contract.

Safe Working Procedures will be based on the following four aspects of job safety:

- **Safe Place**: Work site will be designed and controls set up to ensure that working environment provides no significant risk to personnel, property and the environment.
- **Safe Equipment**: All equipment for any job, including tools, machinery and protective equipment will be specified and/or designed to ensure that it poses no significant risk to personnel, property or the environment. All equipment will comply with legislative standards for conformity and test.
- **Safe Procedure**: Procedures will be designed for all aspects of the job to facilitate safe use of equipment at the work site to complete tasks with no significant risk to personnel, property or the environment. Design of procedure will be based on step-by-step analysis of the tasks involved (Job Safety Analysis), identification of associated hazards and elimination of control of those hazards. Procedures should allow for work in ideal conditions as well as under aggravating conditions e.g. adverse weather.
- **Trained Personnel**: Suitable job-specific, safety skills and supervision training will be provided to personnel involved in construction and operation activities so that they are able to use the procedure and equipment at the worksite with no significant risk to personnel, property and environment.

Safe Working Procedures will be available to contractors and sub-contractors, who will adopt the relevant labor laws of the country.

6.8. Identification of Environmentally Safe Aspects

EMS will identify Environmental aspects at the initiation of activities at the site with regard to:

- Emissions of fugitive dust and gaseous pollutants from vehicles and equipment,
- Discharges of liquid effluent including oily waste and seepage to land, and water
- Disposal of excavated material and solid waste to land, water and air
- Noise
- Consumption of natural resources and energy
- Emergency releases
- Fauna including high flying/straying birds, and Flora.

6.9. Environmental Assessment of Safe Procedures

After identifying the environmental aspects, the related impacts will be assessed and the significance of each issue will be evaluated. Following aspects will be identified for evaluating the impacts:

- Parts of microenvironment impacted
- Parts of macroenvironment impacted
- Whether the impact is beneficial or damaging
- Severity of impact
- Frequency or likelihood of impact
- Existing mitigation measures
- Adequacy of mitigation measures
- Concerns of stakeholders/interested parties
- Regulatory requirements and their compliance

6.10. Impact rating

Impact rating will be assessed for each identified aspect to determine the significance as small, medium and high intensity or non-significant.

6.10.1. Pre-Construction Phase

Following are likely to be the main activities at pre-construction phase:

- Photographs of the project area will be taken for recording current status of environment to compare with alterations introduced by the Project
- Monitoring disturbance or alterations in the natural drainage of NTWF Project land, and soil erosion, if any
- Number of approach routes to different facilities over the wind farm and the substations will be minimized
- Use of horns will be avoided
- Soaking pits for waste water from campsites will be constructed and hazardous waste from these pits will be treated during rehabilitation and restoration phase
- Leakages and drips from operating vehicles and equipment will be attended to immediately; vehicles with leaks will be restrained from operation at the site. All vehicles will carry fire extinguishers

6.10.2. Environmental Aspects of Construction Activity

Construction activities for establishment of NTWF Project would likely include the following main elements:

- Location of campsite and field construction office
- Land clearance

- Construction of site roads, turn-around areas and crane pads at each wind turbine location
- Construction of turbine tower foundations and transformer pads
- Installation of electrical collection system – underground and some overhead lines
- Assembly and erection of wind turbines
- Construction and installation of substations
- Plant commissioning and energizing

The above activities would likely entail the following issues that may have impact on the environment and require adoption of mitigation measures during the implementation phase:

- Heavy weight and/or long trucks haulage
- Surface sealing (WTG foundations)
- Topsoil removal
- Compressing of topsoil
- Fuel storage
- Concrete production
- Waste disposal
- Dust emission
- Construction related noise
- General conditions of construction site (visual)
- Disturbance of fauna, including reptiles and resident birds
- Impact on flora
- Emergency response
- Site rehabilitation.

6.10.3. Potential Impact of Construction Activity & Mitigation Measures

Construction at the proposed site of Wind Farm would not involve extensive land preparation and the likely impact will be minor and not significant on the microenvironment that has currently insignificant land use, while Haji Suleman Village is outside the Project site.

- Site preparation activities would include clearing, excavation, earth and fill movement; transportation of towers, rotors, wind turbine sets and associated equipment to the site. The said activities will lead to soil erosion resulting from removal of topsoil at the site, but to improvement of its quality. The fugitive dust emission would be extensive because of aridity of the soil. Dust emission due to other materials of construction will be controlled through appropriate measures to reduce the level of impact to minor significance.
- Temporary disturbance to the landscape will be limited to the microenvironment during construction at site, turn-around areas and crane pads at each wind turbine location; construction of turbine tower foundations and transformer pads; installation of electrical

collection system, including underground and overhead lines; assembly and erection of wind turbines, and construction and installation of substations.

- Formation of internal access tracks, foundation excavations, electrical trenching and other site works may have an impact on Haji Suleman Village especially Dust and Noise. Estimates available from other sites show that 7 - 10% of the project area is temporarily disturbed for road and crane pad construction. At completion of the project, the turbines, access tracks and associated equipment occupying about 1% of the site area, will meaningfully add value to the wasteland. On the other water sprinkling practices and noise attenuation devices will be utilize on the site.
- Co-habitation issues with existing wind farm operations may require assessment and negotiation with landowners.
- Diesel and other petroleum products used for the operation of construction machinery and transportation equipment would cause air pollution besides causing soil pollution through oil spills. The impact from such activity would be of minor significance and would be controlled by good housekeeping practices.
- Water required for numerous construction activities would not be of such order as to result in any significant impact on other beneficial water uses or its reduced availability for functions of villages inside Project land. Conservation practices would nevertheless be adopted during the entire course of construction.
- Noise, visual impact, flicker shadow and shadow impact will be limited to the microenvironment comprising the allotted land.
- No major operational impact is envisaged at the construction stage from the NTWF Project.

6.10.4. Potential Impacts at Operation Stage & Mitigation Measures

Environmental problems identified at the operations stage of NTWF Project relate to:

- Air quality and noise level changes due to operation of fleet of long vehicles, container trucks and operation of mechanical equipment.
- Visual Effects
- Noise Effect
- EMI Assessment
- Flicker Effects
- Cultural Heritage and Archaeological Issues
- Flora
- Fauna (Wildlife, Birds)
- Operation of Wind Farm would not release air pollutants into the airshed, and wastewater will be discharged into the soak pits after treatment.
- Diesel and other petroleum products used for operation of mechanical equipment and transportation vehicles may cause air pollution and also soil pollution through oil spills.

The impact from such activity would be of minor significance and would be controlled by good housekeeping practices.

- Noise emissions from the wind turbines at NTWF Project site will have a high level at the top but the same would attenuate with distance. The noise level at the living areas at more than 500 m or 5 times the hub height will be within acceptable limits of the World Bank Guidelines and the limits recently proposed by Federal EPA.
- 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 500 m or 5 times the hub height outside the Project area in Haji Suleman Brohi Village.
- Daily water requirement at the site during operation and wastewater discharges would not be of such magnitude as to result in any significant impact on other beneficial water uses or its reduced availability for the functions in the villages that are even otherwise outside the operations area of NTWF Project site. Conservation practices would nevertheless be adopted during the entire course of construction.
- Generation of solid and hazardous waste will be of small order and good housekeeping practices will be adopted to reduce their impact.
- 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 straying high flying birds.

Mitigation Plan: Mitigation plan provided in section 6.11 as a key component of EMS lists all the potential impacts of project activities and associated mitigation measures identified in the IEE.

6.11 Environmental Management Programme

The following environmental aspects would require planned intervention by EMS for the Norinco Thatta Wind Farm Project:

NTWF Pr

Project Activity	Potential Hazards & Environmental Impacts	Proposed Mitigation Measures and Residual impact	Institutional Responsibilities & Actions Taken
Site Selection	Land Lease in Jhimpir Wind Corridor Land use, Resettlement of Population Relocation of assets	NTWF Project land in Taluka Thatta is part of the Project. There are no issues relating to existing land use and land tenure or on loss of land, or loss of business. No involuntary resettlement is consequently required and no business is to be considered lost on the land. There is no vegetation on wasteland of NTWF. There are no sensitive assets of concern on the NTWF Project land	*Design Consultant* Accounted for in the Land Lease
	Seismic Activity Changes in sub-soil structure resulting from Location of campsite and field construction office	Allowable bearing capacity to be adopted for Seismic Zone 2A. Temporary disturbance to the landscape that will occur during construction of site roads, turn-around areas and crane pads at each wind turbine location; construction of the turbine tower foundations and transformer pads;	*Design Consultant* Will be accounted for in the Detailed Design

Project Activity	Potential Hazards & Environmental Impacts	Proposed Mitigation Measures and Residual impact	Institutional Responsibilities & Actions Taken
	Construction of internal roads at site, turn-around areas and crane pads at each wind turbine location; Construction of turbine tower foundations and transformer pads; Installation of electrical collection system – underground and some overhead lines; Assembly and erection of wind turbines; Construction and installation of substation	installation of the electrical collection system, including underground and some overhead lines; assembly and erection of the wind turbines, and construction and installation of the substation, will be limited to the microenvironment. Estimates from other sites show temporarily disturbance over 7 - 10% of project area for road and crane pad construction. On completion of project, the turbines, access tracks and associated equipment occupying about 1% of the site area, will meaningfully add value to the wasteland at NTWF. Co-habitation issues with existing wind farm operations will require assessment and negotiation with landowners. Diesel and other petroleum products used for operation of construction machinery and transportation equipment would cause air pollution besides causing soil pollution through oil spills. The impact from such activity would be of minor significance and would be controlled by good housekeeping practices. Water required for numerous construction activities would not result in any significant impact on other beneficial water uses or reduce its availability for functions of villages outside Project area. Conservation practices would nevertheless be adopted during the entire course of construction. Noise, visual impact, flicker shadow and shadow impact will be limited to the microenvironment comprising the allotted land. No major operational impact is envisaged at the construction stage from the NTWF Project.	
	Construction activity induced Changes in Ecology	Land use changes in ecology and Loss of vegetation will be non-issue on the wasteland of proposed NTWF Project. IFC's EHS Guidelines will be strictly followed to minimize changes if any	*Environmental Consultant*
	Construction Activity induced Land Use Changes	Restoration of land after use and Plantation of indigenous Trees	*Environmental Consultant*

Project Activity	Potential Hazards & Environmental Impacts	Proposed Mitigation Measures	Institutional Responsibilities & Actions Taken
	Safety on Access Road, 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	IFC's EHS Guidelines will be strictly followed Incorporation of Safety provisions The impacts from Wind Farm Project during construction, and installation of machinery and the resulting emission of noise and gaseous effluent, and wastewater discharges during siting, construction and operation of the NTWF Project would be of small order and would be of little significance at Project site or its microenvironment and none in its macroenvironment.	*Environment Specialist/Design Consultant* Design to include the on-site facility in NTWF Project
	Water Supply & Drinking Water	IFC's EHS Guidelines will be strictly followed NTWF Project would have its share of water from deep groundwater well that will have no significant impact on the current beneficial water uses in the area.	*Environment Specialist/Design Consultant* Detailed Designs to include water supply and sewerage system and standard septic tanks at construction sites.
	Slope Protection	IFC's EHS Guidelines will be strictly followed Intersecting natural flow will be diverted to protect foundations/piles towards bandats for use in vegetation	*Environment Specialist/Design Consultant* Designs will provide for directing surface flow away from WTG foundation and into bandats/temporary reservoirs for subsequent use in plantation.
	Wastewater	IFC's EHS Guidelines will be strictly followed Sewerage system for conveyance of wastewater from construction sites to septic tanks and separate arrangement for sludge disposal to be provided at campsite and residential area of workers and officials at NTWF Project. Provision of Gravel/Sand Bed for passing Workshop/Yard wastes containing oil & grease	*Environment Specialist/Design Consultant* Septic tanks will clarify the wastewater by sludge settlements and reduce BOD with increased residence time. Overflow from the septic tank will flow into standard soak pits.

Project Activity	Potential Hazards & Environmental Impacts	Proposed Mitigation Measures	Institutional Responsibilities & Actions Taken
	Solid waste Construction Waste	IFC's EHS Guidelines will be strictly followed Solid waste at camp & construction sites will not be mixed with hazardous waste and will not be disposed of into open land or into the dry wadis (valleys) in the area. Segregation at source and provision of containers for conveyance to burn-pit at construction sites. Construction waste will be disposed of in designated areas at borrow pits.	*Environment Specialist/ Design Consultant* Positioning of containers and burn pits will be provided for in the furnishings.
	Air Quality	IFC's EHS Guidelines will be strictly followed The airshed of the NTWF Project is unpolluted. The dust fall in the microenvironment is high as a result of high aridity in the airshed of the macroenvironment as well as that of the site itself.	*Design Consultant* Detailed Designs to account for impact of high dust fall
	Air Pollution	IFC's EHS Guidelines will be strictly followed Air and noise pollution and other forms of nuisance in the microenvironment and macroenvironment of site will be mitigated by monitoring the level of particulate matter and noise. Air pollution due to fugitive dust emission and operation of equipment during construction will be controlled by good housekeeping practices e.g. sprinkling water.	*Environment Specialist/Supervision Consultant* Implementation of EMP and Monitoring Plan will ensure mitigation of impact of air pollution.
	Noise Pollution	IFC's EHS Guidelines will be strictly followed Noise from wind turbines does not generally exceed background noise levels at a distance 5 rotor blade diameter from the turbines (5 - 7 rotor diameters is the conventional separation from older versions of turbines; noise footprint of newer turbines is smaller). No mitigation measures would be necessary on siting the NTWF Project at 500 m from any living/activity area. Provision of ear plugs to personnel working in areas with noise level above 85 dB(A) (WHO Guidelines).	*Environment Specialist/Design Consultant* Implementation of EMP and Monitoring Plan will ensure mitigation of impact of noise pollution.

Facilities

Environmental Issue	Requirement	Mitigation Measures	Institutional Responsibilities & Actions Taken
Topsoil Conservation	Management of Project facilities and Conservation of soil	IFC's EHS Guidelines will be strictly followed Identification & inclusion of siting in the overall design of different activity centers such as camp site, borrow pits, WTG foundation sites.	*Environment Specialist/Design Consultant* Design to include the on-site facilities at NTWF Project.
Location & Management of Project Facilities	Management of Project facilities	IFC's EHS Guidelines will be strictly followed The Design would ensure that Campsite is at 500 m distance from living area/village Campsite does not hinder movement of villagers Construction wastes are removed & disposed of in designated burrow pits in environmentally sustainable manner Excavation of 50 cm soil for borrow area Fugitive dust emission is kept to the minimum Site for storage of construction waste is duly restored after use Borrow pits for waste disposal at natural depressions are provided with impervious layer Hazardous waste including concrete waste, if any is segregated & disposed of into borrow pits with impervious layer and liner Oil containers are in place for temporary storage of lubricants Soil contamination is avoided Walls are constructed and suitably landscaped near sensitive locations such as schools, mosques and graveyards for providing sanctity to the structure and protection against noise pollution.	*Environment Specialist/Design Consultant/Contractor* Design to include the on-site facility at NTWF Project and Contractor to implement the mitigation measures duly supervised by Supervision Consultant and Environment Specialist by implementation of the EMP and Monitoring Plan.

[illegible] Construction Phase – [illegible] Land Use

Project Activity	Potential Hazards & Environmental Impacts	Proposed Mitigation Measures	Institutional Responsibilities
Mobilization of contractor(s) and pertinent equipment and machinery	Awareness on Environmental Aspects related to use of equipment and associated environmental and occupational health hazards	IFC's EHS Guidelines will be strictly followed Creation of awareness on procedures of safety health environment Provision of protective devices for safety Provision of protective measures for workers	EPC Contractor
Mobilization of project equipment and materials	Awareness on Aspects related to use of equipment and associated environmental and occupational health hazards	IFC's EHS Guidelines will be strictly followed Provision of protective devices for safety Provision of protective measures for workers	EPC Contractor
Establishment and operation of construction camps	Awareness on Aspects of environmental, occupational health & safety	IFC's EHS Guidelines will be strictly followed Provision of jobs for locals Provision of protective devices for safety Provision of protective measures for workers	EPC Contractor
Pre-Construction Phase: Land Preparation			
Initiation of activities at site	Stony Wasteland, scanty vegetation	IFC's EHS Guidelines will be strictly followed Take cognizance of stony wasteland.	*Contractor/supervised by HSE Manager*
Construction activities at site	Operation of heavy equipment, Noise, Fugitive dust emission Gaseous emission from construction equipment Accidents	IFC's EHS Guidelines will be strictly followed Safe Working Procedures; Environmentally Sound Standard Operating Procedures Emergency Response Plan	*Contractor/supervised by HSE Manager*
Topsoil Conservation	Stony wasteland Topsoil sandy	IFC's EHS Guidelines will be strictly followed Implement good housekeeping and environmentally sound standard management practices	*Contractor/supervised by HSE Manager*
Environmental Enhancement Re-vegetation and Plantation	Damages done to arid ecosystem by natural and man-made activities including sand/ & gravel excavation/ stone crushing /wood cutting & transportation	IFC's EHS Guidelines will be strictly followed Rainwater harvesting and using the water accumulation for re-vegetation and Establishment of Biodiversity Park specific to arid zone environment.	*Contractor/supervised by HSE Manager*

Project Activity	Potential Hazards & Environmental Impacts	Proposed Mitigation Measures	Institutional Responsibilities
Management of Drainage System	Damages done by construction activity to drainage system, and structures, and likely impact during construction	IFC's EHS Guidelines will be strictly followed Take cognizance of arid/stony wasteland that is sandy Avoid location of Camps and access tracks/internal roads on land sloping towards the wadis Campsite will not be established in the vicinity of water supply sources to village in the surrounding. Maintenance of vehicles and other equipment will be allowed only in designated areas underlain with concrete slabs and a system to catch runoff. Washing of vehicles will be restricted.	*Contractor/supervised by HSE Manager*
Protection of Cultural & Community Owned assets	Adverse impact of siting campsites	IFC's EHS Guidelines will be strictly followed Camps, access tracks, and other project sites will avoid cultural and community owned assets. No campsite will be established in the vicinity of cultural sites and community owned assets. Land development will not require resettlement of population or relocation of structures.	*Contractor/supervised by HSE Manager*

[illegible] Program[illegible]

Project Activity	Potential Hazards & Environmental Impacts	Proposed Mitigation Measures	Institutional Responsibilities
Emergency Medical Aid Services	Emergency Management	IFC's EHS Guidelines will be strictly followed Establishment of emergency First Aid system Provision of speedy transportation system staffed by trained Medical Technicians Adoption and implementation of fire/emergency/contingency plans	Ambulance to be provided at the Construction site *HSE Manager* to implement Emergency Management Plan and Disaster Management Plan
Environmental Awareness	Creation of awareness on procedures of safety health environment	IFC's EHS Guidelines will be strictly followed Provision of protective devices for safety Provision of protective measures for workers	*HSE Manager*

Project Activity	Potential Hazards & Environmental Impacts	Proposed Mitigation Measures	Institutional Responsibilities
Environmental Management Services	Availability of campsite environmental management services	IFC's EHS Guidelines will be strictly followed Adoption and implementation of environmental services plans, including: Best Management of Road construction Environment Best Ground & Housekeeping Management Practices Professional on-site management and support resources Assurance of access to emergency services at NTWF Project WTG Units	*HSE Manager*
Emergency Management	Availability of emergency services	IFC's EHS Guidelines will be strictly followed Establishment of emergency systems Adoption and implementation of fire/emergency/contingency plans	*HSE Manager*
Disaster Management	Keeping prepared for disaster	IFC's EHS Guidelines will be strictly followed Establishment of Contingency Plan for WTG units Preparedness for Disaster & Implementation of fire/emergency/contingency plans	*HSE Manager*

6.13. Emergency Response Plan

NTWF Project EMS would implement its own Emergency Response Plan during the pre-construction and construction stages. The Emergency Response Plan during the construction period will be managed and monitored by NTWF Project EMS Emergency Response Team. The Response team will ensure that the operations are carried out in minimal time avoiding any fire, safety and security hazard and affecting the environment. The team will be in readiness to adopt the following procedure:

- Evaluation of the situation to identify the most important steps, which must be taken first and can have an important bearing on the overall action to be taken.
- Deployment of required manpower and equipment.
- Organizing required logistical support so that there are no bottlenecks hampering the operation.
- See to it that injured persons are cared for.
- Respond to calls for ambulances for shifting the injured persons to neighborhood hospitals/healthcare units and if necessary to DHQ Hospital Thatta.
- Isolate all sources of ignition and environmental hazard.
- Evacuation of people who are in immediate or imminent danger. Response Team and/or in-charge of the Campsite will exert positive leadership and give instructions calmly,

firmly, explicitly, and courteously and obtain help of law enforcement agencies, if necessary.

- Block approach roads if necessary for safety of operations.
- Arrange for emergency notifications of water shed areas, public utilities, and the like to safeguard the public and property.
- Surveillance and monitoring operations.
- Retrieval and disposal of earth/debris and resources affected by the hazard at appropriate site.
- Termination of clean-up operation.

In the event of any EHS incident, Subcontractors will report details to the EPCC project manager or EHS Chief.

External response services may be required where the site is not capable of responding to an incident or may require additional support services. These services may include local fire departments, medical emergencies teams or rioting response units where available, and they must be able to respond in an appropriate time frame.

An information schedule should be prepared in advance to prevent delays if it is necessary to contact a service provider. This should include:

- Exact location of the site including directions to the site from a well-known place such as highway exit or landmark.
- Inventory of chemicals that may be spilled/released.
- Site contact person(s) including 24 hour contact numbers

6.14. Training and Exercises

To ensure effective implementation of the Emergency Response plan, training programs for Disaster response personnel will be organized regularly in collaboration with wind farms in the neighborhood. The training program will aim at:

- Maintaining the plan and working document to be fully operational.
- Inform the Response Team members and other relevant personnel of their respective duties and procedures to be followed.
- Familiarize all relevant personnel with the use of equipment.

The training program will be structured according to the level of responsibility of the participants:

- Classroom instructions as well as field demonstration will be conducted.
- Regular operational exercise/drills will be conducted to ensure that the response organization and other components detailed in the plan function effectively and
- Response Team members and other relevant personnel assigned specific responsibilities become fully familiar.

All EHS training programs for site personnel will include the following:

- EPCC EHS Policy and Objective.
- Project related activities with potential EHS impacts.
- Mitigation requirements.
- Environmentally sensitive areas potentially impacted by the project.
- Specific activities mitigation measures and site EHS requirements.
- Chemical storage and handling.
- Reporting of EHS incidents.
- Emergency response strategies (including those for oil and chemical spill/releases).

All environmental orientation and training documentation shall be made available upon request.

6.15. Environmental Monitoring Program

Monitoring of different activities will be required to assess the impacts of activities during construction and operation on the environment. For this purpose NTWF Project EMS will establish its own unit to:

- Coordinate with other units
- Follow the monitoring frequency of selected parameters as per the monitoring plan given in the following Table.
- Record all non-conformities observed and report them along with actions to Project Manager for further action.
- Report any impact anticipated along with recommendations for further action.

Contractor shall take note of the recommendations relating to issues arising during monitoring of construction activities. The following Tables show the checklist of actions for monitoring different environmental aspects during the construction and operations phases of the Project:

[illegible] Monitoring Plan

Stage	Monitoring areas	Location of monitoring	Parameters to monitor	Documentation & Monitoring Frequency
Construction & Operation	Ecological Conditions	Access Road to Wind Mast, and Access Rd from Wind Farm to Powerhouse	Visual analysis and observations on flora and fauna for loss of biodiversity, recording number of trees lost, animals hunted/killed and number of visiting birds, hunted, killed or saved	Quarterly

Stage	Monitoring areas	Location of monitoring	Parameters to monitor	Documentation & Monitoring Frequency
Construction	Water	Sampling points at campsite, deep water well;	Water analysis for following parameters: pH Dissolved Oxygen Total suspended solids Common ions Oil & grease Coliform count	Quarterly
Construction	Wastewater	Outlet of the wastewater treatment system / septic tanks	Wastewater analysis for the following parameters: pH Total suspended solids DO BOD Oil & grease	Quarterly
Construction	Solid Waste (Kitchen)	Collection, handling and disposal to designated areas/borrow pits	Observations on solid waste type, quantity and disposal arrangement	Quarterly
	Solid Waste			Quarterly
Construction	Air quality	15 meters distance from activity area	Parameters to monitor include: CO SPM SO2 NOx	i. Before beginning of construction ii. Monthly during construction iii. Quarterly during operations
End of Construction	Restoration of sites	All excavation sites & Borrow pits	Visual Observations	Status Report for Completion of Construction
Operations	Accidental risk /Avian collision at site	Whole NTWF Site	Visual Observations Recording accidents /avian collisions during operation of WTG & equipment	Quarterly
	Noise	Activity area, Wind Farm, Access Road	Noise intensity measurement	Quarterly
Construction & Operations	Occupational Safety	Installation of Machinery and equipment Operations areas	Visual observations and Recording hazard/accident	Quarterly

Chapter 7 Findings, Recommendations & Conclusion

7.1. Summary of Findings

Overall assessment of the environmental aspects and screening of potential impacts of the proposed activities pertaining to establishment of NTWF Project in Taluka Thatta, Jhimpir finds that:

- NTWF Project site in the Jhimpir Wind Corridor is the preferred alternative and ideally suited for establishment of a large wind farm for wind classes 4-5.
- An appropriate number of wind turbine generators (WTGs) will be sited on the wasteland area, with each WTG spaced at optimum distances apart following the annual maximum wind direction.
- There will not be any issues on land acquisition, loss of land, or loss of business and no involuntary resettlement will be required.
- Noise emissions from the wind turbines at NTWF Project site may have a high level at the top of the turbine but the noise level will be reduced with distance. The noise level at the living areas at more than 500m or in excess of one rotor diameter equivalents will be within acceptable limits of the World Bank Guidelines and the limits recently proposed by Federal EPA.
- Visual effect, noise effect, EMI effect, flicker effect induced by operation of the wind turbines may have an impact on the living area, located 500 m from the NTWF Project. Therefore as a mitigation measure, it is proposed that wile siting the WTGs, a distance of 1 km should be maintained from Haji Suleman Brohi Village.
- Detailed design will give due consideration to location of the WTGs close to the living area at Haji Suleman Brohi Village. At the distance of 1 km, the noise from the wind turbine is reduced to acceptable levels, while the visibility, shadow flicker and shadow effects are not an annoyance but a curiosity.
- Results from Stakeholder consultation with key informants of Haji Suleman Brohi Village suggests that the expectations of villagers should be met e.g. priority in unskilled Jobs during construction, provision of healthcare facility, installation of WTGs not too close to their village.
- The related impact on operation of the wind turbines on the microenvironment will be monitored through environmental management plan and the IFC's HSE Guidelines, and mitigated, if necessary, by adoption of suitable measures at the site.
- According to the Code for Seismic Design of Buildings (GB50011-2001), there is no seismic liquefaction in the area foundation.
- The foundation (rock) soil mass in the project area is mainly composed of two layers: Layer ① is composed of rubbles, mainly of moderate ~ dense structure, the bearing capacity characteristic value of which is 200 kPa~350 kPa. With fair mechanical property, it can be used as natural foundation. Layer ② is mainly composed of highly ~ moderately

weathered limestone, developed with small dissolved pores and karst cave, the bearing capacity characteristic value of which is 500 kPa~1200 kPa. With better mechanical property, it can be used as the foundation supporting layer or the underlying layer of wind turbine and ancillary buildings.

- Precious ecology of the microenvironment of NTWF Project will be protected. The land being stony wasteland has no worthwhile vegetation. A few patches of dead wood and dried up shrubs may have to be removed for land clearance but the same will have only minor impact on the environment.
- 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. Kinjhar Lake is located at a distance of 10 km away from the project.
- Due vigilance will be kept for protecting the wildlife that may still be there.
- Adoption of mitigation measures identified for different stages of the project will be keenly monitored to further enhance the environmental performance of the NTWF Project.

Assessment of impact of activities during construction processes and operation stages at the NTWF Project site in Taluka Thatta shows that the impacts will be of temporary nature and small order. They are not expected to have any significant adverse impacts on the microenvironment and macroenvironment of the Project. The minor impacts resulting from said activities or operation of facilities would be mitigated.

7.2. Recommendations

IEE of the NTWF Project has identified the key environmental aspects that need to be attended to. Mitigation measures for the likely impact have been suggested. General specification/details have been worked out in respect of type of structures, grade of concrete, and all other materials of construction for the construction phase of NTWF Project.

It is recommended that:

- The structures and materials conform to recommended standards and follow standard practice of civil works.
- Environmentally sound materials and goods are selected, with priority being accorded to products meeting national and international standards.
- Traditionally well-tried materials are chosen for provision of utilities services in the Project.
- Temporary inconveniences due to construction works are minimized through planning and coordination with local population and organizations in the neighborhood.
- The foundations of the wind turbine towers are of concrete on bearing soil. Bearing capacity, settlement, static and dynamic loading conditions are determined while seismic conditions pertain to placement of the site in zone 2A and taken into account in the working designs that will submitted for approval.
- The stability of soil is verified before laying the foundations of the wind turbines.

- Environmental Performance Monitoring will be an integral part of the Project to ensure environmental safeguards.

7.3. Conclusions

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 IEE Study for assessment of impact of different activities for establishment of NTWF Project. The review process finds that:

- The impacts from NTWF 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 NTWF 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 NTWF Project would be economically viable and environment friendly.
- No untreated wastewater would be discharged from the NTWF 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 NTWF 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 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 NTWF Project operations will have no significant impact either on its microenvironment that includes the proposed site for NTWF Project, or on its macroenvironment.

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 NTWF Project has remained an isolated component of the ecosystem of Lower Sindh for a long time. Location of NTWF 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 Jhimpir.
- On the Other hand, the site is already designated for Wind Power projects and 11 wind farms are constructed or planned near the NTWF site (as described in figure 4.10).
- Visual effect, noise effect, EMI effect, flicker effect induced by operation of the wind turbines may have an impact on the living area, located 500 m from the NTWF Project. Therefore as a mitigation measure, it is proposed that wile siting the WTGs, a distance of 1 km should be maintained from Haji Suleman Brohi Village. 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.

- Results from Stakeholder consultation with key informants of Haji Suleman Brohi Village suggests that the expectations of villagers should be met e.g. priority in unskilled Jobs during construction, provision of healthcare facility, installation of WTGs not too close to their village.
- 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. Kinjhar Lake is located far at a distance of 10 km away from the project.
- Finding of archaeological artifacts during the construction phase will be immediately reported to the Department of Archaeology, Sindh.
- The proposed NTWF Project, when commissioned, would become integral part of microenvironment of already developed wind farm area.

This IEE Study finds that the value-addition characteristics of NTWF 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".

It is therefore concluded that if the field activities, including the implementation of all mitigation measures, are carried out in line with recommendations suggested in the report, the impacts from project's construction and operations will not be adverse so as to deteriorate the environmental quality of the project area and a more detailed report will not be required in the form of an EIA. Additionally careful implementation of the EMP will ensure that environmental impacts are managed and minimized and the project proponent meets all statutory requirements.

There are two essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. The Proponent shall ensure that:

- All mitigation, compensation and enhancement measures proposed in this IEE report are implemented in full, as described in the document;
- The Environmental Management and Monitoring Plan will be implemented in letter and spirit.

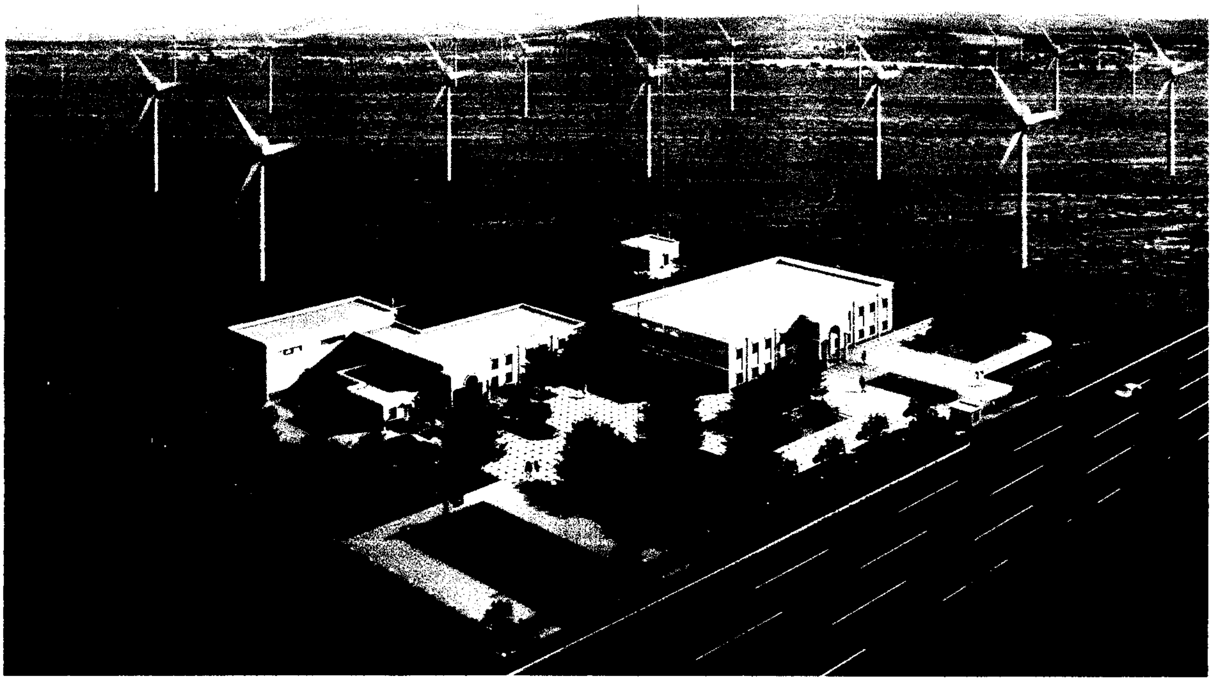
Screening of potential impact suggests that the Construction & O&M of Norinco Thatta Wind Farm Project will, on adoption of the suggested mitigation measures, be an environmentally acceptable proposition and provide clean and renewable energy. It is recommended that the IEE be approved with the condition that recommendations given in the IEE and NOC will be duly followed by the proponent.

Norinco International Thatta Phase-II

50MW Wind Power Project

("Norinco-2")

Feasibility Study Report



北方国际
NORINCO international

NORINCO International Thatta Power (Private) Limited

April 2017

Table of Contents

1 GENERAL STATEMENT

1.1 Briefing

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is located at Jhampir in Sindh Province of Pakistan, about 110km northeast away from Karachi and 80km northeast away from Port Qasim, with geographical coordinates of 68°0′4"~68°3′55" E and 25°5′23"~25°8′4" N. The project area stretches in nearly northwest-southeast direction, with a length of about 6.7km and a width of 1.6km. The elevation of the project area is 40m~60m.

Starting from Karachi, driving along the M-9 national Highway to Nooriabad and then driving along the highway via Thatta-Thano Road for 30km, it will reach the wind farm area by a country road which enjoys good conditions for traffic.

The geographical location of the wind farm is shown in Figure 1.1, the locations of neighboring wind farms in the project area are shown in Figure 1.2, and the national Highway (M9) to the wind farm is indicated in Figure 1.3.

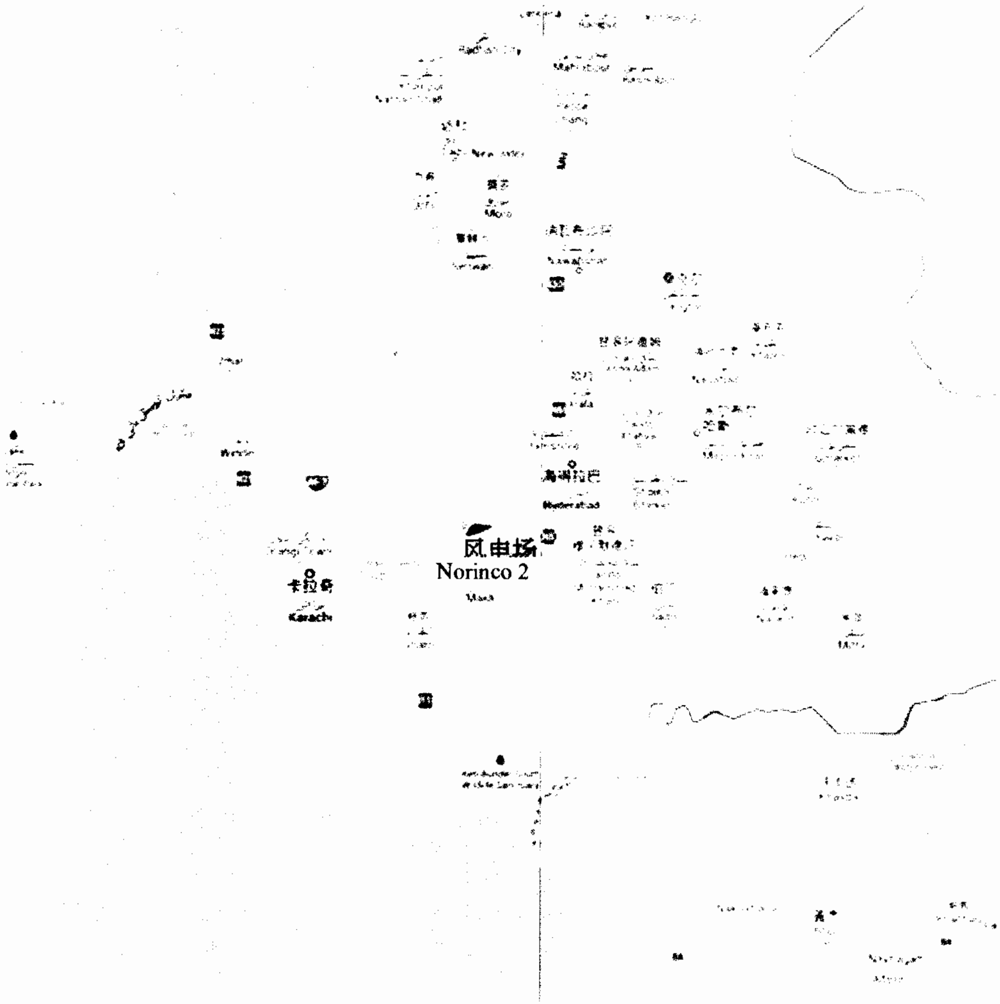


Figure 1.1 Geographical location of Thatta wind farm

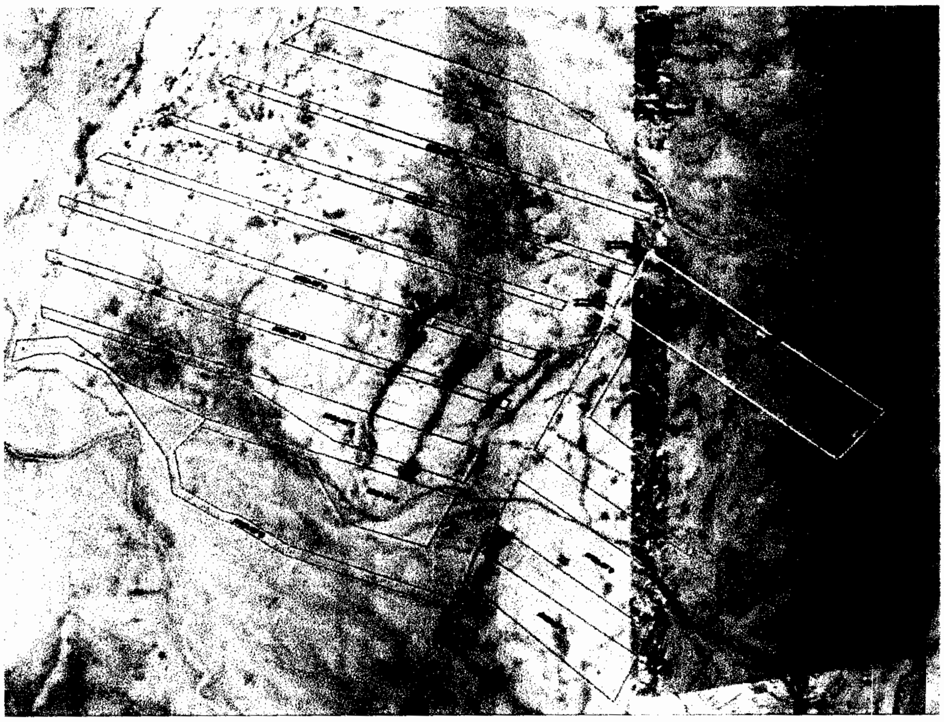


Figure 1.2 Locations of other 12 wind farms

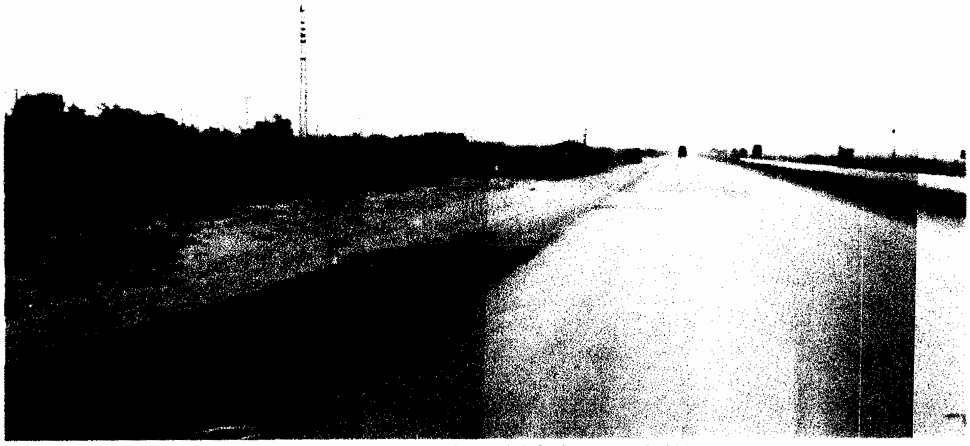


Figure 1.3 National highway (M9)

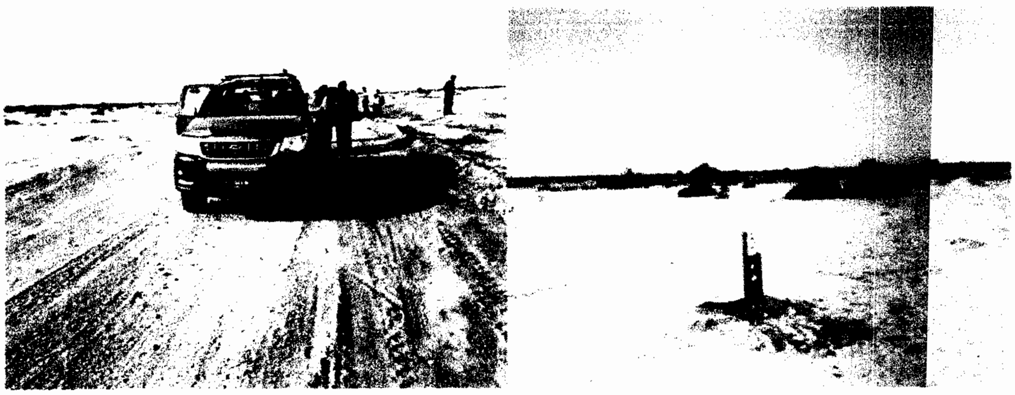


Figure 1.4 Low-cost road Figure 1.5 Project area

Wind data observed by two anemometer towers (FFC and Lucky) which are the nearest to Thatta wind farm are collected in this stage. FFC anemometer tower is 80m high, with coordinates of 67°58′22.20" E and 25°4′33.20" N, about 7km southwest from the Thatta wind farm; wind date collected by FFC is available from June 1, 2007 to April 31, 2010. Lucky anemometer tower is 80m high, with coordinates of 67°59′46.9" E and 25°8′08" N, about 500m north from Thatta wind farm; wind date collected was available from January 1, 2009 to December 31, 2011. For the geological positions of the existing anemometer towers in Sindh Province, please see Figure 1.6 and Figure 1.7.

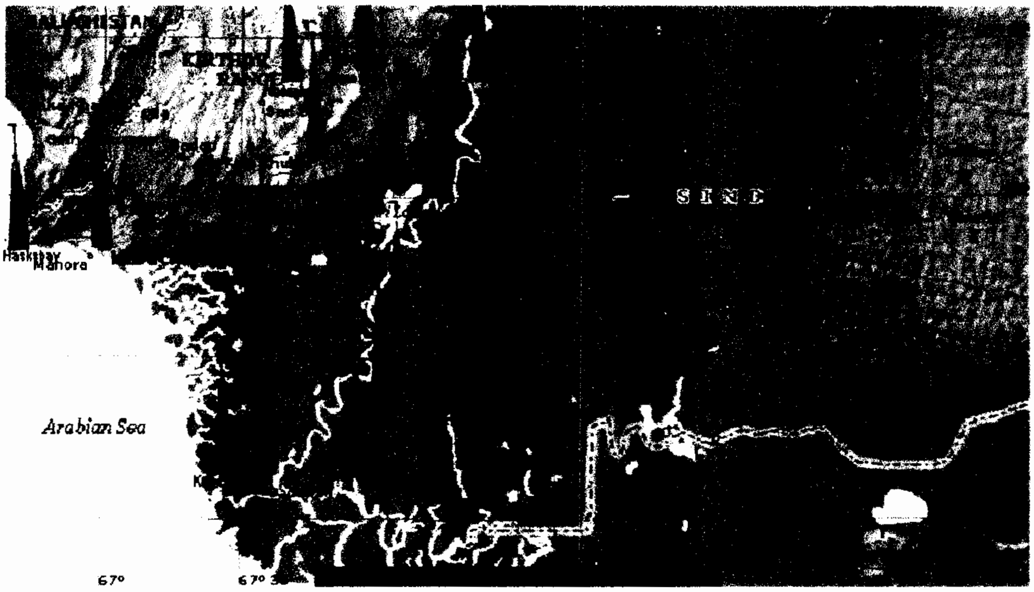


Figure 1.6 Geographic locations of existing anemometer towers in Sindh province

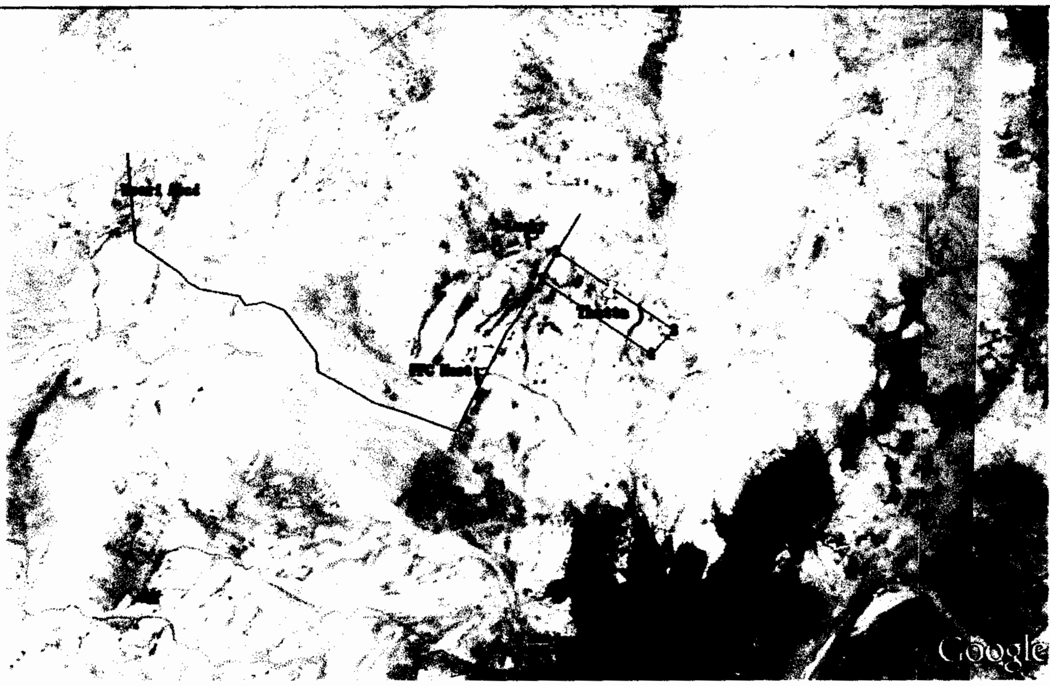


Figure 1.7 Geographic locations of Thatta wind farm and the anemometer towers

From data collected by anemometer towers near Thatta wind farm, it can be found that there is no destructive wind speed, wind energy resource and wind quality here are better, prevailing wind direction is stable. Therefore, Thatta wind farm is an ideal wind farm with certain development prospects. The wind energy resource distributions in Pakistan are shown in Figure 1.8.

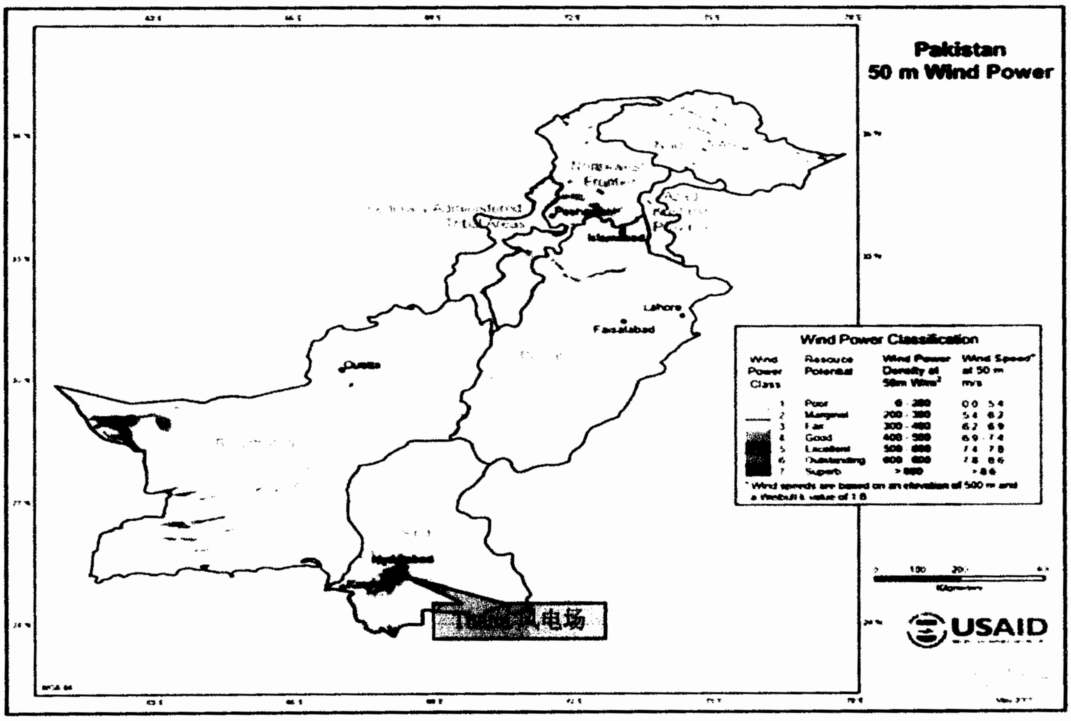


Figure 1.8 Wind energy resource distributions in Pakistan

Entrusted by NORINCO INTERNATIONAL, Power China Northwest Engineering Corporation Limited conducted the feasibility study of Thatta wind farm. The design in the feasibility study stage mainly involves engineering geology, wind resources, WTG (wind turbine generator) type selection and electric power generation estimate, electrical engineering, civil works, environmental protection and water & soil conservation, design budget estimate, financial evaluation and social effect analysis, etc. This feasibility study report is prepared in accordance with the *Preparation Method of Feasibility Study Report for Wind Farm Projects* issued by Development & Reform Office, Energy [2005] No.899 and relevant regulations.

1.2 Wind Energy Resources

The main wind direction of Thatta wind farm is consistent with the main wind energy direction. Wind speed and wind energy frequency in directions of WSW and W are at maximum. The prevailing wind direction is stable.

According to the observed data of Lucky anemometer tower in neighborhood, the annual mean wind speed at 90m height is 7.62 m/s (calculated as per the height of 85m and shear index of 0.14, the same as below), the annual mean wind power density is 382 W/m^2; the annual mean wind speed at 85m height is 7.56 m/s, the annual mean wind power density is 372 W/m^2; the annual mean wind speed at 60m height is 7.2 m/s, the annual mean wind power density is 331 W/m^2. In accordance with the *Technical Specification for Measurement and Evaluation of Wind Energy Resources for Wind Farms,* it is judged that the wind power density grade of this wind farm approaches Class III, the wind energy resources are relatively rich.

Turbulence intensity at different heights of Lucky anemometer tower in Thatta wind farm at wind speed of 15m/s is 0.069~0.104, turbulence intensity at different heights of FFC anemometer tower is 0.076~0.132, showing that the turbulence intensity is lower. The calculation result of maximum (extreme) wind speed based on a variety of methods suggests that the wind turbines with safety standards adequate for IEC Class II or above can be selected for Thatta wind farm tentatively. In conclusion, there is no destructive wind speed in Thatta wind farm, wind energy resources and wind quality here are better, prevailing wind direction is stable. Therefore, Thatta wind farm is an ideal wind farm with certain development prospects.

1.3 Engineering Geology

According to *Seismic Risk Map of Karachi, Hyderabad Divisions and Lasbela District, Pakistan,* the seismic intensity of the project area is at degree VII. The overburden in the area is thinner, mainly consisting of highly to moderately weathered limestone, with good mechanical properties. The area is classified as Type I with favorable a seismicity, suitable for wind farm construction.

The project area stretches in northwest - southeast direction, with a length of about 6.7km and a width of 1.6km. It is a low and gentle hilly land with flat and open terrain and less fluctuation, higher in the south and lower in the north, forming an inclined platform, with a general elevation of 40m~60m. Gullies with drought-enduring shrub are developed in the area. A large gulley formed by seasonal flood is developed in the east side of the project area, the width of which is 60m~200m and the cutting depth is 20m in general, covered by dense vegetation.

Figure 1.9 Riverside highland

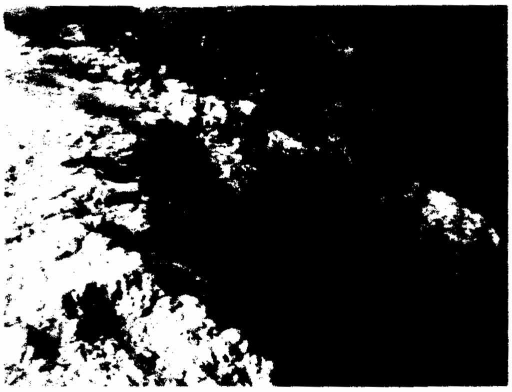


Figure 1.10 Exposed rocks

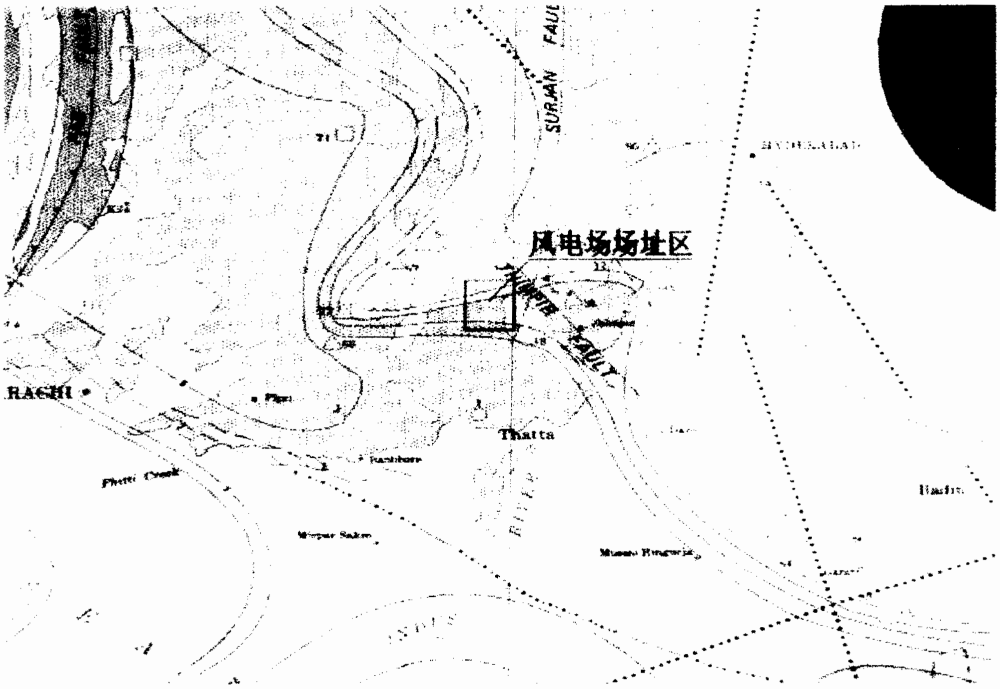


Figure 1.11 Zoning plan of regional seismic hazard of the project area

The foundation (rock) soil mass in the project area is mainly composed of two layers: Layer ①is composed of rubbles, mainly of moderate ~ dense structure, the bearing capacity characteristic value is 200 kPa~350 kPa. With fair mechanical property, it can be used as natural foundation. Layer ②is mainly composed of highly ~ moderately weathered limestone, developed with small dissolved pores and karst caves, the bearing capacity characteristic value is 500 kPa~1200 kPa. With better mechanical property, it can be used as the foundation supporting layer or the underlying layer of wind turbine and ancillary buildings.

The possible karst bedrock in the project area can be excavated and replaced or treated with consolidation grouting, so as to increase the bearing capacity of the foundation.
The buried depth of groundwater is greater than 10m in general, so the influence of groundwater on building foundation can be omitted.

Two quarries are found about 12km in the south of the project area which can supply concrete aggregates for the project with satisfied quality and storage. The quarries are connected with the project area by asphalt road, the traffic condition is convenient.

Water for construction and living can be obtained from the Lake Kalri about 10km away from the project in the southeast.

1.4 Project Task and Scale

Thatta wind farm is located in Sindh Province, Pakistan. Its main task is to generate electric power. Construction of the wind farm complies with development direction of industrial policy for renewable energy sources in Pakistan. It is benefit for improvement of energy structure and will mitigate electric power shortage at certain degree. Furthermore, it can meet the demands for sustainable development of local economy, ecological improvement and environmental protection.

According to the *Technical Specification for Measurement and Evaluation of Wind Energy Resources for Wind Farm,*, it is judged that the wind power density grade of this wind farm approaches Class III, the wind energy resources are relatively rich. The project is located in a low and gentle hilly land with flat and open terrain and less fluctuation, and is connected to Karachi by highway and country road, with a fairly good traffic conditions.

In conclusion, the topographic condition and wind energy storage of the project area are suitable for constructing the wind farm- I with an installed capacity of 50MW. The convenient transportation condition of the project is favorable to project construction. The installed capacity of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is appropriate at this stage.

1.5 Type Selection & Layout of Wind Turbines and Estimation of Power Generation

As the wind direction in the project area is relatively stable, with west-southwest (WSW) and west (W) wind having the maximum wind speed, wind energy and wind frequency, the prevailing wind direction is stable, and utilization rate of wind energy is higher. According to the perennial wind direction and the main wind direction as well as terrain conditions, wind turbines are arranged at those spots with high wind energy indicator and high development value as much as possible.

The project area presents a long strip of 6.7km long and 1.6km wide. Considering the project condition and in line with the principle of rational utilization to the maximum extent and engineering experience, WTGs are arranged perpendicular to the prevailing wind direction WSW and W based on the 2.5D×12D scheme.

The distance between nearby wind farms in the southwest and Thatta wind farm is about 0.5km ~ 4km, mostly greater than 2km, and there is a river in the north of the Thatta wind farm. Therefore, the effect of wake flow is relatively small, which is beneficial to the power generation of the Thatta wind farm.

GW121-2500kW/90m wind turbine is recommended tentatively at this stage. The layout of wind turbines is shown in Figure 1.12.

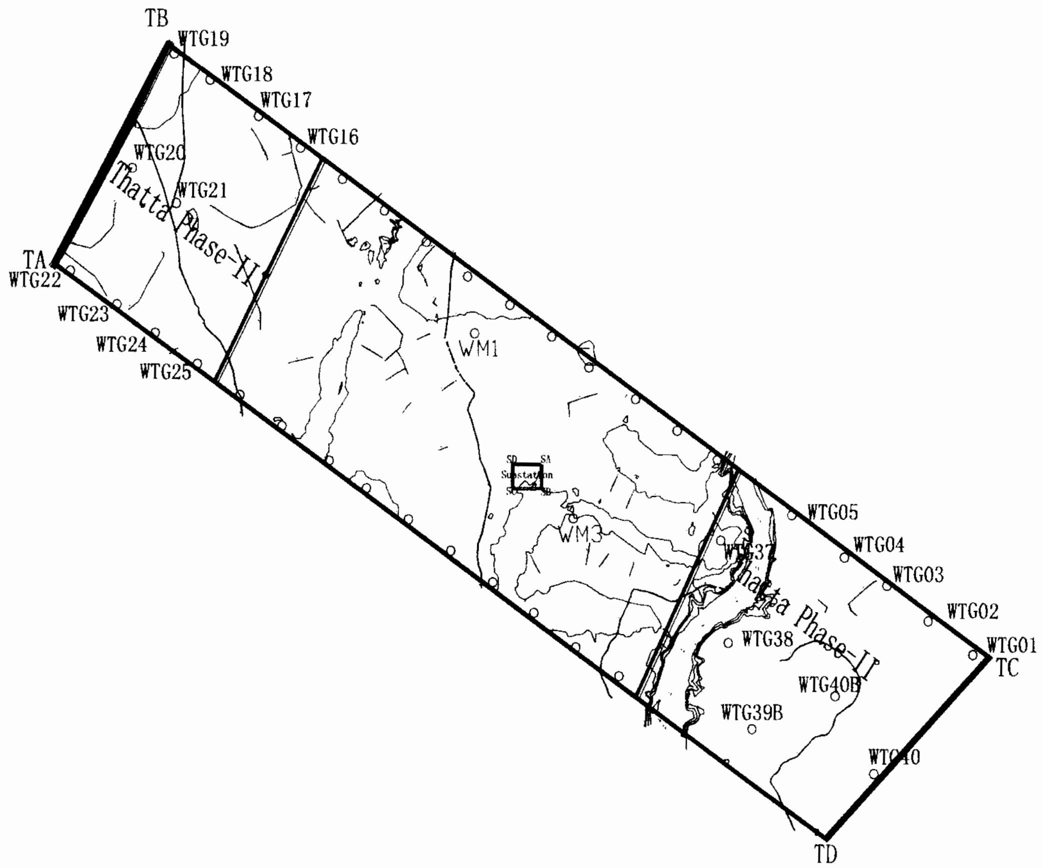


Figure 1.12 Layout of GW121-2500kW wind turbine

20 sets of GW121-2500kW/90m wind turbine with a total install capacity of 50MW are designed for the Thatta wind farm. According to the power generation of the recommended wind turbine layout calculated by WASP10.0 software and in consideration of comprehensive reduction with factors of wind turbines utilization rate, reduction of control and turbulence effect, reliability of wind turbine power curve, blade contamination and climate, etc., it is worked out that the annual grid energy is 173.30GWh, the annual utilization hours are 3466 and the capacity factor is 0.396.

1.6 Electrical System

Voltage classes of main network of the national power transmission & distribution company (NTDC) are 500kV and 220kV, while voltage classes of power distribution network of local power company is 132kV and 66kV, of which 66kV is being converted gradually to 132kV. The maximum power load in Pakistan in 2017 and 2020 will be 27840MW and 31900MW, respectively, with an annual average growth rate of 7.8% in 2013~2020. According to the power balance analysis of power system in Pakistan, power shortage will be 14777MW in 2017 for the power grid of Pakistan, the power shortage will be 1632MW in Sindh Province and Karachi; power shortage will be 17223MW in 2020 for the power grid of Pakistan, the power shortage will be 745MW in Sindh Province and Karachi. In accordance with the power system planning of Pakistan, Jhimpir New 220/132 kV collector substation with two transformers (2500MW) will be built about 10km away from Thatta wind farm, which will be connected to the nearby wind farms including Sunec, Titan, FINA, Hartford and Tapal, etc.

According to the Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") *at Nooriabad, Sindh, Pakistan* and the planning of national grid of Pakistan, power access scheme of Thatta project is as follows: a 132 kV collector substation will be built with main transformer capacity of 3×50 MVA, two circuits of 132kV power transmission lines will be connected to the Jhimpir New 220/132 kV collector sub-station, with a transmission distance of about 10km.

According to the Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") *at Nooriabad, Sindh, Pakistan* supplied by the Employer, the status of other wind farms in Pakistan and the site condition of Thatta wind farm, to reduce land occupation and shorten installation time, GIS double bus connection is proposed as 132kV power distribution installation (since GIS is technically advanced with appropriate price).

132 kV busbar is designed with double busbar electrical connection; two incoming line bays, two outgoing line bays, two protection bays and one bus-tie bay for main transformers will be provided in total. Single busbar sectional electrical connection is proposed at 35 kV side of the 132 kV collector sub-station, circuit breakers are set between two busbar sections. Direct grounding system is adopted at the 132kV side of

the main transformer.

Two 315 kVA service transformers will be adopted for the 132 kV collector sub-station in this stage. One 200 kW diesel generator will be used as backup power source. Substation service power system is equipped with automatic backup switching unit, 0.4kV single busbar sectional electrical connection is adopted, and five GCS-0.4 LV switchgears are proposed.

A total of 20 WTGs with unit capacity of 2500kW will be installed in the wind farm- Ⅰ; one WTG will be connected to one box-type transformer. The transformer with a rated capacity of 2750kVA will be installed near the WTG tower.

33kV embedded cable is selected as the power collection line to transmit power. According to layout of WTGs and box-type transformers, capacity of WTGs and route of power collection line, an 4-circuit trunk power collection line is designed; each circuit with respective capacity of 12.5MW will be connected to 5 WTGs. Within each circuit of trunk power collection line, No.1, No.2 and No.3 box-type transformers will be connected by power cables, while No.4 and No.5 box-type transformers will be connected by power cable. All the cables will be embedded and extended outside of the 132kW collector sub-station fencing and connected to 33kV switch cabinet through cable trench.

The 20 WTGs will be divided into 8 groups, and the 20 box-type transformers will be divided into 4 groups accordingly. Each group of WTGs and box-type transformers share one optical fiber cable that is connected to the control equipment in wind farm control center, forming an optical fiber ring network that performs control and monitoring for each WTG and box-type transformer.

The final access mode of the project will subject to the review comment by NTDC.

1.7 Civil Works

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") has an installed capacity of 50MW, 20 sets of GW121-2500-90m wind turbines will be installed, and a new 132kV collector sub-station will be built. According to the *Classification and Design Safety Standard of Wind Power Projects* (FD 002-2007,Trial), the wind farm is classified as Grade Ⅲ, medium-sized project; the foundation structure of tower is designed as Grade I, the tower structural safety is of Grade I; for the collector sub-station, the structure is of Grade II and the structural safety is of Grade

II. The return periods for both the flood design standard of tower foundation and the flood design standard of monitoring center of the wind farm are 30 years.

Based on the aseismic design code, the seismic fortification of tower foundation is Class C; the seismic fortification of the main structures of the collector sub-station is Class C and that of minor structures of the collector sub-station is Class D.

According to the geological conditions of the wind farm and data on WTG load, cylindrical shallow footing of reinforced concrete is selected for the WTG tower foundation of the project. The upper cushion cap is a round one in shape, with a diameter of 20.0m. The buried depth of foundation is 3.9m.

Starting from Karachi, one can arrive at the area near the wind farm along M9 highway and Bula Khan road, and then enter the project area through a low-cost gravel road with a width of 8m and a length of 8km or so. According to the general layout of WTGs, low-cost road with total length of 14.3km and pavement width of 10m will be built in the wind farm area for construction use. After land leveling, the exposed gravel subgrade can be used as the temporary road surface during construction period. After hoisting of wind turbine is completed, the construction road will be reconstructed into the maintenance road, which will has 3m wide graded gravel pavement, 0.5m wide shoulders on each side; the rest 2m wide pavement will be reverted to the original relief.

Box-type sub-station applies concrete box foundation. The plan view size of the foundation is determined according to box-type transformer dimensions.

At this stage, the collector sub-substation of the project consists of comprehensive building, operation building, 132kV collector sub-station building, pump room, guard room, etc., covering a total area of 12070m^2. Rainfall in this region is small, and in light of possible large flood in short time in flood period, drainage facilities should be well prepared.

1.8 Construction Planning

Production and living materials: Karachi City, 110km away from the wind farm, is the industrial, commercial and cultural centers. Its industrial turnover accounts for 40% of the whole country. The main industries include shipbuilding, steel, machine tools, cement, jute processing, textile and glass making, etc. Both construction materials and construction markets are of certain scales. Construction materials and goods involved by the project such as cement, steel materials, reinforcement, timber, fuels, sand, aggregate, cables and small electric equipment all can be available from construction materials market and equipment suppliers in Karachi City and its surrounding towns. Living materials can also be available from the above-mentioned cities and towns.

Wells will be dug for water supply during the wind farm operation, and water for construction could be drawn from Lake Kalri about 10km away from the wind farm in the southeast. Temporary power supply can be obtained from two sets of 300kW diesel generators.

Transportation: the proposed route for wind turbine equipment and transformer transport is as follows: WTG assembly plant → Shanghai Port (China) → Karachi Port (Pakistan) → Thatta wind farm (Pakistan); the sea transportation distance from Shanghai Port to Karachi Port is about 11600km, and the land transportation distance from Karachi Port to Thatta wind farm is about 140km.

The traffic route from Karachi Port to the project is as follows: Karachi Port → M9 national highway (about 110km) → Nooriabad → Bula Khan road (about 30km) → construction site. The Bula Khan road has an 8m-wide asphalt pavement. There are no large buildings or trees along the road and the road slope is fairly low. The traffic condition is good enough to meet the transport requirement of large-scale wind turbine equipment.

Land acquisition: the state-owned land is acquired based on relevant policies of Pakistan and local governments. Land occupation of the wind farm is 2500 acres.

The planned construction period of this project is 18 months.

1.9 Design Estimates of the Project

Budget estimate of the project is prepared in accordance with laws, regulations and system of Pakistan with reference to existing documents, regulations, fees quota and rate standards and price level of the fourth quarter in 2015 of China.

The total static investment of Thatta wind farm is 108,610,544.51 USD, the total dynamic investment is 119,630,548.47 USD (excluding transmission works), the static investment per kW is 2,172.21 USD and the dynamic investment per kW is 2,392.61 USD.

Capital source: capital fund accounts for 30% of the total investment, and the rest will be from bank loan.

Table 1 Summary of main technical economic indexes

Name	Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2")		Price of WTG		USD/kW	928.5
Location	Sindh province, Pakistan		Price of tower barrel		USD/t	1888.5
The Designer	POWERCHINA NORTHWEST ENGINEERING CORPORATION LIMITED		Cost of foundation		USD /set	289,707.27
The Contractor	NORINCO INTERNATIONAL		Step-up substation		USD/set	14,416,761.09
Installed capacity	MW	50	Main work quantity	Earth-rock excavation	m^3	88,490.6
Capacity of single unit	kW	2500		Backfilling	m^3	81,805.35
Annual power generation	GW·h	173.30		Reinforcement	t	1,227.05
Annual utilization hours	h	3466		Concrete	m^3	15,184.35
Static investment	USD	108,610,544.51		Tower (including foundation ring)	t	6,135.8
Total investment	USD	119,630,548.47	Required land for construction		Acre	2500
Investment per kW	USD/kW	2,392.61	Planned construction period	Construction period for power generation of first batch of wind turbines	Month	
Investment per kWh	USD/kW·h	0.69		Total construction period	Month	18
Financing cost	USD	10,409,048.63	Fixed number of production staff		Person	20
Transmission works investment	USD	0.00				

1.10 Conclusions

a) Karachi is a region with advanced economy in Pakistan, its economic strength is powerful and energy demands are huge. Currently, energy supply in Pakistan mainly comes from hydropower and coal-based thermal power. Pressure of environmental protection in power field is great. Therefore, development of wind energy resource along Karachi coast is not only the demand of the sustainable development of local economy but also the demands of raising the local people's living standard and improving the local power industry development.

b) Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is located in the northeast of Karachi City. There is less destructive wind speed in the region where the wind farm is seated. The regional geology is stable, both transport and electric access conditions are convenient, the general development conditions are superior and it has good representative features in the coastal wind power base.

c) Construction of Thatta wind farm is feasible in term of technology through analysis on wind resources for Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2")with a total installed capacity of 50WM, comparison and selection of schemes for wind turbine layout and main electric connection as well as study on scientific and reasonable construction method.

d) The total static investment of Thatta wind farm is 108,610,544.51USD, the total dynamic investment is 119,630,548.47 USD (excluding transmission works), the static investment per kW is 2,172.21 USD and the dynamic investment per kW is 2,392.61 USD.

Annex A Property list of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") (recommended scheme)

Description				Unit (or Model)	Qty.	Remarks
Location	Elevation			m	40m~60m	
	Longitude (East longitude)				68°0'4"~68°3'55"	
	Latitude (North latitude)				25°5'23"~25°8'4"	
	Annual average wind speed (at hub height of 80m)			m/s	7.62	
	Annual average wind power density (at 80m high)			W/m^2	382	
	Prevailing wind direction				WSW、W	
Main equipment	Main electromechanical equipment	Wind turbine	Number	set	20	
			Rated Power	kW	2500	
			Number of blades	Nos.	3	
			Rotor diameter	m	121.5	
			Swept area	m^2	11595	
			Cut-in wind speed	m/s	3	
			Rated wind speed	m/s	9.3	
			Cut-out wind speed	m/s	22	
			Extreme wind speed	m/s	52.5	
			Hub height	m	90	
			Generator capacity	kW	2600	
			Rated voltage	V	690	
		Main electromechanical equipment	33kV box-type substation	2750/33.5 2750kVA	20	

	Collector sub-station	Main transformer	Model	SZ11-100000/132, YN,d11 132±8×1.25%/33.75kV		
			Number	set	3	
			Capacity	MW	50	
			Rated voltage	kV	132/33	
		Number of outgoing line circuits and voltage level	Number of outgoing circuit	Circuit	2	
			Voltage level	kV	132	
Civil works	Foundation of wind turbine		Number		20	
			Type	Reinforced concrete foundation		
	Foundation of box-type substation		Number		20	
			Type	Reinforced concrete foundation		
Construction	Works	Earth-rock excavation		m^3	88,490.6	
		Earth-rock backfill		m^3	81,805.35	
		Foundation concrete		m^3	15,184.35	
		Steel bar		t	1,227.05	
		New road		km	14.3	
		Total duration (construction period)		Month	18	
Estimate indicators	Static investment (year of preparation)			USD	108,610,544.51	
	Total project investment			USD	119,630,548.47	
	Dynamic investment per kW			USD /kW	2,392.61	
	Construction auxiliary works			USD	459,545.17	
	Equipment and installation			USD	81,096,513.22	
	Constructional engineering			USD	10,671,523.45	
	Other costs			USD	11,211,023.76	
	Basic reserve fund			USD	5,171,930.28	

2 WIND ENERGY RESOURCES

2.1 Overview

Pakistan, located in the northwest of the South Asia subcontinent, borders the Arabian Sea to the south, India to the east, China to the north and Afghanistan and Iran to the west, with a territory area of 796,000 km^2 and a coastline length of 980 km. Three-fifths of the territory mainly consists of mountainous and hilly lands, the southern coastal area mainly comprises deserts, while plateau pastures and fertile soils stretch to the north. The 2300km-long Indus River, originating from China, flows north to south and finally joins the Arabian Sea.

Pakistan geographically enjoys tropical monsoon climate; most part of the country is located in the regions with subtropical climate that is hot and dry; annual average rainfall is less than 250mm, one-fourth of the national land has a rainfall of less than 120 mm, especially in the hot season-June and July, the temperature at noon exceeds 40 ℃

Sindh province is located in the southeastern part of Pakistan. The capital of the province is Karachi. The province is bordered by India to the east and the Arabian Sea to the south, with a land area of 140,900 km^2 and population of 20.312 million, most of which are Sindhis. Located in the lower Indus plains, the province has a dry climate with an annual rainfall of 170mm.

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is located in the northeast of Karachi, a southern coastal city in Sindh Province, Pakistan. The wind farm is about 110km northeast away from downtown of Karachi City and about 80km away from Port Qasim. The project area has a strip arrangement, stretching in northwest - southeast direction, with a length of about 6.7km and a width of 1.6km. The geographical location of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is shown in Figure 2.1.

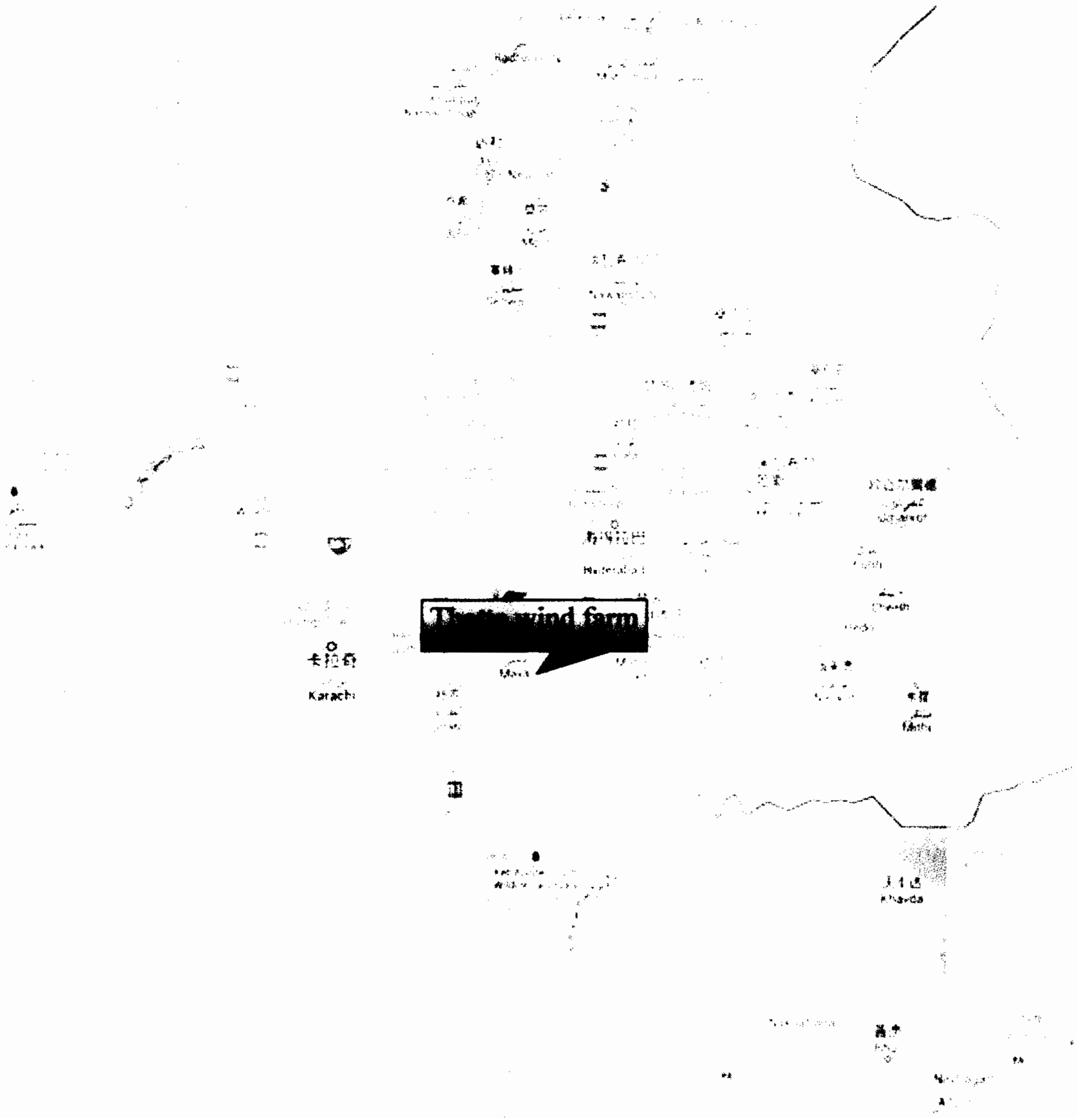


Figure 2.1 Geographical location of Norinco International Thatta Phase-II 50MW Wind Power Project (“Norinco-2”)

2.2 Karachi Meteorological Station

2.1.1 Basic data

1) Monthly average air temperature data (1971 to 2010);

2) Average monthly wind speed and wind direction at 00:00 UTC (Knots) (1971 to 2010);

3) Average monthly wind speed and wind direction at 03:00 UTC (Knots) (1971 to 2010);

4) Average monthly wind speed and wind direction at 120:00 UTC (Knots) (1971 to 2010).

2.2.2 Basic condition

Karachi meteorological station, built in 1928, close to Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") , is located northwest of the wind farm, about 90km from Karachi (airport) in straight-line distance, and is situated to the east of Karachi and to the west of Karachi airport. Coordinate of observation field center is 24°54′ N and longitude 67°08′ E, the ground elevation is 21m, the anemometry height is 7m. The weather element statistics of Karachi meteorological station are shown in Table 2.1.

Sindh Province is located in the southeastern part of Pakistan, the capital of the province is Karachi, located at the northwest of Indus river delta, it is bordered by the Arabian Sea to the south and enjoys tropical monsoon climate, with low rainfall (annual rainfall is about 200mm), most of rain occurs in July and August, climate in winter (November ~ next February) is warm, and hot in summer (April ~ August).

Table 2.1 Weather element at Karachi meteorological station (1971~2010)

Item	Unit	Value	Remarks
Average air temperature	℃	26.0	
Extreme highest air temperature	℃	47.0	Recorded in June, 1979
Extreme lowest air temperature	℃	1.3	Recorded in December 1986
Average air pressure	hPa	1008.0	
Average vapor pressure	mb	21.65	
Average wind speed	m/s	4.75	

2.2.3 Annual average wind speed

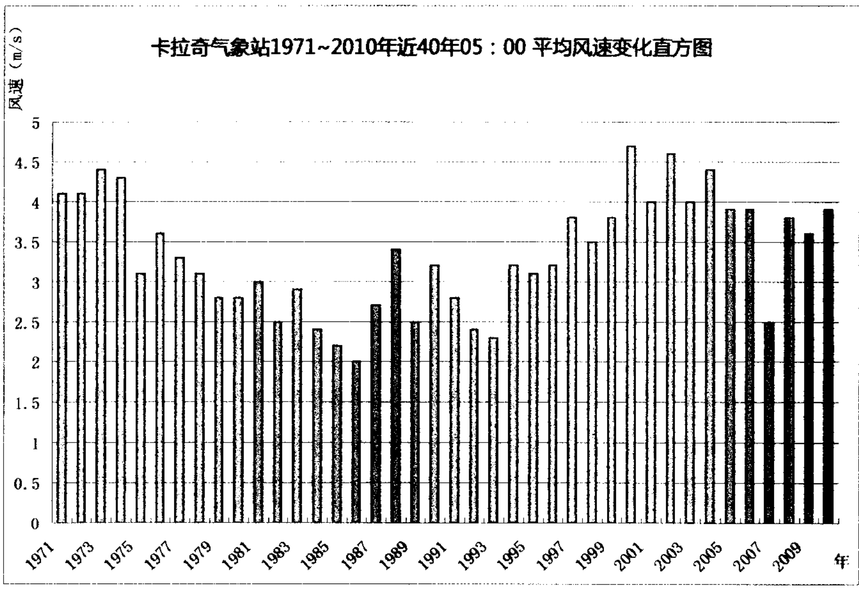
Statistical analysis of observational data obtained at Karachi meteorological station (1971 to 2010) shows that the annual average wind speeds at the weather station are 3.35 m/s, 3.50 m/s and 7.42 m/s at 00:00 UTC, 03:00 UTC, 12:00 UTC respectively, the inter-annual change in average wind speed is shown in Table 2.2 and Figure 2.1.

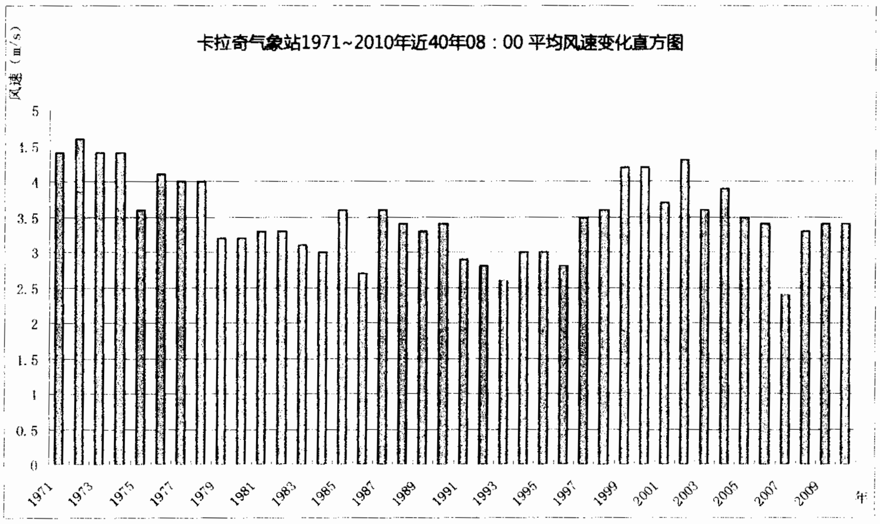
To conduct comparative analysis on the data obtained at the weather station and that measured by anemometer towers, the UTC time is converted into local time, so 00:00 UTC, 03:00 UTC and 12:00 UTC correspond to the local time of 05:00, 08:00 and 17:00, respectively.

Table 2.2 Statistics of annual average wind speed at Karachi meteorological station

Unit: m/s

Year	05:00	08:00	17:00	Year	05:00	08:00	17:00
	Annual average	Annual average	Annual average		Annual average	Annual average	Annual Average
1971	4.1	4.4	8	1991	2.8	2.9	6.7
1972	4.1	4.6	8.4	1992	2.4	2.8	5.7
1973	4.4	4.4	8.2	1993	2.3	2.6	6
1974	4.3	4.4	8.7	1994	3.2	3	5.9
1975	3.1	3.6	7.4	1995	3.1	3	6.6
1976	3.6	4.1	7.6	1996	3.2	2.8	7.5
1977	3.3	4	8.3	1997	3.8	3.5	7.9
1978	3.1	4	8.4	1998	3.5	3.6	7
1979	2.8	3.2	7	1999	3.8	4.2	7.4
1980	2.8	3.2	6.9	2000	4.7	4.2	8.8
1981	3	3.3	7.6	2001	4	3.7	7.7
1982	2.5	3.3	7.3	2002	4.6	4.3	8.8
1983	2.9	3.1	7.2	2003	4	3.6	8
1984	2.4	3	7	2004	4.4	3.9	8.7
1985	2.2	3.6	6.9	2005	3.9	3.5	7.8
1986	2	2.7	6.5	2006	3.9	3.4	7.7
1987	2.7	3.6	7.4	2007	2.5	2.4	7.4
1988	3.4	3.4	6.5	2008	3.8	3.3	7.9
1989	2.5	3.3	6.5	2009	3.6	3.4	7.8
1990	3.2	3.4	7.1	2010	3.9	3.4	6.7





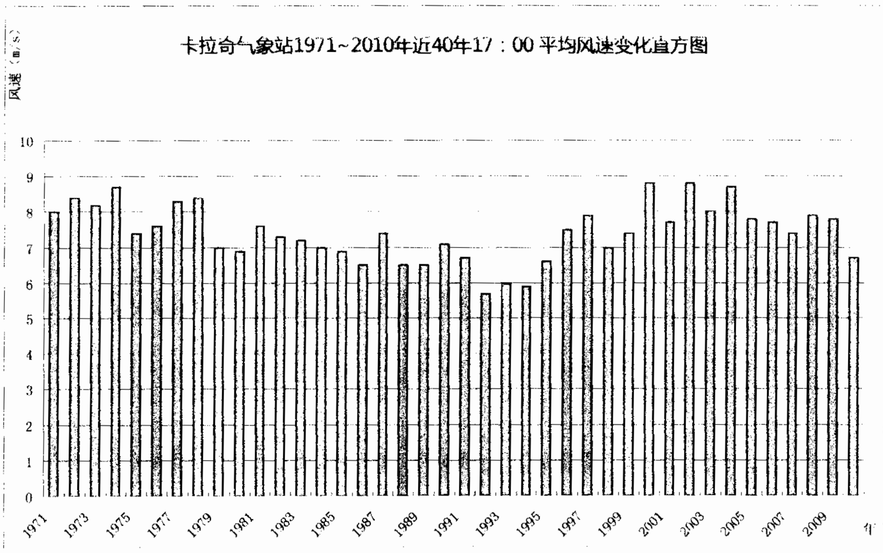


Figure 2.2 Average wind speed variation histogram obtained from Karachi meteorological station (1971~2010)

Table 2.2 and Figure 2.3 show that wind speed changes greatly at different times. At 05:00, annual average wind speed is 3.35m/s, at 17:00, annual average wind speed is 7.42m/s, with an increase of 4.07m/s, indicating that the daily variation of wind speed in this region is significant.

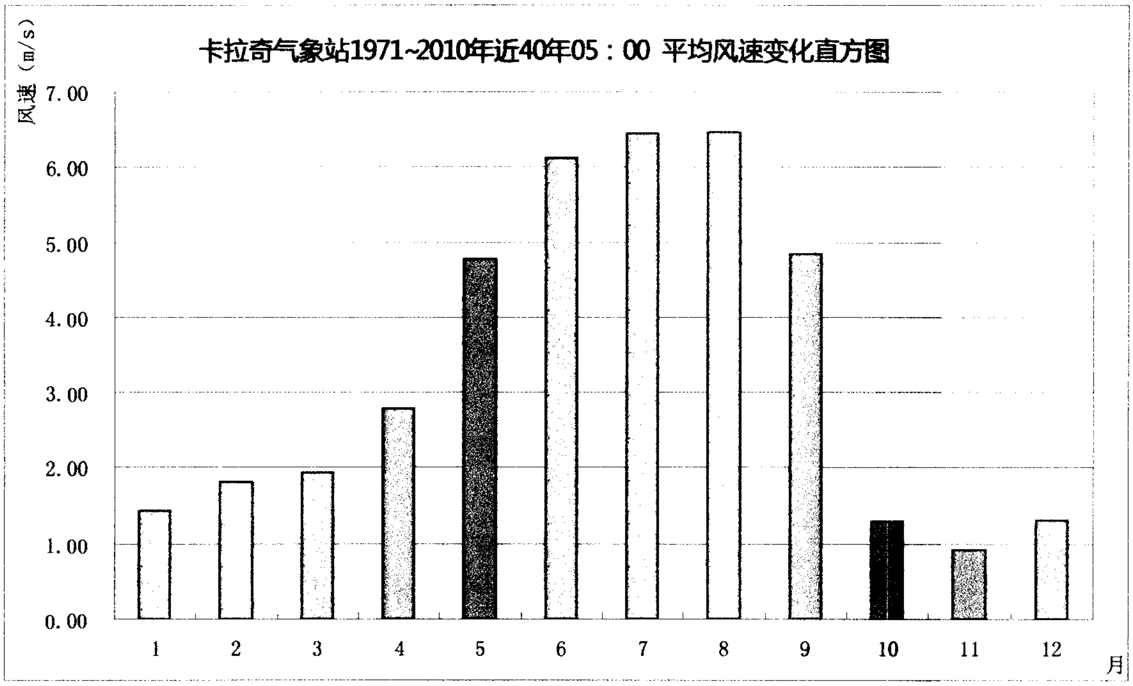
2.2.4 Monthly average wind speed

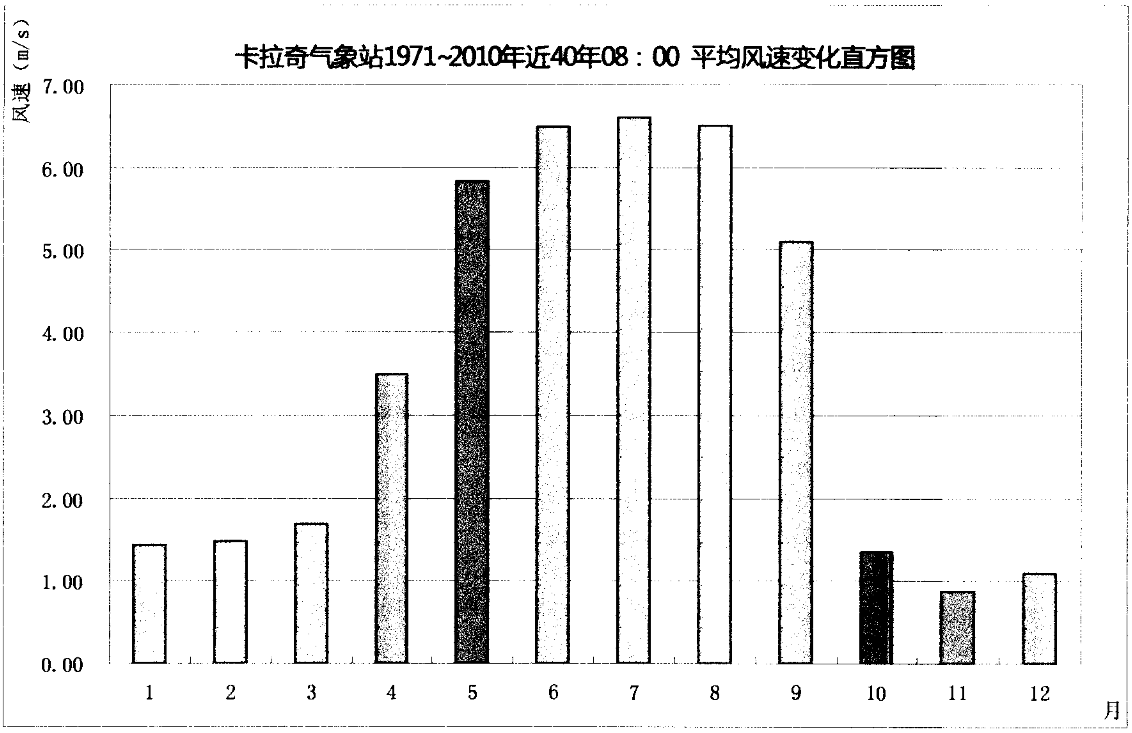
Monthly average wind speed variation at Karachi meteorological station (during the period from 1971 to 2010) is shown in Table 2.3 and Figure 2.3.

Table 2.3 Monthly average wind speed at the Karachi station

Unit: m/s

	1	2	3	4	5	6	7	8	9	10	11	12	Average
05:00	1.44	1.81	1.94	2.79	4.77	6.14	6.45	6.47	4.85	1.30	**0.93**	1.31	3.35
08:00	1.43	1.49	1.70	3.49	5.84	6.50	6.60	6.50	5.10	1.36	**0.88**	1.10	3.50
17:00	5.01	6.41	7.55	8.32	9.83	9.97	9.73	8.98	8.02	6.06	**4.75**	4.39	7.42





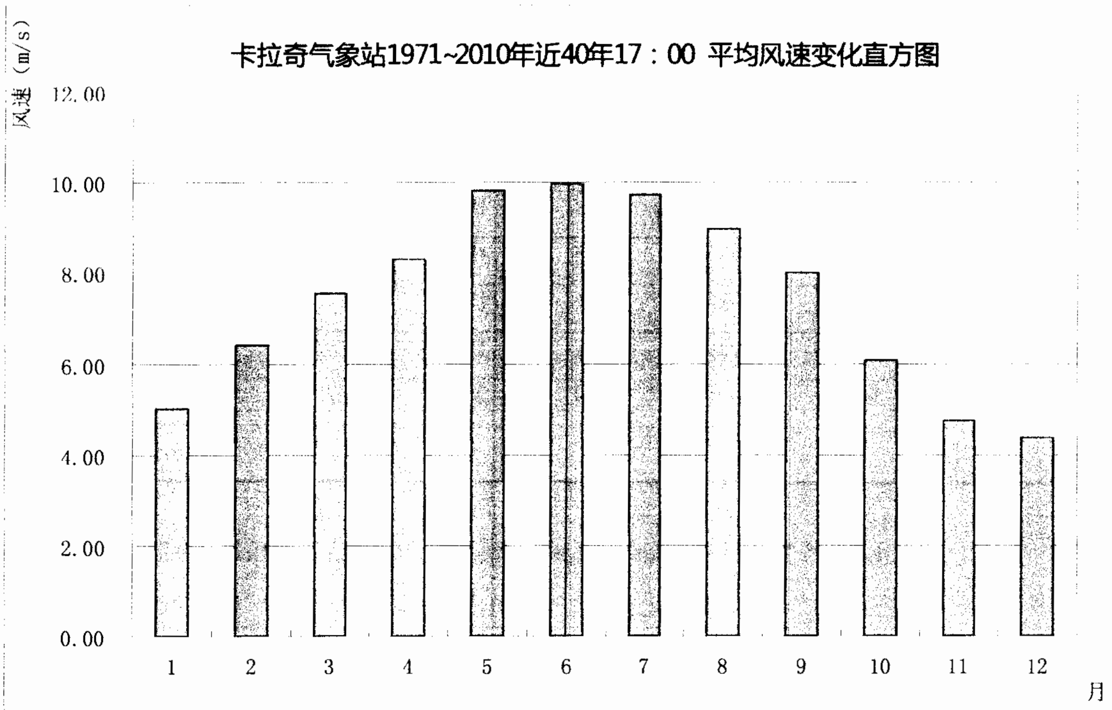


Figure 2.3 Monthly average wind speed variation histogram obtained from Karachi station (1971~2010)

Figure 2.3 shows that strong wind occurs in May to September and weak wind in October to next April.

2.2.5 Air temperature

Table 2.4 and Table 2.5 show the average temperature values over the years and the monthly average temperature values of Karachi meteorological station obtained based on statistics of the monthly average temperature values of nearly 40 years from 1971 to 2010 in Karachi station. The inter-annual variation and inter-monthly variation of average temperature are shown in Figure 2.4 and Figure 2.5, respectively.

Variation histogram of annual average temperature at Karachi meteorological station shows that air temperature in this area has a trend of gradual increase. The average annual temperature from 1971 to 1998 is 26.2℃, and average annual temperature from 1998 to 2010 is 27.2℃, increasing by nearly 1℃.

Table 2.4 Annual average temperature at Karachi station (1971~2010)

Year	Average temperature (℃)	Year	Average temperature (℃)	Year	Average temperature (℃)	Year	Average temperature (℃)
1971	26	1981	26.3	1991	26.1	2001	27.9

1972	25.8	1982	26.2	1992	26.3	2002	26.8
1973	25.9	1983	25.9	1993	27.2	2003	26.9
1974	25.8	1984	25.6	1994	26.1	2004	27.3
1975	25.9	1985	26.1	1995	26.6	2005	27
1976	25.9	1986	25.8	1996	26.4	2006	27.4
1977	26.6	1987	26.5	1997	26.2	2007	27.5
1978	26	1988	27.1	1998	27.3	2008	26.8
1979	26.2	1989	26.1	1999	26.7	2009	27.6
1980	26.4	1990	25.9	2000	27.1	2010	27.5
						Average	**26.5**

Table 2.5 Monthly average temperature at Karachi station (1971~2010)

Unit: ℃

Month	1	2	3	4	5	6	7	8	9	10	11	12	Average
Temperature	8.0	20.4	24.6	28.2	30.3	31.1	29.9	28.6	28.8	28.2	24.2	20.1	26.0

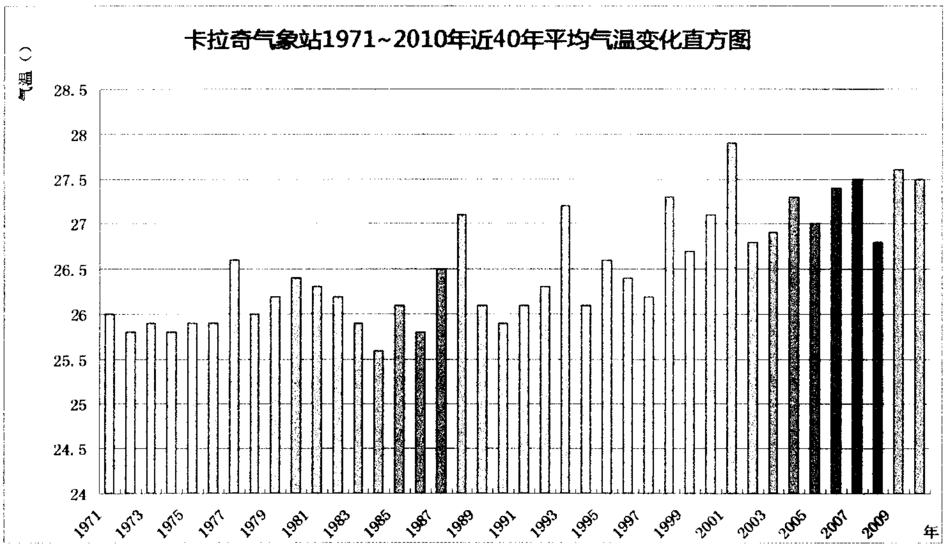


Figure 2.4 Histogram of annual average temperature change at Karachi station (1971~2010)

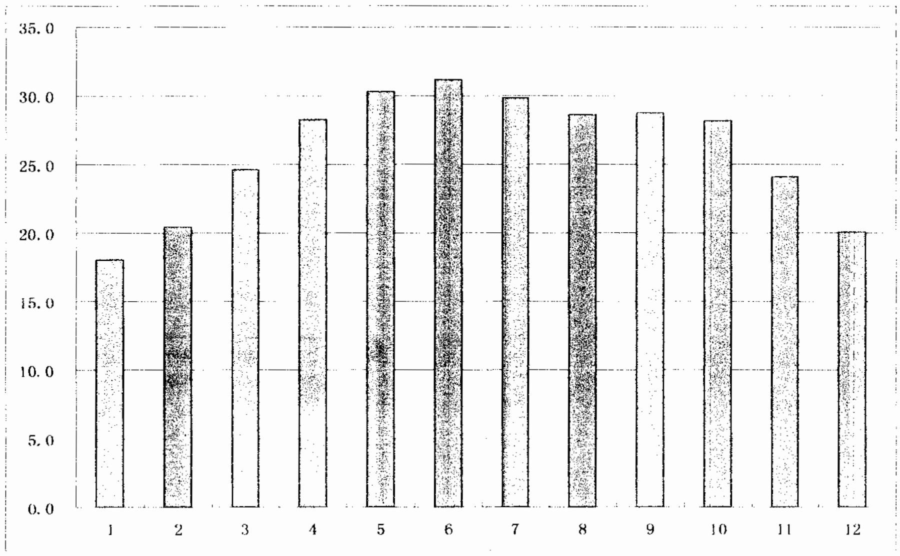


Figure 2.5 Histogram of monthly average temperature change at Karachi station (1971~2010)

2.3 Wind Data of the Wind Farm

2.3.1 Basic wind data

Wind data measured by two anemometer towers (Lucky and FFC) near Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") have been collected. Lucky anemometer tower is 4km away from the center of the wind farm site in crow flight distance and FFC anemometer tower 7km. Wind data of both anemometer towers over a whole year are available and the integrity rate of valid data is relatively high.

To verify the representativeness of the anemometer towers, 3TIER numerical weather predication model of U.S. is used to conduct a simulating calculation on the wind resource situation over the past 30 years of this region, the result is shown in Figure 2.6, and the area pointed by arrow is the center of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2").

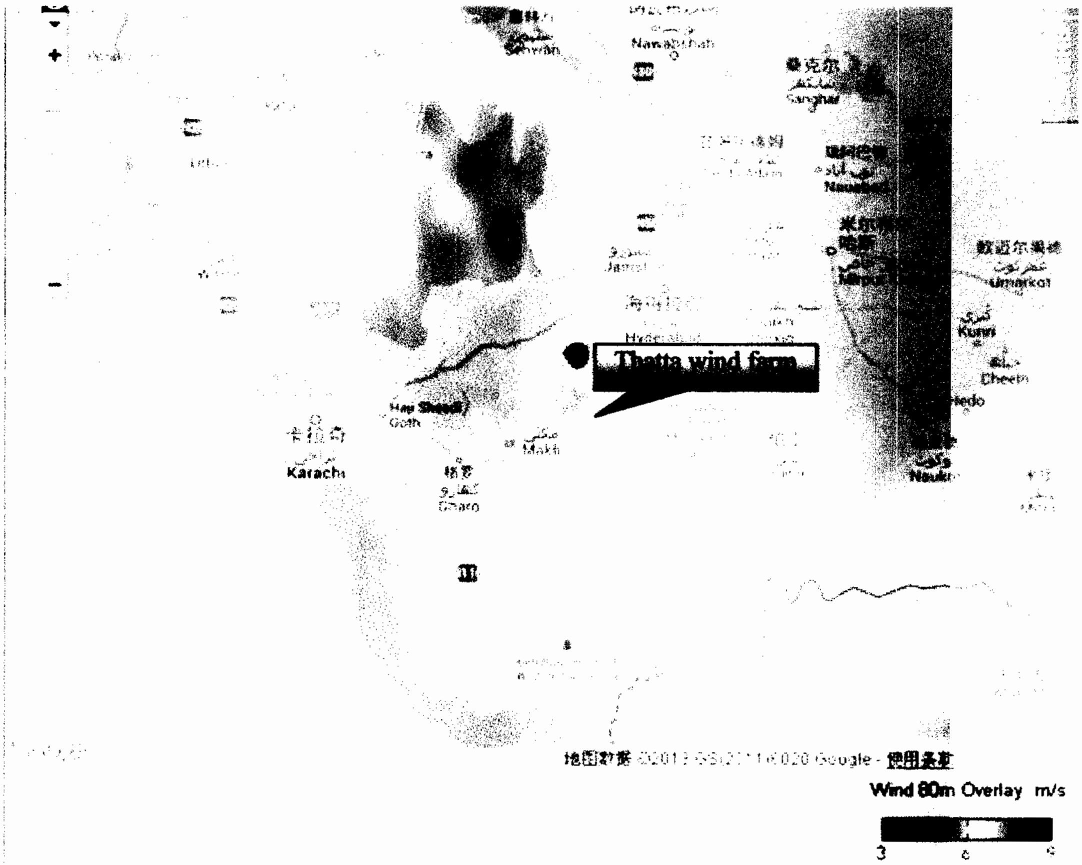


Figure 2.6 Simulated wind resource distribution map for Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") at 80m height by 3TIER database

In accordance with the annual average wind speed at 80m height in Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") area simulated with 3TIER database statistics is 8.1±1.1m/s, and the annual average wind speed at 80m height for both Lucky and FFC anemometer towers is 7.8±1.0m/s, it can be seen that the annual average wind speeds in the two areas have a little difference, indicating Lucky and FFC anemometer towers have a better representation with regard to Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2"). Lucky anemometer tower is only 4km away from the center of the wind farm and has a completed measured data of three years, thereby, the wind data of three years (January 1, 2009 ~ December 31, 2011) of Lucky anemometer tower is used as the basis of this wind resource analysis and calculation, and FFC anemometer tower is used as the reference.

The basic information of the anemometer towers is given in Table 2.6. The locations of the anemometer towers are shown in Figure 2.7

Table 2.6 Basic information of the anemometer towers in Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") area

Tower	Height	Wind measurement cycle	Coordinate	Elevation	Anemometer tower configuration
Lucky	85m	2009.01.07 ~ 2011.12.31	N 25° 8'08" E 67°59'46.9"	85m	Anemograph 10m\30m\60m\85 Wind vane 28.5m\83.5 Temperature and air pressure
FFC	80m	2007.06.01 ~ 2010.04.31	N 25° 4'33.20" E 67°58'22.20"	50m	Anemograph 10m\30m\、60m\80m(1)\80m(2) Wind vane 28m\78m Temperature and air pressure

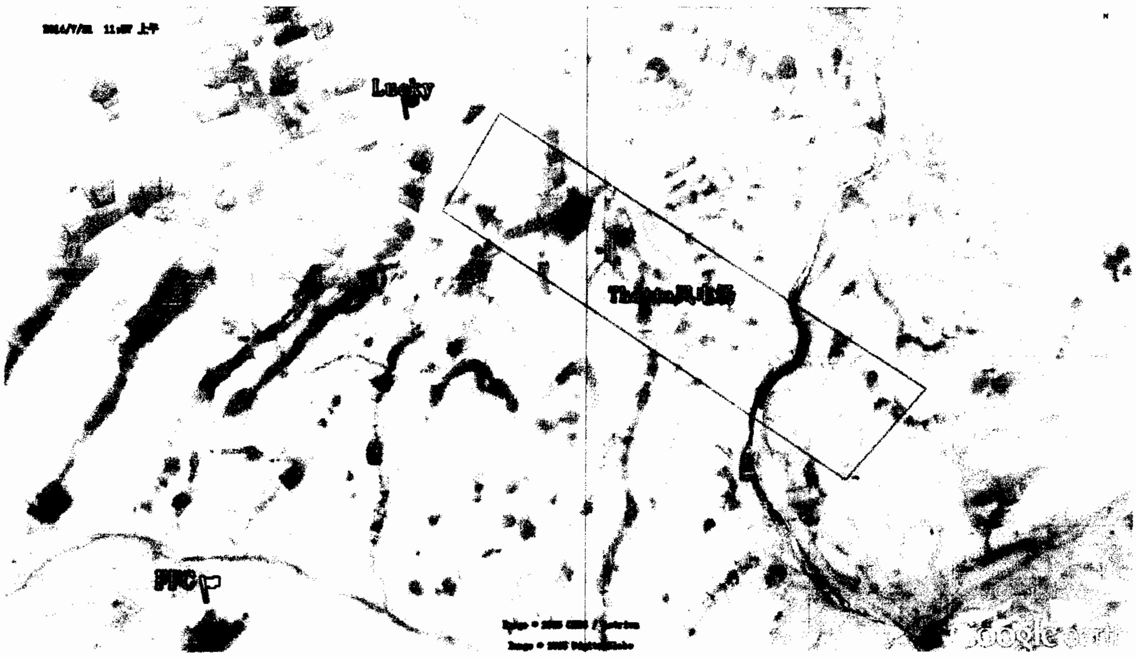


Figure 2.7 Geographical location of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") and the anemometer towers

2.3.2 Validation and analysis of wind measurement data

To effectively evaluate the wind energy resources of the wind farm, all the original wind measurement data have been respectively verified and the discretion on the data integrality and rationality has been made, thus to find out the irrational data and absent data.

According to the *Methodology of Wind Energy Resource Assessment for Wind Farm*

(GB/T18710-2002), Wind Data Validation & Evaluation Software for Wind Farm Design (2.0 version) developed by Beijing Millennium Engineering Software Co., Ltd has been applied for validation of integrity, range, relativity and wind speed variation trend on the measured data of each anemometer tower, including the following items:

(1) Hourly average wind speed range: 0m/s~40m/s;

(2) Wind direction range: 0°~360°;

(3) When the cut-in wind speed is over 5.0m/s, the wind speed and wind direction remain unchanged for continuous 6 hours;

(4) Hourly average wind speed variation is less than 6.0m/s;

(5) Under height difference of 1m~20m, the average wind speed difference is less than 2.0m/s;

(6) Under height difference of 21m~40m, the average wind speed difference is less than 4.0m /s;

(7) When the cut-in wind speed is over 5.0m/s, the standard deviation of wind speed is less than 10.

After validation, all irrational data and absent data as well as the corresponding duration have been listed out. The irrational data have been checked again so as to find out the valid data and insert the data back to the original data group. For check result of each anemometer tower, please refer to Table 2.7. For measured wind speed of each anemometer tower, please refer to Table 2.8.

Table 2.7 Check of wind data of anemometer towers

Tower	Check duration	Supposed data	Absent data	Irrational data	Valid data	Integrity rate of valid data
FFC	2007.06.01 ~2010.04.31	153361	11586	0	141775	92.4%
Lucky	2009.01.01 ~2011.12.31	157680	5177	0	152503	96.7%

Table 2.8 Monthly average wind speed at each height measured by each anemometer tower (unit: m/s)

Tower		Height	1	2	3	4	5	6	7	8	9	10	11	12	Annual Average
Lucky	2009	85m	8.0	6.1	6.2	7.0	8.9	8.8	9.3	9.3	8.5	5.7	6.9	7.1	7.66
		60m	7.5	5.7	5.8	6.7	8.7	8.6	9.0	9.1	8.1	5.3	6.4	6.6	7.30
		30m	6.3	4.9	5.2	5.9	8.0	8.0	8.4	8.5	7.3	4.6	5.2	5.3	6.49
		10m	5.2	4.0	4.3	5.0	7.1	7.2	7.5	7.5	6.3	3.7	4.0	4.0	5.49
	2010	85m	6.5	6.2	6.6	8.0	9.9	9.6	8.1	7.1	6.6	6.0	6.7	7.3	7.39

Tower		Height	1	2	3	4	5	6	7	8	9	10	11	12	Annual Average
		60m	6.1	5.8	6.3	7.7	9.6	9.3	7.9	6.7	6.3	5.5	6.3	6.7	7.02
		30m	5.1	5.0	5.5	6.9	8.8	8.6	7.3	6.1	5.6	4.7	5.3	5.5	6.21
		10m	4.0	4.0	4.6	6.0	7.7	7.7	6.4	5.2	4.7	3.8	4.1	4.3	5.22
	2011	85m	6.7	6.3	6.7	6.5	10.0	10.7	9.5	8.3	7.7	6.0	5.9	7.1	7.63
		60m	6.2	5.9	6.3	6.2	9.8	10.4	9.2	8.0	7.2	5.6	5.6	6.6	7.28
		30m	5.2	5.0	5.5	5.6	9.1	9.7	8.6	7.4	6.3	4.8	4.6	5.4	6.45
		10m	4.1	4.0	4.6	4.7	8.0	8.6	7.7	6.5	5.3	3.8	3.5	4.1	5.42
FFC	2007	80m						8.9	8.8	9	8.5	6.1	5.2	7.1	(7.62)
		_80m						9	8.7	8.8	8.3	6.1	5.2	7.2	(7.56)
		60m						8.7	8.6	8.7	8.2	5.8	4.9	6.7	(7.33)
		30m						8.1	8	8.1	7.6	4.9	4.1	5.5	(6.55)
		10m						7.1	7	7.2	6.6	3.7	3	4.2	(5.47)
	2008	80m	7.1	5.2	6.6	7.4	11.9	9	10.2	9.5	8.2	6.8	7.4	6.5	8.11
		_80m	7.1	5.2	6.6	7.3	11.5	8.9	9.9	9.1	7.9	6.7	7.4	6.5	7.97
		60m	6.7	5	6.3	7.1	11.6	8.9	10.1	9.3	7.9	6.5	6.9	6.2	7.84
		30m	5.6	4.3	5.6	6.5	10.9	8.4	9.5	8.7	7.2	5.6	5.7	5.2	7.09
		10m	4.3	3.3	4.6	5.5	9.7	7.4	8.5	7.8	6.3	4.5	4.4	4.2	6.03
	2009	80m	7.9	6.1	6.5	7.2	9.2	9.2	8.8	9.2	8.5	5.5	6.7	6.8	7.55
		_80m	7.9	6.1	6.4	7.1	9.0	9.0	8.6	8.8	8.2	5.5	6.8	6.8	7.45
		60m	7.4	5.8	6.2	6.9	9.0	9.1	8.6	8.9	6.3	5.2	6.3	6.3	7.07
		30m	6.3	5.0	5.5	6.2	8.4	8.5	8.1	7.6	7.4	4.4	5.2	5.2	6.40
		10m	5.2	4.0	4.6	5.2	7.4	7.6	7.2	7.5	6.4	3.5	3.8	3.9	5.40
	2010	80m	6.4	6.2	6.8	8.2									(6.9)
		_80m	6.4	6.3	6.7	8.1									(6.85)
		60m	6	5.9	6.4	7.9									(6.54)
		30m	5	5	5.8	7.3									(5.75)
		10m	3.8	3.9	4.7	6.3									(4.69)

Note: () means incomplete statistics.

2.3.3 Analysis of representativeness of long series data

To obtain a set of data representing long-term average wind speed at the wind farm, the long-term wind data recorded at Karachi meteorological station shall be used for revision and amendment of the data collected by Lucky anemometer tower. Annual average wind speed of Karachi station in the past 30 years (January 1981 ~ December 2010) is 4.63m/s; in the past 20 years (January 1991 ~ December 2010) is 4.78m/s; in the past 10 years (January 2001 ~ December 2010) is 5.07m/s. According to investigation, the wind data of Karachi station have been obtained through manual observation at 05:00, 08:00 and 17:00 every day and the data are of poor accuracy. Therefore, during this wind energy resource analysis, the hourly wind speed and wind direction data collected by Lucky anemometer tower at 85m height from January 1991 to December 2010 are revised and analyzed additionally with the long series data of MERRA database.

MERRA, a reanalysis data product established by "Model Analysis and Forecasting" project of NASA, is developed on the basis of GEOS-5, which includes various modern climate observation systems such as EOS, with normal accuracy of 5km per pixel and highest accuracy of 3.5km per pixel. MERRY covers all the remote sensing data from 1979 to the present.

In this study, the hourly wind data measured at 80m height in nearly 30 years (January 1981 ~ December 2014) at the location of Lucky tower in MERRY database is collected. According to statistics of MERRA' data, the average wind speed in the time period of nearly 30 years is 7.78m/s, the average wind speed in the time period of nearly 20 years is 7.66m/s, and the average wind speed in the time period of nearly 10 years is 7.43m/s. While the contemporary record (January 2009 ~ December 2011) of average wind speed at the location of Lucky anemometer tower in MERRY database is 7.35m/s. Considering the global climate change, the time period for representative characteristic analysis of long series shall not be too long, so the average wind speed in the time period of nearly 10 years in MERRY database is taken as analysis base. The contemporary record at the location of Lucky anemometer tower is 1.09% smaller than the MERRY's data, and is close to the average in nearly 10 years of the meteorological station, showing a good long series representation.

With comprehensive consideration of the representativeness analysis of long series data of Karachi station and MERRA, no correction is made in this design report.

2.4 Calculation of Wind Resources

2.4.1 Air density

Average air density is calculated by using the following formula according to average monthly temperature, air pressure and vapor pressure measured at Karachi station (1971 to 2010):

$$\rho = \frac{1.276}{1+0.00366t} \times \frac{p-0.378e}{1000}$$

Where,

t - average monthly temperature;

p - average monthly air pressures;

e - average monthly vapor pressure.

Regional average air density in Karachi station is calculated as 1.163kg/m^3. The air density at the hub height in the site is estimated to be 1.150kg/m^3 according to the data of Karachi station.

In addition, Lucky and FFC anemometer towers are furnished with free air temperature gauges and barometers. Air density is calculated by the following formula:

$$\rho = \frac{P}{RT}$$

Where,

ρ - air density, kg/m^3;

P - average annual atmospheric pressure, hPa;

T - average annual air Kelvin absolute temperature (℃+273);

R - meteorological constant (287J/kg·K).

For Lucky anemometer tower, the average air temperature measured is 32.49℃, average air pressure is 999.70hPa, substituting the values into the formula, the air density at the hub height is worked out as 1.131kg/m^3. For FFC anemometer tower, the average air temperature measured is 26.67℃, average air pressure is 1002.29hPa, substituting the values into the formula, the air density at the hub height is worked out as 1.155kg/m^3. Considering that Lucky anemometer tower with same altitude as the wind farm is only 4km away from the center of the wind farm, and temperature and air pressure data of three years are available at the anemometer tower. Based on comprehensive analysis, the air density of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") site is estimated as 1.131kg/m^3.

2.4.2 Calculation of wind energy

(1) Average wind speed and wind power density

According to the statistics of data obtained from Lucky anemometer tower from January 1, 2009 to December 31, 2011, annual average wind speed at height of 90m (calculated based on 85m with shear index of 0.14) is 7.62 m/s, annual average wind power density is 382 W/m^2, utilization hour at annual effective wind speed (3.0m/s~20.0m/s) is 7357; annual average wind speed at height of 85m is 7.65 m/s, annual average wind power density is 372 W/m^2, utilization hour at annual effective wind speed (3.0m/s~20.0m/s) is

7339; annual average wind speed at height of 60m is 7.2 m/s, annual average wind power density is 331 W/m^2, utilization hour at annual effective wind speed (3.0m/s~20.0m/s) is 7311. Monthly average wind speed and wind power density statistical results of Lucky anemometer tower at various heights are shown in Table 2.9.

Table 2.9 Statistics of monthly average wind speed and wind power density at various heights of Lucky anemometer tower

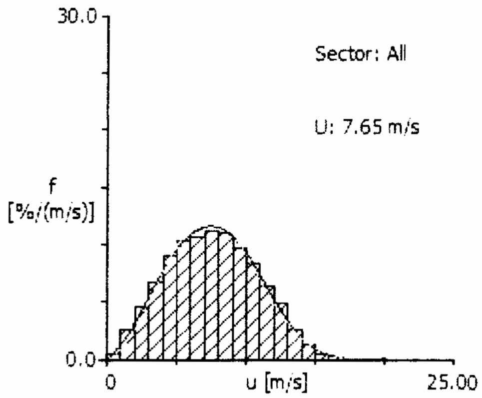
Wind speed: m/s; wind power density: W/m^2

Height	Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual average
90m	Wind speed	7.13	6.24	6.53	7.25	9.7	9.77	9.03	8.26	7.65	5.91	6.54	7.23	7.62
	Wind power density	320	226	240	322	657	665	580	433	319	175	264	348	382
85m	Wind speed	7.07	6.19	6.48	7.19	9.62	9.69	8.96	8.20	7.59	5.86	6.48	7.17	7.56
	Wind power density	313	221	235	315	641	650	566	423	311	171	258	339	372
60m	Wind speed	6.6	5.81	6.13	6.84	9.33	9.45	8.72	7.92	7.2	5.49	6.06	6.62	7.2
	Wind power density	248	179	204	281	604	619	536	394	276	141	205	254	331
30	Wind speed	5.55	4.98	5.41	6.13	8.63	8.79	8.09	7.28	6.42	4.71	5.04	5.38	6.39
	Wind power density	147	111	144	211	487	502	431	311	204	89	116	131	242
10m	Wind speed	4.4	3.99	4.51	5.23	7.62	7.81	7.18	6.37	5.46	3.73	3.87	4.13	5.38
	Wind power density	83	63	91	141	342	355	301	213	134	51	61	67	160

(2) Wind frequency curve and Weibull parameters

Curve fitting calculation is conducted by using WASP10.0 program, annual average wind speed measured by Lucky anemometer tower at height of 90m is 7.65m/s, average wind power density is 387W/m^2, Weibull parameters A = 8.7, k = 2.69; annual average wind speed measured by Lucky anemometer tower at height of 85m is 7.59m/s, average wind power density is 379W/m^2, Weibull parameters A = 8.6, k = 2.69; annual average wind speed measured by Lucky anemometer tower at height of 60m is 7.23m/s, average wind power density is 330W/m^2, Weibull parameters A = 8.2, k = 2.62. The Weibull distribution of wind speed measured by Lucky anemometer tower at height of 90m and

85m is shown in Figure 2.8. The Weibull distribution curve fitting is good in general.



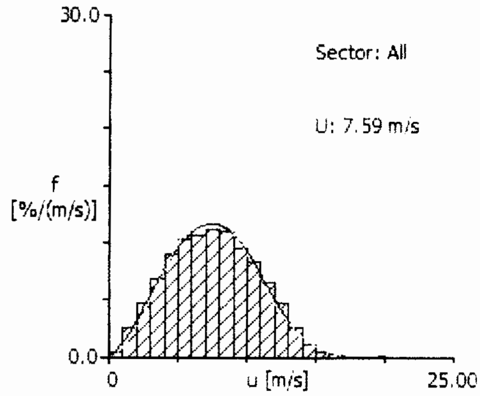


Figure 2.8 Weibull distributions of wind speed at height of 90m and 85m of Lucky anemometer tower

(3) Wind speed and wind direction characteristics

a) Wind direction and wind speed

Annual wind direction and wind energy rose diagram plotted based on data measured by Lucky anemometer tower at height of 90m are shown in Figures 2.10 and 2.11, respectively. Figures show that the main wind direction for Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is west-southwest (WSW) wind and west (W) wind, accounting for 31.62%, 30.99% of all year's wind, respectively; prevailing wind energy direction is also west (W) wind and west-southwest (WSW) wind, accounting for 23.54% and 22.79% of all year's wind, respectively, the prevailing wind direction is consistent with prevailing wind energy direction. The statistics for wind direction and wind energy proportion of various sectors at height of 90m in Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") are shown in Table 2.12.

Table 2.12 Annual wind direction and wind energy proportion of various sectors at height of 90m for Lucky anemometer tower

Unit: %

Sector	N	NNE	NE	ENE	E	ESE	SE	SSE
Wind direction	0.32	7.46	15.64	2.37	0.42	0.13	0.07	0.08
Wind power	1.34	6.19	14.84	6.23	2.23	0.82	0.66	0.56

Sector	S	SSW	SW	WSW	W	WNW	NW	NNW
Wind direction	0.24	0.37	2.26	31.62	30.99	5.23	2.13	0.67
Wind power	1.34	1.67	3.72	22.79	23.54	8.17	3.93	1.97

The histogram of wind speed and wind energy distribution plotted based on data measured by Lucky anemometer tower at height of 90m is shown in Figure 2.12. Wind speed distribution shows that the wind speed mainly varies from 3.0m/s to 12.0m/s, accounting for 89.09% of the year's wind; wind energy mainly varies from 7.0m/s to 14.0m/s, accounting for 87.11% of the year's wind, this wind speed distribution is favorable to annual power generation. The wind speed and wind energy distribution plotted based on data measured by Lucky anemometer tower at height of 90m are given in Table 2.13.

Table 2.13 Wind speed and wind energy distribution at 90m of Lucky anemometer tower

Sector (m/s)	Wind speed frequency (%)	Wind power frequency (%)	Sector (m/s)	Wind speed frequency (%)	Wind power frequency (%)
<0.5	0.02	0	12	5.7	14.52
1	0.92	0	13	3.72	11.99
2	3.44	0.05	14	1.7	6.79
3	5.81	0.24	15	0.61	2.99
4	7.78	0.76	16	0.24	1.43
5	9.86	1.85	17	0.17	1.2
6	10.57	3.39	18	0.06	0.53
7	11.13	5.67	19	0.03	0.29
8	11.18	8.52	20	0.01	0.09
9	10.39	11.16	21	0	0
10	8.91	13.2	22	0	0.06
11	7.76	15.26	Total	100%	100%

b) Wind speed variation within a year

Normally, the wind speed within the period from May to September is relatively higher; the wind speed of the rest seven months is relatively lower. The variation curve of wind speed and wind power density of Lucky anemometer tower at height of 90m within a year is indicated in Figure 2.14.

c) Daily variation of wind speed

The wind speed variation within a day is very complex; it's difficult to be expressed by a curve. The daily variation curve of wind speed and wind power density based on wind measurement statistics of Lucky anemometer tower at height of 90m is shown in Figure 2.13; the monthly daily variation curve of wind speed and wind power density based on wind measurement statistics of Lucky anemometer tower at height of 90m is shown in Figure 2.17. It can be seen from the above figures that the wind speed decreases from dawn and reaches the minimum at 2:00 pm, then quickly increases and reaches the maximum at 6:00 pm, after which, it slowly decreases until dawn, showing a "M" shaped variation.

(4) Wind shear indices

The wind shear indices of each anemometer tower in the Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") at various heights are shown in Table 2.14.

Table 2.14 Wind shear indices of each anemometer tower in the Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") at various heights

	Height	10m	30m	50m	60m
Lucky	30m	0.157			
	60m	0.163	0.172		
	85m	0.159	0.161		0.140
FFC	30m	0.157			
	60m	0.155	0.143		
	80m(1)	0.150	0.156		0.117
	80m(2)	0.156	0.154		0.162

According to the wind measurement data of Lucky anemometer tower at various heights, the equation of correlationship between different heights and corresponding wind speeds is fitted, the fitting equation: $Y=6.410X^{0.155}$, the correlation coefficient is 0.996, the shear index is 0.155, the fitting curve is shown in Figure 2.9. According to the wind measurement data of FFC anemometer tower at various heights , the equation of correlationship between different heights and corresponding wind speeds is fitted, the fitting equation: $Y=6.615X^{0.140}$, the correlation coefficient is 0.997, the shear index is 0.140, and the fitting curve is shown in Figure 2.10.

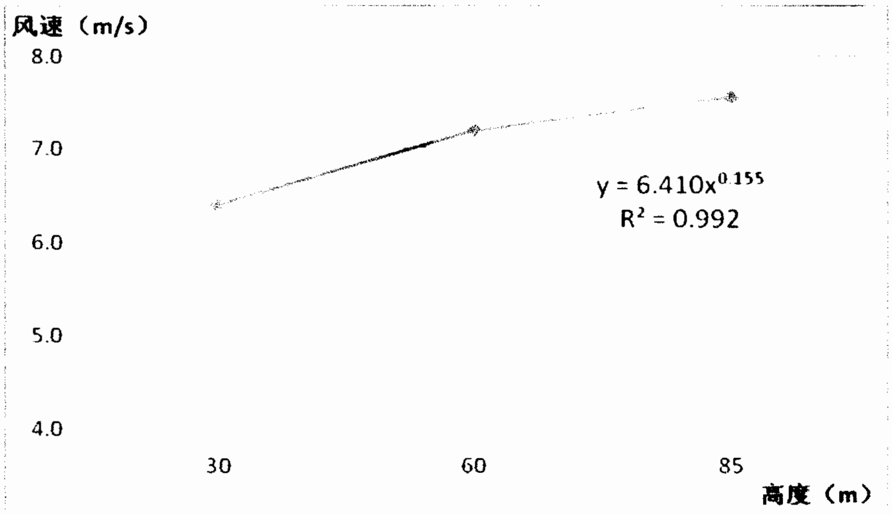


Figure 2.9 Fitting curve of wind shear index for Lucky anemometer tower

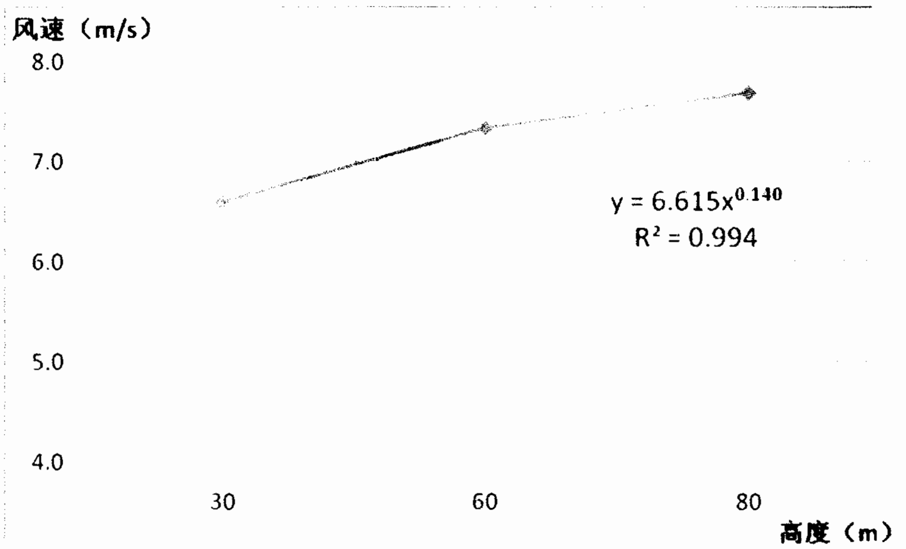


Figure 2.10 Fitting curve of wind shear index for FFC anemometer tower

According to the above calculation results, the wind shear indices of various heights for Lucky anemometer tower vary from 0.140 to 0.172, the wind shear indices of various heights for FFC anemometer tower vary from 0.117 to 0.162, and the wind shear values of the two anemometer towers at various heights are consistent with that obtained from the fitting equation. Consulting assessment of other nearby wind farms, the wind shear index is taken as 0.14.

(5) Turbulence intensity

The turbulence intensity of 15m/s wind speed section is calculated by the following formula:

$$I_T=\sigma/ V$$

Where,

V - average wind speed of 15.5m/s> V> 14.5m/s;

σ - standard deviation of corresponding wind speed.

The average turbulence intensity of the anemometer towers at different heights under wind speed sector of 15m/s are shown in Table 2.15.

Table 2.15 Average turbulence intensity of the anemometer towers at different heights

Tower	85m	80m (1)	80m (2)	60m	30m	10m
Lucky	0.076			0.088	0.109	0.132
FFC		0.069	0.075	0.077	0.101	0.104

From Table 2.15, turbulence intensity of both anemometer towers decreases with the increase of height, the turbulence intensity is relatively small. The average turbulence intensity and representative turbulence intensity of the two anemometer towers at 90m height under different wind speed sectors are shown in Table 2.16 and Table 2.17, and the turbulence intensity variation under different wind speed sectors are shown in Figure 2.11 and Figure 2.12.

Table 2.16 Calculation result of turbulence intensity of Lucky anemometer tower at 90m height under different wind speed sectors

Wind speed sector (m/s)	Record number	Average turbulence intensity	Standard deviation of turbulence intensity	Representative turbulence intensity	Maximum turbulence intensity
3	8612	0.179	0.11	0.32	1.067
4	11892	0.132	0.086	0.241	0.86
5	14878	0.103	0.067	0.189	0.783
6	16002	0.086	0.055	0.156	0.729
7	16739	0.077	0.047	0.137	0.746
8	17078	0.074	0.04	0.125	0.468
9	15784	0.073	0.036	0.119	0.495
10	13594	0.074	0.033	0.116	0.536
11	11783	0.072	0.031	0.112	0.481
12	8520	0.072	0.031	0.111	0.412
13	5760	0.07	0.031	0.109	0.267
14	2563	0.076	0.027	0.11	0.36
15	1047	0.076	0.024	0.107	0.311
16	438	0.081	0.027	0.115	0.387
17	213	0.084	0.02	0.11	0.173
18	106	0.087	0.031	0.127	0.253
19	49	0.082	0.023	0.111	0.148
20	16	0.071	0.029	0.107	0.17
21	12	0.067	0.026	0.101	0.139

22	5	0.1	0.052	0.166	0.192
23	1	0.061	0	0.061	0.061

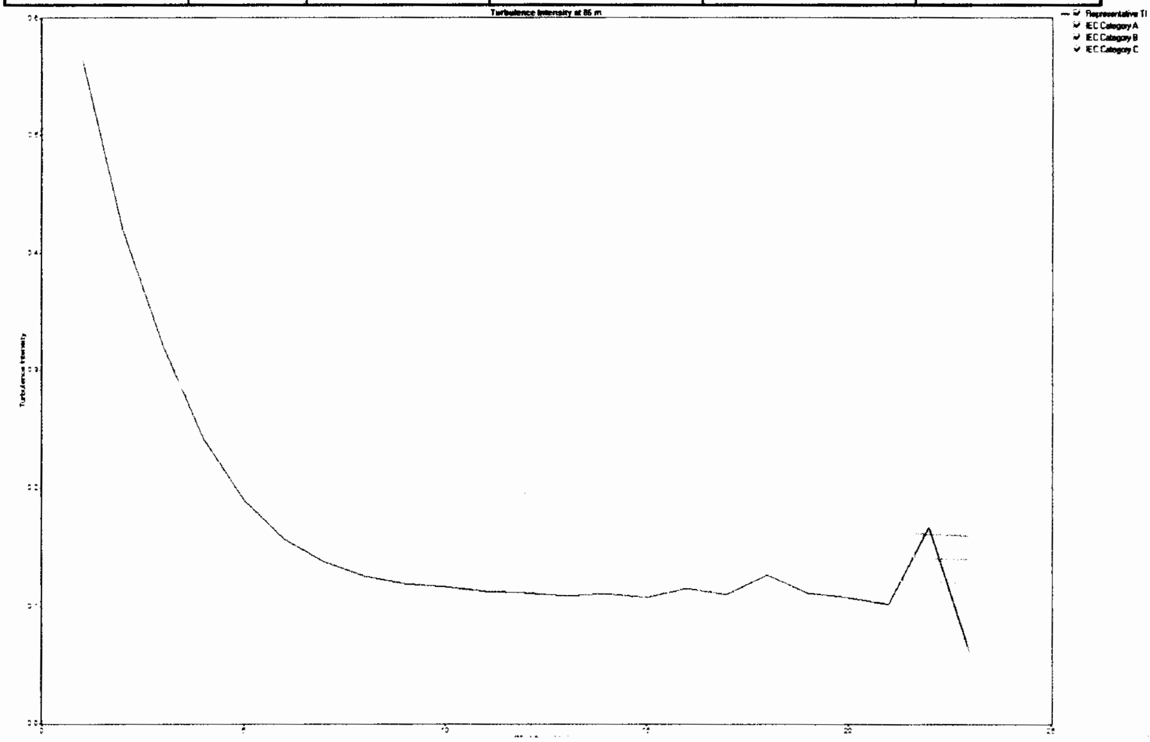


Figure 2.11 Turbulence intensity variation of Lucky anemometer tower at 90m height under different wind speed sectors

Table 2.17 Calculation result of turbulence intensity of FFC anemometer tower at 90m height under different wind speed sectors

Wind speed sector (m/s)	Record number	Average turbulence intensity	Standard deviation of turbulence intensity	Representative turbulence intensity	Maximum turbulence intensity
3	2832	0.173	0.109	0.313	0.769
4	3778	0.131	0.084	0.239	0.649
5	4768	0.107	0.067	0.192	0.660
6	5297	0.090	0.053	0.157	0.458
7	5835	0.083	0.044	0.139	0.557
8	6250	0.077	0.038	0.126	0.487
9	5657	0.075	0.035	0.120	0.660
10	4929	0.075	0.033	0.117	0.268
11	3811	0.075	0.031	0.115	0.189
12	2806	0.076	0.032	0.116	0.355
13	1860	0.066	0.034	0.110	0.156
14	915	0.070	0.033	0.112	0.186
15	533	0.076	0.031	0.116	0.289
16	302	0.083	0.022	0.111	0.139
17	170	0.087	0.018	0.110	0.132
18	97	0.082	0.014	0.101	0.115
19	36	0.085	0.020	0.110	0.150

20	10	0.076	0.019	0.101	0.108
21	4	0.068	0.003	0.073	0.072
22	7	0.060	0.008	0.070	0.074
23	2	0.060	0.004	0.064	0.062

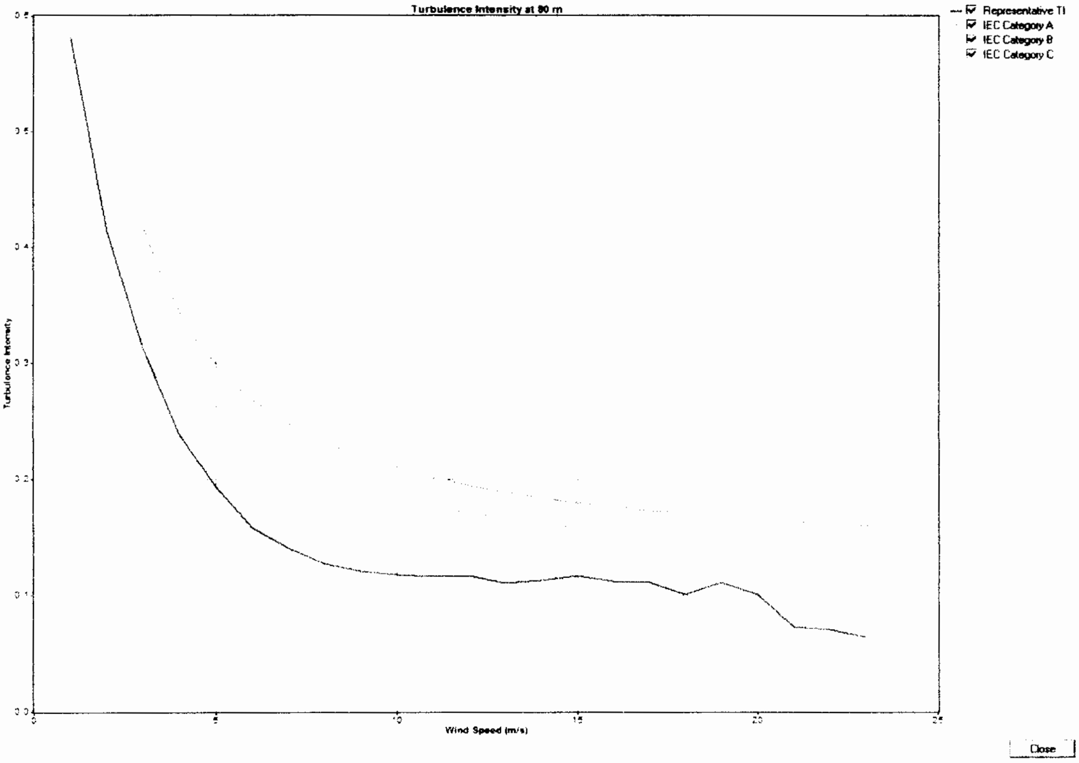


Figure 2.12 Turbulence intensity variation of FFC anemometer tower at 90m height under different wind speed sectors

From the above tables and figures, the turbulence intensity of the two anemometer towers at height of 90m shows a decreasing tendency with the increase of wind speed, the turbulence is of type IEC c, and the turbulence intensity is not high.

(6) 50-year extreme high wind speed

As the hourly wind data of Karachi weather station and anemometer tower over the same period cannot be collected, so the correlation cannot be established to calculate the 50-year maximum wind speed of the wind farm. Therefore, the following calculation methods are used in this report to determine the 50-year maximum wind speed of the wind farm.

1) 7-day wind speed extremum method

In this method, 10 minutes of observation data of anemometer tower is used in the wind farm, a maximum value is selected within 7 days, based on this 7-day wind speed extremum, 50-year maximum wind speed of the wind farm is estimated using Ⅰ-type extremum probability distribution.

Based on the measured data of Lucky and FFC anemometer towers, the 50-year extreme wind speeds at the wind turbine hub heights of 90m calculated using the above method are 34.2m/s and 35.9m/s, respectively (shear index is 0.14). The advantage of this method is that the data of anemometer towers can be directly used, the disadvantage is that the representation of the results is slightly worse due to relatively short time series.

2) Measured data of wind farm

The maximum and extreme wind speeds at different heights of each anemometer tower are obtained based on the measured data of five anemometer towers around the wind farm, as shown in Table 2.18.

Table 2.18 Maximum and extreme wind speeds at different heights of the anemometer towers

Wind Speed: m/s

Baburband					
Measurement period	2008-05-26 ~ 2011-11-30				
Height (m)	81.5	80	60	30	10
Maximum wind speed	27.7	27.7	25.5	22.7	18.7
Extreme wind speed	33.7	34.4	33.1	31.7	31.5
Lucky					
Measurement period	2009-01-01 ~ 2011-12-31				
Height (m)	85	85	60	30	10
Maximum wind speed	23	23	21.8	19.6	16.8
Extreme wind speed	29.5	29.4	30.2	29.9	30.1
FFC					
Measurement period	2009.01.01 ~ 2009.12.31				
Height (m)	80	80	60	30	10
Maximum wind speed	37.9	38.4	37.1	32.8	27.4
Extreme wind speed	51.6	52.3	52.4	48.9	44.1
Zorlu A					
Measurement period	2007.04.01 ~ 2009.03.31				
Maximum wind speed	37.13				
Extreme wind speed	54.5				
Master					
Measurement period	2007.04.01 ~ 2009.03.31				
Maximum wind speed	38.22				
Extreme wind speed	48.1				

Notes: No measured data is available at Zorlu A and Master anemometer towers; and the data in the above table has consulted the Feasibility Study Report of one wind power farm project in Karachi.

The statistic table shows that, with regard to the measured wind date from 2007 to 2009 of FFC and Master anemometer towers, the 10-minute maximum wind speed reached

37.5m/s, 3-second extreme wind speed of Zorlu A is greater than 52.5m/s, exceeding the standard of wind farm of Grade IEC III.

3) Estimation using empirical formula of average wind speed

The measured average wind speeds at the height of 85m data of Lucky anemometer tower is 7.56m/s, the measured average wind speeds at the height of 80m data of FFC anemometer tower is 7.55m/s. The empirical formula of average wind speed of IEC61400-1(2005) standard is used to estimate the maximum wind speeds of the two anemometer towers in Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") , the results are 37.8m/s and 37.75m/s, respectively, and is 36.32m/s and 36.27m/s after corrected to the standard air density. The calculation results of Lucky and FFC anemometer towers reach the 50-year extreme wind speed standard of IEC II.

4) Conclusion

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is located in Jhimpir, according to the calculation results of FFC, Zorlu A and Master anemometer towers, it's determined tentatively to adopt the wind turbine with IEC II safety standard or above for Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") . After long series wind speed data of the weather station is available, further analysis and calculation will be conducted.

2.5 Evaluation of Wind Resources

Based on the above analysis, the main wind direction of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is basically consistent with that of the main wind energy, and west-southwest (WSW) and west (S) winds have the maximum speed, power and frequency, with the prevailing wind in a direction stable.

According to the measured data by Lucky anemometer tower from January 1 2009 ~ December 21, 2011, the annual average wind speed at height of 90m is 7.62m/s, annual average wind power density is 382W/m^2, utilization hours with annual effective wind speed (3.0m/s-20.0m/s) are 7357; the annual average wind speed at height of 85m is 7.56m/s, annual average wind power density is 372W/m^2, utilization hours with annual effective wind speed (3.0m/s-20.0m/s) are 7339; the annual average wind speed at height of 60m is 7.2m/s, annual average wind power density is 331W/m^2, utilization hours with annual effective wind speed (3.0m/s-20.0m/s) are 7311. Curve fitting calculation is conducted by using WASP10.0 program, annual average wind speed measured by Lucky anemometer tower at height of 90m is 7.65m/s, average wind power density is 387W/m^2, Weibull parameters A=8.7, k=2.69; annual average wind speed measured by Lucky anemometer tower at height of 85m is 7.59m/s, average wind power density is 379W/m^2, Weibull parameters A=8.7, k=2.69; annual average wind speed measured by Lucky anemometer tower at height of 60m is 7.23m/s, average wind power density is 330W/m^2, Weibull parameters A=8.2, k=2.62. According to *Technical Regulations for Wind Energy Resource Measurement and Assessment of Wind Farm*, the wind power density standard of the wind farm is determined to be Grade III, indicating that the wind energy resources are relatively abundant.

The calculated based on wind speed data measured by Lucky anemometer tower at various heights under wind speed of 15m/s, turbulence intensity varies between 0.069~0.104, the calculated based on wind speed data measured by FFC anemometer tower at various heights under wind speed of 15m/s, turbulence intensity varies between 0.076~0.132, indicating that turbulence intensity is smaller. According to the results of a variety of calculation methods, it's proposed to tentatively adopt the wind turbine with IEC II safety standard or above for Norinco International Thatta Phase-II 50MW Wind Power Project (“Norinco-2”) .

In summary, there is no destructive wind speed in Norinco International Thatta Phase-II 50MW Wind Power Project (“Norinco-2”) , the wind quality is good, the prevailing wind direction is stable, enjoying good wind energy resources. Therefore, Norinco International Thatta Phase-II 50MW Wind Power Project (“Norinco-2”) boasts a desirable site for wind power development.

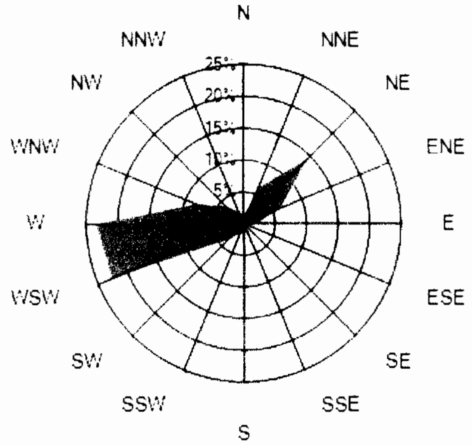


Figure 2.13 Rose diagram of wind direction at height of 90m for Lucky anemometer tower

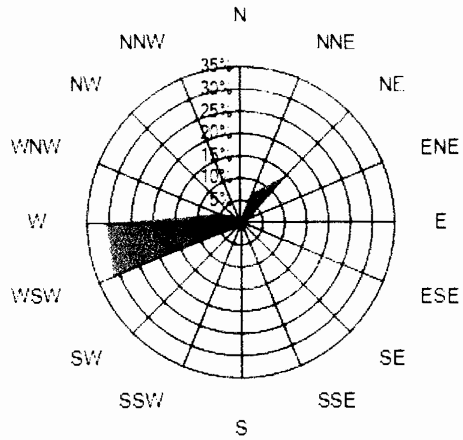


Figure 2.14 Rose diagram of wind energy at height of 90m for Lucky anemometer tower

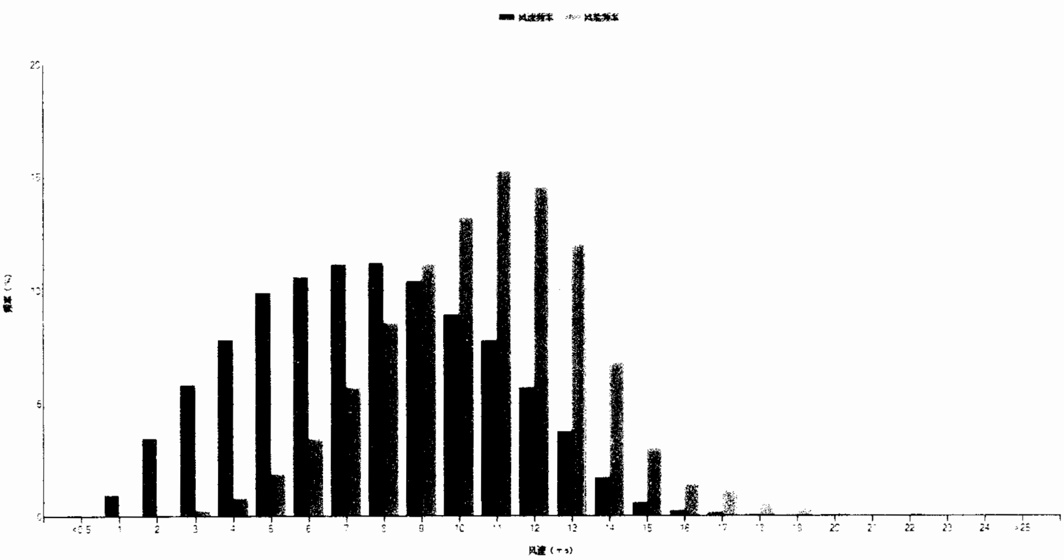


Figure 2.15 Distribution histogram of wind speed and wind energy at height of 90m for Lucky anemometer tower

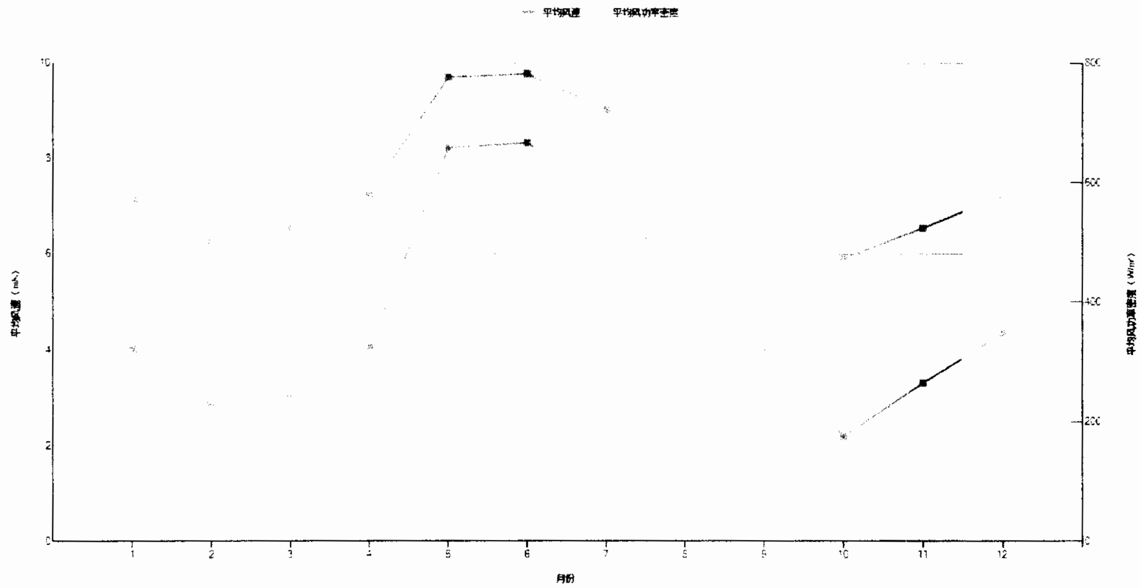


Figure 2.16 Annual variation curve of wind speed and wind power at height of 90m for Lucky anemometer tower

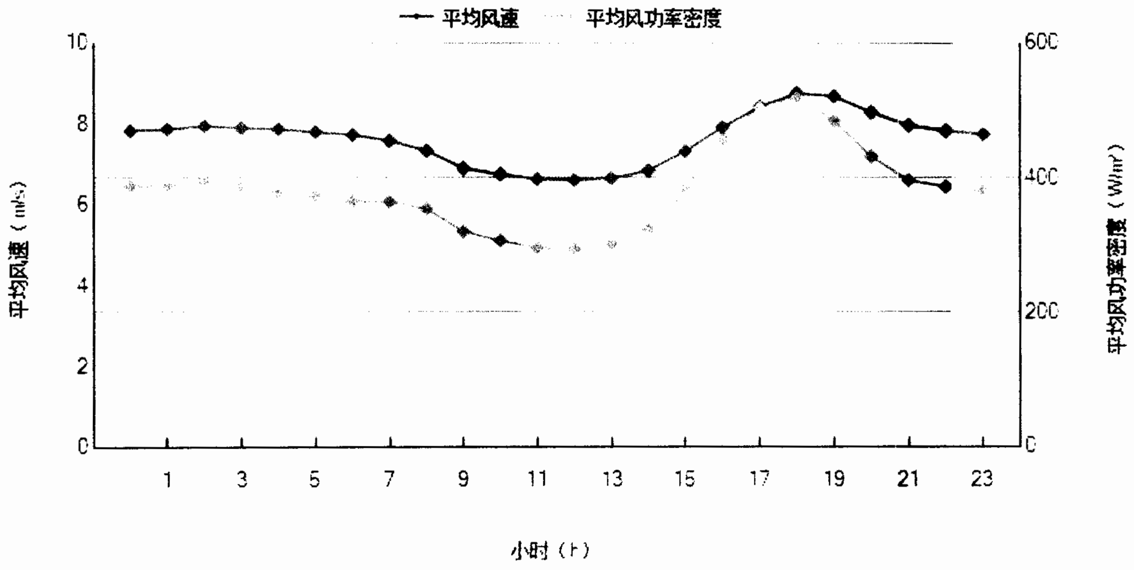


Figure 2.17 Daily variation curve of wind speed and wind power at height of 90m for Lucky anemometer tower

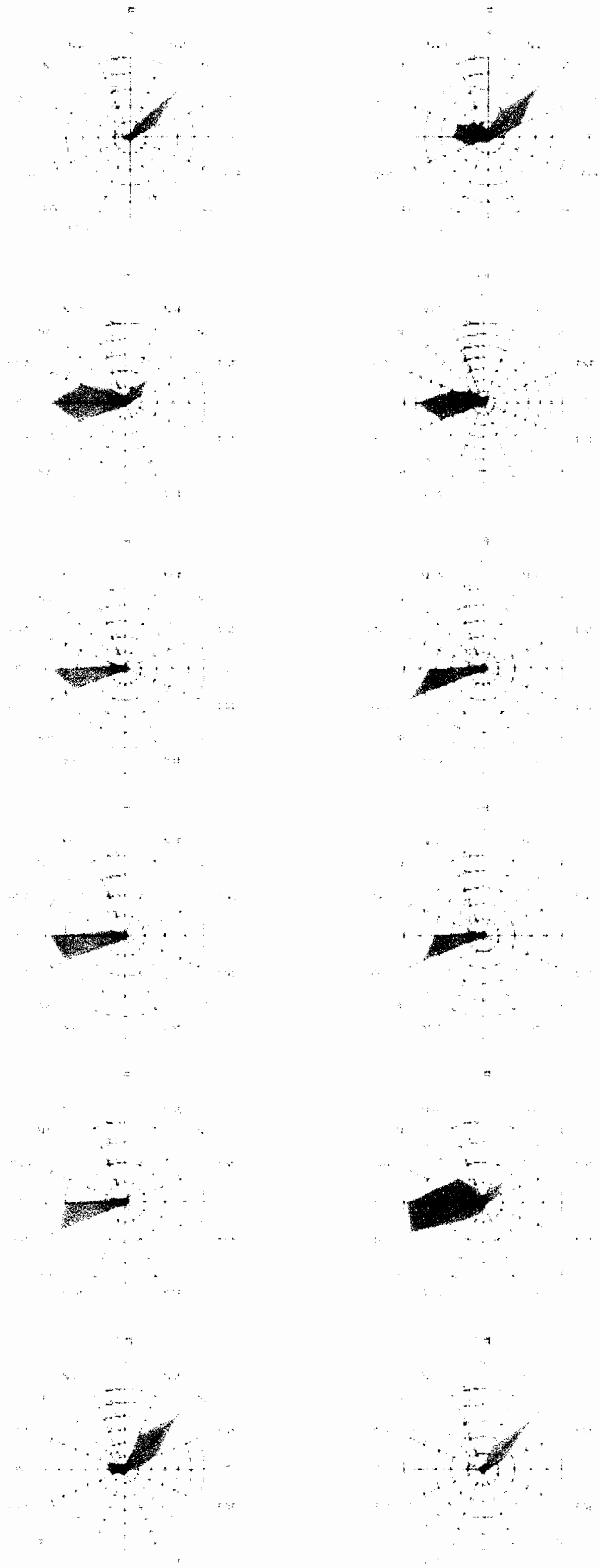


Figure 2.18 Monthly wind rose diagram of Lucky anemometer tower at height of 90m

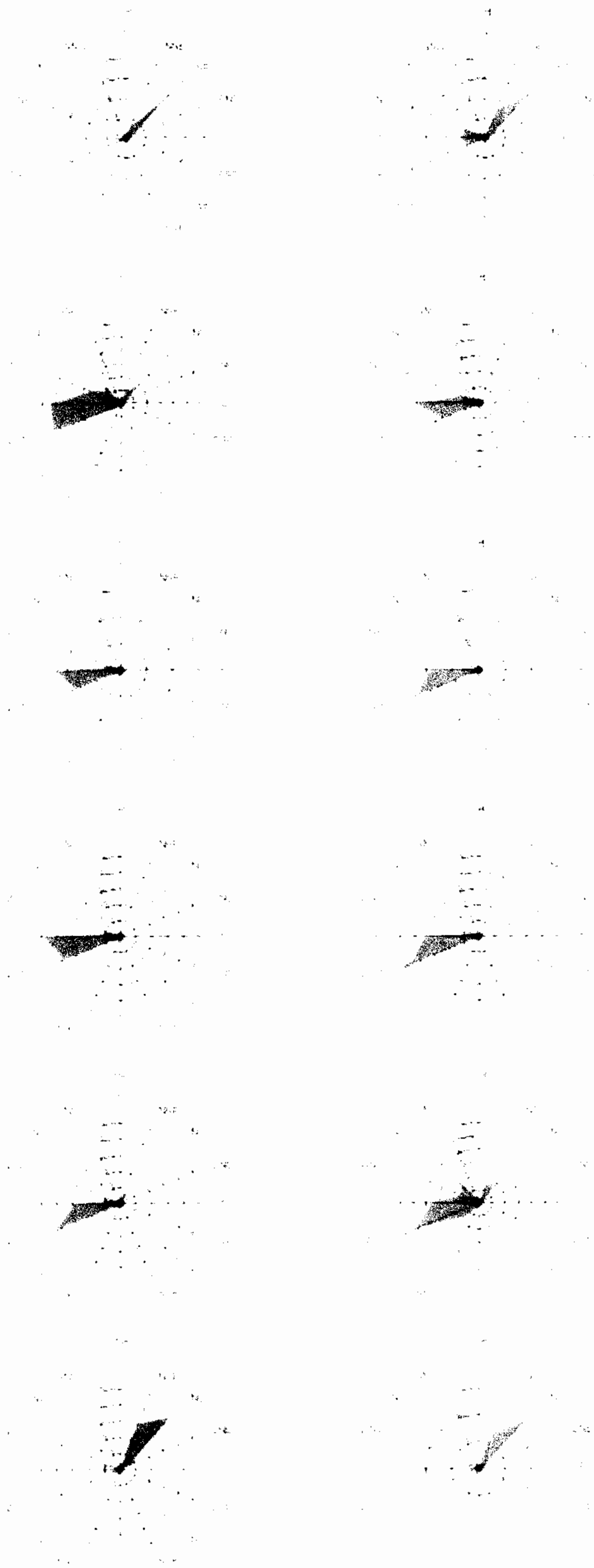


Figure 2.19 Monthly wind energy rose of Lucky anemometer tower at height of 90m

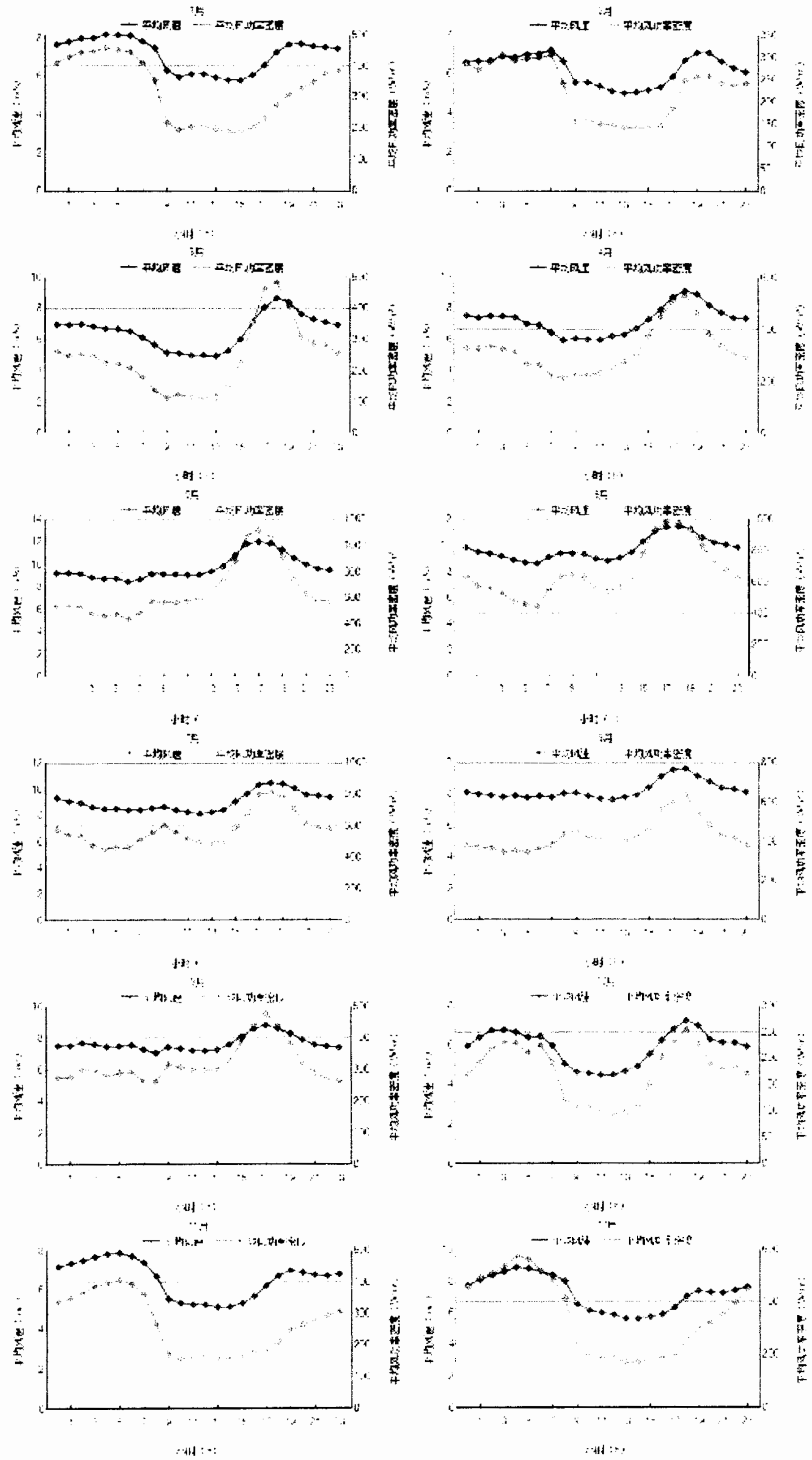


Figure 2.20 Daily variation curve of wind speed and wind power at height of 90m for Lucky anemometer tower within each month

3 ENGINEERING GEOLOGY

3.1 Preface

3.1.1 Project profile

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is located at Sindh province in Pakistan, about 110km away from Karachi. The elevation of the wind farm area is about 40m~60m. Figure 3.1 shows the location of the project. This engineering geological report is prepared on the basis of comprehensive analysis of the area survey data, the geological investigation data of nearby existing wind power farms, the seismic ground parameter zoning map and the historical earthquake data of the area.

Figure 3.1 Geographical location of Thatta wind farm

3.1.2 Design basis

3.1.2.1 Related document

(1) Work Instruction Document (for geological investigation) of Powerchina Northwest Engineering Corporation Limited, ISO-9001/2000.

3.1.2.2 Codes and specifications

(1) Technical Regulations for Engineering Geological Investigation of Wind Farm Area

(Development & Reform Office, Energy [2003] No.1403);

(2) Code for Investigation of Geotechnical Engineering, (GB 50021-2001), (2009 version);

(3)Standard for Soil Test Method (GB 50123-1999);

(4) Specification of Soil Test (SL 237-1999);

(5) Quality Standard for Groundwater (GB/T14848-93);

(6) Code for Seismic Design of Buildings (GB 50011-2010);

(7) Code for Design of Building Foundation (GB/T50007-2011);

(8) Specifications for Engineering Geological Investigation of Onshore and Offshore Wind Farm Projects (NB/T 31030-2012);

(9) Quality Management System Document of Powerchina Northwest Engineering Corporation Limited.

3.1.3 Investigation content and task

3.1.3.1 Regional geology

In accordance with the basic requirements in this stage, the major investigation task was to collect regional geological and seismic data, make clear the regional geological conditions of the project area, define the seismic peak acceleration and corresponding seismic intensity of the project area on the basis of the ground motion parameter zonation map and historic seismic data of the area, and evaluate the regional structural stability and adaptability.

3.1.3.2 Engineering geological condition of the project area

(1) Investigate the engineering geological condition of the proposed area on the basis of topography, geomorphology, and macroscopic geologic conditions;

(2) Preliminarily investigate the topography and geomorphology, strata, rock type and structure, geological formation and distribution of unfavorable geological phenomena;

(3) Preliminarily investigate the thickness, genetic type and properties of overburden, and the material composition, strata structure, distribution law, uniformity in horizontal and vertical directions of soil;

(4) Preliminarily investigate the distribution range, layer thickness, structure, natural compaction rate, physical & mechanical properties of soft soil layer and other special soil layer;

(5) Carry out field test and laboratory test for engineering properties of rock-soil mass in the project area, test the physical and mechanical properties of rock-soil mass, including the natural water content, dry/wet density, relative density, particle size analysis, shearing strength, deformation modulus, permeability, etc., and preliminarily provide the suggested values of foundation bearing capacity, etc.;

(6) Preliminarily evaluate the uniformity, bearing capacity, stability against sliding of foundation, the influences of unfavorable geological hazard and groundwater on foundation, etc.;

(7) Put forward earthquake effect of the project area and the foundation, provide calculation parameters required for foundation design and the design scheme;

(8) Define area classification and the thickness of frozen soil.

3.1.3.3 Hydrogeological condition of the project area

Preliminarily investigate the hydrogeological condition, groundwater level, surface water and groundwater quality within the project area, and evaluate the corrosion degree of the water.

3.1.3.4 Geological hazard

Investigate and preliminarily evaluate the geological hazard (landslide, debris flow, etc.) within the project area, analyze the hazard and assess its harmfulness, and put forward effective treatment measures.

3.1.3.5 Natural construction materials

Conduct general survey for the natural construction materials near the project area, preliminarily investigate the proposed quarry, reserves, quality and physical & mechanical properties of the natural construction materials, and survey the exploitation and transportation conditions of the materials.

3.2 Physical geographic condition

Karachi, the capital of Sindh province, is the largest seaport and naval port in Pakistan; furthermore, it is also the center of industry and commerce, trade and business of the country, as well as the international airport connecting Southeast Asia, Middle East, Africa and European. The city is located at the northwest side of the Indus river delta, facing the Arabian Sea on the south. The climate in Karachi is pleasant for most of the year, the average minimum temperature in winter (Jan. and Feb.) is 13℃, the average maximum temperature in summer (May and June) is 34℃, and the annual average precipitation is only 200mm.

3.3 Regional geology

The coastal area of Pakistan is composed of Markran Mountain in the west and South Sindh plain in the east, with north-south fold belt in the middle. In general, the coastal area can be divided into three tectonic zones: Markran area in the west which comprises a group of parallel mountains with E-W trending; south Sindh plain in the east; and the N-S fold belt in the middle which is formed during basal splitting of Indian Plate happened in collision period. Except for the ophiolite belt in Lasbela to the east of Baluchistan and the Precambrian granite exposed in Nagar Parkar to the east of Sindh, all rocks exposed in this area originate from sedimentation.

According to the SEISMIC RISK MAP OF KARACHI, HYDERABAD DIVISIONS AND LASBELA DISTRICT, PAKISTAN, the seismic intensity of the project area is at degree VII. A fault (JHAMPIRE FAULT) is developed near the area. The regional tectonic stability of the area is comparatively low, see Figure 3.2 for the zonation map of the regional seismic hazard of the project area.

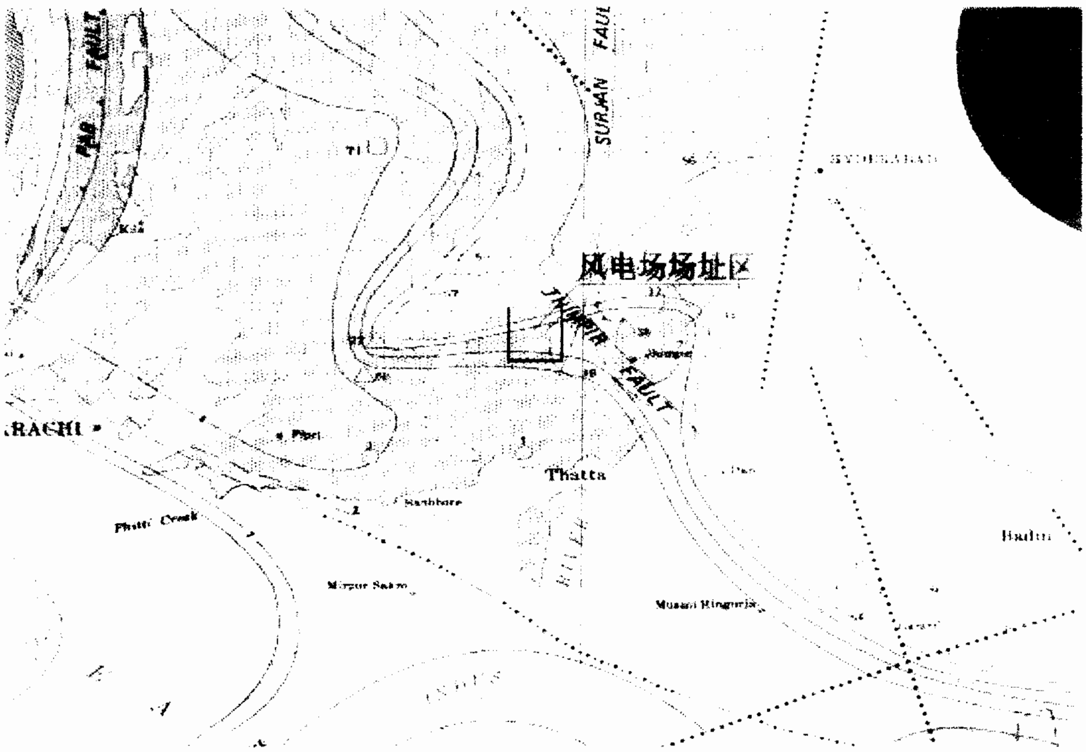


Figure 3.2 Zonation map of regional seismic hazard of the project area

3.4 Basic geological conditions of the project area

(1) Topography and geomorphology

The wind farm is about 6.7km long and 1.6km wide. It is a low and gentle hilly land with flat and open terrain and less fluctuation, higher in the south and lower in the north, forming an inclined platform, with general elevation of 40m~60m. Gullies with drought-enduring shrub are developed in the area.

(2) Stratum and rock type

According to area survey and engineering investigation data of nearby existing wind farms, the project area area is mainly composed of the Quaternary Holocene alluvial and proluvial deposits and the underlying Jurassic limestone. From top to bottom it is divided into two main layers:

Layer ①: Quaternary Holocene alluvial and proluvial rubbles, which is dry, composed of rubbles of 0.5cm~1.5cm in size with less medium ~ coarse sand and clay, limestone is the dominant rock type. The layer is unevenly distributed, generally 0.1m~0.5m thick on the platform surface and 0.2m~1.5m along gentle slope and at the bottom of gullies, of moderate ~ dense structure.

Layer ②: Jurassic limestone, which is hard, grey white in color and widely exposed in the project area. The occurrence of the layer is nearly horizontal, and the thickness of highly weathered rock mass is 3m~5m according to estimation. Karst development can be seen in the layer, mainly appearing as small dissolved pores and karst caves of 0.5cm~7cm in diameter, which are mostly filled.

(3) Hydrogeology

Investigation shows that the groundwater depth is comparatively great, exceeding 10m according to estimation. The corrosive effect of groundwater on structures can be omitted.

Water for construction and living can be obtained from the Lake Kalri about 10km away from the area in the southeast.

(4) Thickness of frozen soil

According to local meteorological data, there is no seasonal frozen soil in the project area.

3.5 Physical & mechanical properties of foundation (rock) soil mass

On the basis of geological investigation data and the engineering geological properties of foundation (rock) soil mass in the project area, the physical & mechanical parameters of the foundation (rock) soil mass are proposed as follows.

Table 3.1 Proposed values of physical & mechanical parameters of the foundation (rock) soil mass

Rock / soil	Weathering level	Thickness (m)	Gravity density (natural) (kN/m^3)	Deformation modulus (MPa)	Cohesion (kPa)	Friction angle (°)	Characteristic value of bearing capacity (kPa)
Layer ①	Loose	<1.5	22.5	10～15	0.0	28	200
Layer ②	Highly weathered	3～5	25.5	200～400	100~300	35	500~800
	Moderately weathered	>10	26.5	400～1000	400~600	45	1200

3.6 Evaluation on major engineering geological conditions

3.6.1 Classification of foundation and environment

According to the characteristics of the geological conditions of the project area, and in light of the Code for Investigation of Geotechnical Engineering (GB 50021-2001), the complexity of the project area and the foundation, and the environment form are classified as follows:

(1) According to the scale and the characteristics of the project and considering the consequence of project damage or abnormal operating caused by geotechnical engineering problems, the importance level of the project is defined as Grade II, i.e. the general project with severe consequence.

(2) The seismic fortification intensity of the project area is Grade Ⅶ the topography and geomorphology is comparatively complex, and the groundwater has minor effect on the project, so the project area is classified as a moderately complicated area (Grade II) and the foundation is defined as a simple one (Grade III).

(3) The project area belongs to arid region, the foundation soil water content w<20%, so the area environment class is defined as Type III.

3.6.2 Seismic effect on the project area and foundation

The basic seismic intensity of the wind farm area is classified as VII degrees. The area overburden is comparatively thin, mainly composed of highly ~ moderately weathered limestone, with better mechanical property. The construction area is classified as Grade I, belonging to the area that is favorable to seismic design of structures. The area is suitable for construction of the wind farm.

According to the Code for Seismic Design of Buildings (GB50011-2001), there is no seismic liquefaction in the area foundation.

3.6.3 Corrosivity of foundation (rock) soil mass and water

(1) Corrosivity of foundation (rock) soil mass

According to pertinent data, the foundation (rock) soil mass is slightly ~ moderately corrosive to concrete, steel bars in reinforced concrete and steel structure, anti-corrosion measures should be taken accordingly.

(2) Corrosivity of water

Wind turbines are mostly arranged on the top of mountain ridges and peaks, where the buried depth of groundwater is greater than 10m in general, so the influence of groundwater on building foundation can be omitted.

3.6.4 Evaluation on engineering geological characteristics of foundation (rock) soil mass

Layer ①is dry, composed of rubbles of 0.5cm~1.5cm in size with less medium ~ coarse sand and clay, limestone is the dominant rock type. The layer is mainly of moderate ~ dense structure, the bearing capacity characteristic value of which is 200 kPa ~ 350 kPa. With fair mechanical property, it can be used as natural foundation.

Layer ②is stable in distribution, mainly composed of highly ~ moderately weathered limestone, developed with small dissolved pores and karst cave, the bearing capacity characteristic value of which is 500 kPa~1200 kPa. With better mechanical property, it is proposed to be used as the foundation supporting layer or the underlying layer of wind turbines and ancillary buildings.

3.6.5 Unfavorable geological process and geological hazard

Area survey shows that despite the surface corrosion of the limestone and the development of solution cracks and pores (the pore is 0.5cm~7cm in diameter with poor connectivity), there is no unfavorable geological phenomenon such as large karst caves in the project area. Nevertheless, the condition of foundation soil for each wind turbine and the step-up substation shall be investigated in the next stage.

The terrain of the project area is comparatively flat and gentle, with undeveloped surface drainage, dense vegetation, great groundwater depth, and nondevelopment of landslide and debris flow. There are no adverse geophysical phenomena such as goaf, ground fissure and large karst caves.

According to investigation, intermittent flood would occur in rainy season in the project area, which is caused by short-time rainstorm in local area. The flood would spread along small gullies in hilly land with gentle slopes, lasting for short time. Design of Thatta wind farm should take into account the effect of the flood in high flow year.

3.6.6 Resistivity of foundation soil

Foundation (rock) soil mass mainly comprises rubble and highly weathered limestone, the resistivity of foundation soil is proposed as 1000Ω·m~2000Ω·m.

3.7 Construction materials

According to investigation of the natural construction materials in the project area and the neighboring area, two quarries are found about 12km in the south of the project area which can supply concrete aggregates for the project with satisfied quality and storage. The quarries are connected with the project area by asphalt road, the traffic condition is convenient.

3.8 Conclusions and suggestions

(1) According to the SEISMIC RISK MAP OF KARACHI, HYDERABAD DIVISIONS AND LASBELA DISTRICT, PAKISTAN, the seismic intensity of the project area is at VII degrees. The area is basically stable in structure, appropriate for construction of the wind farm.

(2) The project area is classified as a moderately complicated area (Grade II) and the subgrade is defined as a simple one (Grade III). The project area belongs to arid region,

the foundation soil water content w<20%, the site environment class is defined as Type III. The area is classified as Type I with favorable aseismicity.

(3) The foundation (rock) soil mass in the project area is mainly composed of two layers: Layer ① is composed of rubbles, mainly of moderate ~ dense structure, the bearing capacity characteristic value of which is 200 kPa~350 kPa. With fair mechanical property, it can be used as natural foundation. Layer ②is mainly composed of highly ~ moderately weathered limestone, developed with small dissolved pores and karst cave, the bearing capacity characteristic value of which is 500 kPa~1200 kPa. With better mechanical property, it can be used as the foundation supporting layer or the underlying layer of wind turbine and ancillary buildings.

(4) There is neither seismic liquefaction in the site foundation nor adverse geophysical phenomenon such as goaf, landslide, ground fissure and large karst caves. The possible karst bedrock could be excavated and replaced or treated with consolidation grouting. However, the effect of intermittent flood in high flow year should be paid more attention.

(5) The foundation (rock) soil mass is slightly ~ moderately corrosive to concrete, steel bars in reinforced concrete and steel structure, anti-corrosion measures should be taken accordingly. The buried depth of groundwater is greater than 10m in general, so the influence of groundwater on building foundation can be omitted.

(6) Two quarries are found about 12km in the south of the project area that can supply concrete aggregates for the project with satisfied quality and storage. The quarries are connected with the project area by asphalt road, and the traffic condition is convenient. Water for construction and living can be obtained from the Lake Kalri about 10km away from the area in the southeast.

(7) It is recommended to further ascertain the physical & mechanical properties of foundation (rock) soil mass as well as main engineering geological problems in combination with the layout of wind turbines and ancillary structures, and investigate in details the conditions of natural construction materials and water for construction and living.

4 PROJECT TASK AND SCALE

4 Project Task and Scale

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is located in Sindh province of Pakistan, about 110km away from Karachi, and 80km away from Port Qasim. The total capacity of the project is proposed to be 2x50MW, two Phases, the Second phase will be 50MW with installation of 20 sets of 2.5MW, and a new booster station (132kV) will be constructed accordingly.

4.1 Local economic status and development plan

Pakistan is located in the northwest of the South Asian Subcontinent, neighboring India in east, China in the northeast, Afghanistan in the northwest, Iran in the west, and Arabian Sea in the south. The national total territory area of the country is 796,000km^2 (excluding 13,000 km^2 Kashmir region controlled by Pakistan). Three fifths of its land is mountainous area and upland. The Indus River flows into Pakistan from north, and meanders 2,300 km towards south, and finally empties into the Arabian Sea.

The climate of Pakistan belongs to subtropical climate except for the southern part which features tropical climate. Its southern region is humid and hot with a longer rain period due to influence of monsoon, while its northern region is dry and cold, local areas are covered with snow all the year around. The annual average temperature is 27℃.

Pakistan is composed of four provinces (Punjab, Sindh, Baluchistan and Khyber-Pushtun), the capital Islamabad, Azad Jammu and Kashmir and 7 tribe regions directly under the jurisdiction of the federation. Each province consists of special administrative regions, counties, townships and villages. The total population is 197 million, and the most of people believe in Islamism.

Pakistan has vast hilly and mountainous areas, featuring noticeable diastrophism in history and frequent earthquake activities. Accordingly this area has a geographic potential for generating large amount of mineral resources. The coal reserves are 185 billion t, mainly distributed in Sindh province, with majority of Class A lignite; the copper ore reserves are 0.5 billion t, iron ore 0.6 billion t, aluminium 0.74 billion t. Besides, there are large amount of chromite, limestone, sandstone, dolomite, marble, precious stone, mine salt and silicon sand, etc.

Pakistan features rich natural gas and scarce oil resources. The oil and gas resources are mainly distributed in northern Potwar basin, Indus river basin and offshore continental shelf in the south. It is preliminarily estimated that the total storage of natural gas is 7984.8 billion m^3, the proved recoverable reserves are 1491.4 billion m^3, among which 537.7 billion m^3 have been exploited. The total oil reserves are 27 billion barrel, the proved reserves are 0.883 billion barrel, among which 0.559 billion barrels have been exploited. Currently, the energy consumption structure of Pakistan is severally unbalanced, the degree of dependence on oil and natural gas is up to 79%, what's more, the annual demands shall still increase by 5.7% and 7.5%, respectively. The government of Pakistan has to import a great quantity of crude oil and oil products every year to meet the growing energy demand. The higher international prices for oil and gas have brought huge pressure to the national finance and national economy in recent years.

The hydropower potential of Pakistan is about 46000 MW, presently only 14% (about 6500 MW) has been developed, and the development and utilization of hydraulic resources are lower. Meanwhile, there is huge wind energy potential in Pakistan, and the reserves of wind power along 1046 km coastline are about 50000 MW in Sindh province. Currently, five wind farms have been commissioned and connected to the grid in the total capacity of 256MW, and five more wind farms are under construction. There are rich solar energy for development and utilization in Pakistan. In most parts of the country, especially Sindh, Baluchistan and southern Punjab, the lighting time is more than 3000 h in a year, and the reception of solar radiation is 2000 kWh/m^2, which is among the highest levels in the world. However, there is no grid-connected solar power plant up to now, except that a 100MW solar PV power plant is under-construction, which is invested by Punjab Province and contracted by TBEA.

The Pakistan economy depends heavily on agriculture, main crops include cotton, wheat, rice and sugar crane, among which, cotton is the most important economic crop with its yield accounting for 5% of total product of the world, making Pakistan the fifth largest cotton producing country in the world. The Indus plain and north mountainous regions have complex irrigation system, providing better condition for growing food and economic crops. Pakistan has achieved self-sufficient in grains and output of rice and cotton. Owing to subtropical climate, Pakistan has rich fruit resources, plain and low-lying land abound in banana, orange, mango, guava and various melons, while mountainous area and tableland abound in peach, grape and persimmon, etc.

The industrial base of Pakistan is weak, the overall scale, industry scale and enterprise scale are not large, and the industrial categories are not complete. Currently, the industries include textile, metallurgy and metal machining, fuel & power industry, mechanical manufacturing, chemical fertilizer, cement, chemical industry, sugar refining, tobacco, paper making, mining, IT, small-scale industry and handicraft. Among the stated industries, textile industry based on agriculture is the pillar of the national economy, while energy, IT and small & medium-sized industries are in fastest growing. The imported products mainly include oil & oil products, mechanical & traffic equipments, steel goods, chemical fertilizer and electric appliance. The exported products mainly include cotton, textile, rice, fruit, fishery products, leather goods, physical training goods, medical treatment appliance and carpet. The handicraft work of Pakistan is known as exquisite.

In accordance with the ***Pakistan Vision 2030*** prepared by the government of Pakistan, the 2030 development goal of Pakistan is to take knowledge advance as impetus, make use of resource effectively, insist on fast and sustainable development and construct a country flourish in economy and justicial in society. The gross domestic product (GDP) shall be 700 billion US dollars by 2030, and per capita GDP shall reach 3000 US dollars (counted as per constant price in 2005).

4.2 Current status of local electric power system and development plan

4.2.1 Status of electric power system

According to statistical data, in the 2012/13 fiscal year, the total energy yield of the country is 98894 GWh, basically in the same level of the previous year, of which, hydropower, thermal power and nuclear power are 30032 GWh, 64681 GWh and 4181GWh, respectively accounting for 30.4,%, 65.4% and 4.2%. The maximum load is about 15270MW, decreasing by 13.5% compared to the previous value. The power demand is dominated by household consumption in the percentage of 45%, then the industries in the percentage of 29%, and the others are agriculture, commerce and miscellaneous uses, respectively in 11%, 8% and 7%. The main load centers are concentrated in Punjab and Islamabad, accounting for about 60% of the total, and the loads of Sindh province and Karachi, Baluchistan and Khyber-Pushtun account for 20%, 6% and 14%, respectively.

As of June 2013, the gross capacity of power plants constructed in Pakistan amounts to 23664MW, of which thermal power, hydropower, nuclear power and wind power account for 67.62% (16000MW), 28.84% (6828MW), 3.33% (787MW) and 0.21% (100MW).

In these completed power sources, thermal power is mainly distributed in Punjab, Sindh and Baluchistan, respectively accounting for 47.18%, 39.64% and 13.18%. Sindh and Baluchistan have only thermal power plants. Hydropower is mainly concentrated in KP, AJ&K and Punjab, respectively accounting for 57.40%, 16.32% and 26.28%. KP and AJ&K have only hydropower plants. Power sources are distributed in the overall pattern of "hydropower in north and thermal power in south", and electric energy flows from both directions (north and south) to the middle region.

Currently, Pakistan is extremely short of electricity, and power supply has to be suspended or limited nation-widely. According to power sector statistics, the total available capacity of the whole grid power sources in the 2012/13 fiscal year is about 15823MW, the disabled capacity is 7800MW, and the power shortage is more than 5000MW. Among the existing power plants, the equipment is seriously ageing with low availability; the power source structure is irrational as those main power sources are relying on oil or gas fuels; shortage of oil and gas reserves/supplies often results in inadequate energy output. Besides, the total loss in the transmission and distribution processes surpasses 20%, so the power supply capability has been greatly abated, and the operational economy is rather poor.

An integrated power system has basically covered the whole country from north to south. A 500kV power grid stretches from Peshawar Substation in the north to HUBCO Thermal Power Plant in the south, and some load centers have their own 500kV looped networks. However, the power grid in Gilgit-Baltistan which is situated in the northern remote region has not been interconnected with the trunk grid. The voltage ratings of the trunk power transmission networks are 500kV and 220kV, and the voltage ratings of the local distribution networks are 132kV and 66kV, of which the 66kV lines are being transformed into 132kV.

The current national power transmission network is shown in Figure 4.1.

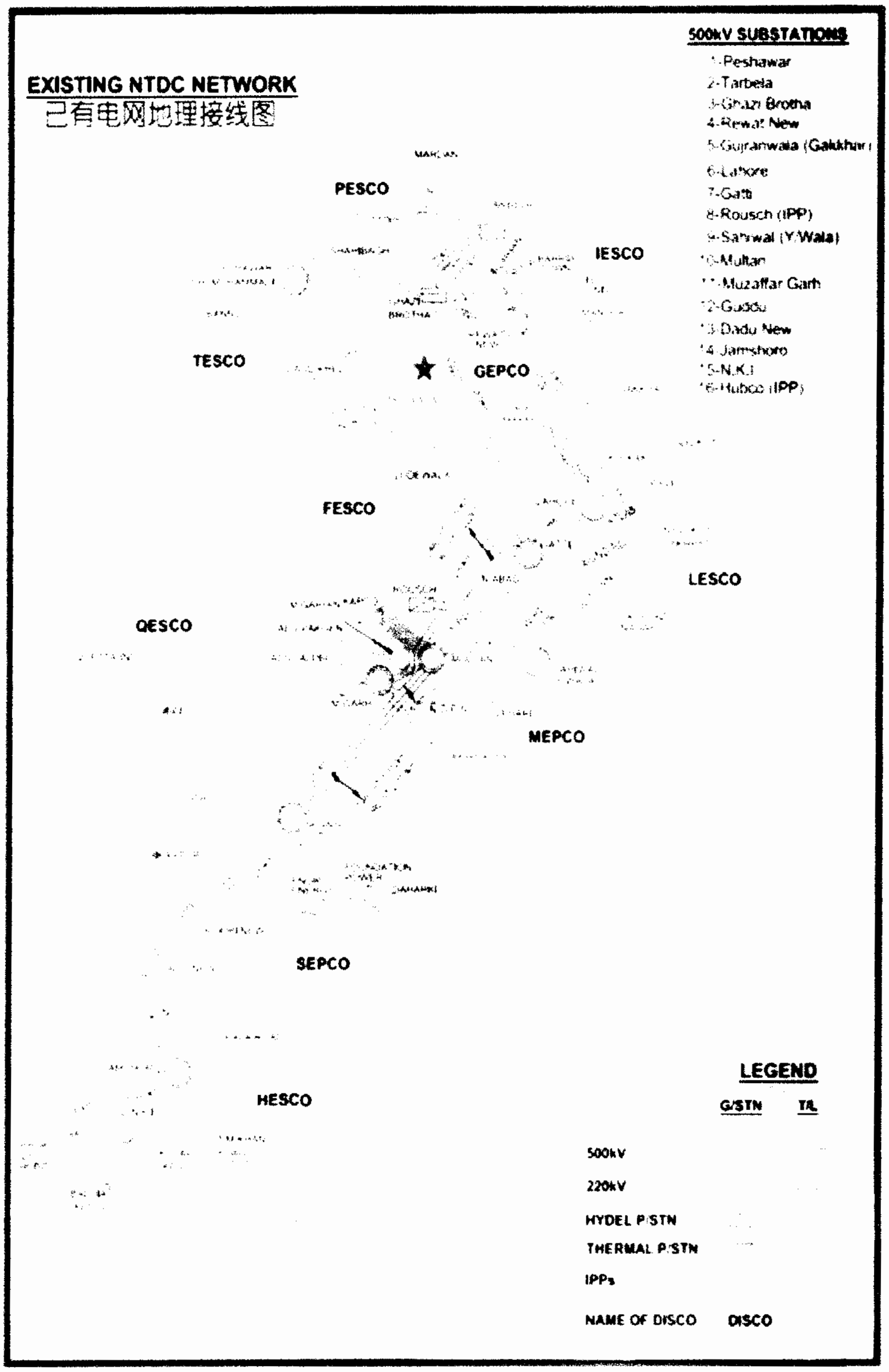


Figure 4.1 Power transmission network

The problems existed in the power industry of Pakistan are:

(1) Lack of construction fund;

(2) Weak in construction ability;

(3) Severe in transmission loss;

(4) Unreasonable in power structure;
(5) Unreasonable in electric price, big burden on government.

4.2.2 Demand prediction

Based on WAPDA's data, the maximum load values of Pakistan will reach 27840MW and 31900MW respectively in 2017 and 2020, and will increase by 7.8% yearly on average from 2013 to 2020.

Table 4.1 Maximum load prediction

Year	2016	2017	2018	2019	2020
Anticipated maximum load (MW)	26540	27840	29160	30500	31900

The electric power development of Pakistan before 2030 is planned as follows:
(1) It is encouraged to adopt PPP or BOT mode to construct large and middle-sized hydropower stations on main rivers, especially the Indus River, construct small-scale hydropower stations on canals or streams, so as to increase the installed capacity to 32660MW by 2030.
(2) To develop coal power to maximum limit so as to make the installed capacity of coal-fired power plants reach 20,000MW before 2030, accounting for 18% of the total energy yield.
(3) To develop nuclear power enthusiastically so as to realize the goal of 8800MW installed capacity of nuclear power by 2030.
(4) To develop renewable energy actively, so as to make the renewable energy capacity reach 9700MW.
(5) To strength the maintenance and upgrade of transmission networks, raise the transmission capacity and reduce power loss.
(6) To speed up the restructuring and privatization pace for development of the state-owned power departments such as WAPDA, and national grid companies through the commercial operation, improve the work efficiency, quality and service level in such departments.

4.2.3 Preliminary analysis of power market

According to WAPDA's data, the maximum loads of Pakistan's power grid will be 27840 MW and 31900 MW in 2017 and 2020, respectively. Considering appropriate load reserve, the installed capacities are required to be about 36190 MW and 41470 MW respectively, to meet the Pakistan's power demand by 2017 and 2020. As of 2013, the existing thermal power capacity of Pakistan reached 16000MW, the hydropower capacity 6872MW, and according to the power construction planned in the schedule, 3765MW and 7425MW new power sources will be commissioned respectively in 2017 and 2030, but there would be still a big supply-demand gap by 14777MW and 17220MW respectively in 2017 and 2030.

As a clean energy, wind power has bright future, but due to its instability, wind power share in the grid should not be too large. It is commonly believed that in case of wind power capacity not more than 10% of the total installed capacity, the grid operation should be economical and safe, but given different power source structures and different grid compositions, some countries, such as like Germany, Denmark, France and Spain, have higher proportions of wind power in their national grids. The power supply structure of Pakistan is not so rational, mainly depending on thermal power, and with poor stability. Therefore, the power market analysis is made based on two scenarios separately with lower and higher shares, i.e. Scenario 1 (wind power capacity accounting for 10% of the total installed capacity) and Scenario 2 (wind power capacity accounting for 5% of the total installed capacity). The preliminary analysis of wind power market is shown in Table 4.2.

Table 4.2 Preliminary analysis of wind power market in Pakistan

Designation		2017	2020
Maximum load (MW)		27840	31900
Total installed capacity (MW)		36190	41470
Wind power capacity of electric system (MW)	Scenario 1 (10%)	3619	4147
	Scenario 2 (5%)	1810	2074
Wind power capacity of existing, under-construction & planned wind farms (MW)		750	750
Required additional wind power capacity (MW)	Scenario 1 (10%)	2869	3397
	Scenario 2 (5%)	1060	1324

Based on Scenario 1, it is preliminarily estimated that, besides the capacities of the existing and planned wind farms, additional wind power capacities will be required by 2869 MW as of 2017 and 3397 MW as of 2020, respectively; based on Scenario 2, additional wind power capacities will be required by 1060MW as of 2017 and 1324MW as of 2020, respectively. Wind power has big potential to enlarge in capacity.

Due to the oil and coal shortage problem, as well as the long-term of hydropower construction, its near-term power demand cannot be satisfied at earlier time. However, the ideal endowment of wind energy resources and the short construction cycles make the wind power as the best power source option to satisfy the power market demand, and also as one of sustainable energies to meet the increasing power demand in Pakistan.

The present energy consumption structure is quite unbalanced, as the dependency degree on petroleum and natural gas products is higher than 79%, and their annual demands increase by 5.7% and 7.5%. To satisfy the ever-increasing energy demand, the government of Pakistan has to spend large amounts of foreign exchanges to import crude oil and associated products, which brings about a great pressure on Pakistani finance, national economy and environment. As a clean energy form, wind energy features low-energy consumption and short construction period, which can suit Pakistani power development well. Preliminary analysis of wind energy potential shows that wind power still has a great development space in Pakistan. However, it should be noted that with the fast development pace and flocking investors, the grid interconnection permit for the project should be applied for and obtained as earlier as possible, in order to get one favourable electricity tariff, and speed up the project construction.

4.3 Necessity of project construction

(1) Complying with the industrial development policy for renewable energy sources in Pakistan

In the 2030 Energy Strategy Plan, the government of Pakistan puts the renewable energy generation at an important strategy position. In accordance with the *Pakistan Vision 2030*, the government makes a definite plan on renewable energy development, and the installed capacity of renewable energy shall reach 800MW by 2015 and 970MW by 2030, accounting for 5% of the total installed capacity. The government encourages investment and utilization of renewable energy, constitutes policies and strategies for renewable energy, including mini hydropower (not exceeding 100MW), wind power and solar power. The project construction complies with the industrial development policy of renewable energy sources in Pakistan, and will also promote the local wind power industry development.

(2) Meeting the demand for energy structure improvement

Currently, the energy structure of Pakistan is dominated by thermal power, depending highly on oil and natural gas. In recent years, the continuous price rising of oil and gas in the international market has brought huge economic pressure to Pakistan. Based on the long-term strategy of ensuring energy dominion and in order to reduce the dependence on oil, the Pakistan government constitutes a series of energy development plans to encourage renewable energy development so as to promote the energy consumption restructuring. As a clean energy form, the implementation of this wind farm project shall improve the energy structure to some extent, and be favorable to increase the proportion of renewable energy in the power system.

(3) Rational exploitation of wind energy resources to ease power shortage problem

Pakistan suffers serious power shortage problem. It is reported that, in the peak time of electric shortage, power cut would be 6 hours per day in Islamabad, 9 hours in Karachi, and more than 12 hours or even 16 hours in other cities or surrounding areas. In the end of December 2008, blackout time in most middle and small cities last 20 hours to 22 hours, and exceeded 18 hours even in the metropolis like Karachi.

Sindh province where Thatta wind farm is proposed to be located is one of regions where wind energy can be utilized. With appropriate wind speed, better wind quality and steady prevailing wind direction, the wind energy resource is better, having better development prospect. Upon completion, the wind farm would partly increase the system power supply and mitigate power shortage problem in the country.

(4) Meeting the demand for sustainable development of local and national economy

Power shortage in Pakistan has imposed increasing restriction on the national economic development. Along with economic growth, the power shortage would be more serious. Some enterprises have to close due to shortage of power, which would result in the unemployment rate growth. Construction and operation of this project would promote the development of related local industries such as building materials, transportation, equipment manufacturing, benefit employment increase, tax revenue increment and third industries development, and promote the national economy development and social progress.

(5) Meeting the demand for improving and protecting ecological environment

It is a common aspiration of the world people to protect and improve the environment the human being depends on so as to realize sustainable development. The effective approaches to improve and protect ecological environment include developing and utilizing natural resources reasonably, improving the way of resource utilization, adjusting the structural configuration of resource, raising the utilization rate of resource, etc. Wind energy is clean and renewable, the development and construction of wind farms can effectively reduce the consumption of conventional energy and protect ecological environment. Currently due to the electricity shortage, some enterprises in Pakistan can only depend on thermal power, which results in large amounts of pollutions such as sulfur dioxide emission. The construction of Thatta wind farm will reduce the emission of pollutions to some extent and therefore benefit ecological environment protection in Pakistan.

(6) Meeting the demand for sustainable development of going-global strategy of Chinese enterprises

In the trend of economic globalization, the Chinese enterprises must face the international competition and go globally to seek survival and growth in the international market.

According to relevant polices issued by Chinese government, Chinese enterprises are encouraged to invest overseas in accordance with international practices, conduct overseas project contracting and labor export service, enhance cooperation and development under mutual benefit, and develop technical and economic cooperation with neighboring countries.

In recent years, China strengthens the strategy of "going global", encourages and supports the competent enterprises to invest overseas. Construction of Thatta wind farm would meet the demand of sustainable global development of Chinese enterprises.

(7) Providing investment opportunity to Chinese enterprises on the basis of good cooperation between China and Pakistan

The long-term friendly relationship between China and Pakistan and relevant policies of Pakistan encouraging foreign investment to enter the electric power sector, provide a good basis and facilitate the cooperation of both parties in the power sector. Currently, China and Pakistan have worked together on development of many power projects, establishing a solid foundation for further cooperation.

Above all, the construction of Thatta wind farm will promote the sustainable growth of local economy, improve the living standard of local residents, facilitate the development of local electric power industry, and meet the demand of sustainable development of Chinese enterprises in the international market. Therefore, the construction of the project is necessary.

4.4 Power supply scope

Norinco International Thatta Phase-II 50MW Wind Power Project("Norinco-2") is located in Sindh province, about 110km away from the Pakistan's largest port and the industrial city of Karachi, and 80km away from Port Qasim. According to the early-stage design result, the project will supply power to the national power grid of Pakistan.

4.5 Project scale

Analyzed from the perspective of wind energy resources, the main wind direction and main wind energy direction of Thatta wind farm are generally consistent, the wind speed and wind energy in SW and WSW are maximum and most frequently, and the prevailing wind direction is stable. According to the observed data of the anemometer towers in the wind farm, the annual mean wind speed at 90m height is 7.62m/s, and the annual mean wind power density is $382W/m^2$; the annual mean wind speed at 85m height is 7.56m/s, and the annual mean wind power density is $372W/m^2$; the annual mean wind speed at 60m height is 7.2m/s, and the annual mean wind power density is $331W/m^2$. In accordance with the *Technical Specification for Measurement and Evaluation of Wind Energy Resources for Wind Farms*, it is judged that the wind power density grade of this wind farm can be rated as Class III, and the wind energy resources are relatively ample.

In conclusion, the topographic condition and wind energy storage of the project site are suitable for constructing the Norinco international Thatta Phase-II 50MW Wind Power Project("Norinco-2"). The convenient transport condition of the site is favorable to project construction. The installed capacity of Norinco international Thatta Phase-II 50MW Wind Power Project is appropriate at this stage.

5 TYPE SELECTION & ARRANGEMENT OF WIND TURBINES AND POWER GENERATION ESTIMATION

5 Type Selection & Arrangement of Wind Turbines and Power Generation Estimation

5.1 Selection of WTG type

In the construction of wind farms, the selection of wind turbines is restricted by natural environmental conditions, transport conditions, as well as lifting and erection conditions, etc. Meanwhile, under the prerequisite of advanced technology and reliable operation, selection of WTGs shall be economically feasible. In selection of WTGs, the following main factors shall be considered:

(1) Air temperature

Mean monthly temperature data of nearly 40 years from 1971 to 2010 in Karachi weather station indicate that the mean annual air temperature in Karachi is 26.5□; extreme maximum air temperature is 47□; extreme minimum air temperature is 1.3□. And according to the wind data of the Lucky anemometer tower, the time duration of air temperature higher than 40□ is 59160min, accounting for 38.8%; according to the wind data of FFC anemometer tower, the time duration of air temperature higher than 40□ is 40min, accounting for no more than 1%; the time duration of air temperature higher than 30□ is 64000min, accounting for 12.2%.

The above analysis indicates that the wind farm is in the subtropical climate zone and the temperature may bring great threat to the safe operation of the wind turbines. Therefore, high-temperature type wind turbines should be selected to meet ambient temperature requirements.

(2) Wind energy resources condition

As long-term wind speed series data of the regional weather stations are not available, only the measured wind speed data of anemometer tower can be used to determine the 50-year frequency extreme wind speed. According to the wind data measured by Zorlu A, Master and FCC anemometer towers, the extreme wind speed in this wind farm would exceed the 50-year extreme wind speed, and estimated with different methods, the wind turbines with safety standard of IEC Class □ or above may be selected for this wind farm. The turbulence intensities at different heights of Lucky anemometer tower within the wind speed range of 15m/s are 0.069~0.104; the turbulence intensities at different heights of FCC anemometer tower within the wind speed range of 15m/s are 0.076~0.132, suggesting small turbulence at the wind farm. According to IEC 61400-1

(2005) standard, the wind turbines with safety standard of IEC Class □ or above can be selected for this wind farm.

(3) Selection of wind turbine manufacturer

The Manufacturers to be chosen should have certain technical strength and possess mass production capability to meet the work progress requirement of this project. Meantime, the Manufacturers are required to guide handling, erection and debugging independently, and assist other parties in the auxiliary constructions such as civil and electrical works, and ensure the work progress of this wind farm. Moreover, in the case of selecting WTGs, the reliable operation of the wind farm shall be fully considered, mainly involving the operation environment adaptation and availability assurance.

In light of the actual situation of the project and the current status of wind turbines manufacturing industry, the following four wind turbine models are selected at this stage for technical and economical comparisons of electric energy production: GW121/2.5MW, MY104/2.0MW, G114/2.0MW and SE87/1.5MW. The results are listed in Table 5.1.

Table 5.1 Economical comparison of preliminarily selected models

Designation	Unit	Scheme 1	Scheme 2	Scheme 3	Scheme 4
		GW121/2500	MY104/2000	G114/2000	SE8715
Total installed capacity	MW	50	50	50	49.5
Single capacity	kW	2500	2000	2000	1500
Number of units	set	20	25	25	33
Wheel diameter	m	121	104	114	87
Hub height	m	90	80	90	70
Annual on-grid energy	10^4 kW·h	19075.1	18672.5	19455.15	17522.45
Annual equivalent full load hours	h	3468	3395	3537	3186
Ranking in economy		1	3	2	4

Notes: Data in the table are interim results out of calculations.

Table 5.1 shows that the grid annual equivalent full load hours of the wind farm range from 3186h to 3537h. According to the calculation results of various schemes, Scheme 1 would result in larger energy yield and have the lowest investment per kWh. Taking into account the project progress and the manufacturers' supply capacity and after-sales service, preferential financing policy, high temperature climatic condition, market performance and the Employer's intention, Scheme 1 (GW121/2.5MW) is proposed at this stage.

5.2 Comparison of technical parameters of WTGs

The main technical parameters of the proposed wind turbine models are shown in Table 5.2, and the power curve of standard air density (1.131kg/m^3) and the thrust coefficient curve are shown in Table 5.3. The power curve of the proposed wind turbine is shown in Figure 5.1, and the thrust coefficient curve is shown in Figure 5.2.

Table 5.2 Comparison of main technical parameters of proposed WTG models

Model	GW121/2500
1. Wind turbine	
Rated power (kW)	2500
Power regulation mode	Variable speed and variable pitch
Wheel diameter (m)	121.5
Cut-in wind speed (m/s)	3
Rated wind speed (m/s)	9.3
Cut-out wind speed (m/s)	22
Extreme wind speed (m/s)	52.5
Operation temperature scope	-30℃～+40℃
Direction facing wind	Upwind direction
2. Blade	
Number of blades	3
Speed at blade tip line (m/s)	85.8
Swept area (m^2)	11595
3. Generator	
Model	Goldwind/GW2.5MW-TFY
Rated power (kW)	2600
Rated voltage(V)	690
Rated rotating speed (r.p.m)	
Protection class	IP54
4.Nacelle and tower	
Nacelle (t)	84.4
Blade (t)	43.5
Hub (t)	28.57
Tower height (m)	90
Tower weight (t)	278.9

Table 5.3 Power curve and thrust coefficient curve of proposed model under local air density (1.131 kg/m^3)

Wind speed (m/s)	Power (kW)	Thrust coefficient
3	59	1.068
4	185	0.855
5	372	0.797
6	645	0.797
7	1024	0.797
8	1516	0.797
9	2096	0.750
10	2500	0.560
11	2500	0.387
12	2500	0.288
13	2500	0.223
14	2500	0.177
15	2500	0.144
16	2500	0.119
17	2500	0.099
18	2500	0.084
19	2500	0.073
20	2500	0.063
21	2500	0.055
22	2500	0.049

Notes: The above data are provided by the corresponding manufacturer of the proposed model.

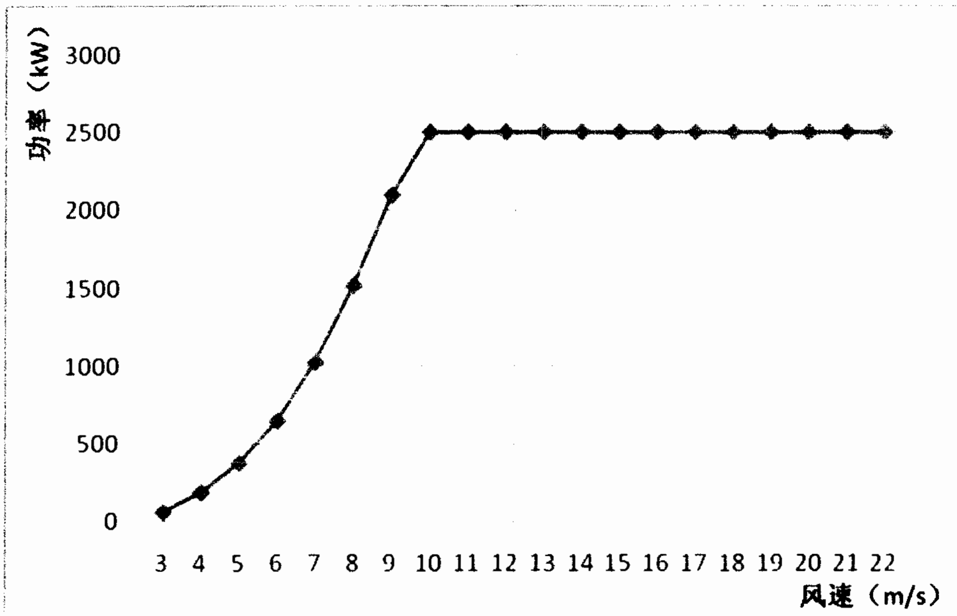


Fig. 5.1 Power curves of proposed model (air density:1.131kg/m^3)

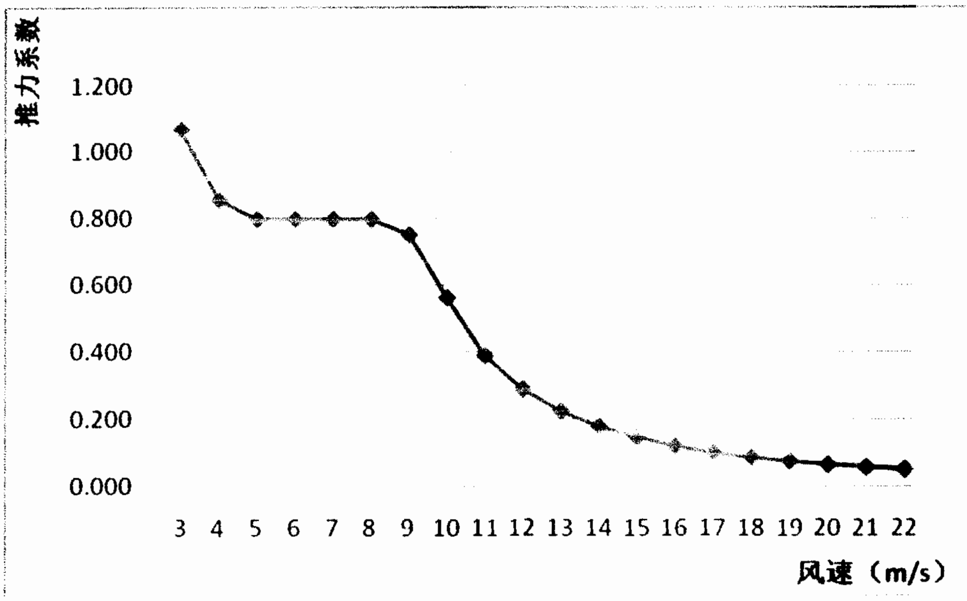


Fig. 5.2 Thrust coefficient curves of proposed model (air density:1.131kg/m^3)

5.3 Layout of WTGs

5.3.1 Principles

Wind turbines should be arranged mainly based on the characteristics of wind energy resources and geological conditions at the wind farm site, and the layout principles are as follows:

(1) Firstly, it should fully consider the surrounding constraints around the wind farm, and arrange wind turbines within the planned area;

(2) According to the distribution characteristics of wind resources, it should make full use of the prevailing wind direction to reasonably locate those wind turbines with proper space;

(3) When arranging wind turbines, not only the wake flow influence between wind turbines should be minimized to the least, but also the cable lengths between wind turbines shall be shortened to the least so as to reduce auxiliary works cost and power loss in the transmission and transformation processes;

(4) In consideration of different schemes, energy output capability of the entire wind farm should be optimized to its maximum as well as energy output of individual units.

5.3.2 Layout of WTGs within wind farm

As the wind direction in Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") area is relatively constant and stable, west-southwest (WSW) wind has maximum speed and energy as well as highest frequency; the prevailing wind direction is stable and the availability of wind energy is high. According to the prevailing wind direction and topography condition of this wind farm, the arrangement of wind turbines should take advantage of locations with high wind energy index and greater exploitation value.

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") site takes on a long strip about 6.5km long and 1.6km wide. Taking into account the characteristics of the site area, for optimal utilization of the available ground area, it is proposed to arrange those WTGs of the recommended models perpendicular to the prevailing wind direction in the pattern of 2.5D × 12D. The layout fashions for WTGs of each capacity of 2.5MW are shown in Fig. 5.3.

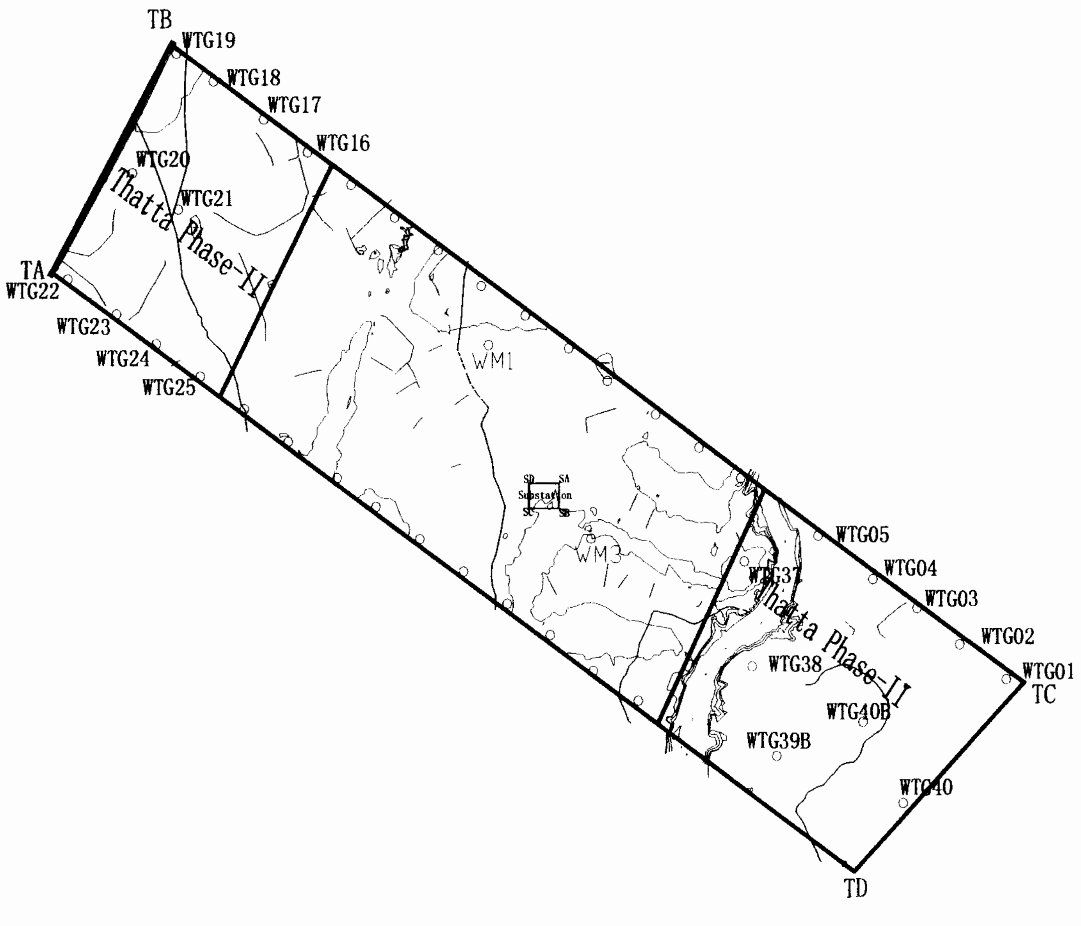


Fig.5.3 Layout scheme for 2.5 MW WTGs

5.4 Annual on-grid energy

(1) Calculation of theoretical annual energy yield

The annual on-grid energy of this wind farm can be estimated based on comprehensive analysis of the wind data measured by Lucky anemometer tower in the representative year, the layout plan for recommended WTGs, and the site 1:50000 topography map. By using the power curve and thrust coefficient curve of the recommended WTG model under the local air density of 1.131kg/m^3, Wasp10.0 software is employed to compute the theoretical annual energy output value and the annual energy yield after taking into account the wake flow effect.

(2) Utilization rate of WTGs

Taking into account the WTG fault, maintenance and grid fault factors, routine maintenance shall be conducted in the month with smaller wind speeds. According to current wind turbine manufacturing level and the actual conditions of the wind farm, the availability of the wind turbines is determined to be 97%, i.e. the correction factor is taken as 0.97.

(3) Guarantee rate of wind turbine power curve

In calculating energy output values, the guarantee rate of wind turbine power curve shall be 95%, i.e. the correction factor is 0.95.

(4) Control and turbulence effect reduction

When wind direction changes, the blade and nacelle of the wind turbine shall change gradually. But in the actual operation, the WTG control always falls behind the wind change. Therefore, this reduction should be considered in energy output calculation. The turbulence intensities at different heights of Lucky anemometer tower within the wind speed range of 15m/s are 0.069~0.104; the turbulence intensities at different heights of FCC anemometer tower within the wind speed range of 15m/s are 0.076~0.132, suggesting small turbulence at the wind farm. The reduction coefficient out of these two factors for this wind farm is taken as 3%.

(5) Reduction due to blade contamination

Contamination on the blade surface may add to its surface roughness and dwindle the aerodynamic characteristics of airfoil. Considering that the industrial pollution impact of this wind farm is small, the blade contamination reduction factor is determined to be 1%, i.e. the correction factor is 0.99.

(6) Shutdown due to weather effect

The measured extreme maximum temperature for 40 years (1971-2010) at Karachi weather station is 47℃; the measured extreme minimum temperature is 1.3 And according to the wind data of the Lucky anemometer tower, the time duration of air temperature higher than 40°C is 59160min, accounting for 38.8%; according to the wind data of the FFC anemometer tower, the time duration of air temperature higher than 40°C is 40min, accounting for less than 1%; the time duration of air temperature higher than 30°C is 64000min, accounting for 12.2%. By referring to other projects, the shutdown coefficient due to weather effect takes 2%, i.e. the correction factor is 0.98.

(7) Energy loss due to plant service power and line loss

According to the statistics and analysis of the existing wind farm projects in China and abroad, loss generally includes losses in transmission lines within site, outgoing transmission lines and transformer, as well as service power consumption. The wind farm energy loss coefficient is set to be 2%, i.e. the correction factor is 0.98.

(8) Other influence factors

The wind farm operation would surely encounter some other influence factors, such as the offset of general software model. The reduction coefficient of 1% will be counted.

(9) Reduction due to wake flow effect of neighboring wind farms

There have other wind farms situated around Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") . According to our engineering experience, the wake flow effect is counted to be 3%.

After counting the above reductions (overall reduction coefficient of 20%), the energy yield indicators of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") with recommended WTGs are given in Table 5.4.

Table 5.4 Energy yield indicators of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") with proposed WTGs

Designation	Unit	GW121/2.5MW
Wheel diameter	m	121
Counted height	m	90
Single unit capacity	kW	2500
Number of units	set	20
Total installed capacity	MW	50
Annual on-grid energy	10^4 kW·h	17330
Annual utilization hours	h	3466
Capacity factor		0.376

From Table 5.4, with the recommended scheme for Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") 20 sets of 90m-high WTG model (GW121/2.5MW) are installed with a total installed capacity of 50MW, an annual on-grid energy of 173.30 GWh, an annual utilization hours of 3297h, and a capacity factor of 0.396.

5.5 Analysis of applicability of the proposed WTG model

The applicability of the proposed Goldwind WTG model ban be refer to their special analysis report.

6 ELECTRICAL SYSTEM

6.1 Primary Electrical System

6.1.1 Design bases and normative references

GB311.1-2012	Insulation Coordination, Part 1: Definitions, Principles and Rules
GB/T11022-2011	Common Technical Requirements for High Voltage Switch Equipment and Control Equipment Standards
GB11032-2010	AC Metal-oxide Surge Arrester without Gaps
GB17467-2010	HV and LV Prefabricated Substation
GB/T17468-2008	Guidelines for Selection of Power Transformers
GB/T19071-19073	Wind Turbine Generator System
GB/T19963-2011	Technical Regulations for Access Power System of Wind Farm
GB50059-2011	Code for Design of 35kV～110kV Substation
GB50060-2008	Code for Design of High Voltage Electrical Installation
GB50065-2011	Code for Design of AC Electrical Installations Earthing
GB50217-2007	Code for Design of Cables of Electric Engineering
GB50229-2006	Code for Design of Fire Protection of Fossil Fuel Power Plants and Substations
DL/T537-2002	High-voltage/Low-voltage Prefabricated Cubical Substation
DL/T620-1997	Overvoltage Protection and Insulation Coordination for AC Electrical Installations
DL/T5056-2007	Technical Code of General Plan Design for Substation
DL/T5222-2005	Design Technical Rule for Selecting Conductor and Electrical Equipment
NB/T 31026-2012	Electric Design Code for Windpower Projects
IEEE 665	IEEE Guide for *Generating Station Grounding*
IEEE C62.11	IEEE Standard for Metal-Oxide Sure Arresters for Altermating Current Power Circuits
IEEE C62.22	IEEE Guide for the Application of Metal Oxide Surge Arresters for AC Systems
IEEE Std C62.92.4	IEEE Guide for Application of Neutral Grounding in Electrical Utility Systems

IEEE Std 519	IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
IEEE Std 80	IEEE Guide for Safety in AC Substation
IEC 60364	Low-voltage Electrical Installations
IEC 61024	Protection of structures against lightning
IEC 60229	Electric cables –Tests on extruded oversheaths with a special protective function
IEC 60071	Insulation co-ordination
IEC 60076	Power transformers
IEC 60044-1	Instrument Transformers –Part 1: Current Transformers
IEC 61400-1	Wind turbines-Part1 Design requirements
IEC 61400-24	Lightning protection for wind turbine systems
IEC 62271-203	Gas-insulated metal-enclosed switchgear for rated voltage of 72.5kV and above

Quality/Occupational, Health, Safety/Environment Management System Documents (Hydrochina Northwest Engineering Corporation, 2012)

Other industrial codes, standards and design manuals of China. .

6.1.2 Power access system

Pakistan NTDC grid voltage grades are 500V and 220V, and voltage grades of power grids owned by local power companies are 132kV and 66 kV, of which 66 kV is being gradually upgraded to 132 kV. The maximum power loads will be 27840MW and 31900MW in 2017 and 2020, average annual increase rate of power consumption in Pakistan from 2013 to 2020 is 7.8%. According to analysis of Pakistan power grid balance, power shortage in 2017 will be 14777MW, power shortage in Sindh province and Karachi will be 745MW. Jhimpir New 220/132 kV collector sub-station will be built about 10km of the planned Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") , two 250MVA power transformers will be installed in this substation and wind farms such as Sunec, Titan, FINA, Hartford Tapal will be connected to this substation.

Norinco international Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is located in Sindh province. According to the approved Grid Interconnection Study for the project, a 132 kV substation will be built with three 50 MVA power transformers, two circuits of 132kV power transmission lines will be connected to Jhimpir New 220/132 kV collector sub-station with a distance of about 10km.

6.1.3 Main Electrical Connection

6.1.3.1 Main electric connection of wind farm

(1) Electrical connection of WTG and GSU (Generator GSU)

A total of 20 WTGs with a unit capacity of 2500kW will be installed in the wind farm; unit connection will be adopted, i.e. one WTG will be connected to one GSU. GSU with a rated capacity of 2750 kVA will be installed closely to WTG tower.

WTG is connected with GSU via 8 power cables (4 pieces of cables are served as phase conductors, ZR-YJV23-0.6/1kV-3×300mm^2, and 2 pieces of cables are served as grounding conductors, ZR-YJY-0.6/1kV-1×300mm^2).

(2) Line connection at HV side of GSU

In line with the topography of the project site, operation experience of WTGs in the local area and the Feasibility Study of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") at Nooriabad, Sindh, Pakistan, 33kV embedded cables are used for power collection. A total of 4 collection lines are designed, each line (capacity 12.5MW) is connected to 5 WTGs; power cables (ZR-YJV32-26/33kV-3×70mm^2) are connected to No. 1~3 GSUs, and power cables (ZR-YJV32-26/33kV-3×150mm^2) are connected to No. 4~5 GSUs; all the embedded collection lines are installed beyond the fence of 132kV substation and further connected to 33kV switchgear through trench.

6.1.3.2 Main electrical connection of 132kV step-up substation

According to the Feasibility Study of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") at Nooriabad, Sindh, Pakistan provided by the Employer and other wind power projects built in Pakistan as well as actual site conditions, GIS double-busbar connection scheme is proposed as 132 kV power distribution installations to minimize land occupation and equipment installation period as GIS technology is fully fledged.

Considering China's wind farm design and operation situation, main electrical connection for the substation are proposed with the following options: a single busbar sectional electrical connection (Fig. 6.1.1) and single busbar electrical connection (Fig. 6.1.2).

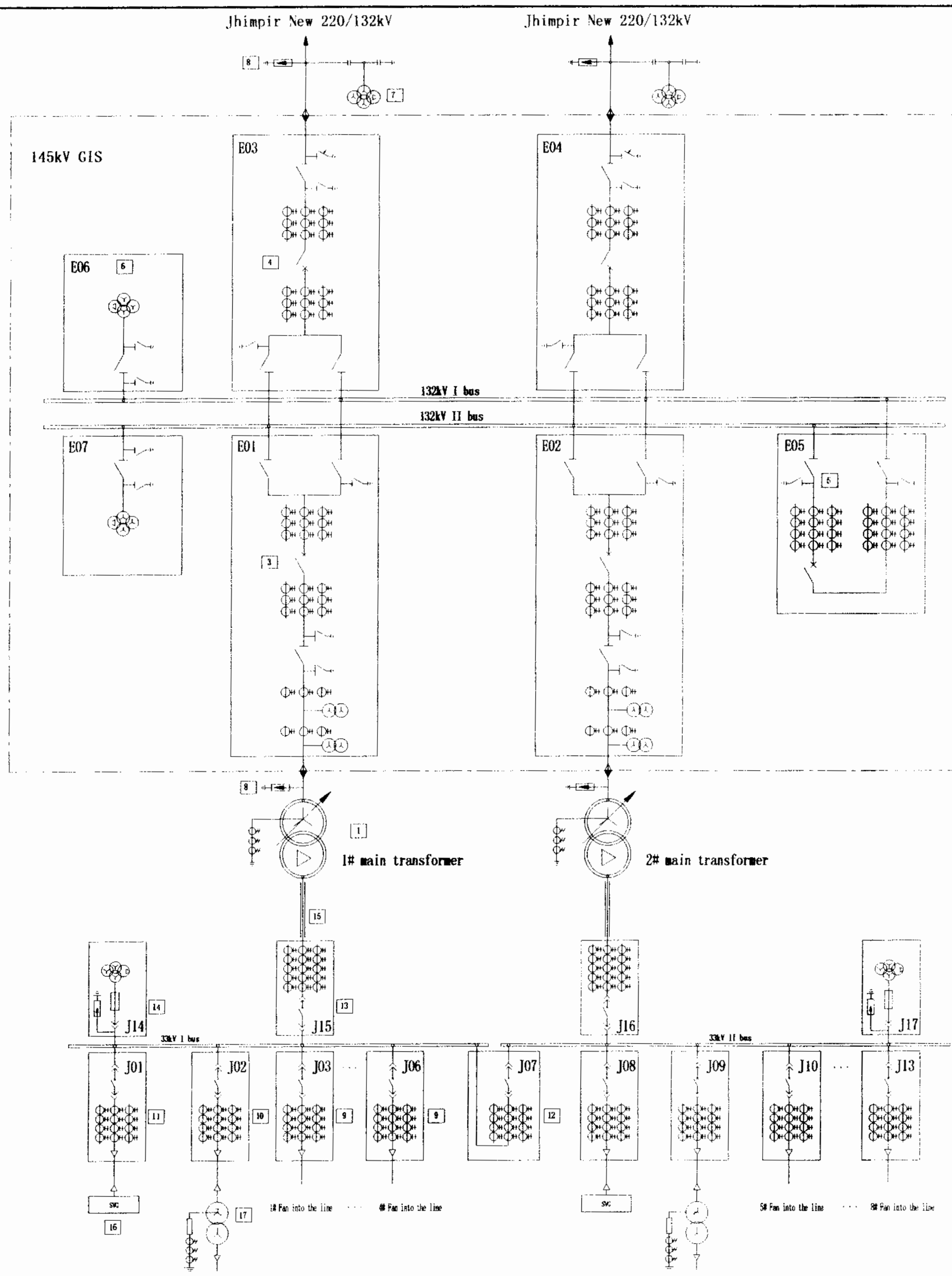


Fig. 6-1 Main electrical connection of 132kV step-up substation

(1) Electrical connection at 132 kV side

Double-busbar is designed at 132 kV side, and two incomer bays, two outgoing feeder bays, two protection bays and one bus-tie bay are installed.

(2) Electrical connection at 33kV side

Single busbar sectionalized electrical connection is proposed at 33kV side of the 132 kV substation; circuit breaker is set between two busbar sections.

(3)Neutral point grounding

Solid grounding is adopted at power transformer 132kV side, capacitive short-circuit current of busbar single-phase grounding of 33kV substation is about 112A. Single-phase fault of power collection lines shall be quickly rejected; 33kV side neutral point is grounded via low resistance; fault circuit can be quickly dropped in case of single-phase grounding fault of power collection system to avoid expansion of fault. Grounding transformer capacity is 800kVA, and grounding resistance is 85 Ω /225A.

(4) SVG

According to the *Feasibility Study Report* provided by the Employer, and combined with *Technical Regulations on Wind Farm Access Power System (GB/T 19963-2011) and Electric Design Code for Wind Power Projects (NB/T 31026-2012)*, wind farm reactive power regulation scope and response time shall conform to voltage adjustment at power interconnection point and requirement of wind farm operation and total reactive power should be automatically and quickly regulated. One 20Mvar SVG will be installed at 33kV side of power transformer in the substation. SVG type and capacity will be decided by NTDC/CPPA.

6.1.4 Selection of Main Electrical Equipment

6.1.4.1 Short-circuit breaking current

According to the feasibility study report provided by the Employer, electrical equipment selection in this stage is based on 132kV busbar short-circuit breaking current 40kA, 33kV busbar short-circuit breaking current 31.5 kA.

6.1.4.2 Natural conditions of equipment operation

Altitude above sea level	50m
Average annual temperature	26°C
Minimum temperature	0°C
Maximum temperature	50°C
Maximum wind speed	37.1m/s (Height: 10m)
Seismic intensity	Grade VII

6.1.4.3 Technical data of main electrical equipment

(1) WTGs

A total of 20 WTGs (20×2500kW) will be installed. WTGs shall be designed with low voltage ride-through capability, e.g. WTGs can be able to perform interconnection operation at least for 625ms in case voltage at interconnection point has dropped to 20% of rated voltage; and can be able to perform interconnection operation in case voltage at interconnection point has increased to 90% of rated voltage within 2s after voltage drop.

WTG main data are as follows:

Rated output power	2500 kW
Rated output voltage	690 V
Frequency	50 Hz
Power factor	capacitive 0.95～ inductive 0.95

(2) GSU and RMU

Prefabricated substation (GSU and RMU) is adopted for the project to ensure safe and reliable operation of power distribution equipment set at WTG high voltage side. GSU mainly consists of the following equipment:

a) Step-up transformer

Dry type 3-phase dual-winding natural air cooling transformer is adopted.

Type	SC11-2200/33.5
Rated capacity	2750kVA
Rated voltage	33.5/0.69kV
Short-circuit impedance	6.5%
Non-load tap changing	33.5±2×2.5% kV
Vector group	D, yn11

b) Circuit breaker

GSU is adopted with circuit breaker at33kV side, circuit breaker main data:

Type	Vacuum circuit breaker
Rated voltage	40.5kV
Rated current	630A
Rated breaking current	31.5kA
Rated peak withstand current	80Ka
Rated short-term withstand current	31.5kA
Rated short-circuit period	2s

(3) Power transformer

According to the requirement for wind farm voltage regulation, three oil immerged natural air cooling 3-phase dual-winding on-load tap-changing transformers are adopted for 132kV substation.

Type	SZ11-50000/132
Rated capacity	50000 kVA
Rated voltage	132±8×1.25%/33.75kV
Voltage regulating mode	on-load tap changing switch at HV side
Coil Vector group	Yn, d11
Cooling mode	ONAN
Impedance voltage	10.5%
132kV neutral point	Solid grounding

(4) 132kV power distribution device

a) 132kV power distribution device type

GIS equipment (double busbar) is adopted for 132kV power distribution device; GIS equipment is less affected by environmental factors and it is characterized by high operation liability, short installation period, long overhaul period and small land occupation.

b) 132kV GIS data

Rated voltage	145kV
Frequency	50Hz
Lightning surge withstand voltage (peak):	Phase-ground: 650kV
Phase-phase: 650kV	
Isolating distance: 770kV	
1min power frequency withstand voltage (RMS):	Phase-ground: 275kV
Phase-phase: 275kV	
Isolating distance: 360kV	
Rated short-term withstand current	40kA/3s
Rated peak withstand current	100kA

(5) 33kV power distribution device

Type	KYN-40.5kV
Rated voltage	40.5kV
Rated current	630A, 1250A, 2500A
Rated breaking current	31.5kA

(6) 33kV grounding transformer and grounding resistance cabinet

Type	DKSC-800/33-315/0.4
Grounding transformer capacity	800kVA
Auxiliary transformer capacity	315kVA
Grounding resistance	85Ω/225A

(7) SVG

One set of 20Mvar SVG will be installed. SVG is characterized by quick response, sound LV performance and low energy loss.

Type	SVG
Rated voltage	33kV
Uninterrupted regulating range	inductive 20 Mvar～capacitive 20 Mvar
Response time	≦30ms

6.1.5 Service Power Supply System

Two 315 kVA auxiliary transformers will be adopted for 132 kV substation in this stage. One 150 kW diesel generator will be used as backup power source. Substation service power system is equipped with backup automatic switching device, 0.4kV single busbar sectionalized electrical connection is adopted, and 5 LV (GCS-0.4) LV switchgears are proposed.

6.1.6 Over-voltage Protection and Grounding

6.1.6.1 Over-voltage protection

The over-voltage protection is designed as per *Insulation Co-ordination Part I: Definition, Principle and Rules (GB 311.1-2012), Insulation Coordination for High Voltage Transmission and Distribution Equipment (DL/T620-1997),* and *General Design Code for 110kV Substation (Q/GDW 203-2008).*

(1) Over-voltage protection of WTGs

Impulse capacitor and lightning arrester are arranged at the connection of WTGs and their control systems as lightning protection and electrical fault protection for WTGs and their control systems. Communication line and control & protection system and remote control system used for wind farm monitoring are equipped with lightning protection and buffering devices. Both 33kV and 690V electric systems of the GSU are equipped with over-voltage protection devices.

(2) Over-voltage protection for 132kV substation

In order to prevent wave lightning voltage from intruding the line, a surge arrestor is installed at HV side of power transformer and outlet of 132kV line, respectively.

(3) Direct lightning protection

The WTG rotor blade is equipped with lightning protection system; grounding cable is arranged in nacelle; one lightning rod is installed on nacelle top. These devices are directly connected to grounding cable. Lightning is transmitted to foundation grounding system through tower. All metal objects shall be equal-potentially grounded.

A total of four 30m high lightning rods will be provided in 132kV substation at proper locations according to equipment layout.

6.1.6.2 Insulation coordination for electrical installations

Insulation coordination of 132kV electrical equipment is designed based on residual voltage of lightning over-voltage under nominal discharge current of 10kA and insulation level of main electrical installations is given in Table 6.1.1

Table 6.1.1 Insulation Level of 132kV Equipment

	Equipment Withstand Voltage				
	Lightning impulse withstand voltage (kV, peak value)			1min power frequency withstand voltage (kV, RMS)	
	Full wave		Clipped wave	Inner insulation	Outer insulation
	Inner insulation	Outer insulation			
Power transformer, 132kV side	650	650	770	275	275
Other electrical installations	650		770	275	
Open contact of circuit breaker	650			275	
Open contact of disconnector		770			360

Table 6.1.2 Insulation Level of 33kV Equipment

	Equipment Withstand Voltage						
	Lightning impulse withstand voltage (kV, peak value)				1min power frequency withstand voltage (kV, RMS)		
	Full wave			Clipped wave	Inner insulation	Outer insulation	
	Inner insulation	Outer insulation					
Power transformer, 33kV side	200	200 (dry)	220 (wet)	220	85	85 (dry)	80 (wet)
Other electrical installations	185				95		

Open contacts of circuit breaker	185			95	
Post insulator, disconnector, open contact		215			118

6.1.6.3 Grounding system

The grounding system of the project shall be designed to be applicable to working grounding, protection grounding, lightning grounding of mechanical and electrical equipment to ensure that grounding resistance, step potential and contact potential conform to *Guidance for Safe Grounding for AC Substation Electrical Installations (IEEE Std 80-2000).*

According to the project geological investigation data, the ground mainly consists of angular gravels and highly weathered lime stones with high resistivity, therefore, copper stranded wires and copper bars are selected as grounding conductors.

The grounding system mainly consists of the followings:

(1) WTG and GSU grounding network

WTG and GSU share one grounding system. WTG grounding network is connected to iso-potential bodies, e.g. tower foundation flange, at the same time; all the metal elements (such as tower foundation, reinforcement elements and metal junction box, etc.) are electrically connected to grounding conductors. GSU equipment is connected to grounding network outgoing line with copper stranded wires (at least two outgoing lines shall be connected). Grounding resistance of the grounding networks shall be less than 5 Ω. Horizontal grounding conductor of the grounding network shall be copper stranded wire to ensure that grounding resistance can meet specifications.

(2) 132 kV substation grounding network

According to *Guidance for Safe Grounding for AC Substation Electrical Installations (IEEE Std 80-2000)*, the total grounding resistance of the grounding system shall not be greater than 1 Ω. A proper number of vertical grounding electrodes shall be installed in the locations where grounding system is connected to surge arrestors, lightning rods to intensify current discharge.

Grounding resistance, step potential and contact potential of the grounding system shall conform to *Guidance for Safe Grounding for AC Substation Electrical Installations (IEEE Std 80-2000).*

6.1.7 Lighting System

The working power of the lighting system of 132 kV substation is fed from 0.4 kV busbar without installation of lighting transformer; emergency lighting power will be fed from UPS power source. Lighting system voltage is 380/220V.

6.1.8 Arrangement of Main Electrical Equipment

6.1.8.1 GSU

GSU is arranged on foundation of WTG tower bearing platform.

6.1.8.2 Arrangement of operation building

132 kV sub-station is provided with 33kV switchgear room, incomers are made of cables, outgoing line cabinet is connected to power transformer via non-segregated busbar.

6.1.8.3 Arrangement of 132kV distribution device

Indoor GIS is adopted as 132kV power distribution device.

6.1.8.4 Arrangement of cables

Cables, cable structures shall be arranged to the nearest electrical equipment, the path should be as short as possible and the arrangement shall be aesthetic. Horizontal and vertical arrangement shall be coordinated, detours and crossings shall be minimized, and the arrangement shall be convenient for cable construction, maintenance and expansion works at later stage.

Cable trench shall be arranged along path/road, structures according to electrical equipment layout; cable ditch shall be constructed under indoor 33kV HV switchgear, 0.4 kV LV panel where cables are densely arranged and cable ditch shall be interconnected to outdoor cable trench. Cable duct is used in locations that are close to equipment where a few cables are required.

6.1.9 List of Main Electrical Equipment of the Substation

Table 6.1.3 List of primary electrical equipment/accessories

No.	Equipment or accessories	Specification/type	Unit	Qty.	Remarks
I	Transformer				
1	Power transformer	SZ11-50000/132,	set	3	

No.	Equipment or accessories	Specification/type	Unit	Qty.	Remarks
		YN,d11 132±8×1.25%/33.75kV			
II	132kV power distribution device (GIS with double busbar)				
1	Incomer circuit breaker bay	145kV, 2000A, 40kA	set	2	
2	Outgoing line circuit breaker bay	145kV, 2000A, 40kA	set	2	
3	Bus-tie circuit breaker bay	145kV, 2000A, 40kA	set	1	
4	PT protection bay	145kV, 2000A	set	2	
	CT	500/1A	no.	12	
5	Surge arrestor	Y10W-120/320	no.	12	
4	132kV main busbar and branch busbar	GIS	set	1	
III	33kV power distribution device				
1	Metal enclosed armoured movable HV switchgear KYN-40.5	40.5kV, vacuum circuit breaker 630A, 31.5kA	no.	4	WTG incomer cabinet
2		40.5kV, SF6 circuit breaker1250A, 31.5kA	no.	2	SVG cabinet
3		40.5kV,vacuum circuit breaker2500A	no.	2	Outgoing line cabinet
4		40.5kV,vacuum circuit breaker 630A, 31.5kA	no.	2	Grounding/auxiliary transformer cabinet
5		40.5kV, vacuum circuit breaker 2500A,	no.	1	Bus tie cabinet
6		PT, Surge arrestor, harmonic wave eliminator	no.	2	Protection cabinet
7	SVG	SVG, 20MVar	set	2	
8	Grounding transformer	DKSC-800/33-315/0.4	set	2	

No.	Equipment or accessories	Specification/type	Unit	Qty.	Remarks
9	Non-segregated busbar	40.5kV 2500A	m	25	
IV	Miscellaneous				
1	LV switching cabinet	GCS-0.4	no.	5	
2	Power distribution box		no.	20	
3	Channel steel foundation	[10	m	150	
4	33kV power cable	ZR-YJV23-26/33kV-3 × 150	km	0.6	
5	33kV cable terminal	Cold shrinkage	set	8	
6	0.4kVpower cable		km	1.2	
7	Lighting				
7.1	Florescent lamp	2×36W	no.	100	
7.2	Wall lamp	1 × 15W energy saving lamp	no.	50	
7.3	Outdoor projection lamp	Lamp post	no.	20	
7.4	Yard lamp	1 × 70W energy saving lamp	no.	150	
7.4	Switch		no.	80	
7.5	Socket		no.	150	
7.6	Conductor		km	20	
8	Fire protection				
8.1	Fire resistant partition		m^2	30	
8.2	Fireproof putty		m^3	0.8	
8.3	Fireproof coating		t	0.6	
9	Grounding				
9.1	Copper stranded line	$95mm^2$	t	9.5	
9.2	Copper stranded line	$50mm^2$	t	3	
9.3	Corrosion resistant conductive coating		t	0.8	

No.	Equipment or accessories	Specification/type	Unit	Qty.	Remarks
9.4	Resistance reducer		t	10	
10	Angle steel		t	8	
11	Water gas pipe	GG32-GG100	t	4.5	
12	Lightning rod	H=30m	set	4	

6.1.10 Electrical Equipment of the Wind Farm

Table 6.1.4 List of electrical equipment of the wind farm

No.	Equipment/accessories	Specification/type	Unit	Qty.	Remarks
1	WTG	PN=2500kW	set	20	
2	GSU	2750/33.5 2750kVA	set	20	
3	Power cable	$ZR\text{-}YJV_{23}\text{-}0.6/1.0kV\text{-}3\times300$	km	3.6	
4	Power cable	ZR-YJY-0.6/1.0kV-1×300	km	1.2	
5	Cold shrinkage cable terminal	3-core	set	480	
6	Cold shrinkage cable terminal	1-core	set	160	
7	WTG/GAU grounding				
7.1	Copper stranded wire	$95mm^2$	km	17	
7.2	Corrosion resistant conductive coating		t	3.5	
8	Fire protection for cable	φ16mm L=2500mm	pcs.	320	

No.	Equipment/accessories	Specification/type	Unit	Qty.	Remarks
8.1	Organic putty		t	11	
8.2	Inorganic putty				
9	Embedded duct	PVC 150	t	3.0	

6.1.11 35kV collection line materials

Table 6.1.5 35kV collection line materials

No.	Equipment/accessories	Specification/type	Unit	Qty.	Remarks
1	Power cable	ZR-YJV_{23}-26/33kV-3×70	km	11.8	
2	Power cable	ZR-YJV_{23}-26/33kV-3×150	km	20.4	
3	Cable terminal	YJV_{23}-26/33kV-3×70 cable	set	48	
4	Cable terminal	YJV_{23}-26/33kV-3×150 cable	set	32	
5	Middle joint	YJV_{23}-26/33kV-3×150 cable	set	8	

6.2 Relay Protection, Control, Monitoring and Measuring System

6.2.1 Design basis

Main standards referenced for design:

(1) *Design Code for33kV~110kV Substations (GB 50059-2011);*

(2) *Technical Code for Relay Protection and Security Automatic Equipment (GB/T 14285-2006);*

(3) *Design Code for Automatic Fire Alarm System* (GB 50116-2013);

(4) *Design Code for Cables of Electric Engineering* (GB 50217-2007);

(5) *Management Code for Electric Energy Metering Device (*DL/T 448-2000);

(6) *Universal Technical Conditions for Automatic Fault Recording of Power System* (DL/T 553-2013);

(7) *Design Code for DC System of Power Project* (DL/T 5044-2004);

(8) *Design Code for Dispatch Automation in Power Grid* (DL/T 5002-2005);

(9) *Design Code for Dispatch Automation in Electrical Power System* (DL/T 5003-2005);

(10) *Design Code for Secondary Electrical Wiring for Thermal Power Plant and Substation*, DL/T5136-2012

(11) *Design Code for Electrical Measuring and Energy Metering Devices*, DL/T 5137-2001

(12) *Design Code for 220kV~500kV Substation* (DL/T 5218-2012);

(13) *Technical Code for Grid Connection of Wind Farms* (Q/GDW 392-2009);

(14) *Technical Code for Wind Farm Power Access System* (GB/Z 19963-2005)

6.2.2 Design Principles

(1) The substation shall be designed according to the principle of "unattended operation" (less person on-duty).

(2) The SCADA system equipment of the wind farm is bay-level equipment of SCADA system of the substation, and the monitoring data of the wind farm is transmitted to the system via the SCADA system of the substation. The LV ride-through capacity, active power control, reactive power and voltage control of the WTGs shall comply with the requirements of related technical standards.

(3) WTG consists of equipment monitoring and control system that are designed to perform local control and management of 20 sets of 2500 kW WTGs and 20 sets of GSUs. WTG central SCADA system perform data exchange with substation SCADA system that is equipped with remote communication equipment, which is designed to perform remote functions for automation dispatching required by power access system.

(4) Protection of the wind farm and WTGs shall be coordinated with the power access system to meet requirements of the power system on adaptability of voltage, frequency as well as power quality.

(5) The response time of dynamic compensation of SVG shall satisfy the requirement of power system.

(6) 33kV system of wind farm substation is grounded via low resistance and is equipped with single-phase grounding failure protection so as to ensure rapid isolation of power collection line system fault and prevent accident expanding and deteriorating.

(7) 33kV busbar is equipped with busbar differential protection.

(8) On-line power quality monitoring system shall be equipped to monitor power quality index at interconnection point, the data is uploaded to on-line power quality monitoring station.

(9) Communication system of the substation shall comply with requirement of security and protection of power system.

6.2.3 Control and Protection of the Wind Farm

6.2.3.1 Control and protection of WTGs

(1) Control and monitoring of WTGs

WTG monitoring equipment includes local monitoring equipment and centralized monitoring equipment. The local monitoring equipment can perform local control, monitoring of protection action signals and measuring data for WTGs; centralized monitoring equipment in the central control room can perform monitoring for WTGs.

1) Local control

WTG's local control system mainly includes electrical control system, yaw control system, pitch control system, local control cabinet installed in tower bottom. Local control system can automatically control WTG startup and shutdown, perform monitoring and control during normal operation. At the same time, it can perform data communication with WTG centralized SCADA system, upload WTG operation state data, and receive control, regulation commands from WTG centralized SCADA system, and perform remote manual WTG startup and shutdown.

Operation personnel can be able to conduct manual WTG startup and shutdown, electrical motor startup and shutdown, WTG rotor clockwise or counterclockwise rotation through local control cabinet. Control device uninterruptedly performs monitoring of WTG rotation speed, completeness of braking system to ensure safety level of WTG braking system. Control device can also adjust WTG power factor, etc. Some operation mode switches and local manual switches and buttons are set in electrical motor nacelle on top of WTG tower.

Local control system ensures normal interconnection and safety operation of WTGs and provides functions e.g. emergency shutdown, fault alarm, normal startup, shutdown, yaw, reset, recording and displaying of energy output, energy generation time, interconnection time etc. Backup UPS is provided to ensure no missing of operational data recording in case of power outage or power grid failure.

The local control system does not rely on centralized SCADA system and it can uninterruptedly control WTGs and ensure normal operation in case of failure of centralized SCADA system.

WTG is equipped with all kinds of testing devices and transducers, and can display real-time state of each WTG on screen such as date and time, rotor rotational speed, generator rotation speed, wind speed, ambient temperature, WTG temperature, active and reactive power, current, voltage, WTG yaw situation, total energy output and annual energy output, etc., WTG computer monitor can display signals related to a fault or a failure, e.g. location, quantity, nature, date and time, etc.

2) Centralized control equipment

WTG centralized control equipment is arranged in central control room. Attendants or operators perform monitoring through man-machine interface in central control room and centralized control equipment can be able to receive commands from dispatching terminal in order to perform WTG monitoring, control and regulation.

Centralized monitoring equipment should have functions, e.g., WTG start/shutdown operation (in normal or emergency condition), low voltage ride through, active power control, reactive power control, control parameters resetting, monitoring various operation data, real-time data recording, saving and uploading as per dispatching system requirement. Wind farm power variation rate should satisfy design standard. In case of any abnormal operation, such as fault and emergency shutdown, manual star and shutdown, over-high wind speed shutdown, over-high ambient temperature, the centralized monitoring system shall be able to send video, audio alarm signals.

The centralized monitoring equipment is fed by substation UPS and performs data exchange with substation SCADA system. And its self-protection function denies any unauthorized access. When the system is withdrawn due to fault, all WTGs can be operated normally. Local control device of WTG is designed with Ethernet structure and several independent ring networks consisting of embedded optical fibers are connected to the centralized monitoring system.

3) Protection of WTGs

In order to ensure normal operation of power system and electricity quality and to reduce potential damage of failure equipment and adverse impact on power supply for neighborhood when electrical equipment fails and failure equipment can be automatically disconnected from the power grid in shortest time limit, WTGs are designed with protection and detection installations, e.g. over-high temperature protection, over-load protection, low-voltage protection, power grid fault protection, vibration overrun protection, over-speed protection, lightning protection, irregular cable twining protection, etc. Protection device acts and sends action signals before automatically cutting off fault or rejecting generator operation.

6.2.3.2 GSU control and protection

One GSU protection and control system is provided to perform control, metering and protection. Real-time GSU data are acquired and uploaded to dispatching system via substation SCADA.

HV circuit breakers are set up at high voltage side of transformer and one protection, metering and control device is provided for GSU to perform over-current, quick-breaking, zero sequence current protection, over-load protection, non-electricity protection, GSU monitoring, etc.

GSU protection and control system is an independent network with open, hierarchical structure, consisting of centralized control equipment, local metering and control device, network equipment, etc. GSU centralized control layer consists of star Ethernet with a transmission rate of 10/100Mbps (TCP/IP protocol) and optical fiber is used to transmit data.

6.2.4 Dispatching Management

The project, after being built, will be under unified management of local power dispatching authority to which remote control information will be transmitted. Dispatching management will be subject to NTDC requirement.

6.2.5 Substation SCADA System

6.2.5.1 Objectives

SCADA system is designed to perform automatic control and regulation for substation 132 kV lines, power transformer, 33kV lines, auxiliary transformer, SVG, etc., according to the requirement of power system and substation operation mode. The objectives include:

1) Accurate acquisition, processing, uploading of operation information of substation equipment on real-time basis.

2) Monitoring of electrical equipment operation on real-time basis to ensure safety operation and automatic management.

3) Optimal control and regulation according to requirements of power system dispatching for wind farm operation.

6.2.5.2 SCADA system structure

Substation's SCADA system is of an open type, hierarchical distribution structure. The whole system consists of station control level and bay control level; data distribution management is adopted. Station control level is of function distribution structure; bay control level is designed with local control device. Local control function of bay equipment can be performed independently in case of station control level and network failure.

Station control level is connected with bay control level via dual-Ethernet structure. The Network medium may adopt STP, coaxial cable and optical fiber.

6.2.5.3 SCADA system equipment configuration

The system is mainly configured with hardware and software. Station control level equipment and bay control level equipment are configured with following hardware equipment:

(1) Station control level equipment

Host computer and operator station: 2 host computers

Engineer station: 1 Engineer working station

Remote communication equipment: backup equipment is configured

Microcomputer "mal-operation prevention" system: 1 set of microcomputer controlled mal-operation prevention system equipment is configured

Intelligent equipment interface: 1 set of intelligent interface equipment is configured for station control level

Printer: 2 sets of laser printers are configured

GPS clock system: 1 set

(2) Network equipment

Station control level: 2 sets of network switches

Other network equipment includes optical/electric converter, interface equipment (optical fiber junction box) and network connecting wire, cable, optical fiber and network safety equipment, etc.

(3) Bay level equipment

I/O measuring and control devices are designed with functions e.g. AC sampling, measuring, mal-operation-prevention locking, synchronous detection, local circuit breaker emergency operation, single line connection state and measuring digital display to perform information acquisition, conversion, process and transmission for substation equipment. Each electrical device is equipped with switch electrical equipment, each section of busbar is equipped with busbar device, and public unit is equipped separately.

Secondary electrical panel room and switchgear room are equipped with 2 network switches respectively that are used for connection of local unit equipment and connection with network switches of station control level.

WTG centralized monitoring device is equipped with one centralized SCADA system provided by the WTG manufacturer, it performs WTG information acquisition via wind farm optical fiber communication network.

GSU centralized control device is equipped with one set of centralized control system supplied by the manufacturer. It performs substation information acquisition via wind farm optical fiber communication network.

6.2.5.4 SCADA system functions

SCADA system is designed with the following functions:

1) Data acquisition and processing

SCADA system can perform data acquisition and processing, including analogue, switch quantity, electric energy, and data of other intelligent equipment, it performs real-time acquisition of analogue, switch quantity and other information through I/O control device; receives data of other intelligent equipment through intelligent equipment interface. The analogue, except for DC voltage, temperature that are input through transducer, is input by AC sampling; switch quantity is input at potential - free contact; other intelligent equipment data is input via data communication.

SCADA system performs real-time acquisition and off-limit alarm for analogue; performs real-time acquisition and abnormal alarm for state quantity and data processing such as event recording.

2) Database building and maintenance

SCADA system shall be designed with real-time database to store and update all the real-time data transmitted from I/O device and communication interfaces of real time; historical database shall be built to store and regularly update historical data and operation report data that are needed. Database shall be highly reliable, all the acquired data can't be modified; database can be maintainable on line or designed to generate off-line-data.

3) Control operation

SCADA system is designed to control voltage level of circuit breaker and disconnector, power transformer and auxiliary transformer tapping position, SVG switch in/off, startup/shutdown of other important equipment.

SCADA system is designed with manual control mode and automatic control mode, manual control includes dispatching center control, central control room control, local manual control which can be switched. Control priority in order is dispatching center control, central control room control; automatic control includes sequence control and regulation control; voltage-reactive automatic regulation control system set in central control room shall take full consideration of operation mode and locking conditions.

In case service of station control level and network of SCADA system is outage, circuit breaker shall be operated in bay control level. In automatic control process, alarm information shall be output to stop control operation and maintain state of controlled equipment in case of any software, hardware fault.

4) Mal-operation preventive locking system

Mal-operation preventive locking system shall be designed to prevent mal-operation of circuit breaker (switch in/off), disconnecting switch (switch in/off with electrical load), prevent electrified connection of grounding line, prevent electricity transmission while connecting ground wire feeder and prevent straying into charged bay.

All operational control is designed with mal-operation preventive locking system that provides fault alarm signals and judgment output information. SCADA system is designed with mal-operation preventive locking working station. Remote control performs locking function for all substation equipment via mal-operation preventive locking system, local control performs locking function for all electrical devices via computer key and locking device.

5) Alarm function

SCADA system is designed with accident alarm and warning alarm function. Accident alarm includes circuit breaker tripping and protection device action signals triggered by improper operation; warning alarm includes equipment displacement, abnormal state information, analogue or temperature quantity out-of-limit, etc. Alarm processing shall be at varied levels according to varied categories. Alarm output information (sound, light, color signals) shall be visual, noticeable.

6) Event sequence recording and accident recalling

Equipment action sequence, time shall be recorded, stored, displayed, printed to generate an event recording report for inquiry, event sequence recording shall be uploaded to dispatch center.

Accident recalling shall include all the analogue values collected during 1 min period before accident and 2 min after accident. Sampling period shall be consistent with real-time system sampling period. System can generate accident recalling table that can be displayed and printed.

7) Image display

SCADA system is designed with functions such as user edition, image generation, power grid topology recognition, recognition of electrified equipment color, graphical cell edition and graphical image operation. All kinds of information that is displayed on operation working station's screen in central control room should be provided to operation personnel in format of report and graphics.

Image displayed shall include main electrical connection diagram, zoning, unit electrical connection diagram, real-time and historical graphic curves, voltage and load bar chart, bay unit and substation alarm diagram, SCADA system configuration and operation condition graphics, protection system diagram, DC system diagram, service electrical system diagram, report and table display, etc.

Main electrical connection diagram shall show real-time electrical quantity, equipment operation status, current flow direction, positions of circuit breaker, disconnector, grounding switch, "local/remote" switch etc., graphics and curves can be stored and hard copied; users can generate, produce and modify graphics.

8) Online calculation and tabulation

SCADA system conducts calculation for collected primary electrical quantity data. Statistical calculation shall be conducted for routine operation data of substation and operation status of main equipment; optimized computation shall be conducted for automatic control scheme. Calculation results can be processed and displayed.

SCADA system shall be able to generate operation reports in varied formats, including real-time value table, punctual value table, substation load operation log table (duty schedule), electric energy table, reporting table, hand-over records, event sequence recording, alarm records, microcomputer protection setting value list, main equipment data table, self-diagnosis report, etc. The generated report can be easy for real-time and timing display, recall and print, and can be edited, modified, defined by users.

9) Remote control function

SCADA system is equipped with remote communication equipment to perform non-disturbance automatic switchover; all the real-time information is uploaded to all levels of dispatching authorities and power data network or control and modification commands are received through Ethernet that is connected to computer system. Remote communication equipment is designed with remote data processing, protocol conversion and communication functions to meet requirement for automatic dispatching, and designed with serial port output and network interface output, which can perform communication with all levels of master dispatching stations via conventional analog channels and dispatch data network channels.

10) Clock synchronization

GPS synchronous clock is adopted for SCADA system that can accept dispatching clock synchronization via remote communication equipment. Clocking precision can meet requirement of power system equipment for time synchronization accuracy.

11) Man-machine interface

Attendant can perform operation on computer screen by using mouse or keyboard. Operator can invoke, display and copy all sorts of graphics, curves, reports, send control operation commands, check historical data and setting values, produce, modify graphics and reports, affirm alarm, withdraw/restore alarm point, display operation instructions, edit, print and produce online documents in operator's working station. Maintenance personnel perform database, program definition and modification, secondary program development and other duties in engineer's working station. Bay level local control device shall be provided with a few numbers of data displaying and operating buttons.

12) System self-diagnosis and self-recovery

SCADA system is designed with online self-diagnosis function. It performs diagnosis for operation status of software and hardware (including various communication interfaces), find abnormal data and send alarm signals. The system can automatically protect real-time database in case of software deadlock, hardware errors or power source outage. Once fault is eliminated, SCADA system can be restarted and resumed to normal operation.

13) Other equipment interface

Relay protection trip signal or important alarm signals are transmitted to I/O control device at potential-free contact; at the same time, SCADA system is connected to information acquisition device of protection device or protection information management sub-station to acquire protection information at serial port or internet access.

DC power source system, AC UPS system, fire alarm device, electric energy acquisition device and main equipment online monitoring system, WTG centralized monitoring system are connected to SCADA system after protocol is converted via RS-485 communication port of intelligent interface equipment.

14) Operation management

SCADA system performs various management functions according to operation requirements, including operation instruction, accident analysis and retrieval, online equipment analysis, operation sequence, simulation operation and other substation routine management, etc. Management function shall meet requirements for document storage, retrieval, edition, display and printing.

6.2.6 Relay Protection and Automatic Safety Device

6.2.6.1 Configuration design principle

1) Microcomputer type protection device is adopted and relay potential-free contact is adopted at outlet of protection device.

2) Relay protection and safety automatic device shall be reliable, selective, sensitive and responsive.

3) Main relay protection shall be priority while design of backup relay protection and secondary electrical loop shall be simplified.

4) Electricity protection and non-electricity protection shall be designed with independent power source loop.

5) 132 kV line protection and safety automatic device shall be configured based on

requirement of power access system. However, they are tentatively configured according to relevant specifications in this stage before requirement of power access system is available.

6) Equipment at 33kV side shall be provided with low resistance grounding system.

6.2.6.2 Configuration of relay protection and automatic safety device

1) Protection of 132 kV line

It will be configured according to requirement of power access system, in this stage and it is temporarily configured as per the following principles:

One set of independent quick-action protection device with backup protection function and one set of three-phase circuit breaker operation cabinet with reclosing protection function are configured.

2)132 kV bus-tie protection

One set of 132kV bus-tie differential protection device will be configured with following protection functions:

Three-step over-current protection

Zero-sequence current protection

Over-loading protection

3) 132kV busbar protection

One 132kV busbar differential protection device with circuit breakers is provided and it has function of current protection.

4) Power transformer protection

One electricity protection device (equipped with transformers for main and backup protection) and one non-electricity protection device are configured.

Main protection is configured with differential protection.

Backup protection at HV side is configured with compound voltage lockout overcurrent protection, gap zero sequence current and voltage protection, and over-load protection.

Backup protection at LV side is configured with compound voltage starting over-current protection, zero sequence current protection, over-load protection.

Non-electricity protection items include heavy gas, pressure release, light gas, abnormal oil level, oil temperature, winding temperature, pressure regulating heavy gas, regulating pressure release, regulating light gas, regulating abnormal oil level, regulating oil temperature and regulating winding temperature.

5)33kV busbar protection

Each 33kV busbar section is configured with a set of busbar differential protection device that can be accessed to all branches of 33kV busbar.

6) 33kV line protection and control device

33kV line is configured with a set of protection and control device, which includes:

Current quick-breaking protection;

Three-step over-current or three-step distance protection;

Zero sequence current protection;

Over-load protection

7) 33kV SVG branch protection and control device

According to wind farm power accessing report, SVG is provided, however, protection scheme will be decided in the next stage based on SVG type.

8) 33kV grounding transformer protection

Grounding transformer is configured with a set of protection and control device, which includes:

Three-step phase to phase current protection, zero sequence current protection (quick-breaking protection, over-current protection), non-electricity protection, over-load protection; zero sequence current protection is connected to CT in neutral point resistance circuit of grounding transformer.

9) 33kV bus-tie protection

One set of protection and control device is provided for bus-tie protection, which includes:

Three-step over-current protection

Zero-sequence current protection

Over-loading protection

10) Fault recording

One set of fault recording device is set for 132kV equipment and power transformer; one set of fault recording device is set for 33kV equipment. The devices shall be equipped with multiplex analogue and switching value that can be used to automatically record all kinds of fault information, including fault time, fault name and nature, distance of fault point, electricity graphs of analog input (such as current, voltage, etc.) before and after system fault or oscillation, state of switch input before fault occurrence and variation of switch input before and after unit startup, etc. Fault information can be displayed, printed and stored to provide reliable basis for fault analysis.

11) PMU

PMU shall be equipped as per the requirements of local power grid companies.

12) Safe automation device

Safe automation device shall be equipped as per the requirements of local power grid companies.

13) Protection and fault information management station

It shall be equipped as per the requirements of local power grid companies.

6.2.7 Substation Control Power Supply System

6.2.7.1 DC control power source system

Substation will be equipped with a set of DC control power source system. The DC system capacity is estimated according to the project scale. Number of feeder branches is based on the project scale.

DC unit is equipped with 2 battery sets (300 Ah), 2 charging/float charging devices. Single busbar sectional connection is adopted. The DC control power source system adopts voltage level of DC110V. Each DC busbar section is set with one DC insulation monitoring device designed to monitor DC system insulation level, busbar voltage and grounding condition of each branch. Battery is set with one cell inspection device. Radial DC power distribution mode is adopted.

6.2.7.2 AC control power source system

Substation is equipped with AC control power source system, consisting of UPS system and AC power source distribution system. The capacities of the two systems are estimated based on the project scale and terminal size. Number of feeder branches of both systems is also determined based on the project scale.

Substation is equipped with 1 set of 10kVA power UPS; no separate battery set is equipped. The UPS units supply AC power for station control level equipment, fire automatic alarm system, image surveillance and safety & security system, WTG centralized monitoring system and electricity billing system equipment.

One AC control power source distribution panel (AC 220V) is provided; one section of voltage busbar is provided to supply power for auxiliary lighting and heating equipment installed in bay control level cabinet.

6.2.8 Substation secondary electrical connection

6.2.8.1 Measuring and billing point

Electrical measuring system is set up in compliance with *Technical Code for Designing Electrical Measuring and Energy Metering Device (DL/T5137-2001)*. All electrical quantities are transmitted to SCADA system via AC sampling mode and conventional electrical measuring instrument is not equipped in the central control room, while necessary conventional measuring instrument is installed in the switchgear. Measuring signals of non-electrical quantity shall be transmitted to SCADA system (switch value input) for online surveillance.

Measuring and billing check point is set up according to the final power access system information. At the current stage, it is proposed that power transformer HV side, power transformer LV side, auxiliary transformer feeder, SVG unit feeder and 33kV line side are chosen as measuring and billing check points, where two-way smart multi-function watt-hour meter (1+0) is equipped. Watt-hour meter adopts 3-phase four-wire electrical connection; active and reactive precision of watt-hour meter on 33kV busbar reactive branch are 0.2s class and 1.0 class, respectively; those of other points are 0.2s class and 2.0 class, respectively.

6.2.8.2 Current transformer and voltage transformer

Precision of current transformer used in billing, metering circuits is 0.2s and 0.5; precision of current transformer used for metering is 0.5 class; current transformer level-P is used for protection and fault recording circuits.

One voltage transformer (with three secondary windings) is adopted for 132 kV line, 132 kV busbar, 33kV busbar respectively, i.e., one star secondary winding (for electrical energy billing), one star secondary winding (for protection and measuring) and one winding for residual voltage measuring.

6.2.9 Dispatching Automation of Step-up Substation

Dispatching automation shall be configured according to NTDC/CPPA requirements.

6.2.9.1 Remote control system

Remote control function is performed by SCADA system and remote control information shall be transmitted to dispatching center through remote control working station with dual-redundancy design. The remote control system shall be configured in accordance with NTDC/CPPA requirements.

6.2.9.2 Energy billing system

1) Gateway billing

Gateway billing point is set at substation side where two-way gateway energy meters (one service meter, one backup meter) are installed. The meter is designed with three-phase six wire electrical connection with active precision of 0.2 s and reactive precision of 2.0. Final configuration is subject to the requirement of the local power grid company.

2) Electric energy remote terminal

One remote energy terminal is set to perform electric energy metering and information acquisition, data processing, time-sharing storage, long time saving and remote transmission at check points. The device performs electric meter communication and acquisition of electricity information via RS485 serial-port; the terminal performs communication with electricity measuring and billing system of dispatching centers at all levels through power digital network (main channel) and public/private automatic telephone dialing system is proposed as backup communication channel. The terminal performs communication with substation SCADA system via RS485 interface or network.

3) Electric energy quality monitoring

One electric energy quality monitoring equipment (energy analyzer) is equipped to perform management and appraisal for energy data.

6.2.9.3 Power dispatching data network access equipment

It is configured according to the requirements of the local power grid company.

6.2.9.4 Secondary electrical system safety protection equipment

It is configured according to the requirements of the local power grid company.

6.2.10 Video surveillance and safety & security system

Substation and central control center are equipped with a set of video surveillance and safety & security system and its functions shall satisfy requirements for safety and security as well as surveillance for equipment operation site. At least 36 cameras are considered.

Video surveillance and safety & security system consist of video server, terminal monitor, multi-picture separator, DV, PTZ, protective cover, encoder and infrared detector or electric fence, etc. Backstage video monitoring equipment of entire CCTV system performs monitoring, management, printing and external communication, etc; fore-front video monitoring equipment collects image video signals; image signal transmission equipment transmit image data, control signals from backstage video equipment. The system performs communication with SCADA system via public interface.

6.2.11 Automatic Fire Alarm System

The step up substation is provided with a set of automatic fire alarm system. The centralized automatic fire alarm system consists of fire detector, manual alarm button, fire control communication, linkage control and centralized fire alarm controller etc.; device, detection alarm and linkage control share one bus. Centralized fire alarm controller can display fire alarm zone and detection zone; 96 detecting points are considered.

6.2.12 Arrangement of Secondary Electrical Equipment

132 kV substation mainly consists of complex building, operation building and outdoor open yard. Central control room and secondary electrical equipment panel room are located in complex building; 33kV switchgear room is arranged in operation building.

Station control level equipment and network equipment of SCADA system are arranged in secondary electrical equipment panel room. Monitors and keyboards are set on working station in the central control room; 132 kV equipment control, protection panel, AC power distribution panel, gateway metering panel, measuring and checking panel, DC system equipment, UPS, automatic fire alarm system, image surveillance, safety & security system and WTG centralized monitoring system panel are arranged in the secondary electrical equipment room; 33kV protection, control device is arranged in the switchgear; 33kV feeder meter is installed in the 33kV switchgear.

6.2.13 Wind Power Prediction System

Wind power forecast is an important means used to predict future energy output of a wind farm; real-time data is collected by anemometer tower in wind power. Wind power forecast system consists of anemometer tower, mini automatic weather station, hardware system and software system etc.

Wind power forecast system shall comply with *Specification for Wind Power Forecast* enacted by the State Grid Corporation of China and be able to provide the short-term power forecast and extreme short-term power forecast. The forecast results shall be submitted to the dispatching communication center of the local power grid company. The system can be able to perform real-time wind resource surveillance and report real-time observation data, wind farm installed capacity, WTG maintenance capacity, planned WTG installed capacity and the maximum energy output, etc.

Short-term wind power forecast shall include forecast of power curve of the wind farm in 0~72h with a minimum time interval of 15 min; extreme short-term power forecast shall include forecast of power curve of wind farm in 0~4h with a minimum time interval of 15 min, e.g. wind power is forecasted every 15min.

6.2.14 Active/reactive Power Automatic Control System

One set of active and reactive power automatic control system is provided and active, reactive power output are automatically regulated as per power grid frequency to ensure maximum wind farm output and power system stability in case of grid fault and unusual operation condition. Reactive power loss and power variation rate shall be no more than allowed values required by dispatching department. NTDC requirement shall be followed.

Table 6.2.15 List of secondary electrical equipment

No.	Item	Unit	Qty.	Remarks
I	Wind farm			
1	WTG SCADA			To be supplied along with main equipment
1.1	Local protection, monitoring and control device	20	set	Including switch, optical fiber conjunction box
1.2	WTG centralized monitoring	1	set	

No.	Item	Unit	Qty.	Remarks
	system			
2	GSU monitoring and control			To be supplied along with main equipment
2.1	Local protection, metering and control device	set	20	Including switch, optical fiber conjunction box
2.2	GSU centralized monitoring and control	set	1	
3	Wind power forecast system	set	1	
II	132kV substation			
1	SCADA system			
1.1	Station control level equipment			
1.1.1	Host computer and operator working station	set	2	
1.1.2	Engineer working station	set	1	
1.1.3	Mal-operation prevention working station	set	1	
1.1.4	Remote control communication panel	set	1	
	Including 2 remote control communication devices			One in service, one for backup
1.1.5	network communication panel (including)	no.	1	
	Industrial network switch	set	2	
	Intelligence interface unit	set	1	
	Master clocking system	set	1	
1.1.6	Printer	set	2	
1.2	Secondary electrical panel bay control equipment			
1.2.1	Public control and network communication panel (including)	no.	1	
	Industrial network switch	set	2	
	Public control device	set	1	
	Satellite clocking system	set	1	
1.2.2	132kV line control panel (including)	no.	1	
	132kV line control device	set	2	
1.2.3	No.1 power transformer control panel (including)	no.	1	
	No.1 transformer HV side control device	set	1	
	No.1 transformer LV side control device	set	1	
	No.1 transformer control device	set	1	

No.	Item	Unit	Qty.	Remarks
1.2.4	No.2 power transformer control panel (including)	Panel	1	
	No.2 transformer HV side control device	set	1	
	No.2 transformer LV side control device	set	1	
	No.2 transformer control device	set	1	
1.3	33kV switchgear room bay control level equipment			
1.3.1	33kV lines monitoring and control protection device	set	8	Installed in 33kV switchgear
1.3.2	33kV SVG control protection device	set	2	Installed in 33kV switchgear
1.3.3	33kV grounding transformer monitoring and control protection device	set	2	Installed in 33kV switchgear
1.3.4	33kV bus-tie control protection device	set	2	Installed in 33kV switchgear
1.3.5	0.4kVATS device	set	2	Installed in 0.4kV switchgear
1.3.6	Network switch	set	2	Installed in 33kV switchgear
1.3.7	Public control device	set	2	Installed in 33kV switchgear
2	Relay protection and safety automatic device			
2.1	System relay protection and safety automatic device			
2.1.1	132kV lines protection panel	panel	4	Including remote end, operation box, it shall be equipped as per NTDC requirement
2.1.2	132kV bus-tie protection panel	panel	1	
2.1.3	132kV busbar protection panel	panel	1	
2.1.4	Protection and fault information management station	set	1	It shall be equipped as per the requirement of the local power grid company
2.1.5	Safe automation device	set	1	It shall be equipped as per the requirement of the local power grid company
2.2	Component relay protection and safe automation device			
2.2.1	No.1power transformer protection panel (including)	panel.	1	
	Electricity protection device	set	1	
	HV side backup protection device	set	1	Including operation box
	LV side backup protection device	set	1	Including operation box
	Non-electricity protection device	set	1	
2.2.2	No.2 power transformer protection panel (including)	panel	1	

No.	Item	Unit	Qty.	Remarks
	Electricity main protection device	set	1	
	HV side backup protection device	set	1	Including operation box
	LV side backup protection device	set	1	Including operation box
	No.2power transformer protection panel (including)	panel	1	
2.2.3	33kV busbar protection panel	panel	1	
2.2.4	132kV fault recording panel	panel	1	
2.2.5	33kV fault recording panel	panel	1	
3	Control power source system			
3.1	DC control power source			
3.1.1	Battery bank	set	2	DC 110V, 52no. each bank, 300Ah
3.1.2	Charging panel	set	2	Each panel is provide with one charging /floating charging device
3.1.3	Bus sectionaliser panel	no.	1	
3.1.4	Feeder panel	set	2	
3.1.5	Discharging device	set	1	
3.2	AC power source			
3.2.1	AC power distribution panel	set	1	
3.2.2	UPS panel	set	2	10kVA
4	Dispatching system equipment			
4.1	PMU	set	1	It shall be equipped as per the requirement of the local power grid company
4.2	Data network accessing equipment panel (including)	panel	1	It shall be equipped as per the requirement of the local power grid company
	Dispatching data network accessing equipment	set	1	
	Protection equipment	set	1	
4.3	Gateway electric energy billing meter	pcs.	4	It shall be equipped as per the requirement of the local power grid company
	Electric energy data acquisition device	set	1	
	Electric energy quality on-line monitoring device	set	1	
	Gateway electricity meter	set	4	Time recoding function when voltage is lost
4.4	Energy meter panel (including)	set	1	
	No.1 power transformer HV side watt hour meter	set	1	

No.	Item	Unit	Qty.	Remarks
	No.2 power transformer HV side watt hour meter	set	1	
	No.1 power transformer LV side watt hour meter	set	1	
	No.2 power transformer LV side watt hour meter	set	1	
4.5	Energy meter			
	33kV line electric energy meter	pcs.	8	Installed in 33kV switchgear
	33kV auxiliary transformer electric energy meter	pcs.	2	Installed in 33kV switchgear
	33kV grounding transformer electric energy meter	pcs.	2	Installed in 33kV switchgear
	33kV SVG branch electric energy meter	pcs.	2	Installed in 33kV switchgear
4.6	Active power control system	set	1	It shall be equipped as per the requirement of the local power grid company
4.7	Reactive voltage control system	set	1	It shall be equipped as per the requirement of the local power grid company
5	Automatic fire alarm system	set	1	
6	Image monitoring and safety & security system	set	1	
7	Miscellaneous			
7.1	132kV control cabinet	set	1	Supplied with GIS
7.2	132kV voltage change-over panel	set	1	Including one voltage device
7.3	SVG local control panel	set	2	Supplied with SVG, including 2 SVGs
7.4	Control cable	km	25	
7.5	Secondary equipotential grounding network	set	1	
7.6	System coordination	Item	1	

6.3 Communication

6.3.1 General

6.3.1.1 Design scope

According to the scale and layout of this project, the design scope of communication is as follows:

(1) Communication of wind farm;

(2) PABX system;

(3) System communication;

(4) Communication equipment layout and grounding

6.3.1.2 Design Basis and references

(1) *IEC Recommended Documents;*

(2) *ITU-T-International Telecommunication Union - Telecommunication Standard;*

(3) *Feasibility Study for* Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") *at Nooriabad, Sindh, Pakistan;*

(4) Specification for Electrical Design of Wind Power Project (NB/T31026-2012);

(5) Specification for Wind Farm Design (DL/T5383-2007);

(6) Power System Digital Dispatching Exchanger (DL/T 795-2001);

(7) High Frequency Switch-Mode Power Supply for Communication System (YD/T 1058-2007);

(8) High Frequency Switch-Mode Rectifier for Telecommunications (YD/T 731-2008);

(9) VRLA Battery for Telecommunications (YD/T 799-2010);

(10)Design Specification for Telecommunication Line Engineering (YD 5102-2010)

6.3.1.3 Design Principles

(1) Reasonable communication method is selected according to the scale and layout of the project and the design of the power access system;

(2) Communication system equipment shall be properly configured considering the demand to expand the capacity for future extension.

6.3.2 Wind Farm Communication

(1) Mobile wind farm communication

The mobile communication in wind farm is adopted for maintenance and inspection of the wind farm, namely, voice communications between WTGs, WTG tower top and ground surface as well as WTGs and control room. Communication at the wind farm shall adopt high-power wireless walkie-talkies with assistance of public network mobile communication. Ten high-power wireless walkie-talkies are proposed.

(2) Communication between WTG and GSU control system

WTG and GSU control system communication refers to the communication network used for control and operation of WTGs and GSUs; the design scope of which mainly includes design for optical fiber cable route linking each WTG and control equipment in control center, mode selection of optical fiber cable, etc. The optical fiber cable line is laid along 33kV power collection line, forming an optical fiber network based on the distribution and control method of WTG and GSU, to ensure the communication demand of each WTG and GSU in operation control, maintenance management, fault information uploading, etc.

A total of 20 WTGs (every five WTGs are divided into one group) with a unit capacity of 2500kW will be installed in the wind farm, and each WTG is connected to one GSU.

Each GSU monitoring data is transmitted to one feeder device through optical and further transmitted to monitoring center. WTG and GSU share one line that is connected to wind farm monitoring center. Each WTG and GSU have independent optical fiber loop network that is used for WTG, GSU monitoring.

A total of 8 GYFTA53 embedded optical cable lines with total length of 34km are provided in the wind farm; 16-core single mode optical cable lines is proposed (four in service and four for backup).

6.3.3 PABX

The 132kV substation is provided with one set of PABX that is used to provide voice communication for control center, power grid dispatching center and PSTN. PABX consists of PABX console and wire telephone network.

(1) PABX console

PABX console is equipped with one 256-port digital PABX that is designed with dispatching, exchange and telephone conference service. Analog and digital interfaces are provided and telephone user can be changed to dispatching user and management user as per user's requirement. Dispatching user is preferential.

Loop relay interfaces for two lines, four lines (E&M) and 2M digital relay interface are provided for PABX to connect dispatching department and local public telephone network; one dispatching console, one digital recording equipment and one telephone console are provided; one PABX maintenance terminal is provided as well.

(2) Wire telephone network

Wire telephone network consists of VDF, telephone junction box, telephone terminal box, telephone and telephone cable. PABX user's line is connected to VDF testing terminal and further connected junction box via security terminal, finally it is connected to user's telephone via cable junction box. PABX analogue relay line is also connected to VDF testing terminal and drawn out through security terminal before being further connected to transmission equipment. Telephone cable is of fire retardant cable.

6.3.3.1 Equipment configuration

(1) Digital PABX

a) Public control section: 2 sets (1+1 hot backup)

b) Analog user's interface: 20 lines

c) Digital user's interface: 4 lines

d) 2-line loop relay interface:16

e) 4-line E&M relay interface: 8

f) 2M digital relay interface: 1

g) Outage switching board (8-line): 1 .

h) Dispatching console (32 key-type, two-handle): 1

i) Telephone console: 1

j) Digital recording system (4-line):1

k) Maintenance terminal (including remote maintenance terminal):1

l) Inverter (48VDC/220VAC-1000VA):1

(2)Telephone equipment

a) Voice line unit (200-line, 100% over-current/over-voltage protection):1

b) Telephone: 20

c) Multiple-function-copier (Fax /copying /scanning/printing):1

d) Telephone junction: 3

e) Telephone terminal box: 17

f) Telephone cable (fire retardant):0.2km

g) Telephone user cable (fire retardant):3km

6.3.3.2 Specifications and functions of dispatching PABX

(1) Dispatching PABX shall meet the requirements of ISDN integrated service digital network, providing services, e.g., voice, data and image communication;

(2) Dispatching PABX shall be able to provide a variety of interfaces, including users' interfaces, digital users' interfaces, PRI interfaces, BRI interfaces, loop relay interfaces, 2/4 w. E&M interfaces, 2 Mbit/s digital relay interfaces, etc., and provide different signaling mode such as China's No. 1, China's No. 7, MFC, MFC-R2 and E/M,

depending on varied networks and users;

(3) Dispatching switch' s transmission index, user' s signal mode, signal mode between innings, ringing current, signal sound and other technical data shall meet or comply with the relevant China national standards, China' s relevant industry standards and ITU-T related standards and recommendations;

(4) Basic system function

a) The system shall be configured with administrative management exchange functions, priority for dispatching users; certain isolation shall be reserved between dispatching users and management users, isolation level can be configured;

b) The system shall be designed with dispatching functions such as multi-user meeting, selective calling, group calling, set calling, evictions and intrusion;

c) Relay routing directions shall not be less than 64;

d) Under abnormal circumstance, relay trunk line or user' s extension can be automatically locked and restored;

e) Function of self-diagnosis positioning and testing shall be provided;

f) Recording interfaces shall be provided;

g) Alarm function shall be provided;

h) Dedicated dispatching signaling forming dispatching private networks shall be provided;

i) The system can be connected to other PABX in power system via power line carrier, microwave, optical fiber to perform DID, BID, DOD_2, DOD_1 succession.

6.3.4 System Communication

The system communication between wind farm, dispatching center, grid station including transmission rate, capacity and flow direction are related to system communication network planning, which will be determined by NTDC.

As no information regarding system communication has been available, OPGW is temporarily adopted. And one OPGW line is installed on 132kV transmission line; SDH equipment shall be installed in Thatta and remote end station to provide digital optical fiber channel that is used for transmission of voice, dispatching automation, relay protection, etc. SDH transmission rate is 155Mbit/s, optical fiber cable is of 24-core (OPGW shall be supplied by transmission line vendor, quantity and detailed data refer to vendor' s technical document).

6.3.4.1 Equipment configuration

(1) SDH 155M (ADM):2 sets (one for Thatta, one for remote-end station)

Each SDH includes:

Public system: 2 sets (1+1 hot backup)

SDH 155M interface: 2 .

2M interface: 21

10M/100M Ethernet interface: 4

(2) PCM: 2 sets (one for Thatta , one for a remote-end station)

Each PCM includes:

Public system: 2 sets (1+1 hot backup)

2M interface: 2

LGE (FXO) interface: 8

LGS (FXS) interface: 8

4-line E&M interface: 8.

V.24/V.28 interface: 8.

G.703 64k data interface: 8no.

(3) Local maintenance terminal: 1 set

(4) Composite distribution device: 2 sets (one for Thatta, one for remote-end station)

(5)Incomer optical cable (24-core non-metal fire retardant): 1km

6.3.4.2 Technical data of communication equipment

(1) SDH 155M

a) Type: STM-1(ADM);

b) It can be upgraded to STM-4(622M);

c) SDH can be in compliance with ITU-T G.703, G.707, G.708, G.781, G.783, G.784, G.813, G.825, G.826, G.841, G.842, G.957 and G.958 standards;

d) It can send STM-1signals;

e) STM-1optical interface, STM-1electrical interface, E1 electrical interface, 10M/100M Ethernet interface, etc.

f) High order VC and low order VC, i.e., HPC and LPC; for non-blocking crossing connecting capacity, high order matrix no less than 16×16 no.VC-4, low order matrix no less than 252×252 no.VC-12.

g) Shunt-line interface: no less than 21×2M signals;

h) STM-1 optical interface:

ITU-T G.707, G.957 standard;

NRZ code，compliance with ITU－T G.707;

Bit rate is 155520kbit/s;

Working wave length is 1310nm, 1550nm.

(2) PCM

a) Interface requirement:

PCM interface: user line interface LGS (FXS), loop relay interface LGE (FXO), 2/4 line E&M interface, V.35 interface, RS-232/ V.24 interface.

b) Basic data:

PCM capacity: single box≥90-line;

2M voice-line: 30-line;

Sampling frequency rate: 8000/s±50ppm;

Bit rate: 2048kbit/s±50ppm;

Coding rate:13 folded line，rule A，in compliance with ITU G.711;

Quantitative series: 256;

Interface code: HDB_3 code

c) Function requirement:

At least two 2Mbit/s (E1) interfaces, with up and down voice lines, 2Mbit/s digital bit steam bypass and direct communication;

6.3.5 Communication Power Supply System

Communication power supply system is an important part of the communication system; in order to ensure reliable operation of communication equipment; the power supply system must be stable and reliable and supply power to communication equipment unremittingly. Meanwhile, the power supply system shall meet quality of electricity supplied by power supply system for communication equipment.

6.3.5.1 Power supply scope

The communication power supply system of the wind farm will supply stable power for the communication equipment of 132kV substation in the wind farm. The power supply scope covers digital PABX (including host, dispatch console, digital recording equipment), system communication equipment and public network access/transmission equipment, etc. Consideration is temporarily made that communication equipment of remote end station is fed by the existing communication power source.

6.3.5.2 Power supply mode

One set of high-frequency switch power supply and two sets of battery floating charging system (voltage: -48V) are provided to supply DC power communication equipment, 2 circuits of AC power sources of high-frequency switch power supply are connected from different busbar sections of service power system. The emergency power supply duration of battery set is 4 hours.

6.3.5.3 Equipment configuration

Based on the current configuration of communication equipment in 132kV substation and the possible communication equipment configuration, the configuration of communication power supply system is as follows:

(1) -48V/120A high-frequency switch power supply: 1 set

a) AC distribution device: 1 set

b) High-frequency switch rectifier module: N+1 backup (total capacity of N modules≥120A)

c) DC distribution device: 1 set

d) Control device: 1 set

(2) 48V/300Ah valve controlled sealed lead acid battery: 2 sets

6.3.5.4 Specification

(1) HF switch power source

a) Stabilized voltage precision: ≥±1%;

b) System DC output terminal peak voltage (0MHz～20MHz) shall be no greater than 200mV;

c) AC input voltage: 3-phase-5-wire connection 380V, allowable range is 323 ~ 418V; frequency 50Hz±2.5%;

d) DC output voltage: - 48 V, adjustable range -43.2 V ~ -57.6 V;

e) Over or under voltage protection for AC input and DC output;

f) Rectification module shall be able to work in parallel and sustain proportional load;

g) Battery management function;

h) Efficiency: ≥90%;

i) Power factor: ≥0.92;

j) Monitoring device sets and controls all parameters of power source system and provides audible alarm signals (bell, light), performs real-time monitoring of equipment working status, acquires and stores equipment operation data.

(2) Battery

a) Battery type: valve control sealed lead acid battery;

b) Battery capacity: 2V/300Ah;

c) Float charging service life: more than 10 years;

d) Carrying capacity: current discharging capacity≥$0.95C_{10}$ (25 ℃), current $1.0I_{10}$A is discharged until terminate voltage 1.80 V is reached;

e) High current discharging: battery current $30I_{10}$ (A) discharges for 3min, post terminal, internal electrical bus shall not be fused and their visual appearances shall be normal;

f) Acid-mist-proof performance: acid mist emission is forbidden during normal battery float charging;

g) Explosion-proof performance: no flaming and explosion in case of fire during battery charging

6.3.6 Communication Equipment Arrangement and Grounding

132kV substation will not be provided with communication equipment room and main communication equipment will be arranged in electrical equipment room; dispatching console will be arranged in central control room. Communication equipment grounding, protection grounding and surge arrestor grounding will be connected to electrical grounding network.

6.3.7 List of Main Communication Equipment

Table 6.3-1 List of Main Communication Equipment

No.	Equipment name	Type and specification	Unit	Qty.	Remarks
I	Wind farm communication equipment				
1.1	High power wireless		set	10	

No.	Equipment name	Type and specification	Unit	Qty.	Remarks
	walki-talki				
1.2	WTG, GSU monitoring and control optical cable	GYFTA53	km	34	
II	PABX system equipment				
2.1	Digital dispatching switch	25-port	set	1	
2.2	Voice line unit	200-line,100% over-current/over-voltage protection	set	1	
2.3	Inverter	48VDC/220VAC-1000VA	set	1	
2.4	Telephone		set	20	
2.5	Multi-function-copier	Fax/copying /scanning/printing	set	1	
2.6	Telephone junction box		set	3	
2.7	Telephone terminal box		set	17	
2.8	Telephone line cable		km	0.2	
2.9	Telephone user cable		km	3	
III	System communication equipment				To be confirmed by NTDC; OPGW is included in 132kV outgoing line design
3.1	SDH optical transmission equipment	155Mbit/s	set	2	One for Thatta, one for remote-end station
3.2	PCM equipment		set	2	One for Thatta, one for remote-end station
3.3	Distribution cabinet		set	2	One for Thatta, one for remote-end station
3.4	Incomer optical cable	Non-metal fire retardant optical cable	km	1	
IV	Communication power source system equipment				
4.1	HF switch power source	-48V/120A	set	1	
4.2	Valve control sealing lead acid battery	48V/300Ah	set	2	

7 CIVIL WORKS

7.1 **Engineering Geology and Project Grade**

7.1.1 **Engineering Geology**

(1) According to *SEISMIC RISK MAP OF KARACHI, HYDERABAD DIVISIONS AND LASBELA DISTRICT, PAKISTAN*, the seismic intensity of the project area is VII and the tectonic structures at the area is basically stable, so it is suitable for constructing a large wind farm

(2) The project area has a basic fortification intensity of VII, with relatively complicated topography. Basically, ground water will not impact the project. The project area is of Grade II (moderately-complicated) and the foundation is of Grade III (simple foundation). The project is seated in the arid area, with a moisture content in the foundation soil of $w<20\%$. The environment of the project area is of Class III. For foundation soil in the project area, the overburden is thin and mainly composed of highly ~ moderately weathered limestone, with good mechanical properties. The project area is located in the section favorable for seismic resistance and is of Class I.

(3) Engineering geology evaluation of strata mainly developed in the project area: The breccia stratum is mainly composed of breccia, with the lithology of limestone, characteristic value of bearing capacity being 200 kPa ~ 350 kPa and good mechanical properties, so it can be used as natural foundation. Limestone is hard, with seriously local outcrop corrosion, developed dissolved pores, characteristic value of bearing capacity of 500 kPa ~ 1200 kPa and good mechanical properties, so it can be used as the bearing stratum or underlying stratum of the foundation.

(4) The foundation soil at the project area is slightly ~ moderately corrosive to concrete structures and the steel bars and steel structures in concrete structures.

7.1.2 **Project scale and structure grade (designed based on Chinese Standards)**

The total installed capacity of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") (20x GW121-2500-90m WTGS), and one 132kV step-up substation will be constructed as well. According to *Classification and Design Safety Standard of Windpower Projects (FD002-2007, Trial)*, the project is of Grade II large scale (2). The design grade of WTG tower foundation structure is Class 1 with a structure safety grade of I and the design grade of substation structure is Class 2 with a

Table 7.1 Loads on upper flange at top of foundation ring (excluding safety factor)

Partial load	Normal operating case	Extreme load case	Frequent earthquake case
Horizontal load (kN)	508.4	1018	621.4
Vertical load (kN)	4335.1	4247	4276
Bending moment (kN·m)	41221	82110	62090
Moment of torque (kN·m)	270.3	4522	270.3
Turbine tower weight (t)	278.8		
Nacelle weight (t)	29		
Blade weight (t) (including blade, hub and generator)	127.5		
Hub height (m)	90		

c. Main design control indexes

The main control indexes of the WTG foundation design are listed in Table 7.2.

Table 7.2 Main control indexes of the WTGs

Item	Unit	Load case in normal operation	Extreme load case	Frequent Earthquake case
		Control value	Control value	Control value
(1) Checking bearing capacity of foundation				
Eccentricity (e) / foundation bottom radius (R)		0.25	0.43	0.25
Average pressure on foundation bottom	kPa	fa	fa	fa
Maximum pressure on foundation bottom edge	kPa	1.2×fa	1.2×fa	1.2×fa
(2) Checking calculation of foundation deformation				
Checking calculation of settlement deformation	mm	100	100	
Checking calculation of tilting deformation		0.005	0.005	
(3) Checking calculation of foundation stability				
Checking calculation of anti-overturning		1.6	1.6	1
Checking calculation of anti-sliding		1.3	1.3	1
Notes: when eccentricity (e) / foundation bottom radius (R) = 0.25 and 0.43, the corresponding ratios of cavity areas of foundation bottom will be 0 and 0.25, respectively.				

Table 7.4 Calculation Results

Item	Unit	Load case in normal operation		Extreme load case		Load case in frequent earthquake	
		Calculated value	Allowable value	Calculated value	Allowable value	Calculated value	Allowable value
(1) Checking of bearing capacity of foundation							
Eccentricity (e) / foundation bottom radius (R) (ratio of empty areas)		0.163	0.25	0.349	0.43	0.224	0.25
Average pressure on foundation bottom	kPa	120	300	112	300	108	300
Maximum pressure on foundation bottom edge	kPa	172	300×1.2	260	300×1.2	230	300×1.2
(2) Checking calculation of foundation deformation							
Checking calculation of settlement deformation	mm	15	100	1.1	100	0.6	100
Checking calculation of tilting deformation		0.001	0.005	0.003	0.005	0.001	0.005
(3) Checking calculation of foundation stability							
Checking calculation of anti-overturning		3.1	1.6	4.2	1.6	4.9	1.6
Checking calculation of anti-sliding		16.2	1.3	6.7	1.3	12.7	1.3

(4) Fatigue check

Reinforced elastic modulus:200000.000MPa

Concrete fatigue deformation modulus:15000.000MPa

Reinforcement area (as determined by the extreme load conditions):

Radial reinforcement per unit arc length of bottom of base plate: 0.008m^2

7.2.1.3 Conclusions

The geological data suggests that the bearing stratum in the tower foundation is breccia stratum or limestone stratum. As indicated in Table 7.4, all the bearing capacity, settlement deformation and stability calculation of the tower foundation can meet the design requirements. Based on repeated calculation, the foundation dimensions are the minimum ones that could meet the design requirements and make the project reasonably economical.

Foundation design of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is as follows: engineering quantities for one tower foundation works (GW121-2500-90m): excavation is 1785.0m^3, backfill is 1417.5m^3, C40 foundation concrete is 613.2m^3, C20 foundation cushion concrete is 54.6m^3, reinforcement is 55.2t and foundation corrosive protection is 410m^2 approximately.

7.2.2 **Foundation Design of Box-type Substation**

According to electrical design in the wind farm, combination mode of wind turbine generator unit and box-type substation is one-generator-one-substation, i.e. each wind turbine is provided with one box-type substation. Foundation of the box-type substation is connected with power cable trench. The capacity of the box-type substation for recommended proposal is 2750 kVA. Based on the geological conditions and the capacity of box-type substation, the foundation of the box-type substation is determined as the concrete foundation with a basic dimension of 3.9m×4.2m×1.70m (L×W×H). All box-type substations are directly laid on C25 reinforced concrete foundation. Foundation of box-type substation is joined with the power cable trench.

Calculation shows that the excavation, concrete and backfill quantities for each 2750 kVA box-type substation foundation are 40m^3, 13m^3 and 20m^3, respectively.

7.3 **Earthing Grid and Current Collection Line**

7.3.1 **Earthing Grid**

An artificial earthing grid will be set around every WTG foundation and box-type foundation. The earthing device is composed of flat steel and steel tube. One independent earthing grid will be formed by one WTG and one box-type substation.

Fig.7.1 Access road at the site

7.6 Flood Control Facilities

In order to prevent the tidewater, the centralized control center is selected to be located at a higher elevation, and the foundation elevation will be raised accordingly. And flood facilities will be set around the centralized control center to collect and drain out flood water. During construction of the WTG foundations and box-type substation foundations, the foundation elevations should be raised appropriately. Ford or culvert should be provided above the gully crossings of access road and on-site road so as to keep smooth traffic.

7.7 132kV Step-up Substation

The step-up substation of the wind farm cover a total area of 12,070m^2, comprising operation and living zones, in rectangular shape, 150m long and 75m wide. Of which, living zone occupies an area of 6450 m^2, accommodating complex building, underground water pump room, water treatment room, oil depot and garage; operation zone occupies an area of 7488 m^2, accommodating operation building and SVG room

station service transformer room and storage battery room; the second floor is provided with GIS room secondary panel room and central control room. The ground of the building floor adopts cement mortar. External wall insulation adopts grade B1 EPS polyphenyl board. Color coating is applied as external wall finish. Inner wall surface adopts latex paint; all ceilings shall just be coated.

The water pump room and domestic water & fire water pool (180m^3) are of semi-underground reinforced concrete structure.

Table 7.5 shows the engineering quantities of living zone and operation zone of 132kV step-up substation.

Table 7.5 Bill of Quantities for Main Civil Works of Step-up Substation

Item	Unit	Quantities of Works	Remarks
1. Quantities of outdoor works			
(1) Total land area used	m^2	6450	
(2) Total area for buildings	m^2	1603	
(3) Roads in the plant area	m^2	570	05J909 Road 2-2(H=180) 1.180mm-thick C25 concrete, placed alternately in separate block every 4~ 6m. 2. 300mm-thick naturally graded sand. 3. Compaction of plain concrete, with compaction rate greater than 93%.
(4) Fence wall	m	235	02J003, Page 62, fence wall constructed with concrete masonry unit, H=2.4m
(5) Gate		75	02J003, Page 56, fence wall constructed with concrete masonry unit, H=2.4m
(6) Froot door	Pec.	1	Motor-driven gate:12000x1500
(6) Spreading of concrete	m^2	2827	05J909 Road 2-2 (H=120) 1. 120mm-thick C25 concrete, placed alternately in separate block every 4~ 6m. 2. 300mm-thick naturally graded sand. 3. Compaction of plain concrete, with compaction rate greater than 93%.
(7) Greening	m^2	1450	
2. Quantities of Building Works			
(1) Complex building	m^2	2342	Two-storey, simple reinforced concrete frame structure
(2) Water treatment room	m^2	102	One-storey, simple brick-concrete structure
(3) Oil depot	m^2	62	One-storey, simple brick-concrete structure

Table 7.5-2 Bill of Quantities for Main Civil Works of Step-up Substation

Item	Unit	Quantities of Works	Remarks
1. **Quantities of outdoor works**			
(1) Total land area used	m^2	4875	
(2) Total area for buildings	m^2	755	
(3) Roads in the plant area	m^2	705	05J909 Road 2-2(H=180) 1.180mm-thick C25 concrete, placed alternately in separate block every 4~ 6m. 2. 300mm-thick naturally graded sand. 3. Compaction of plain concrete, with compaction rate greater than 93%.
(4) Fence wall	m	203	02J003, Page 56, fence wall constructed with concrete masonry unit, H=2.4m
(5) Gate	Pec.	1	Wrought iron gate dimension:4200x2100
(6)Concrete floor	m^2	1263	05J909 Road 2-2 (H=120) 1. 120mm-thick C25 concrete, placed alternately in separate block every 4~ 6m. 2. 300mm-thick naturally graded sand. 3. Compaction of plain concrete, with compaction rate greater than 93%.
(7) Pebble floor	m^2	2152	Placing 200mm thick pebble with grain size of 50mm～80mm.
2. Quantities of step-up substation buildings			
(1) Operation building	m^2	1256	Two-storey, simple reinforced concrete frame structure
(2) SVG room	m^2	127	One-storey, simple reinforced concrete frame structure

7.7.1.3 132kV step-up substation

It is proposed to use herringbone column made of annular steel pipes with straight welding seam as the framework of incoming and outgoing lines and use beams made of annular steel pipes with straight welding seam as the cross beam of framework. The lightning arrester tower is assembled with variable cross-section angle steel, and independent reinforced concrete foundation is used.

Reinforced concrete foundation is used as the main transformer foundation, and independent reinforced concrete foundation is used as the foundation of framework and supports. The emergency oil sump is of reinforced concrete structure and is arranged

No.	Item	Unit	Quantities of Works	Qty.	Remarks
	framework				steel pipe
	Beam framework	t	1.9		Φ450×6 straight seam welded steel pipe
	Diagonal bracing	t	1.2		Φ325×8 straight seam welded steel pipe
	Ladder	t	0.5		
	Main transformer framework foundation (C30)	m^3	33		Cup base
	Main transformer framework foundation cushion	m^3	12.9		
	Reinforcement	t	1.5		
3	Independent lightning rod	t	8.4		
4	110 supporting Structure				
	Herringbone pillar framework	t	3.5		Φ300×6 straight seam welded steel pipe
	Steel Beam	t	1.4		Φ400×6 straight seam welded steel pipe
	Steel ladder	t	0.8		
	Column cap ground wire	t	0.6		Φ300×6 straight seam welded steel pipe
5	Outdoor equipment foundation				
	Earth excavation	m^3	141		
	Earth backfilling	m^3	111		Compaction coefficient not less than 0.94
	Concrete (C30)	m^3	39		Independent foundation
	Cushion	m^3	5.3		
	Reinforcement	t	0.4		
	Embedded iron	t	0.5		Plank
	bolt	t	0.5		
6	800x800(concrete trench)	m^3	73		
	1200x1200(concrete trench)	m^3	60		
	Cable trench concrete cover	m^3	20		
	Cable trench reinforced cover	t	2.6		
7	Dynamic reactive power compensation				

The total amount of water consumption unforeseen and leakage from pipe network is calculated as 10% of the sum of the three kinds of water consumption mentioned above, i.e. $0.82m^3/d$.

e) Total water consumption

The maximum total daily water consumption is $8.24m^3/d$ for the Project. Table 7.7 summarizes the detailed water consumption.

Table 7.7 Summary of Water Consumption for All Items

S.No.	Type	Water consumption quota	No. of water consuming units	Hourly variation factor (Kh)	Utilization hours (h)	Water consumption		remarks
						Maximum daily water consumption (m^3/d)	Maximum hourly water consumption (m^3/h)	
1	Domestic water	150L/person·d	28 person	3	24	4.20	0.53	
2	Greening water	$2.0L/m^2 \cdot d$	$1450m^2$	1	8	2.90	0.36	
3	Water for roads and squares	$2.0L/m^2 \cdot d$	$570m^2$	1	8	1.14	0.14	
4	Subtotal					8.24	1.03	
5	Water consumption unforeseen and leakage from pipe network	10%				0.82		
6	Total					9.06	1.03	

7.7.2.3 Water supply system

Secondary pressurized water supply is employed for the project, with the water source from well water. The wind farm is provided with an underground water pool (domestic & firefighting water pool with an effective capacity of $180m^3$), water pump room (firefighting pump and domestic pump) and water treatment room that accomdates water treatement equipment with a capacity of $1.0m^3/h$, a $9m^3$ domestic water tank, a set of domestic constant pressure water supply equipment (including two domestic water supply pumps, mutually standby) and two ultraviolet ray sterilizers. Water in the deep well is lifted by deep-well pump to be stored in the underground water pool (domestic and firefighting water tank with an effective capacity of $180m^3$), water is drawn by domestic water pump and conveyed to water treatment room. After treatment, the

7.7.2.6 Main equipment and materials for domestic water supply and drainage

Table 7.8 and Table 7.9 show the main equipment and materials for domestic water supply and drainage.

Table 7.8 Main Equipment and Materials for Domestic Water Supply and Drainage

No.	Description	Specification/ Model	Unit	Qty.	Remarks
1	Domestic water tank	$V=9m^3$	Set	1	Combined stainless steel water tank
2	Water supply treatment equipment	Treatment capacity: $1m^3/h$	Set	1	
3	Domestic water tank	$Q=(2.6\text{-}3.7\text{-}4.4)m^3/h$ H=(29-28-26)m N=1.1kW mutually standby	Set	2	
4	Frequency-conversion constant-pressure water supply equipment	Attached two water pumps: $Q=(10\text{-}16\text{-}20)m^3/h$ H=(40.5-37.5-33)m N=3.0kW One in service and one on standby Pressure tank:φ630mm	Set	1	
5	UV sterilizer	Capacity: $20m^3/h$	Set	2	
6	Submersible wastewater pump	$Q=2.1m^3/h\sim12m^3/h$ H=14.8m～9m N=0.75kW	Set	2	
7	Wastewater treatment equipment	Treatment capacity: $0.5m^3/h$	Set	1	Including equipment, pipeline, valve, cable and accessories between control cabinet, wastewater regulating tank and catch basin
8	Water closet		Set	14	
9	Hydraulic pedal flushing valve squat toilet		Set	8	
10	Induction type flushing valve wall hung urinal		Set	6	

No.	Description	Specification/ Model	Unit	Qty.	Remarks
49	Internal and external surface hot dip galvanized steel pipe	DN65	m	10	
50	Internal and external surface hot dip galvanized steel pipe	DN100	m	10	
51	Internal and external surface hot dip galvanized steel pipe	DN200	m	10	
52	PE100 plastic pipe	DN65	m	30	
53	PE100 plastic pipe	DN80	m	60	
54	PVC—U drain pipe	DN50	m	70	
55	PVC—U drain pipe	DN75	m	20	
56	PVC—U drain pipe	DN100	m	150	
57	PVC — U double-wall corrugated drainage pipe	DN200	m	200	

Table 7.9 Quantities of Main Domestic Water Supply and Drainage Structures

No.	Description	Specification/ Model	Unit	Qty.	Remarks
1	Underground water pump room and water pool	Effective volume 180m^3		1	
2	Water treatment room			1	
3	Reinforced concrete septic tank	G2-4F type		1	
4	Reinforced concrete septic tank	GG-1F type		1	
5	Wastewater regulating tank	9m^3		1	
6	Reinforced concrete catch basin	50m^3		1	
7	Brickwork wastewater inspection well	φ1000		12	
8	Brickwork sprinkler head well	φ1200		5	
9	Brickwork valve well	φ1500		1	
10	Reinforced concrete rectangular valve well	1400×1800(L×B)		1	
11	Reinforced concrete rectangular valve well	1100×1200(L×B)		1	
12	Deep well			1	Including lifting pipe, deep well and valve fittings

7.7.3 HVAC

7.7.3.1 Codes and standards for design

(1) *Code for Design of Heating, Ventilation and Air Conditioning (GB 50019-2003);*

(2) *Code for Design on Fire Protection and Prevention of Buildings (GB 50016-2014);*

(3) *Design Standard for Energy Efficiency of Public Buildings (GB*

7.7.3.5 Fire protection design for ventilation and air conditioning system

(1) Independent air exhaust system is provided for oil depot, with fans and motors of explosion-proof type.

(2) The oil depot is provided with an emergency ventilation system (combined with normal ventilation system), which will be closed in case of fire. After the confirmation of fire extinguishment, the post-emergency ventilation will be made by the fire control center or through local air exhaust fans.

(3) In case of fire, the operation of ventilation and air conditioning system of relevant parts should be stopped.

(4) Emergency ventilation design for ventilation system

For the oil depot, its emergency ventilation system is combined with normal ventilation system and the air exhaust fans are fire-control high-temperature smoke exhaust fans. In case of fire, the ventilation system is closed. After the confirmation of fire extinguishment, the post-emergency smoke exhaust will be made by the fire control center or through local smoke exhaust fans.

7.7.3.6 Main HVAC equipment

The main HVAC equipment is listed below in Tables 7.10 ~ 7.16.

Table 7.10 Quantities of HVAC Works of Complex Building

No.	Description	Model & Specification	Unit	Qty.	Remarks
1	Cabinet air conditioner	Model:KFR-72LW/R1(72533L1)-JN2 Refrigerating capacity:7200W Power:2275W Power supply:220V	Set	15	
2	Cabinet air conditioner	Model:KFR-32GW/E(3251)ZD-JN1 Refrigerating capacity:3200W Power:840W Power supply:220V	Set	17	
3	Pipe-type ventilating fan	Model:BPT25-56A Air volume:800m³/h Air pressure:410Pa Motor power:150W	Set	2	
4	Pipe-type ventilating fan	Model:BPT15-34A Air volume:260m³/h Air pressure:165Pa Motor Power:36W	Set	2	
4	Bath heater	Model:FDP810	Set	14	

7 CIVIL WORKS

7.1 Engineering Geology and Project Grade

7.1.1 Engineering Geology

(1) According to *SEISMIC RISK MAP OF KARACHI, HYDERABAD DIVISIONS AND LASBELA DISTRICT, PAKISTAN*, the seismic intensity of the project area is VII and the tectonic structures at the area is basically stable, so it is suitable for constructing a large wind farm

(2) The project area has a basic fortification intensity of VII, with relatively complicated topography. Basically, ground water will not impact the project. The project area is of Grade II (moderately-complicated) and the foundation is of Grade III (simple foundation). The project is seated in the arid area, with a moisture content in the foundation soil of w<20%. The environment of the project area is of Class III. For foundation soil in the project area, the overburden is thin and mainly composed of highly ~ moderately weathered limestone, with good mechanical properties. The project area is located in the section favorable for seismic resistance and is of Class I.

(3) Engineering geology evaluation of strata mainly developed in the project area: The breccia stratum is mainly composed of breccia, with the lithology of limestone, characteristic value of bearing capacity being 200 kPa ~ 350 kPa and good mechanical properties, so it can be used as natural foundation. Limestone is hard, with seriously local outcrop corrosion, developed dissolved pores, characteristic value of bearing capacity of 500 kPa ~ 1200 kPa and good mechanical properties, so it can be used as the bearing stratum or underlying stratum of the foundation.

(4) The foundation soil at the project area is slightly ~ moderately corrosive to concrete structures and the steel bars and steel structures in concrete structures.

7.1.2 Project scale and structure grade (designed based on Chinese Standards)

The total installed capacity of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") (20x GW121-2500-90m WTGS), and one 132kV step-up substation will be constructed as well. According to *Classification and Design Safety Standard of Windpower Projects (FD002-2007, Trial)*, the project is of Grade II large scale (2). The design grade of WTG tower foundation structure is Class 1 with a structure safety grade of I and the design grade of substation structure is Class 2 with a structure safety grade of II. The design flood standard is 30-year flood reoccurrence period both for the WTG tower foundation and centralized control center of the wind farm.

According to relevant aseismic design codes, the earthquake fortification grades for WTG tower foundation, main structures and secondary structures of substation are C, C and D, respectively.

7.2 Foundations for WTGs and Box-type Substation

7.2.1 Foundation Design of WTGs

7.2.1.1 Design Bases

(1) Codes and Standards

a. *Classification and Design Safety Standard of Windpower Projects (FD002-2007, Trial)*;

b. *Design Regulations on Subgrade Foundation on Wind Turbine Generator System (FD003-2007, Trial);*

c. *Code for Design of High-rising Structures (GB 50135-2006);*

d. *Code for Design of Building Foundation (GB 50007-2011);*

e. Technical Code for *Ground Treatment of Building (JGJ79-2012);*

f. *Code for Design of Concrete Structu*res (GB 50010-2010);

g. *Load Code for Design of Building Structures (GB 50009-2012);*

h. *Code for Seismic Design of Buildings* (*GB 50011-2010)*

(2) Basic Design Information

a. Basic Design Information

The proposed values for physical and mechanical parameters of the foundation soil will be applied.

b. Wind turbine loads and related data

In this stage, the loads of WTGs with the model of GW121-2500-90m will be utilized as the load design basis. The loads on the top of the foundation ring (Class II wind farm) provided by the Manufacturer are shown in Table 7.1.

Table 7.1 Loads on upper flange at top of foundation ring (excluding safety factor)

Partial load	**Normal operating case**	**Extreme load case**	**Frequent earthquake case**
Horizontal load (kN)	508.4	1018	621.4
Vertical load (kN)	4335.1	4247	4276
Bending moment (kN·m)	41221	82110	62090
Moment of torque (kN·m)	270.3	4522	270.3
Turbine tower weight (t)	278.8		
Nacelle weight (t)	29		
Blade weight (t) (including blade, hub and generator)	127.5		
Hub height (m)	90		

c. Main design control indexes

The main control indexes of the WTG foundation design are listed in Table 7.2.

Table 7.2 Main control indexes of the WTGs

Item	**Unit**	**Load case in normal operation**	**Extreme load case**	**Frequent Earthquake case**
		Control value	**Control value**	**Control value**
(1) Checking bearing capacity of foundation				
Eccentricity (e) / foundation bottom radius (R)		0.25	0.43	0.25
Average pressure on foundation bottom	kPa	fa	fa	fa
Maximum pressure on foundation bottom edge	kPa	1.2×fa	1.2×fa	1.2×fa
(2) Checking calculation of foundation deformation				
Checking calculation of settlement deformation	mm	100	100	
Checking calculation of tilting deformation		0.005	0.005	
(3) Checking calculation of foundation stability				
Checking calculation of anti-overturning		1.6	1.6	1
Checking calculation of anti-sliding		1.3	1.3	1
Notes: when eccentricity (e) / foundation bottom radius (R) = 0.25 and 0.43, the corresponding ratios of cavity areas of foundation bottom will be 0 and 0.25, respectively.				

7.2.1.2 Foundation structure type and calculation

(1) Type of structure

The recommended proposal at this stage is based on WTG with the model of GW121-2500-90m, and according to the engineering geological conditions and the wind turbine load data of the wind farm, the tower foundation of WTGs is determined to employ reinforced concrete cylinder shallowly-buried foundation. The basic shape is round, with a foundation bottom diameter of 20.0 m and a buried depth of 3.9m. Table 7.3 indicates the proposed dimensions of the foundation and Attached Drawing 3 reveals the WTG foundation outline.

Table 7.3 Foundation Dimensions

Item	Quantity
Bottom diameter of round foundation: D (m)	20
Top surface radius of round foundation platform: R1 (m)	3.3
Pillar radius: R2 (m)	3.1
Outer height of foundation slab: H1(m)	1
Height of round foundation slab: H2(m)	1.5
Pillar height: H3(m)	1.4
Buried depth of foundation (m)	3.9

(2) Calculations

According to the *Design Regulations on Subgrade Foundation on Wind Turbine Generator System (FD003-2007, Trial),* the bearing capacity, vertical settlement deformation and stability of pile foundation are calculated and checked in this stage.

(3) Foundation treatment

Excavation & backfilling or consolidation grouting can be applied for places with potential of karst phenomenon at the wind farm so as to improve bearing capacity of the foundation.

(4) Calculation results

The foundation calculation results of recommended WTG with the model of GW121-2500-90m are summarized in Table 7.4. For WTG's foundation outline, please refer to Attached Drawing 3.

Table 7.4 Calculation Results

Item	Unit	Load case in normal operation		Extreme load case		Load case in frequent earthquake	
		Calculated value	Allowable value	Calculated value	Allowable value	Calculated value	Allowable value
(1) Checking of bearing capacity of foundation							
Eccentricity (e) / foundation bottom radius (R) (ratio of empty areas)		0.163	0.25	0.349	0.43	0.224	0.25
Average pressure on foundation bottom	kPa	120	300	112	300	108	300
Maximum pressure on foundation bottom edge	kPa	172	300×1.2	260	300×1.2	230	300×1.2
(2) Checking calculation of foundation deformation							
Checking calculation of settlement deformation	mm	15	100	1.1	100	0.6	100
Checking calculation of tilting deformation		0.001	0.005	0.003	0.005	0.001	0.005
(3) Checking calculation of foundation stability							
Checking calculation of anti-overturning		3.1	1.6	4.2	1.6	4.9	1.6
Checking calculation of anti-sliding		16.2	1.3	6.7	1.3	12.7	1.3

(4) Fatigue check

Reinforced elastic modulus:200000.000MPa

Concrete fatigue deformation modulus:15000.000MPa

Reinforcement area (as determined by the extreme load conditions):

Radial reinforcement per unit arc length of bottom of base plate: 0.008m^2

Circumferential reinforcement per unit width of bottom of base plate:0.007m^2

Radial reinforcement:

Maximum moment:-176.939kNm

Minimum moment:-176.939kNm

Rectangular section compressive zone height:0.59m

Rectangular section compressive zone inertia:0.38m^4

The maximum shear (fatigue cap load calculation):-139.78kN

Concrete compressive stress at the edge of compressive zone:σfcmax=-0.277MPa

Design valu of concrete axial compressive fatigue strength:ffc=19.1MPa, σfcmax<ffc, meeting the requirement.

Stress amplitude of tensile zone longitudinal reinforcement: $\Delta\sigma$fs1=0MPa

Stress amplitude limit of reinforcement fatigue: Δffy=31MPa, $\Delta\sigma$fs1<ffy, meeting the requirement.

Shear stress of section neutral axis: τf=-0.065MPa

Design value of concrete axial tensile fatigue strength: fft=1.026MPa, τf<fft, meeting the requirement.

Circumferential reinforcement:

Maximum moment:-156.995kNm

Minimum moment:-156.995kNm

Rectangular section compression zone height:0.57m

Rectangular section compression zone inertia:0.35m^4

Maximum shear (fatigue cap load calculation):-139.78kN

Concrete compressive stress at the edge of compressive zone: σ fcmax=-0.255MPa

Design valu of concrete axial compressive fatigue strength:ffc=19.1MPa, σfcmax<ffc, meeting the requirement.

Stress amplitude of tensile zone longitudinal reinforcement: $\Delta\sigma$fs1=0MPa

Stress amplitude limit of reinforcement fatigue: Δffy=31MPa, $\Delta\sigma$fs1<ffy, meeting the requirement.

Shear stress of section neutral axis: τf=-0.065MPa

Design value of concrete axial tensile fatigue strength: fft=1.026MPa, τf<fft, meeting the requirement.

7.2.1.3 Conclusions

The geological data suggests that the bearing stratum in the tower foundation is breccia stratum or limestone stratum. As indicated in Table 7.4, all the bearing capacity, settlement deformation and stability calculation of the tower foundation can meet the design requirements. Based on repeated calculation, the foundation dimensions are the minimum ones that could meet the design requirements and make the project reasonably economical.

Foundation design of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is as follows: engineering quantities for one tower foundation works (GW121-2500-90m): excavation is 1785.0m^3, backfill is 1417.5m^3, C40 foundation concrete is 613.2m^3, C20 foundation cushion concrete is 54.6m^3, reinforcement is 55.2t and foundation corrosive protection is 410m^2 approximately.

7.2.2 **Foundation Design of Box-type Substation**

According to electrical design in the wind farm, combination mode of wind turbine generator unit and box-type substation is one-generator-one-substation, i.e. each wind turbine is provided with one box-type substation. Foundation of the box-type substation is connected with power cable trench. The capacity of the box-type substation for recommended proposal is 2750 kVA. Based on the geological conditions and the capacity of box-type substation, the foundation of the box-type substation is determined as the concrete foundation with a basic dimension of 3.9m×4.2m×1.70m (L×W×H). All box-type substations are directly laid on C25 reinforced concrete foundation. Foundation of box-type substation is joined with the power cable trench.

Calculation shows that the excavation, concrete and backfill quantities for each 2750 kVA box-type substation foundation are 40m^3, 13m^3 and 20m^3, respectively.

7.3 **Earthing Grid and Current Collection Line**

7.3.1 **Earthing Grid**

An artificial earthing grid will be set around every WTG foundation and box-type foundation. The earthing device is composed of flat steel and steel tube. One independent earthing grid will be formed by one WTG and one box-type substation.

7.3.2 Collection Power Line

Busbar trunk is applied to wiring of collection power line and 33kV direct-buried cable is applied for power transmission (power cable and optical communication cable are buried in one trench). The backfill volume is equal to the excavation volume.

7.4 Safety Monitoring

Three WTGs of the wind farm shall be selected for safety monitoring which mainly monitors the foundation settlement and incline after WTGs erection and during operation period. Specific monitoring method and practice is as follows: four observation posts shall be arranged on each WTGs foundation along two orthogonal longitudinal directions. Each observation post requires C30 concrete of about 0.207m^3. Three reference piers shall be provided about 30m to the WTGs. Each reference pier requires C30 concrete of about 0.675m^3. The observation shall adopt gradienter. Observation shall be first made upon completion of the foundation. After application of all loads, observation shall be made again; at least two observations are required during the operating period; observation shall be made in the case of special event such as earthquake or strong wind.

7.5 Road

The wind farm is about 110km away from Karachi and about 80km away from Port Qasim. The wind farm is at an elevation of 40m～60m. Starting from Karachi, driving 110km along the M-9 Highway to Nooriabad from where, it drives 30km along Bula Khan Road to the farm.

It is considered to build a new access road from Bula Khan Road. to the wind farm with a width of about 8km (see Fig.7.1). The access road is paved with asphalt concrete, with a length of 17km and a width of 6m. After leveling road pavement, the road will be paved with macadam as temporary pavement. The road will be paved with macadam as temporary pavement. After the wind farm is completed, the simple road will be reconstructed as a permanent on-site road for maintenance purpose, 3m wide, and shoulders in 0.5m width on either side, paved with graded macadam. The remaining 2m-wide road surface will be restored to the original landform.

Fig.7.1 Access road at the site

7.6 **Flood Control Facilities**

In order to prevent the tidewater, the centralized control center is selected to be located at a higher elevation, and the foundation elevation will be raised accordingly. And flood facilities will be set around the centralized control center to collect and drain out flood water. During construction of the WTG foundations and box-type substation foundations, the foundation elevations should be raised appropriately. Ford or culvert should be provided above the gully crossings of access road and on-site road so as to keep smooth traffic.

7.7 **132kV Step-up Substation**

The step-up substation of the wind farm cover a total area of 12,070m^2, comprising operation and living zones, in rectangular shape, 150m long and 75m wide. Of which, living zone occupies an area of 6450 m^2, accommodating complex building, underground water pump room, water treatment room, oil depot and garage; operation zone occupies an area of 7488 m^2, accommodating operation building and SVG room

7.7.1 **Building Design**

7.7.1.1 Design Basis

The following specifications and codes are used in the design:

(1) General Rule for Architectural Design of Civil Buildings *(GB 50352-2005);*

(2) *Code of Design for Fire Protection of Buildings (GB 50016-2014);*

(3) *Load Code for Design of Building Structures (GB 50009-2012);*

(4) *Code for Design of Concrete Structures (GB 50010-2010);*

(5) *Code for Design of Building Foundation (GB 50007-2011);*

(6) *Code for Design of Masonry Structure*s (GB 50003-2011);

(7) *Code for Seismic Design of Buildings (GB 50011-2010);*

(8) *Technical Specification for General Plan Design of Substations (DL/T5056-2007);*

(9) *Technical Specification for Design of Building Structures of Substations (DL/T5457-2012).*

7.7.1.2 Complex building, operation building and other Buildings

The complex building is 45.5m long and 33.35m wide, with a floor area of 2,342m^2. It's a two-storey building which is of reinforced concrete framed structure, with the office, power distribution room, dormitory and dining hall on the first floor, while the central control room, communication equipment room, battery room, shift room, office and dormitory, etc. on the second floor. As for floor finish of the buildings, except that the central control room adopts antistatic false floor, all others adopt tile floor; external wall insulation adopts grade B1 EPS polyphenyl board; color coating is applied for external wall finish. As for inner wall surface, except that toilet and kitchen adopt wall tile, all others adopt latex paint finish. As for ceiling, except that the toilet in the dormitory adopts aluminum pinch plate, all other ceiling shall just be coated.

The operation building is 44m long and 19.4m wide, with a floor area of 1256m^2. There are two storeys for the operation building which is of reinforced concrete framed structure. The first floor is provided with 35kV panel room, diesel generator room, station service transformer room and storage battery room; the second floor is provided with GIS room secondary panel room and central control room. The ground of the building floor adopts cement mortar. External wall insulation adopts grade B1 EPS polyphenyl board. Color coating is applied as external wall finish. Inner wall surface adopts latex paint; all ceilings shall just be coated.

The water pump room and domestic water & fire water pool (180m^3) are of semi-underground reinforced concrete structure.

Table 7.5 shows the engineering quantities of living zone and operation zone of 132kV step-up substation.

Table 7.5 Bill of Quantities for Main Civil Works of Step-up Substation

Item	Unit	Quantities of Works	Remarks
1. Quantities of outdoor works			
(1) Total land area used	m^2	6450	
(2) Total area for buildings	m^2	1603	
(3) Roads in the plant area	m^2	570	05J909 Road 2-2(H=180) 1.180mm-thick C25 concrete, placed alternately in separate block every 4~ 6m. 2. 300mm-thick naturally graded sand. 3. Compaction of plain concrete, with compaction rate greater than 93%.
(4) Fence wall	m	235	02J003, Page 62, fence wall constructed with concrete masonry unit, H=2.4m
(5) Gate		75	02J003, Page 56, fence wall constructed with concrete masonry unit, H=2.4m
(6) Froot door	Pec.	1	Motor-driven gate:12000x1500
(6) Spreading of concrete	m^2	2827	05J909 Road 2-2 (H=120) 1. 120mm-thick C25 concrete, placed alternately in separate block every 4~ 6m. 2. 300mm-thick naturally graded sand. 3. Compaction of plain concrete, with compaction rate greater than 93%.
(7) Greening	m^2	1450	
2. Quantities of Building Works			
(1) Complex building	m^2	2342	Two-storey, simple reinforced concrete frame structure
(2) Water treatment room	m^2	102	One-storey, simple brick-concrete structure
(3) Oil depot	m^2	62	One-storey, simple brick-concrete structure

Item	Unit	Quantities of Works	Remarks
(4) Garage	m^2	190	One-storey, simple brick-concrete structure
(5)Firefighting water pond and underground pump room	m^2	Underground: 197 Above ground: 26	Underground: one-storey, reinforced concrete structure Aboveground: one-storey, simple brick-concrete structure

Table 7.5-2 Bill of Quantities for Main Civil Works of Step-up Substation

Item	Unit	Quantities of Works	Remarks
1. Quantities of outdoor works			
(1) Total land area used	m^2	4875	
(2) Total area for buildings	m^2	755	
(3) Roads in the plant area	m^2	705	05J909 Road 2-2(H=180) 1.180mm-thick C25 concrete, placed alternately in separate block every 4~ 6m. 2. 300mm-thick naturally graded sand. 3. Compaction of plain concrete, with compaction rate greater than 93%.
(4) Fence wall	m	203	02J003, Page 56, fence wall constructed with concrete masonry unit, H=2.4m
(5) Gate	Pec.	1	Wrought iron gate dimension:4200x2100
(6)Concrete floor	m^2	1263	05J909 Road 2-2 (H=120) 1. 120mm-thick C25 concrete, placed alternately in separate block every 4~ 6m. 2. 300mm-thick naturally graded sand. 3. Compaction of plain concrete, with compaction rate greater than 93%.
(7) Pebble floor	m^2	2152	Placing 200mm thick pebble with grain size of 50mm~80mm.
2. Quantities of step-up substation buildings			
(1) Operation building	m^2	1256	Two-storey, simple reinforced concrete frame structure
(2) SVG room	m^2	127	One-storey, simple reinforced concrete frame structure

7.7.1.3 132kV step-up substation

It is proposed to use herringbone column made of annular steel pipes with straight welding seam as the framework of incoming and outgoing lines and use beams made of annular steel pipes with straight welding seam as the cross beam of framework. The lightning arrester tower is assembled with variable cross-section angle steel, and independent reinforced concrete foundation is used.

Reinforced concrete foundation is used as the main transformer foundation, and independent reinforced concrete foundation is used as the foundation of framework and supports. The emergency oil sump is of reinforced concrete structure and is arranged underground.

It is proposed to use C30 plain concrete or reinforced concrete to build a cable trench within the project area and such cable trench is planned to be provided with prefabricated reinforced concrete cover plate. In the station, the cable trench is 0.10m higher than the designed ground and the trench top is also served as a patrol path. For drainage of the cable trench, vertical design is considered, i.e. sump pit is set at the lowest point to drain water into the closest rain water sewer within the station area.

As the foundation soil is moderately corrosive to concrete structures, moderately corrosive to steel bars in reinforced concrete and steel structures, necessary anti-corrosion measures should be taken for masonry, concrete and steel structures buried underground.

Table 7.6 indicates the details of main work quantities for major equipment foundations of the step-up substation.

Table 7.6 Main Work Quantities of Major Equipment Foundations of the 132kV Step-up Substation

No.	Item	Unit	Quantities of Works	Qty.	Remarks
1	Leveling works				
	Surface clearing excavation	m^3	3398		
	Earth excavation	m^3	6796		
	Earth-rock backfilling	m^3	10509		Compaction coefficient not less than 0.97
2	Foundation works of power transformation equipment				
	Earth excavation	m^3	1638		
	Earth-rock backfilling	m^3	1353		Compaction coefficient not less than 0.97 (main transformer + framework)
	Concrete (C30)	m^3	158		Main transformer foundation
	Steel bar	t	7.4		
	Bed course	m^3	25		
	Pebble	m^3	120		
	Emergency oil sump, V=40m^3emergency oil sump V=40m3			1	
	Herringbone pillar	t	5.9		Φ325×8 straight seam welded

No.	Item	Unit	Quantities of Works	Qty.	Remarks
	framework				steel pipe
	Beam framework	t	1.9		Φ450×6 straight seam welded steel pipe
	Diagonal bracing	t	1.2		Φ325×8 straight seam welded steel pipe
	Ladder	t	0.5		
	Main transformer framework foundation (C30)	m^3	33		Cup base
	Main transformer framework foundation cushion	m^3	12.9		
	Reinforcement	t	1.5		
3	Independent lightning rod	t	8.4		
4	110 supporting Structure				
	Herringbone pillar framework	t	3.5		Φ300×6 straight seam welded steel pipe
	Steel Beam	t	1.4		Φ400×6 straight seam welded steel pipe
	Steel ladder	t	0.8		
	Column cap ground wire	t	0.6		Φ300×6 straight seam welded steel pipe
5	Outdoor equipment foundation				
	Earth excavation	m^3	141		
	Earth backfilling	m^3	111		Compaction coefficient not less than 0.94
	Concrete (C30)	m^3	39		Independent foundation
	Cushion	m^3	5.3		
	Reinforcement	t	0.4		
	Embedded iron	t	0.5		Plank
	bolt	t	0.5		
6	800x800(concrete trench)	m^3	73		
	1200x1200(concrete trench)	m^3	60		
	Cable trench concrete cover	m^3	20		
	Cable trench reinforced cover	t	2.6		
7	Dynamic reactive power compensation				

No.	Item	Unit	Quantities of Works	Qty.	Remarks
	Earth excavation	m^3	267		
	Earthwork backfilling	m^3	214		
	Concrete (30)	m^3	98		Independent foundation
	Reinforcement	t	2.2		
	Cushion	m^3	4.7		

7.7.2 Design of Domestic Water Supply and Drainage

7.7.2.1 Design basis

(1) *Code for Design of Outdoor Water Supply Engineering (GB 50013-2014);*

(2) *Code for Design of Outdoor Water Supply (GB 50013-2006);*

(3) Code for Design of Outdoor Water Drainage Engineering (GB 50014-2006) (2014Edition);

(4) Code for Design of Building Water Supply and Drainage (GB 50015-2003) (2009 Edition).

7.7.2.2 Domestic water supply and drainage system

(1) Water source

Water source: outdoor deep well water is fed for the project.

(2) Water consumption

a) Domestic water consumption

The number of water consuming persons is considered as 28, the domestic water quota is 150L/person·d and the maximum daily water consumption is 4.20m^3/d.

b) Water consumption for greening

The greening area is about 1,450m^2 for the project, so the quota for watering is 2.0L/m^2·d and the maximum daily water consumption is 2.90m^3/d.

c) Water consumption for roads and squares

The total area of roads and squares for the project is about 570m^2, so the quota for watering is 2.0L/m^2·d and the maximum daily water consumption is 1.14m^3/d.

d) Water consumption unforeseen and leakage from pipe network

The total amount of water consumption unforeseen and leakage from pipe network is calculated as 10% of the sum of the three kinds of water consumption mentioned above, i.e. $0.82m^3/d$.

e) Total water consumption

The maximum total daily water consumption is $8.24m^3/d$ for the Project. Table 7.7 summarizes the detailed water consumption.

Table 7.7 Summary of Water Consumption for All Items

S.No.	Type	Water consumption quota	No. of water consuming units	Hourly variation factor (Kh)	Utilization hours (h)	Water consumption		remarks
						Maximum daily water consumption (m^3/d)	Maximum hourly water consumption (m^3/h)	
1	Domestic water	150L/person·d	28 person	3	24	4.20	0.53	
2	Greening water	$2.0L/m^2 \cdot d$	$1450m^2$	1	8	2.90	0.36	
3	Water for roads and squares	$2.0L/m^2 \cdot d$	$570m^2$	1	8	1.14	0.14	
4	Subtotal					8.24	1.03	
5	Water consumption unforeseen and leakage from pipe network	10%				0.82		
6	Total					9.06	1.03	

7.7.2.3 Water supply system

Secondary pressurized water supply is employed for the project, with the water source from well water. The wind farm is provided with an underground water pool (domestic & firefighting water pool with an effective capacity of $180m^3$), water pump room (firefighting pump and domestic pump) and water treatment room that accomdates water treatement equipment with a capacity of $1.0m^3/h$, a $9m^3$ domestic water tank, a set of domestic constant pressure water supply equipment (including two domestic water supply pumps, mutually standby) and two ultraviolet ray sterilizers. Water in the deep well is lifted by deep-well pump to be stored in the underground water pool (domestic and firefighting water tank with an effective capacity of $180m^3$), water is drawn by domestic water pump and conveyed to water treatment room. After treatment, the introduced water is stored in the domestic water tank. Water in the tank is supplied to each unit by a frequency conversion domestic water supply set after passing through UV sterilizers. The domestic water tank has parameters of Q = (2.6-3.7-4.4)m^3/h, water supply pressure of H= (0.29-0.29-0.26) MPa. The model of frequency conversion domestic water supply set is Q= (10-16-20) m^3/h, with water supply capacity of H= (0.405-0.375-0.33) MPa. UV sterilizer has a capacity of 16m^3/h. Hot water in the washroom is supplied by the electric water heater.

7.7.2.4 Water drainage system

Separate flow of rainwater and wastewater is employed for water drainage system of the project.

(1) Rainwater drainage system

Building roof rainwater is drained outside. Outdoor rainwater is drained out of the site along the roade slope under gravity.

(2) Wastewater drainage system

The indoor domestic sewage is drained to outdoor sewage pipe network under gravity and kitchen wastewater is drained to outdoor sewage pipe network after being treated by oil separation tank. One 4m^3 septic tank, one 4.5m^3 wastewater adjustment pool, one set of wastewater treatment equipment with a capacity of 0.50m^3/h and one wastewater catch basin with a capacity of 50m^3 are set outside. Wastewater is treated and drained to the 50m^3 wastewater catch basin before being used for site greening or discharged out of the site.

7.7.2.5 Pipe materials and connection

PE water supply pipes are used as outdoor water supply pipes, with fusion connection. PVC-U double-wall corrugated water drainage pipes are used as outdoor wastewater pipes, with rubber ring socket connection; steel-plastic composite pipes are used as indoor water supply pipes, with special accessory connection. PVC-U water drainage pipes are used as indoor domestic wastewater pipes, with adhesives connection; and steel-plastic transition joint or special flange joint must be used for connecting PE water supply pipes, metal pipelines, valves and equipment.

7.7.2.6 Main equipment and materials for domestic water supply and drainage

Table 7.8 and Table 7.9 show the main equipment and materials for domestic water supply and drainage.

Table 7.8 Main Equipment and Materials for Domestic Water Supply and Drainage

No.	Description	Specification/ Model	Unit	Qty.	Remarks
1	Domestic water tank	$V=9m^3$	Set	1	Combined stainless steel water tank
2	Water supply treatment equipment	Treatment capacity: $1m^3/h$	Set	1	
3	Domestic water tank	$Q=(2.6\text{-}3.7\text{-}4.4)m^3/h$ H=(29-28-26)m N=1.1kW mutually standby	Set	2	
4	Frequency-conversion constant-pressure water supply equipment	Attached two water pumps: $Q=(10\text{-}16\text{-}20)m^3/h$ H=(40.5-37.5-33)m N=3.0kW One in service and one on standby Pressure tank: φ630mm	Set	1	
5	UV sterilizer	Capacity: $20m^3/h$	Set	2	
6	Submersible wastewater pump	$Q=2.1m^3/h\sim12m^3/h$ H=14.8m~9m N=0.75kW	Set	2	
7	Wastewater treatment equipment	Treatment capacity: $0.5m^3/h$	Set	1	Including equipment, pipeline, valve, cable and accessories between control cabinet, wastewater regulating tank and catch basin
8	Water closet		Set	14	
9	Hydraulic pedal flushing valve squat toilet		Set	8	
10	Induction type flushing valve wall hung urinal		Set	6	

No.	Description	Specification/ Model	Unit	Qty.	Remarks
11	Desktop washbasin		Set	20	
12	Mop sink		Set	4	
13	Shower		Set	14	
14	Electric water heater	V=60L N=2kW	Set	14	
15	Kitchen sink		Set	4	
16	Floor drain	DN50	Pec.	20	
17	Grid-type floor drain	DN100	Pec.	1	
18	Shield vent cap	Z-200Type	Pec.	2	
19	Umbrella vent cap	DN100	Pec.	5	
20	Check hole	DN100	Pec.	10	
21	Nodular cast iron well cover and support	φ700	Pec.	12	
22	Nodular cast iron well cover and support	φ800	Pec.	7	
23	Stop valve	J11W-10T Type DN20	Pec.	15	
24	Stop valve	J11W-10T Type DN50	Pec.	5	
25	Gate valve	Z44H-10T Type DN50	Pec.	5	
26	Gate valve	Z44H-10T Type DN65	Pec.	3	
27	Gate valve	Z44H-10T Type DN80	Pec.	10	
28	Check valve	HQ41X-10C Type DN40	Pec.	2	
29	Check valve	HQ41X-10C Type DN65	Pec.	2	
30	Magnetic valve	DN65 P=1.0MPa	Pec.	1	
31	Circumnutating rubber joint	DN50 P=1.0MPa	Pec.	4	
32	Circumnutating rubber joint	DN80 P=1.0MPa	Pec.	4	
33	Pressure gage	Y-100Type P=0MPa～1.0MPa	Pec.	2	
34	A type flexible waterproof casing water-proof casing pipe	DN50	Pec.	3	
35	B type rigid waterproof casing	DN50	Pec.	13	
36	B type rigid waterproof casing	DN100	Pec.	1	
37	B type rigid water-proof casing	DN200	Pec.	1	
38	sprinkler head	DN25	Pec.	5	
39	Water level gauge		Set	3	
40	PP-R hot water pipe	DN15	m	70	
41	PP-R hot water pipe	DN15	m	70	
42	PP-R hot water pipe	DN20	m	50	
43	Steel-plastic composite pipe	DN25	m	30	
44	Steel-plastic composite pipe	DN32	m	30	
45	Steel-plastic composite pipe	DN40	m	30	
46	Steel-plastic composite pipe	DN50	m	30	
47	Steel-plastic composite pipe	DN65	m	30	
48	Steel-plastic composite pipe	DN80	m	50	

No.	Description	Specification/ Model	Unit	Qty.	Remarks
49	Internal and external surface hot dip galvanized steel pipe	DN65	m	10	
50	Internal and external surface hot dip galvanized steel pipe	DN100	m	10	
51	Internal and external surface hot dip galvanized steel pipe	DN200	m	10	
52	PE100 plastic pipe	DN65	m	30	
53	PE100 plastic pipe	DN80	m	60	
54	PVC—U drain pipe	DN50	m	70	
55	PVC—U drain pipe	DN75	m	20	
56	PVC—U drain pipe	DN100	m	150	
57	PVC — U double-wall corrugated drainage pipe	DN200	m	200	

Table 7.9 Quantities of Main Domestic Water Supply and Drainage Structures

No.	Description	Specification/ Model	Unit	Qty.	Remarks
1	Underground water pump room and water pool	Effective volume 180m^3		1	
2	Water treatment room			1	
3	Reinforced concrete septic tank	G2-4F type		1	
4	Reinforced concrete septic tank	GG-1F type		1	
5	Wastewater regulating tank	9m^3		1	
6	Reinforced concrete catch basin	50m^3		1	
7	Brickwork wastewater inspection well	φ1000		12	
8	Brickwork sprinkler head well	φ1200		5	
9	Brickwork valve well	φ1500		1	
10	Reinforced concrete rectangular valve well	1400×1800(L×B)		1	
11	Reinforced concrete rectangular valve well	1100×1200(L×B)		1	
12	Deep well			1	Including lifting pipe, deep well and valve fittings

7.7.3 HVAC

7.7.3.1 Codes and standards for design

(1) *Code for Design of Heating, Ventilation and Air Conditioning (GB 50019-2003);*

(2) *Code for Design on Fire Protection and Prevention of Buildings (GB 50016-2014);*

(3) *Design Standard for Energy Efficiency of Public Buildings (GB*

50189-2005).

7.7.3.2 Outdoor air calculation parameters

The average minimum air temperature in the coldest month is 1.3℃, and the average maximum air temperature in the hottest month is 47℃.

7.7.3.3 Indoor air calculation parameters

(1) Indoor air conditioning temperature in summer

Central control room, communication equipment room: 26℃;

Office, meeting room, reference room, dormitory, activity room and dining hall: 26℃;

7.7.3.4 Air conditioning and ventilation system

The complex building of this project is designed to use split air conditioning system (heat pump type) to satisfy the indoor temperature requirement for communication equipment room and central control room and the requirement for comfort of other rooms.

Mechanical ventilation system is provided for the 35kV equipment room, power distribution room, primary panel room, oil depot, pump room, water treatment room and kitchen to reinforce ventilation and remove waste heat or peculiar smell in these rooms. The air exhaust system of the oil depot is also served as emergency ventilation system to keep indoor negative pressure, with air intake capacity being 80% of air exhaust capacity.

SF6 gas reclaiming equipment is provided in the 35kV equipment room. In addition, the 35kV equipment room is provided with emergency exhausting system with air outlet in the lower section of the room. During emergency ventilation, the exhaust fan at bottom of the room shall start or stop as per the SF6 gas concentration in the room.

A comprehensive ventilation system is provided for the operation room of the kitchen, and local ventilation systems are uniformly set by the kitchen equipment supply company based on the kitchen wares.

7.7.3.5 Fire protection design for ventilation and air conditioning system

(1) Independent air exhaust system is provided for oil depot, with fans and motors of explosion-proof type.

(2) The oil depot is provided with an emergency ventilation system (combined with normal ventilation system), which will be closed in case of fire. After the confirmation of fire extinguishment, the post-emergency ventilation will be made by the fire control center or through local air exhaust fans.

(3) In case of fire, the operation of ventilation and air conditioning system of relevant parts should be stopped.

(4) Emergency ventilation design for ventilation system

For the oil depot, its emergency ventilation system is combined with normal ventilation system and the air exhaust fans are fire-control high-temperature smoke exhaust fans. In case of fire, the ventilation system is closed. After the confirmation of fire extinguishment, the post-emergency smoke exhaust will be made by the fire control center or through local smoke exhaust fans.

7.7.3.6 Main HVAC equipment

The main HVAC equipment is listed below in Tables 7.10 ~ 7.16.

Table 7.10 Quantities of HVAC Works of Complex Building

No.	Description	Model & Specification	Unit	Qty.	Remarks
1	Cabinet air conditioner	Model:KFR-72LW/R1(72533L1)-JN2 Refrigerating capacity:7200W Power:2275W Power supply:220V	Set	15	
2	Cabinet air conditioner	Model:KFR-32GW/E(3251)ZD-JN1 Refrigerating capacity:3200W Power:840W Power supply:220V	Set	17	
3	Pipe-type ventilating fan	Model:BPT25-56A Air volume:800m³/h Air pressure:410Pa Motor power:150W	Set	2	
4	Pipe-type ventilating fan	Model:BPT15-34A Air volume:260m³/h Air pressure:165Pa Motor Power:36W	Set	2	
4	Bath heater	Model:FDP810	Set	14	

		Motor Power:100W			
5	Axial flow fan	Model:T35-11-NO3.55 Air volume:5484m³/h Power:473W Air pressure:284Pa Power supply:220V	Set	4	
6	Wall-mounted exhaust fan	Model:WEX-350D4-0.15 Air volume:1600m³/h Air pressure:100Pa Motor Power:0.15kW(380V)	Set	1	

Table 7.10 Quantities of HVAC Works of the Operation Building

No.	Description	Model & Specification	Unit	Qty.	Remarks
1	Explosion-proof cabinet air conditioner	Model:BKGR-50 Refrigerating capacity:5000W Power:1940W Power supply:220V	Set	1	
2	Cabinet air conditioner	Model:KFR-50LW/R(50315L)B-N3 Refrigerating capacity:5000W Power:1628W Power supply:220V	Set	2	
3	Cabinet air conditioner	Model:KFR-72LW/R1(72533L1)-JN2 Refrigerating capacity:7200W Power:2275W Power supply:220V	Set	2	
4	Wall-mounted explosion-proof anti-corrosion exhaust fan	Model:WEX-350EX4-0.12Type Air volume:1600m³/h Air pressure:100Pa Motor Power:0.15kW(380V)	Set	1	
5	Wall-mounted explosion-proof exhaust fan	Model:WEX-400EX4-0.25Type Air volume:2500m³/h Air pressure:100Pa Motor Power:0.25kW(380V)	Set	1	
6	Axial flow fan	Model:T35-11-NO3.55Type Air volume:5484m³/h Power:473W Air pressure:284Pa Power supply:220V	Set	2	
7	Anti-corrosion axial flow fan	Model:T35-11-NO6.3Type Air volume:12345m³/h Power:833W Air pressure:218Pa	Set	1	

No.	Description	Model & Specification	Unit	Qty.	Remarks
		Power supply:220V			
8	Anti-corrosion axial flow fan	Model:T35-11-NO6.3Type Air volume:18250m^3/h Power:1734W Air pressure:300Pa Power supply:220V	Set	1	
9	Wall-mounted anti-corrosion axial flow fan	Model:DFBZ$^{\text{TypeNO4.0}}$ Air volume:4470m^3/h Air pressure:109Pa Motor Power:0.25kW(380V)	Set	7	
10	Single deflection grille	FK-2 type 1000X250		17	
11	Exterior wall air grille	FK-54 type 1200X630		2	
12	Exterior wall air grille	FK-54 type 600x400		2	
13	70℃fire damper	FH-FHT type 500x320		1	
14	70℃fire damper	FH-FHT type 1000x500		2	

Table 7.12 Quantities of HVAC Works of SVG room

No.	Description	Model & Specification	Unit	Qty.	Remarks
1	Air cooling type air conditioner	Model:LF14N Refrigerating capacity:13.8kW Power:5.23kW Power supply:380V	Set	2	
2	Anti-corrosion wall-mounted axial flow fan	Model:DFBZTypeNO3.2 Air volume:2250m^3/h Air pressure:68Pa Motor Power:0.09kW(380V)	Set	4	

Table 7.13 Quantities of HVAC Works of Water Pump Room

No.	Description	Model & Specification	Unit	Qty.	Remarks
1	Wall-mounted exhaust fan	Model:WEX-400D4-0.19Type Air volume:2500m^3/h Air pressure:100Pa Motor Power:0.19kW(380V)	Se t	1	

Table 7.14 Quantities of HVAC Works of Oil Depot

No.	Description	Model & Specification	Unit	Qty.	Remarks
1	Anti-corrosion	Model:DFBZTypeNO3.2	Set	1	

	wall-mounted axial flow fan	Air volume:2250m^3/h Air pressure:68Pa Motor Power:0.09kW(380V)			

Table 7.15 Quantities of HVAC Works of Maintenance Room

No.	Description	Model & Specification	Unit	Qty.	Remarks
1	Wall-mounted exhaust fan	Model:WEX-400D4-0.19Type Air volume:2500m^3/h Air pressure:100Pa Motor Power:0.19kW(380V)	Set	1	

Table 7.16 Quantities of HVAC Works of the Gate House

No.	Description	Model & Specification	Unit	Qty.	Remarks
1	Wall-mounted air conditioner	Model:KF-32GW/DY-J (E4) Refrigerating capacity:3200W Heating capacity:3950W Power:1.5kW Power supply:220V	Set	1	

8 CONSTRUCTION METHOD STATEMENT

8.1 Construction Method Statement

8.1.1 Natural Condition

Feasibility Study Report of Norinco International Thatta Phase-II 50MW Wind Power Project("Norinco-2") is located in Sindh province, about 110km from northeastern Karachi and about 80km from Port Qasim. The wind farm covers a belt zone and gullies with draught-enduring shrubs are developed in the area. The wind farm site is at El.40m ~ El.60m.

8.1.2 Transport Condition

Starting from Karachi, driving along the M-9 national Highway to Nooriabad and then driving along the highway via Thatta-Thano Road for 20km, it will reach the wind farm area by a country road which enjoys good conditions for traffic.

8.1.3 Construction Water, Power and Communication Conditions

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") is relatively flat and wide in topography. Only some areas need to be excavated, filled and leveled in construction, which is convenient for WTG lifting, moving and turning of crane, assembly of WTG blades and temporary stockpile of containers. Thus, the construction conditions are relatively favorable.

Source of main construction materials: several petroleum and gas substations are located along the way from Karachi to the wind farm, as well as two cement plants, including the largest one in Karachi called Lucky Cement Plant, necessary construction materials (cement, timber, steel, aggregate, oil, etc.) can be directly bought in the neighborhood.

Living materials and other construction materials can be purchased from the town about 30km away from the wind farm. Water for the wind farm in operation period is ground water from well to be dug. According to field survey, water for construction can be transported from Lake Kalri about 10km away from the site in the southeast.

Two 300kW diesel generators, three 15kW diesel generators and temporary transmission line can be adopted for temporary power supply.

Construction machinery repair and processing systems will mainly rely on local capacity; small-scale repairing and processing system may be set in the construction area. Given that a much higher requirement is put forward for installation technology of

WTGs, it is necessary to choose a construction team with vigorous capacity, installation experience of WTGs and equipment lifting capacity.

8.1.4 Construction Characteristics

In this phase, 20 WTGs with 2500kW each will be installed, with a total installed capacity of 50MW. Construction characteristics of the project are that works of single unit is decentralized, which requires decentralized foundation construction, too.

8.2 General Layout of Construction

8.2.1 Layout of Plant Facilities and Warehouses

Construction site of the wind farm project is located at an open area, WTGS and box transformers are subject to decentralized arrangement and the construction arrangement condition is relatively favorable. Temporary works for construction in the farm mainly include integrated processing plant, material warehouse, equipment warehouse, concrete mixing plant, aggregate stack yard and temporary production and living buildings, etc.

According to engineering construction characteristics, the construction will be subject to both centralized and decentralized arrangement; concrete mixing plant, material workshop, equipment and material warehouses and auxiliary workshop, etc. will be located at a relatively flat position near step-up switchyard in the farm. Temporary facilities of the wind farm project take a floor area of about 9,600m^2. Table 8.1 indicates temporary work quantities in construction period.

Table 8.1 Work Quantities of Temporary Construction Buildings

Description	Area
Temporary dormitory and office	1600m^2
Concrete mixing plant	2000m^2
Aggregate stack yard	1500m^2
Material and equipment warehouses	2500m^2
Wood processing plant and reinforcement workshops	2000m^2
Total	9600m^2

8.2.2 Scheme for Power Load, Power Supply, Voltage and Power Transmission & Transformation of Construction

According to the characteristic of decentralization existing in construction of the wind farm, concrete placement will be conducted through concrete pump. Construction power consumption in this stage can be supplied by two 300kW diesel generators and three 15kV diesel generators. The electricity generated can be sent to the power consumption equipment at construction site through power control box, lighting box and insulated flexible wire.

According to primary calculation, electrical load for construction of the project at peak time is 200kW.

8.2.3 Scheme for Construction Water Consumption and Supply

Water consumption for construction includes water consumption of production and living; the former includes water consumption for building construction, machinery and environmental protection. Water consumption for construction at peak day is about $150m^3/d$, including $50m^3/d$ domestic water. Considering the coverage of ground water in the wind farm area, water can be transported from Lake Kalri with a distance of about 10km. After completion of the wind farm, domestic water can be supplied by well water.

Water consumption of the wind farm in operation period is relatively lower; it is considered to set a $180m^3$ domestic water tank combined with firefighting water tank in the step-up switchyard to meet domestic water and firefighting water demand in the step-up substation at early stage of fire disaster.

Owing to high demand of water in construction period, it is considered to set a temporary water storage tank near concrete batching plant. Water for concrete curing will not be taken into consideration because it will be subject to membrane curing.

8.2.4 Material Supply

Main materials necessary for the project include aggregate, cement, steel, timber, oil and explosive materials, etc. Materials can be mainly bought from the town 30km away from the wind farm. Huge equipment or materials can be bought from Karachi City with a distance of 110km.

8.3 Transport Condition

8.3.1 External Transportation

Routes of huge wind turbine generator and transformer are: wind turbine generator factory- Shanghai (China) - Port Karachi (Pakistan) – wind farm (Pakistan), among which the shipping is about 11,600km from Tianjin (China) to Port Karachi (Pakistan), then another land transportation is about 140km from Port Karachi (Pakistan) to the wind farm (Pakistan).

The wind farm is located in the northeast of Karachi, about 110km from Karachi and about 80km from Port Qasim. The farm is at EL.40m ~ 60m. Starting from Karachi, driving about 100km along the M-9 Highway till Bula Khan Road and then leaving Bula Khan Road, the wind farm area will be reached through 30km along access road. The Bula Khan Road is paved with asphalt and about 8m wide. There is no huge building or trees along the road; road gradient is relatively small, in good condition and can fully meet transportation requirement of huge wind turbine generators; the transportation is convenient.

8.3.2 Transportation in the Farm

According to general layout of WTGs in the wind farm, a simple road about 17km long and 6m wide will be built in the farm with macadam pavement. After construction of the wind farm is completed, a permanent road for maintenance in the farm with 3m width and left and right shoulder of 0.5m respectively will be built with macadam pavement based on simple construction road. The other 2m-wide road surface will be restored to the original landform.

8.4 Land Occupation of the Project

Land requisition for the wind farm is permanent with the total occupied area of 2,500 acre.

8.5 Construction for Main Works

8.5.1 Foundation of WTG

8.5.1.1 Construction sequence

Construction sequence of the wind turbine foundation: positioning and setting out

→mechanical excavation of foundation → manual cleaning and trimming → acceptance of foundation trench → bedding cushion concrete placement → setting out → foundation reinforcement fixing → installation of embedded pipes, parts and bolts → installation of formworks → foundation concrete placement →formworks removal → acceptance →backfill.

8.5.1.2 Foundation construction

(1) Excavation and backfill of foundation pit

1) According to coordinate control points at construction site, the foundation axis and excavation line of the foundation pit will be determined; then excavation will begin when no error is found through check.

2) Earth is excavated mainly by machinery and supplemented by manual cooperation. Slope excavation will be conducted according to the requirements of construction drawings; the foundation bottom elevation will be controlled well in excavation; over-excavation is forbidden; excavated soil and stone will be piled according to requirement of water and soil conservation. After foundation excavation of WTG reaches specified elevation and trench is proven qualified by the Engineer and geological professional, then it is allowed to go to next procedure.

3) Earth backfill: after foundation construction is completed and concrete strength meets requirement of specification and design passes acceptance for concealed works, earth backfill will be conducted in time. Earth will be backfilled through auto transportation, layer-wise manual backfilling and mechanical compaction. In addition, sundries in foundation must be cleaned prior to backfilling.

4) Foundation earthing of WTG will be conducted concurrently with excavation of foundation pit and acceptance of concealed works will be carried out prior to backfilling of the foundation pit.

5) After excavation of the foundation pit is completed, it will be protected prior to placement of bedding cushion concrete.

(2) Placement of bedding cushion concrete

C20 concrete is applied for WTG foundation cushion of the Project; after foundation pit is excavated to proper position and qualified through acceptance, concrete placement of foundation layer will be carried out in time to provide protection for foundation pit; sundries will be cleaned, block surface will be leveled, little water will be sprinkled, compaction and leveling will be conducted prior to concrete placement of the foundation.

(3) Installation of foundation ring and support bracket

1) WTG tower is connected to support bracket with pre-embedded foundation bolts. Foundation ring is directly buried in concrete of foundation and will be subject to fixing of support bracket with foundation bolts in construction.

2) Prior to reinforcement fixing, foundation centerline will be set out on cushion at first, densified control network will be built around foundation to mark out location of foundation centerline, sideline and foundation ring; after it is checked without error, installation of support bracket of foundation ring and reinforcement fixing will begin.

3) Owing to relatively strict requirement put forth for flange installation of foundation ring, the installation will follow these procedures: four 400 × 400 × 20mm steel plates will be embedded in concrete cushion; lower end of support bracket of foundation ring will be connected with embedded foundation slab, and its upper end with adjusting bolt; foundation ring and support bracket will be subject to connection of adjusting bolt which can help adjust smoothness of foundation ring so that elevation of foundation ring can be controlled in accuracy.

4) Reinforcement fixing will begin after installation of foundation ring is accepted as qualified. Bolt support bracket will not be connected with steel bar, formwork, formwork support system, and scaffolds should be in an independent system so as to prevent bolts from influence caused by vibration and deformation of framework in concrete placement.

5) After installation works of support bracket of foundation bolt and foundation ring are completed, overall acceptance and check will be conducted, including acceptance of control axis and foundation centerline and dimension acceptance for embedded parts of foundation. Reinforcement fixing and formwork sealing will begin after mounting bracket of foundation ring is accepted as qualified.

(4) Steel bar works

1) Reinforcement fixing will begin after installation of foundation ring is accepted as qualified. Support bracket of foundation ring will not be connected with steel bars.

2) Main stressed steel bars at parts of foundation like bottom, top, upper pillar etc. are subject to steel bar of common length without overlapping. Connection between steel bars is 100% subject to fixing instead of welding.

3) If structural steel for support bracket of foundation ring and embedded cable

conduit are met in arrangement of steel bars, spacing between steel bars will be adjusted to avoid them, while steel bar shall not be cut off to cause damage to stress structure.

4) After reinforcement fixing and installation of foundation ring is completed, foundation ring will be checked and adjusting bolts will be used to adjust error existing in centerline, elevation, smoothness etc. of foundation ring; when each indication is in line with requirement of design and specification, support bracket and foundation ring will be reinforced, adjusting bolts will be fixed through spot welding to assure accuracy for position of foundation ring.

(5) Formworks

Enough strength and rigidity is necessary for formworks, mould and nodes of different members to meet requirement for dimension error; inner surfaces of formworks and moulds shall be kept clean.

(6) Concrete placement of foundation

1) Concrete will be subject to the placement method of centralized mixing through site mixing plant, transportation by mixer trucks, delivered by concrete pumps and vibration by inserted vibrators. During concrete placement, special personnel must be arranged to monitor the displacement of formworks, foundation rings, and bolts and embedded pipes to find any problem and solve them.

2) Construction joint shall not occur in concrete placement and main body concrete shall be placed at a time.

3) Design drawings and supplier's equipment drawings shall be carefully studied and thoroughly understand prior to concrete placement of the foundation, construction will begin only after it is fully understood; absolute accuracy of holes of reserved foundation bolts and integrity of mass concrete foundation must be assured.

4) Much attention must be paid to internal placement for support bracket of foundation bolts in concrete placement. Concrete placement between ends of star steel bars at inner side of support bracket will be carried out through tremie so as to assure that the foundation tower will not displace but kept at center position.

5) Steel bars and anchor bolts must be cleaned prior to placement so as to assure cohesion between concrete and steel bars.

6) Measures shall be taken in concrete placement to assure layer-wise placement from top to bottom; concrete will be controlled to go up evenly to prevent support bracket of bolt from side pressure caused by different heights of concrete.

7) In order to assure that the final installation of foundation ring is correct, measuring instrument shall be used in concrete pouring to strengthen measurement so as to keep smoothness of foundation ring on the support bracket as it is.

8) Construction will be subject to layered placement and vibration, meanwhile good combination between upper and lower layers of concrete must be assured prior to initial setting so that no construction joint will occur.

9) Weather condition shall be learned before concrete construction; rainy day is not suitable for concrete placement and construction in winter will be avoided as much as possible.

(7) Control measures for temperature difference of foundation concrete

1) Prior to concrete placement, calculation for temperature difference between inside and outside of concrete will be carried out according to the annual temperature in determined placement period, cement, aggregate to be used etc. so as to confirm whether the difference between the maximum central temperature of concrete and surface temperature is more than 25℃ in that situation; if it is not more than the specified value of 25℃, control measure for temperature difference may not be taken, if it is more than 25℃, control measure for temperature difference must be taken.

2) Temperature monitoring inside concrete

16 temperature measuring points will be set inside concrete, and 2 air temperature measuring points will be set outside concrete, as well as 2 temperature measuring points for thermal insulation materials and 1 temperature measuring point for curing water; 21 working measuring points are arranged in total. The additional 10 stand-by measuring points will be set. Site temperature monitoring data will be automatically collected by data collector and analyzed; temperature of each measuring point and temperature difference between the central and surface measuring points at each measuring position will be printed and output once every two hours; it will be used as basis for study on adjustment of temperature measures to prevent concrete from temperature crack.

(8) Curing of foundation concrete

Concrete curing is to keep it under certain temperature and humidity; special personnel will be arranged to measure concrete temperature regularly during curing so as to assure that temperature difference between inside and outside of concrete will not be more than 25℃

concrete will be covered in time after placement; backfill will be timely carried out at the formwork after it is disassembled so as to reinforce curing of thermal insulation and moisture preservation; concrete will be subject to curing of moisture preservation through spraying after placement.

(9) Crack resistance measures of foundation

1) Slag cement with low heat of hydration will be applied, cement consumption in single cube and cement ash ratio will be reduced, and water reducing agent will be added to reduce heat of hydration in concrete.

2) Concrete will be subject to curing of thermal insulation and moisture preservation immediately after placement so as to make its temperature reduce slowly; concrete surface will be subject to thermal insulation through covering of straw bag with plastic membrane on its top; special personnel will be arranged for curing and the curing period will not be less than 14 days.

3) Time for formwork removal of concrete will be extended; for underground foundation, earth backfill will be conducted immediately after the formwork is removed so as to maintain the situation of thermal insulation and moisture preservation.

4) Mass concrete shall not be placed in season especially hot or cold as possible.

5) Soil content of aggregate shall be controlled well with sediment content for sand not more than 2% and that for gravel not more than 1%.

(10) Foundation sealing

Foundation sealing will be carried out in line with technical requirement provided by the Supplier of WTGs.

8.5.2 Installation of WTGs

In recommended scheme of this Project, WTGs with a single capacity of 2500kW is selected. Owing to the difference existing in installation method of WTGs from different manufacturers or of different models, it is largely identical but with minor differences. Therefore, the following installation method description of common WTGs is made for reference. This method features short preparation time, fast lifting and flexible application.

Installation sequence of WTGs: construction preparation –tower lifting– nacelle lifting – blade assembly – blade lifting – installation of control cabinet – cable installation – electrical connection – connection of hydraulic pipelines.

The following description of main lifting components is listed for reference.

8.5.2.1 Construction preparation

Construction plan shall be made before installation of WTGs; the plan shall be consistent with safety production regulations of Chinese codes and be approved by the Engineer.

(1) The following works shall be completed before lifting:

1) Road at WTG installation site shall be flat and smooth and be assured to provide safe access for various kinds of construction vehicles.

2) WTG installation site shall meet lifting requirement and have enough place for storage of parts.

3) Reliable safety measures shall be taken for temporary power supply at construction site.

4) Safety facilities like warning board, fence etc. shall be set at construction site if necessary.

5) Common medical articles shall be prepared at installation site.

6) Before lifting, the personnel must check parts of crane and choose lifting tools correctly.

7) Before lifting, WTG equipment shall be checked carefully to avoid dropping of parts.

8) Dedicated person must be arranged to command at the lifting site. The commander must have a certificate for lifting command and conduct specified command gestures and signals.

9) Crane operator shall be responsible for the whole lifting process. Before lifting, the rigger and crane operator shall be familiar to lifting scheme. The commander shall make the crane operator know his/her works completely.

10) When heavy fog, thunderstorm, insufficient lighting is encountered and the commander can not see each work position clearly or the crane operator can not see the commander, lifting must be halted.

11) Only a single person is allowed to climb or work at the same section of ladder within the tower.

(2) Selection of lifting equipment

WTG lifting is the key and important step for construction of wind farm project; generally, the heavy-tonnage crawler crane lifting equipment is applied and supplemented by autocrane; crane is used mainly to complete installation of three main components, i.e. nacelle, tower and blades.

Lifting equipment shall be in line with the requirements of DL408, DL409 and the *Rules on Work Safety of Power Engineering* enacted by the Ministry of Power Industry (DAS [1994] No.227).

Control parameters for selection of huge WTGs crane are hub height and weight of the largest component; for the 2.5 MW WTG in recommended scheme, it is the largest hub at height of 90m and weight of the largest component of 84.4t. Three cranes of 600t, 200t and 75t are applied to perform WTG lifting.

(3) Requirements of lifting site

The installation will be subject to joint operation of two cranes; in order to assure that crane boom will not get contacted with tower in lifting, enough space is required for crane; working space for WTGs shall not be less than 50m × 50m. Enough places are required for storage of parts, fittings or small crane at side of access road. Width of construction road in the farm shall not be less than 6m so as to assure crawler crane can pass smoothly. Figure 8.1 shows WTG lifting plan.

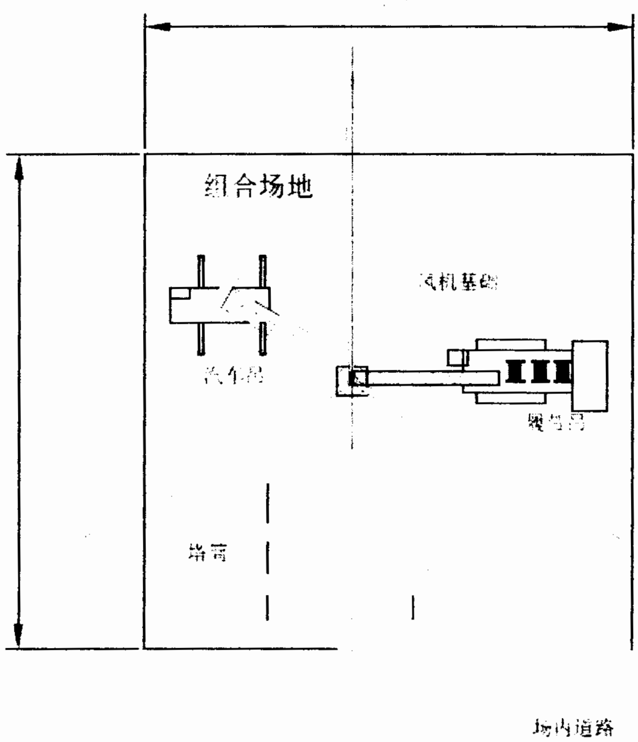


Fig. 8.1 Schematic plan for WTG lifting operation

8.5.2.2 Installation of WTG tower

In this stage, the WTG tower shall be tubular one composed of three parts, and flange plate shall be used for connecting every two parts. These tubular towers shall be transported by sections, and hoisting shall be carried out after the parts in the tower are installed at the site. When stockpiling tower at the site, the tower shall be put onto hardwood and prevented from rolling, and the stockpile area shall be plane and free from slope as possible. Tower and its parts must be inspected at the site to confirm whether they are damaged during transportation, and in order to avoid corrosion, any surface damage shall be repaired immediately and any dirt shall be cleaned.

Base shall be inspected prior to installation, the evenness of base shall be calibrated with leveling instrument, and the allowable error of tower shall be consistent with specification of the manufacturer.

The dust on foundation ring flange and residua of concrete pouring shall be cleaned before installing tower. Especially for flange position, there must be no corrosion. Abrasive paper may be used for polishing if necessary.

(1) Lifting procedures for bottom section of tower

1) Prior to lifting of the bottom section of tower is finished, installation of support and body of tower foundation control cabinet must be completed.

2) Prior to lifting, leveling instrument will be used to check elevation and levelness of foundation ring; sundries like dust, rust, and scrap iron in bolt hole of foundation ring shall be cleaned, as well as lower and upper flanges of foundation ring; sealant shall be applied on upper flange surface of foundation ring.

3) Bolts, nuts and gaskets for connection of the bottom section of tower and foundation ring will be made ready and put in foundation ring;

4) Threads of all bolts shall be applied with special lubricant.

5) Main and auxiliary cranes shall be arranged in place according to requirement of installation scheme, and lifting tools shall be made prepared. Lifting tool of main crane will be connected with upper flange of tower (evenly-distributed connection at four positions), lifting tool of auxiliary crane with one position at lower flange of tower; head of lifting tool will be hung at the main hook of main and auxiliary crane with safety pin fastened.

6) Two pulling ropes will be bound through bolt hole at lower flange of lower section of tower to adjust tower direction.

7) Main and auxiliary cranes will be lifted at the same time; when the tower is lifted away from ground, main crane continues hoisting, auxiliary crane will be used to adjust distance of end of the tower from the ground;

8) When the tower is lifted to a vertical position by main crane, lifting tools of auxiliary crane will be disassembled to make the tower down with bottom accurately in a line with flange surface of foundation ring, pulling rope will be used to adjust direction of the tower; correct position of tower entrance will be found; the tower will be turned to make it in line with bolt hole of foundation ring; then the tower will be put down, when lower section of the tower is 3 ~ 5mm from flange surface of foundation ring, hole pin can be used to fasten.

9) Bolts will be pre-tightened by electric or hydraulic spanner;

10) Then, lifting tools of main crane will be disassembled;

11) Connecting bolts for the tower and foundation ring will be tightened and the tightening torque for bolts must be consistent with requirement;

12) Earth wire connection;

13) Installation of lighting wires in the tower

(2) Lifting of middle and top sections of tower

Lifting of middle and top sections of tower is the same with that for bottom section of tower. Before lifting, upper flange surface and bolt hole of installed tower will be cleaned and bolts for flange connection will be made ready. When mane crane lifts the tower to a vertical position, lower flange surface and bolt hole of tower will be cleaned. Correct position and hole position and reliable connection will be assured in butt joint of tower.

8.5.2.3 Installation of WTGs and nacelles

WTG installation will be subject to components lifting; good weather will be chosen for installation which is not allowed in rainy day or day with wind speed more than 12m/s. According to lifting capacity of crawler crane, the nacelle can be lifted by crawler crane directly to tower top and fastened; subgrade boxes shall be laid for the supporting parts of crawler crane to increase ground contact area so that hoisting load can be dispersed and ground settlement can be prevented. When the nacelle is lifted by crane to top of upper flange of tower, pulling rope will be used to adjust direction of the nacelle to make position correct; yaw slide block is used to lead nacelle to required position. When clearance is about 10mm, vertical axis of the nacelle will be adjusted perpendicular to wind direction; tooling will be used to locate the nacelle so as to install fixing bolts; then the nacelle will be put down in place and all bolts will be tightened, ropes will be loosened; bolts will be tightened to specified torque through diagonal method for two times; yaw brake will be installed and hydraulic oil pipe will be connected.

8.5.2.4 Installation of WTG blades

Rotor blades will be installed to the hub on the ground according to technical requirements on installation; then lifting can begin. Hub and blades are assembled on the ground and blades will be supported by supports to keep level. Following assembly, special fixtures are used to clamp the hub; meanwhile, two blades will be tied with rope and top of the other one blade is placed on special movable trolley. Prior to rotor blades are installed, cleaning equipment will be used to clean blade flange and hub flange. When the hub is lifted up slowly by crawler crane, blades swing will be controlled by manual pulling of rope on the ground till blades are hoisted to the installation height; then, installation workers will get in the nacelle to finish assembly and connection.

8.5.2.5 Safety measures after lifting

In general, WTGs shall not be subject to commissioning and grid connection immediately following installation. Therefore, measures shall be taken in accordance with requirement of WTGs supplier to assure that performance of WTGs is in good condition in commissioning.

The main issues are as follows:

1) WTGs shall be locked before it is put into operation;

2) Parts of WTGs will be checked regularly for rust which shall be removed if found;

3) Before it is put into operation, stator, rotor and control equipment of WTGs will be checked regularly to determine whether they are affected with damp; if they are affected, measures like heating and dehumidification will be taken to solve such problem;

4) Before it is put into operation, both oil and water circulating systems of WTGs will be started regularly;

5) Inside of control equipment, tower and WTGs will be checked to see whether there is trace of small animals; if there is, prevention measures like blocking and killing

will be taken to solve the problem.

8.5.3 Box Transformer

8.5.3.1 Foundation construction

Foundation of box transformer will be subject to concrete. At first, the foundation will be subject to excavation of small excavator and supplemented by manual slope excavation of foundation pit; after foundation excavation is completed, foundation pit shall be cleaned and inspected for acceptance. When foundation pit is accepted, foundation will be treated according to geological condition. During foundation concrete placement, a 150mm thick C20 concrete cushion shall be placed at first; when it is set, reinforcement fixing and formwork installation can begin for placement of foundation concrete; then, equipment will be installed following concrete strength gets consistent with that required through 7 days curing.

8.5.3.2 Installation of box transformer

Capacity of box transformer selected in this Project is 2750kVA

(1) Preparation prior to installation

Cables shall be laid before box transformer is in place and be proven without electricity through inspection.

Products shall be checked for damage, deformation and break through opening the box. Completeness of accessories and special tools will be checked in terms of packing list, and they will be installed in line with requirement after no error is found.

(2) Installation of box transformer

There is hook near the box top for assembling and disassembling; degree between wire rope under tensile status and vertical line shall not exceed 30°; if necessary, transverse post will be used to support wire rope to prevent structure of box transformer or lifting hook from deformation. Most of the weight of box transformer is from the transformer in package equipped with iron core, winding and insulation oil; most of the HV and LV terminal box is empty and the weight is relatively low; improper use of hook or crane may cause damage to box transformer or its accessories or bring injury to personnel. After installation, it will be connected to test cable plug and be tested according to relevant test regulations of Chinese codes.

Because specific model and manufacturer of box transformer will be finally determined after bidding in construction period, the installation method will be revised in construction period according to requirement and instruction of the Manufacturer.

8.5.4 132kV Step-up Substation and Monitoring Center

8.5.4.1 Construction technical requirements and installation works quantity of electrical equipment

(1) Construction technical requirements of electrical equipment

Construction technical requirements of electrical equipment will be in line with China's relevant standards, details are as follows:

1) *Code for Construction and Acceptance of Switchboard Outfit, Complete Cubicle and Secondary Circuit Electric Equipment Installation Engineering (GB50171-2012);*

2) *Erection Works of Electrical Installations - Code for Construction and Acceptance of Power Transformers, Oil Reactor and Mutual Inductor (GBJ148-90);*

3) *Code for Construction and Acceptance of Cable System Electric Equipment Installation Engineering (GB50168-2006);*

4) *Code for Construction and Acceptation of Electric Lighting Device & Electric Equipment Installation Engineering (GB50259-96);*

5) *Code for Construction and Acceptance of Grounding Connection & Electric Equipment Installation Engineering (GB50169-2006)*

(2) Work quantity for installation of main electrical equipment

1) MV power transmission and transformation equipment and installation

2750 kVA box transformer	20 sets
Earthing of wind farm	1item

2) HV power transmission and transformation equipment and installation

50MVAvoltage regulation transformer	3 sets
20MVar reactive compensation device	2 sets
HV switchgear	17 panels
Earthing works	1item

3) LV power transmission and transformation equipment and installation

Station transformer	2 sets

4) Central monitoring system equipment and installation

Wind farm monitoring system	1 set

(3) Installation of main transformer

Fig.8.3 remarks the main transformer installation.

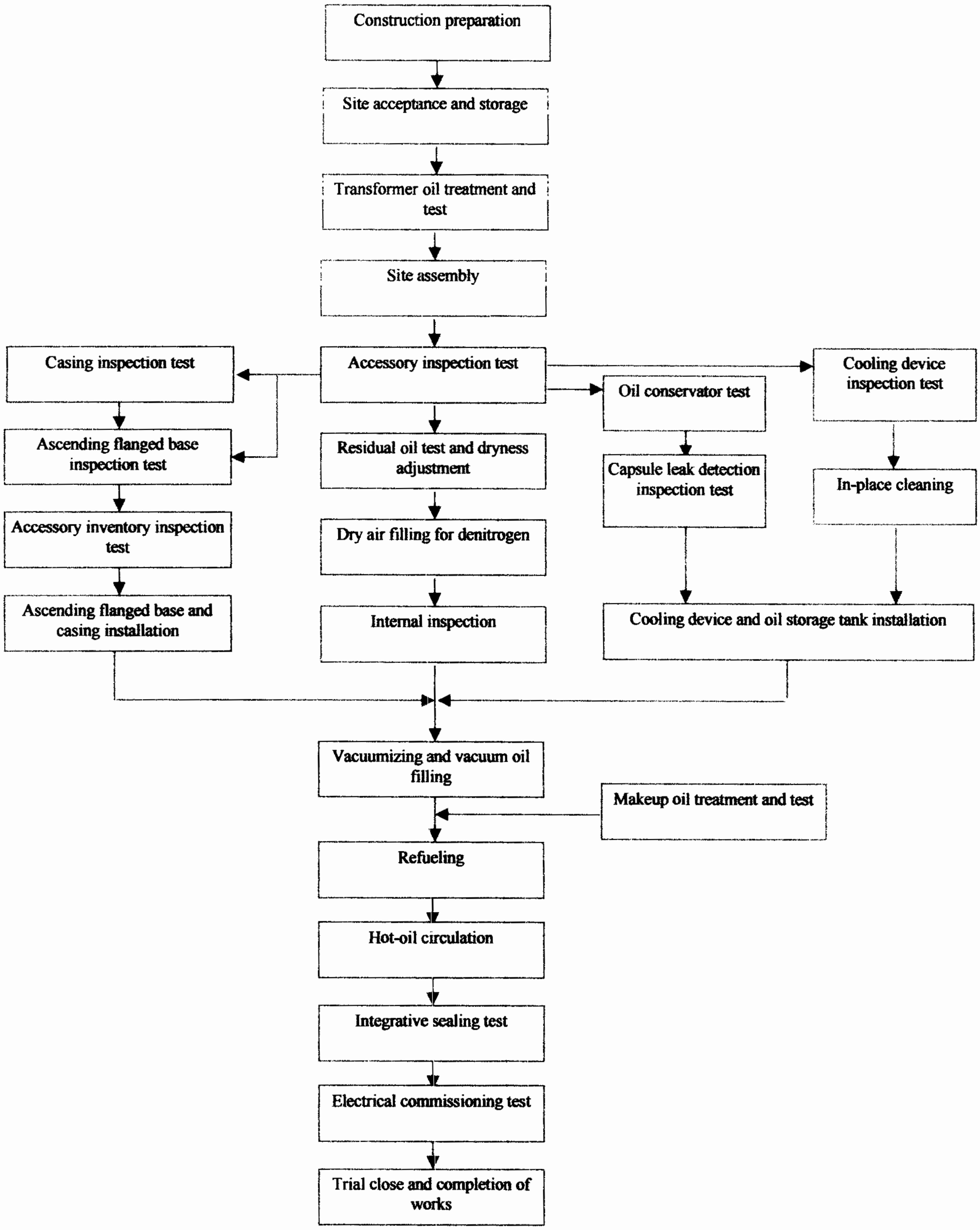


Fig.8.2 Installation process flow of main transformer

(4) Installation of sulfur hexafluoride circuit breaker

Fig.8.4 shows installation process flow diagram of sulfur hexafluoride circuit breaker.

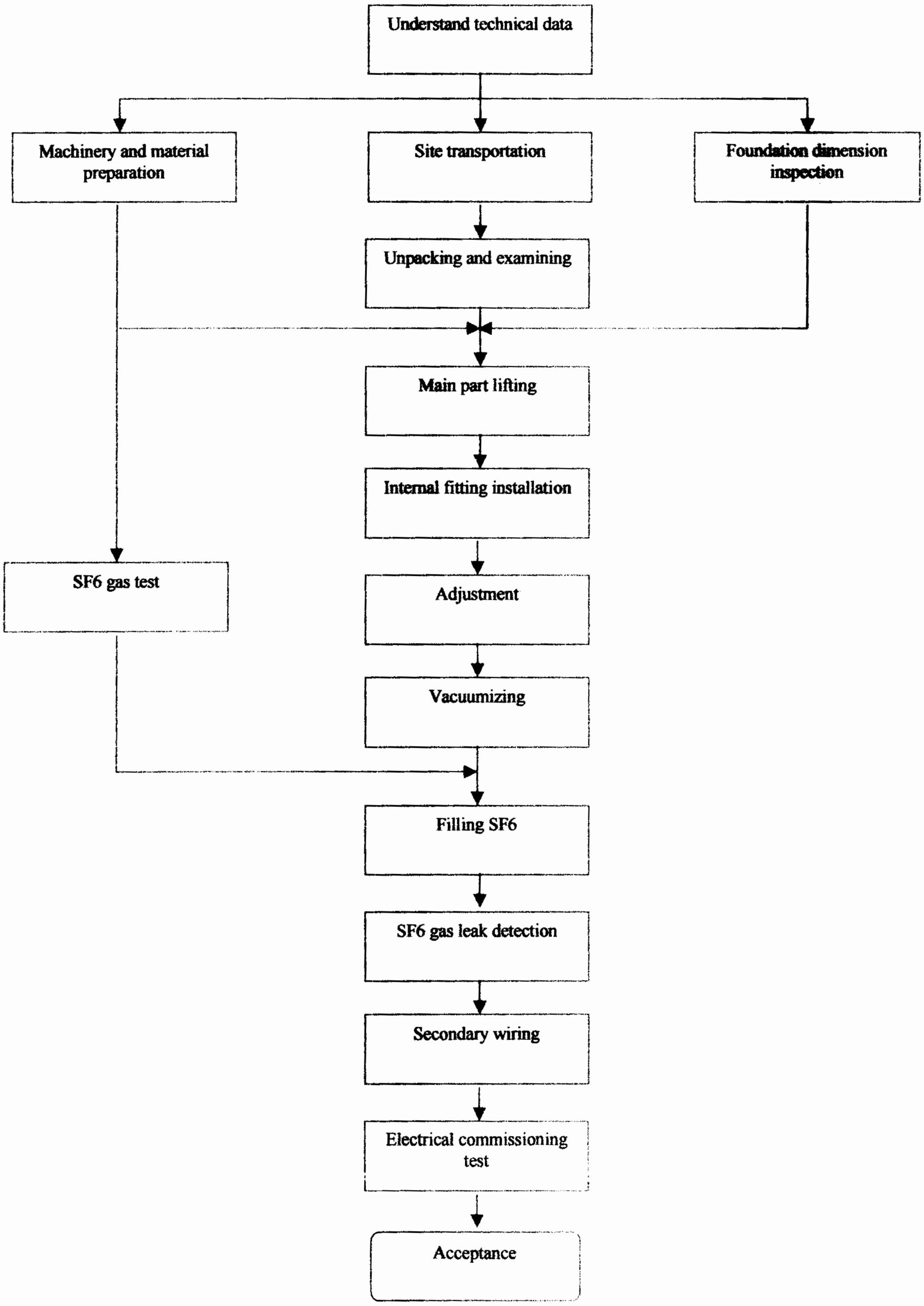


Fig.8.3 Installation process flow of sulfur hexafluoride circuit breaker

(5) Tubular bus installation

Fig.8.5 indicates installation process flow diagram of tubular bus

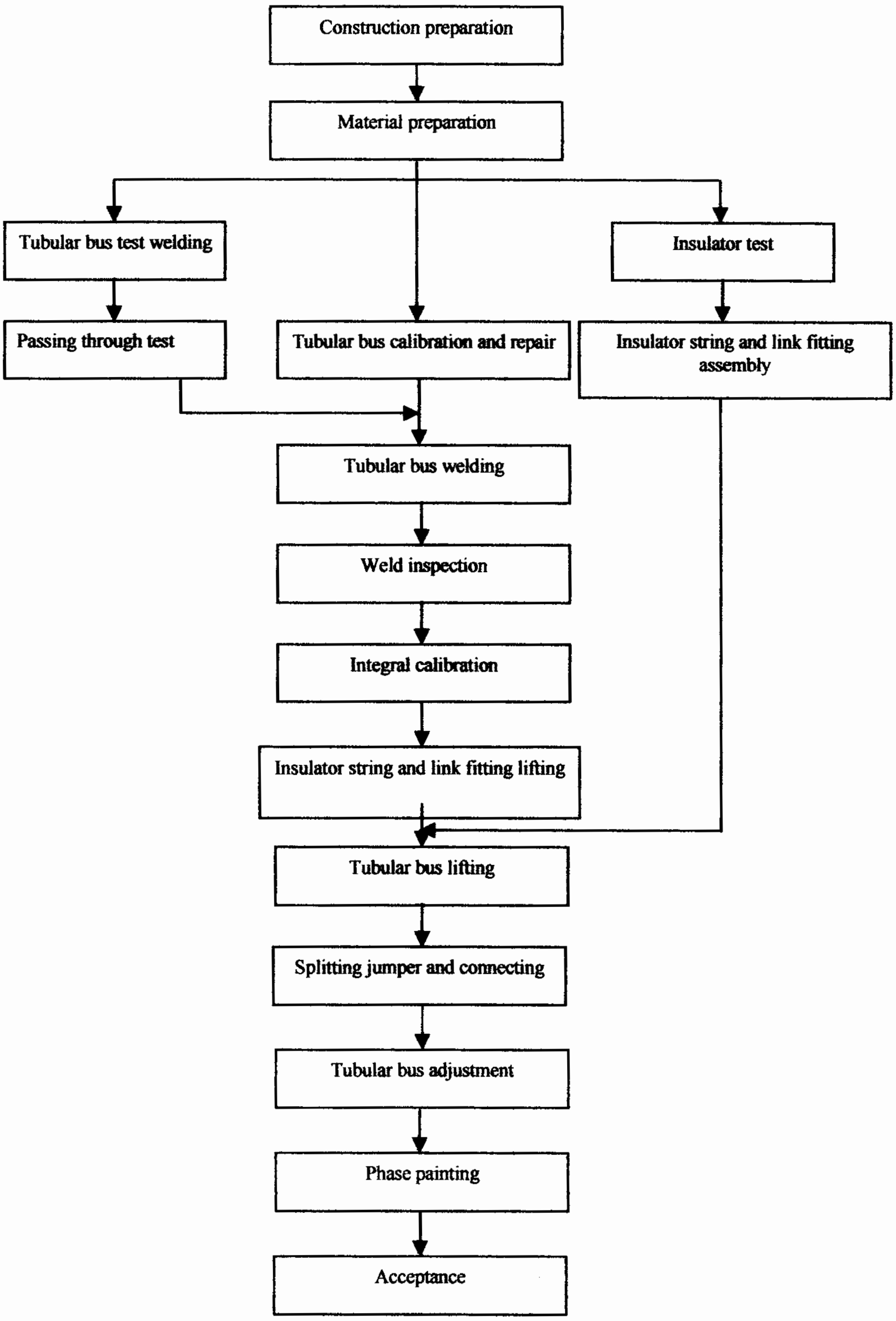


Fig.8.4 Installation process flow of tubular bus

(6) Installation of disconnector

Fig.8.6 reveals installation process flow diagram of disconnector.

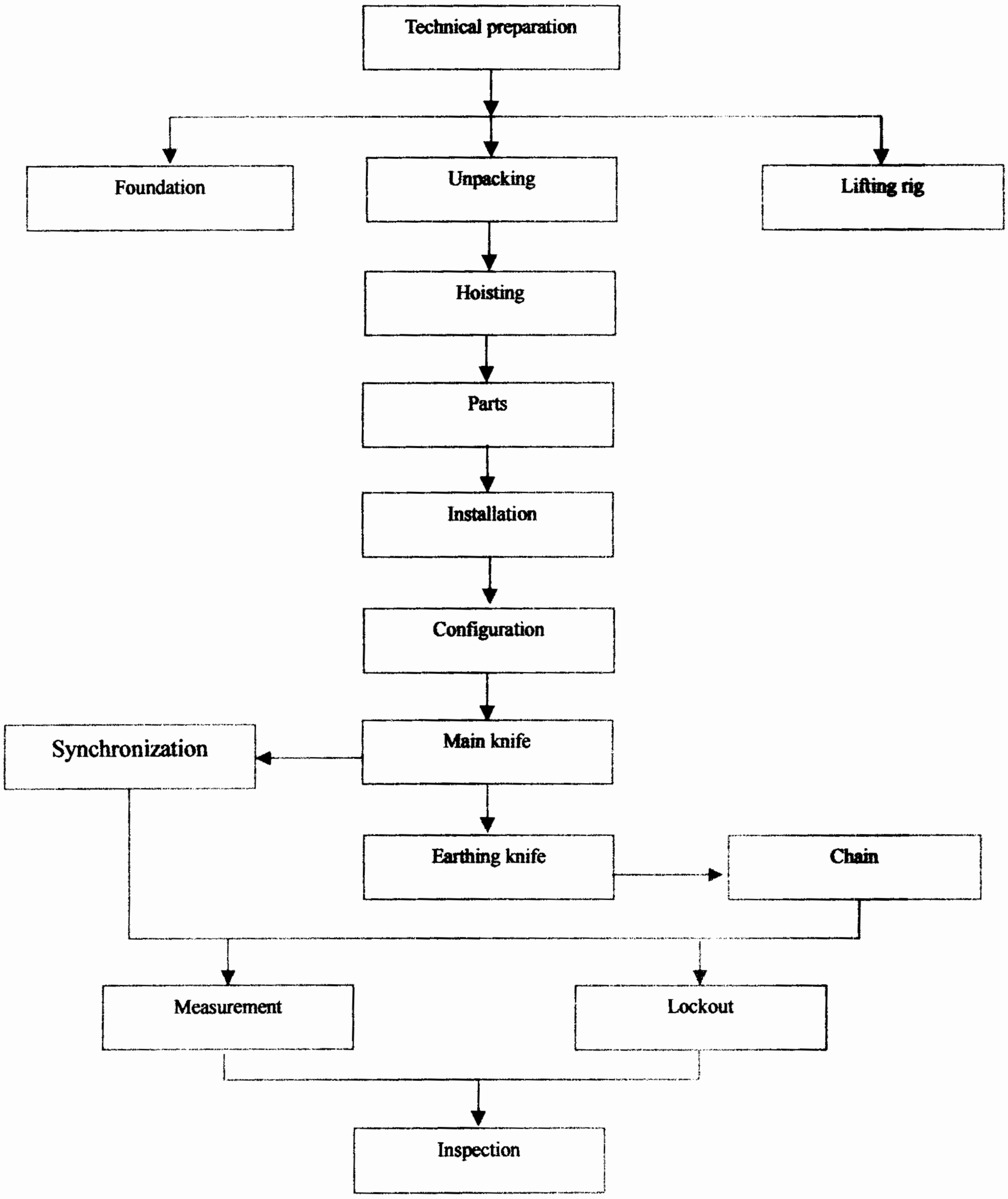


Fig.8.5 Installation process flow of disconnector

(7) Fig.8.7 shows installation process flow diagram of high voltage switchgear

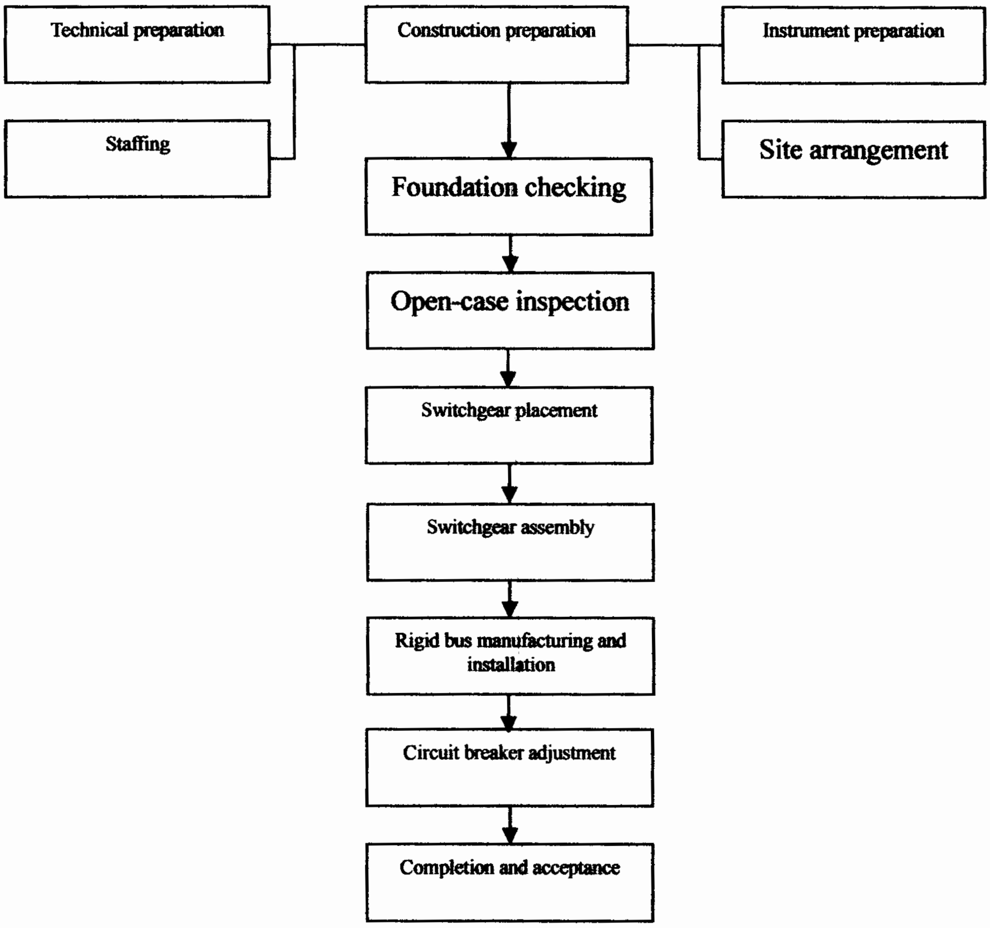


Fig.8.6 Installation process flow of HV switchgear

(8) Cable laying and secondary wiring construction

Fig.8.8 indicates construction process flow chart of cable laying and secondary wiring.

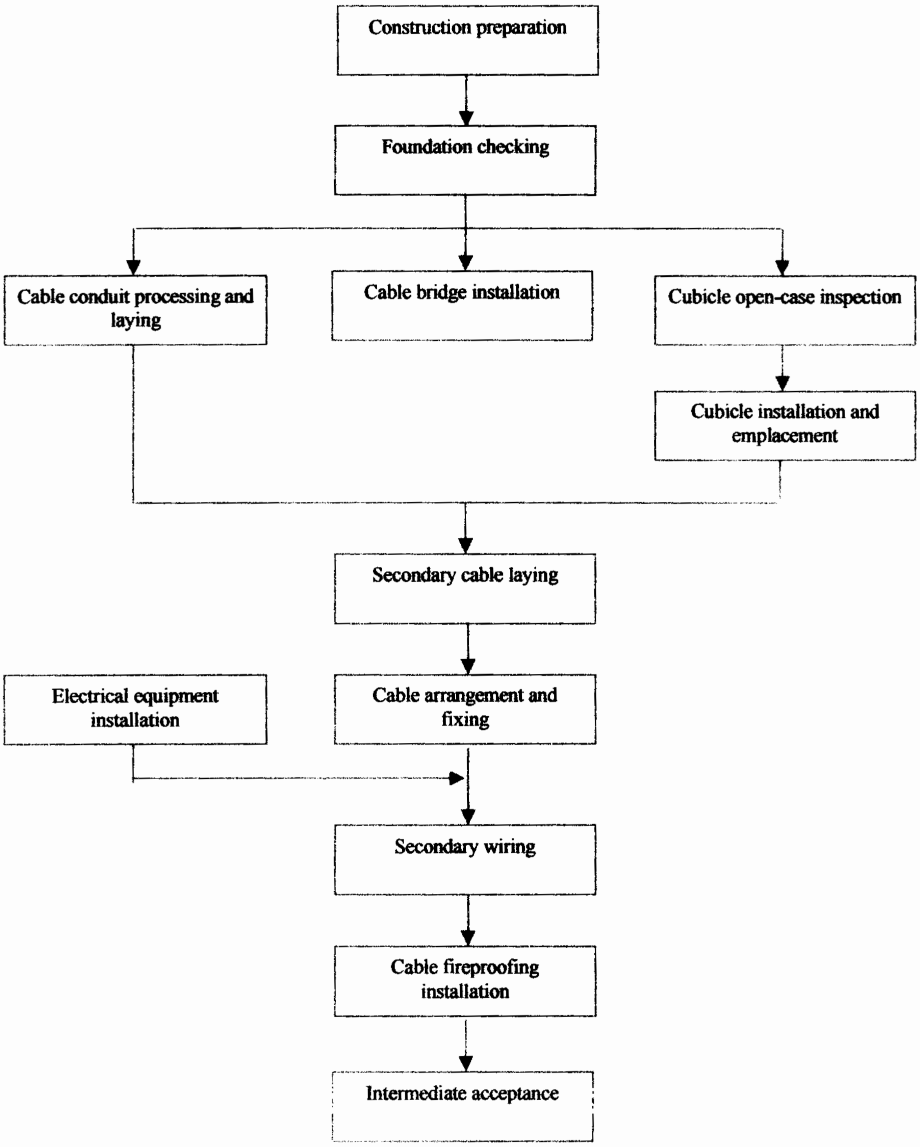


Fig.8.7 Construction process flow of cable laying and secondary wiring

8.5.4.2 **Construction of main structures**

(1) Control and complex buildings

It is proposed to apply frame structure to the control building and the complex building, with cast-in-situ reinforced concrete floor, roof plate and the independent foundation under column. Construction sequence of the structures is: construction preparation – foundation pit excavation – foundation concrete placement – foundation pit backfill – concrete placement of column, beam and slab – wall masonry – indoor and outdoor decoration and construction of water supply and drainage system – indoor installation and debugging of electrical equipment.

Floor of the buildings shall all be tiled floor except those in the communication room and central control room with anti-static floors, with colored coating sprayed on the exterior wall surface. External thermal insulation with XPS boards shall be applied to heat insulation of the exterior wall.

(2) Power distribution device area of 132kV step-up substation

Foundation of 132kV power distribution device area is subject to concrete structure; the concrete is processed by site mixing plant and building construction is subject to conventional method. Construction of 132kV power distribution device area: foundation trench soil is subject to mechanical excavation (including underground cable trench between foundations). Reserved 30cm original soil in the trench will be manually excavated; foundation concrete placement, masonry, sealing and earth backfill of underground cable trench wall will start following the trench is proven qualified through inspection. Construction of pipe ducts and embedded pipes will be completed, as well as laying and installation of pipelines; attention shall especially be paid to underground HV and LV cables of the substation and concealed works of pipe ducts so as to fulfill arrangement and passage of various kinds of pipelines. Formwork, support concrete, embedded parts and reserve holes shall be measured in concrete placement to solve any deformation and displacement (if found) in time and assure quality. Concrete shall be subject to curing within 12h after placement; it shall not be tramped and formworks and supports shall not be removed when concrete strength is less than 1.2N/mm^2

The substation framework will be lifted in place by crane; connection between column base and foundation is subject to cup-inserted type. After the framework is in place, wind rope will be applied to assure its stability, and then fine-aggregate concrete will be placed to fix it. When curing period of concrete ends, temporary fixing facilities will be removed.

8.5.4.3 Main construction machinery

The wind farm is designed with 20 WTGs and has an installed capacity of 50MW with a construction term of 18 months. According to decentralization characteristics of the wind farm construction, the construction shall be performed based on centralization and decentralization principle. As the construction term is relatively short, additional construction machinery shall be provided to meet requirement of construction strength. Table 8.3 indicates the main construction machinery.

Table 8.3 Main construction machinery of the proposed scheme

No.	Item	Specification	Unit	Quantity.
1	Crawler crane	650t	set	1
2	Truck crane	200t	set	1
3	Truck crane	75t	set	1

No.	Item	Specification	Unit	Quantity.
4	Concrete batching plant	HZS60	set	2(one in use one in standby)
5	Concrete mixing carrier	$10m^3$	set	7
6	Concrete pump truck	Arm length 30m	set	2
7	Tractor-trailer group	40t		2
8	Tractor-trailer group	60t		2
9	Concrete mixer	400L	set	4
10	Mortar mixer	JI-200	set	6
11	Water truck	8000L		6
12	Internal combustion road roller	15t		1
13	Steel-bar straightener	Not more than φ14	set	2
14	Steel bar cutter	Not more than φ40	set	2
15	Steel bar bender	Not more than φ40	set	2
16	Diesel generator	300Kw	set	2
17	Diesel generator	15kW	set	3
18	Backhoe shovel	$1.5m^3$	set	2
19	Embedded vibrator	CZ-25/35	set	32
20	DC welder		set	4
21	Crawler dozer	165kW	set	1
22	Wheeled loader	$3.0m^3$	set	2
23	AC welder		set	6
24	Dump truck			5

8.6 Overall Construction Schedule

8.6.1 Principles of Preparation

Construction method statement is prepared in accordance with conditions of construction, resources, technology and economy in the wind farm so as to make principled arrangement for construction of main works in the wind farm, provide basis for construction bidding of the Project and determine basic direction for construction scheme of unit works.

(1) Construction of temporary living facilities shall be carried out at first, and then the construction of production facilities

At first, working and accommodation demand of construction personnel is to be met; it requires building working and living facilities at priority so as to meet management need, improve working efficiency and reduce management expense.

(2) Construction of 132kV step-up substation (including monitoring center) shall be carried out in advance

Construction of production facilities shall make generation of the first WTG; as well as transmission of 132kV step-up substation (including monitoring center); then, commissioning of each WTG will be carried out for being put into operation and obtaining investment benefits as early as possible.

(3) Construction of other works

When construction organization principle of the aforementioned (1) and (2) is assured, works like foundation treatment of WTGs, concrete foundation etc. can be conducted at the same time and in parallel. Its sub-items may be subject to flow process to accelerate the construction progress and ensure the construction period.

(4) Determination of WTGs mobilization and lifting time

Manufacturing and processing of towers in China takes about 6 ~ 8 months and successive supply is possible; manufacturing and supply period of WTGs requires about half a year; another half year is taken by shipping; so stage-wise and batch-wise supply are required by reasonable construction procedures. Preparation for lifting equipment shall be finished before arrival of the first batch of equipment.

8.6.2 Construction Schedule

The installed capacity of the Project is 50MW with installation of 20 WTGs and an entire construction period of 18 months; it shall be completed in two years. **Work quantity to be completed in the first year (Oct. ~ Dec., 3 months) includes:** ①
acquisition, bidding document preparation), ②
contract, ③ **Work to be completed in the second year (Jan. ~ Dec., 12 months)**: ①construction of access roads and construction road in the wind farm, ②geological survey, ③delivery of WTGs, ④
purchase contract, ⑤manufacture of tower foundation ring, ⑥design of electric engineering drawing, ⑦bidding of installation works and contract signing, ⑧installation of WTGS, ⑨ civil work design, bidding and construction, ⑩construction of earthing works, central control center bidding, construction and acceptance, installation debugging and acceptance of some WTGs and monitoring system. **Work to be completed in the third year (Jan. ~ Mar.):** installation debugging and acceptance of all WTGs and monitoring system; all WTGs shall be put into production.

According to climate conditions in JHAMPIRE wind farm area, a whole-year civil works construction is allowed due to nonexistence of ice period and cold period. Therefore, sub-item construction schedule is arranged as follows:

(1) Construction of preparation works: it lasts from October of the first year to January of the second year; water supply, power supply, road construction and site leveling as well as construction of temporary facilities will be completed.

(2) Construction installation of 132kV step-up substation and monitoring center: civil works will last from June of the second year to October of the second year.

(3) Civil works construction of WTGs and box transformer: foundation excavation and placement construction of 20 WTGs and box transformer will be completed from April of the second year to August of the second year.

(4) Shipping and arrival times of WTGs: the shipping period of WTG is from May of the second year to October of the second year, and products will arrive during August of the second year to November of the second year successively.

(5) Installation of WTGs: WTGs and tower will be installed after foundation construction is completed; it is arranged in September of the second year to December of the second year.

(6) Installation of box transformer and current collection lines: power collecting lines will be used to connect WTGs to 132kV step-up substation. Lying of the lines is subject to direct burial and is arranged in May to August of the second year.

(7) Debugging of WTGs and monitoring system: this is arranged from January to March of the third year.

The total construction period is 18 months, including 3 months for construction preparation and 15 months for construction of the main works. All WTGs will be connected to the grid for generation in the 18th month. Refer to Attached Drawing 4 for overall construction schedule.

9 BUDGET ESTIMATE

9.1 Description of Preparation

9.1.1 Project Profile

Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") project is located in Jhampir of Sindh Province, about 110km to the northeast of Karachi city and 80km to the of Port Qasim. The zonal project area stretches in nearly northwest-southeast direction, with a length of about 6.7km and width of 1.6km. The ground elevation of the project site is 40m~60m or so.

20 WTGs with unit capacity of 2.5MW and total installed capacity of 50MW are planned for the Project. The project consists of WTGS, towers, box-type transformers, buried cables, access roads within the site, one 132kV step-up substation and monitoring center.

Construction period of the project is 18 months.

Capital source: cash capital accounts for 30% of the gross investment and the other 70% shall be collected through bank loan.

9.1.2 Total Project Budget Estimate

Table 9.1 Total Project Budget Estimate

Unit: 1.0USD

No.	Description	Equipment purchase expense	Construction and installation expenses	Miscellaneous expenses	Total	Percentage
I	Auxiliary works for construction		459,545.17		459,545.16	0.38%
1	Traffic works for construction		111,592.70		111,592.70	
2	Power supply works for construction					
3	Water supply works for construction		35,801.07		35,801.07	
4	Other auxiliary works for construction		312,151.40		312,151.40	
II	E&M equipment and installation works	77,174,322.47	3,922,190.75		81,096,513.22	67.79%
1	Power generation equipment and installation works	66,150,786.91	2,871,010.39		69,021,797.30	
2	Step-up transformer equipment and installation works	3,059,563.27	235,121.97		3,294,685.24	
3	Control equipment and installation works	1,093,057.92	189,738.75		1,282,796.66	
4	Other equipment and installation works	890,759.36	626,319.64		1,517,079.00	
5	Freight and miscellaneous expenses of equipment	5,980,155.02			5,980,155.02	
III	Civil works		10,671,523.45		10,671,523.45	8.92%
1	Wind farm works		7,069,213.88		7,069,213.88	

No.	Description	Equipment purchase expense	Construction and installation expenses	Miscellaneous expenses	Total	Percentage
2	Step-up transformer works		152,050.68		152,050.68	
3	Building works		1,994,628.58		1,994,628.58	
4	Traffic works		685,180.20		685,180.20	
5	Miscellaneous		770,450.11		770,450.11	
IV	Other Expenses			11,211,023.76	11,211,023.76	9.37%
1	Project construction land use expense			807,904.47	807,904.47	
2	Project construction management overhead			6,556,053.67	6,556,053.67	
3	Operation preparatory expense			467,188.39	467,188.39	
4	Investigation and design expense			1,384,954.36	1,384,954.36	
5	Miscellaneous taxes and dues			1,994,922.88	1,994,922.88	
	Total of I ~ IV	77,174,322.47	15,053,259.36	11,211,023.76	103,438,605.61	86.47%
V	Contingency cost				5,171,930.28	4.32%
	Total project static investment (I ~ V)				108,610,535.89	90.79%
VI	Price difference contingency				610,963.96	0.51%
VII	Financing cost				10,409,048.63	8.70%
1	Interest during construction period				7,613,951.05	6.36%

No.	Description	Equipment purchase expense	Construction and installation expenses	Miscellaneous expenses	Total	Percentage
2	Financing charges				1,069,686.81	0.89%
	Management fee for loan				733,324.68	0.61%
	Loan commitment fee				336,362.14	0.28%
3	Overseas investment insurance				1,725,402.11	1.44%
VIII	Total project investment (I ~ VII)				119,630,548.47	100.00%
	Static investment per kilowatt (USD/kW)				2,172.21	
	Dynamic investment per kilowatt (USD/kW)				2,392.61	

9.2 Principles and Basis of Preparation

9.2.1 Principles

The preparation is conducted in accordance with laws, regulations and system of Pakistan with reference to existing documents, regulations, fees quota and rate standards and price level of the fourth quarter in 2016 of China.

9.2.2 Basis of preparation

1. Method for the preparation of budget estimate, calculation basis and quota of Chinese wind farm projects and local actual conditions of the Project;
2. Laws, regulations and policies in respect of economic relationship development between China and Pakistan;
3. Guidelines on Investment Cooperation in Foreign Countries & Regions (2014) - Pakistan;
4. Design Documentation of Norinco International Thatta Phase-II 50MW Wind Power Project ("Norinco-2") project;
5. Supplementary requirements on investment composition in the feasibility study report by NORINCO INTERNATIONAL (March 27, 2015);
6. Related boundary conditions of dynamic investment & financing and insurance of NORINCO INTERNATIONAL (September, 10, 2015);
7. Other information collected concerning the Project;

9.3 Project Construction Land Use Expense

Pursuant to Pakistan local government's regulations, the expense is charged on the basis of 3000 Rupees/sq.yd./year during the 1st ~ 10th year, 5000 Rupees/sq.yd./year during the 11th ~ 20th year and 8000 Rupees/sq.yd./year during the 21st ~ 30th year.

9.4 Price and Freight of Main E&M Equipment

(1) Price of main E&M equipment (FOB)

The prices of WTGs, tower barrels and other electrical equipment are determined with reference to the existing price level in China and characteristics of international projects.

(2) Freight and miscellaneous expenses of main E&M equipment

The freight includes ocean freight, port incidentals, customs clearance fees (including Port Tianjin in China and Port Qasim in Pakistan) and road freight in Pakistan.

(3) According to the laws and regulations of Pakistan, the budget estimate does not take into account the import duty of the E&M equipment to Pakistan.

9.5 Financing Expense

1. According to Regulations of Pakistan's Wind Power Development Policy, no customs duty and sales tax is imposed on mechanical equipment and spare parts (including construction machine, equipment and temporary importation of dedicated vehicles), therefore, this is excluded from the budget estimate.

2. Pursuant to Sustainable Energy Development Policy of Pakistan, the transmission and distribution of electric power is subject to National Power Transmission and Distribution Company in Pakistan, and electricity purchasers are held accountable for power transmission and electricity purchase from step-up substation of wind farm, hence, the cost of power transmission works is not reckoned in the budget estimate.