The Registrar
National Electric Power Regulatory Authority
2nd Floor, OPF Building,
Sector G-5/2,
Islamabad

SUBJECT: Application for a Generation License for Noor Solar Energy (Pvt.) Limited 50 MW Wind Power Project

I, **Tanveer Ahmed**, the **Technical Director**, being the duly authorized representative of Noor Solar Energy (Pvt.) Limited by virtue of Board Resolution dated February 07, 2017 hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to Noor Solar Energy (Pvt.) Limited pursuant to Section 15 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 (**"AMPR"**), 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.

A Bank Draft in the sum of **292,896/=**, being the non-refundable license application fee calculated in accordance with Schedule II of the AMPR, is also attached herewith. Further, additional documents/information, pursuant to the AMPR, are attached herewith.

Mr. Tanveer Ahmed
Technical Director
Noor Solar Energy (Pvt.) Limited

NOOR SOLAR ENERGY (PVT) LTD. KARACHI

Noor Solar Energy (Pvt.) Limited

A/51-A, S.I.T.E., Karachi-75700 Pakistan.
Tel: (92-21) 32578100-16 (17 Lines),
Fax: (92-21) 32564600-32561050
E-mail: liberty@libertymillslimited.com

OTHER GROUP COMPANIES
Liberty Mills Limited
Liberty Power Tech Limited – IPP (200 MW)

Extracts from
Resolution Passed by the Board of Directors of
OF Noor Solar Energy (Private) Limited

On February 7, 2017

"**RESOLVED** that an application for the Generation License (the "**GL Application**") be filed by and on behalf of Noor Solar Energy (Private) Limited (the "**Company**") with the National Electric Power Regulatory Authority ("**NEPRA**"), in connection with the GL Application for the Company in respect of the Company's 50 MW wind energy power project at Jhimpir, Sindh (the "**Project**").

RESOLVED FURTHER that Mr. Tanveer Ahmed the Technical Director of the Company, be and is hereby authorized to sign the GL Application, and any documentation ancillary thereto, pay all filing fees, and provide any information required by NEPRA in respect of the Project, and do all acts and things necessary for the processing, completion and finalization of the GL Application.

NOOR SOLAR ENERGY (PVT) LTD. KARACHI

Certified true copy

Company Secretary
Noor Solar Energy (Private) Limited

CERTIFICATION

CERTIFIED, that, the above resolution by circulation was duly passed by the Board of Directors of Noor Solar Energy (Private) Limited on May 14, 2016 for which the quorum of directors was present.

FURTHER CERTIFIED, that the said resolution has not been rescinded and is in operation and that this is a true copy thereof.

NOOR SOLAR ENERGY (PVT) LTD. KARACHI

Company Secretary
Noor Solar Energy (Private) Limited

APPLICATION FOR THE GRANT OF A GENERATION LICENSE UNDER SECTION 15 OF THE ACT AND REGULATION 3 OF THE AMP REGULATIONS

1. NEPRA's Participation in the Process

1.1. Section 15 of the Regulation of Generation, Transmission, and Distribution of Electric Power Act, 1997 (the "**Act**") provides, *inter alia,* that:

> *"(1) No person except under the authority of a license issued by the Authority under this Act and subject to the conditions specified in this Act and as may be imposed by the Authority, construct own or operate a generation facility.*
>
> *(2) An application for the grant of a license for a generation facility shall specify-*
>
> *(i) the type of facility for which the license is applied;*
>
> *(ii) the location of the generation facility; and*
>
> *(iii) the expected life of the generation facility."*

1.2. Furthermore, Regulation 3 of the National Electric Power Regulatory Authority (Application and Modification Procedure) Regulations, 1999 (the "**AMP Regulations**") provides that an application for a license shall be made in the form specified in the AMP Regulations and further enumerates the documents required to be submitted to the Authority along with the requisite application.

1.3. This Application for the grant of a generation license is made pursuant to Section 15 of the Act and Regulation 3 of the AMP Regulations (this "**Application**").

2. Introduction of the Applicant/Sponsor

2.1. As required under the Section 24 of Act Noor Solar Energy (Pvt.) Limited (the "**Applicant**" or the "**Company**" or the "**Project Company**") is a private limited company incorporated under the Companies Ordinance, 1984, to act as a special purpose vehicle (the "**SPV**") and develop a 50 MW wind power

generation facility located at Jhimpir, District Thatta, Province of Sindh (the "**Project**"). The constitutive documents, other pertinent details of the Applicant and description of the Project are annexed herewith as **Annex- A** hereto.

Sponsors- Liberty Mills Limited & Individuals of Mukaty Family (liberty Mills Sponsors)

2.2. By way of background and introduction, Liberty Mills Limited (the "**Sponsor**"), established in the year 1962 by Mr. Salim N. Mukaty enjoys leading positions in textile sector of Pakistan. The Sponsor is now one of the largest manufacturers and exporters of textile goods in Pakistan having state of the art processing unit producing 66 million meters fabric annually. Located in the industrial heart of Karachi, it is today one of the largest textile processing units in Pakistan. The whole production is exported directly and indirectly to customers who include vendors of internationally recognized brands and departmental stores. Its substantial foreign remittance through export business has been greatly contributing towards national exchequer.
Liberty Mills Limited and its Sponsors have also established 200 MW RFO based Power Plant in Faisalabad. The said Power Plant has been running under the name of Liberty Power Tech Limited and supplying uninterrupted electricity to National Transmission and Despatch Company Limited. Detailed Profile of Liberty Power Tech Limited is attached as Annex

3. The Project Overview

3.1 Project Company

3.1.1 The Company is developing its Project under the NEPRA Upfront Tariff regime. The Letter Of Intent (the "**LOI**") has been awarded by Directorate of Alternative Energy (the "**DAE**"), Energy Department Government of Sindh to the Noor Solar Energy (Pvt.) Limited dated August 28, 2015. The Project Company is diligently working towards the early implementation of the Project. The Project Company proposes to design, engineer, construct, insure, commission, operate and maintain the Project. The construction of 50 MW wind power plant on Gamesa G114-2.0MW technology (briefly explained in Para 8) will take approximately 18 Months from the issuance of notice to proceed to the project contractors, so that plant commissioning is expected in the 2nd Quarter of 2018. The LOI for this Project is annexed as **Annex-B** hereto.

3.1.2 The Project Company will develop, own and operate a 50 MW wind farm as an independent power project (the "**IPP**") in Sindh. The Project Company shall develop wind farm and the sub-stations while CPPA will be the purchaser of power and NTDC will evacuate the power from project door step.

3.2 Issuance of "Letter of Intent"

3.2.1 The project development phase has recently started after getting the Letter of Intent (LOI) from Directorate of Alternative Energy, Energy Department Government of Sindh and land allocation from Government of Sindh (GoS) on January 14, 2016.

3.2.2 Although the Applicant will opt for the Upfront Tariff and as such all risks associated with the Project are to be borne by the Applicant, nevertheless, the Company has undertaken various studies to assess the feasibility of the Project. These studies *inter alia* include the following:

a. Wind resources assessment;
b. Geo technical investigation;
c. Digital topographic map;
d. Initial environmental examination; and
e. Grid interconnection study. (Attached)

A complete feasibility study that has already been submitted by the Project Company to DAE, Government of Sindh is annexed as **Annex-C** hereto.

4. Power Purchaser

4.1. The electricity generated from this Project would be supplied to Central Power Purchasing Agency (Guarantee) Limited. The power generated by the Project will be sold for the term of 20 years under the standard Energy Purchase Agreement (the "EPA") starting from commencement of commercial operations.

5. Site

5.1. The proposed Project site is located at Jhimpir, District Thatta, Province of Sindh, Pakistan (the "**Site**"). The Site proposed for the implementation of the Project has been selected by considering the following:

a. Location in the wind corridor;
b. Wind conditions at the Site;
c. Topographic conditions;
d. Site accessibility; and
e. Location of the grid with reference to the Site for interconnection.

5.2. The Site is located within the wind corridor identified by DAE, GOS. As already mentioned above the Site is located in Jhimpir, District Thatta, Sindh, which is one of the most promising areas where wind power projects can be viably installed. The Project's wind farm site is located 138 KM from Port Qasim Karachi in the East direction with easy road access. Nooriabad Industrial Estate (situated on the M9 motorway connecting Karachi and Hyderabad) is 35 KM from the wind farm.

5.3. This Land Description of the Project Site:

NOOR Solar Energy (Pvt.) Limited, 50MW Wind Power Project			
S.no	Details	Long	Lat
1	330 Acres	24.900817	67.793202
2		24.901968	67.793978
3		24.943312	67.718515
4		24.94443	67.719293

5.4. The Project Site is exposed to very strong westerly winds, wind data analysis of the area suggests that, 80% wind blows from the south west direction. The terrain of the area is flat with small change in altitude. The proposed site lies under roughness class 1.5 as there is low vegetation. The site is easily accessible through

roughness class 1.5 as there is low vegetation. The site is easily accessible through metallic roads. The ground is hard and rocky; the subsurface soil also includes clay and silt.

5.5. The proposed wind farms lies on a flat inland area with hard and rocky ground conditions. The site would be categorized as inland wind development as opposed to offshore/coastal wind project development (which is more difficult to develop due to tides and soft subsoil clay). The general terrain at the site can be described as simple and flat terrain. Internal access roads are the roads connecting the single wind turbine locations with each other and the external access roads and grid station would be constructed during the civil works of the wind farm. The general layout of 50 MW NSEPL and neighboring wind farms is shown in figure below:

Wind Farms Layout at the Project Site

The wind farms site is in long and narrow in shape, the topography is relatively flat and the elevation above sea level is approximately 37-97m. There is little vegetation at the wind farm site.

Topographical and Geological Conditions at Project Site

Topographic conditions

The Site is on a plain area at an elevation of 37-97m, which is generally flat, but a bit higher on the west and lower on the east. The landform at wind farm sites is mainly of pediment and the vegetation there is less developed.

Geological conditions

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

Hydrology

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

The Site Map and other pertinent details regarding the project site is annexed Annex- **E** hereto.

6. Operations & Maintenance Arrangement

6.1. For the purpose of designing, engineering, procuring, constructing, installing, testing, completing, commissioning, operation and maintenance of the Project, the Project Company has signed the 'Heads of Agreement' with 'Gamesa Wind (Tianjin) Co. Ltd.,' and 'Orient Energy System (Pvt) Ltd.,' on February 26, 2016.

6.2. With 20 years' experience, Gamesa is a global leader in the design, manufacture, installation and maintenance of wind turbines, with over 28,800

MW installed in 43 countries across five continents. Operation & Maintenance (O&M) is one of the key activities upon which Gamesa bases its development, having 70% of its fleet under an Operation & Maintenance contract thanks to an expansion of this activity in over 30 countries.

6.3. Backed by 20 years of experience in wind turbine O&M and optimization, Gamesa continues to be committed to adding value, offering cutting edge solutions, such as the useful life extension, integral solutions for the O&M of other manufacturers' wind turbines, and personalized financing options to meet the needs of each customer. Gamesa focuses intensively on programs for maximizing energy production, improving availability and reducing O&M related costs, with the goal of decreasing energy costs by 30%.

Information regarding Operation & Maintenance is appended herewith as **Annex-F.**

7. Financing

7.1. The Project Company will own the 25% of equity while for the remaining financing arrangements will be explored from International Lenders or local Banks or a consortium of International lenders or local Banks and the selection of financing source, mode and mechanism will be based on financial models. Currently the project cost is estimated to be around USD 110.250 million. The project is expected to produce 153.3 GWh of electricity and the electrical power produced by this farm will be purchased by CPPA and distributed on national grid by NTDC.

7.2. The Project is intended to be financed by debt-equity ratio of 75:25.

8. Selection of Technology

8.1. The proposed wind farm contains 25 Gamesa G114-2.0MWCIIA Wind Turbines at 80m hub height for the Company's Wind Power Project. The output of the farm will be 50 MW with capacity fact or not less than 35%. The project construction timeline will be around 18months after issuance of Notice to Proceed (NTP) with 4 months Pre-NTP. The WTG is sourced from world renowned wind turbine manufacturer, GAMESA Corporation with a total of 21

years of experience and more than 31.2 GW capacity installed around the world. GAMESA is the world technology leader in Wind Power.

Specifications of G114-2.0 MW CIIA Wind Turbine

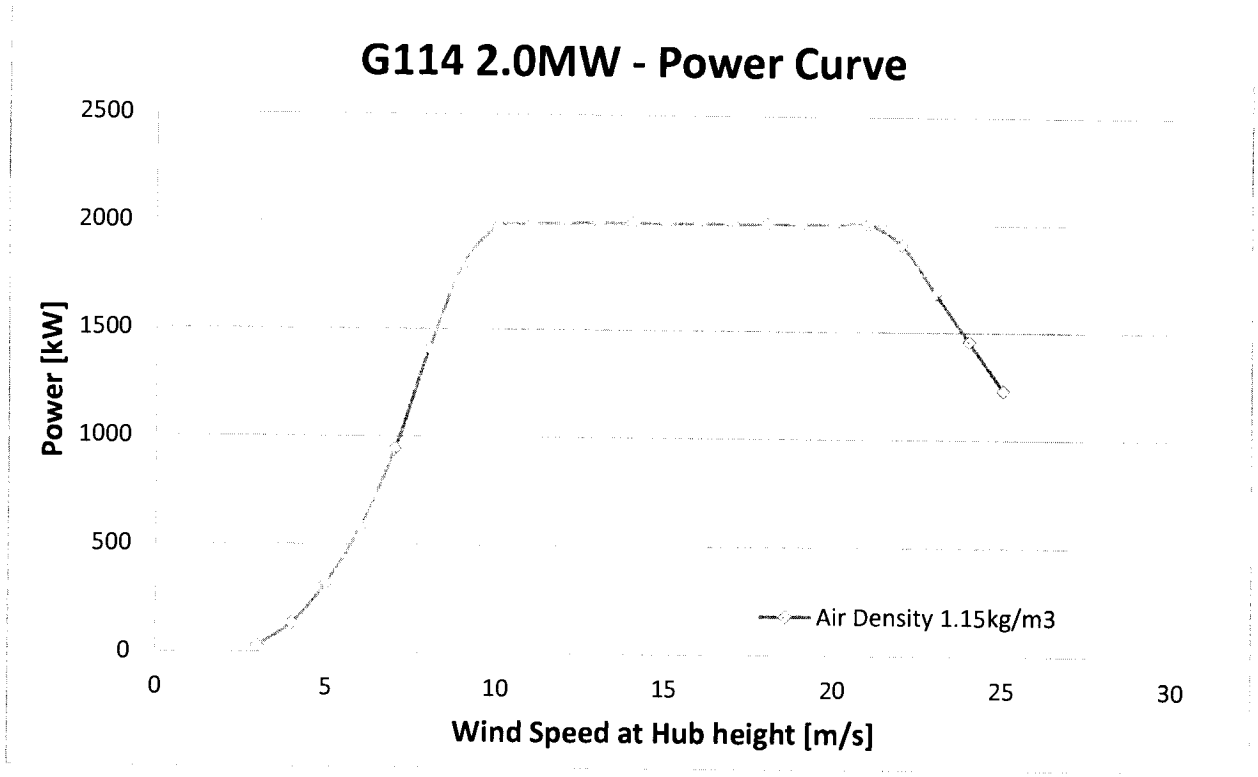
(a).	**Rotor**	
(i).	Number of blades	3
(ii).	Rotor diameter	114 m
(iii).	Swept area	10207 m^2
(iv).	Power regulation	Combination of blade pitch angle adjustment, and generator / converter torque control.
(v).	Cut-in wind speed	3 m/s
(vi).	Cut-out wind speed	25 m/s
(vii)	Survival wind speed	59.5 m/s (Maximum 3 sec)
(viii)	Pitch regulation	Electric motor drives a ring gear mounted to the inner race of the blade pitch bearing.
(b).	**Blades**	
(i).	Blade length	56 m
(ii).	Material	Composite material reinforced with fiberglass through resin infusion technology.
(c).	**Gearbox**	
(i).	Type	3 combined stages: 1 stage planetary, 2 parallel shift gears.
(ii).	Gear ratio	1:128.5
(iii).	Main shaft	Cast shaft
(d).	**Generator**	
(i).	Nominal Power	2040 (kW)
(ii).	Voltage	690 V

(iii).	Type	Doubly fed with coil rotor and slip rings
(iv).	Degree of Protection	IP54 Turbine – IP21 Ring Body
(v).	Coupling	Main Shaft: Cone Collar, High Speed Shaft: Flexible coupling.
(vi).	Power factor	0.95
(e).	**Control System**	
(i).	Type	Automatic or manually controlled.
(ii).	Scope of monitoring	Remote monitoring of different parameters, e.g. temperature sensors, pitch parameters, speed, generator torque, wind speed and direction, etc.
(iii).	Recording	Production data, event list, long and short-term trends
(f).	**Brake**	
(i).	Design	Mechanical brakes
(ii).	Operational brake	Aerodynamic brake achieved by feathering blades.
(iii).	Secondary brake	Mechanical brake on (high speed) shaft of gearbox.
(g).	**Tower**	
(i).	Type	Conical barrel tube
(ii).	Hub heights	80 m

Power Curve of Gamesa G114-2.0MW Wind Turbine Generator

The tabular and graphical values of Power curve are shown below:

Wind Speed (m/s)	Power (kW)
3	29
4	135
5	319
6	581
7	943
8	1408
9	1804
10	1977
11	1993
12	1999
13	2000
14	2000
15	2000
16	2000
17	2000
18	2000
19	2000
20	2000
21	2000
22	1906
23	1681
24	1455
25	1230


G114 2.0MW - Power Curve
2500
2000
1500
1000
500
0
Power [kW]
0
5
10
15
20
25
30
Wind Speed at Hub height [m/s]
Air Density 1.15kg/m3

The energy production of Wind Farm is given in table below:

(1).	Total Installed Gross ISO Capacity of the Generation Facility /Wind Farm (MW/GWh)	50 MW
(2).	Total Annual Full Load Hours	3066
(3).	Average Wind Turbine Generator (WTG) Availability	97%
(4).	Total Gross Generation of the Generation Facility/Wind Farm (in GWh)	173.74
(5).	Array & Miscellaneous Losses GWh	12.58
(6).	Availability Losses GWh	4.72
(7).	Balance of Plant Losses GWh	3.14
(8).	Annual Energy Generation (20 year equivalent Net AEP) GWh	153.3
(9).	Net Capacity Factor	35 %

9. Health and Safety

9.1. During the construction and operation of the Project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personal safety of workers.

9.2. The Company shall ensure that the EPC Contractor shall take all due precautions to ensure the safety of its employees, agents and subcontractors and, in collaboration with and to the requirements of the local health authorities, to ensure that suitable arrangements such as medical staff, first aid equipment and stores, sick bay and suitable ambulance services are available at all times

throughout the period of the construction period as necessary and that suitable arrangements are made for all necessary welfare and hygiene requirements.

9.3. The EPC Contractor shall maintain records concerning safety, health and welfare of persons and damage to property, and make such reports, as are consistent with Good Utility Practice and shall report details of any accident to the Company as soon as possible after its occurrence.

10. Environmental Impact

10.1 Management Consultants & Trainers was awarded the contract to conduct the Initial Environmental Examination (IEE) study for the 50MW Wind farm proposed by the Project Company. Since the project is located in an area which was historically reported as the major and significant migratory bird's route during winter, therefore the environmental impact related to mortality of birds due to wind turbines is also evaluated along with any human resettlement. Based on the site evaluation and wind data measurement done by National Renewable Energy Laboratories (USA) under the USAID assistance program in 2007, the project locations within this Jhimpir area falls among the best wind corridors w.r.t. wind power generation.

10.2 The wind farm will be developed in an area which is not under intensive agriculture use. There is no sensitive habitats with a high ecological value were found during the field survey on the proposed land and no impacts caused by the human settlement is expected. The same assessment is made regarding the possible impacts on soil. The proposed project will acquire a 330 acre of land for the turbine towers and right of way for the access road. No rare or threatened vegetation species grow along the proposed site or access road. Most of the plants found here have a wide ecological aptitude and populations large enough to ensure their genetic diversity. The removal of a small portion of vegetation will not harm the overall diversity of plant communities in the area. Only raptors use the proposed site as a hunting ground and for soaring overhead.

10.3 Given that wind power is a 'clean' source of energy, its key environmental benefit is in terms of the emission offsets it provides. The wind farm will offset between 39,409 to 87,265 tons of carbon dioxide equivalent per year depending on the efficiency of the power plant that it will replace. Over a twenty-five year time horizon, i.e. the assumed life of this project, the wind farm has the potential to offset 0.9 to 2.1million tons of CO_2 equivalents. It will also offset between 145 to 323 tons of sulfur dioxide. The local benefits of this are obvious in the sense that the ingestion of SO_2 and particulates is harmful for human health. Sulfur

dioxide also contributes to acid rain. Therefore, if a thermal power station option was exercised as opposed to the wind farm, the additional cost of mitigating the SO2 and particulate emissions would have to be borne.

Lifespan of the Wind Farm

10.4 It is envisaged that the wind farm will be in operation for up to 20 years. At the end of this period the wind farm will either be decommissioned or new wind turbines will be installed. Once the wind farm has reached the end of its lifespan, the decommissioning process will include removal of the turbines and the return of the site to its condition prior to the construction of the wind farm.

11. Evidence/relevant correspondence:

11.1. Copies of the pertinent correspondence are enclosed herewith for the learned Authority's assistance and consideration.

11.2. The Applicant would be pleased to provide any other assistance that the learned Authority may require in the matter of grant of Generation License.

11.3. This Application and its Annexures are being submitted in triplicate, with certain documents certified as necessary, each in accordance with Regulation 3(4) of the AMP Regulations.

12. Additional Grounds

12.1. The Applicant seeks to raise further additional grounds in support of this Application at the hearing stage.

PRAYER

It is most humbly prayed to the esteemed Authority as follows:

A. That the Applicant be granted a Generation License for the development of the Project.

B. That the terms of the Generation License may kindly be made consistent with the terms of the GoP concession documents.

C. That the Authority may be pleased to treat the Applicant's request for the grant of Generation License on a non-discriminatory basis and any concession offered to comparable projects on the date of filing of this Applicant and at any stage subsequent to the grant of license may kindly be granted to the Applicant as well.

D. Any further and better relief that the Authority may deem appropriate in the circumstances may kindly be granted to the Applicant.

We hope the information/explanation provided above meets your requirements, and remain available to assist you if you have any further queries.

Respectfully submitted for and on behalf of the Applicant:

Sincerely,
Noor Solar Energy (Private) Limited
February 20, 2017

Schedule-I-Generation-License Noor

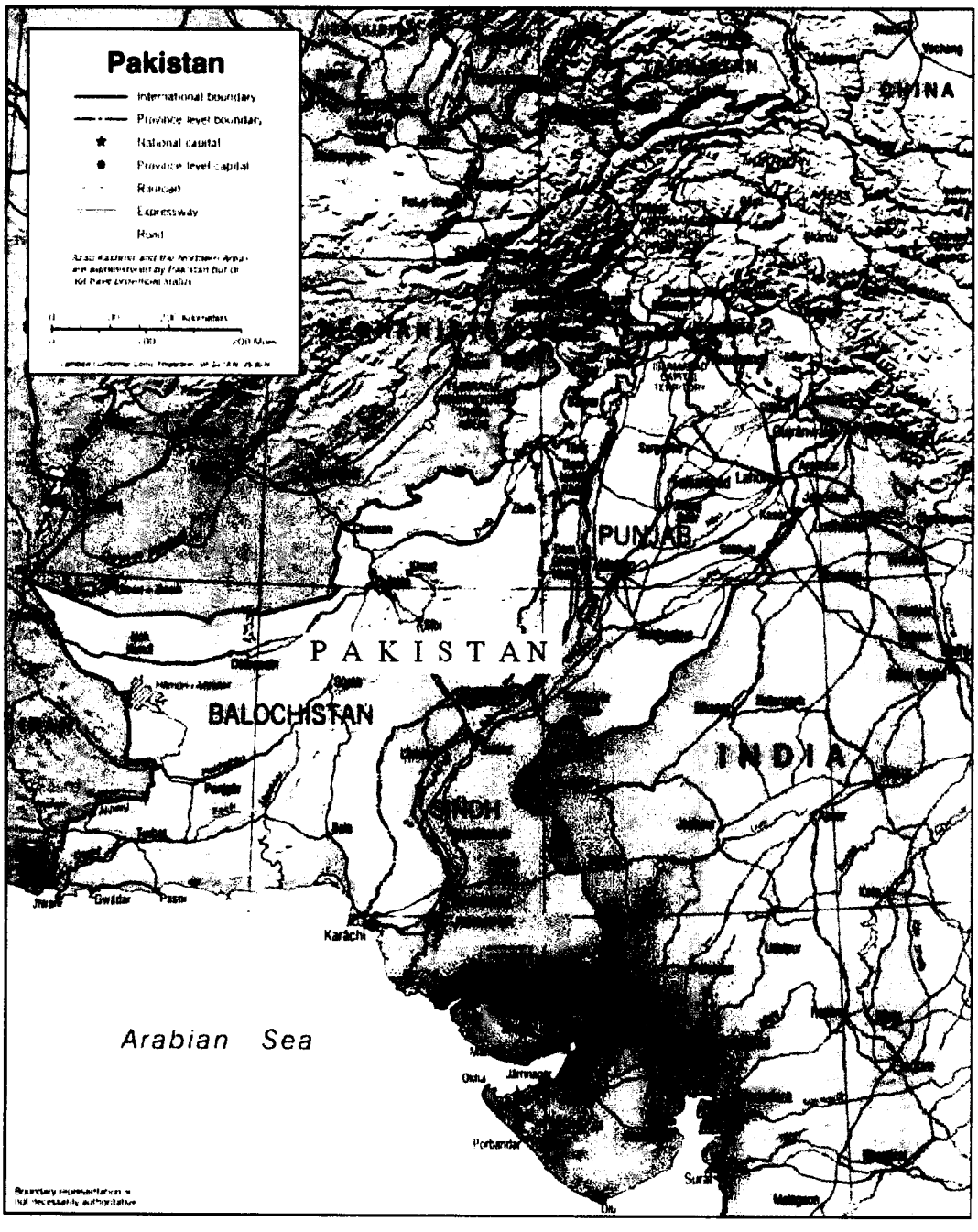
SCHEDULE-I

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

Actual drawings pertaining to Wind Farm Location Map, Wind Farm Lay Out, Wind Farm Micro-Sitting, Single Line Diagram (Electrical System of the Wind Farm),

Location of Generation Facility/ Wind Farm

The wind farm Project is located in Jhimpir, which is located approximately 120 km from Karachi, Pakistan's commercial hub and main coastal/port city. The Project site consists of 330 acres of land, which has been acquired by the project company. The Karachi-Hyderabad Motorway (Super Highway) and National Highway are the connecting roads to the Project site. The Jhimpir wind corridor is identified as potential area for the development of wind power projects. The geographical location of the project is shown in figure below.



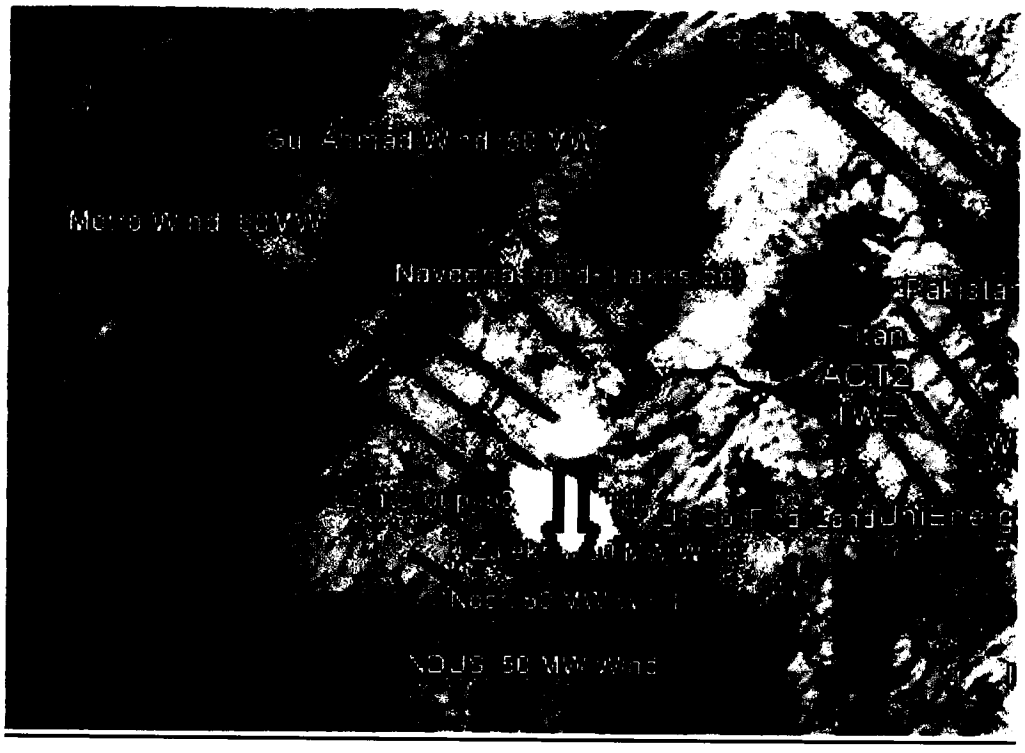
The Project Site has flat terrain with sparse vegetation, consisting of small shrubby bushes. The map is given in Figure below:

Project Size

The Project shall have an installed capacity of approx. 50 MW rated power. The number of WTGs are 25 with capacity of 2.0 MW each.

Layout of Generation Facility/ Wind Farm

The general layout along with neighboring Wind Farms of 50 MW NSEPL is shown in figure below.



Land Coordinates of Generation Facility/Wind Farm

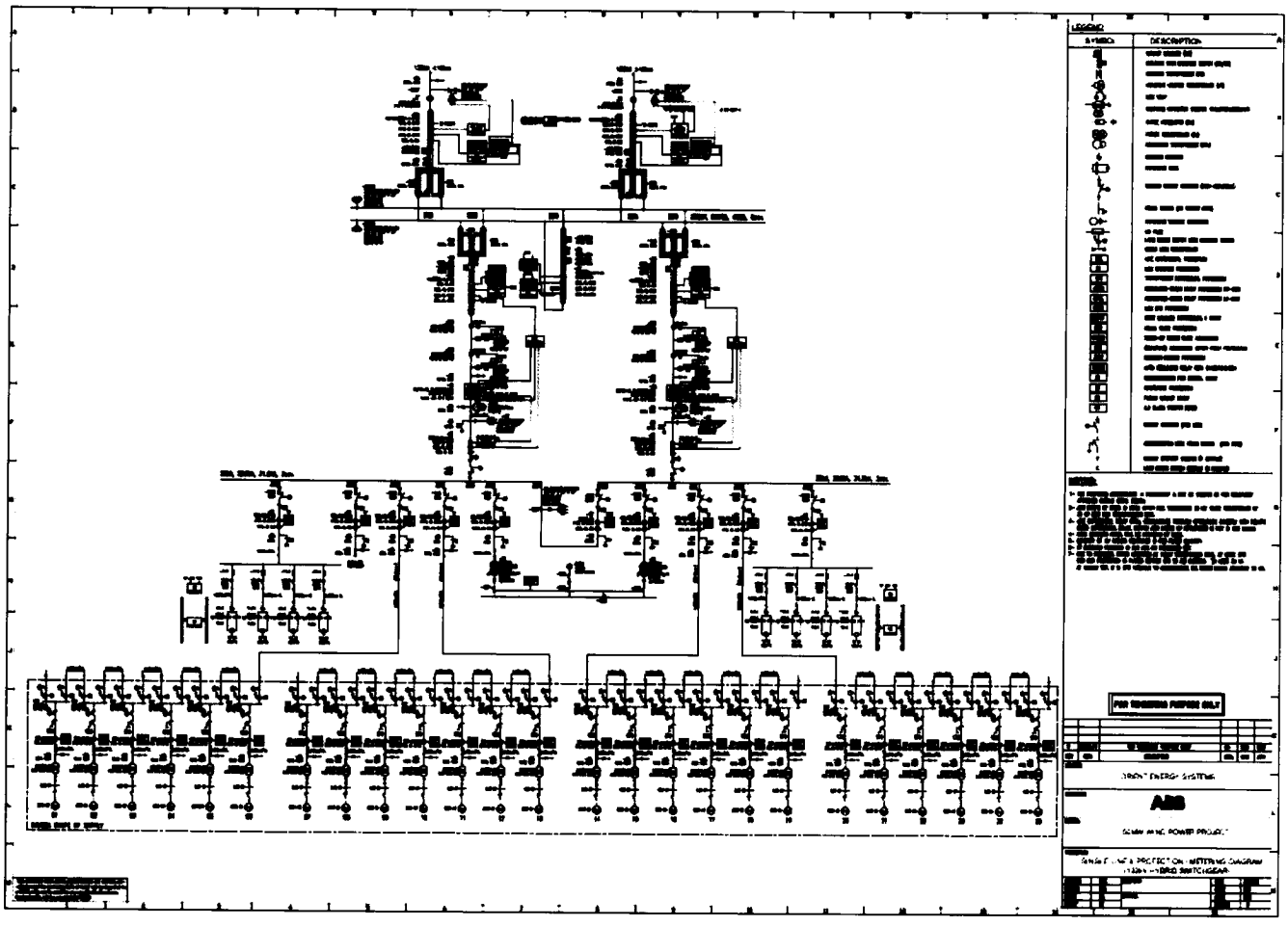
Location: Jhimpir – Sindh, Pakistan

The Site coordinates are given in Table below.

50MW NOOR		
S. No.	**Latitude**	**Longitude**
1	24.900817	67.793202
2	**24.901968**	**67.793978**
3	24.943312	67.718515
4	**24.94443**	**67.719293**

Electrical System Single Line Diagram of Generation Facility/Wind Farm

The project will install 25 WTGs (Gamesa G114-2.0). There shall be four (04) WTG collector group.



Micro-Sitting of Generation Facility/Wind Farm

The micrositing of Wind Farm with 25 WTGs is given in figure below.

Noor Solar Energy (Private) Limited – 50MW Wind Farm – Coordinates of WTGs

The coordinates are WTGs are given in table below.

NOOR_G01	378108	2754601
NOOR_G02	377800	2754797
NOOR_G03	377492	2754994
NOOR_G04	377184	2755190
NOOR_G05	376875	2755386
NOOR_G06	376567	2755582
NOOR_G07	376259	2755779
NOOR_G08	375950	2755975
NOOR_G09	375642	2756171
NOOR_G10	375334	2756367
NOOR_G11	375026	2756564
NOOR_G12	374717	2756760
NOOR_G13	374409	2756956
NOOR_G14	374101	2757152
NOOR_G15	373792	2757348
NOOR_G16	373484	2757545
NOOR_G17	373176	2757741
NOOR_G18	372868	2757937
NOOR_G19	372559	2758133
NOOR_G20	372251	2758330
NOOR_G21	371943	2758526
NOOR_G22	371634	2758722
NOOR_G23	371326	2758918
NOOR_G24	371018	2759115
NOOR_G25	370710	2759311

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

Detail of Generation Facility/Power Plant/ Wind Farm

(A). General Information

(i).	Name of Applicant/Company	Noor Solar Energy (Pvt.) limited (NSEPL)
(ii).	Registered/Business Office	A/51-A,S.I.T.E, Karachi, Pakistan
(iii).	Plant Location	Jhampir, Nooriabad, District Thatta, Sindh
(iv).	Type of Generation Facility	Wind Power

(B). Wind Farm Capacity & Configuration

(i).	Wind Turbine Type, Make & Model	Gamesa G114-2.0 MW
(ii).	Installed Capacity of Wind Farm (MW)	50 MW
(iii).	Number of Wind Turbine Units/Size of each Unit (kW)	25 x 2000 kW

(C). Wind Turbine Details

(a).	Rotor	
(i).	Number of blades	3
(ii).	Rotor diameter	114 m
(iii).	Swept area	10207 m^2
(iv).	Power regulation	Combination of blade pitch angle adjustment, and generator / converter torque control.
(v).	Cut-in wind speed	3 m/s
(vi).	Cut-out wind speed	25 m/s

(vii)	Survival wind speed	59.5 m/s (Maximum 3 sec)
(viii)	Pitch regulation	Electric motor drives a ring gear mounted to the inner race of the blade pitch bearing.
(b).	**Blades**	
(i).	Blade length	56 m
(ii).	Material	Composite material reinforced with fiberglass through resin infusion technology.
(c).	**Gearbox**	
(i).	Type	3 combined stages: 1 stage planetary, 2 parallel shift gears.
(ii).	Gear ratio	1:128.5
(iii).	Main shaft	Cast shaft
(d).	**Generator**	
(i).	Nominal Power	2040 (kW)
(ii).	Voltage	690 V
(iii).	Type	Doubly fed with coil rotor and slip rings
(iv).	Degree of Protection	IP54 Turbine – IP21 Ring Body
(v).	Coupling	Main Shaft: Cone Collar, High Speed Shaft: Flexible coupling.
(vi).	Power factor	0.95
(e).	**Control System**	
(i).	Type	Automatic or manually controlled.
(ii).	Scope of monitoring	Remote monitoring of different parameters, e.g. temperature sensors, pitch parameters, speed, generator torque, wind speed and direction, etc.
(iii).	Recording	Production data, event list, long and short-term trends
(f).	**Brake**	
(i).	Design	Mechanical brakes

(ii).	Operational brake	Aerodynamic brake achieved by feathering blades.
(iii).	Secondary brake	Mechanical brake on (high speed) shaft of gearbox.
(g).	**Tower**	
(i).	Type	Conical barrel tube
(ii).	Hub heights	80 m
(h).	**Yaw System**	
(i).	Yaw bearing	PETP
(ii).	Brake	Active Yaw
(iii).	Yaw drive	Motor Drive
(iv).	Speed	0.42*/s Controlling speed

(D). Other Details

(i).	Project Commissioning Date (Anticipated)	2019
(ii).	Expected Life of the Project from Commercial Operation Date (COD)	25 Years

Power Curve of Gamesa G114-2.0MW Wind Turbine Generator

The tabular and graphical values of Power curve are shown below:

3	29
4	135
5	319
6	581
7	943
8	1408
9	1804
10	1977
11	1993
12	1999
13	2000
14	2000
15	2000
16	2000
17	2000
18	2000
19	2000
20	2000
21	2000
22	1906
23	1681
24	1455
25	1230

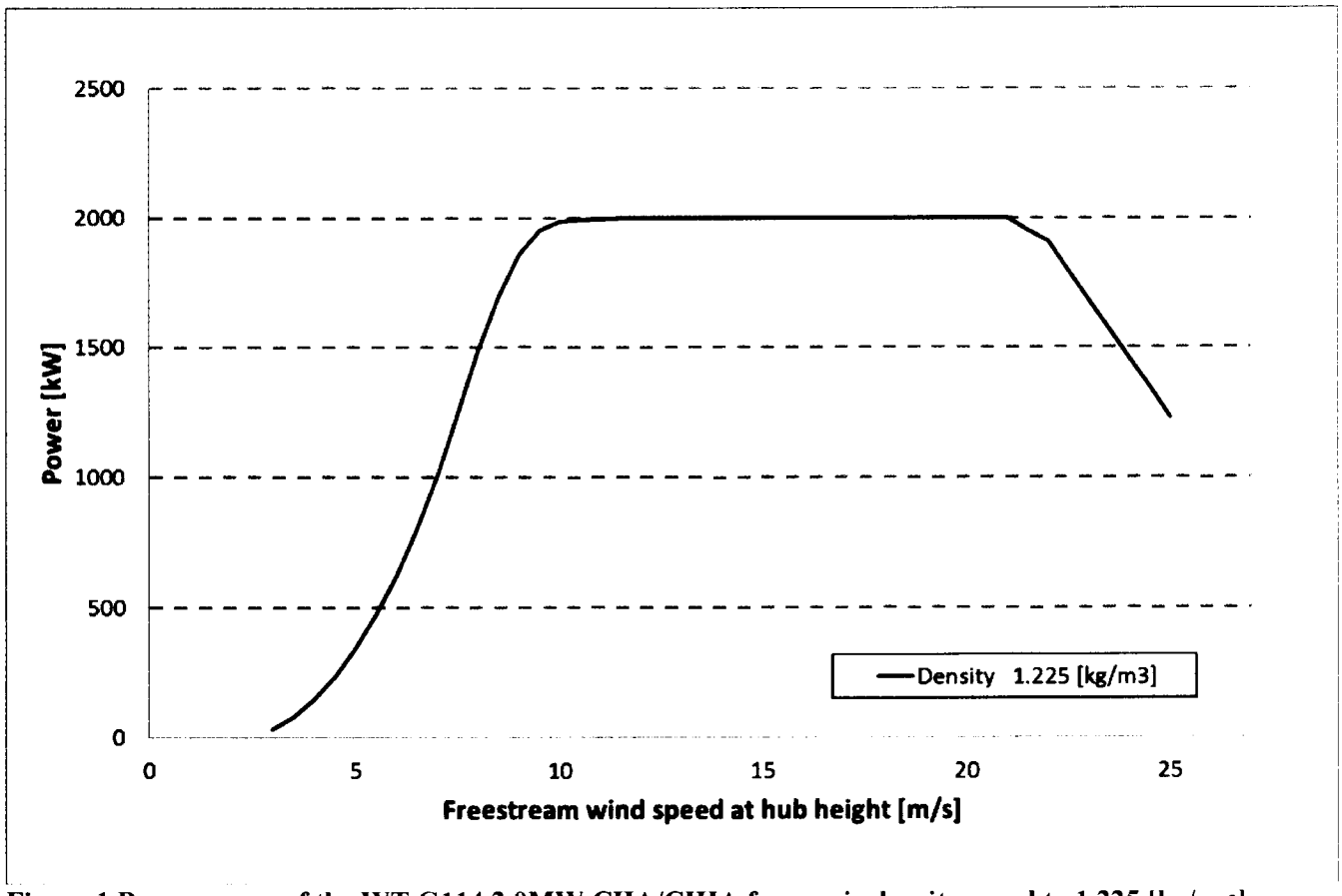


Figure 1 Power curve of the WT G114 2.0MW CIIA/CIIIA for an air density equal to 1.225 [kg/ m3]

SCHEDULE-II

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

SCHEDULE-II

(1).	Total Installed Gross ISO Capacity of the Generation Facility /Wind Farm (MW/GWh)	50 MW
(2).	Total Annual Full Load Hours	3066
(3).	Average Wind Turbine Generator (WTG) Availability	97%
(4).	Total Gross Generation of the Generation Facility/Wind Farm (in GWh)	173.74
(5).	Array & Miscellaneous Losses GWh	12.58
(6).	Availability Losses GWh	4.72
(7).	Balance of Plant Losses GWh	3.14
(8).	Annual Energy Generation (20 year equivalent Net AEP) GWh	153.3
(9).	Net Capacity Factor	35 %

Note:

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

A006470

SECP

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. 0092876

I hereby certify that **NOOR SOLAR ENERGY (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 **Eighth** day of **April,** Two Thousand and **Fifteen**.

Incorporation fee Rs. **14000/=** only

Company Registration Office Karachi

(Sidney Custodio Pereira)
Joint Registrar of Companies
Karachi

Certified to be true Copy

Deputy Registrar of Companies

THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

Memorandum of Association

of

NOOR SOLAR ENERGY (PRIVATE) LIMITED

I. The name of the Company is "NOOR SOLAR ENERGY (PRIVATE) LIMITED".

II. The Registered Office of the Company will be situated in the Province of 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 businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply.

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

3. To carry on all or any of the businesses of wholesalers, retailers, traders, importers, exporters, suppliers, distributors, designers, developers, manufacturers, installer, filters, testers, repairers, maintainers, contractors, constructors, operators, users, inspectors, reconditioners, improvers, alterers, protectors, removers, hirers, replacers, importers and exporters of and dealers in, electrical appliances, systems, products and services used for energy conservation, equipments, machinery, materials and installations, including but not limited to cables, wires, meters, pylons, tracks, rails, pipelines and any other plant, apparatus equipment, systems and

things incidental to the efficient generation, procurement, transformation, supply and distribution of electricity.

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

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

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

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

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

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

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

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

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

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

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

6. It is, hereby, undertaken that the Company shall not engage in banking business or any business of investment company or non-banking finance company or insurance or leasing or business of managing agency or in any unlawful business and that nothing contained in the object clauses shall be so construed to entitle it to engage in such business directly or indirectly and the Company shall not launch multi-level marketing (MLM), P*yramid* and *Ponzi* schemes.

7. 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 authorized capital of the company is Rs. 1,000,000/- (Rupees: One Million Only) divided into 100,000 ordinary shares of Rs. 10/- each with power to enhance, reduce or consolidate the share capital and to divide the shares of the company into different classes and kinds subject to the provisions of the Companies Ordinance, 1984.

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

Name and surname (present & former) in full (in Block Letters)	**NIC No. (in case of foreigner, Passport No)**	**Father's/ Husband's Name in full**	**Nationality with any former Nationality**	**Occupation**	**Residential Address in full**	**Number of shares taken by each subscriber**	**Signature**
Muhammad Salim Mukaty	42301-7936353-1	S/o Noor Muhammad Mukaty	Pakistani	Business man	House #26, Khayaban-e-Muhafiz, Phase V, D.H.A., Karachi	10,000 (Ten Thousand Only)	
Hamida Salim Mukaty	42301-7948100-6	W/o Muhammad Salim Mukaty	Pakistani	--	House #26, Khayaban-e-Muhafiz, Phase V, D.H.A., Karachi	10,000 (Ten Thousand Only)	
Mr. Azam Sakrani	42301-0900943-3	Abdul Aziz Sakrani	Pakistani	Service	F-22/1, Block-8, Clifton, Karachi	100 (One Hundred Only)	
			Total number of shares to be taken			**20,100 (Twenty Thousand One Hundred Only)**	

Date: April 6, 2015

Witness:

Name:

Address:

NIFT (PVT) LIMITED
5TH FLOOR, AWT PLAZA,
I.I. CHUNDRIGAR ROAD,
KARACHI – 74000

Serial No.
Name of Company
Brief Description
Date of Registration

Joint Registrar of Companies
Company Registration Office
Karachi

THE COMPANIES ORDINANCE, 1984

(Private Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF

NOOR SOLAR ENERGY (PRIVATE) LIMITED

1. The Regulations contained in Table 'A' to the First Schedule to the Companies Ordinance, 1984 (the "Ordinance") shall be the regulations of **NOOR SOLAR ENERGY (Private) Limited** (the "Company") so far as these are applicable to a private company.

PRIVATE COMPANY

2. The Company is a "Private Company" within the meaning of Section 2(1)(28) of the Ordinance and accordingly:

(1) No invitation shall be made to the public to subscribe for the shares or debentures of the Company.

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

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

TRANSFER OF SHARES

3. A member desirous to transfer any of his shares shall first offer such shares for sale or gift to the existing members and in case of their refusal to accept the offer, such shares may be transferred to any other person, as proposed by the transferor member, with the approval of the Board of Directors.

DIRECTORS

4. The number of directors shall not be less than two or a higher number as fixed under the provisions of Section 178 of the Ordinance. The following persons shall be the first directors of the Company and shall hold the office upto the date of First Annual General Meeting:

1.	Muhammad Salim Mukaty	CNIC # 42301-7936353-1
2.	Hamida Salim Mukaty	CNIC # 42301-7948100-6
3.	Azam Sakrani	CNIC # 42301-0900943-3

We, the several persons whose names and addresses are subscribed, are desirous of being formed into a company, in pursuance of these articles of association, and we respectively agree to take the number of shares in the capital of the company set opposite our respective names.

Name and surname (present & former) in full (in Block Letters)	**NIC No. (in case of foreigner, Passport No)**	**Father's/ Husband's Name in full**	**Nationality with any former Nationality**	**Occupation**	**Residential Address in full**	**Number of shares taken by each subscriber**	**Signature**
Muhammad Salim Mukaty	42301-7936353-1	S/o Noor Muhammad Mukaty	Pakistani	Business man	House #26, Khayaban-e-Muhafiz, Phase V, D.H.A., Karachi	10,000 (Ten Thousand Only)	
Hamida Salim Mukaty	42301-7948100-6	W/o Muhammad Salim Mukaty	Pakistani	--	House #26, Khayaban-e-Muhafiz, Phase V, D.H.A., Karachi	10,000 (Ten Thousand Only)	
Mr. Azam Sakrani	42301-0900943-3	Abdul Aziz Sakrani	Pakistani	Service	F-22/1, Block-8, Clifton, Karachi	100 (One Hundred Only)	
			Total number of shares to be taken			**20,100 (Twenty Thousand One Hundred Only)**	

Date: April 6, 2015

Witness:
Name:
Address:

NIFT (PVT) LIMITED
5TH FLOOR, AWT PLAZA,
I.I. CHUNDRIGAR ROAD,
KARACHI – 74000

Serial No .....
Name of Company .....
Brief Description of the document .....
Date of Registration .....

Joint Registrar of Companies
Company Registration Office,
Karachi

DETAILED PROFILE OF THE EXPERIENCE OF THE COMPANY

Noor Solar Energy (Pvt.) Limited is a SPV sponsored by the Mukaty Family which owns the Liberty Group having companies namely Liberty Mills Limited and Liberty Power Tech Limited.

The Group heritage starts from M/s Noor Mohammad Haji Mohammad & Sons, established by grandfather of Mr. Ashraf Mukaty in 1908 in the subcontinent with the Head Office in Bombay and branches in Calcutta, Chennai, Rangoon. After migration in 1947, the Head Office of the Group shifted to Karachi, Pakistan. The group mainly dealt in Textiles, Dyes & Chemicals, Food and Real Estate related businesses.

Brief Profiles of the Main Sponsors are given below:

Salim N Mukaty

Mr. Salim N. Mukat was born in 1942 in Jetpur, India. He received his primary education in Karachi and went to London for higher studies. However, unfortunately due to ill-health of his father, he had to return to Pakistan without fully completing his higher studies. Thereafter, he founded Liberty Mills Ltd, as a private limited company, which was later converted into Public Limited Company in 1969.

Besides Liberty Mills Limited, Mr. Mukaty also expanded the business in automobile, real estate and import and export of food items and commodities with the name of "Noor Mohd Haji Mohd & Sons', established in 1908, Ashraf Enterprises' and 'Liberty Construction Company (Pvt.) Ltd'. Moreover, he established two power companies (i) Liberty Energy (Pvt) Ltd in the year 2000 as captive power plant which was later merged into Liberty Mills Limited in 2011 and (ii) Liberty Power Tech Limited, an Independent power producing company operating since January 2011.

Mr. Salim Mukaty has been dedicatedly contributing towards the noble cause. Some of his contributions are as follows:

- *Established Zulekha Bai Community Centre, in Hyderabad, for educational and social purposes of the community and it is the single community centre for Memon community in Hyderabad.*
- *Established TCF School in Itihad Town, Karachi where over 800 students are receiving education.*

Ashraf S. Mukaty

Mr. Ashraf Mukaty was born in Karachi in 1964. He completed his education from Karachi and joined the family business in 1982. Simultaneously, he attended several training courses in Europe with a number of machinery manufacturers. Subsequently, he was fully engaged in looking after the production, quality control and finishing departments of the

Company. Since last decade, he is also handling the entire exports of the Company and is actively engaged in the import of various commodities for the Group.

Under his leadership Liberty Mills Limited has experienced tremendous expansion and growth and major investments in technology, skill development and effective human resource management which resulted in achievements of various international accreditations including: ISO 9001 / 2000; 2000 OEKO – TEX STANDARD 100; LYCRA Accredited Mills Network; Performance Testing Laboratory Accredited by Target

Mr. Ashraf was the person behind the diversification in Power Sector through Liberty Power Tech Limited and performed great leadership role throughout the project i.e. approvals from government agencies, negotiation with banks and EPC contractors, development and achieving timely completion of the Project. Under his management, the company has been supplying uninterrupted electricity to NTDC at almost 90% plant factor.

He has been awarded export trophy for the 'Best Exporter' of made-ups in the year 2006 by the Prime Minister of Pakistan.

Brief Profile of other Group Companies:

Liberty Mills Limited

*Liberty Mills Limited ("**LML**"), established in the year 1962 by Mr. Salim N. Mukaty, enjoys leading positions in textile sector of Pakistan for more than 5 decades. LML is now one of largest manufacturers and exporters of textile goods in the country having state of the art processing unit producing 66 million meters fabric annually.*

Located in the industrial heart of Karachi, it is today one of the largest textile processing unit in Pakistan with a production capacity of 500,000 square meters of fabric per day. The whole production is exported directly and indirectly to customers who include vendors of internationally recognized brands and departmental stores. Its substantial foreign remittance through export business has been greatly contributing towards national exchequer.

Liberty Mills Limited is an ISO 9001-2008, OCS 100/OCS Blended Standards, Oeko -Tex Standard 100 and SA 8000:2008 Certified company.

Liberty Power Tech Limited

Liberty Power Tech Limited ("the company") was incorporated in September-2007. The core idea behind the incorporation was to contribute and add the values in energy sector of the country considering dire demand of electricity. The company was formed under Power Policy 2002 as an Independent Power Producer (IPP) to build, own, operate and maintain RFO based combined cycle power complex having gross capacity of 200 MW. The company has most efficient and advanced technology 11 Engines having generation capacity of 16.911MW each and 1 Steam Turbine 13.979 MW imported directly from Wartsiala, Finlad who is the leading

and global supplier of power plants. The total project cost amounting to USD 240.239 million was sponsored as 25% from Equity and 75% from Debt.

The company got approved tariff on cost plus basis from National Electric Power Regulatory Authority ("NEPRA") in Feb-2008 and formally obtained generation license from NEPRA in April-2008. The company signed Implementation Agreement (IA) with Islamic Republic of Pakistan ("GOP") in Jun-2008 which acts as sovereign guarantee for the debt and equity investors of the project and guarantees the obligation of NTDC (company owned by WAPDA) under the Power Purchase Agreement.

Power Purchase Agreement ("PPA") was signed between the company and National Transmission & Dispatch Company Limited (NTDCL) in July-2008. Under the PPA, NTDCL had contracted to purchase total net generation capacity of 196.139 MW from the company for a period of 25 years against the pre-determined tariff already approved by the NEPRA. Fuel component of the tariff is entirely Pass Through based on monthly prevailing price of RFO under the head of Energy Purchase Price. However, other components like O&M, ROE, Insurance, Working Capital and debt component are indexed to various factors i.e. international and local CPI, devaluation of PKR to USD and variation in interest rate on quarterly basis. Under the Power Policy – 2002, the company is guaranteed return of 15% IRR in USD.

The company achieved financial close in Mar-2009 in accordance with the plan despite the severe economic meltdown of year 2008 when the lenders were reluctant to finance such a mega power projects. The sponsors of the company were only able to accomplish said essential and near to impossible milestone because of carrying good standing and reputation with the bankers and financial institutions. It is the matter of great honor that the company had issued largest SUKUK ever in the history of the country. The project was successfully completed and finally commissioned in Jan-2011. *Alhamdulillah,* it was an immense pleasure that the company had achieved the entire milestone within the timeline as already determined in the PPA and the said accomplishment made us distinguished among the other IPPs.

The plant is being operated and maintained by the world class O&M operator i.e. Wartsila Pakistan (Subsidiary of Wartsila, Finland) which has further strengthen our generation capability. Since the commissioning, the plant is generating and supplying uninterruptedly electricity to NTDC at around 88% plant factor with the annual turnover of Rs. 28.697 billion. The availability of plant invariably remained greater than the required i.e. 88%.

Zulaikha Energy (Private) Limited

The sponsors are also developing another wind power plant of 50 MW in Jhimpir under the above name. LOI have already been issued by Energy Department, Government of Sindh whereas land has already been awarded by Land Utilization Department, Government of Sindh. NEPRA has also approved generation license of Zulaikha Energy.

PROFILE OF THE MANAGEMENT & TECHNICAL STAFF

Mr. Zain Mukaty

Mr. Zain Mukaty is an eldest son of Mr. Ashraf Mukaty who joined the family business in 2014. Mr. Zain graduated with highest honors from the University of Pennsylvania, in 2013 with a Bachelors Economics and Bachelors in Engineering. His first job was at Cornerstone Research in New York as Financial Litigation Consultant where he served for a year before moving back to Pakistan to join his family business. With his engineering background and emphasis on data driven analytics, he helped to develop and implement an ERP system and greatly improved efficiencies. Furthermore, he has been a critical part of the new venture development team, especially focusing on the Power Sector.

Mr. Azam Sakrani

Mr. Sakrani has been the Chief Executive Officer of Liberty Power Tech Limited (IPP 200 MW RFO based Power Project) since October-2014 and also designated CEO of our both wind project. Mr. Sakrani has over 20 years of experience particularly in project financing, business development, strategic management with different leading banks and industrial conglomerate of the country. He also possesses sound experience in the development of an ethanol production plant from the beginning to successful commissioning by way of project feasibility, development, construction monitoring with a well-known industrial undertaking of the country.

Mr. Sakrani has done his B. Sc. In Finance and holds MBA degree from renowned universities of USA.

Mr. Tanveer Ahmed

Mr. Tanveer Ahmed is the Project Director of Liberty Power Tech Limited since the beginning of the said project. Previously, he was remained associated with Liberty Group since 1990 as General Manager Maintenance. His specialties are engineering and operations of power generation facilities. Mr. Tanveer also performed key role in the construction phase of 200 MW RFO based Power Project. He has obtained extensive exposure for the development and construction of power plant particularly with the technical requirement of WAPDA / NTDC. He has maintained good relationship with different government agencies like NEPRA, CPPA, NTDC, WAPDA, FESCO etc.

Mr. Tanveer has done his BE Electrical from NED and hold MS degree in Power Control System.

Mr. Madni Gul Muhammad

Mr. Madni is a Director of Liberty Mills Limited and has been associated with Liberty Group since last 27 years. He has diversified experience of handling finance, business planning and project financing. Mr. Madni also performed important role in financial close of Liberty Power Tech Limited. He has established good business relationship with different senior executives of leading banks of the country.

He is Chartered Accountant Finalist.

Annex-L Prospectus

Applicant – Noor Solar Energy (Pvt.) Limited

The Project Company, being the applicant under this Generation License Application, is a private limited company incorporated under the laws of Pakistan and has been specifically established to undertake power generation business and activities in Pakistan.

The Project Company (following grant of a generation license and approval of the Project Company's reference generation tariff by NEPRA) proposes to design, engineer, construct, insure, commission, operate and maintain the Project constituting of a 50 MW power generation facility (the Facility) to be located at Jhimpir, District Thatta, Province of Sindh, Pakistan (the Site).

For the purposes of designing, engineering, procuring, constructing, installing, testing, completing, commissioning, operation and maintenance of the Project, the Project Company has signed the 'Heads of Agreement' with 'Gamesa Wind (Tianjin) Co. Ltd.,' and 'Orient Energy System (Pvt) Ltd.,' on February 26, 2016.

Sponsor – Liberty Mills Limited

*Liberty Mills Limited ("**LML**"), established in the year 1962 by Mr. Salim N. Mukaty, enjoys leading positions in textile sector of Pakistan for more than 5 decades. LML is now one of largest manufacturers and exporters of textile goods in the country having state of the art processing unit producing 66 million meters fabric annually.*

Located in the industrial heart of Karachi, it is today one of the largest textile processing unit in Pakistan with a production capacity of 500,000 square meters of fabric per day. The whole production is exported directly and indirectly to customers who include vendors of internationally recognized brands and departmental stores. Its substantial foreign remittance through export business has been greatly contributing towards national exchequer.

Liberty Mills Limited is an ISO 9001-2008, OCS 100/OCS Blended Standards, Oeko -Tex Standard 100 and SA 8000:2008 Certified company.

Tehrmal *Power: Liberty Power Tech Limited*

Liberty Power Tech Limited ("the company") was incorporated in September-2007. The core idea behind the incorporation was to contribute and add the values in energy sector of the country considering dire demand of electricity. The company was formed under Power Policy 2002 as an Independent Power Producer (IPP) to build, own, operate and maintain RFO based combined cycle power complex having gross capacity of 200 MW. The company has most efficient and advanced technology 11 Engines having generation capacity of 16.911MW each and 1 Steam Turbine 13.979 MW imported directly from Wartsiala, Finlad who is the leading

and global supplier of power plants. The total project cost amounting to USD 240.239 million was sponsored as 25% from Equity and 75% from Debt.

The company got approved tariff on cost plus basis from National Electric Power Regulatory Authority ("NEPRA") in Feb-2008 and formally obtained generation license from NEPRA in April-2008. The company signed Implementation Agreement (IA) with Islamic Republic of Pakistan ("GOP") in Jun-2008 which acts as sovereign guarantee for the debt and equity investors of the project and guarantees the obligation of NTDC (company owned by WAPDA) under the Power Purchase Agreement.

Power Purchase Agreement ("PPA") was signed between the company and National Transmission & Dispatch Company Limited (NTDCL) in July-2008. Under the PPA, NTDCL had contracted to purchase total net generation capacity of 196.139 MW from the company for a period of 25 years against the pre-determined tariff already approved by the NEPRA. Fuel component of the tariff is entirely Pass Through based on monthly prevailing price of RFO under the head of Energy Purchase Price. However, other components like O&M, ROE, Insurance, Working Capital and debt component are indexed to various factors i.e. international and local CPI, devaluation of PKR to USD and variation in interest rate on quarterly basis. Under the Power Policy – 2002, the company is guaranteed return of 15% IRR in USD.

The company achieved financial close in Mar-2009 in accordance with the plan despite the severe economic meltdown of year 2008 when the lenders were reluctant to finance such a mega power projects. The sponsors of the company were only able to accomplish said essential and near to impossible milestone because of carrying good standing and reputation with the bankers and financial institutions. It is the matter of great honor that the company had issued largest SUKUK ever in the history of the country. The project was successfully completed and finally commissioned in Jan-2011. *Alhamdulillah,* it was an immense pleasure that the company had achieved the entire milestone within the timeline as already determined in the PPA and the said accomplishment made us distinguished among the other IPPs.

The plant is being operated and maintained by the world class O&M operator i.e. Wartsila Pakistan (Subsidiary of Wartsila, Finland) which has further strengthen our generation capability. Since the commissioning, the plant is generating and supplying uninterruptedly electricity to NTDC at around 88% plant factor with the annual turnover of Rs. 28.697 billion. The availability of plant invariably remained greater than the required i.e. 88%.

Environmental Impact

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. Wind Power Project is a green energy Project and, therefore, there is no major long lasting social or environment impact foreseen. 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 Area does not fall under any sensitive, protected area. No threatened / Near-Threatened species of wildlife was recorded in the Project Area. There are no settlements in and around the project area. Other

settlements are outside from the wind farm site at distance of approximately 10 Kilometers therefore no disturbance to the inhabitants is foreseen. 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. Regarding bird mortality due to collision, it is found that birds landing area is around 10 km away from the wind farm and the migratory birds are not seen in the wind farm area and there are minimal to zero chance of bird collision from these wind turbines. Noise impacts will be less than 70 DB (A) which is within the range as per National Environmental Quality Standards (NEQs) of Pakistan.

After careful review and analysis of the Initial Environmental Examination, the SEPA accorded its approval for the Project through its decision (Ref: EPA/2016/03/17/IEE/30) dated March 29, 2016 (the IEE Approval Decision). A copy of the IEE Approval Decision is attached for NEPRA's perusal.

Social Impact

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.

Proposed Investment

The Total Project Cost of US$ 110 Million (United States Dollars One Hundred and Ten Million) is to be financed in a debt to equity ratio of 75:25, which is in accordance with the RE Policy 2006.

DEBT

With regards to debt financing for the Project, the Project Company has already signed financing term sheets/ Expression of Interest with a consortium of leading local banks (same as for the previous project) and Asian Development Bank.

EQUITY

Based on the Debt to Equity ratio of 75:25, the equity required to be injected by Liberty Mills Limited (the **Equity**), being the primary sponsor, amounts to USD 27.5 Million. The Sponsor has already committed the equity in respect of the Project and such arrangements have been agreed with the Mandated Lead Arrangers.

The financial strength and net worth of Liberty Mills Limited (being the primary sponsor of the Project Company).

Salient Features of the Facility

Project Background

Since the issuance of the LOI, the Project Company conducted various studies to assess the feasibility of the Project. These studies *inter alia* included the wind resource assessment, geo technical investigation, digital topographic map, initial environmental examination and grid interconnection study. The complete feasibility study was submitted by the Project Company to DAE, GOS.

Project Site

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

- Location in the wind corridor;
- Wind conditions at the Site;
- Topographic conditions;
- Site accessibility; and
- Location of the grid with reference to the Site for interconnection. The Site is located within the wind corridor identified by DAE, GOS.

The Site is located in Jhimpir, District Thatta, Sindh, which is one of the most promising areas where wind power projects can be viably installed. The Project's wind farm site is located 138 km from Port Qasim Karachi in the East direction with easy road access. Nooriabad Industrial Estate (situated on the M9 motorway connecting Karachi and Hyderabad) is 35 Km from the Wind Farm.

Land Description of the Project Site:

NOOR Solar Energy (Pvt.) Limited, 50MW Wind Power Project			
S.no	**Details**	**Long**	**Lat**
1	**330 Acres**	24.900817	67.793202
2		24.901968	67.793978
3		24.943312	67.718515
4		24.94443	67.719293

The Project site is exposed to very strong south westerly winds; wind data analysis of the area suggests that, 80% wind blows from the south west direction. The terrain of the area is flat with small change in altitude. The proposed site lies under roughness class 1.5 as there is low

vegetation. The site is easily accessible through metallic roads. The ground is hard and rocky; the subsurface soil also includes clay and silt.

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

Wind Farms Layout at Project Site

The wind farms site is in long and narrow in shape, the topography is relatively flat and the elevation above sea level is approximately 45-70m. There is little vegetation at the wind farm site.

Topographical and Geological Conditions at Project Site

Topographical conditions:

The Site is on a plain area at an elevation of 45-70m, which is generally flat, but a bit higher on the west and lower on the east. The landform at wind farm sites is mainly of pediment and the vegetation there is less developed.

Geological conditions:

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

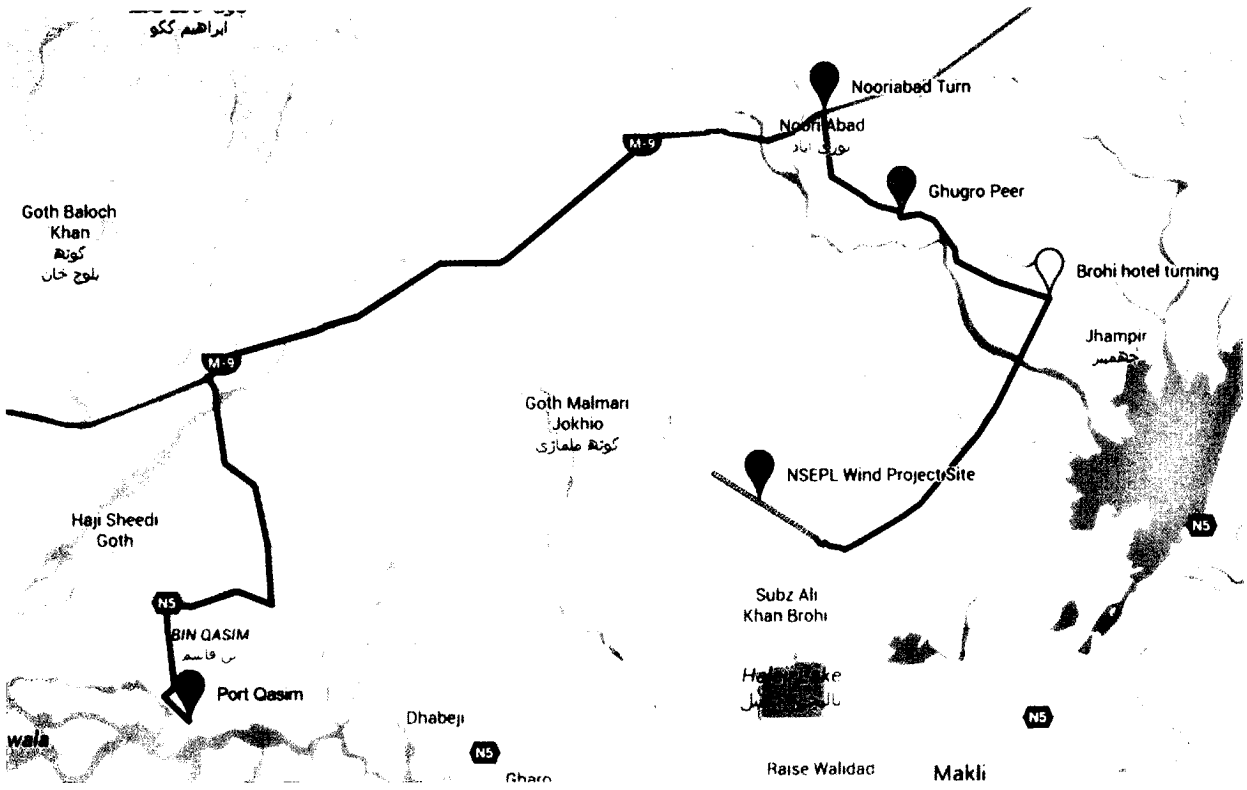
Hydrology:

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

Site Accessibility

The Project is located on Thatta-Bannu Khan Road heading towards Jhimpir from M-9 Khi-Hyd highway. The machinery for the Project will be routed from Port Qasim Karachi which is on the eastern edge of the city and closer to the Project site, for which the transporter has to travel to

Jhimpir from Karachi port through populated areas. The distance of Project site from Karachi is 138 km. The proposed route to the Project site is given in the below Illustration.



Telecommunication at project site

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

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

Availability of Semi-Skilled and Skilled Labor

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

General Information

(i).	Name of Applicant/Company	Noor Solar Energy (Pvt.) Limited
(ii).	Registered/Business Office	A/51-A, SITE, Karachi, Pakistan
(iii).	Plant Location	Jhampir, Nooriabad, District Thatta, Sindh
(iv).	Type of Generation Facility	Wind Power

Wind Farm Capacity & Configuration

(i).	Wind Turbine Type, Make & Model	Gamesa G114-2.0MW
(ii).	Installed Capacity of Wind Farm (MW)	50 MW
(iii).	Number of Wind Turbine Units/Size of each Unit (KW)	25 x 2000 KW

Wind Turbine Details

(i).	Wind Turbine Type, Make & Model	Gamesa G114-2.0MW
(ii).	Installed Capacity of Wind Farm (MW)	50 MW
(iii).	Number of Wind Turbine Units/Size of each Unit (KW)	25 x 2000KW
(iv).	Number of blades	3

(v).	Rotor diameter	114 m
(vi).	Hub Height	80 m
(vii).	Generator Voltage	690 V
(viii).	Cut-in wind speed	3 m/s
(ix).	Cut-out wind speed	25 m/s
(x).	Survival wind speed	59.5 (Maximum 3 sec)

Expected Date of Financial Close:
June 2017

Expected COD:
July 2019

Reference No: EPA/ 2016/03/17/IEE/27

ENVIRONMENTAL PROTECTION AGENCY

GOVERNMENT OF SINDH

Plot # ST 2/1, Sector 23, KIA, Karachi-74900
Ph: 5065950, 5065598, 5065637
5065532, 5065946, 5065621
epasindh@cyber.net.pk
Facsimile: 5065940

Date: 29-03-2016

SUBJECT:-**DECISION ON INITIAL ENVIRONMENTAL EXAMINATION (IEE).**

1.	**Name & Address of Proponent:**	Mr. Azam Sakrani CEO M/s Noor Solar Energy Private limited
2.	**Description of Project:**	Construction of 50 MW Wind power project
3.	**Location of Project:**	Jhampir District Thatta Sindh
4.	**Date of Filing of IEE:**	17-03-2016

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

a. The mitigation measures provided in the IEE report and implementation of Environmental Management Plan shall strictly be followed by the proponent to minimize or reduce the impacts on physical and biological environment. As for this, cost of EMP shall separate be allocated and be part of the tender document.

b. The project proponent makes ensure to treat effluent generated from sewerage & waste water generated from the project activities and reduced its concentration at permissible level for compliance of National/Provincial Environmental Quality Standards (NEQS/SEQS) prior to discharge. However, the discharge should be planned away from environmental sensitive areas, with special attention to high water tables, vulnerable aquifers, and wetlands, community receptors, including water wells, water intakes and high value agriculture land.

c. The gaseous emissions (SO_2, NOx, & CO) and particulate matters released from all construction and utilities machineries shall conform/meet to the National/ Provincial Environmental Quality Standards (NEQS/SEQS) all the time; at no time, the discharge/emission levels shall go higher than stipulated standards of this office.

d. The machinery used for construction or other project activities shall meet the NEQS/SEQS positively. However, proponent shall possess environmental and safety fitness certificate prior to use of the machinery equipment.

e. The impact on Water, Air, Soil and noise shall be minimized by adopting adequate precautionary measures as stipulated in current national and international guidelines (Pak-EPA, IFC, World Bank)

f. All the types of adversely affect of wind project on local environment shall be reduced by means of mitigation efforts that should be completed during the design, construction, and operation phase of wind warm by proponent in order to avoid damages to vulnerable ecological systems.

g. The project proponent shall bound to adopt effective mitigation measures with respect to environmental issues posed by wind turbines that includes wildlife safety, bio-safety disturbance, noise, visual pollution, electromagnetic inferences and local climate change.

h. The project proponent shall follow current national and international guidelines with respect to wind energy such as OPIC & (IFC) during construction, operation & decommissioning of the project activities.

i. The Wind Energy induced environmental impacts on birds, bats, and other physico-chemical parameters i.e. temperature, ambient air, water, and noise quality should be minimized & monitored by independent Monitoring Consultant (IMC) having expertise in carrying out Environmental & Social Impact monitoring. In addition, the IMC will monitor the implementation of the Environmental Management Plan, HSE Management System, CSR Plan Implementation and commitments made in IEE report same will be submitted to EPA on quarterly basis. The proponent shall identify and report HSE and CSR performance in monitoring reports including near misses, accidents, lost time incidents (LTI).

j. The vegetation of the disturbed project area should be replanted soon as after completion of construction work in order to overcome or reduced the impact of soil erosion.

k. The waste generated from project activity shall confirm to dispose as environment friendly manner as non-hazardous waste shall be disposed at designated and approved waste disposal site and hazardous waste shall be transferred/disposed off only in a manner as prescribed in Waste Management Rules 2014 of Sindh EPA

l. The Project proponent shall prepare on-site & off-site emergency plans for fires-safety, spillage control, human accidents ect; as disaster risk management and other as per extent rules in this regard.

m. A complete Occupational, Health, Safety and Environment (HSE) commissioning management system shall be developed, implemented and monitored for compliance as per national if available or international guidelines. For this purpose, HSE setup should be supervised by a designated HSE officer at the senior level with sufficient administrative and technical authority to perform the designated functions. And proponent shall make sure that the operating instructions and emergency actions are made available to every worker/labor at the site. Moreover, proponent shall place all required resources and take necessary safety measures to prevent any incident and accident to human during project activity.

n. The proponent shall ensure that no unfortunate HSE incident(s) are caused due to construction and operation of project. The cost of damage to the environment, property and life of the people/workers shall lie on the proponent.

o. If project proponent is storing bulk diesel/ furnace oil then project proponent bound to obtain necessary approval from Department of Explosive.

p. The project proponent shall have secondary containment equivalent to 110% of storage capacity for safety measures and prevent from soil contamination. However, chemicals of any forms (solid,

liquid, gases) shall be handled by wearing personal protective equipments (PPEs) and care shall be taken to prevent any spillage.

q. The proponent shall ensure that emissions/effluents from project activity do not pose an unacceptable risk to human health or become nuisance to the neighborhood.

r. For all engineering designs, NFPA (National Fire Protection Authority) codes will be followed. Standard fire and smoke detection and protection devices such as alarms, sprinklers, fire hoses and hydrants will be provided at all critical locations.

s. This approval is accorded only for the construction of project activity and proponent shall submit separate EIA or IEE as required under EIA/IEE regulation 2014 o SEP ACT, for any enhancement or change in the design of project.

t. Under the CSR policy, community development scheme should be initiated after assessment of needs of community in terms of formal social assessment and CSR implementation plan.

u. The proponent shall ensure that maximum unskilled and skilled workforce employment be made locally preferably near/around project area and in compliance with all the applicable laws with respect to employment, working hours, compensation and benefits etc respectively.

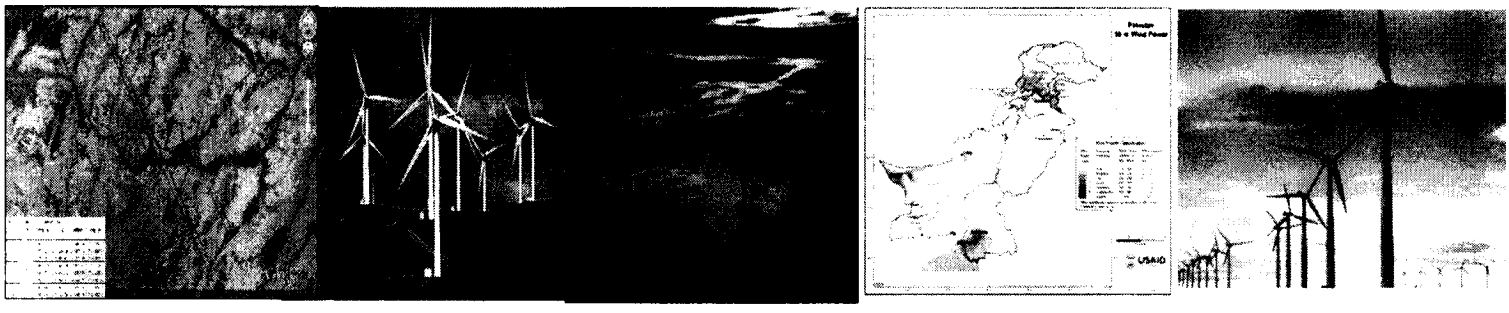
v. Proponent shall facilitate EPA Officer(s)/Official(s) as and when required for inspection of compliance status under provisions of Sindh Environmental Protection Act, 2014, rules and regulations framed there under and the conditions laid down in this approval.

w. The Department reserves the right to stipulate additional conditions, if found necessary and the company/ project proponent in a time bound manner will have to implement those conditions.

x. No violation of any regulations, rules, instruction and provision of SEP Act, 2014, shall be made and in case of any such violation of the rules/laws in the approval shall stand cancelled without any further notice.

6. All the environmental conditions of this approval shall be incorporated in the terms and conditions of Engineering, Procurement, Construction (EPC) & Operational & maintenance (O & M) tender document of the project for commitment and compliance.
7. The proponent shall be liable for compliance of SEP Act 2014 & EIA/IEE Regulations 2014, in force relating to conditions for approval, confirmation of compliance, entry, inspection and monitoring
8. The proponent shall be liable for compliance of EIA/IEE Regulation 2014 of SEP ACT 2014, which direct for conditions for approval, confirmation of compliance, entry, inspection and monitoring.
9. This approval is issued only for construction phase however, the validity for this approval is three years with effect from date of issuance
10. This approval shall be treated as null and void if all or any of the conditions mentioned above, is are not complied with. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force.

Waris Ali Gabol
(Deputy Director Tech)

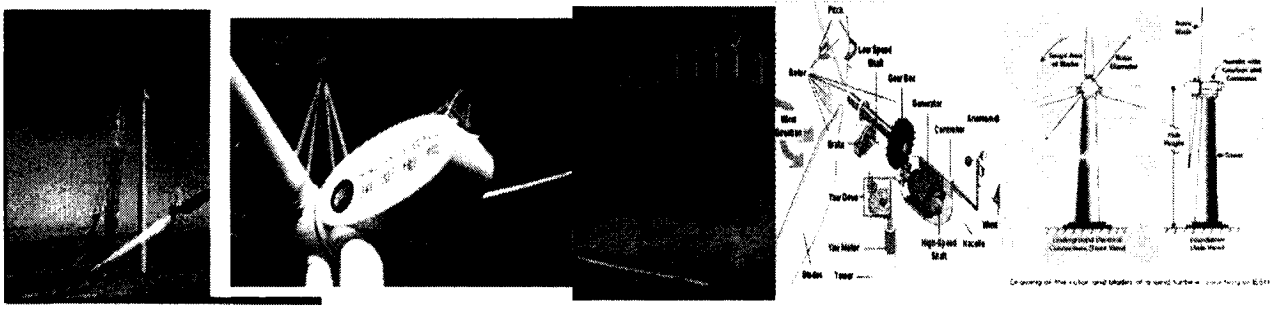


NOOR SOLAR ENERGY PVT LTD

50 MW WINDFARM

AT

JHIMPIR, THATTA, SINDH



INITIAL ENVIRONMENTAL EXAMINATION (IEE) REPORT

2016

ARCH ASSOCIATES

Table of Contents

Abbreviations

EIA	Environment Impact Assessment
IEE	Initial Environmental Examination
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
NEQS	National Environmental Quality Standard
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
ESRP	Environment & Social Review Procedure
OPIC	Overseas Private Investment Corporation
IFC	International Finance Corporation (World Bank Group)
ADB	Asian Development Bank
OPIC	Overseas Private Investors Corporation
ICBC	Industrial and Commercial Bank of China
EWEA	European Wind Energy Association
PEPC	Pakistan Environmental Protection Council
SEPA	Sindh Environmental Protection Agency
SS	Suspended Solids
WWF	World Wide Fund
SDPI	Sustainable Development Policy Institute
NTDC	National Transmission & Dispatch Company
NEPRA	National Electric Power Regulatory Authority
PEPA	Pakistan Environmental Protection Agency
EPC	Engineering, Procurement & Construction
O&M	Operation and Maintenance
CDM	Clean Development Mechanism
NSEL	Noor Solar Energy Pvt Limited
AEDB	Directorate of Alternative Energy, Energy Department Government of Sindh

Definitions

Act means the Pakistan Environmental Protection Act, 1997 and Sindh Environmental Protection Agency Act 2014

Aesthetic Value/Aesthetic Quality beauty or landscape (of an area)

Activation Energy - Activation energy of a reaction is the amount of energy needed to start the reaction.

Active Heating System - A solar water or space-heating system that moves heated air or water using pumps or fans

Alternative Fuel - A popular term for "non-conventional" transportation fuels made from natural gas (propane, compressed natural gas, methanol, etc.) or biomass materials (ethanol, methanol).

Ampere - A unit of measure for an electrical current; the amount of current that flows in a circuit at an electromotive force of one Volt and at a resistance of one Ohm. Abbreviated as amp.

Anthropogenic - Made or generated by a human or caused by human activity. The term is used in the context of global climate change to refer to gaseous emissions that are the result of human activities, as well as other potentially climate-altering activities, such as deforestation.

Carbon Dioxide - A colorless, odorless noncombustible gas with the formula CO2 that is present in the atmosphere. It is formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass) and by respiration, which is a slow combustion in animals and plants, and by the gradual oxidation of organic matter in the soil

Chemical Energy - Energy stored in a substance and released during a chemical reaction such as burning wood, coal, or oil.

Cumulative Effects - A project's effect on the environment combined with the effects of projects and activities (past, existing or imminent). These may occur over a certain period of time or distance.

Contamination introduction of impurities in the environment

Deforestation - The net removal of trees from forested land.

Direct Current - An electric current that flows in only one direction through a circuit, as from a battery.

Electrical Energy - The energy associated with electric charges and their movements.

Electricity - A form of energy characterized by the presence and motion of elementary charged particles generated by friction, induction, or chemical change.

Electricity Generation - The process of producing electric energy or the amount of electric energy produced by transforming other forms of energy, commonly expressed in kilowatt-hours (kWh) or megawatt hours (MWh).

Electric Motor – A device that takes electrical energy and converts it into mechanical energy to turn a shaft.

Electric Power - The amount of energy produced per second. The power produced by an electric current.

Emission - A discharge or something that is given off; generally used in regard to discharges into the air. Or, releases of gases to the atmosphere from some type of human activity (cooking, driving a car, etc). In the context of global climate change, they consist of greenhouse gases (e.g., the release of carbon dioxide during fuel combustion

Energy Consumption - The use of energy as a source of heat or power or as a raw material input to a manufacturing process.

Environment- The components of the earth including

(a) Land, water and air, including all layers of the atmosphere;
(b) All organic and inorganic matter and living organisms; and
(c) The interacting natural systems that include components referred to in (a) and (b).

Environmental Component - A fundamental element of the natural and human environment, such as air, water, soil, terrain, vegetation, wildlife, fish, avifauna and land use.

Environmental Effect - With respect to a project, any change that the project may cause in the environment, including any changes to health and socio-economic conditions, physical and cultural heritage, and current land and resources used for traditional purposes by Aboriginal persons. Also included are changes to any structure or site that is of historical, archaeological, paleontological or architectural significance, and any change to the project that may be caused by the environment

Environmental Assessment a technique and a process by which information about the environmental effects of a project is collected, both by the developer and from other sources, and taken into account by the planning authority in forming their judgments on whether the development should go ahead.

Environmental Management to carry out the developmental activities in sustainable manner

Global Warming - An increase in the near surface temperature of the Earth. Global warming has occurred in the distant past as the result of natural influences, but the term is today most often used to refer to the warming some scientists predict will occur as a result of increased anthropogenic emissions of greenhouse gases.

Greenhouse Effect - The effect of the Earth's atmosphere, due to certain gases, in trapping heat from the sun; the atmosphere acts like a greenhouse.

Greenhouse Emissions - Waste gases given off by industrial and power plants, automobiles and other processes.

Greenhouse Gases - Gases that trap the heat of the sun in the Earth's atmosphere, producing the greenhouse effect. The two major greenhouse gases are water vapor and carbon dioxide. Lesser greenhouse gases include methane, ozone, chlorofluorocarbons, and nitrogen oxides.

Grid - The layout of an electrical distribution system.

Habitat the general place or physical environment in which a population lives

Impact on Environment means any effect on land, water, air or any other component of the environment, as well as on wildlife harvesting, and includes any effect on the social and cultural environment or on heritage resources.

Megawatt - A unit of electrical power equal to 1000 kilowatts or one million watts.

Methane -A colorless, flammable, odorless hydrocarbon gas (CH4) which is the major component of natural gas. It is also an important source of hydrogen in various industrial processes. Methane is a greenhouse gas.

Mitigation - With respect to a project, the elimination, reduction or control of adverse environmental effects, including restitution through replacement, restoration, compensation or any other means for any damage to the environment caused by such effects.

Monitoring - A continuing assessment of conditions at and surrounding the action taken with respect to a project. Monitoring determines whether effects occur as predicted, operations remain within acceptable limits and if mitigation measures are as effective as expected.

Offshore - The geographic area that lies seaward of the coastline. In general, the coastline is the line of ordinary low water along with that portion of the coast that is in direct contact with the open sea or the line marking the seaward limit of inland water.

Offshore Reserves and Production - Unless otherwise dedicated, energy source reserves and production that are in either state or Federal domains, located seaward of the coastline.

Organic Waste - Waste material of animal or plant origin

Power - The rate at which energy is transferred. Electrical energy is usually measured in watts. Also used for a measurement of capacity.

Power Degradation - The loss of power when electricity is sent over long distances.

Power-Generating Efficiency - The percentage of the total energy content of a power plant's fuel which is converted into electric energy. The remaining energy is lost to the environment as heat.

Power Plant - A facility where power, especially electricity, is generated.

Recycling - The process of converting materials that are no longer useful as designed or intended into a new product.

Residual effects - Effects that remain after mitigation measures have been applied.

Soil Erosion physical removal of soil either by wind or by running water

Siltation accumulation of silt in a water body

Subsidence the sudden collapse of land into a hollow beneath it

Transformer - A device which converts the generator's low-voltage electricity to higher-voltage levels for transmission to the load center, such as a city or factory.

Transmission (Electric) - The movement or transfer of electric energy over an interconnected group of lines and associated equipment between points of supply and points at which it is transformed for delivery to consumers or is delivered to other electric systems. Transmission is considered to end when the energy is transformed for distribution to the consumer.

Transmission Line - A set of conductors, insulators, supporting structures, and associated equipment used to move large quantities of power at high voltage, usually over long distances between a generating or receiving point and major substations or delivery points.

Transmission System (Electric) - An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers or is delivered to other electric systems.

Wetland, a lowland area such as a march or swamp that is saturated with moisture, especially when regarded as the natural habitat of wildlife

Wind - The term given to any natural movement of air in the atmosphere. A renewable source of energy used to turn turbines to generate electricity.

Wind Machine - Devices powered by the wind that produce mechanical or electrical power.

Wind Tower - Devices, some as tall as 120 feet, which lift wind turbine blades high above the ground to catch stronger wind currents.

1

Executive Summary

Arch Associates –Management Consultants & Trainers was awarded the contract to conduct the Initial Environmental Examination (IEE) study for the 50 MW Wind farm proposed by Noor Solar Energy Pvt Limited (NSEL)

This report predominantly documents the environment impact assessment with respect to the following parameters

- Site Selection for Wind Farm
- Project Design w.r.t. Micrositing, Wind farm Layout, Hub height, Rotor diameter, Flickering effect, Noise impact etc
- Construction Phase
- Operational Phase
- Decommissioning Phase

The project development phase has recently started after getting the Letter of Intent (LOI) from Directorate of Alternative Energy, Energy Department Government of Sindh and land allocation from Government of Sindh (GoS) on January 14, 2016. Many information aspects are not yet available at the time of compiling this report, therefore the approach for environmental aspect identification and impact assessment was based on MECE (Mutually Exclusive, Collectively Exhaustive) methodology which directs to include broad range of aspects w.r.t. financing arrangement, regulatory requirements and controls of lender, turbine type, wind farm layout etc based on current under construction and operational wind farm projects in same region.

The IEE study process for this wind farm project make use of all International and National guidelines related to Wind Farm Projects Design, Construction and Operation. The initial project development phase of this project forms the basis of including broader range of lender regulatory framework.

Most common International lenders regulatory framework are from IFC/World Bank, OPIC, EWEA, ADB, Bank of China, ICBC and National regulatory framework is published by the Pakistan Environmental Protection Agency (Pak EPA), Sindh Environmental Protection Agency (SEPA).

Similarly Equator Principles (EP) is focused during the environmental assessment of this project as EP is the tool used by International lender for risk assessment.

The land for the proposed wind farm is located in Jhimpir, District Thatta, Sindh and is spread over an area of 330 acre. Currently a 120 meter wind mast has been installed and micrositing data collection and topographic survey including geological testing is in process. Based on the micrositing data, available technologies, financial considerations and experience of existing operational wind farms with existing turbines, turbine manufacturer and its make and model will be decided. Similarly application for tariff determination and generation license will be applied after completion of Grid Interconnectivity study, selection of EPC and O&M contractors

Noor Solar Energy Pvt Ltd (NSEL) will own the 25% of equity while for the remaining financing arrangements will be explored from International Lenders or local Banks or a consortium of International lenders or local Banks and the selection of financing source, mode and mechanism will be based on financial models.

Currently the project cost is estimated to be around USD 113 million. The project is expected to produce 151 GWh of electricity and the electrical power produced by this farm will be purchased by CPPA and distributed on national grid by NTDC.

The environmental impacts were assessed in compliance with relevant Pakistan and international environmental legislations and guidelines related to wind farm projects development and operations.

Since the project is located in an area which was historically reported as the major and significant migratory bird's route during winter, therefore the environmental impact related to mortality of birds due to wind turbines is also evaluated along with any human resettlement.

Based on the site evaluation and wind data measurement done by National Renewable Energy Laboratories (USA) under the USAID assistance program in 2007, the project locations within this Jhimpir area falls among the best wind corridors w.r.t. wind power generation.

Data on the pre-existing environmental baselines were collected with a site visit and through literature survey.

The wind farm will be developed in an area which is not under intensive agriculture use. There is no sensitive habitats with a high ecological value were found during the field survey on the proposed land and no impacts caused by the human settlement is expected. The same assessment is made regarding the possible impacts on soil.

Environmental Impacts and Mitigation

An environmental impact is assessed by first identifying the potential impact, followed by evaluating and quantifying (where possible) the impact before interpreting its significance. Environmental screening is a process through which the range of potential effects is evaluated to identify those that merit detailed assessment.

For the proposed wind farm, the impacts that were screened out as not requiring a detailed assessment are visual intrusion; archeological disturbance (no archeological sites in the vicinity of the wind farm); hydrological interference (no natural water courses in the vicinity of the wind farm); dust (it will be generated mostly within the project area during the construction phase well away from dwellings); public safety (no dwellings or regular human activity in the vicinity of the wind farm); and, cultural conflict (very short-term duration, that is, during the construction phase).

A more detailed and thorough assessment was, however, carried out for the impacts described below.

Loss of Habitat

The proposed project will acquire a 330 acre of land for the turbine towers and right of way for the access road. No rare or threatened vegetation species grow along the proposed site or access road. Most of the plants found here have a wide ecological aptitude and populations large enough to ensure their genetic diversity. The removal of a small portion of vegetation will not harm the overall diversity of plant communities in the area. Only raptors use the proposed site as a hunting ground and for soaring overhead.

Burrowing taxa, such as rodents and reptiles, will face some loss of habitat because of site preparation and access road construction.

The disturbance to wildlife will be minimized through management controls, such as reducing the size of the fenced area to the extent possible; training project staff to avoid killing or chasing wild animals; and minimizing noise generated by project activities.

Disturbance to Birds

Though not a significant impact, wind turbines affect birds' staging or roosting because of the noise they create, or because their location forces birds to change their migration paths. Studies indicate that wind turbines affect staging or roosting birds up to a distance of 500 m. Raptors are the only birds to roost in the desert portion of the proposed site.

Avian Collisions

It has been estimated that between 100 million to well over 1 billion birds are killed annually in the United States because of collisions with human-made structures. However, wind generation facilities account for only 10,000 to 40,000 of these fatalities.
This indicates that avian collision mortality attributed to wind turbines is the lowest when compared to other sources of mortality, and does not appear to cause any significant population impact.4 Auditory and visual stimuli will be used to warn birds of the turbines' presence.

Waste Disposal

The main types of waste that will be generated during the construction phase of the project are waste oil, camp waste, medical waste, demolition waste, packing waste, and excess construction material. Every effort will be made to minimize the waste generated while construction is in progress, and a special waste-minimization program will be initiated. In addition, project management will be responsible for all waste generated by the project until its final disposal. A waste disposal site will also be developed, containing a lined landfill and a burn pit. Furthermore, an inventory of all waste generated during the project will be maintained.

Aircraft Safety

Although wind turbines can pose a safety hazard for low-flying aircraft, the Civil Aviation Authority (CAA) has a detailed code that specifies the maximum height of structures that are allowed in the vicinity of commercial airports. The proposed wind turbines will meet CAA safety standards and will not interfere with aircraft.

Interference with Telecommunication Systems

The moving blades of a wind turbine can distort electromagnetic signals. In the Jhimpir area, four different sources of electromagnetic signals may be affected: the microwave communication link between Jhimpir and other towns of Sind, the television rebroadcast tower in Nooriabad, the VHF omni-directional radio (VOR) communication link, and the military radar. The wind turbines are not

expected to interfere with any of these sources of electromagnetic signals because they are situated too far away from these facilities.

Land Use Conflict

Previously in 2008, the local community claimed that the district revenue department of Thatta have record that the villages in this portion of land leased by Directorate of Alternative Energy, Energy Department (AEDB) Government of Sindh are the actually property of local community as these villagers are settled here for more than 100 years. Local community has raised objection regarding leasing of land by Sind Government to AEDB and by AEDB to private companies with no consultation from and compensation to local community.

Nevertheless, the project's footprint is only a small fraction of the total area of the leased for windfarm and it involves no relocation or resettlement.

It is, therefore, feasible for the wind farm and the project proponent intends to cultivate Biofuels and this cultivated land will become the source of income for the local community.

Employment Opportunities

There is a high expectation among the population of Jhimpir that the project will generate significant local employment opportunities. Skilled or unskilled labor brought in from outside Jhimpir is, therefore, likely to cause resentment in the local community, reducing opportunities for human capital development and creating tension between non-local labor and resident communities.
If suitably skilled labor is not available in Jhimpir itself, then residents of the Thatta district will be given preference, followed by residents of the rest of Sind, and then the rest of the country. Wherever feasible, local laborers will be trained to enhance their skills. No person under the age of 18 will be employed on the project.

Tourism Potential

At present, apart from a few occasional, local visitors, recreational visits to the proposed wind farm site are rare. The installation of the wind farm is likely to increase visitors to the area.

Environmental Benefits

Given that wind power is a 'clean' source of energy, its key environmental benefit is in terms of the emission offsets it provides. The wind farm will offset between 39,409 to 87,265 tons of carbon dioxide equivalent per year depending on the efficiency of the power plant that it will replace. Over a twenty-five year

time horizon, i.e. the assumed life of this project, the wind farm has the potential to offset 0.9 to 2.1million tons of CO2 equivalents.
It will also offset between 145 to 323 tons of sulfur dioxide. The local benefits of this are obvious in the sense that the ingestion of SO2 and particulates is harmful for human health. Sulfur dioxide also contributes to acid rain. Therefore, if a thermal power station option was exercised as opposed to the wind farm, the additional cost of mitigating the SO2 and particulate emissions would have to be borne.
The elimination of the need for fuel for generating electricity, such as high speed diesel (HSD), by switching to wind power will result in the elimination of the hazards associated with the transport and storage of flammable HSD and hydrocarbon contamination risks from spills.
Another important benefit is in terms of the elimination of cooling water requirements for the baseline case of diesel-based generation. It is estimated that nearly 106,000 m3 of water will be conserved on this account in this water-deficient region if the wind farm is developed instead.

Resulting from the investigation of the baseline conditions and the site evaluation and the mitigation measures adopted by the NSEL, we are of the opinion that the change in turbine rating from 1.5 MW to 1.6 MW will not have any adverse impact as the nature of change is related to software component which helps in increasing the efficiency of the turbine without any change in the hardware component or its functioning. Therefore we recommend that wind farm should be developed, constructed and operated without any significant and permanent environment impacts if the recommendations of the environmental management plan are followed.

2

Introduction and Purpose of Study

Introduction

Background

Pakistan is facing severe energy shortages since 2006. The main reasons include inadequate capacity addition, limited exploration, ineffective exploitation of hydro and coal, renewable potential and inefficient use of energy resources. The situation leads to a demand supply gap resulting in load-shedding of electricity and gas. Pakistan continues to suffer from the power crisis as nearly one-third of demand for electricity, during 2013-14 could not be met due to the supply constraints. On average, the supply deficit of around 5,000 Megawatt (MW) was experienced, while it touched the peak of over 7,000 MW in July 2014

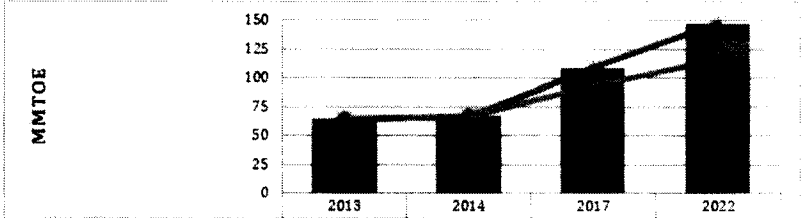
The energy demand in Pakistan has largely increased during the last decades, with an increment in the number of consumers by 83% between 1992 and 2006. The expected electricity supply-demand gap is illustrated below

Electricity Supply Vs Demand

	2010	2011	2012	2013	2014	2015	2016	2017
Expected Available Generation	18503	20814	21167	23368	23538	24408	25630	27481
Demand (Summer Peak)	19352	20874	22460	24126	25919	28029	30223	35504
Deficit	-849	-60	-1293	-758	-2381	-3621	-4593	-8023

Note : Electricity Demand Increasing@ 8 % per Annum
Source : Private Power & Infrastructure Board - Govt of Pakistan

Based on the above electrical power supply-demand deficit and the expected power generation, below table illustrates the primary energy demand to cater the expected available generation.



	2013	2014	2017	2022
Coal	3.86	8.9	9.8	15.7
Hydro-Nuclear-Imported	8.31	3.6	11	18.4
Gas	31.45	31.3	52.3	69.4
Oil	20.97	23.0	36.2	44
Total at GDP growth Rate 6.5% (ACGR 6.09%)	64.59	66.80	109.3	147.5
Total at GDP growth Rate 4.5% (ACGR 4.37%)	64.59	66.80	93.5	116

Data Source: Petroleum Institute of Pakistan-Energy Outlook 2007-22 FY 2013 & 14 actual figures
Source: HDIP Energy Year Book 2014

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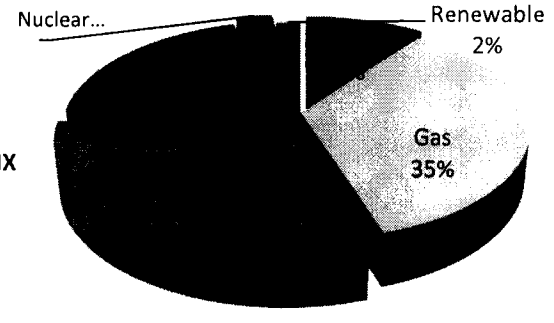
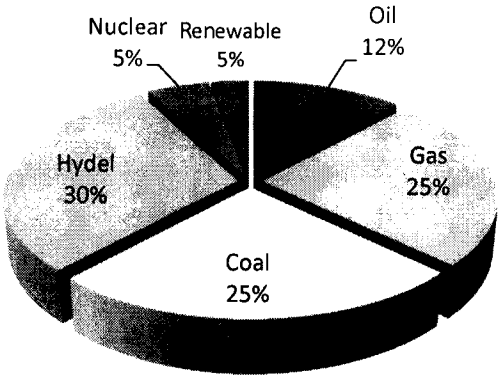
There is rising need for alternate and renewable sources of energy, especially in Pakistan whose progress and economic growth is strongly be indexed to its development. With the finalization of China-Pakistan Economic Corridor (CPEC), renewable energy projects in Sindh have been marked as the high priority projects.

Based on this Pakistan revisited its energy mix model and the future energy mix and electricity generation by renewable source is depicted below

PRIMARY ENERGY MIX
PLAN 2030



ELECTRICITY
GENERATION BY SOURCE
PLAN 2030



At the same time, according to the World Bank Report of 2013 *(Ref: Reducing Poverty by Closing South Asia's Infrastructure Gap)* only 67 % of the population in Pakistan has access to electric power. The remaining 33 % of the population without electricity lives in rural and mountainous areas. Due to the remoteness of rough terrain, the extension of the national grid to these areas is uneconomical. Development of renewable energy sources would provide electricity to the remote areas and less-developed regions of the country.

Small-scale applications could provide power in remote and backward areas, facilitating development of these areas, providing job opportunities to rural poor and enhancing children's welfare, health and education. In this sense, 14 micro wind turbines were installed in 2002 for demonstration purposes in the regions of Sindh and Baluchistan; they proved that small-scale wind farms are viable, in both economic and technologic senses, for the electrification of remote communities living far from the national grid. At the same time, large applications, connected to the national grid, could help alleviate power shortages in the country (Mirza et al., 2007). Therefore, renewable energies are a suitable option for reducing the national energy deficit and at the same time encourage the development of remote areas without access to electricity.

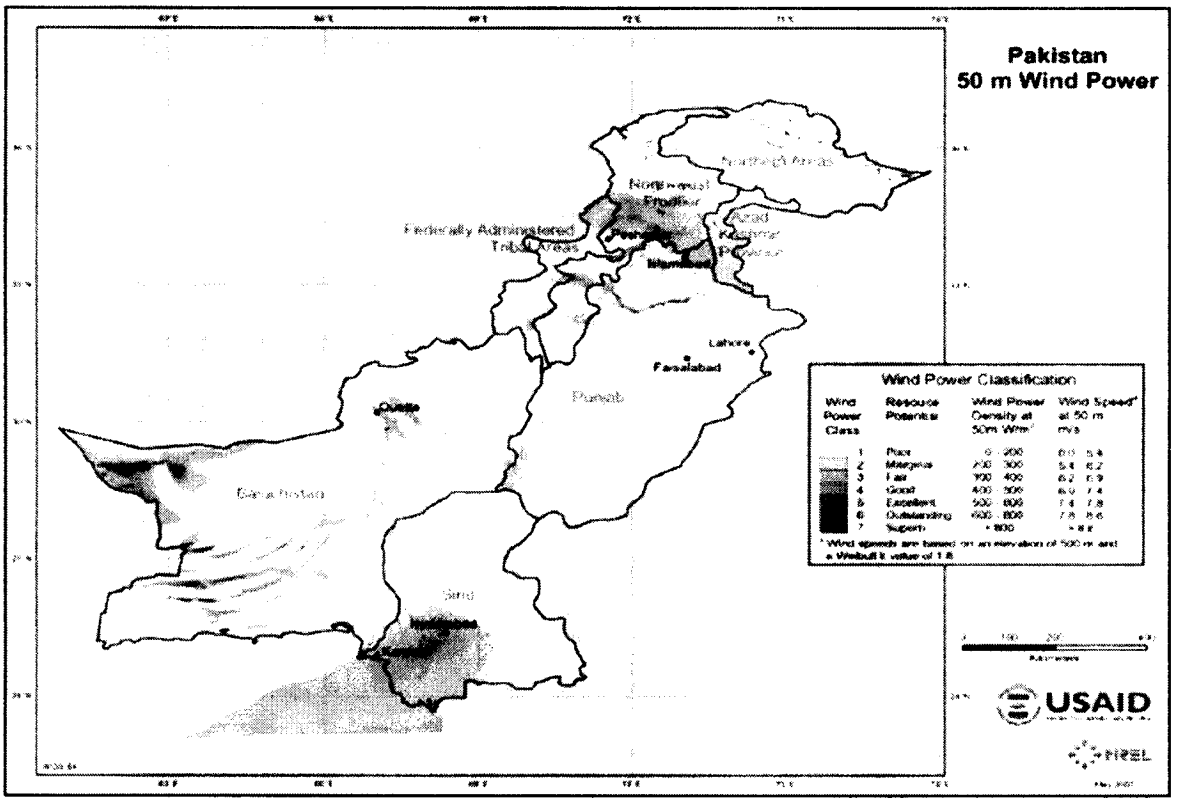
Pakistan Wind Resource Mapping by USAID

In Pakistan major wind resource areas are

- Southeastern Pakistan especially
  - Hyderabad to Gharo region in southern Indus Valley
  - Coastal areas south of Karachi
  - Hills and ridges between Karachi and Hyderabad
- Northern Indus Valley especially
  - Hills and ridges in northern Punjab
  - Ridges and wind corridors near Mardan and Islamabad
- Southwestern Pakistan especially
  - Near Nokkundi and hills and ridges in the Chagai area
  - Makran area hills and ridges
- Central Pakistan especially
  - Wind corridors and ridges near Quetta
  - Hills near Gendari
- Elevated mountain summits and ridge crests especially in northern Pakistan

Windy land area and theoretical wind potential estimates indicates

- Class 4+ (good-to-excellent for utility-scale applications)
  - 26,400 sq km, about 3% of Pakistan's total land area (800,000 sq km)
  - 132,000 MW of potential installed wind capacity (assumes 5 MW/sq km)
- Good potential for many wind/diesel and off-grid applications
  - Almost 9% of Pakistan's land area has Class 3 or better wind resource



PAKISTAN - WIND ELECTRIC POTENTIAL

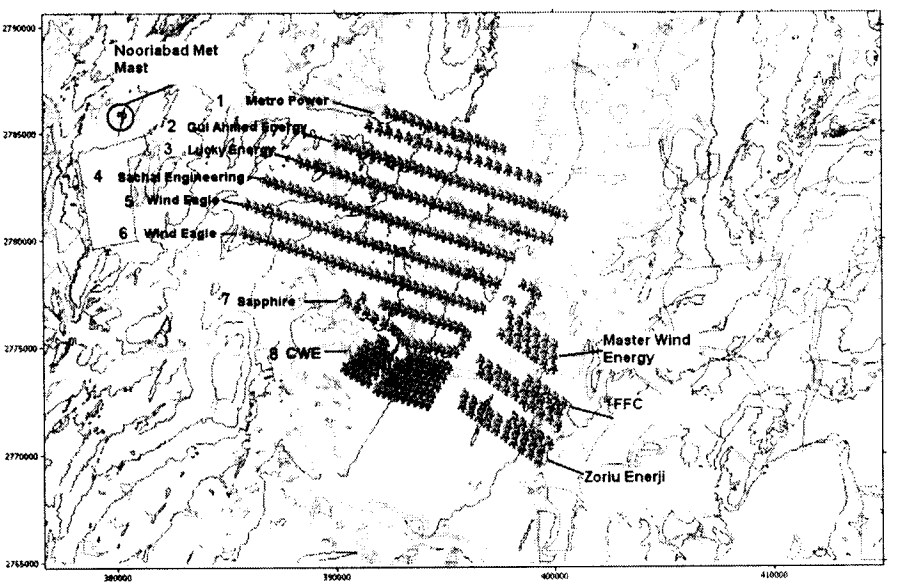
Good-to-Excellent Wind Resource at 50 m (Utility Scale)

Wind Resource Utility Scale	Wind Class	Wind Power W/m^2	Wind Speed m/s	Land Area km^2	Percent Windy Land	Total Capacity Installed MW
Good	4	400 - 500	6.9 – 7.4	18,106	2.1	90,530
Excellent	5	500 - 600	7.4 – 7.8	5,218	0.6	26,090
Excellent	6	600 - 800	7.8 – 8.6	2,495	0.3	12,480
Excellent	7	> 800	> 8.6	543	0.1	2,720
Total				26,362	3.0	131,800

Assumptions
Installed capacity per km^2 = 5 MW
Total land area of Pakistan = 877,525 km^2
Only land area included in calculations

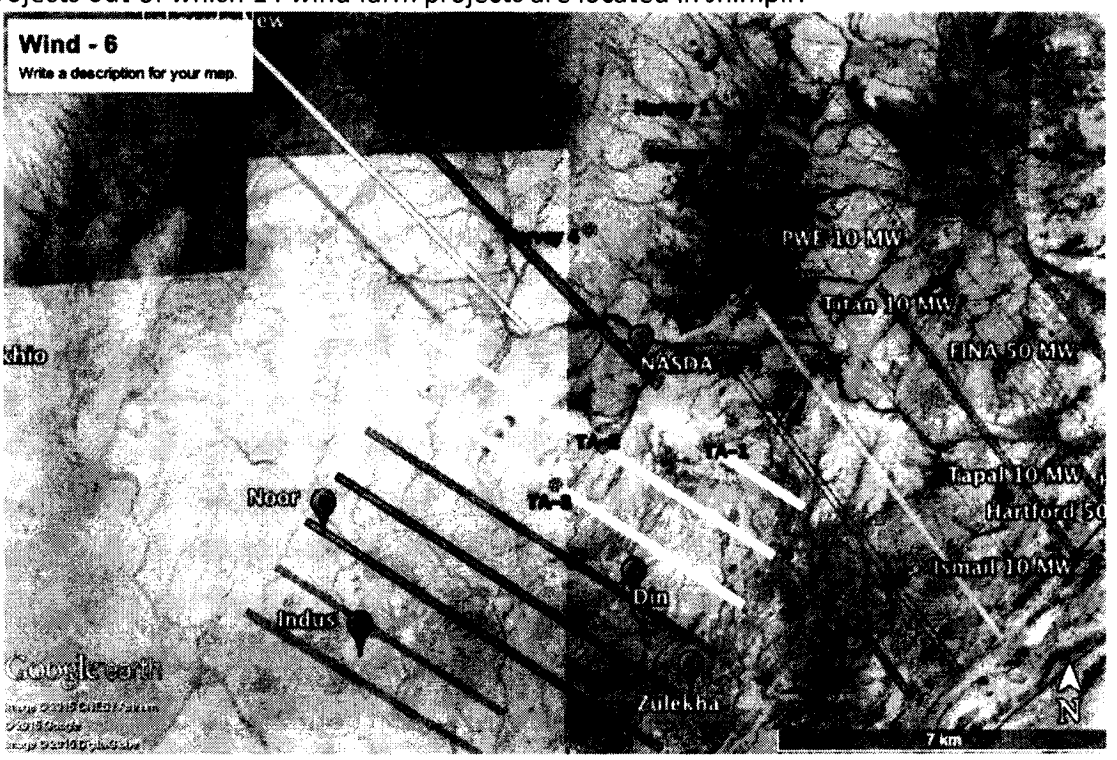
The Gharo –Keti Bundar and Jhimpir-Jamshoro Wind Corridor

According to studies of the Pakistan Meteorological Department (PMD) and National Renewable Energy Laboratories (NREL-USA) under the USAID assistance program in 2007, the Gharo-Jhimpir corridor (Sindh region, Pakistan), with a length of 180 km and width of 60km having average monthly wind speed of 7-8 m/s is identified among the best wind corridors in world having the potential to generate 60,000 MW of electricity by means of wind power (Alternative Energy Development Board). Detailed studies have been carried out by the government of Pakistan in order to assess the wind power potential of Gharo, it being considered suitable for the development of commercial wind energy plans. As a result, in Jhimpir area currently four wind farms 200 MW are operational while five wind farms 250 MW are under construction phase as a first phase plan to produce 700 MW of wind power in two areas of the region (Gharo Coastal and Inland Jhimpir Wind Farm sites) by means of 14 wind farms of 50 MW, whose location is shown in the cartography of this report, and some investors have already been allotted land for developing their wind farms.



CURRENT UNDER CONSTRUCTION AND OPERATIONAL WIND FARMS IN JHIMPIR

Recently Government of Sindh has allotted land to 33 project proponets of wind and solar projects out of which 14 wind farm projects are located in Jhimpir.



PROPOSED PROJECTS UNDER DESIGN PHASE IN JHIMPIR

Alternate Energy Development Board (AEDB)

Alternative Energy Development Board (AEDB) was established in 12th May 2003 for development, promotion and facilitation of renewable energy technologies, formulation of plans, policies and development of technological base for manufacturing of renewable energy equipment in Pakistan.

AEDB has been tasked to ensure 5% of total national power generation capacity (i.e. 9700 MW) to be generated through renewable energy technologies by the year 2030.

Since then, AEDB has remained engaged in establishing national and international linkages, foster sustainable development and use of alternative / renewable energy through initiation of policies, projects, and enhancement of technical skills in the alternative energy fields. All these initiatives are directed towards creating a market-based environment that is conducive to private sector investment and participation.

2.1 Project Proponent

Noor Solar Energy Pvt Limited (NSEL) which is the project of Liberty Textile Mills Group, is the project proponent for establishing a wind farm in Jhimpir. NSEL will develop, own and operate a 50 MV wind farm as independent power project (IPP) in Sindh.

2.2 Project Overview

NSEL has received the LOI from AEDB and land allocation from Government of Sindh. Currently NSEL project is in initial design phase and wind data collection and geological survey is in process.

Based on the micrositing data, soil testing, geological survey, grid interconnectivity study, different turbine manufacturers and turbine make & model will be evaluated along with selection of EPC and O&M contractor.
The project will have 15 months of construction phase and expected to come in operation by 2018

NSEL will develop wind farm and the sub-station while CPPA will be the purchaser of power and NTDC will evacuate the power from project door step. The provision of infrastructure w.r.t power transmission on the main Grid will be the responsibility of NTDC.

The environmental factors related to wind farm mainly flickering effect, noise were considered based on the available technologies and configuration of turbines, different manufacturer's (GE, Nordex, Vestas, Gamesa and Goldwind) specifications and the calculation of results from tools provided by Danish Wind Energy.

2.2.1 Lifespan of the Wind Farm

It is envisaged that the wind farm will be in operation for up to 20 years. At the end of this period the wind farm will either be decommissioned or new wind turbines will be installed. Once the wind farm has reached the end of its lifespan, the decommissioning process will include removal of the turbines and the return of the site to its condition prior to the construction of the wind farm.

2.3. Purpose of Study and Introduction of IEE

2.3.1 Purpose of Study

Wind farms are usually located in exposed and windy landscapes and the value placed upon these landscapes and the perceived impacts of development upon them vary considerably. Generally, responses depend on both the individual observer and the site being considered.

Sindh Environmental Protection Act 2014 (SEPA 2014) requires the proponents of every development project in the province of Sindh to submit either an Initial Environmental Examination or Environmental Impact Assessment to the Sindh Environmental Protection Agency (SEPA).

The IEE/EIA Regulations 2014 issued under SEPA 12014 provides separate lists for the projects requiring IEE or EIA. Wind farms of any capacity if not located in environment sensitive area falls under IEE category of study.

2.3.2.Objectives of IEE

- To evaluate the NSEL IPP development, operational and decommissioning activities in line with Sindh Environmental Protection Agency standards, and applicable international environmental guidelines during the phase of design phase, pre-construction activities e.g. land development, layout planning, infrastructure and amenities development, construction activities e.g. wind turbine foundations construction, equipment transportation, Turbines installation, sub-station construction, operation and decommissioning of wind farm.

- To highlight existing environmental conditions of the project area along-with the identification of environmentally sensitive area and stake holders

- To address and assess the various activities (such as planning, infrastructure, construction, installation and operation of turbines etc).

- To identify environmental aspects associated with all phases of wind farm life cycle, their potential impacts on environment, evaluate these impacts, determine their significance and determine mitigation measures to reduce/control the impacts.

- **To propose**
  - appropriate mitigation measures that can incorporated into the wind farm layout (TSF layout, wind turbines location, access road layout, sub-station layout etc)
  - operational controls for environmental aspect including occupational health & safety
  - activities that minimize hazardous effects.

- To identify the consequences identified on the basis of environmental assessment.

- To monitor aspects in line with NEQS – Pakistan and IFC standards.

2.3.2 Scope of IEE

The DEL 50 MW IPP IEE study covers the following:-

- Description of physical, environmental, and socio-economic condition in and around the site of project location within 5 km. of radius.
- Impact identification and significance at all stages of planning, implementation, and operation.
- Identification and assessment of the workability of operational controls to mitigate or minimize negative project impacts on environment

2.4 Approach and Methodology

IEE study for NSEL 50 MW IPP confines to four main phases comprising of scoping, baseline study, impact assessment and necessary documentations, as per following details.

2.4.1 Scoping

- Project data compilation for generic description of the proposed activities, within the project area relevant to environmental assessment.
- Data on weather, soil, water resources, wildlife and vegetation within and around 10 km. radius of the project was reviewed and compiled.
- Information on applicable legislation, regulations, guidelines and standards was reviewed and compiled.
- Identification of aspect and their potential impacts were reviewed in considering the data of the above steps.

2.4.2 Baseline Data Collection

Sufficient baseline information on the project area was available from existing literature and studies at site and locations close to the project area were conducted. A field visit was conducted to collect primary data on the proposed site.

2.4.3 Impact Assessment

The environmental, socioeconomic, and project information collected was used to assess the potential impacts of the proposed activities. The issues studied included potential project impacts on:

- Geomorphology;
- Groundwater and surface water quality, with particular reference to the coast.
- Ambient air quality and ambient noise levels;
- The ecology of the area, including flora and fauna
- Local communities;
- Baseline Noise Assessment
- Flickering Effect
- Birds Collision Risk Analysis

2.4.4 Vegetation Survey

The vegetation survey was carried out to find out the plant species in the proposed premises and within 5 km radius of project site. A large quantity of wild bushes, herbs, shrubs, different types of grass, different types of trees, parasitic plants were found. Plenty of floral species of several types are also exists.

2.4.5 Wildlife Study

Wildlife survey was carried out to find faunal species in the proposed premises and within 10 km. radius of mill site. Mammals, dogs, flies, reptiles, birds exist in the surrounding area of the project.

2.4.6 **Physical Environment:** Physical Environmental study was carried out for potable water, surface water, ground water and soil of the area. Test results of potable water, surface water, ground water and soil are placed at Annexure.

2.4.7 Socioeconomic Study:

Social assessment was conducted for livelihood, culture, leadership, gender issues, spiritual and temporal leadership, demographic information, existing use of land

resources, community structure, employment, distribution of income, goods and services, public health, local religious and cultural values, and local customs, aspirations, and attitudes.

2.4.8 **Archeological Study**

Team also visited an archeological site outside the project area. The study included field survey. During the survey, sites of archeological or historical significance were identified and documented.

2.4.9 **Impact Assessment**

Potential impacts was studied with respect to:

- Geomorphology ;
- Groundwater and surface water quality ;
- Ambient air quality;
- Ecology of the area, including flora and fauna;
- Local communities;
- Identification of potential impacts;
- Likelihood and significance of potential impacts;
- Mitigation measures to reduce impacts to as low as possible;
  Prediction of impacts, including all long-term and short-term, direct and indirect and adverse impacts ;
- Evaluation of the importance or significance of impacts ;
- Implementation of mitigation measures (i.e. environmental management) ;
- Determination of residual impacts :
- Identification of controls and monitoring of residual impacts.

2.4.11 **Documentation**

Documentation includes environmental impacts assessment reports in line guidelines of the Pakistan Environmental Protection Agency, along with the followings:

- Findings of the assessment;
- Impacts detail and
- Mitigation measures.

2.5. Method for Evaluating Impacts.

The description of baseline conditions (see Section-4) represents the basis for evaluating the impacts of the project. The description and evaluation of the environmental impacts are presented in Section 6 --9. "Impacts assessment during site selection, project design, construction and operation phase". Notes and proposals for measures to be taken to mitigate and compensate for any determined environmental impacts are contained in the environmental management plan (EMP) as well as a monitoring plan, including all parameters that need to be measured, and the frequency of monitoring (Section 10)

In the interest of transparent presentation and evaluation, tabulated evaluation procedures has been applied. On the basis of a point system, the severity of a particular environmental impact together with its general trends i.e. negative or positive is described. The evaluation scale applied is as follows

Extent of Impact

❑❑❑	= High
❑❑	= Medium
❑	= Low
○	= No impact
✓	= Locally favorable
✓✓	= Regionally favorable

For this judgment, international and national standard like those of the World Bank, WHO, etc are used (Section 3). According to these standards, impacts are evaluated as follows

Extent of Impact	Reason
High	International and national standards are exceeded.
Medium	Between international and national standards
Low	International and national standards are met

2.6 Organization of this report

- Section 1 of this report briefly discusses the Executive Summary.
- Section 2 of this report discusses the introduction about the project and purpose of the IEE study.
  Section 3 of this report discusses Regulatory framework in the form of policy and guidelines for this project and resulting legislation for sustainable development and environmental protection, and then presents the legislative requirements that need to be followed while conducting an IEE.
- Section 4 of this report describes the environment of project area's Including the existing physical, biological, and socioeconomic condition, including geomorphology and soils, water resources, and air quality, flora and fauna, and demography.
- Section 5 of this report describes the project description of the proposed windfarm project.
- Section 6 of this report describes the environmental impacts related to site selection
- Section 7 of this report describes the environmental impacts related to Project design and layout
- Section 8 of this report describes the environmental impacts related to Construction phase of the windfarm
- Section 9 of this report describes the environmental impacts related to Operation phase of the windfarm
- Section 10 of this report presents the Environmental Management and Monitoring Plan.
- Section 11 of this report presents the Public Consultation Process and the feedback from the public.
- Section 12 of this report presents the Analysis of Project Alternatives

3

Policy, Legal and Administrative Framework

Policy, Statutory and Institutional Framework

The study of environmental assessment is tangible means that highlight the project under discussion is environmentally sound and sustainable depends in large measure on the capability of regulatory institutions for environmental management. Sustainable development is a concept that has emerged over the past three decades to describe a new framework aimed at economic and social development whilst maintaining the long-term integrity of the ecological system. The principles of sustainable development are in the process of being incorporated into national policies and legislation in Pakistan through various statutory instruments. As in the project financing from the foreign company is involved, the assessment has been carried out to comply with both local and IFC guidelines. This chapter describes the current legal framework for assessment of the proposed project in the context of the environment and sustainable development, and the institutions that exist in Pakistan that may influence the environmental management, and the IFC including World Bank.

The Government of Pakistan has actively pursued the cause of environmental protection. It has been a party to several international declarations, agreements and conventions and has also ratified these documents.
Pakistan has also created organizational structures and enacted rules for the protection of the environment. The Constitution of Pakistan contains provisions for environment protection and resource conservation. Several laws exist for the protection of the environment, which are discussed below.

Pakistan Penal Code 1861 (adopted from British legacy), which is a general criminal law, and applies all over the country, contains specific provisions on the subject. Thus it prohibits mischief by killing or maiming animals, or damaging works of irrigation or a river or a road or a bridge or drain or firing explosive substances with intent to cause damage. The Code also prohibits public nuisance by acting negligently to spread the infection of disease or disobeying quarantine rule or causing adulteration of food or drink or drug, or fouling water or making the atmosphere noxious to health etc.

The promulgation of the **Environmental Protection Ordinance, 1983** was the first codifying legislation to the issue of environmental protection. Later, the

Government passed the **Pakistan Environmental Protection Act (PEPA), 1997**, which is the basis of IEE/EIA studies carried out for the projects in Pakistan.

3.1 Statutory Requirements of Pakistan

3.1.1 Overview

The development of statutory and other instruments for environmental management has steadily gained priority in Pakistan since the late 1970s. The Pakistan Environmental Protection Ordinance, 1983 was the first piece of legislation designed specifically for the protection of the environment. 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 (NCS) in 1992. Provincial environmental protection agencies were also established at about the same time. The National Environmental Quality Standards (NEQS) were established in 1993. The enactment of the Pakistan Environmental Protection Act, 1997 (PEPA, 1997) conferred broad-based enforcement powers to the environmental protection agencies. The publication of the Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2000
(IEE-EIA Regulations, 2000) provided the necessary details on the preparation, submission, and review of initial environmental examinations and environmental impact assessments.

The Ministry of Environment deals with environment and wildlife issues at the federal level. Within the ministry, the Pakistan NCS unit established in 1992 is responsible for overseeing the implementation of the NCS.
Two organizations, the Pakistan Environmental Protection Council (PEPC) and the Pak-EPA, are primarily responsible for administering the provisions of the PEPA 1997. The PEPC oversees the functioning of the Pak-EPA. Its members include representatives of the government, industry, non-governmental organizations, and the private sector. The Pak-EPA is required to ensure compliance with the NEQS, establish monitoring and evaluation systems, and both identify the need to, as well as initiate legislation whenever necessary. It is thus the primary implementing agency in the hierarchy. The provincial environmental protection agencies (EPA's) are the provincial arms of the federal EPA, which is authorized to delegate powers to its provincial counterparts. One of the functions delegated by the Pak-EPA to the provincial EPA's is the review and approval of environmental assessment reports.

Each provincial government has its own environmental protection institution responsible for environmental pollution control. The Sindh Environmental

Protection Agency is responsible for the approval of the EIA and IEE of new developments undertaken in Sindh.

3.1.2 National Conservation Strategy

The NCS is a broad-based policy statement aimed at achieving environmentally sustainable economic and social development in Pakistan. The three overriding objectives of the NCS are:

- Conservation of natural resources
- Sustainable development
- Improved efficiency in the use and management of resources.

Three operating principles are identified to achieve these objectives. These are:

- Greater public participation in development and environmental management
- A merging of environment and economics decision-making
- Lasting improvements in the quality of life.

The NCS was developed over a nine-year period (1983-1992) after an extensive consultation process with thousands of experts, interested individuals, communities, nongovernmental organizations (NGOs), and government agencies. The Federal Cabinet approved the documents in March 1992, as the principal policy document for environmental management in the country.

The NCS sets out the basic guidelines for an integrated effort aimed at protecting the environment and natural resources of the country. This broad framework provides a comprehensive point of reference for all agencies, departments, private sector companies, financial institutions, and donor agencies for undertaking systematic efforts to bring about an effective change for sustainable development.

The NCS has three main parts.

Part 1, Pakistan and the Environment, provides the context of the document.

Part 2, Elements of National Conservation Strategy, contains the basic policy statement. It defines the objectives and principles of the NCS and then discusses issues and opportunities for sustainable development in various sectors and the policy measures required to address these issues.

Part 3, Implementation Arrangements, provides the action agenda and implementation strategy. It is organized into 14 program areas for priority implementation. Within the 14 program areas, 68 specific programs have been identified and long-term goals and expected outputs and physical investments have been identified for each. The implementation strategy discusses the role of

the various tiers of the government as well as that of the community and private sector.

The NCS proposes policies in 14 primary, secondary, and tertiary sectors. Of these, the policies and measures proposed in nine sectors (agriculture, forest management, rangeland rehabilitation, livestock management, water resources,1 wildlife, mineral resources, energy, and human settlement) do not have direct relevance to the proposed project. The policies proposed in marine and coastal resource management, fisheries, industrial development, pollution control, and tourism are relevant to the proposed project. The policies for these sectors include the following:

i. Marine and coastal resource management: Development of alternate sources of employment for coastal communities to prevent over-exploitation of coastal resources such as mangroves; conducting research on environmental and social impact of traditional resource-use practices

ii. Fisheries: Development of sea fisheries to the sea's full sustainable yield level; protection and restoration of shrimp fishing habitat

iii. Industrial development: Development and enforcement of effective pollution controls; promotion of clean industrial processes and recycling; establishment of incentives for environmental beneficial or benign industries; development of a policy for setting of industries in areas of low environmental sensitivity; building awareness within industry.

iv. Pollution control: Promotion of domestic wastewater treatment technologies that provide for
recovery and reuse of water, nutrients, and organic matter; focusing on the regulatory approach for industrial discharge; supporting recovery and use of heavy metals from industrial effluents; promoting biological methods of wastewater treatment wherever practicable; giving priority to areas where there is a risk of groundwater contamination; promotion of proper maintenance of motor vehicles, industrial boilers, and furnaces; encouragement of higher fuel efficiency in motor vehicles; undertaking environmental impact of plant sitting; promotion of reuse and recycling; encouraging marketing assistance for effective use of scavenging systems.

v. Recreation and tourism: Supporting the 1991 Tourism Policy's top priority of protecting, conserving, and restoring the basic natural capital and heritage resources

The proposed project is consistent with the stated policies on marine and coastal resource management and on fisheries. As 97% of the fresh water consumption is in the agricultural sector, the policy focuses on increasing irrigation efficiency.

3.1.3 Statutory Framework

The key environmental laws that have implications for the proposed project are discussed as under::

i. **Sindh Environmental Protection Act, 2014** : The SEPA, 2014 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. The key features of the law that have a direct bearing on the proposed project relate to the requirement for an initial environmental examination (IEE) and EIA for development projects. Section 12(1) requires that: "No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an initial environmental examination or, where the project is likely to cause an adverse environmental effect, an environmental impact assessment, and has obtained from the Federal Agency approval in respect thereof." The Pak-EPA has delegated the power of review and approval of environmental assessments to the provincial environmental protection agencies. As the proposed project will be located near Karachi, it falls under the jurisdiction of the PEPA.

ii. **Sindh Environmental Protection Agency Review of IEE and EIA Regulations, 2014**

The SEPA, 2014 provides for two types of environmental assessments: IEE's and EIA's. EIA's are carried out for projects that have a potentially 'significant' environmental impact, and IEE's are conducted for relatively smaller projects with a relatively less significant impact. The IEE-EIA Regulations, 2014, prepared by the Sindh-EPA under the powers conferred upon it by the SEPA, 2014 categorizes projects for IEE and EIA. Schedules I and II, attached to the IEE-EIA Regulations, 2014, list the projects that require IEE and EIA, respectively.

The proposed project falls into the category that requires an IEE. The IEE-EIA Regulations, 2014 also provide the necessary details on the preparation, submission, and review of IEEs and EIAs. The following is a brief step-wise description of the approval process:

- A project is categorized as requiring an IEE or EIA using the two schedules attached to the Regulations.
- An EIA or IEE is conducted as per the requirement following the Pak-EPA and guidelines.

- The EIA or IEE is submitted to the concerned EPA—provincial EPA if the project is located in the provinces or the Sindh-EPA if it is located in Islamabad.
- A fee, depending on the cost of the project and the type of the report is submitted along with the document.
- The submittal is also accompanied by an application in the format prescribed in Schedule IV of the Regulations
- The EPA conducts a preliminary scrutiny and replies within 10 days of the submittal of a report, a) confirming completeness, or b) asking for additional information, if needed, or c) returning the report requiring additional studies, if necessary.
- The EPA is required to make every effort to complete the IEE and EIA review process within 45 and 90 days, respectively, of the issue of confirmation of completeness.
- When the EPA's accord their approval subject to certain conditions: Before commencing construction of the project, the proponent is required to submit an undertaking accepting the conditions.
- Before commencing operation of the project, the proponent is required to obtain from the EPA a written confirmation of compliance with the approval conditions and requirements of the EIA.
- An Environmental Management Plan (EMP) is to be submitted with a request for obtaining confirmation of compliance.
- The EPA's are required to issue confirmation of compliance within 15 days of the receipt of request and complete documentation.
- The IEE approval is valid for three years from the date of accord. This IEE has been prepared following the guidelines of the Sindh-EPA. It will be submitted to the SEPA by the NSEL.

A monitoring report is to be submitted to the EPA after completion of construction, followed by annual monitoring reports during operation.

3.1.4 National Environmental Quality Standards

The NEQS were first promulgated in 1993 and have been amended in 1995 and 2000. The NEQS specify the following standards:

i. Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to inland waters, sewage treatment facilities, and the sea (three separate sets of numbers).

ii. Maximum allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources.

iii. For power plant operating on oil or coal: a. Maximum allowable emission of sulfur dioxide from the power plant b. Maximum allowable increment in concentration of sulfur dioxide in ambient air due to operation of the plant c. Maximum allowable concentration of nitrogen oxides in ambient air when the plant is operating d. Maximum allowable emission of nitrogen oxide for steam generators as a function of heat input.

iv. Maximum allowable concentration of pollutants (2 parameters) in gaseous emissions from vehicle exhaust and noise emission from vehicles. The complete set of NEQS is placed at the end of this report at Annexure-

3.1.5 The Sindh Wildlife Protection Ordinance 1972

The Sindh Wildlife Protection Ordinance, 1972 empowers the government to declare certain areas reserved for the protection of wildlife and control activities within these areas. It also provides protection to endangered species of wildlife. As no activities are planned in declared protected areas, no provision of this law is applicable to the proposed project.

3.1.6 The Sindh Fisheries Ordinance, 1980

The Sindh Fisheries Ordinance, 1980 regulates fishing in the public waters, including the coastal areas, of Sindh. It empowers the government of Sindh to issue licenses for fishing in public waters, put restriction on the type of equipment that can be used for fishing, restrict fishing in certain areas or of certain species of fish, regulate the onshore trade of fish catch, and regulate the fish processing industry. Article 8 of the Ordinance prohibits the discharge of wastewater to public waters without the consent of the Director Fisheries. A copy of the EIA report will be sent to the Director Fisheries, Government of Sindh for his consent when the report is submitted to the SEPA for environmental approval.

3.1.7 The Forest Act, 1927

The Forest Act, 1927 empowers the government to declare certain areas reserved forest. As no reserved forest exists in the vicinity of the proposed project, the provisions of this law are not applicable to the proposed project.

3.1.8 Hazardous Substance Rules, 2003 (Draft)

Section 14 of the PEPA 1997 requires that "no person shall generate, collect, consign, transport, treat, dispose of, store, handle or import any hazardous substance except (a) under a license issued by the Federal Agency and in such

manner as may be prescribed; or (b) in accordance with the provisions of any other law for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement or other instrument to which Pakistan is a party." Pak-EPA has drafted the Hazardous Substance Rules to implement the licensing requirement. The rules are still in their draft form and are pending notification.

3.1.9 The Antiquities Act, 1975 & the Sindh Cultural Heritage (Preservation) Act, 1994

The Antiquities Act of 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 Government of Pakistan 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 Department of Archaeology, Government of Pakistan any archaeological discovery made during the course of the project. 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. No antiquity protected under these two laws was identified in the vicinity of the proposed project.

2.1.10 Other Relevant Laws

Some of the other relevant laws and legislations are listed below:

Industrial Relations Ordinance, 1969
Canal and Drainage Act, 1873
The Explosives Act, 1884
The Ports act, 1908
The Fire Wood and Charcoal (Restriction) Act, 1964
Motor Vehicles Ordinance, 1965
The West Pakistan Regulation and Control of Loudspeaker and Sound Amplifier Ordinance, 1965
Agriculture Pesticides Ordinance, 1971
Sind Building Control Ordinance
Sind Local Government Ordinance
Karachi Development Authority Order
Karachi Development Authority (Amendment) Order
Karachi Building and Control Authority Regulations

3.2 Guidelines

Key environmental guidelines are reviewed below.

i. **Pakistan Environmental Assessment Procedures**: The Federal EPA has published a set of environmental guidelines for carrying out environmental assessments and the environmental management of different types of development projects. These are general guidelines that are designed to provide information on the various methods that are available for environmental assessments. There are four general guidelines (Policy and Procedures for Filing, Review and Approval of Environmental Assessments; Guidelines for the Preparation and Review of Environmental Reports; Guidelines for Public Consultation; and Guidelines for Sensitive and Critical Areas) and nine sectorial guidelines. The relevance of the guidelines to the proposed project is briefly reviewed below:

ii. **Policy & Procedures for Filing, Review & Approval of Environmental Assessments**: These guidelines define the policy context and the administrative procedures that will govern the environmental assessment process, from the project pre-feasibility stage to the approval of the environmental report. All specific requirements given in this guideline, except the policy for handling projects with trans-province impact, have been superseded by the requirements in the IEE-EIA Regulations, 2000 (Section 2.3.2). As the proposed project is entirely in the province of Sindh and no trans-boundary impact is envisaged, this guideline will not have implications for the proposed project.

iii. **Guidelines for the Preparation & Review of Environmental Reports** : The Guidelines on the Preparation and Review of Environmental Reports is broadly divided into four parts: Chapters 1 to 5 describes the environmental assessment process, and the desired contents of the environmental assessment report; Chapter 6 provides guidelines on reviewing and decision-making; Chapter 7 discusses monitoring and auditing; and guidelines for environmental study project management are provided in the last chapter. The requirements for environmental assessment as specified in this guideline are consistent with the requirements of the World Bank (see Section 2.4.2). The IEE of the proposed project has been conducted meeting the requirements of this document.

iv. **Guidelines for Public Consultation** : These guidelines 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. Public consultation has been conducted as part of the proposed project meeting the basic requirements of these

guidelines.

v. **Guidelines for Sensitive and Critical Areas** : The purpose of these guidelines is to help project proponents identify sensitive and critical areas in Pakistan. The sensitive and critical areas include protected ecosystems (national parks, wildlife sanctuaries, and game reserves), and protected archeological and cultural sites. The guidelines provide a list of areas that are protected against exploitation under the various wildlife laws of Pakistan and a list of all sites and buildings that are protected under federal and provincial laws related to archeological and cultural heritage. The proposed approach to environmental assessment for development projects in sensitive and critical areas includes the proper identification of such sites and close coordination with the relevant government departments for assessment of potential environmental impact. As the project is not located in a protected ecosystem or near any protected cultural heritage, the provisions of these guidelines are not applicable to it.

2.1.6 Sectorial Guidelines for Environmental Reports – Housing Estates and New Town Development

These guidelines deal with housing estates coming of more than 100 houses or developed on an area greater than ten hectares . These guidelines assists the proponent in identification of environmental issues that need to be addressed as well as the mitigation measures and alternatives that needs to be considered.

These guidelines identify the key environmental issues that need to be assessed as well as mitigation measures and project alternatives to be considered in the actual EIA.

These guidelines include:

- A Sector overview of the industry and the processes
- Potential impacts of site selection, project design, construction and operation on the environment
- Mitigation measures
- Monitoring and reporting
- Management and training
- Checklist of likely environmental impacts and mitigation measures

3.3 Requirement of IFC and World Bank

The IFC and the World Bank require all projects funded by these agencies to be constructed and operated in an environmentally responsible manner. All projects that receive IFC funding must therefore comply with appropriate World Bank Group environmental policies and guidelines. As

the project proponents are likely to seek funding from the IFC for the proposed expansion project, the EIA has been carried out to comply with both national and IFC guidelines. The key documents of the IFC are discussed below.

3.4 Social and Environmental Review Procedures

IFC's Environment and Social Review Procedure (ESRP) outlines the process through which IFC staff implement the Corporation's commitment to promoting projects that are environmentally and socially sustainable. This commitment is a fundamental part of IFC's mission and is elaborated on in IFC's Policy and Performance Standards on Social and Environment Sustainability (PPS) as well as in IFC's Policy on Disclosure of Information (the Disclosure Policy). The ESRP applies to the full range of IFC's investment activities: direct lending to private enterprises (including both corporate and project finance); lending to financial intermediaries; minority equity/shareholding in companies, financial institutions, and other entities; structured finance products (guarantees, securitizations); and municipal finance. The ESRP also describes IFC's approach to its technical assistance and advisory activities, including both investment related work and capacity building to help support private sector development in emerging markets. The ESRP also describes the application methodology that IFC staff must follow in order to implement IFC's institutional disclosure requirements in accordance with the Disclosure Policy. The application of the PPS varies according to the nature of IFC's intervention with the client and the nature of the client's business (for example, industrial companies versus financial institutions). The ESRP covers IFC's review and supervision responsibilities for environmental and social performance throughout the project life cycle. The timing of an IFC investment in relation to a client's business activities and project implementation process varies from project to project. IFC does not control the timing of its entry into a project; IFC's engagement, more times than not, occurs well after the project is conceived, with the site selected and development started. When considering whether or not to participate in a transaction, IFC's review takes into account any project development work undertaken beforehand. IFC has a range of other tools to help staff assist its clients in improving the environment and social outcomes of their projects. Other sources of information that complement the PPS include the Guidance Notes for the Performance Standards; IFC Environmental Health and Safety Guidelines, which provide specific benchmark criteria in line with good international practice; and a diverse range of best practice material. The ESRP therefore does not provide technical support or guidance for specific environmental and social issues. Instead it is a defined and structured process that helps IFC maintain consistency and quality of

its review process and ensure that policy requirements are identified and committed to. It thus helps fulfill the Corporation's commitment to sustainable outcomes in the operations it invests in or supports. Assessing and managing environmental and social impacts in a manner consistent with the PPS is the responsibility of the client. IFC's responsibility is to review the work of the client, identify opportunities to improve outcomes, and ensure consistency with policy requirements. IFC's approach is to take full advantage of any work undertaken by the client before IFC's own entry into the transaction, thus minimizing additional processing burdens where it is possible to do so while still meeting the Corporation's policy requirements. IFC's investment or advisory support is used to influence and improve performance whenever possible. The ESRP includes an amended categorization methodology, which categorizes projects according to potential adverse impacts after IFC's review rather than during initial screening. Categorization was previously used as a determinant of certain procedural requirements for the client relating to assessment, community engagement and disclosure. The ESRP recognizes that all process requirements of the client have now been captured in the PPS and that categorization is now used only to determine IFC's institutional disclosure requirements. IFC's environmental and social specialists are essential and integral parts of the process the Corporation uses to optimize outcomes. The ESRP is not a substitute for professional judgment and expertise but provides a framework for the consideration and documentation of key issues and decisions that are made during the project cycle. It also provides staff with a process for document preparation.

3.5 IFC Performance Standards on Social and Environmental Sustainability

1. IFC applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. The Performance Standards may also be applied by other financial institutions electing to apply them to projects in emerging markets. Together, the eight Performance Standards establish that the clients are to meet throughout the life of an investment by IFC or other relevant financial institution:

- Performance Standard 1: Social and Environmental Assessment and Management System.
- Performance Standard 2: Labor and Working Conditions.
- Performance Standard 3: Pollution Prevention and Abatement.
- Performance Standard 4: Community Health, Safety and Security.

- Performance Standard 5: Land Acquisition and Involuntary Resettlement.
- Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management.
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

Performance Standard 1 establishes the importance of: (i) integrated assessment to identify the social and environmental impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of social and environmental performance throughout the life of the project.

Performance Standards 2 through 8 establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate. While all relevant social and environmental risks and potential impacts should be considered as part of the assessment,

Performance Standards 3 through 8 describe potential social and environmental impacts that require particular attention in emerging markets. Where social or environmental impacts are anticipated, the client is required to manage them through its Social and Environmental Management System consistent with Performance Standard 1.

In addition to meeting the requirements under the Performance Standards, clients must comply with applicable national laws, including those laws implementing host country obligations under international law.

2. IFC will apply the Performance Standards to projects it finances, consistent with the provisions in the accompanying IFC's Policy on Social and Environmental Sustainability. IFC's institutional disclosure of information will be pursuant to IFC's Policy on Disclosure of Information.

3 The term "client" is used throughout the Performance Standards broadly to refer to the party responsible for implementing and operating the project that is being financed, or the recipient of the financing, depending on the project structure and type of financing. The term "project" is defined in Performance Standard 1.

A set of Guidance Notes, corresponding to the Performance Standards, offers helpful guidance on the requirements contained in the Performance

Standards, including reference materials, and on good sustainability practices to help clients improve project performance.

3.6 World Bank Guidelines on Environment

The Pak-EPA recommends using World Bank (WB) environmental guidelines for areas where there may be a gap in the national guidelines. The principal World Bank publications that contain environmental guidelines are listed below.

- Pollution Prevention and Abatement Handbook 1998: Towards Cleaner Production.
- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectorial Issues. 5
- Environmental Assessment Sourcebook, Volume II: Sectorial Guidelines

The first two publications listed above provide general guidelines for conducting an EIA, and address the EIA practitioners themselves as well as project designers. While the Sourcebook in particular has been designed with Bank projects in mind, and is especially relevant to impact assessments of large-scale infrastructure projects, it also contains a wealth of information useful to environmentalists and project proponents. The Sourcebook identifies a number of areas of concern that should be addressed during impact assessment. It lists activities that may have significant negative consequences for biodiversity, and mentions loss of habitat resulting from mining and mineral exploration as one such activity. It sets out guidelines for determining the project impact in such cases, provides a checklist of tools to identify possible biodiversity issues, and suggests possible mitigation measures. Possible project development effects on wild lands, wetlands, forests, etc., are also identified, and mitigation measures suggested. The Sourcebook also highlights core concerns in social impact assessment and emphasizes the need to incorporate socioeconomic issues into environmental impact assessment exercises. The Environmental Assessment Sourcebook dealing with Sectorial assessment is more specific. It contains sections on dams, reservoirs, watershed development, and flood protection. In addition to these documents, several other World Bank operational policies and directives that provide guidelines for environmental assessment were used during the assessment.

4 World Bank, UNIDO, and UNEP. 1999. Pollution Prevention and Abatement and book, Towards Cleaner Production. Environment Department, The World Bank; UNIDO; UNEP.

5 World Bank. 1991. Environmental Assessment Sourcebook, Volume I, Policies, Procedures, and Cross- Sectorial Issues. World Bank Technical Paper No. 139. Environment Department, The World Bank.

6 World Bank. 1991. Environmental Assessment Sourcebook, Volume III, Sectorial Guidelines. World Bank Technical Paper No. 140. Environment Department, The World Bank

3.7 **Non-governmental Organizations**

International environmental and conservation organizations, such as the World Conservation Union (IUCN) and the World Wide Fund for Nature (WWF), have been active in Pakistan for some time. Both these organizations have worked closely with the government and have played an advisory role with regard to the formulation of environmental and conservation policies. In the 14 years since the Rio Summit, a number of national environmental NGOs have also been formed that have been engaged in advocacy and, in some cases, research. The most prominent national environmental NGOs, such as the Sustainable Development Policy Institute (SDPI) is members of the IUCN's Pakistan National Committee. All concerned agencies were consulted during the preparation of EIA.

3.8 **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 Gharo 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.

However as the Wind Corridor is not used much by the domestic air traffic (except for a proximity to one not frequently used route/air port in Nawabshah), it is highly unlikely that wind farm construction and operation activities might be affected by any of the aforementioned rules

3.9. The Biodiversity Action Plan

The Biodiversity Action Plan (BAP), 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 BAP recognises that an EIA is used as a tool at a project level to identify environmental effects of proposed projects and to plan for reducing adverse effects. The BAP further stipulates that an EIA needs to be initiated at an early stage of project development and that public participation in the review of potential effects is important.

3.10 Policy for Development of Renewable Energy for Power Generation

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, photovoltaics and wind energy. Over the short term, i.e. to mid-2008, technologies that are already in commercial use internationally are to be trialled 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.

3.11 Renewable Power Generation

3.11.1. Alternative Energy Development Board (AEDB)

The Alternative Energy Development Board (AEDB) was established as an autonomous body attached to the Cabinet Division on 12th May 2003. The Board was established to act as a central agency for development, promotion and facilitation of renewable energy technologies, formulation of plans, policies and development of technological base for manufacturing of renewable energy equipment in Pakistan. In Feb 2006, the administrative control of the Board was shifted from the Cabinet Division to the Ministry of Water & Power. The AEDB is also responsible for developing the national policy for promoting renewable energy sources in the medium and long term, which has been set out in a set of measures known as the Policy for Development of Renewable Energy for Power Generation. AEDB is also responsible for getting land leased from the Revenue department and lease it out to various investors/promoters for wind farms development.

3.12 1992 Climate Change Convention and Koyoto Protocol

The convention aims at stabilizing greenhouse gases (GHGs) concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the Legal and Regulatory Framework climate system. To achieve the objective of the convention, all parties are generally required to develop national inventories of emission; formulate and implement national and regional programs of mitigation measures; all developed country parties were specifically obliged to take measures to limit GHG emissions by the year 2000 at 1990 levels and the developing countries to take all measures in support of the protection of the atmosphere without any formal commitment on the quantified reduction of these gases in a time frame.

The Kyoto Protocol is an amendment to the United Nations Framework Convention on Climate Change (UNFCCC) an international treaty on global warming. Ratifying developed countries commit to reduce their combined greenhouse gas levels by 5%, including six GHGs, i.e. Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), and Sulfur hexafluoride (SF6).

As of November 2007, total of 174 countries have signed and ratified the agreement, with the notable exception of the United States of America. If successful, the Kyoto Protocol is expected to reduce the average global temperature between 0.02°C and 0.28°C by the year 2050. The Kyoto Protocol proposes to set up framework for (a) Joint Implementation of projects aimed at reduction of GHGs, (b) establishment of Clean Development Mechanism (CDM), and (c) Emissions Trading, which could be availed by all developing country Parties, including Pakistan. Pakistan signed the United Nations Framework Convention on Climate Change (UNFCCC) in Rio in 1992. It was ratified in June 1994 and it became effective for Pakistan, as Party, with effect from 30th August 1994. One hundred and thirty-seven (137) developing countries have ratified the protocol. Developing countries including Pakistan have no obligation beyond monitoring and reporting emissions.

3.13.The Convention on Biological Diversity

The Convention on Biological Diversity was adopted during the Earth Summit of 1992 at Rio de Janeiro. The Convention requires parties to develop national plans for the conservation and sustainable use of biodiversity, and to integrate these plans into national development programmes and policies. Parties are also required to identify components of biodiversity that are important for conservation, and to develop systems to monitor the use of such components with a view to promoting their sustainable use.

3.14 The Convention on the Conservation of Migratory Species of Wild Animals, 1979

The Convention on the Conservation of Migratory Species of Wild Animals (CMS), (1979), requires countries to take action to avoid endangering migratory species. The term "migratory species" refers to the species of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries. The parties are also required to promote or co-operate with other countries in matters of research on migratory species.
The Convention contains two appendices. Appendix I contain the list of migratory species that are endangered according to the best scientific evidence available. For these species, the member states to the Convention are required endeavour to:

- Conserve and restore their habitats.
- Prohibit their hunting, fishing, capturing, harassing and deliberate killing.
- Remove obstacles and minimize activities that seriously hinder their migration.

- Control other factors that might endanger them, including control of introduced exotic species.

Annexure lists the migratory species, or groups of species, that have an unfavourable conservation status as well as those that would benefit significantly from the international co-operation that could be achieved through intergovernmental agreements. This Convention is of extreme importance to the Jhimpir and Gharo Wind Corridor and at short term to the Coastal Gharo Wind farm site due to its proximity to the Indus River and the actual Indus Delta. Both the river and Delta are part of the International Migratory Bird Route Number 4, also called the Green Route or Indus Flyway, considered to be one of the busiest in the world.

3.15 The Convention on Wetlands of International Importance, Ramsar 1971

Pakistan is a signatory to the said Convention. The principal obligations of contracting parties to the Convention are:

- To designate wetlands for the List of Wetlands of International Importance.
- To formulate and implement planning so as to promote wise use of wetlands, to make EIA before transformations of wetlands, and to make national wetland inventories.
- To establish nature reserves on wetlands and provide adequately for their wardening and through management to increase waterfowl populations on appropriate wetlands.
- To train personnel competent in wetland research, management and wardening.
- To promote conservation of wetlands by combining far-sighted national policies with coordinated international action, to consult with other contracting parties about implementing obligations arising from the Convention, especially about shared wetlands and water system.
- To promote wetland conservation concerns with development aid agencies.
- To encourage research and exchange of data.

So far 19 sites in Pakistan have been designated as wetlands of International Importance or Ramsar Sites. A total of five Ramsar sites are located in the Gharo Wind Corridor however no Ramsar site is present directly in the Coastal Gharo and Inland Jhimpir project areas. The nearest Ramsar site to the Coastal Gharo area is the Indus Delta whereas the nearest Ramsar site to Inland Jhimpir area is the Kinjhar Lake.

3.16.Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This convention came into effect on 3 March 1973 in Washington. In all 130 countries are signatory to this convention with Pakistan signing the convention in 1976.

The convention requires the signatories to impose strict regulation (including penalisation, confiscation of the specimen etc.) regarding trade of all species threatened with extinction or that may become so, in order not to endanger further their survival.

The Convention contains three appendices. Appendix I include all species threatened with extinction, which are or may be affected by trade. The Convention requires that trade in these species should be subject to strict regulation. Appendix II includes species that are not necessarily threatened presently but may become so unless trade in specimens of these species is subject to strict regulation. Appendix III includes species which any contracting party identifies as subject to regulations in trade and requires other parties to co-operate in this matter.

The list of the species identified in the wind farm sites that are also included in the CITES appendices are provided Tables B-11, B-13, B-14 and B-15 of Appendix B.

3.18 International Union for Conservation of Nature and Natural Resources (IUCN) Red List

The red list is published by IUCN and includes those species that are under potential threat of extinction. These species have been categorised as

- Endangered: species that are sent to be facing a very high risk of extinction in the wild in the near future, reduction of 50% or more either in the last 10 years or over the last three generations, survive only in small numbers, or have very small populations.
- Vulnerable in Decline: species that are seen to be facing a risk of extinction in the wild, having apparent reductions of 20% or more in the last 10 years or three generations.
- Vulnerable: species that are seen to be facinga high risk of extinction in the wild, but not necessarily experiencing recent reductions in population size.
- Lower Risk: species that are seen to be facing a risk of extinction that is lesser in extent that for any of the above categories.

- Data Deficient: species that may be at risk of extinction in the wild but at the present time there is insufficient information available to make a firm decision about its status.

Two bird species namely Black bellied Tern (Sterna acuticauda) and Long-tailed Grass Warbler (Prinia burnesii), three mammal species including Fulvous Leaf nosed Bat (Hipposideros fulvus), Indian Fox (Vulpes bengalensis) and Trident Leaf nosed Bat (Asellia tridens) and one reptile species namely Indian Cobra (Naja naja) were identified in the inland Jhimpir wind farm site area. The black bellied Tern, Indian Fox as well as Indian Hump-backed Dolphin (Sousa plumbea/Sousa chinensis) were observed in the Coastal Gharo wind farm site. All of the above mentioned species are listed in IUCN Red List 2006. Black bellied Tern and Long-tailed Grass Warbler are categorised as Near Threatened (NT) species. The later is also included in Appendix I and II of the CMS.

3.19 World Bank / IFC Guidelines for the Environment, Health & Safety for Wind Energy

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP)1. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied asrequired by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

4

Baseline Condition

Physical

4.1.Location

The Gharo wind corridor is located in the south western parts of Sindh province. The wind corridor is located between latitudes 23°48' - 25° 41' North and longitudes 67° 16'- 69° 25' East . The corridor is located across Thatta, Hyderabad and Badin districts of Sindh province. The southern portion of the corridor predominantly lies in the Indus Delta. The total area of the Gharo wind corridor is approximately 24,450 square kilometres (sq.km). The location of the wind corridor is shown in Figure.

The potential wind farm development sites of coastal Gharo and inland Jhimpir are located in Thatta district. The Coastal Gharo wind farm sites are located between latitudes 24°44' - 24° 32' North and longitudes 67° 22' - 67° 30' East. The Inland Jhimpir wind farm site is located between latitudes 25°12' - 25° 02' North and longitudes67° 51' - 68° 01' East. The land for the development of the wind farms in coastal Gharo covers an area of approximately 102sq.km whereas for Inland Jhimpir the allocated land area is approximately 157sq.km. The location of the proposed wind farm sites is also shown in figure

4.2. Physiography

Topographically Sindh can be divided into four distinct parts: the Kirthar range in the west; a central alluvial plain bisected by the Indus River; the desert to the east; and the Indus Delta in the south. The Gharo wind corridor lies in the south western part of the Sindh province and is mostly covered in the Indus Delta covering parts of Thatta, Hyderabad and Badin districts.

Thatta district comprise of all the topographical features found in Sindh province. The north western area of the district is hilly tract known as Kohistan tract. These hills are the extension of the Kirthar Range. It has been described as succession of broad valleys lying between ranges of hills running generally north and south. The valleys are more or less level and fairly covered with grass or brushwood. The hills are bare and mostly composed of limestone. Southwards the area degenerates into sandy formations, uncultivated and almost devoid of vegetation, but much broken up by short ranges of low, stony hills, and intersected by Nais (locally called meaning torrent beds) which carry the drainage of the Kohistan to the Indus.

A major part of Thatta taluka is a mountainous area known as Kohistan touching the Kalat region. The Makli hills, close by Thatta, is an area of rocky elevation covering an area of 32km by 6km.

Hyderabad and Badin district is the part of the lower Indus plain conformed of vast alluvial along the course of the Indus River. The Indus bifurcates the district of Dadu from Hyderabad and stretches for 110km on the western flanks of the district, and is surrounded by riverine forests. There are no mountains or hills anywhere in the districts except some small hillocks and off shoot of Kirthar lime stone (middle Eocene) range known as Ganjo Takkar located in Hyderabad district. They run parallel to the river Indus for about 22km south of Hyderabad city. The highest point in these hillocks is known as "Gaho" which is about 75m above mean sea level (msl). There are also two small hillcocks on the north of Tando M. Khan town. They are named Budhaka Takker. The rest of the district as well as whole of Badin district is a fertile plain with an elevation of about 50m above msl.

4.2.1.Inland Jhimpir

The land form of the Inland Jhimpir area is mainly flat and barren with little (in the form of grass, shrubs and scrubs) or no vegetation. The soil texture in this area is mostly rocky and gravely with the kohistan hills which are an extension of the Kirthar range also present in the surroundings. Various water bodies including Kinjhar Lake (at a distance of 2km) and Haleji Dhand (at a distance of 32km) are also present in the project vicinity.

Various physiographic units covered in the wind corridor and proposed wind farm sites have been established using GIS technique. The procedure used to classify the Satellite imagery of the Gharo wind corridor is called "Unsupervised Classification" technique.

Initially 75 classes were developed using this standard technique and thereafter these classes were reclassified to 7 final Physiographic classes. These Physiographic units are shown in Figure and are also tabulated in Table .

Table : Main Physiographic Units within the Wind Corridor

No	Unit	Area (sq km)	Percentage (%) of the Total Area
1	Fresh Sand Deposits	430.6	1.76
2	Mangrove Forests	1431.7	5.86
3	Marshy Land	1773.7	7.25
4	Open Land	8514.9	34.83
5	Saline Area	757.2	3.10
6	Water bodies	2581.4	10.56

7	Vegetation	8960.8	36.65
	Total	24450.4	100

4.3.Geology

On the basis of the physical environment and geology, the project area falls in the Indus basin, which is briefly describe below.

The Indus basin essentially forms the western extension of Indo-Gangetic plain and consists of the silt brought by the Indus and its numerous tributaries, such as Jhelum, Chenab, Ravi and Sutleg on the east bank, and Kabul, Kurram, Tochi and other on the west bank. The Indus Plain is known for its agricultural fertility and cultural development through out history.

The left bank tributaries of the Indus river all meet at Panjnad and flow as one large stream for about 75 Km before joining the Indus at Mithankot, and south of it, the Indus flows almost alone upto the Arabian sea without receiving any noticeable tributary.

The average annual discharge of the Indus – 92 millions acre feet (MAF) at Attock khurd – is much higher than the combine discharge of its tributaries. There is a great fluctuation in their seasonal discharge, especially in the hot summer and rainy season. Almost all of its tributaries and the Indus itself have their sources in snow and glaciated area of Himalayan, Karakoram and Hindukush mountain system.

On the basis of hydrology and landforms, the Indus plain can be divided into the upper and lower Indus plains. The upper Indus plain differs from the lower Indus plain (Where the project area is located) primarily because of the major tributaries (Jhelum, Chenab, Ravi and Sutleg) divide the land surface into several interfluves of doabs. The two plains are separated by a narrow corridor near Mithan court where the Suleiman range approaches the Indus River. The lower Indus plain is very flat generally sloping to the south with an average gradient of 95 mm/Km (6 inches/mile). The lower Indus plain can be divided in 5 distinct micro-relief landforms active flood plain, meander floodplain, cover flood plain, scalloped interfluves, and the Indus delta. In the north east, the meander flood plain is more extensive, while in the central and lower Indus plain, the cover flood plain is more prominent.

Topographically, Sindh can be divided into four distinct parts with the dry and barren kirthar range in the west, a central alluvial plain bisected by the Indus River, a desert belt in the east, and the Indus delta in the south.

Inland Jhimpir

The proposed inland Jhimpir wind site area is covered under the Eocene Sedimentary and Unconsolidated Surfical Deposits of silt, sand and gravel geologic formations belonging to the Tertiary and Quaternary ages respectively. The area is also rich in coal deposits with the Meting-Jhimpir coal field being explored currently for coal reservoirs.

Coal is associated with basal part of laterite where a sequence of lateritic clay and shale with beds of arenaceous sandstone of Laki Formation, named as Sonhari Member of Early Eocene age is found. Laki formation attains a thickness of 55m near Thatta However; the latter sequence of Laki Formation is mainly composed of nodular limestone with shale and sandstone. The Sonhari coal is of poor quality lignite with high Sulphur. Sonhari member varies in thickness from 10m to 30m. The meting limestone and Shale member consists mainly of creamy white nodular limestone with subordinate sandstone in the upper part. The shale is grey, greenish yellow, weathering dark rusty brown ferruginous and gypsiferous. The limestone is thin bedded and arenaceous where as the sandstone is commonly ferruginous. Meting Member is about 70m thick at the type locality.

Geologic Formations covered in the Wind Corridor and Wind Farm Sites

Geological Symbol	Description	Percentage (%) of Total Area
Wind Corridor		
Inland Jhimpir		
Q	Unconsolidated surfical deposits of silt sand and gravel of Recent period	32.57
Te	Eocene sedimentary rocks(mostly limestone) of Tertiary ages	67.43

Geological Setting

The Prevailing geologic conditions in the region are the results of extensive in undation, deposition, coastal movements, and erosion 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 angel strike-slip fault 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 detailed, that the effect can be appreciated.

Most part of Sindh is covered either by recent alluvium or wind borne sand. The principal features of the geological significance are to be found in the hilly portion of the province, toward the west of Indus. Outline extension of this hilly track occurs east of the Indus as well near Sukkar, Hyderabad and Jerruck. The isolated hills of Nagarparker 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 is some exposure of rocks belonging to the next older system; the cretatious with the exceptions of some volcanic beds associated with these cretatious strata, all the rocks formation of western Sindh are the sedimentary origin. All of the more important hills messes consist of limestone. Great majorities of this limestone deposit belongs to the nummultic period and are largely built up of the accumulated shells of foraminifera principally those belonging to the genus nummulties.

Soil Classification

The texture of soils in the wind corridor ranges from loamy saline, silty and clayey in the coastal areas to gravely, mainly loamy and clayey soils in the inland areas.

The loamy soils in the coastal areas are strongly saline (hence devoid of any agriculture), moderately alkaline (pH of 7.9 to 8.4) and strongly calcareous ($CaCO_3$ content greater than 15%).

The soil in the inland areas, especially those areas covered under the lower Indus basin, consists mainly of loamy and clayey soils. These soils have little or no salinity (0 to 4dSm-1) and are moderately alkaline (pH of 7.9 to 8.4). The soils are generally non-saline, nonsodic except local saline patches in inter-dunal valleys and some parts of the alluvial plain.

The soil in the lower half of the wind corridor consists mainly of loamy fine sand saline soils. These soils have high salinity (greater than 15dSm-1) with a few patches slightly saline (salinity between 4 to 8dSm-1). These soils are neutrally to moderately alkaline (pH of 6.6 to 8.4) and moderately to strongly calcareous (CaCO3 content greater than 15%) in nature.

The soils in the remaining portion of the wind corridor consists mainly of loamy part gravely soils. The soil is similar in nature to the soils of the coastal areas of the wind corridor. However the soils in some patches may be different with a slight salinity (between 4dSm-1 to 8dSm-1). This type of soil is usually neutral (with a pH of 6.6 to 7.3), and moderately calcareous (with CaCO3 content in the range of 3% to 15%)

Inland Jhimpir

The soils of inland Jhimpir wind farm site are also classified as mainly loamy saline and part gravely. The soil is similar in nature to the soil of Gharo area. However the soils in some patches may be different with a slight salinity (between 4dSm-1 to 8dSm-1). This type of soil is usually neutral (with a pH of 6.6 to 7.3), and moderately calcareous (with CaCO3 content in the range of 3% to 15%). Properties of soil in some patches of the wind farm may be indifferent to the ones stated above with moderately alkaline (pH of 7.9 to 8.4), strongly calcareous (with a CaCO3 content of greater than 15%) with little or no salinity (between 0dSm-1 to 4dSm-1).

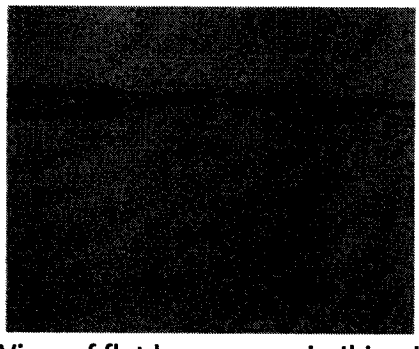
The soil and soil properties map is shown in Figure 3-4 and 3-5 respectively. The different soil classes covered in the wind corridor and wind farms sites is provided in Table. Whereas the properties of soil in these areas is provided in Table

Soil Classification in the Wind Corridor and Wind Farm Sites

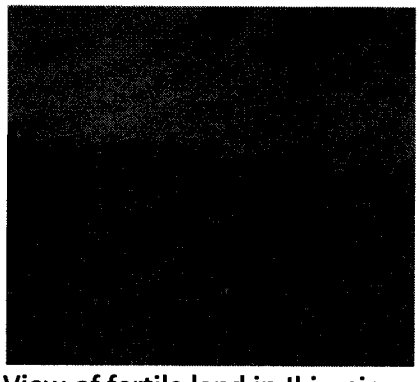
Soil Type	Description	Percentage (%) of Total Area
Wind Corridor		
Inland Jhimpir		
23	Mainly loamy, part gravely soils	100

Soil Properties in the Wind Corridor and Wind Farm Sites

Soil Nature	Alkalinity	Calcare-ousness	pH (range)	$CaCO_3$ Content (%)	Electrical Conductivity (dSm^{-1})	Percentage (%) of the Total Area
Wind Corridor						
Inland Jhimpir						
Strongly calcareous	Moderate	Strong	7.9-8.4	>15	0-4	6.44
Slightly saline	Neutral	Moderate	6.6-7.3	3-15	4-8	2.89
Strongly saline	Moderate	Strong	7.9-8.4	>15	>15	49.41
Rough/ Broken land	N.D	N.D	N.D	N.D	N.D	40.59



View of flat barren area in Jhimpir



View of fertile land in Jhimpir

Land Capability

The different soil regimes identified in the wind corridor and wind farm sites have different land use potentials on the basis of their characteristics or on the basis of other external limiting factors such as aridity, erosion etc. The potential land use for the soil regimes within the wind corridor has been identified in this study using the map of land capability for Sindh. This classification is expected to help in the management of soils in the area and for further planning on land use within the wind corridor and wind farm sites.

In the land capability map for Sindh, eight land capability classes are designated by Roman numerals (I to VIII). In this system classes I to IV denote arable lands with decreasing agricultural potential and classes V to VIII denote rangelands with decreasing range potential.

The wind corridor covers the land areas ranging from very good (loamy) irrigated crop land (Class I) to areas un-productive for agriculture (Class VIII).

Approximately 60% of the land area covered in the wind corridor is productive land capable of agriculture (ranging from Class-I to Class-IV). The remaining land is unproductive comprising mainly of loamy grazing, severely saline tidal flats, open water and marsh and urban areas.

The percentage wise descriptive distribution of land capability classes covered in the wind corridor is provided in Table and is shown in Figure

Inland Jhimpir

The land area covered by the wind farm site of Jhimpir consists of complex of agriculturally unproductive (rock) land and some poor grazing (gravely land) (Class VIII, VII). This area constitutes about 38.3% of the total wind farm area and is also incapable of agriculture as the soil underneath mainly consists of rock and gravel. The remaining portion (about 61.7%) of the land is a complex of poor torrent-watered crop land and poor (loamy) grazing land. Some part of this land is capable of agriculture being fed by torrent water whereas the remaining portion comprises of grazing area (capable of growing grass and shrubs).

The percentage wise descriptive distribution of land capability classes covered in the two wind farm sites is also provided in Table and is shown in Figure

Land Capability Classes in the Wind Corridor and Wind Farm Sites

Classification No.	Soil (Class)	Capability	Percentage (%) of Total Area
Wind Corridor			
Inland Jhimpir			
7	IV,VII	Complex of poor torrent-watered crop land and poor (loamy) grazing land	61.68
10	VIII,VII	Agriculturally unproductive (rock) land and some poor grazing (gravely) land	38.32

Land Use

Agriculture, followed by the forestry, is the main land use in the central alluvial plain. Although more than 50 percent of the total geographic area is cultivable, only 26 percent of it is actually located in the central plain. The land inside the Indus embankments is almost equally employed by agriculture and forestry, while that outside the embankments is more extensively utilized for agriculture in the form of sparsely distributed irrigated plantation

Exhibit: Land Use in Sindh

Land Use	Area (Million Ha)	Percentage
Not Sown	3.022	21.446
Current Fallow	1.439	18.935
Cultivable Waste	2.688	10.212
Total Available for Cultivation	7.149	50.593
Not Available For Cultivation	5.830	41.374
Forest	1.125	7.984
Unreported	0.007	0.049
Total	14.091	100.000

Inland Jhimpir

Inland Jhimpir wind farm site consists of areas that have variable land use. The rocky and gravely soil formation devoid the major land area for any agricultural use. However the land area is also influenced by perennial grazing consisting of short grasses shrubs and scrubs. A few patches of cultivated land also exist in the close vicinity and surroundings of the wind farms site which comes under the torrent water restricted cropping. This area is dependent on residual moisture from torrent overflows. The major crops in this area include gram, oilseeds, barley, and pulses.

The percentage wise descriptive distribution of land use areas covered in the wind farm sites of Coastal Gharo and inland Jhimpir is also shown in Figure and is tabulated in Table.

Land Use Classification in the Wind Corridor and Wind Farm Sites

Category	Source of Moisture	Important Crops	Percentage (%) of Total Area
Wind Corridor Inland Jhimpir			
Torrent-Watered restricted cropping	Residual moisture from torrent overflows	Grazing land with little agriculture	18.71
Perennial grazing	Rain	Bunch/short grasses, shrubs and scrub with few drought resistant trees	27.13
No agriculture use	Gravely/rocky terrain	Almost none	54.16

Soil

The soil in the plain of Sindh is plastic clay that has been deposited for 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

Water Resources

Surface Water Resources.

Indus River

The river Indus is the main source of water in the project area. The Indus rises in Tibet, at an altitude of about 18000 feet amsl, and has a total catchments area of 654,329 km2. Length of the Indus River in the country is about 2,750 km. five main rivers that join Indus from the eastern side are Jhelum, Chenab, Ravi, Sulej and Bias. Besides these, two minor rivers - Soan and Harrow also drain into the Indus. On the western side, a number of small rivers join Indus, the biggest of which is River Kabul with its main tributaries i.e. Swat, Panjkora and Kunar. Several small streams such as Kurram, Gomal, Kohat, Tai and Tank, also join the Indus on the right side.

The Indus River exhibits great seasonal variations, with more than 80% of the total annual flow occurring during the summer month, peaking In June, July and August.

The Indus River and its tributaries on an average bring about 154 MAF of water annually. This includes 144.9 MAF from the three western rivers and 9.14 MAF from the eastern rivers. Most of this, about 104.7 is diverted for irrigation, 39.4 MAF flows to the sea and about 9.9 MAF is consumed by the system losses which includes evaporation, seepage and spills during floods. The flows of the Indus and its tributaries vary widely from year to year and within the year. As is the case with the water availability there is significant variation in annual flows into sea.

The Indus Delta

Historically, the Indus Delta has formed in an arid climate under conditions of high river discharge to the proportion of 4 billion tons of sediment per year. In the past, this has contributed to a prograding seaward of the delta as a result of interaction of fluvial and marine processes and a moderate tide range of approximately 2.6 meters. Progradation has occurred in spite of extremely high wave energies of the order of 1,400 million ergs/sec. During the past six decades, however, the construction of dams and barrages and extensive engineering works upstream has reduced the sediment load to 100-650 million tons per year (based on different studies). This decrease in sediment load together with the extremely high wave energies is expected to cause rapid reworking and transgression of the Indus delta.

What makes Indus delta unique is the fact that it experiences the highest wave energy of any river in the world. During the monsoon season, from May-September, the delta front receives more wave energy in a single day than the Mississippi delta receives in the entire year.

The Indus delta is triangular in shape and occupies a large part of the province of Sindh, covering about 30,000 km2. It is about 240 km in length along the axis of the river and 220 km at its widest, from Karachi to the great Rann of Kutch.

River Water Quality

The water quality of Indus River is generally considered excellent for irrigation purposes. The total dissolved solids (TDS) range from 60 mg/l in the upper reaches to 375 mg/l in the lower reaches of the Indus, which are reasonable levels for irrigated agriculture and also as raw water for domestic use. The disposal of saline drainage from various irrigation projects has been a major factor in the increased TDS in the lower reaches of the rivers in the Indus Plain. There is progressive deterioration downstream and-the salinity is at its maximum at the confluence of the Chenab and Ravi rivers, where the TDS ranges from 207 to 907 mg/l. A slight improvement in water quality is noted further downstream at Panjnad due to dilution from the inflow from Sutlej River. The quality of the Indus water at Guddu,

however, is within acceptable limits for agriculture; TDS being in the range of 164-270 mg/l.

In the upper reaches of the Indus River, the Dissolved Oxygen (DO) content remains above 8.5 mg/l which is well above the acceptable levels of 4 mg/l. The Biochemical Oxygen Demand (BOD) downstream of Attock has been recorded as 2.9 mg/l. At Kotri, it has a suspended solid (SS) content of 10 to 200 mg/l. Indus River water quality has been studied at the Dadu - Moro Bridge and Kotri Barrage, with nitrate levels at 1.1 and 7.5 mg/l, phosphate at 0.02 and 0.3 mg/l, BOD at 2.4 and 4.1 mg/l, faecal coliforms at 50 and 400 per ml, and aluminum at 1.8 and 0.2 mg/l respectively. Due to industrial waste discharges from Punjab and Sindh, a high content of heavy metals such as nickel, lead, zinc and cadmium have also been found in Indus water.

Lakes

There exist several fresh water and brackish lakes in the Sindh Province. The salient among these includes Manchar, kenjhar and Haleji lakes. Kenjhar Lake is situated 5 km approx. to the proposed site. In addition there exist a large number of small lakes and ponds in the irrigated areas of Sindh.

Ground water

The Indus Basin was formed by alluvial deposits carried by the Indus and its tributaries. It is underlain by unconfined aquifer covering about 15 million acres (60,700 Km2) in surface area. In Sindh, about 28% of the area is underlain by fresh ground water. This is mostly used as supplemental irrigation water pumped through tube-wells. Some ground water is saline. Water from saline tube-wells is generally put into drains and, where this is not possible, it is discharge through large canals for use in irrigation, after diluting with the fresh canal water.

Before the introduction of widespread irrigation, the ground water table in the Indus basin varied from about 12 m in depth in Sindh and Bhawalpur areas to about 30 m in Rechna Doab. After the introduction of weir-controlled irrigation, the ground water 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.

Hydrology- Inland Jhimpir
Surface Hydrology

The only perennial water channel in the area is the Kalri Baghar (KB) Upper Feeder which feeds Kinjhar Lake with Indus water from Kotri Barrage. The KB Feeder is about 20km away from the Jhimpir wind farm site and lies on its eastern side. The KB feeder is about 61km long and its design discharge is about 258 cubic meters per second (cumecs).
Kinjhar Lake is also being fed by the hill torrents during floods from the western side. The catchment area of these hill torrents are about 1664sq km and have their outfall into the Kinjhar Lake18. These hill torrents includes; Rodh Nai and Liari Nai. Baran Nai which is the principal source of flood drops into the River Indus downstream of Kotri barrage.

Kinjhar Lake is the main source of fresh water for drinking and irrigation for the areas downstream of Jhimpir including the city of Karachi. Kinjhar Lake is an artificial water storage reservoir located in Thatta district. It came into existence as a consequence of implementation of the Kotri Barrage canals Irrigation Project. This artificial reservoir has been formed out of natural depressions of Sonheri and Kinjhar Dhands. The gaps between the surrounding hills of the dhands were closed with the construction of earthen embankments having an average height of about 7.6m. The salient features of Kinjhar Lake are provided in Table.
Apart from KB Feeder, hill torrents and Kinjhar Lake there is no other source of surface water available in the area. The quantity of water in Kinjhar Lake is ample to fulfil the requirements of the downstream areas for irrigation and drinking purpose. The location of the surface water sources within the Jhimpir Project Area is also shown in Figure.

Groundwater Hydrology

Jhimpir area has meager ground water resources which are mostly saline. Scattered patches of sweet ground water do exist. In general the aquifer is of limited thickness to poor and paucity (very limited presence of water) aquifer. The yield varies from $10m^3/hr$ to $50m^3/hr$ down to 150m.
The mean annual rainfall is about 200mm with maximum occurring in the monsoon season. The consolidated deposits exposed are sedimentary in nature and are the extensions of Kirthar range and southern axial belt. These sedimentary rocks consist mainly of limestone, shale, sandstone and conglomerate and have little interstitial porosity.
A few tube wells were visited during the field survey in order to collect information regarding yield, quality of water and depth of water table. Generally all the tube wells were drilled between 50m to 80m depth and have a yield of about $50m^3/hr$. Except for one (Sheikh Nasir which has sweet water) all the visited tube-wells have saline/brackish water, though the locals were using it for

domestic, livestock, drinking and irrigation purpose. According to the locals the water quality improves as one moves north-west.

Locals usually bring drinking water in tankers from the Nooriabad area where government and private tube wells deliver sweet water on payment. Potential zones of the ground water resources and its quality within the Jhimpir Project Area are shown in Figure.

Raw water supply for construction, operation and drinking could be managed from Kinjhar lake and tube wells in the Nooriabad area if required.

Kinjhar Lake

Sweet Groundwater well

Saline /Brackish water in Jhimpir

Meteorology

The climate of most part of the Sindh is arid characterized for 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 form Mid – September to

Mid – November except coastal belt where mostly dry and humid conditions persists round the year. There exist several meteorological stations in Sindh; data recorded at some of these stations is provided in the following sections.

Temperature

June is the hottest month in most part of the Sindh, with mean daily maximum temperature recorded as 44.33 C. January is the coldest month in the area, with the mean daily minimum temperature recorded as 5.42 C

Exhibit: Mean Monthly Maximum Temperature Recorded at Karachi (C)

	2008	2009	2010	2011	2012	2013	2014
Jan	27.2	27	27.6	26.6	24.9	26	26.9
Feb	29.6	28.2	28.5	29.9	26.3	31.3	29.4
Mar	33.1	33.3	32.4	36.2	31.5	31.8	31.4
Apr	34.6	35.4	36.6	35.4	35.3	34	37.7
May	35.1	35.6	35.7	36.8	35.4	34.6	36
Jun	34.9	35.1	34.9	35.6	36	35.3	36.4
Jul	32.2	32.2	34.1	33.8	33.2	33.8	37
Aug	32.3	31.6	32.6	32.7	32.2	31	37.6
Sep	33.1	31.4	32.5	32.8	34.2	34.2	35
Oct	36	36.5	37	33.7	35.2	35	35.3
Nov	33.5	32.7	32.2	33.1	33.1	33.4	33
Dec	30.4	28.1	28.3	29.4	28.4	26.3	29
Annual	32.7	32.3	32.7	33	32.1	32.2	33

Source: Pakistan Meteorological Department

Exhibit: Mean Monthly Minimum Temperature Recorded at Karachi (C)

	2008	2009	2010	2011	2012	2013	2014
Jan	11.5	12.8	12.7	12.9	12.3	11.7	13
Feb	14.9	13.8	16.9	14.5	11.3	18.1	17.3
Mar	19.6	19.5	19.8	19.1	20.3	19.6	19.7
Apr	23.8	23.9	24.2	24.8	23	24.5	24.7
May	28.1	27	26.5	27.3	26.4	27.5	27.6
Jun	29	28.2	28.2	28.8	28.3	28.5	28.6
Jul	27.1	25.6	27	26.3	27.5	27.2	28.3
Aug	26.5	25.6	27	26.3	26.6	26.3	27.4
Sep	25.9	24.8	25.3	25.3	26.6	26.8	27
Oct	24.4	22.5	20.9	22.4	22.9	25.7	26.4
Nov	18.6	17.7	15.2	18	18.9	19.4	19.8
Dec	15.8	14.9	12	15.4	13	14	13.7
Annual	22.1	21.7	21	21.9	21.4	22.5	21.8

Source: Pakistan Meteorological Department

Mean daily maximum and mean daily minimum temperatures of various districts in the project area are presented in following exhibits. In view of the very small differences among these temperatures, this data can be taken as representative for the entire project area.

Exhibit: Mean Monthly Maximum Temperatures at Different Cities (°C)

Month	Nooriabad	Umerkot	Sanghar	Badin	Jacobabad
Jan	25.04	26.49	24.31	25.78	22.60
Feb	28.15	29.16	27.06	28.59	25.24
Mar	33.38	34.52	33.29	34.02	31.38
Apr	38.87	39.12	39.25	38.40	38.00
May	41.62	41.49	43.53	39.85	43.08
Jun	40.15	39.72	43.23	38.02	44.33
Jul	37.40	36.19	40.37	35.11	40.56
Aug	36.30	34.51	38.60	33.61	38.24
Sep	36.84	35.70	38.14	34.36	37.00
Oct	37.19	37.12	37.14	35.80	35.32
Nov	31.95	32.98	31.59	31.87	30.06
Dec	26.27	27.95	25.53	26.68	24.11
Annual	34.47	34.52	35.19	33.48	34.15

Source: Pakistan Meteorological Department

Exhibit: Mean Monthly Minimum Temperatures at Different Cities (°C)

Month	Nooriabad	Umerkot	Sanghar	Badin	Jacobabad
Jan	11.08	5.42	5.92	8.73	7.63
Feb	13.62	8.71	8.72	11.60	10.48
Mar	18.50	14.29	14.22	16.80	16.30
Apr	22.98	20.12	19.71	21.80	22.33
May	26.16	24.50	24.59	25.47	26.74
Jun	28.07	27.17	27.67	27.46	29.38
Jul	27.81	26.82	27.60	27.04	29.22
Aug	26.71	25.73	26.33	26.06	28.25
Sep	25.34	23.88	23.77	24.87	25.85
Oct	22.27	18.54	18.18	21.70	20.29
Nov	17.29	11.89	12.23	15.86	14.08
Dec	12.50	6.62	7.39	10.10	8.74
Annual	21.03	17.84	18.00	19.76	19.95

Source: Pakistan Meteorological Department

Precipitation

July, August and September are the most humid months in the area, whereas May and June are the least humid months.

Exhibit: Precipitation Recorded in Karachi (mm)

	2008	2009	2010	2011	2012	2013	2014
Jan	0	0	6.4	13.7	6.6	Trace	0
Feb	0	2.4	21.8	0	12.8	0	0
Mar	0	0	0	0	Trace	Trace	0
Apr	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0
Jun	10.6	Trace	16.3	Trace	Trace	Trace	11.2
Jul	73.6	Trace	270.4	3	Trace	6.2	
Aug	16.2	52.2	9.8	5.6	0.3	8.6	
Sep	Trace	Trace	Trace	Trace	54.9	21.9	
Oct	0	0	0	39.3	0	0	
Nov	0	0.5	0.2	0	0	3.1	
Dec	0	0.4	0	4.3	17.1	61.3	
Annual	100.4	55.5	324.9	65.9	91.7	301.1	156.8

Source: Pakistan Meteorological Department

Wind Data

Exhibit: Average Wind Speed Recorded at Nooriabad (meter per second or m/s)

	2008	2009	2010	2011	2012	2013	2014
Jan	3	3.6	4.0	3.4	3.6	2.0	2.0
Feb	3.2	3.9	5.0	3.7	4.2	3.0	3.7
Mar	3.3	4.0	5.4	4.0	4.8	3.0	4.0
Apr	5.6	6.5	5.2	6.0	5.1	6.2	4.0
May	7.5	8.5	7.7	8.0	7.1	8.0	6.0
Jun	8.1	8.2	8.8	9.0	7.5	7.7	6.3
Jul	7.8	9.8	6.7	10.0	9.0	8.3	7.7
Aug	7.3	7.3	7.1	9.5	6.9	6.2	7.9
Sep	6.5	7.7	6.0	7.3	6.4	4.7	6.9
Oct	2.7	3.3	3.2	3.8	3.9	4.2	4.1
Nov	2.6	2.9	3.1	1.0	2.0	2.2	2.5
Dec	2.9	3.2	3.0	2.5	1.5	3.0	2.9
Annual	4.9	5.7	5.4	5.7	5.2	4.9	4.3

Source: Pakistan Meteorological Department

Climate

Pakistan's latitudinal and longitudinal extents and its northern rim of lofty mountains are the two 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 classification falls under following five types

Tropical Semi-arid with Dry Winter: This climate type prevails in Karachi, Hyderabad a"c southern Khairpur Division. The mean annual temperature is above 18 °C.

Tropical Arid: This is characterized by average annual temperature of about 18°C with 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 wanres: months between 10 and 0 °C. It comprises eastern and northern parts of Kashmir. ChitraJ, 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 climate of the wind corridor is broadly described as moderate. Various

meteorologists have developed classification schemes to describe local climatic features of Pakistan. Shamshad (1956) has classified the climate of Pakistan on the basis of characteristic seasons found in the country. Taking into account topography, proximity to the sea, rainfall, temperature, and winds, Shamshad has defined eleven climatic zones for Pakistan. Under his scheme, the climate of the wind corridor is classified as 'Subtropical double season", which may further be subdivided into hot land and coast land.

The characteristic features of hot land climatic zone is low rainfall, (less than 250 milli metres per annum) absence of a well-defined rainy season, and high temperatures that increase from east to west. Whereas features of the coast land climatic zone include occurrence of afternoon sea breeze, low rainfall, (less than 250mm per annum) with moderate and high temperatures in coastal and inland areas respectively.

The meteorological stations of Badin and Hyderabad are located within the wind corridor. However, the meteorological data from Karachi station is also representative of the prevailing climatic conditions of coastal areas in the wind corridor. Interpretations of available meteorological data from the station of Hyderabad show that the upper part of the wind corridor constituting parts of Hyderabad district experiences moderate climate as a whole. The months of May and June are very hot during the day with a maximum and minimum temperature of 41°C and 26°C respectively. This follows by an abrupt fall in temperatures during the night with a pleasant breeze. December and January are the coldest months. Humidity varies, highest about the end of August which is much less in May when the air is uncomfortably dry. Fogs are common in the cold season. The district lies in the rain shadow area. Heavily laden south-west monsoon clouds rising from the Arabian Sea pass over this area without any appreciable showers except occasional showers in the month of July. In winter the district gets some rain from the cyclonic winds blowing from the Persian Gulf.

The climatic conditions of Thatta and Badin districts may be taken as moderate as a whole. The climate is tampered by the cool sea breeze which blows for eight months of the year from March to October. During the monsoon season the sky is cloudy but there is very little precipitation. The climate in summer is generally moist and humid. The cold weather in the districts start from the beginning of November when a sudden change from the moist sea breeze to the dry and cold north-east wind brings about as a natural consequence, an immediate fall in temperature. The maximum temperature in the hot weather does not usually exceed 40°C, while the minimum reading in the winter does not go below 8°C. The rainfall varies in different parts of the Thatta district. Small wind storms blow during the summer season. The annual average rainfall of the district is about 200mm. The average annual precipitation for Badin district is about 220mm.

Coastal Gharo and Inland Jhimpir

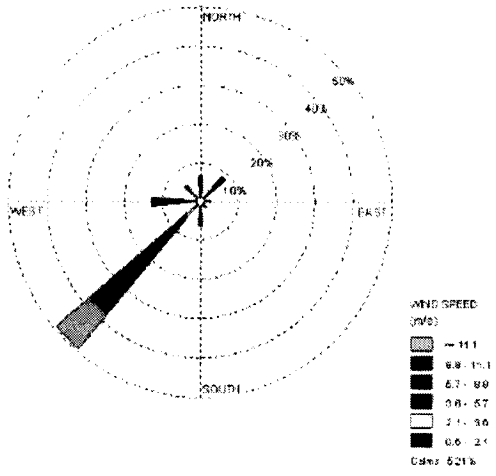
Various wind farm promoters have installed wind masts in order to record the direction and speed of wind at various heights in the proposed wind farm development sites of Jhimpir and Coastal Gharo. Records of various meteorological parameters including wind speed, direction and temperature from 2003 to 2007 are available from these wind masts.

Interpretation of this data has revealed that the climate in the proposed wind farm sites is moderate. The sites experience high wind speeds with an average wind speed of 5.2 meters per second (m/s) in Coastal Gharo and 6.64 m/s in inland Jhimpir. The wind rose plotted indicates that about 35% of the wind is blowing from the west direction in case of Coastal Gharo, whereas approximately 49% of the wind is blowing from the South West (SW) direction for inland Jhimpir. The western hot winds blow particularly in the months of May, June and July. Infrequent dust storms also blow during the hot season in Inland Jhimpir. The northern winds blow during winter season.

The annual average temperatures in the wind farm sites are usually moderate with an annual average of about 25°C for the two sites. April and May are among the hottest months of the year with temperatures rising close to 40°C and 43°C for Coastal Gharo and Inland Jhimpir respectively. December and January are among the coldest months of the year with temperatures in the range of 9°C and 8°C for Coastal Gharo and Inland Jhimpir respectively.

The five years of meteorological data including average wind speed, wind direction, average temperatures, maximum and minimum temperatures for the proposed development sites are shown in Table.

The wind rose of the Jhimpir wind farm sites is shown in Figure.



Summary of Average Wind Speed in Coastal Gharo and Inland Jhimpir (m/sec)

Month	Coastal Gharo					Jhimpir				
	2003	2004	2005	2006	2007	2003	2004	2005	2006	2007
Jan	3.41	3.62	3.79	4.48	4.68	4.26	4.08	3.89	4.98	4.35
Feb	4.01	3.76	3.80	4.94	4.83	4.65	3.99	4.05	4.92	4.59
Mar	4.11	3.76	4.78	5.15	4.71	4.54	4.12	4.97	5.17	4.29
Apr	5.97	6.34	5.37	6.86	5.84	5.81	7.24	5.59	6.32	5.04
May	7.96	7.35	7.25	9.76	7.88	8.10	8.15	7.42	9.44	6.57
Jun	8.65	8.26	7.43	8.15	6.75	9.71	10.80	7.81	7.81	11.36
Jul	5.80	8.26	8.91	8.75	3.97	6.63	10.67	9.64	8.04	N.R
Aug	7.13	9.08	7.55	7.41	5.75	7.69	11.04	8.34	6.03	N.R
Sep	6.58	6.22	6.44	5.00	6.27	7.48	6.97	6.38	4.34	N.R
Oct	2.98	3.75	4.79	5.14	4.38	3.07	4.39	4.37	4.55	N.R
Nov	3.03	2.90	3.64	4.02	3.92	3.85	3.68	3.18	3.44	N.R
Dec	2.98	4.05	4.04	4.04	4.04	3.45	4.61	3.83	4.55	N.R
Annual	5.22	5.61	5.65	6.14	5.25	5.74	6.64	5.79	5.80	-

Summary of Average Wind Direction in Coastal Gharo and Inland Jhimpir

Month	Coastal Gharo					Jhimpir				
	2003	2004	2005	2006	2007	2003	2004	2005	2006	2007
Jan	127.27	130.94	113.59	159.23	81.04	197.33	206.73	99.78	100.24	127.77
Feb	170.01	203.31	190.08	224.07	197.26	203.40	205.90	166.13	187.82	215.46
Mar	225.41	257.67	231.01	248.68	242.61	212.26	231.05	203.28	215.52	219.31
Apr	242.12	261.65	254.38	268.72	278.20	218.71	233.72	243.72	244.12	234.09
May	240.16	259.59	261.82	269.83	271.86	234.27	225.90	252.53	258.39	229.13
Jun	246.02	256.90	250.59	263.79	223.35	223.05	217.49	238.94	238.28	232.91
Jul	215.01	257.18	261.02	264.28	279.26	202.71	218.45	250.26	230.74	N.R
Aug	249.86	265.47	240.02	255.09	291.57	201.54	232.12	238.41	231.96	N.R
Sep	220.95	259.99	260.29	262.17	263.69	224.79	221.98	250.26	224.51	N.R
Oct	211.47	206.74	255.12	241.22	81.69	225.04	211.02	264.01	212.26	N.R
Nov	155.93	184.88	197.94	183.94	79.17	203.00	182.98	200.86	194.68	N.R
Dec	114.32	101.90	110.67	110.67	110.67	189.69	82.24	68.69	165.57	N.R
Annual	201.54	220.52	218.88	229.31	200.03	210.81	205.80	206.41	208.67	-

Summary of Average Temperatures in Coastal Gharo and Inland Jhimpir

Month	Coastal Gharo					Jhimpir				
	2003	2004	2005	2006	2007	2003	2004	2005	2006	2007
Jan	18.81	17.95	16.88	17.51	20.44	17.68	17.13	16.38	15.73	7.62
Feb	20.96	20.89	20.00	22.55	21.41	18.89	21.21	18.37	22.96	20.86
Mar	23.93	26.10	24.16	23.60	23.49	22.77	28.14	24.05	23.91	23.29
Apr	27.68	27.51	26.73	26.53	26.64	23.69	29.62	28.29	28.25	29.21
May	28.35	28.92	28.33	28.36	28.39	17.96	30.42	29.59	29.45	30.89
Jun	29.42	29.58	29.66	29.30	30.22	29.81	30.66	30.41	30.27	31.11
Jul	28.66	28.34	28.12	28.80	29.70	28.26	28.97	28.13	28.44	N.R
Aug	27.92	27.27	27.21	27.37	28.93	27.76	27.10	27.19	26.76	N.R
Sep	27.13	26.93	27.14	27.91	28.41	26.80	27.18	29.02	28.08	N.R
Oct	26.98	25.82	27.28	27.79	27.74	28.82	25.66	27.63	27.59	N.R
Nov	22.57	23.77	24.13	26.82	25.44	22.40	23.70	23.84	23.59	N.R
Dec	18.70	20.04	18.55	18.55	18.55	18.34	19.27	18.22	15.90	N.R
Annual	25.09	25.26	24.85	25.42	25.78	23.50	25.76	25.09	25.08	-

Summary of Maximum Temperatures in Coastal Gharo and Inland Jhimpir

Month	Coastal Gharo					Jhimpir				
	2003	2004	2005	2006	2007	2003	2004	2005	2006	2007
Jan	29.07	29.41	27.36	29.07	28.04	24.62	27.70	25.31	28.39	21.55
Feb	30.44	31.81	33.81	34.20	30.10	33.86	36.94	25.65	36.25	32.15
Mar	36.25	40.01	36.59	35.91	33.86	40.01	41.38	37.28	37.62	37.62
Apr	39.33	37.96	38.99	36.94	36.59	43.95	41.72	41.04	40.70	40.70
May	38.65	38.99	34.54	34.54	37.28	43.78	45.14	45.83	43.43	44.12
Jun	34.88	42.75	39.67	37.28	72.50	39.67	44.12	42.07	44.80	38.30
Jul	36.94	38.99	32.15	41.38	37.96	40.36	38.30	37.96	41.72	N.R
Aug	33.52	39.67	30.78	49.93	46.17	40.01	40.36	38.30	38.99	N.R
Sep	39.67	36.59	31.81	38.99	38.30	40.01	41.04	42.63	41.38	N.R
Oct	38.65	35.57	37.62	35.91	36.25	41.04	37.62	39.67	38.99	N.R
Nov	35.57	35.91	34.54	34.20	35.57	37.62	35.91	36.25	37.28	N.R
Dec	31.81	32.15	30.78	30.78	30.78	35.23	31.81	33.17	25.99	N.R
Annual	35.40	36.65	34.05	36.59	38.62	38.35	38.50	37.10	37.96	-

Summary of Minimum Temperatures in Coastal Gharo and Inland Jhimpir

Month	Coastal Gharo					Jhimpir				
	2003	2004	2005	2006	2007	2003	2004	2005	2006	2007
Jan	6.84	8.55	7.52	4.79	12.31	N.R	8.89	8.55	6.50	N.R
Feb	9.23	9.23	6.78	12.31	12.65	N.R	9.92	9.92	13.68	13.34
Mar	8.21	15.05	15.58	14.36	14.36	N.R	16.42	15.05	15.73	14.02
Apr	19.49	21.55	14.71	19.49	17.78	N.R	20.52	17.44	19.84	18.81
May	20.86	19.15	22.23	24.28	23.94	N.R	20.18	21.89	19.56	21.89
Jun	22.91	26.33	25.65	25.99	26.33	23.94	23.60	23.60	23.26	24.62
Jul	23.94	25.99	25.99	24.28	25.99	20.52	23.60	22.23	22.57	N.R
Aug	25.31	23.94	23.60	23.60	23.94	22.91	21.55	22.23	21.89	N.R
Sep	23.94	21.89	22.57	22.57	21.55	21.55	20.86	21.20	20.52	N.R
Oct	16.76	17.44	19.15	20.52	17.10	19.15	17.78	20.18	20.52	N.R
Nov	11.63	14.36	11.29	18.81	17.10	11.63	16.76	12.31	13.68	N.R
Dec	8.89	9.58	8.21	8.21	8.21	7.87	9.92	10.60	9.58	N.R
Annual	16.50	17.76	16.94	18.27	18.44	-	17.50	17.10	17.28	-

Rainfall

Average area rainfall in the project area ranges between 110 mm (Jacobabad) and 222 mm (Badin). Maximum rainfall (About 60% of the total annual) occur during the monsoon season (July, August and September), while the period of minimum rainfall or drier period is October and November.

Humidity

July, August and September are the most humid months in the area, whereas May and June are the least humid months. Average monthly relative humidity (RH) values at various locations in the project area are provided in following Exhibit

Exhibit: Relative Humidity in %

Month	Hyderabad	Umerkot	Sanghar	Badin	Jacobabad
Jan	47.90	45.52	59.98	50.38	50.88
Feb	45.38	44.45	56.00	48.81	48.23
Mar	42.40	42.55	50.62	48.36	42.76
Apr	41.88	42.73	44.66	48.97	33.01
May	46.96	46.81	42.63	53.10	30.93
Jun	56.35	56.40	51.81	60.70	41.16
Jul	63.42	67.23	62.10	69.61	56.18
Aug	65.26	70.15	66.06	72.55	62.20
Sep	61.37	64.76	62.38	69.78	59.38
Oct	47.65	50.78	55.16	59.15	48.87
Nov	46.40	44.58	59.48	53.88	45.75
Dec	49.26	46.84	62.47	52.46	52.73
Annual	51.19	52.11	56.03	57.56	47.70

Source: Pakistan Meteorological Department

Ambient Air Quality

Since the primary source of air pollution at the site is the vehicular emission, the key pollutants likely to be found at these locations include carbon monoxide (CO), oxides of nitrogen (NOx), sulfur dioxide (SO2), and particulate matters (PM). A typical air quality data for some urban centers in the country which can be used as a generic ambient air quality baseline for the project site.

Ecology

Flora

The flora of the area is governed by the type of soil and the amount of moisture available. The Thatta district has a wide range of soil types due to its diverse land forms which include sandy, deltaic, alluvial, gravel, coastal and mountainous. In the Kohistan region the dominant trees and shrubs are hubul (acacia arabica), kaneli (prosopis spicegra) pi (salvadora olioides), karil (capparis aphylla), rhazya stricta, deamia extensa and many other. The dominant trees, shrubs and under shrubs of sands dunes are represented by ak (calotropis procera), lai (tamerix diocia) beside babul, kandi and karil, etc. The plants found cultivated or wild near villages in the alluvial tracts are neem (azadirachta indica), ber (zizyphus jujube), and serrel (albizzia lebbeck) etc.

Fauna

The wildlife in the area has been affected by colonization of the area and many wild life species have either diminished or vanished. At present hyenas and wolves are hardly ever seen. Jackals are fairly common and foxes are seen in the rapidly contracting area of dry waste. Hog deer which were still found once seen along the bank of river Indus are uncommon and pigs though diminished are still found in small number. Hare and deer are fairly common. The Kenjhar, Haleji hadero Lakes are located on the international flying routes of the birds. Among birds both grey and black partridges are very common in the forest plantation. Most of the common kind of wild duck and water foul are seen in the cold season. Kunj are also regular winter visitors. Sand grouse of various kinds visit the district in the cold weather, but the expansion of the cultivated area has driven them away. This also applies to the houbara which was quite common in former times. Quails are common.

The other birds are found in the area are Indian cursor, small Indian swallow plover, asian open bill stork, black and glossy ibris, sirkeer malikoha or commonly known as cuckoo, Indian scoops owl, dusky horned owl etc. The water foul census revealed the biggest concentration in the whole of Pakistan on Kenjhar Lake.

Biological Resources

This section provides an overview of the ecozones, wild flora and fauna, and the habitat conditions prevailing in the project area. The description in this section has been prepared on the basis of secondary literature review, and field visits carried out in the area during this ESA and earlier assignments.

Original Ecozones of Project Area

Tropical Thorn Forest Ecozone

This habitat was the most extensive ecozone of the Indus plain, and currently exists only in places where the land has not been converted for habitation or cultivation. This habitat comprises low forests of thorny and hard-wooded tree species, dominated by Acacia spp. The trees of such forests have short boles and low branching crowns. These are usually not close-growth trees hence their canopies touch each other in exceptionally favorable spots. The usual height of the trees is 20-30 feet (6-9 m). Other plants that grow mixed with Acacia include Salvadora, Prosopis, Capparis, and Tamarix. The shrubs of the ecozone included Caiotropis, Zizyphus, Suaed, while herbs of the area included Chenopodium, Cailigonum, Haloxylon and various species of grasses.

The major wildlife mammal species of this ecozone was Long-eared Hedgehog, Desert Hare, Porcupine, Desert Wolf, Jackal, Bengal Fox, Desert Fox, Honey Badger, Small Indian Civet, Grey Mongoose, Small Indian Mongoose, Striped

Hyena, Indian Desert Cat, Caracal, Jungle Cat, Wld Boar, Nilgai, Blackbuck and Chinkara Gazelle.

Birds of the ecozone included Grey Partridge, Peafowl, Common Quail, Ring Dove, Red Turtle Dove, Little Brown Dove, Green Pigeon, Hoopoe, Spotted Owlet, Barn Owl, Dusky Horned Owl Indian Nightjar, Wryneck, Golden-backed woodpecker, Pied Woodpecker, Wood Shrike, Great Grey Shrike, Rufous-backed shrike, Fantail Flycatcher, Common babbler, Jungle babbler, Houbara Bustard, Great Indian Bustard and many other species of passerine birds.

Riverine Tract Habitats

Originally the riverine habitats used to have heavy, seasonal floods. Since forecasting and prior warning were not available to the rural people, these habitats were not occupied for agriculture and habitation. Natural resource exploitation was also not extensive. As a result, this natural flora along the rivers flourished. These included: Tamarix, Saccharum, populus and Acacia. Typha growth was common wherever the water was stagnant or slow moving.

Modified Nature of Habitat

Major parts of the original habitats described above have been modified into new habitats, primarily as a result of extensive cultivation and expanding urban centers as well as rural settlements. These new habitat types are briefly discussed below.

Agricultural Habitats

Most parts of Sindh are under very intensive irrigated cultivation. In addition, livestock rearing is also practiced extensively, and milk animals are common. The use of the chemical fertilizers and pesticides is very common. Several species of wildlife have adapted to the changed habitat. These include: Jackal; Jungle Cat, Bengal Fox, Small Indian Mongoose, Shrew, Rodent pests including Porcupine, Fruit Bats and Wld Boar. The avifauna which survived the modified habitat include Doves, Black Partridge, Cuckoos, Koel, Woodpeckers, Parakeets, Bulbuls, Babblers, Black Drongo, Bee-eaters, Finches and House Sparrow. The reptilian species of this modified habitat include Krait, Cobra, Saw-scaled Viper, Rat Snake and Monitor Lizard.

In these modified habitats, the winter bird species from Himalayas have reduced due to the extensive use of pesticides in these areas, since these species feed on the insects. These birds play an important role in controlling insects particularly in the forests. Almost all of the project components are located in this type of habitat.

Rural and Urban Habitats

These include human habitations within agriculture areas, as well as the urban centers. Scavengers like Jackals are attracted to the garbage dumps and human feces for food. House Sparrows breed in the houses. Bank Mynas and Cattle Egrets feed on grasshoppers in the rangelands with cattle and buffalos. Banyan and Peepal trees still grow in villages. Green Pigeons and barbets feed in these trees.

Migratory Birds

There are many migratory bird species, which still visit or pass through the modified ecozones. These include geese and ducks, cranes, many waders, raptors and large variety of passerine birds such as larks, cuckoos, rooks, ravens, starlings, tits, warblers and finches. Some of these birds fly in to stay for the winter, while the rest fly through the year. For many species the province serves as a breeding ground while others procreate in other areas but have been spotted in this region.

Wetlands

Wetlands are among the most productive ecosystems in the world. Since Pakistan is situated on the flyway to Central Asia and South Asia, the birds breeding in Central and Northern Asia, migrate through Afghanistan to the Indus Valley, particularly to the wetlands across Sindh which are major wintering grounds of migratory water birds. Some of the important wetlands are briefly described below.

The Indus Dolphin Reserve is spread over 135 km from the Sukkur upstream to the Guddu Barrage. In 1974, the entire area was declared the home of the endangered Blind Dolphin. The major threats it faces include split populations of the dolphins due to dams and barrages on the River Indus, reduction in habitat size during dry season, high turbidity, pollution, and hunting. The number of dolphins at the site has increased from 150 in 1974 to 620 in 2001.

Manchar Lake, a threatened wetland dying from pollution and mismanagement, was once considered the largest freshwater lake in Asia. It is located about 12 miles west of the town of Sehwan Sharif and spread over an area of 100 square miles that was once renowned for its beauty and the large population of migratory birds and wild fowl. The water supply for Manchar Lake depends on water flows from River Indus via Aral Wah and Danistar Wah, storm water and hill torrents from Kirthar Hills and effluents from drainage units via Main Nara Valley Drain. Over the last two decades, the fresh water intake of the lake has declined significantly relative to the saline and toxic effluents discharged into it.

Keenjhar (Kalri) Lake Keenjhar also known as Kalri Lake is one of the largest freshwater lakes in Pakistan. It is located on 24° 56 N, 068°03'E coordinates. It has length of about 24 km, width 6 km and capacity of 0.53 million acre feet. It is located at a distance of about 122 km east from Karachi and 19 km north-east of Thatta town. The lake was created in 1930s from the two smaller lakes Keenjhar and Kalri by the construction of a dam at Chilya and a 12 km embankment on the eastern side. Indus provides Keenjhar, the required water through Kalri Baghar (KB) Feeder. KB Feeder starts from Kotri Barrage. Since the area is arid and receives less than 200 mm annual rainfall, hence Indus is the only source of water for this lake.

The lake has extensive reed-beds, particularly in the shallow western and northern parts and rich submerged and floating vegetation. The natural vegetation of the surrounding area is tropical thorn forest. The climate is dry subtropical monsoonal.

The lake is internationally important for a wide variety of breeding, staging, passage and wintering water birds. The wintering birds include ducks and geese, shorebirds, flamingos, cormorants, herons and egrets, ibises, coots, gulls, terns etc. The breeding birds reported from this wetland are Cotton Teal, Night Heron; Pheasant tailed Jacana and Purple Moorehen. About 100,000 birds have been recorded from this wetland in winter. This lake has rich submerged and floating aquatic vegetation. The natural vegetation of the surrounding area is tropical thorn forest. The Lake is rich in fish fauna and supports the livelihood of about 50,000 local people. Main activities at the site are commercial fishing, nature conservation and public recreation. The site serves as a major source of drinking water for Karachi. Keenjhar Lake was declared a Garre Sanctuary in 1971 and designated as a Wildlife Sanctuary in 1977.

Drigh Lake: It lies 18 km west of Larkana. It is located on 27° 34 N, 068°06'E coordinates. Drigh is a small, slightly brackish lake, with extensive marshes, situated in the Indus floodplain. The lake is fed by water from the nearby canal system and by local run-off from monsoon rains. The lake is situated in an area of cultivated plains, generally divided into small fields for rice cultivation. It is a semi-natural wetland, supporting rich and diverse aquatic vegetation. The climate is arid and sub tropical, with hot summers and cool winters.

The site regularly hosts over 20,000 water birds, mostly ducks, geese and coot in winter. It is a breeding and wintering area for a wide variety of water birds and an important roosting site for night-heron. The wintering birds also include shorebirds, cormorants, pelicans, flamingos, jacanas, gulls and terns. This lake was designated as a Wildlife Sanctuary in 1972.

Haleji Lake is a perennial freshwater lake with marshes and a brackish seepage lagoon. Considered a game reserve in 1971, this lake was declared a wildlife sanctuary and in 1976, the lake proceeded to become a Ramsar site. Haleji serves as an important source of water for Karachi besides being a popular recreational

destination. The Lake is located in Thatta district on 24° 47 N, 067°46'E coordinates.

Jubho Lagoon is a shallow, small brackish water lagoon with mudflats and marshes that support a large concentration of migratory birds including flamingos and endangered Dalmation pelicans, a rare species in the world. This was declared a Ramsar site in 2001 because of the efforts made by IUCN Pakistan. The lagoon is located in Thatta district on 24° 20 N, 068°40'E coordinates.

Nurri Lagoon is also a brackish, privately owned lagoon with barren mudflats that is visited by large concentrations of migratory water birds. It was also declared a Ramsar site in 2001. Increased salinity, sea intrusion, population pressures, agricultural and industrial pollution are major threats to this site. The lagoon is located in Badin district 24° 30 N, 068°47'E on coordinates.

Deh Akro is a wildlife sanctuary consisting of four major habitats; desert, wetland, marsh, and agricultural. Located in Nawabshah district, it is a natural inland wetland ecosystem, which supports a variety of rare and endangered wildlife species. This area hosts a considerable number of rare fauna. Many indigenous fish species are also found here. Water scarcity during a persistent dry spell is adversely affecting this area.

Other iakes of the province include Badin and Kadhan Lagoons, Charwo Lake, Ghauspur Jheel, Hadiero Lake, Hamal Katchri Lake, Khango Lake, Khipro Lakes, Langh Lake, Mahboob Lake, Phoosna Lakes, Pugri Lake, Sadhori Lake, Sanghriaro Lake, Shahbuderand Jaffri Lake, Soonhari Lake and Tando Bago Lake.
Important Point: The project is not located in the immediate vicinity of any of these wetlands.

Occurrence of migratory birds observed/reported from project areas

Migratory Birds	Inland Jhimpir	Coastal Gharo	RIS*
Common	13	13	24
Less Common	5	5	4
Abundant	5	13	17
Rare	2	1	5
Total	25	32	50

- RIS= Ramsar Information Sheet

Inland Jhimpir

Habitats

Flat Plains

This habitat occupies a major portion of the project area. The flat plains are mainly gravely in nature while in depressions (where rain water accumulates), vegetation was observed. A total of 22 plant species belonging to 16 families have been identified within the Inland Jhimpir project area. Some of these floral species include Capparis deciduas, Limeum indicum and Zizyphus nummularia. The faunal attributes found within this typical habitat were Ratel/Honey badger (Mellivora capensis), Asiatic jackal (Canis aureus), Common red fox (Vulpes vulpes pusilla), Indian fox(Vulpes bengalensis), Indian porcupine (Hystrix indica), Indian desert cat (Felis silvestris ornate), Indian grey mongoose (Herpestes edwardsi), Indian hare (Lepus nigricollis), Houbara bustard and other raptor species, etc.

Land in the Inland Jhimpir area is also allocated to Arab Sheikhs for Houbara bustard hunting. Six different types of bats were also observed in the area, two of them were fruit eating and the remaining were insectivorous species.

Dry Stream Beds

Dry stream bed is also an important habitat observed in the area. The stream beds are ephemeral in nature and are fed only through rain water. A total of 37 floral species belonging to 17 families have been identified within this habitat of which the most frequently occurring species include Acacia jacquemontii, Aerva javanica, Cressa cretica and Dactyloctenium aegyptium. A number of common wildlife species were also recorded from the habitat including Ashy crowned Finch Lark (Eremopterix grisea), Blue cheeked Beeeater (Merops superciliosus), Common Babbler (Turdoides caudatus), Asiatic Jackal(Canis aureus), Indian Grey Mongoose (Herpestes edwardsi), Gerbils, rats and mouse species and among reptiles Bengal Monitor (Varanus bengalensis), Gecko and Agama species.

Hillocks/foot hills

Small hills are located towards the north and west sides of Inland Jhimpir proposed development site. The hillocks spans from north to south direction. A total 13 floral species belonging to 14 families has been identified from this habitat of which the most frequently occurring species include Prosopis cineraria, Salvadora oleoides and Indigofera oblongifolia. Some of wildlife species found within the habitat are Yellow bellied Prinia (Prinia flaviventris), Wood Sandpiper (Tringa glareola), Whiskered Tern (Chlidonias hybridus), Little Green Bee-eater (Merops orientalis), Common Moorhen (Gallinula chloropus), Indian Hare (Lepus nigricollis), Long-eared Desert Hedgehog (Hemiechinus collaris), Cliff Racer (Coluber rhodorachis rodorachis), Desert Monitor (Varanus griseus koniecznyi), Glossy- bellied Racer (Coluber ventromaculatus) and Indian Fringed- toed Sand Lizard (Acanthodactylus cantoris).

Flora

In the Inland Jhimpir Area, 45 plant species belonging to 21 families were identified at random locations sampled in main habitats within the project area. Out of the 45 species 24 are Perennial, 17 are Annual, 2 are herbs, 1 each is sedge and semi-perennial. The quantitative analysis of floral composition was carried out in calculating, Relative cover, Relative density, Relative frequency and important value index (IVI) of species. Four distinct plant communities were identified based on the physical features of the project area. Life forms of the identified species are as follows:

Life form	Number
Grass	9
Herb	14
Tree	5
Shrub	16
Sedge	1

Many plants of the area possess great medicinal properties. The local people use these plants in many ailments and for many other purposes.

No endemic or rare species were identified during the field survey of Inland Jhimpir area. Most of the species identified have a wide distributional range.

Fauna

Inland Jhimpir is located north to the Indus delta on the right bank of Indus River and close to Kinjhar Lake. The lake, a freshwater reservoir, is also a wildlife sanctuary and Ramsar site. During the field work for REA, 69 species of birds, 27 species of mammals and 24 species of reptiles were recorded from the Inland Jhimpir area. The site is located close to a huge water body, mainly constitutes arid environment with undulating stony plains and scattered vegetation. Few patches of seasonal barani agriculture may also be seen which are cultivated during the rainy season. In comparison to the Indus Delta, this area is of less ecological significance and a lot of human activities including coal mining, seasonal agriculture can be observed. However, stony plains are wintering habitat for many migratory birds including Sandgrouse, Houbara bustard and raptor species. The Jhimpir area is also allocated to Arab Dignitaries for Houbara bustard hunting. This area is further dissected by the communication network including main railway tracks, black top roads and high tension power lines. A

huge industrial complex (Nooriabad) is also located at north-western side on the Super Highway.

Avian Fauna

A total of 69 species of birds were observed on this site during the baseline data collection. These include 44 resident and 25 migratory species. The migrant avian fauna are expected during the winter season which winters in Kinjhar Lake or terrestrial environment of surrounding areas including the project site. Out of the 69 observed species of birds, 38 are common, 19 abundant, 7 less common and 5 are rare. While the remaining 7 are protected under the Sind Wildlife Protection Ordinance (SWPO), 2 are listed in IUCN Red List 2007 and 12 are on CMS Appendices.

Mammalian Fauna

A total of 27 species of mammals were recorded from project site in Inland Jhimpir area. These include 19 common, 1 less common and 1 rare, i.e. Ratel/Honey badger. Ratel/Honey badger and Indian desert cat are protected under the SWPO while 5 are listed in CITES Appendix-II and III. None of the observed species were threatened, except for Indian fox which has been categorized as Data Deficient (DD) species. This area was once a habitat for Chinkara deer which has got extinct. But together with other ungulates, Chinkara deer still survive in neighbouring protected areas like Mahal Kohistan Wildlife Sanctuary and Kirthar National Park located approximately 67km at the western edge of the Inland Jhimpir proposed development site across the Super Highway. A total of 6 Bat species were also recorded
including 4 fruit eating and 2 insectivores.

Reptilian Fauna

A total of 24 species of reptiles were reported from the project site. These include 7 common, 3 abundant, 14 less common and none rare species. Out of total 24 species, 5 are protected under the SWPO and Indian cobra is categorized as data deficient (DD) species under the IUCN Red List 2007 and 6 are on CITES appendices. The recorded reptiles included 2 poisonous snakes namely Indian cobra and Saw scales viper and 4 non-poisonous snakes, Checkered keelback, Cliff racer, Glossy bellied racer and Pakistan ribbon snake. Reptiles are also captured for medicinal and trade purposes.

Inland Jhimpir-Key Faunal Species

Ratel/Honey badger and Houbara bustard (winter visitor) may be considered as key species of the project (Jhimpir) area. Moreover, fruit eating and insectivorous bats recorded from the project area have special significance.

Socio- Economic Resources

The Population And Human Settlements

Jhimpir being in the administrative control of Thatta district is unique in terms of population sensibility and characteristic. The total area of Thatta is 17,355 sq/km. the total population consist of 1,113,194. Gender wise distribution shows a figure as 589,341 are Male and 523,853 are of Female. The population density of Thatta is 64.1 per sq/ km. the percentage of total population receding in urban setting is 11.2 %. The average house hold of size is of 5.1 persons. The average growth rate of population has remained from 1981-98 as 2.26.

Exhibit: Demographic Data of Thatta District

Taluka	Union Councils	Revenue Villages	Villages	Households	Population (1998 Census)
Thatta	13	61	1,107	41,408	253,748
Mirpur Sakro	10	92	1,526	32,099	198,852
Sujawal	06	72	687	22,665	127,299
Mirpur Bathoro	08	63	1,295	27,706	151,915
Shah Bunder	05	80	634	17,094	100,575
Jati	06	112	734	22,337	123,957
Kharo Chan	01	24	169	2,540	25,666
Ghorabari	05	59	851	15,700	105,482
Keti Bunder	01	21	197	3,928	25,700

Exhibits: Population, Income and Electricity Consumption – Sindh

Year	Population (Million)	Per Capita Income (Rs)	Energy Sale (GWh)	Per Capita Energy Consumption (kWh)
2000-01	24.40	18,000	3,722	151
2001-02	24.90	19,440	3,871	153
2002-03	25.42	20,995	4,026	156
2003-04	25.94	22,675	4,187	159
2004-05	26.47	24,489	4,354	162
2005-06	27.02	26,448	4,529	165
2006-07	27.58	28,564	4,710	169
2007-08	28.14	30,849	4,898	172
2008-09	28.72	33,317	5,094	175
2009-10	29.32	35,982	5,298	178

Other Socio Economic Indicator

Literacy rate for Thatta is amongst the lowest in Sindh. Total Literacy Rate stands at 22 %. There are marked urban and rural and male and female differential in Thatta as 46% urban and 19% rural.

The health infrastructure in Thatta is scanned in the sixth coastal talukas, 3 do not have any rural health center (RHC) or any veterinary dispensary. BHUs and dispensaries are also in small number. In Thatta district piped water is available to only about 14% of the housing unit. About 13% of rural house holds have hand pump inside the housing units, while 16% use outside ponds for fetching water and 6% of housing units use well water.

NGOs Working in the Area

Different national and international NGOs are working in Thatta district with the help of their local partners. Their scope of work Ranges from relieve operation in coastal areas of Thatta to social welfare and livelihood improvements initiatives. Some are working on CPI (Community Physical Infrastructure). Some have found their way in providing microfinance to local communities through social collateral. Few of these are also working on awareness and advocacy.

NGOs and institution working in the area include NRSP (national Rural Support Program), Aga Khan Planning and Building Services (AKPBS), PPAF (Pakistan Poverty Alleviation Fund), IUCN, WWF, SPO and Pakistan Fisher Folk Forum.

Poverty

Historically Sindh was prosperous and rich province. However, presently Sindh is largely witnessing poverty and destitution. According to recent study (ADB: Sindh Rural Development Project, 2000), poverty level is quite high in Sindh: 37% of the population lives below the poverty line; 20% of the urban and 53% of the rural population is poor. The ADB study covering four districts – Thatta, Badin, MirpurKhas and Sanghar - claims that poverty is widespread throughout the region. Health and education indicators are very poor in these areas. According to this report a majority of households in these areas do not own land. Tenant farms alone; represent 44% of total private farms. About 20% land owners in rural areas are big land lords and they own about 68% of the private farms.

According to ADB Sindh Coastal and Inland Community Development Project interim Report, the poverty figures in Badin and Thatta district are higher as much as 70 percent. According to the Report, 54 percent of the population lies in poorest category while 44 percent were poor. According to the report poverty was highly correlated with household economic characteristic such as land ownership and employments opportunities. Land owner are usually among the not poors. The sea intrusion has badly affected the agricultural activities in these areas. According to community perception of poverty, the poorest are those who have no capital or other resources of their own. They mostly depend on land and grounds of others for their livelihood, and usually work on daily basis.

Main Occupation

Cultivation and the related businesses are the main occupations in the project area. The other key economic activities include fisheries, livestock rearing, government and private sector jobs. In the coastal areas of Thatta and badin, fisheries are among the prime livelihood activities of the majority of the people.

Livestock is also one of the key livelihood sources for the rural population of the area. The farmers, in these districts traditionally keep a few head of livestock, ranging from bullocks to plough, cows for milk and poultry for egg and meat. Good breeds of buffalos and cows are also found in these districts.

Market in Jhimpir

Gender Perspectives

Sindh has been the land of Sufism strongly believing in the equity and equality irrespective of race, religion and Gender. However, with the passage of time, the Sindhi society has accepted the impact of different cultures, traditions and customs. Presently the gender based approaches and attitudes are not favorable for women in the project areas.

Variations exist in gender perceptions, attitudes, roles and responsibilities among lower, central and upper Sindh. In this respect, the coastal districts are less conservative as compared to the upper and central Sindh areas. The tribal clans in upper Sindh, Sanghar and Mirpurkhas districts of Central Sindh are more conservative with regards to women and their status, which is a key development indicator.

The women particularly in urban area have fewer rights in all the aspects of their lives. The literacy data clearly corroborates this, and indicates that compared to men, the women are far behind the education, which is a key development indicator.

Education

The over all literacy rate in Sindh is 45.29 percent (1998 census data). The urban literacy is 63.72 percent which is substantially higher than the rural literacy which is 25.75 percent. In the project area, Hyderabad has the highest literacy (61%), whereas Jacobabad has the lowest urban literacy (44%). Larkana enjoy the highest rural literacy of almost 28 percent, whereas Jacobabad is again at the bottom of the list in the project area in terms the rural literacy. Thatta is most backward in terms of the over all literacy (22%) compared to the other districts in the project area.

Exhibit: Educational Institutes in Thatta District
(1998 Census Data)

Schools	2,282
Colleges	4
Others	4

Exhibit: Healthcare Facilities in Thatta District
(1998 Census Data)

Civil Hospital	Taluka Hospital	Basic Health Unit(s)/ Public Health Centers	Rural Health Centers
1	4	46	8

Agriculture
Agro Ecological Zones

The use of land is governed by several interacting factors, which are physical, biological, social and economic in nature. A clear vision of these factors is essential for increased agricultural production in any given region. The Pakistani agricultural research council (PARC) in 1980 divided Pakistan in 10 agro-ecological zones, based on a survey carried out by FAO and review of the available literature on Physiography, climate, soils, land use and other factors affecting agricultural production

Agricultural Production.

Agriculture is the key source of livelihood in Sindh since the majority of the population is associated with this sector. Total 14.1 million hectares land area of Sindh, represent 18% of total geographic area of Pakistan. Out of this, nearly 50 percent or 7 million ha is available for cultivation. More than 80% of rural population depends on agriculture and its allied businesses. Agriculture is the dominant economic activity in the province.

About 80% of the agriculture land of the province is cultivated through controlled irrigation system. The irrigation system of Sindh comprises of three barrages Sukkar, Guddu and Kotri, having a gross command area of 15 million acres. However, cultivation takes place on only 8 million acres. The major crop of Sindh

includes rice, wheat, cotton, sugarcane and oilseeds. Sindh is also known for its orchards, mango, banana, guava and dates being some of the key fruits.

Irrigation System

Irrigated agriculture is the major user of both, surface and groundwater resources of Pakistan. The average annual river diversions for irrigation in the Indus basin are of the order of 104.7 MAF, to irrigate over 14.6 million hectares. Out this, 67.11 MAF on average is diverted during the Kharif period, while 37.63 MAF is diverted during the Rabi period.

During the Kharif period of the last ten years, Punjab used 34.3 MAF annually; while Sindh and Balochistan used m1.4 MAF and NWFP used 2.35 MAF. During the Rabi period of these last ten years, average withdrawals by Punjab, Sindh and Balochistan and NWFP were 19.8 MAF, 16.06 MAF and 1.46 MAF, respectively.

Groundwater Irrigation

An estimated 41.6 MAF of ground water is pumped annually in Pakistan. According to a study, more than 90% of the extracted ground water is used for the irrigation purposes. Ground water reservoirs are recharged from the river as well as the seepage losses from the canals, watercourses, farms channels and the fields.

Salinity and Water Logging.

Before the introduction of the irrigation system, the water table was sufficiently deep. However, due to lack of drainage facilities and improper water management, the water table rose, resulting in water logging and salinity.

About 25% of the irrigated land of Pakistan is affected by Water logging and salinity/ sodicity problems. In addition to other measures like irrigation system rehabilitation, command water management and On-Farm Water Management programs taken up by different government departments, WAPDA completed 57 salinity control and reclamation projects (SCARPs). Those cover a gross area of 7.81 million hectares.

5

Project Description

This section briefly explains the concept of electricity generation through wind turbines and provides a simplified description of Noor Solar Energy Pvt Limited (NSEL) project covering entire life cycle from design phase till decommissioning with specific focus on construction and operational details mainly related to wind turbines and various components of the proposed project and their salient features, location, and phases with particular emphasis on aspects related to the environment. Also provided in this section is detail of supplies, emission and discharges as well as waste disposal arrangement during different project phases.

Wind Energy and its use for Electricity Generation

The sun heating different parts of the earth unequally causes winds. A wind turbine with the help of blades converts the wind's kinetic energy into mechanical energy, which is in turn through gearbox (pitch drive and yaw drive) amplify the mechanical output by increasing the rpm which is then turned into electrical energy by generator. While modern wind turbines are efficient the amount of energy in the wind is low so each turbine only produces a small amount of energy. Therefore a large number of wind turbines called a wind farm are needed to produce sufficient power to meet a demand needs.

Wind power has a light footprint. Its operation does not produce harmful emissions or any hazardous waste. It does not deplete natural resources in the way that fossil fuels do, nor does it cause environmental damage through resource extraction, transport and waste management.

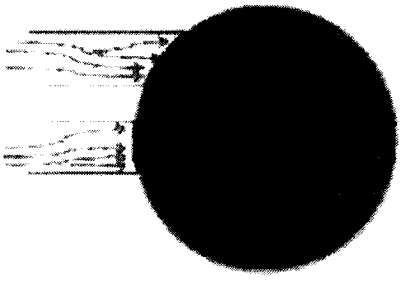
In a wind farm the wind turbine foundations take up less than 1% of the land area while wind turbines are vertical structures. Once up and running, existing activities such as agriculture, grazing etc can continue around them. Farm animals such as cows and sheep are not disturbed by the presence of wind turbine structures and their noise.

Any impacts on the local environment must be set against the much more serious effects of not developing renewable energy sources and there by aggravating the pressures of climate change on the balance of nature.

Wind

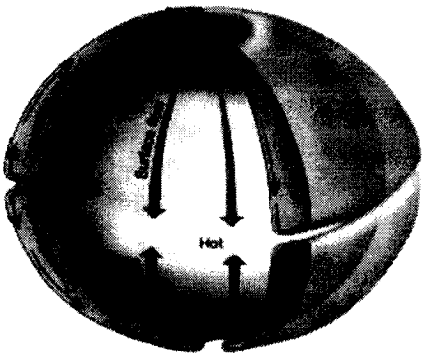
Wind Energy in fact is solar energy. Macro scale global circulation is initialized by difference in sun heating of equatorial regions with much more solar energy input than in polar regions as shown in figure below

Input for Solar Energy



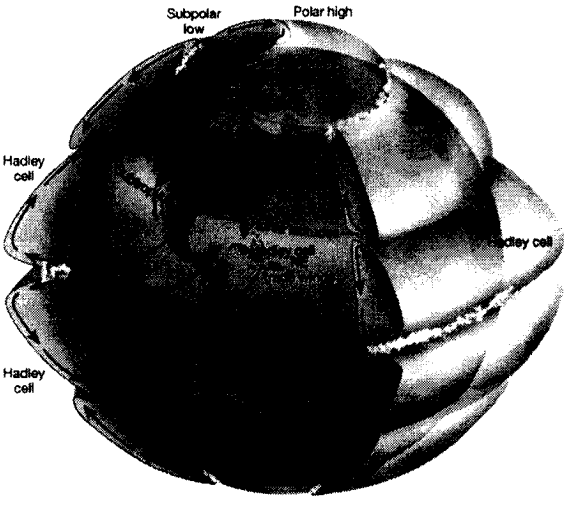
This results in the development of two huge convection cells as shown in figure below

Single Cell Atmospheric Convection in Non-Rotating Earth



Due to earth rotation and effects of land and sea masses, air masses of these convection cells are being redirected and though being the result the global atmospheric circulation. In figure below, an idealized atmospheric convection is shown.

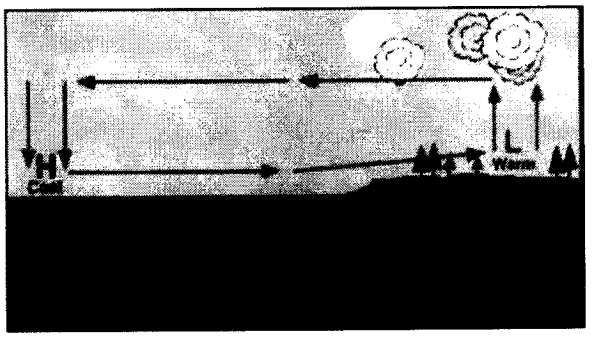
Idealized Three Cell Atmospheric Convection in Rotating Earth



Local Winds

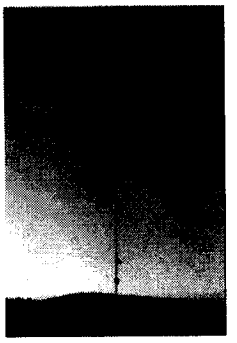
Wind is the movement of air masses to compensate differences in the atmospheric air pressure. Air masses therefore tend to move from high pressure zones to low pressure areas.

Local wind systems are determined by regional configuration of high and low pressure areas and also by thermal effects and local geographic conditions.



Wind Data and Measurement

NSEL has installed wind mast at 120 meter to collect the wind data required for micrositing.



Before the start of the wind measurement process, location of mast, its configuration, sensitivity of the measurement equipment and its calibration status was evaluated in order to have accurate wind potential analysis.

The wind measuring masts is recording wind parameters mainly wind speed, wind direction, wind density, turbulence intensity, temperature, energy content etc.

The data from the wind mast will be used to develop the wind distribution diagram (wind rose).

Wind speed Data and Forecast

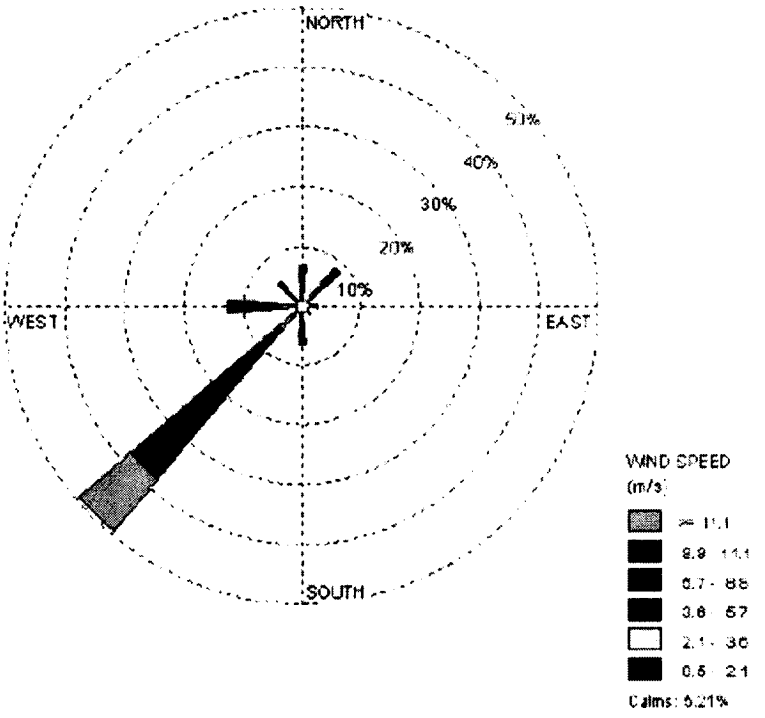
The proposed site is located at Jhimpir. According to the AEDP, it is a best air corridor. PMD data shows the wind speed of the area.

Table: Monthly Benchmark Wind Speeds for Jhimpir sites

	Monthly Mean Wind Speeds (m.sec-1)				
	30m	50m	60m	67m	80m
January	4.25	4.70	4.90	5.02	5.24
February	4.50	4.98	5.18	5.32	5.55
March	4.77	5.28	5.50	5.64	5.89
April	6.39	7.03	7.29	7.46	7.75
May	8.29	9.05	9.36	9.56	9.90
June	8.79	9.50	9.78	9.96	10.25
July	8.83	9.59	9.89	10.08	10.40
August	8.20	8.89	9.16	9.34	9.63
September	6.63	7.28	7.54	7.72	8.01
October	4.22	4.68	4.87	5.0	5.22
November	3.59	3.98	4.14	4.24	4.43
December	3.96	4.38	4.56	4.67	4.88
Annual Average	6.0	6.6	6.8	7.0	7.3

Source: Pakistan Meteorological Department

The typical wind rose map for Jhimpir based on the three year data (2002-2005) is illustrated below



Wind Rose indicates that most of the time the wind direction was southwest. The annual average wind speed is 6.68 m/s and the percentage when wind speed less than 2 m/s is 17.05% only

The wind speed distribution follows a Weibull-function and helps to identify each wind farm site according to its adequacy for wind energy exploitation and to meet project specific decisions such as the type of turbine that could be installed.

The wind rose is essential for NSEL wind farm design, as the exact positions of wind turbines depend on parameter configuration for each turbine site, taking into account the influences in wind flow between the turbines.

How Turbine Works

Power required in moving the wind turbine is available from the kinetic energy of the mass of air moving in the wind. As wind affects the blades of the rotor of a wind turbine, the rotor starts rotating due to the "principle of lift" just like as aircraft wings.

The performance of wind turbines based on that principle is at around 50% due to the relatively high lift-to-drag ratio, whereas simple turbines with small output (up to 2kW) or historic windmills operate according to the "principle of resistance" with a maximum performance of about 12%.
In most common wind turbine types, the rotational momentum of the rotor is being transmitted to a main shaft. A gear box increases number of revolutions per minute (rpm) and the high speed shaft is moving the generator unit thus producing energy.

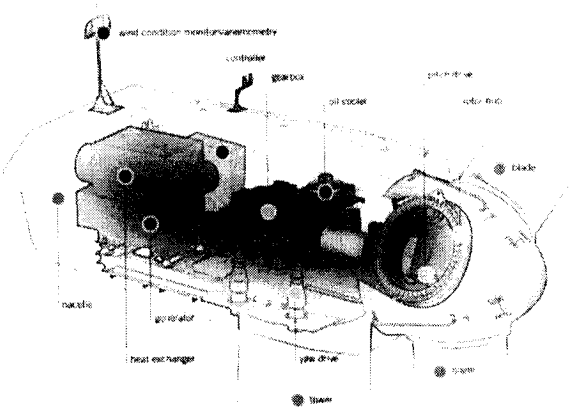
The basic components of a wind turbine are as follows:

1. **Rotor** – three blades, mounted on a hub – typical rotor diameters are 80-90m for today's larger machines. Blades are usually made from Glass Reinforced Plastic (GRP) and incorporate lightning protection measures. The picture below shows a single blade being transported to a wind farm site.

2. **Nacelle** – the "box" within which the main components are housed and home to the gearbox, generator and transformer as well as some of the control electronics. The picture below shows a nacelle being lifted onto the wind turbine tower (if you look closely you can see the construction team at the top of the tower waiting to fix the nacelle in to place)

3. **Gearbox** – converts the rotational speed of the rotor (typically 10-20rpm) to 1500rpm for the generator

4. **Generator** – converts rotational movement to electrical energy



5. **Transformer** – converts electricity from 415V or 690V to 11,000V for transmission down the tower. The transformer can be housed outside or inside the wind turbine tower itself.

6. **Tower** – usually steel, a cylinder supporting the nacelle and rotor. Typical tower heights are between 60m-100m. Cables run down the tower taking the electricity from the generator at the top, into the ground and then onto a connection point to the grid. Lifts or ladders allow maintenance crew to access the nacelle.

7. **Base** – a concrete base, typically 15m x 15m x 1m which acts as the foundation for the structure.

Operation of Turbine

When the wind blows the turbine hub turns into the wind. When the wind passes over the blade, the shape of the blade means that the air flows more quickly over one side of the blade than the other. This results in the turning of the rotor.

Wind turbines operate when the wind speed is within certain limits. There has to be enough wind for the blades to turn – typically 3-4m/s (or 7-9mph, 6-8 knots). When the wind speeds get to 25m/s (56mph, 49 knots), turbines typically shut down to protect the structure from excessive loads. Wind turbines are certified to specified levels and designed to the highest of these.

Instruments at the top of the nacelle (wind vane and anemometer) measure the wind speed and direction.

Control of the turbine

As wind speeds increase, so the energy generated by the turbine does as well. At some point where wind speeds are around 15m/s (34mph, 29 knots), the maximum (or rated) capacity of the turbine is reached. A limit has to be set to define the sizes of the various components – gearbox, generator, cables and rotor blades).

To control production of wind energy above the rated wind speed, the turbine can use various methods:

- **Variable pitch** – the blades of the wind turbine are feathered to limit the energy produced as wind speeds increase
- **Variable speed** – on some wind turbines, the rotor is allowed to speed up and slow down as the wind speed varies

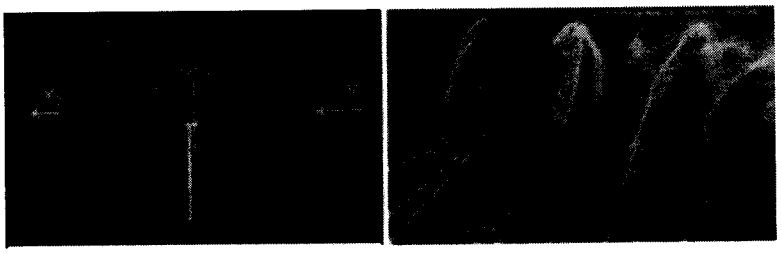
In both cases, changes to the pitch or speed can happen several times a second so the wind turbine is always running in an optimized state for the wind conditions it

sees, providing the most efficient extraction of energy from the wind and therefore maximizing renewable energy production.

All of the information about the wind turbines are recorded by computers and transmitted to an off-site control centre. Wind turbines are for the majority of the time self-sufficient although periodic mechanical checks are usually carried out every few months.

Wind Farm Efficiency

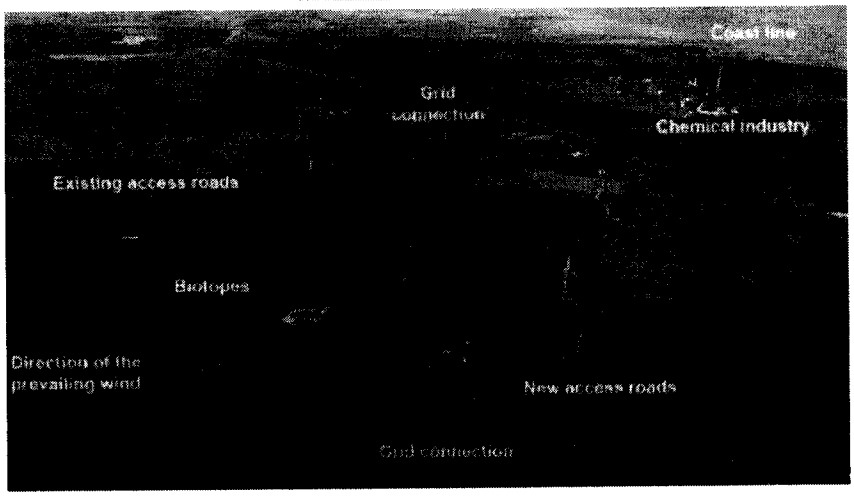
As wind passes a turbine's rotor, wind speed is reduced and air flow gets turbulent as shown in Figure below.



Wind turbines are influenced by turbulence which takes place resulting in wind speed reduction.
Wind farm efficiency is the factor (%) of total production of a wind farm in comparison to the sum of production of all individual turbines considered to be free of influence.
Nowadays, a farm efficiency of more than 41% is considered to have a good efficiency.

Wind Farm Components

A wind farm is composed of several indispensable installations, such as the proper wind turbines, turbines foundation, crane platform, access roads, intern cable trench, electrical evacuation power lines and grid connection components, the electrical substation.
Figure below shows a typical wind farm configuration:


Coast line
Grid
connection
Chemical industry
Existing access roads
Biotopes
Direction of the
prevailing wind
New access roads
Grid connection

Project Details

The proposed project involves developing, owning and operating a 50 MW wind farm Independent Power Plant project in Jhimpir, Sindh, Pakistan.

The generated electrical power will be purchased by the Central Power Purchasing Agency (CPPA) and evacuated by the National Transmission and Dispatch Company (NTDC), which is responsible for the country-wide transmission of the electricity

Noor Solar Energy Pvt Limited (NSEL) is leased 330 acre of land in Jhimpir, District Thatta, Sindh for a period of 33 years by the Government of Sindh.

Project Development Steps

S.#	Steps	Status
	Design Phase	
1	Letter of Interest (LOI)	Achieved
2	Land Allocation by Government of Sindh	Achieved
3	Micrositing	In-Process
4	Topographic Survey/Soil Investigations	Completed
5	Grid Interconnectivity Study	Future milestone/s
6	Selection of Turbine	
7	Selection of EPC Contractor	
8	Selection of O&M Contractor	
9	Feasibility Study	
10	Generation License	
11	Tariff Determination	
12	Submission of Performance Guarantee	
13	Letter of Support (LoS)	
14	Energy Purchase Agreement	
15	Implementation Agreement	
16	Financial Close	
17	Pre-Construction Phase	
18	Technical Drawings Development and Review	
	Construction Phase	
19	Temporary Site Facility (TSF) Construction	Future milestone/s
20	Construction of access roads and Installation of batching plant	
21	Excavation for WTG foundations	
22	Steel Rebar Works	
23	Pouring	

S.#	Steps	Status
Construction Phase		
24	Construction of Sub-Station	Future milestone/s
25	Installation of WTG	
26	Excavation for Cabling	
27	Installation of equipments in Sub Station	
Operation Phase		

Project Location

Noor Solar Energy Pvt Limited (NSEL) wind farm is located in Jhimpir region which is approximately 80 to 100 km east/ northeast of the city of Karachi in the south of Pakistan. Its topography can be considered generally as flat with an increasing height above sea level from about 30 to 40 m in the south up to 70 to 150 m in north-western direction. Some hill slopes of up to 160 m above sea level do exist in the centre and in the north of the region. The roughness is lower in the southern part.
The complete area is characterized of being dry land and with agricultural activities (mainly in its southern part). Jhimpir village is located in this area, although it is not included within the defined wind farm region. In the rest of the region scattered human settlements can be found.

Site Layout

NSEL is in the process of micrositing data collection. Once the data is collected and wind rose maps developed, the data will be shared with the prospective turbine manufacturers who will proposed the WTG's layout based on the micrositing data, the total area allotted, its dimensions and area topographical analysis.

Based on the micrositing data of neighboring projects, as well as the site layout of existing operational and under construction projects, it is most likely that NSEL site layout will follow the below mentioned layout.

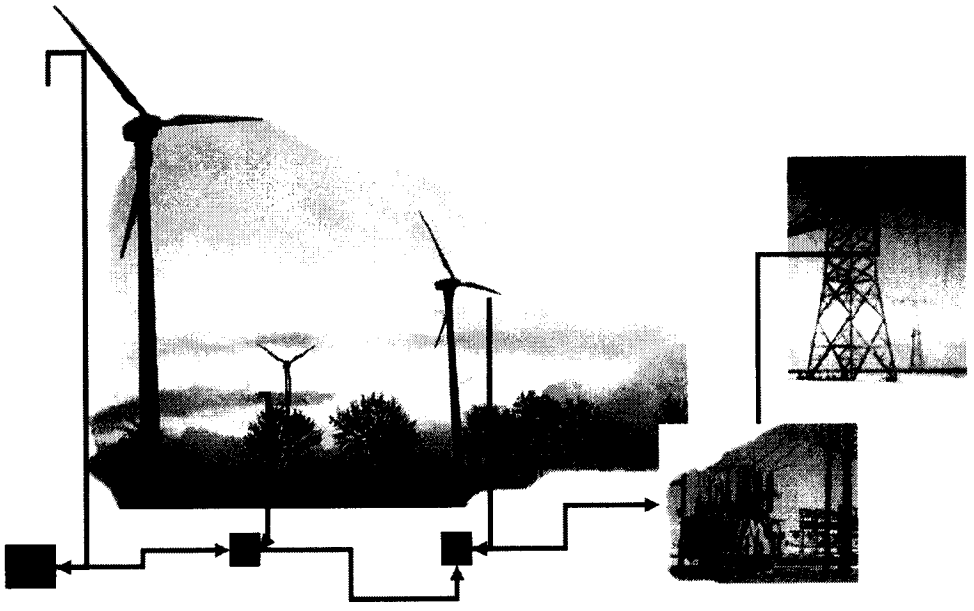
The other possible layout of the site can be as below

Wind Farm Components

The project components are:

- Between 20 (if 2.5 MW turbines are selected) to 29 turbines (1.7 MW turbines are selected) having rotor diameter of 100 m. Each turbine will be mounted on a tower such that the hub height is b/w 85-116 m. The tower will be a prefabricated steel structure.
- Between 20-29 step up transformers mounted at the foot of each turbine tower
- Underground electrical collection system that leads to the project substation.

- Project operations and control building, which will also house the substation and grid connection to NTDC system.
- Project road network linked to all the wind turbines.
- One meteorological masts, 120m height, for collection of wind data.
- Plant O&M facility.
- Camp Site
- Standby generator



Logistics

All equipment, supplies and personnel will be moved to and from the site using road transport. Description of existing roads, additional roads required, and the vehicles to be used are given below.

Roads and Tracks

The project area is connected to Karachi via the Super Highway and the Nooriabad connecting road.

The area's existing tarmac roads will be used by project vehicles as they are, and no improvement will be required except for upgrading of the road leading from Nooriabad to Jhimpir windfarm area. This will entail widening, spreading gravel and compaction at selected locations and construction of lay-bys for ease of heavy transport movement.

Vehicles and Traffic

The movement of heavy vehicular traffic will primarily be during the turbines delivery stage and during the movement of the batching plant and ancillaries. The batching plant usually requires the use of 4 flat bed trailers of 40-feet size with a load carrying capacity of 30 - 35 tons. The movement of the turbines and towers will occur over a two month period and will require 231 heavy haul truck / trailers, 60-feet size, with extended length and multiple axles having a load carrying capacity of 40 -70 tons. Additionally, 66 trucks / trailers of 20 - 25 ton capacity will also be used. A specialized crane will be used for the installation of turbine at a height of around 100 m.

A maximum of 6 vehicles (4 axles and above) per hour will be used during the construction period. This includes the buses and coasters required for movement of the site staff.

Project Schedule

It is expected that work on the project will commence during the first quarter of 2017. Work will commence with the construction of the access road and site preparation (civil works). The construction phase is expected to take 15 months. The schedule of activities is expected to be as follows:

- Feasibility report submission to AEDB—
- Selection of Turbines---
- Generation License---
- Tariff determination with NEPRA
- Financial Closure for wind risk policy---
- Arrangement for investors/Financing ---
- Civil construction - roads:
- WTG foundations:
- Electrical construction start:
- Turbine delivery: October -
- Substation transformer(s) at site:
- Substation commissioned:
- Collection system commissioned:

- Turbine commissioning:

Selection of Wind Turbines

Based on the micrositing data, NSEL will evaluate the turbines of different manufacturer's and decide about the selection of WTG on the basis of following

- Technology offered and the WTG efficiency and its impact on financial viability of the project
- Experience of existing wind farm operators in Jhimpir region
- Compatibility with the Grid

The following table details the different turbine options among which NSEL will select for the project

*Manufacturer	*Make & Model	Rating	Hub Height	Rotor Diameter	# of WTG's
Nordex	N100/2500	2.5 MW	80 m	90 m	20
Vestas	V 100-1.8	1.8 MW	**100 m	**100 m	27
Goldwind	GW 100/2.5 PMDD	2.5 MW	100m	100 m	20
GE	1.7-100	1.7 MW	**100 m	**100 m	29
Gamesa	G114-2.5	2.5 MW	93 M	114 M	20

NSEL may evaluate other manufacturers and their turbine make & models based on any technology development during the project design phase.

**. The Noise data impact assessment is based on the turbine specification which gives the highest value of noise. Birds Collision analysis and flickering impact is based on the highest value of rotor diameter and hub height.

After preparation of financial feasibility and tariff determination by NEPRA, DEL will look for financing arrangements.

Selection of EPC and O&M Contractors

After the collection of micrositing data, NSEL will float the tenders for EPC and O&M Contracts and seek technical and financial proposals. Evaluation criteria will be based on their Technical competency, experience of similar projects internationally and in Pakistan, Financial stability, lenders acceptability etc

The *probable EPC and O&M contractors from which selection can be made are

Power China HydroChina or its following subsidiaries

- HydroChina International Engineering Co Ltd (HIECL)
- HydroChina Development Engineering Co (HDEC)
- Xeibi Energy
- Harvey Energy
- China Machinery Engineering Co (CMEC)
- DESCON

*The actual EPC and O&M contractor may be different from the ones mentioned above.

Construction Activities

EPC contractor on receiving the Notice to Proceed (NTP) will initiate through its sub-contractors, the construction of Temporary Site Facility (TSF) and access roads.

TSF layouts and access roads layouts will be reviewed by the NSEL Civil Construction Engineer and Lender's Engineer for all technical aspects while HSE Consultant will review the layouts for HSE and CSR compliance requirements (international lenders and local laws) incorporation during the design phase.

The site construction camp will cover an area of 12,000 m2 and will have 4 construction trailers and 4 equipment storage trailers. There will also be vehicle parking and equipment staging areas.

The water pit will be lined with an impervious liner to prevent seepage and loss of water. Sewage septic tanks will be lined. These will be periodically emptied into tankers for transporting the sewage to the nearest treatment facility. Gray water (from kitchen and washing areas) pits will not be lined, and water will be allowed to soak into the ground.

All fuel or oil storage areas will have an impervious base, with a containing dyke built around them to contain spills should an accident occur.

NSEL Civil Construction Engineers, Owner's Engineers and Lender's Engineers will review the wind turbine foundation technical drawings before the start of the excavation activities, steel works and pouring.

Each turbine location will involve compaction of around 4647 sq ft (36m x 12m) area, raising to an elevation of 4.5m, corresponding to the level of the road, and covering with a compacted gravel and clay surface {moram type material). This area will be the crane locating pad.

The excavated earth, obtained during the foundation construction will be used to construct the embankment for the road and for back filling. The remaining material required for the road embankments will be from the site.

The turbine manufacturing will have a supervising engineer onsite during the installation phase and the commissioning engineer during the start-up phase.

Installation of the sub-station is likely to be done by EPC contractor sub-contractors

Civil works will also include the construction of the Sub-station and site camp preparation. The steps taken in site preparation are expected to be as follows:

Clearing of vegetation from identified areas

Filling and compaction

Construction of auxiliary facilities such as site camp, equipment and supplies storage areas, water tank and water pits, fuel storage areas and waste pits.

Construction of the turbine foundations and the crane pad

The equipment installation phase will commence once the above activities have been completed. No fabrication at site will take place as all components are prefabricated and only assembly is required.

Staff

It is planned that, on an average, around 100 direct manpower will be required during the construction phase. Local people will be hired for unskilled jobs, especially during the construction phase and for security purposes.

Supplies

All supplies, both for construction and for the camp, will be transported by trucks from either Karachi or the adjoining areas, as required. This will include all fuels

and oils, drilling requirements, spare parts for the construction machinery and food and supplies for the construction camp. Fuels and oils will be unloaded in designated areas.

The onsite storage capacity for fuel will be 12,000 gallons, consisting of 2 steel tanks of 6000 gallons each. The total fuel requirement is estimated to be 2.198 ML.

Water

During the construction phase an estimated 186,300 m3 of water will be required for civil works. The daily maximum will be around 40,000 liters of water for civil works. The onsite storage capacity of water will be approximately 8,000 liters. This water will be obtained from the either the tubewells or lake or water tankers.

The camp will require 8000 liters of potable water each day and this water will be stored in a plastic tank.

Electricity

The expected maximum requirement of electricity for construction and the camp is 1100 KVA. Diesel generators will be used for power generation to operate the construction equipment and for the camp. It is expected that 2 generating sets of 550 KVA each will be sufficient for the requirements. The welding generators will be in addition to the above generating capacity. The daily fuel requirement will be around 6000 liters.

Emissions from the generators will be reduced by ensuring that the engines are always properly tuned and maintained, and generators will be located so that emissions are blown away from the camp and work areas.

Waste Management

All efforts will be made to minimize waste generated during the construction period. The main types of waste that will be generated are:

- Fuels and oils
- Garage waste
- Sewage
- Camp waste

The foundation construction is not likely to generate any waste as bulk concreting will be done using concrete pump wastage of concrete will be minimal.

Fuels and oils will be stored in containers in areas with impervious floors and surrounded by dyke walls. Recyclable materials will periodically be transported out of the site and sold / given to contractors. Non-recyclable material will be collected and disposed of at designated landfill sites.

Most garage waste, such as used spare parts, is recycled in Pakistan. All such waste will be collected and sold / given to contractors for disposal off-site.

As part of the site preparation stage, a drainage and sewerage system will be constructed for the camp. The sewerage system will consist of soak pits for the collection of waste water from the camp kitchen and washing / ablution areas.

Sewage from the toilets will go into lined septic tanks. Sewage and solid waste disposal trucks will be used to remove the sludge, sewage and solid waste from the site.

All combustible domestic waste will be collected and burned in a garbage pit, suitably fenced to prevent it being blown away. Any non-combustible and non-biodegradable waste, such as glass, metal and plastic, will be separated and transported out of the site area, where it will be sold / given to a contractor for recycling or disposal at designated sites.

Noise

The generators and other heavy construction machinery will not produce excessive noise which will exceed the limits at the boundary of the plant. Workers near these machines will use appropriate PPE.

Operational Activities

O&M activities will not be very extensive. The normal greasing and cleaning activities will be done, except for the annual shutdown of the turbine for maintenance. Even during this time it is not expected that any major work will be required each year.

Staff

There will be no residential staff at site once the operation commences. It is planned in addition to the security staff, a maximum of 10 operational people will be employed on three shifts to monitor the windfarm operations from the control room set in Nooriabad. . Security staff will be resident on site.

Supplies

All supplies, both for operations and for the site staff, will be transported by trucks from either Karachi or the adjoining areas, as required. This will include all fuels and oils, spare parts required for maintenance. Fuels and oils will be unloaded in designated areas, which will have above ground storage for 400 gallons of fuel.

Water

February 2016

APPROVAL SHEET

TITLE	:	Feasibility Study Report for 50 MW Wind Power Project in Jhimpir-Sindh, Pakistan	
DOCUMENT NUMBER	:	RE2-141-185-001	Issue: 01
CLASSIFICATION	:	**CONTROLLED**	

SYNOPSIS

This document is a feasibility study report of the 50MW Wind Power Project being developed by Noor Solar Energy (Pvt.) Ltd. It contains hardware specifications, energy yield estimates, electrical interface, civil works design and the project cost. It also includes the environmental impact assessment, soil investigations, site topography, grid interconnection studies and the project management information. This report has been prepared by Renewable Resources (Pvt.) Ltd, Pakistan.

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DATE : February, 2016

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LIST OF ABBREVIATIONS

AC	Alternate Current
AEDB	Alternative Energy Development Board
C.R	Core Recovery
CDM	Clean Development Mechanism
CFCs	Chlorofluoro Carbons
CH4	Methane
cm	Centimeter
CMA	Certified Management Accountant
CNG	Compressed Natural Gas
CO2	Carbon dioxide
CoP	Conference of the Parties
CPPA	Central Power Purchasing Agency
DAE, ED, GoS	Directorate of Alternative Energy, Energy Department, Government of Sindh
DC	Direct Current
DISCOs	Distribution Companies
EE	Energy Efficiency
EMP	Environment Management Plan
EPA	Energy Purchase Agreement
EPC	Engineering, Procurement and Construction
EU	European Union

GDP	Gross Domestic Product
GENCOs	Generation Companies
GHG	Green House Gas
GIS	Geographic Information System
GoP	Government of Pakistan
GPS	Global Positioning System
GW	Gold Wind
HAWT	Horizontal Axis Wind Turbine
HESCO	Hyderabad Electric Supply Corporation
Hz	Hertz
IEE	Initial Environmental Examination
IPPs	Independent Power Producers
JI	Joint Implementation
KANUPP	Karachi Atomic Nuclear Power Plant
KESC	Karachi Electric Supply Company
km	Kilometer
kV	Kilovolt
kW	Kilowatt
LNG	Liquefied Natural Gas
LOI	Letter of Intent
LPG	Liquefied Petroleum Gas
LOS	Letter of Support
LUC	Local Control Unit
m2	Meter square
m3/h	Meter cube per hour
MTDF	Medium Term Development Framework

MVA	Million Volt-Ampere
MW	Megawatt
N2O	Nitrous Oxide
NAPWD	Northern Areas Public Works Department
NCS	National Conservation Strategy
NEPRA	National Electricity Power Regulatory Authority
NEQS	National Environmental Quality Standards
NOCs	No Objection Certificates
NREL	National Renewable Energy Laboratories
NTDC	National Transmission and Dispatch Company
O & M	Operation & Management
OECD	Organization for Economic Cooperation and Development
OHL	Overhead Lines
OLTC	On-Load Tap Changer
PAEC	Pakistan Atomic Energy Commission
PCM	Pulse Code Modulation
PEPA	Pakistan Environment Protection Act
PLC	Programmable Logic Control
PMD	Pakistan Meteorological Department
PPIB	Private Power Infrastructure Board
PVC	Poly Vinyl Carbonate
QC	Quality Control
R & D	Research and Development
RE	Renewable Energy
RE2	Renewable Resources (Pvt.) Ltd

RQD	Rock Quality Designation
SF6	Sulfur Hexafluoride
SPT	Standard Penetration Test
UPS	Uninterruptible Power Supply
USA	United States of America
VAWT	Vertical Axis Wind Turbine
WAPDA	Water And Power Development Authority
WMO	World Meteorological Organization
WTG	Wind Turbine Generator

ACKNOWLEDGEMENTS

The management of Noor Solar Energy (Pvt.) Ltd is thankful to the Ministry of Water and Power and the dedicated team of Directorate of Alternative Energy (DAE, Energy Department) Govt. of Sindh for generous support at all stages of project development and looks forward to their continued support in the future.

The management of Noor Solar Energy (Pvt.) Ltd also looks forward to the cooperation of Government of Sindh and other Government departments (NEPRA, NTDC, HESCO) which is being extended to the Project.

DISCLAIMERS

This report is prepared for the benefit of Noor Solar Energy (Pvt.) Ltd (the "Client"), and may not be relied upon or disclosed to any other person for any purpose, other than as stated below, without the Client's prior written consent in each specific case. The information contained in this report is intended to be used by the Client for such other purpose as may be necessary for the development and implementation of the Project.

COPY RIGHT NOTICE

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DOCUMENT INFORMATION

Purpose and Scope:

The purpose of this report is to provide information required for the relevant agencies to make an informed decision regarding the implementation and execution of this project.

1 EXECUTIVE SUMMARY

Located on the western stretch of the South Asian Continent, The Islamic Republic of Pakistan is largely under the influence of a tropical desert climate. The thermal depression of South Asia and the monsoon winds shape up Pakistan's southern coastal areas and northern mountain areas into a land rich in wind energy resources. The costal wind-energy-rich areas normally refer to Southern Sindh and the vast plateau to the east and the northeast of Karachi city. The relative shortage of conventional energy resources in Pakistan and the hiking of fuel prices worldwide spurred the Pakistan Government to find alternative sources, including wind power.

Government of Sindh has formulated a policy to encourage the participation of private sector in the development and application of renewable energies. A Government organization called the Directorate of Alternative Energy, Energy Department, Govt. of Sindh (DAE, ED, Sindh) has been established to facilitate the implementation of renewable energy projects.

At present, six (06) wind power projects of approx. 50 MW each capacity each are in operation. A total of eight projects (six of 50 MW each, one of 99 MW and one of 30 MW) have achieved financial close and entered construction.

Liberty Mills Limited, located in the industrial heart of Karachi, was founded in 1964. From humble beginning it is today one of the largest textile processing unit in Pakistan with a production capacity of 500,000 square meters of fabric per day. The whole production is exported directly and indirectly to customers which include vendors of internationally recognized brands, departmental stores and mail order firms. Liberty Mills Ltd are an ISO 9001-2008, OCS 100/OCS Blended Standards, Oeko-Tex Standard 100 and SA 8000:2008 Certified company. Upgrading the quality of our products and services, personnel, equipment and infrastructure is an ongoing feature of their operation. The group is also involved in Power business since 2007 and have major share in 200 MW thermal Liberty Power Plant.

Noor Solar Energy (Pvt.) Ltd is sponsored by Libert Group and is interested in setting up a Wind Power Project of 50 MW capacity in Jhimpir, Sindh, Pakistan. Renewable Resources (Pvt.) Limited (RE2) is the consultant for Noor Solar Energy (Pvt.) Ltd for developing this project.

1.1 PROJECT OVERVIEW AND SITE

The wind farm Project is located in Jhimpir, which is located approximately 75 km (aerial distance) East of Karachi, Pakistan's commercial hub and main coastal/port city. The Project site consists of 330 acres of land, which has been acquired by the project company. The KarachiHyderabad Motorway (Super Highway) and National Highway are the connecting roads to the Project site. The Jhimpir wind corridor is identified as potential area for the development of wind power projects. The overview of the project site is shown in ***Figure 1.***

Figure 1: Noor Solar Energy (Pvt.) Ltd Site overview

The Project Site has flat terrain with sparse vegetation, consisting of small shrubby bushes.

Further details of Site are given in Section 07 and the Site Transportation and Access Study are attached as Annex II.

1.1.1 Project Size

The Project site consists of 330 acres of land and the Project shall have an installed capacity of 50 MW

1.1.2 Project Status and Calendar

The project calendar is given on the next page:

Table 1-1: Project Planned Milestones

Activity / Milestone	2015	2016				2017				2018	
	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR	3rd QTR	4th QTR	1st QTR	2nd QTR
Time consumed in Land arrangement and Grid Data.											
Preparation of Feasibility											
Submission of Feasibility Study											
Approval of Feasibility Study											
Generation License											
Upfront Tariff											
Signing of EPA											
Signing of IA											
Financial Close											
Project Construction											
Start of Operations											

Table 1-2: Project Construction Scheduling

Activity / Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Engineering and Mobilization																		
Construction of Temporary Establishment																		
Civil Works of WTGs and Substation																		
Construction of Substation																		
Supply of WTGs and Towers																		
Cables and Interconnection																		
Erection and Installation																		
Testing and Commissioning of EBOP																		
Testing and Commissioning of WTGs																		
EPA Tests and Reliability Run Test																		

1.1.3 Wind Resource Assessment (WRA)

A separate study has been carried out for the WRA including complete analysis of wind data and long term correlation.

1.1.4 Energy Yield Estimates

The energy yield estimates have been generated including development of wind farm layouts, determination of energy yields and uncertainty assessments.

1.1.5 Geological Conditions

The Project area has a wide range of soil types due to its diverse land forms, which include sandy, deltaic, alluvial, gravel, coastal, and mountainous.

The information related to geological conditions is given in Section 11. The detailed Geotechnical Investigation Report is attached as Annex V.

1.1.6 Design of Civil Works

Information related to the civil works is given in Section 12.

1.1.7 Design of Electrical Works

Information related to the electrical works is given in Section 13.

The Project has an installed capacity of 50 MW, using wind turbine generators (WTG), each with a capacity in the range of 1.5 - 3.3 MW and an output voltage of 0.62 - 0.69 kV. A substation consisting of step up transformer and other BOP equipment will connect the farm to the 132 kV power lines. The power from the turbine will be stepped up to Medium voltage (MV) through a generator step up transformer which will be housed in a separate compartment in close proximity to the wind turbine tower. Power from all the WTGs in the plant will be delivered to the substation, and onwards to the grid via the step up transformers and HV switchgear, built within the boundaries of the wind power plant. The switchgear gantries will be the point of metering and connection to the 132 kV power lines.

Grid interconnection point and required reactive power compensation, if any, for the project shall be as per the findings of the grid interconnection study.

Please refer to the Grid Interconnection Study attached as Annex VI.

1.1.8 Construction Management

Information related to the construction management is given in Section 14.

1.1.9 O & M Management

The O&M shall be managed by the O&M Contractor for initial 2 years of Warranty Period followed by a complete Field Service Agreement till end of five years of operations. The local team shall remain part of the O&M and shall gradually take over after having On Job Trainings (OJT).

O&M management will be established with the principle of requiring "few on-duty staff". After entering the electrical equipment and machinery to their stable operation mode, the wind turbine and associated apparatus shall be managed with "no on-call staff and few on-guard staff".

The production area includes facilities such as generators, transformers, and the substation. There shall be buildings for protection and control, telecommunication, DC power supply and for administrative purposes.

1.1.10 Environmental Management

Information related to the environmental management works is given in Section 15.

A separate environment study has been carried out. The Initial Environment Examination (IEE) report is attached as Annex VII.

There are no significant hazards. The minor adjustments required during construction phase have been addressed and mitigation plan provided. A data collection survey was also done that included geology, meteorology, hydrology, ambient air quality, water quality, soil characteristics, noise levels, shadow forecasting, flora and fauna, land use pattern, and socioeconomic conditions.

1.1.11 Health and Safety

During the construction and operation of the Project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personal safety of workers.

A safety and health supervision department will be established on the wind farm, which is to be in charge of the education, training and management of safety and health related issues after

the project is put into operation. There will be safety personnel in the production section, and a part-time worker for the routine safety and health work.

The systems of patrol inspection, operation guardianship, maintenance and over-haul will be established for the daily maintenance of production equipment, instruments and apparatus. The safety and health supervision department will provide sound meter and other appropriate inspection equipment, as well as necessary public education service for production safety.

A comprehensive safety system will be established during the preparation phase, and carefully implemented during the construction process. The systems of work sheet, operation sheet, shift relief, patrol inspection, operation guardianship, maintenance and over-haul will be strictly implemented. The Safety Regulation of the wind farm will also be carefully observed to minimize accidents.

1.1.12 CDM Aspect

The Project is a power generation project using a renewable resource with zero emissions. When put into operation, the project can provide power supply to the southern Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. It can deliver substantial environmental and social benefits. It is also consistent with the spirit of the Kyoto Protocol and qualified for the application of CDM projects.

The Project Company intends to develop a CDM project according to the provisions of the prevailing Policy.

1.2 LIST OF ANNEXURE

ANNEX - I: Pakistan Energy Profile and Global Wind Energy Stats

ANNEX - II: Transportation and Access Study Report

ANNEX - III: Wind Resource Assessment Report

ANNEX - IV: Energy Yield Estimates Report

ANNEX - V: Geo Technical Investigation Report

ANNEX - VI: Electrical Grid Interconnection Study Report

ANNEX - VII: Initial Environmental Examination (IEE) Report

Presently, the Project plans to opt for upfront tariff. Therefore Annex III and Annex IV, being not required for an upfront tariff, are not being submitted for approval. If for any reason, the Project is not able to opt for the upfront tariff, then the cost plus option will be opted and the wind studies will be submitted to relevant departments.

1.3 PROJECT TEAM

1.3.1 Noor Solar Energy (Pvt.) Ltd

Liberty Mills Limited, located in the industrial heart of Karachi, was founded in 1964. From humble beginning it is today one of the largest textile processing unit in Pakistan with a production capacity of 500,000 square meters of fabric per day. The whole production is exported directly and indirectly to customers which include vendors of internationally recognized brands, departmental stores and mail order firms. Liberty Mills Ltd are an ISO 9001-2008, OCS 100/OCS Blended Standards, Oeko-Tex Standard 100 and SA 8000:2008 Certified company. Upgrading the quality of our products and services, personnel, equipment and infrastructure is an ongoing feature of their operation. The group is also involved in Power business since 2007 and have major share in 200 MW thermal Liberty Power Plant.

Noor Solar Energy (Pvt.) Ltd is sponsored by Liberty Group and is interested in setting up a Wind Power Project of 50 MW capacity in Jhimpir, Sindh, Pakistan. Renewable Resources (Pvt.) Limited (RE2) is the consultant for Noor Solar Energy (Pvt.) Ltd for developing this project.

The Sponsors have a valid LOI from Energy Department Government of Sindh ("EDGOS") and has been allotted 330 acres of land in Jhimpir for which the GoS has already issued a land allotment letter.

1.3.2 Renewable Resources (Pvt.) Ltd - Project Consultant

www.renewableresources.com.pk

Renewable Resources (RE2) is the professional technical advisor for the Project. RE2 is a consulting company specialized in Renewable Energy (RE), Energy Efficiency (EE) and Environment (Env) Projects. The company is owned by group of professionals who have been intimately involved in the renewable energy program of Pakistan, and have a fundamental understanding of issues relating to power project development, which include but are not limited to feasibility studies, regulatory approvals, concession and security documents, and applicable policies.

RE2 is capable of conducting full feasibility package featuring power production estimates, grid interconnection and tariff model. RE2 also has the expertise to deal with all technical aspects regarding the legal documents of power projects. The professional team of RE2 is well acquainted with the policies, regulations, methodologies and standards of RE power Projects and its work output meets international standards. RE2 is presently a consultant for various power Projects in Pakistan sponsored by local and international investors, with international banks.

1.3.3 Power Planners International- Electrical and Grid Studies (PPI)

PPI is a limited company registered in England and Wales and has a team of highly skilled and experienced professionals. Power Planners is also registered with Saudi Electricity Company (SEC), with Pakistan Engineering Council and Alternative Energy Development Board, Pakistan. It is a renowned company in power sector in the field of power system analysis and planning especially in the areas of grid interconnection studies of renewable energy resources such as wind, solar, small Hydel etc. PPI comprises of enterprising group of professionals to provide consultancy services for:

- ❖ Feasibility studies of new power plants of any nature; Hydel, Thermal, Wind-Farms and other renewable energy sources, and their interconnections with the main electrical grid.
- ❖ Feasibility Studies for cross-border or cross-country interconnections of electrical grids for power exchange.
- ❖ Analytical studies for electric utilities, Independent Power Producers (IPPs), Independent System Operators (ISOs) and industries, that are planning to add new facilities or seek solutions to problems in their existing systems to enhance power quantity and quality to their customers.
- ❖ Preparation of engineering, design and specifications for new power projects.
- ❖ Training and developing the human resource in technical skills for power planning and expansion of energy sources. PPI's engineers possess highly specialized skills, vast and profound experience, and expertise of the advanced and latest state-of-the art software prevailing in the contemporary power systems industry.

The team at PPI comprises of engineers having a work experience of 10 to 30 years with utilities and consultant companies in Pakistan and Middle East in the fields of transmission planning, power system analysis, load forecasting and generation planning for systems of wide range of operating voltages.

2 COUNTRY AND INDUSTRY OVERVIEW

The detailed stats and situation of energy in Pakistan, specific information and prospects of wind and international trends in wind power sector is given in Annex I.

At this juncture, we are encountering the worst electricity crisis of the history of Pakistan resulting in extended load shedding to an extent which virtually suspends social life. The situation has further forced Government of Pakistan to again take decisions like early market shutdown, power cutoff to industry, and two holidays per week thus affecting all business activities.

Pakistan's major electricity sources are thermal and hydro generation, meeting approximately 70% and 28% (respectively) of the country's annual electricity demand. The primary thermal generation fuels employed are furnace oil and gas. Oil import is a significant burden on the national exchequer. Import of gas could be seen as a viable option to overcome the depleting domestic reserves, but gas import has significant issues, mainly the need for substantial capital investment in infrastructure, security difficulties and physical terrain concerns. Moreover, it would still be an imported product.

Alternatives to further fuel imports for electricity generation are the use of domestic coal, or generation from hydro or other renewable sources, such as wind / solar power. These options will assist in reducing Pakistan's reliance on imported oil, and consequent vulnerability to changes in global oil prices which will in turn have a positive effect on the current trade deficit and inflating import bill.

Looking at how the country's future electricity needs might be met, wind has the potential of being a strong contributor in future because of being an indigenous resource and available in huge quantities in the country.

3 REGULATORY REGIME

Power sector Pakistan has a ministry overlooking the electricity business in the country and a regulatory authority, independent of the ministry, to control the business practices in the market. There are a number of stakeholders involved in the cycle:

- Ministry of Water and Power
- National Electricity Power Regulatory Authority (NEPRA)
- National Transmission and Dispatch Company (NTDC)
- Central Power Purchase Agency Guarantee Ltd. (CPPA-GL)
- Directorate of Alternative Energy, Energy Department, Govt. Sindh.

3.1 MINISTRY OF WATER AND POWER

The federal Ministry of Water and Power is the GoPs executive arm for all issues relating to electricity generation, transmission and distribution, pricing, regulation, and consumption. It exercises these functions through its various line agencies as well as relevant autonomous bodies. It also serves to coordinate and plan the nation's power sector, formulate policy and specific incentives, and liaise with provincial governments on all related issues.

3.2 NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA)

NEPRA has been created to introduce transparent and judicious economic regulation, based on sound commercial principles, in the electric power sector of Pakistan. NEPRA regulates the electric power sector to promote a competitive structure for the industry and to ensure the coordinated, reliable and adequate supply of electric power in the future. By law, NEPRA is mandated to ensure that the interests of the investor and the customer are protected through judicious decisions based on transparent commercial principles.

NEPRA remains to be the same platform for federal as well as provincial projects.

3.3 NATIONAL TRANSMISSION AND DISPATCH COMPANY (NTDC)

NTDC shall be the power purchaser. National Transmission & Dispatch Company (NTDC) Limited was incorporated on 3rd August 1998 and commenced commercial operation on 1st March 1999. It was organized to take over all the properties, rights and assets obligations and liabilities of 220kV and 500kV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA). The NTDC operates and maintains nine 500kV Grid Stations, 4,160 km of 500 kV transmission line and 4,000km of 220kV transmission line in Pakistan.

For low voltage power such as 11 kV, the autonomous distribution companies (commonly called as DISCOS) are the power purchasers. Functionally, DISCOs fall at a step lower than NTDC and are looking after low voltage assets.

3.4 CENTRAL POWER PURCHASE AGENCY GUARANTEE LIMITED (CPPA-GL)

CPPA-GL is an agency to purchase power from Wind power plants on behalf of NTDC. CPPA-GL acts as a one window for all affairs related to NTDC for the Project including signing of the Energy Purchase Agreement (EPA), establishment of Operating Committee (OC), development of Operating Procedures (OP), appointment of Independent Engineer (IE) and testing of the Project leading to declaration of commercial operations. CPPA-GL also handles payments to the Project against sale of electricity and all sort of Non Project Missed Volume (NPMV) under the EPA.

3.5 Directorate of Alternative Energy, Energy Department, Govt. of Sindh (DAE, ED, GOS)

The Directorate of Alternative Energy, Energy Department, Govt. of Sindh is responsible for harnessing the alternative/renewable energy resources, addressed the relevant issues/matters at provincial level, facilitates local and foreign investors and donors for promotion and implementation of alternative energy/renewable energy projects, plan and implement project through public funding, foreign grants, loans etc. and design alternative energy policy for province and review it from time to time.

4 CARBON CREDITS

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

The developed countries are to reduce their collective emissions of six key greenhouse gases by at least 5%. This group target will be achieved through cuts of 8% by Switzerland, most Central and East European states, and the European Union (the EU will meet its group target by distributing different rates among its member states); 7% by the US; and 6% by Canada, Hungary, Japan, and Poland. Russia, New Zealand, and Ukraine are to stabilize their emissions, while Norway may increase emissions by up to 1%, Australia by up to 8%, and Iceland 10%. The six gases are to be combined in a "basket", with reductions in individual gases translated into "CO_2 equivalents" that are then added up to produce a single figure.

Each country's emissions target must be achieved by the period 2008 - 2012. It will be calculated as an average over the five years. "Demonstrable progress" must be made by 2005. Cuts in the three most important gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) will be measured against a base year of 1990 (with exceptions for some countries with economies in transition). Cuts in three long-lived industrial gases - hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulfur hexafluoride (SF_6) - can be measured against either a 1990 or 1995 baseline. A major group of industrial gases, chlorofluorocarbons, or CFCs, are dealt with under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.

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

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

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

4.1 EMISSION REDUCTION MECHANISMS

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

4.1.1 Emissions Trading

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

4.1.2 Clean Development Mechanism (CDM)

Clean Development Mechanism (CDM) allows richer countries to offset their CO_2 emission against the emissions prevented when technology that cuts down on greenhouse gas emissions is deployed in poor countries.

4.1.3 Joint Implementation (JI)

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

4.2 ROLE OF CDM IN THE NOOR SOLAR ENERGY PVT LTD PROJECT

The Project is a power generation project with renewable resource and zero emission. When put into operation, the project can provide power supply to the southern Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. It can deliver good environmental and social benefits. It is also consistent with the spirit of the Kyoto Protocol and qualified for the application of CDM projects. If the project is approved and registered as a CDM project, CERs can provide extra financial resource for the project. It will provide favorable conditions for the project financing, improve competitiveness of the project, and reduce investment risk during the project implementation process. The CDM benefits in the Project (if incurred) shall be availed according to the provision in the Policy.

5 WIND INDUSTRY IN PAKISTAN

5.1 CURRENT STATUS OF WIND IPPs IN PAKISTAN

The wind energy sector of Pakistan has been matured in the last few years. The major impediments delaying the development of wind power projects have been removed. Wind data of almost 10 years is available for two locations, i.e. Gharo and Jhimpir. All the stakeholders are now at the same frequency and are fully motivated to facilitate the development of wind power in the country.

Initially very few suppliers wanted to come to new market like Pakistan. But now most of the suppliers are keen for the Pakistani market. One factor could be the Pakistani market getting matured. Now GE, Nordex, Vestas, Gamesa and Goldwind are all active in the market.

5.1.1 Letter of Intent (LOI)

The total number of LOIs issued by AEDB and DAE, Energy Department, Govt. of Sindh for various projects till date are in the range of 100.

5.1.2 Land Allocation by AEDB / GOS

AEDB and DAE, Energy Department, GoS have got approx. 31,000 acres of land from GOS and further allocated land to Wind IPPs.

5.1.3 Projects at Advanced Stages

Total of six (06) different projects with capacity of more than 300 MW have achieved their CODs. Following projects have started their commercial operations:

No.	Company	Capacity (MW)	COD
[redacted]	**FFC Energy Ltd**	**49.5**	**1st Quarter 2013**
[redacted]	Zorlu Energy	56.4	2nd Quarter 2013
[redacted]	**Foundation Wind Energy I**	**50.0**	**1st Quarter 2015**
[redacted]	Foundation Wind Energy II	50.0	4th Quarter 2014
[redacted]	**Three Gorges First Wind Farm Pakistan (Pvt) Ltd**	**49.5**	**4th Quarter 2014**
[redacted]	Sapphire Wind Energy Ltd	52.8	4th Quarter 2015

Following projects have achieved financial close during 2014-15 and are currently under construction:

No.	Company	Capacity (MW)
[redacted]	**Yunus Energy Ltd.**	**50.0**
[redacted]	Metro Power Company Ltd.	50.0
[redacted]	**Gul Ahmed Wind Power Ltd.**	**50.0**
[redacted]	UEP Wind (Pvt) Ltd.	99.0
[redacted]	**Master Wind Energy Ltd.**	**52.8**
[redacted]	Tapal Wind (Pvt) Ltd.	30.0
[redacted]	**HydroChina Dawood Power (Pvt.) Ltd.**	**49.5**
[redacted]	Tenega Genarsi Ltd.	49.5

5.1.4 Projects at Advanced Development Stages

Following projects have reached the Generation License / Tariff stage:

No.	Company	Capacity (MW)
[redacted]	**HAWA Energy (Pvt) Ltd**	**49.3**
[redacted]	Jhimpir Power Ltd	49.3
[redacted]	**Hartford Energy (Pvt) Ltd**	**49.3**
[redacted]	Tricon Boston 1	49.3
[redacted]	**Tricon Boston 2**	**49.3**
[redacted]	Tricon Boston 3	49.3
[redacted]	**Three Gorges Second Wind Farm Ltd**	**49.5**
[redacted]	Three Gorges Third Wind Farm Ltd	49.5
[redacted]	**Western Energy Ltd**	**49.5**

5.1.5 Projects at Initial Development Stages

During 2015-16, various projects got their LOIs and lands from DAE, Energy Department, GoS. The approvals of land have been done. All these projects are currently at different stages of feasibility study and EPC bidding. Some of these include:

No.	Company	Capacity (MW)
[redacted]	**Master Green Energy Ltd**	**100.0**
[redacted]	Metro Wind Power Ltd	60.0
[redacted]	**Gul Ahmed Electric Ltd**	**50.0**
[redacted]	ACT2 Wind (Pvt) Ltd	50.0
[redacted]	**Artistic Wind Power (Pvt) Ltd**	**50.0**
[redacted]	Uni Energy Ltd	50.0
[redacted]	**Din Energy Limited**	**50.0**
[redacted]	Zulaikha Energy (Pvt) Ltd	50.0
[redacted]	**Lake Side Energy (Pvt) Ltd**	**50.0**

5.2 TARIFF REGIME IN PAKISTAN

5.2.1 Negotiated Tariff for Wind IPPs

The initial regime was of a negotiated tariff, which is still applicable. The Project Company justifies all expenses and financial position to NEPRA through a petition. The NEPRA in return determines the project tariff on a "cost plus" basis. The Project Company is allowed 17% IRR on the equity. There are four projects so far at cost plus tariff and all are currently in operation phase.

5.2.2 Upfront Tariff for Wind IPPs

NEPRA has announced a few upfront tariffs from time to time during past. The wind risk lies with the project company for upfront tariff. In lieu of it, the project companies can create cost efficiencies and draw maximum benefits from this "take and pay" basis. The indexations such as LIBOR / KIBOR, US$ and inflation are available.

The current upfront tariff allows full payment till an annual capacity factor of 35% is achieved. Afterwards, the tariff decreases to 75% from 35% till 36% capacity factor is achieved. Then the tariff starts rising, reaching 80% from 36% till 37% capacity factor is achieved. Thereafter, the tariff regains its 100% value. This scheme is to intensify the high efficiency WTGs.

Most of the projects now prefer upfront tariff. Noor Solar Energy (Pvt.) Ltd will also be opting for the upfront tariff.

6 PROJECT IN TERMS OF POLICY FRAMEWORK

6.1 LETTER OF INTENT (LOI)

First step was to obtain Letter of Intent from DAE, Energy Department, GoS, which was accomplished on 14th July, 2015. This letter entitled the Project Company to start working on wind power project at official level and get support from DAE, Energy Department, GoS and other government departments in the preparation of feasibility study and acquisition of land for the project. The feasibility is being submitted before expiration of LOI and in accordance with the timeline mentioned.

6.2 ACQUISITION OF LAND

The land has been acquired by the project company from the Government of Sindh in terms of legal formalities.

6.3 FEASIBILITY STUDY

The feasibility study of the Project is being finalized in this document.

6.4 GENERATION LICENSE

Rights to produce and sell electricity in Pakistan are granted by NEPRA through "Generation License". Project Company will file an application to NEPRA for Generation License which authorizes a company to produce and sell electricity in the country.

6.5 TARIFF DETERMINATION

A separate application shall be prepared for approval of upfront tariff.

6.6 LETTER OF SUPPORT (LOS)

Once the tariff is approved, the Project Company is required to move for arrangement of financing. DAE, Energy Department, GoS will issue tripartite Letter of Support for the Project Company giving government guarantees until EPA and IA are fully effective to ensure sponsors and lender of the full government support. A bank guarantee of US$ 2,500 / MW shall be required to be submitted by the Project Company before issuance of LOS.

6.7 ENERGY PURCHASE AGREEMENT (EPA)

Agreement between the Power Purchaser and the Project Company is called Energy Purchase Agreement (EPA). This agreement lists terms and conditions for the sale and purchase of electricity between the two companies. As soon as the feasibility study is submitted and upfront tariff is filed, the Project Company shall enter into the discussions of EPA. This is going to be a significant step in the project development.

6.8 IMPLEMENTATION AGREEMENT (IA)

The Implementation Agreement (IA) provides security to the sponsors and lenders against the performance of the power purchases through guarantees from Government of Pakistan. Its discussions shall start alongside the EPA.

6.9 FINANCIAL CLOSE

Upon approval of feasibility study, grant of generation license, determination of tariff and the signing of project documents (EPA and IA); the Project Company shall move forward to complete the financial close. However, the discussions with lenders have already been started.

7 PROJECT SITE

7.1 WIND CORRIDOR OF PAKISTAN

Pakistan has a 1046 km long coastal line with a very encouraging wind regime. According to a study carried out by NREL and the wind masts installed in the Gharo and Keti Bandar wind corridor, the average wind speed in the region is 7.4 m/s making a regional potential of more than 50,000 MW. Wind Map of Pakistan by NREL is shown in ***Figure 3.***

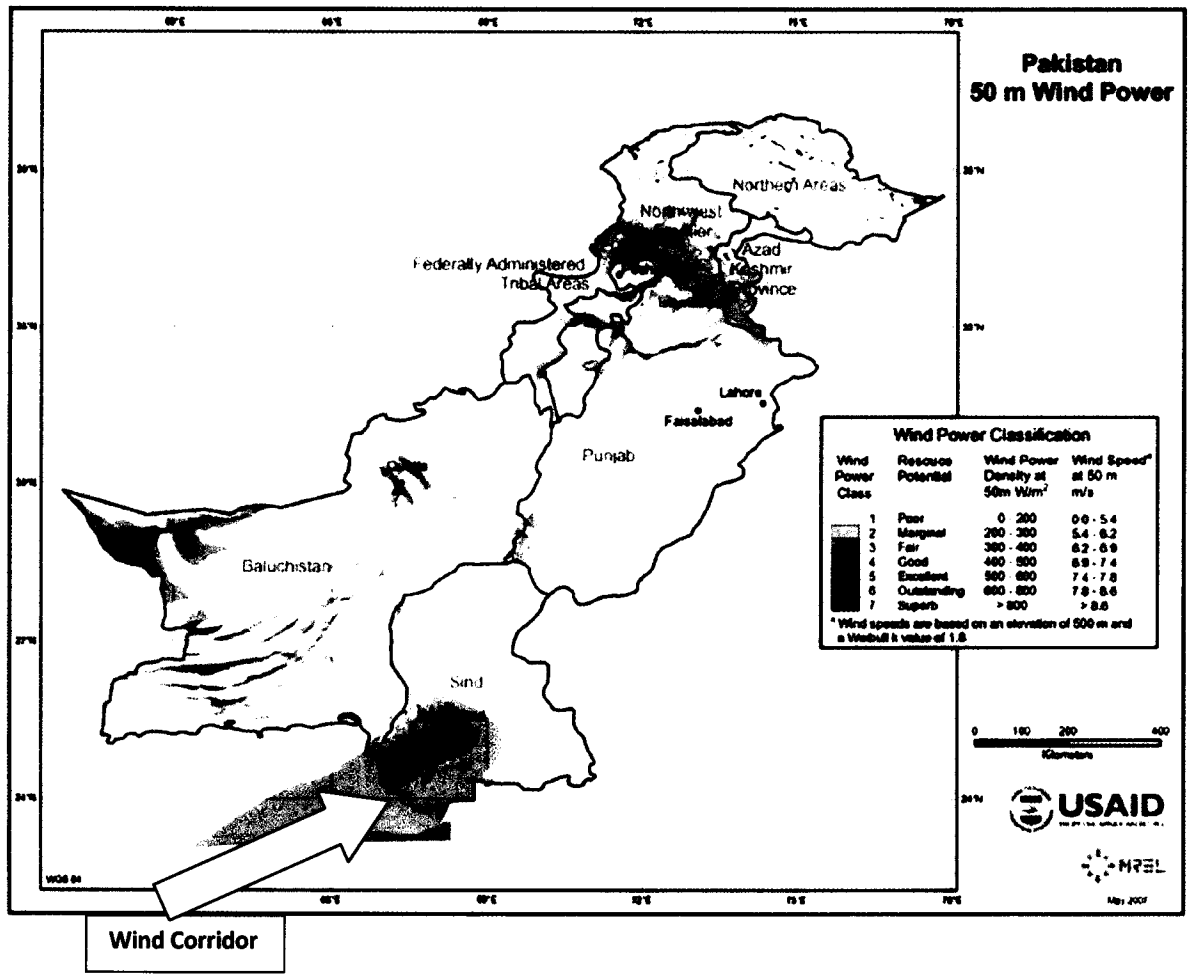


Figure 2: Wind Map of Pakistan by NREL

Based on the wind potential, Government of Pakistan initiated the wind power projects and facilitated land to the potential investors. The lands were allocated in Gharo, Bhambore and Jhimpir, where different wind power developers have taken the land. Later, GOS started facilitating the developers with land as well. The Sponsors have a valid LOI from Energy Department Government of Sindh ("EDGOS") and has been allotted 330 acres of land in Jhimpir for which the GOS has already issued a land allotment letter.

An overview of the project site allocated in Jhimpir region is shown in *Figure 3*:

Figure 3: Overview of Noor Solar Energy Pvt Ltd Site

7.2 SITE DETAILS

The site is located in Jhimpir, Sindh which is towards the North East of Karachi as shown in *Figure 4*.

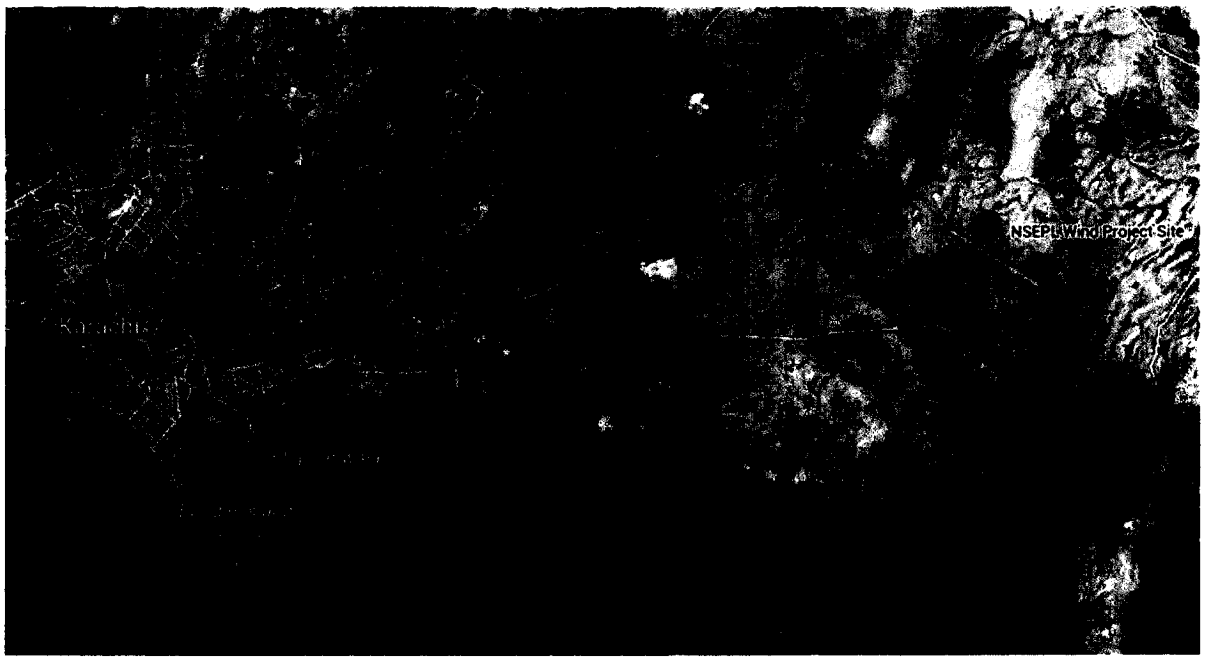


Figure 4: Noor Solar Energy (Pvt) Ltd Site Location

The electrical network within the vicinity of the site of the plant comprises of LV (11 kV) and HV (132 kV and 220 kV) lines.

Hyderabad Electrical Supply Company 132/11 kV grid station is DISCO in Jhimpir. Nearest Grid is New Jhimpir Grid. The distance of the grid station from the Project site is approximately 20 kilometers.

A separate electrical and grid interconnection study will be conducted for the project including Power Quality, Load Flow, Short Circuit and Power Evacuation.

The site is nearly flat with the surroundings having same characteristics.

7.3 TRANSPORTATION AND ACCESS NETWORK

A Transportation and Access Study has been carried out and is attached as Annex II.

The major section of track from Karachi to the site is via the National and Super high-way. The track is a multi-lane road. It has a flat terrain, and long and heavy vehicles can easily navigate through this road. However, access to the site is not suitable for heavy transport for a minor segment of the track, hence requires track maintenance from M-9 Super high-way turning point up until the Project site.

There are many neighboring wind farms in the surrounding area of Thatta. The site is located in Jhimpir, Sindh that is towards the East of Karachi and within the same corridor as many other wind power projects.

The Bin Qasim port, which is one of the major ports of Pakistan, is the point of delivery of equipment for the proposed wind power project. The details are given in Annex II.

7.4 CLIMATIC CONDITIONS

The climate of the southern parts of Sindh is characterized by fluctuating temperatures and sparse rainfall. The summers are hot and humid with average temperature ranging between 33°C to 40°C. The temperature in summers may reach up to 50°C. The winters are pleasant with average temperature in the range of 15°C to 25°C. The months of July and August generally observe the annual monsoon rainfalls. The climate information of Karachi, which lies near to the site, is shown in table below:

Table 7-1: Maximum & Minimum Temperatures in Jhimpir Region[1]

Jan	20.6	20	10.3	34.5	5.7
Feb	22.9	22.3	12.9	33.3	4.8
Mar	26.7	25.9	14.7	42.6	5
Apr	29.8	28.9	20.4	41.9	4.8
May	31.6	30.2	25.2	42.8	4.3
Jun	31.1	30.3	25.9	38.2	2.8
Jul	29.4	28.7	25.7	35.8	2.2
Aug	28.5	27.8	24.7	34.6	2.1
Sep	28.6	27.8	23.6	38.5	3.5
Oct	28.9	28.4	21.6	38.5	4
Nov	25.8	25	17.9	35.9	4.4
Dec	21.8	21.6	9.9	34.8	5.7

Table 7-2: Average Precipitation and Rainfall Days in Jhimpir Region[2]

	6mm	7mm	6mm	5mm	12mm	21mm	50mm	13mm	3mm	0mm	16mm
	1	0	1	0	1	3	4	1	0	0	1

[1] Meteorological Department of Pakistan
[2] Meteorological Department of Pakistan

7.5 TELECOMMUNICATION

PTCL telephone service is not available but mobile carriers have coverage on the site area.

7.6 EARTHQUAKES

According to the seismic zoning map of Pakistan, the Jhimpir region falls in ZONE II-B with moderate to severe damage area probability. This has been separately covered in the Geo Technical Study and the Initial Environment Examination Report.

8 WIND RESOURCE ASSESSMENT AND ENERGY YIELD ESTIMATES

The detailed wind resource assessment report and energy yield estimates have been prepared as Annex III and Annex IV of this document respectively. At present, these studies are not being submitted with this feasibility study to DAE, Energy Department, GoS as the Project plans to opt for the upfront tariff determined by NEPRA.

9 SELECTION OF WTG AND EPC CONTRACTOR

Noor Solar Energy (Pvt) Ltd is currently working on the selection of following WTG suppliers and EPC Contractors. The details of EPC Contractors and WTGs offered by them are as follows:

Power China	□ General Electric GE 1.7-103 □ General Electric GE 2.75 □ Gold Wind GW 121-2.5 □ Gamesa G114-2.0 □ Gamesa G114-2.5	□ 1.7 MW □ 2.75 MW □ 2.5 MW □ 2.0 MW □ 2.5 MW
[illegible]	□ [illegible]	□ [illegible]
Vestas	□ Vestas V126-3.3	□ 3.3 MW

Turnkey EPC proposals have been invited through a bidding process, which will be evaluated on merit and then initial meetings shall take place with all bidders. Following this, detailed negotiations will be done with the two better prospective options to make a final selection.

The main aspects to select the WTG and EPC Contractor are as follows:

a) The quality of WTG and Type Certification according to site suitability
b) The quality and certifications of EBOP equipment
c) The ultimate energy yield potential at P90 for the Project
d) The total EPC cost and resultant tariff / IRR
e) Technical guarantees, warrantees and obligations
f) Time for Completion
g) The commercial and legal terms of the EPC package

At the moment, the entire feasibility is based on all WTGs mentioned in this section. The Project plans to make a final selection of the WTG and EPC Contractor by the time the stage for Generation License and Tariff of the Project is reached.

10 GEOLOGICAL CONDITIONS

In order to collect detailed regional geological information, Noor Solar Energy (Pvt.) Ltd hired professional services of Soil Testing Services-Pakistan Alternative Engineering Services (Pvt.) Ltd: a Pakistani local prospecting agency to conduct field exploration and drilling of (06) bore holes on the Site during February, 2016. The average drilling depth is 20 m. The complete Geotechnical Investigation Report is report is attached as Annex-V.

10.1 OBJECTIVES OF GEOTECHNICAL STUDIES

- ❖ To execute 06 boreholes, at the site of each proposed turbine location, 20m in depth. ❖ To execute field and laboratory geotechnical testing.
- ❖ To investigate the surface and sub-surface soil condition, to evaluate foundation design parameters.
- ❖ To provide shallow and deep foundation recommendations.

10.2 GEOLOGY OF KARACHI REGION AND SURROUNDINGS

Geologically Karachi trough is located on the southern extension of the Kirther folded structures. It carries marine terrigenous and calcareous terrigenous Oligocene and Neogene sediments. Geological structure map of Karachi is shown in figure above.

The folds in the Palaeogene and Mesozoic sediments are overlain by the Oligocene-Neogene sediments of Karachi embayment.

The Karachi trough is delineated by the north-trending severely deformed mountain ranges namely Mor Range, Pab Range and Belaophiolite/mélange zone to the west. It is surrounded by Kirther Range to the north and to the east, and by the Indus delta and the Arabian Sea Creeks to the south-east and south. In the south, the Karachi structural embayment opens to the Arabian Sea. The trough is somewhat an asymmetrical Synclinorium.

The eastern limb of this trough is wider and comparatively greater than the western limb. The prominent strikes of the folds of the trough are sub-meridional north-south changing into southwestern direction in the south. The trough may be sub-divided into three principal regions named below:

- ❖ Northern Relatively Uplifted Region ❖
- Southern Sub Merged Region
- ❖ Western Monocline

The tectonic map of Pakistan, Geological and Sub Surface details of Jhimpir are shown in ***Figure 8 & Figure 9***:

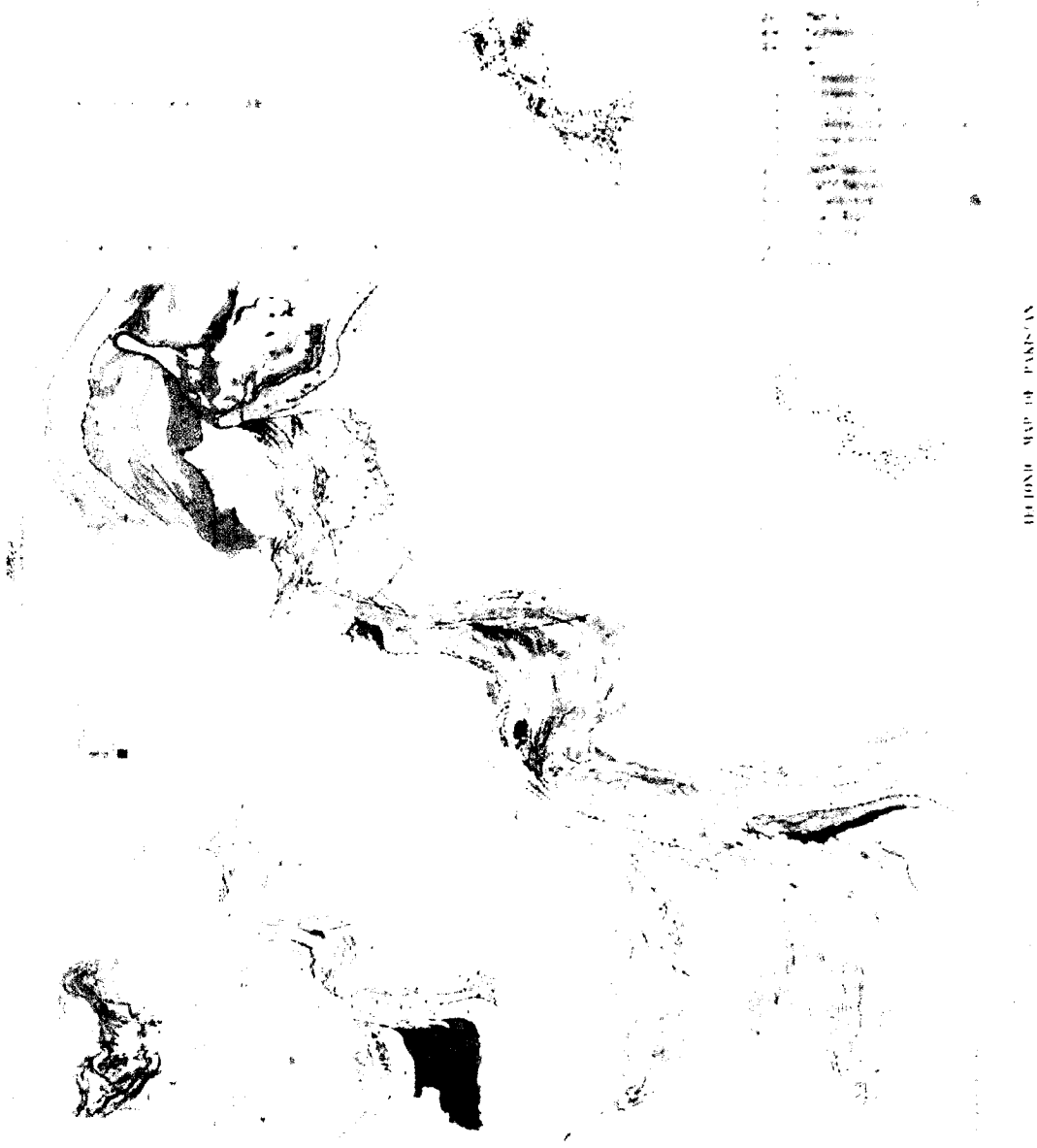


Figure 5: Tectonic Map of Pakistan

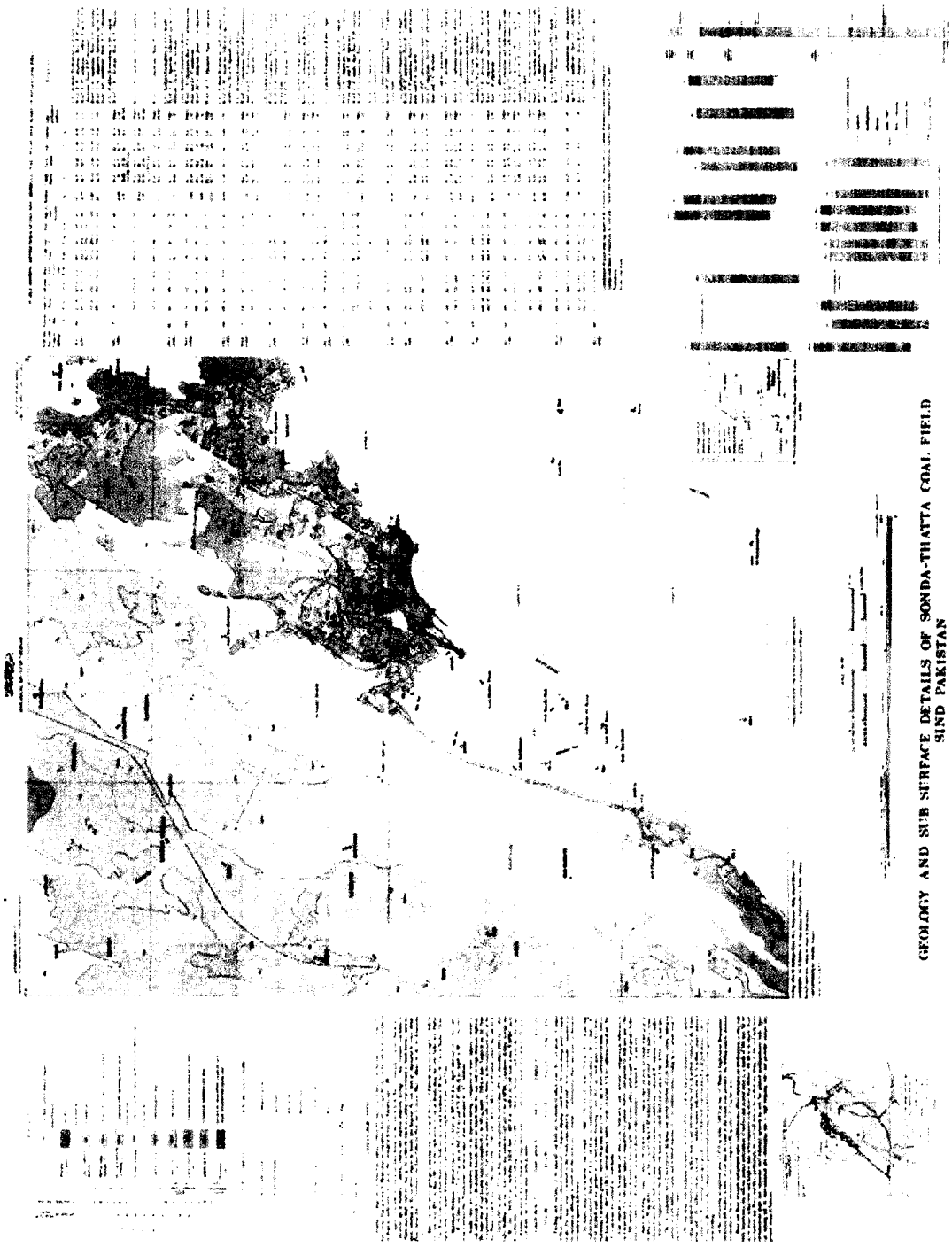


Figure 6: Geological and Sub Surface details of Jhimpir

10.3 SEISMOLOGY OF KARACHI REGION

The region is surrounded by some active fault lines; namely Pab Fault, Ornach Nal Fault and Runn of Kuch Fault. The history of earthquakes in Karachi is given in table below:

Table 10-1: Earthquake Records around Karachi

Year	Longitude	Latitude	Depth (km)	Richter Scale	Modified Mercalli Intensity	Location
1962	24.70	66.00	0	4.50	--	Karachi
1965	25.03	66.76	40	4.50	--	Karachi
1966	25.00	68.00	--	5.00	VI-VII	Jhimpir
1968	24.61	66.42	19	4.10	--	Karachi
1970	25.28	66.65	33	4.90	V	Karachi
1971	25.00	68.00	--	4.50	V	Jhimpir
1972	25.35	66.71	33	4.50	V	Karachi
1973	25.00	68.00	--	5.00	VI	Jhimpir
1973	25.48	66.33	57	4.90	V	Karachi
1975	25.50	66.80	--	4.50	V	Gadani
1975	25.22	66.59	33	4.70	V	Karachi
1976	24.96	70.38	14	4.70	V	Karachi
1984	25.86	66.41	33	5.00	VI	Karachi
1985	24.90	67.39	33	5.00	VI	Karachi
1986	25.34	66.60	33	4.60	V	Karachi
1992	25.25	67.76	33	3.60	IV	Karachi
1996	25.06	66.76	33	--	--	Karachi
1998	25.69	66.46	33	4.40	V	Karachi
1998	24.85	66.35	33	4.50	V	Karachi

The seismic parameters of Karachi region are given in the table below along with the map in ***Figure 10***:

Table 10-2: Seismic Parameters of Karachi

UBC Zone	**2B**
Max Peak Ground Acceleration	16% - 20% of 'g' (g = 9.8 m/s^2)
Seismic Hazard	**Upper Moderate**
Magnitude (Richter Scale)	5.5 to 6.5
Intensity (MM Scale)	**VI - VII**

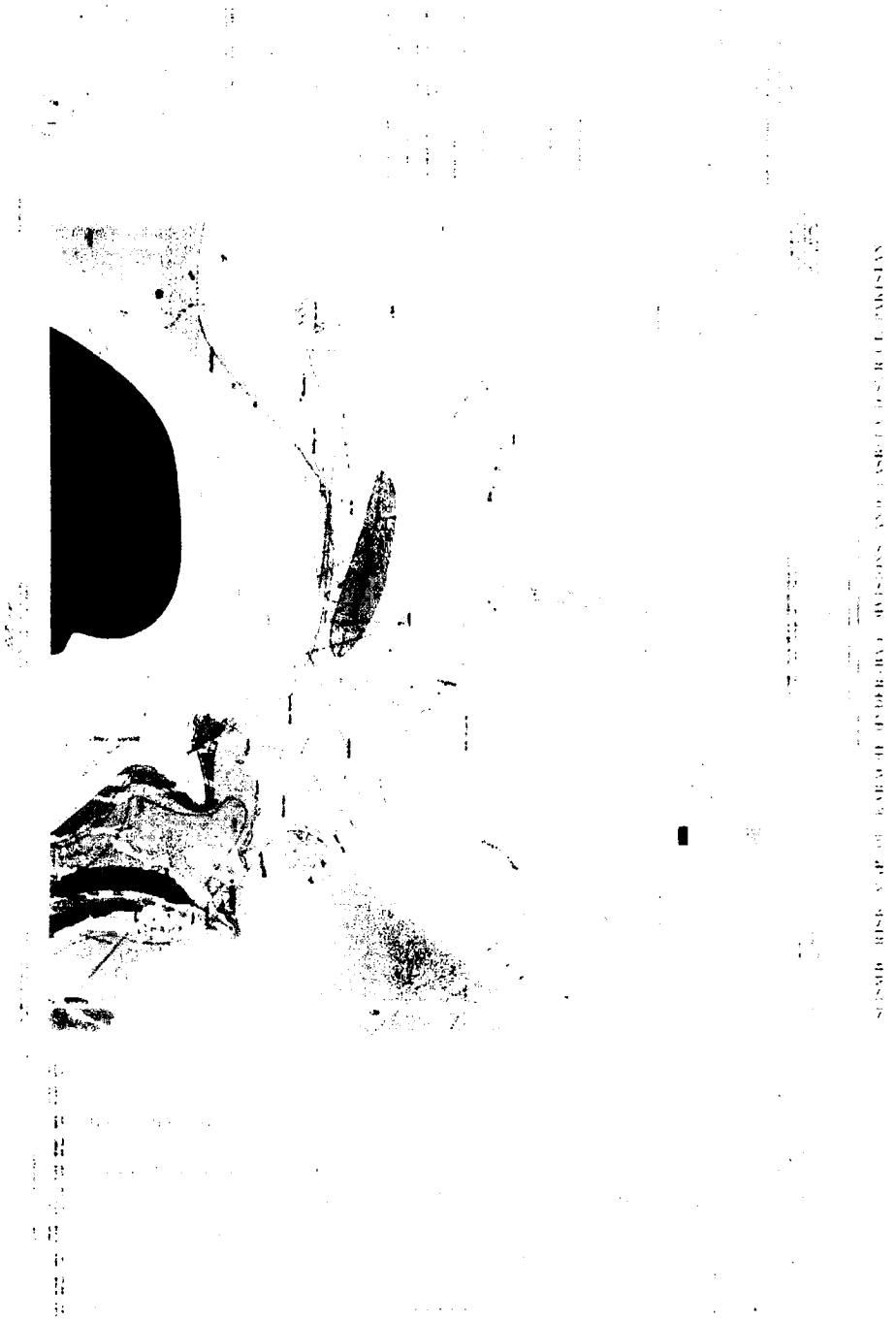


Figure 7: Seismic Map of Pakistan

10.4 FIELD WORK

10.4.1 Borehole Drilling

The drilling and sampling work has been performed using the standards, procedures and equipment's recommended for engineering site investigation. All borings were advanced through soil between sampling intervals by rotary wash methods, using rotary drilling machines of hydraulic feed. These machines are most suitable to the site conditions with all accessories for extending the bore to required depths, taking samples and performing the necessary onsite tests. Minimum drilling fluid consisting of water bentonite slurry was used for flushing out the cutting to provide a positive head and to maintain stability of the drilled hole. The boreholes were also stabilized using casing with a nominal diameter of 130mm. A drag bit was used to advance the boring. Observations during drilling such as change of strata, texture, color and drilling difficulties were noted. The soil layers encountered in the borehole were visually classified and were later upgraded as per laboratory test results. Few samples were obtained from split spoon sampler after performing standard penetration test (SPT). A number of core samples were preserved. The samples were cleaned, labeled and put in especially made core-boxes for onward transmission to the laboratory for testing. Special care was taken during handling and transportation of samples.

10.4.2 Rock Core Drilling

Rock core drilling relates to the procedure in which underlying rock is investigated by coring so as to obtain samples for classification, to determine the quality of rock, and to check for possible detrimental properties such as cracks, fissures and weathering or other deterioration that could affect the strength of the formation. To obtain rock core samples, NX diameter core barrels with special bits were used. Under rotary action, the core bit advances into the rock. A circulating supply of water was provided in the cutting edge to help flush rock cuttings and dissipate heat. "Core Runs" were made to drill the hole in segments. At the completion of a core run, the barrel and rock sample were brought to the surface, the depth of recovery was properly recorded for further evaluation in the laboratory. Based on the length of the rock core recovered from each run, core recovery (C.R.) and rock quality designation (RQD) were calculated for a general evaluation of rock quality encountered. Suitable core samples were preserved for shear strength characteristics.

10.4.3 List of Field and Lab Tests

Geotechnical laboratory testing was carried out on retrieved disturbed soil samples. The following are the relevant tests carried out on selected samples as required for determining the subsurface conditions and correlating with the information obtained from field testing and sampling:

- ❖ Grain Size Analysis
- ❖ Liquid and Plastic limits
- ❖ Natural Moisture Contents ❖

Density

- ❖ Specific Gravity
- ❖ Direct Shear Test
- ❖ Unconfined Compressive Strength of Rocks ❖

Chemical Test

10.5 CONCLUSIONS OF GEOTECHNICAL STUDIES

The Geo technical Investigation for Noor Solar Energy (Pvt.) Ltd Wind Power Project in Jhimpir, Sindh was carried out in Feb, 2016. Scope of work included drilling of (06) bore holes up to 20 meters depth. Soil ERS was also conducted at 06 location across the site. Soil and rock samples were also collected during the field investigation. Laboratory testing of the soil and rock samples has been carried out in STS lab which includes natural moisture content, specific gravity, water absorption, density, unconfined compressive strength etc. Chemical characteristics of the soil and ground water samples have also been assessed through determination of total dissolved solids, sulphate content, chloride content and pH. Keeping in view, the results from field, and laboratory tests and the expected loads being transferred to the founding stratum, allowable bearing pressures for shallow foundations at depth of 1.5meters. Exposure to chloride and sulphate salts is 'negligible' for soil; therefore, Ordinary Portland Cement (OPC) should be used for underground concreting.

11 CIVIL ENGINEERING DESIGN

The civil engineering design mainly includes following structures: ❖

Foundation of WTG Towers

❖ Foundation of substation and grid interconnection apparatus, i.e. transformer, switchgear. ❖ Construction of permanent buildings (residence and offices) of O&M staff.

The design activity of the civil works shall be carried out as part of the EPC contract during early phase of construction. However, the geo technical risk shall lie under contractor's responsibility as per the terms of the EPC Contract.

12 ELECTRICAL ENGINEERING DESIGN

The basic electrical design of the wind farm is discussed in this chapter. The overall electrical system has been designed considering the data from HESCO/NTDC and requirements of the grid code addendum for wind energy approved by NEPRA. As part of the grid interconnection study (**attached as Annex VI**), complete modeling of the wind farm has been performed. Load Flow Studies, Short Circuit Analysis, and Transient Stability Analysis along with the Power Quality Analysis have also been performed on the existing and future planned HESCO/NTDC network as part of the report.

The dispatch voltage shall be 132 kV. There will be a two-stage step voltage, one step up to MV level at each WTG level through individual GSUs, and the other at the substation. The MV level shall be at either 22 kV or 33 kV. The Wind Farm shall have two 132 kV outgoing lines to keep the N-1 grid connectivity criteria. The termination points of the lines on the two remote ends have been identified, which will be firmed up during the construction phase by NTDC considering the network scenario at that time. The protection and telecommunication scheme will be accordingly finalized at that time.

The Wind Farm shall be divided into collector groups, each having approx. five (05) WTGs. Every WTG shall be equipped with own step-up transformer and shall be connected with the successive WTG by means of Ring Main Units (RMU) and vacuum breaker in configuration in/out. The connection of the RMUs to the main MV Switchgear shall be achieved by under-ground XLPE insulated single core aluminum conductor. The MV Switch gear shall have two bus sections with bus-coupler device, each feeding half of the WTG groups. It will also feed auxiliary transformer and capacitor bank to meet the power factor requirements of the national grid code (0.95 lagging).

The 132 kV substation shall consist of two bus sections of a single bus bar with a coupler and two breaker bays to connect main transformers with the 132 kV double circuit overhead lines (OHL). The Main Transformers shall meet the N-1 grid code criteria and thus may be two (02) in number (31.5/40/50 MVA each). The instrumentation transformers (CTs, VTs and CVTs) for all purposes shall be sized according to requirement. The 132 kV OHLs from the Wind farm substation to the 132 kV to far end connection points (whether adjacent grid stations or neighboring project substations) are out of the scope of the contractor and shall be installed and connected by NTDC. The HV/MV switchgear, main power transformer and other protection equipment shall be of reputable manufacturers, confirming to the requirements to be spelled in detail in the EPC Contract and in the EPA. Further, the detailed electrical design will be subject to approval of both Noor Solar Energy and NTDC as per the requirements of EPC Contract and EPA.

In this regard, the concept mentioned in this section serves as guidelines and firm design will be prepared during construction phase, which may be somewhat different from predicted here.

13 CONSTRUCTION MANAGEMENT

Like all wind power projects in Pakistan, the structure of EPC contract is on a "turnkey" basis. Everything shall be managed from one platform (one window) of the EPC contractor. The partners of EPC contractor shall be underneath that platform through "subcontracting" or "joint and several arrangements". In this way, the role of Noor Solar Energy (Pvt.) Ltd shall become to supervise and monitor everything.

Noor Solar Energy (Pvt.) Ltd personnel will supervise construction activities right from the beginning. Noor Solar Energy (Pvt.) Ltd team will monitor the construction schedule, owner's engineers and the EPC contractor to complete the project within given time frame and in-line with HSE guidelines.

Noor Solar Energy (Pvt.) Ltd requires careful management for construction. To achieve this, Noor Solar Energy (Pvt.) Ltd will prepare a Construction Management Master Plan taking into account all relevant aspects. The master plan shall be regularly reviewed, updated and shared with all project stakeholders.

Construction Management Plan depends on the nature of work, likelihood of disruptions, impact on local amenity, dangers or risks involved and any other relevant issue required to be addressed under the planning permit.

In order to manage all the above operations correctly, Noor Solar Energy (Pvt.) Ltd shall have a consultant as a "Construction Supervisor" who shall supervise the quality and progress of all contractors and give approvals of the milestones.

The project construction shall take 18 months from the date of planning till the COD. The activity structure and timelines are given in table below:

Table 13-1: Project Construction Scheduling

Activity / Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Engineering and Mobilization																		
Construction of Temporary Establishment																		
Civil Works of WTGs and Substation																		
Construction of Substation																		
Supply of WTGs and Towers																		
Cables and Interconnection																		
Erection and Installation																		
Testing and Commissioning of EBOP																		
Testing and Commissioning of WTGs																		
EPA Tests and Reliability Run Test																		

14 Initial Environment Examination (IEE)

The Initial Environment Examination (IEE) has been carried out as per the Pakistan Environmental Protection Act, 1997, according to the requirements of Environmental Protection Agency, Government of Sindh and has already been submitted. **The report is attached as Annex VII.**

A data collection survey, which included geology, meteorology, hydrology, ambient air quality, water quality, soil characteristics, noise levels, shadow forecasting, flora and fauna, land use pattern and socioeconomic conditions, was undertaken based on the available secondary information or through data collected in the field. The primary data was collected to establish baseline conditions for the soil, water (surface and ground) quality, flora and fauna, and noise. The secondary data was collected for land, ecology, climate, and socioeconomic factors.

According to the study conducted, the prime benefit of the Project will be the replacement of conventional power generation with renewable energy. Wind energy will replace fossil fuel powered generation, and therefore reduce suspended particulate matter and greenhouse gas emissions into the atmosphere.

The impacts are manageable and can be managed cost effectively - environmental impacts are likely to result from the proposed power project. Careful mitigation and monitoring, specific selection criteria and review/assessment procedures have been specified to ensure that minimal impacts take place. The detailed design would ensure inclusion of any such environmental impacts that could not be specified or identified at this stage and are taken into account and mitigated where necessary. Those impacts can be reduced through the use of mitigation measures such as correction in work practices at the construction sites, or through the careful selection of sites and access routes. Since proposed land is covered with shrubs, thus there is no need for removal of any significant vegetation for the construction of the wind power Project.

The proposed Project will have a number of positive impacts and negligible negative impacts to the existing environment as follows:

- ❖ Significant improvement in economic activities in the surrounding areas due to generation of direct and indirect employment opportunities.
- ❖ There is negligible removal of trees for the Project, which is the main positive impact to the proposed Project area.
- ❖ Environment pollution due to cut and fill operations, transportation of construction materials, disposal of debris, nuisance from dust, noise, vehicle fumes, black smoke, vibration are the short term negative impacts due to proposed Project with mitigations being properly taken care.

Proper GRM will have to be implemented by Noor Solar Energy (Pvt.) Ltd to overcome the public inconvenience during the proposed Project activities.

Based on the environmental and social assessment and surveys conducted for the Project, the potential adverse environmental impacts can be mitigated to an acceptable level by adequate implementation of the mitigation measures identified in the EMP. Adequate provisions are being made by Noor Solar Energy (Pvt.) Ltd to cover the environmental mitigation and monitoring requirements, and their associated costs.

An environment and social analysis has been carried out looking at various criteria such as topology, air, noise, water resources and water quality, ecology, demography of the area, climate and natural habitat, community and employee health and safety etc. The impact analysis, found that due to careful consideration of environmental and social aspects during route and site selection by Noor Solar Energy (Pvt.) Ltd, no major adverse impacts are expected. There is no adverse impact of migration on the habitat, any natural existing land resources and there is no effect on the regular life of people.

The environment and social impact associated with the project is limited to the extent of construction phase and can be mitigated through a set of recommended measures and adequate provision for environment and social impacts which cover monitoring, measuring and mitigation.

Most of the impacts are expected to occur during the construction phase and are considered to be of a temporary nature. The transmission corridor will be carefully selected after undergoing an options assessment. This enabled the right of way alignment to bypass villages and important water supplies and resources. The main project impacts are associated with clearing of shrub vegetation, waste management and excavation and movement of soils.

From this perspective, the project is expected to have a lesser "environmental footprint". No endangered or protected species of flora or fauna are reported near the project sites.

The stakeholder from the Government and Non-Government sector has also appreciated the project activities, raised concerns related to the social and environment areas which shall be addressed through effective planning and management.

Adequate provisions have been made for the environmental mitigation and monitoring of predicted impacts, along with their associated costs. Adverse impacts if noticed during implementation will be mitigated using appropriate design and management measures. Mitigation measures related to Construction, as specified in the EMP, will be incorporated into civil works contracts, and their implementation will be primarily the responsibility of the contractors. Hence, the proposed project has limited adverse environmental and social impacts, which can be mitigated following the EMP & shall be pollution free Renewable source of Power generation with low Environmental foot prints.

Adequate provisions have been made for the environmental mitigation and monitoring of predicted impacts, along with their associated costs. Adverse impacts if noticed during implementation will be mitigated using appropriate design and management measures. The potential cumulative and residual impacts of the project as a whole indicate that the project is classified as a category "B", in accordance with ADB's Safeguards Policy Statement 2009. The project is not considered highly sensitive or complex. The mitigation measures related to construction, as specified in the EMP, will be incorporated into civil works contracts, and their implementation will be primarily the responsibility of the contractors. Hence, the proposed project has limited adverse environmental and social impact, which can be mitigated following the EMP and shall be a pollution free renewable source of power generation with small environmental foot prints.

In view of the aforementioned details, it is concluded that development of the 50 MW wind power project by Noor Solar Energy (Pvt.) Ltd will have no adverse environmental impact and the project can be regarded as an Environmental Friendly Green Project.

15 CONCLUSIONS OF FEASIBILITY STUDY

The detailed feasibility of the project has been conducted which covers all aspects required for developing the Project.

The wind climate observed on the site indicates advantageous annual average wind speed. Thus the annual energy estimates are also favourable and it is feasible to develop the project based on General Electric GE 1.7-103 (1.7 MW), Gold Wind 121-2.5 (2.5 MW), General Electric GE 2.75 (2.75 MW), Gamesa G114-2.0 (2.0 MW), Gamesa G114-2.5 (2.5 MW), Nordex N131-3000 (3.0 MW), Vestas V126-3.3 (3.3 MW) turbines. The IRR of the Project as currently being assessed is suitable.

The project site is feasible for the wind farm with easy access for the transportation of equipment. The climatic conditions at the project site are moderate and there is no significant impact of seismic hazards foreseen in the area. The telecommunication and transportation facilities are adequate.

The Project shall not have negative environmental impact during its life cycle. Instead, the project will bring positive development and improve the socio-economic conditions of the area through generation of employment opportunities and contribute in environmental sustainability of the area.

All WTGs considered in the study are worthy for the project. However, the negotiations of the EPC contract and price shall play a vital role in the final selection.

The project site is conveniently located close to the grid of HESCO and NTDC. However, the remaining Grid Interconnection study will tell exactly which grid is to be selected for the connection.

From here onwards, the project may enter into getting licenses and permits and into negotiation of security documents. The next steps after approval of feasibility study would be to apply for the Generation License and Tariff, and to begin negotiations for EPA and IA. The Project may also enter into discussions with lenders at some stage.

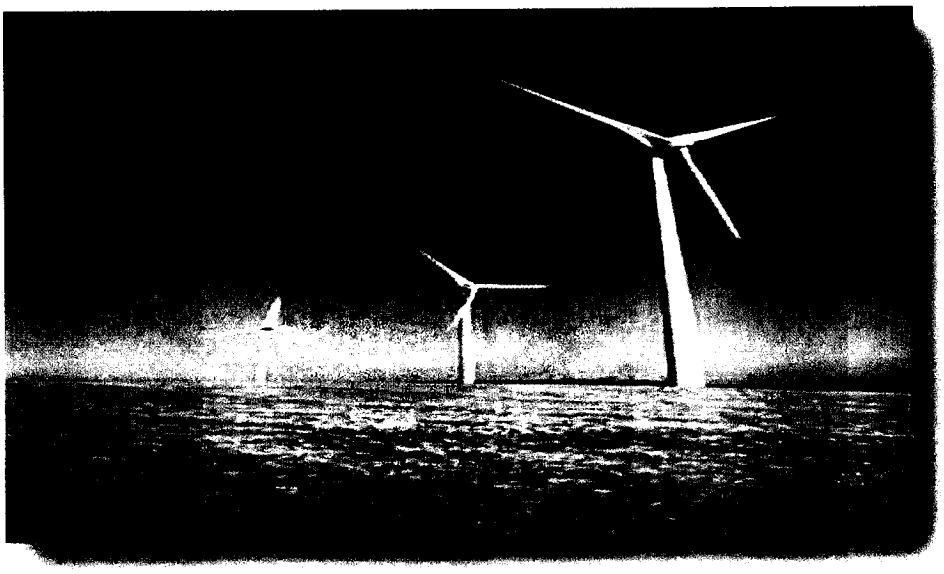
It is expected that the Project will achieve financial close by 4th quarter of year 2016 and construction will be completed by 2nd quarter of year 2018. It is anticipated that the Noor Solar Energy (Pvt.) Ltd Project would be a valuable addition to the National Grid for generating electricity and contributing to overcome the current energy crisis of Pakistan.

Report No. PPI-215.1-Draft-Noor/16

ELECTRICAL GRID STUDIES

For

50 MW Wind Power Plant by Noor Solar Energy Limited



Draft Report
(September 2016)

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Executive Summary

- The study objective, approach and methodology have been described and the plant's data received from the client Noor Solar Energy Limited has been validated.
- The wind project by Noor Solar Energy Limited, referred to as Noor 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-380/3131-33 dated 02-08-2016.
- 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 13 new WPPs in integration with the already planned WPPs and other upcoming WPPs in its vicinity.
- Out of these 13 WPPs, 8 plants which lie in the southern part of Jhimpir namely Indus, DHA City, Noor, Lakeside, Metro-2, Iran Pak, Nasda, Uni-energy WPPs, are proposed to be connected in a second loop at Jhimpir-2 220/132kV Grid station. 3 plants which lie in the northern part of Jhimpir namely Norinco-2, Sinowell and Tricon WPPs 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 existing Jamshoro old – Jamshoro New 132kV single circuit.

- As discussed above, Noor WPP which is the plant under study, has been placed in the second loop at newly proposed 220kV Jhimpir-2 grid station. Noor Wind Power Plant would be connected by a double circuit of 132 kV looping in-out with a sub cluster connecting neighboring Wind Power Plants of Iran Pak 50 MW and Indus 50 MW and the other 5 WPPs in the second loop to Jhimpir-2 220/132 kV collector substation. It should be noted that the length of circuits used for the simulations are approximate and may change slightly during the implementation of the project. In addition, the connectivity of Noor WPP with neighboring wind power plants may change, depending upon the COD of the project.
- The scheme of interconnection of Noor WPP proposes the following reinforcements in place at Jhimpir cluster.
  - 220 kV D/C transmission line approx. 18km 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. 88 km long on twin bundled Greeley conductor for connecting all the 8 WPPs including Indus, Lakeside, DHA City, Noor, Metro-2, Iran Pak, Nasda, Uni-energy to Jhimpir-2 220/132 newly proposed substation. In this scheme the interconnection of Noor WPP includes 132 kV D/C transmission line approx. 2 km long, on twin bundled Greeley conductor for looping in/out on the 132kV single circuit from Indus WPP to Iran Pak WPP.
- The existing grid system of HESCO and NTDC in the vicinity of Noor WPP has been studied in detail by performing load flow, short circuit and dynamic analysis for the conditions prior to commissioning of Noor WPP and no bottlenecks or constraints have been found in the grid system.
- Wind Farm of Noor has been modeled considering Type-3 WTGs. They are Doubly Fed Induction Generators which are designated as Type-3 WTG. The terminal voltage is 0.69 kV. The medium voltage level of wind

farm has been selected as 22 kV for unit step-up transformers, for collector circuits and step-up from MV to HV (132 kV) at Farm substation to connect to the Jhimpir-2 220/132 kV grid station of NTDC.

- The design of scheme of 132/22 kV substation of Noor 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 Noor WPP and a future scenario of 2022, for the dispersal of power from Noor WPP into NTDC system at 220 kV level 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. It is proposed that for this High Wind and High Water season, highly inefficient thermal plant of Jamshoro which comes on the bottom of the merit order dispatch should not be operated. With the proposed reinforcements mentioned above and dispatch control the system is found adequate to absorb output power of Noor WPP and other upcoming WPPs in the same loop. The load flow results for peak and Off Peak scenarios also establish that the proposed scheme of interconnection of Noor 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 Noor WPP 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 Noor 132 kV are 11.30 kA and 11.08 kA

for 3-phase and single phase faults respectively for 2022. This is much less than the switchgear rating of 40 kA recommended for Noor Farm Substation as per NTDC requirements for 132 kV. The fault levels for Noor 22 kV are 24.31 kA and 28.61 kA for 3-phase and single-phase faults respectively for year 2022.

Therefore the short circuit rating for 22 kV switchgear is recommended as 31.5 kA. It has been found that the proposed scheme provides maximum SC strength for the evacuation of Noor WPP power to the grid.

The switchgear ratings for Noor WPP substation are as follows:

132 kV:

Short circuit rating = 40 kA (3 sec.)

Continuous rating = 2500 A

22 kV:

Short circuit rating = 31.5 kA (3 sec.)

Continuous rating = 2500 A

- Transient Stability analysis has been carried out for Noor WPP based on their selection of Type-3 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 Noor WTG unit's dynamic characteristics and the grid connectivity is strong enough to maintain stability under all disturbances. In turn, any disturbance from Noor 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 Noor 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 13 new WPPs was carried out in integration with the already planned / existing WPPs. Noor Energy Private 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 Noor Wind Power Plant on the System
2. Impact of the System on Noor 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 Noor 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 Noor 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 Noor Wind Farm and the NTDC/HESCO substations of 132 kV connecting with the Noor 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 Noor WPP in response to Grid disturbances and vice versa the dynamic impact of disturbances in Noor WPP on the Grid.
9. To check the ability of the wind turbine generators of Noor 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 Noor 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-380/3131-33 dated 02-08-2016. 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 Noor Wind Farm has been provided by the client who has indicated to use 2 MW Gamesa-G114 Type-3 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 having installed capacity of 120 MW and 600 MW respectively. Next to them are Hub with 1200 MW, Lakhra with 70 MW. 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 Noor 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. Noor Wind Energy is considering using 2 MW Gamesa G-114 Type-3 WTGs which are Doubly Fed Induction Generators.

2.2 Approach to the problem

We will apply the following approaches to the problem:

- According to the COD of Noor WPP as provided by the Client Noor Solar Energy 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 Noor Wind PP.

3. Analysis of Network Prior to Noor WPP Interconnection

3.1 Description of the Network

The electrical grid, which is relevant for interconnection of Noor Wind PP, is the 500, 220 and 132 kV network that stretches through South of Hyderabad and Jamshoro up to coastal areas of Southern Sind. 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. There are two loops directly connected to Jhimpir-2 substation. The first loop whose study was carried out by NTDCL planning department comprises of the following 7 WPPs:

- Artistic (50 MW)
- Act-2 (50 MW)
- Gul Ahmed (50 MW)
- Cacho (50 MW)
- Transatlantic (50 MW)
- Din Energy (50 MW)
- Zuleikha Energy (50 MW)

The other three WPPs in the sketch whose study has been completed by NTDCL planning department are Shaheen Foundation (50 MW), Western Energy (50 MW) and Norinco (50 MW) who form a sub cluster with Master at Jhimpir-1 220/132kV substation.

The second loop at Jhimpir-2 220/132 kV substation which comprises of the newly proposed WPPs comprises of the following 8 WPPs:

- DHA City (50 MW)
- Iran Pak (50 MW)
- Noor (50 MW)
- Metro-2 (60 MW)

- Lake Side (50 MW)
- Indus Energy (50 MW)
- Nasda Green (50 MW)
- Uni-Energy (50 MW)

The details of the other 5 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 existing Jamshoro Old – Jamshoro New 132kV single circuit

We have carried out the studies of the case "without" Noor 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 Noor 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 Noor 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 plant such as Thatta, Nooriabad and Kotri-Site at its maximum. Highly Inefficient Jamshoro Power Plant which comes on bottom of the merit order dispatch was switched off for this study scenario and the 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 for the three Southward branches each, and the results are attached in Appendix-3 as below:

Exhibit: 3.1	Iran PAK to Indus 132kV Single Circuit Out
Exhibit : 3.2	DHA-City to Jhimpir-2 132kV Single Circuit Out
Exhibit : 3.3	Zulaikha-E to Jhimpir-2 132kV Single Circuit Out
Exhibit : 3.4	Jhimpir-2 220/132 kV Single Transformer Out
Exhibit : 3.5	Jhimpir-1 to T.M.Khan 132kV Single Circuit Out
Exhibit : 3.6	Jhimpir-2 to Kotri GTPS 132kV Single Circuit Out
Exhibit : 3. 7	Kotri GTPS to Jamshoro Old 132kV Single Circuit Out
Exhibit :3.8	Jhimpir-1 to TM.KH.RD 220kV Single Circuit Out
Exhibit : 3.9	Jhimpir-1 to Jhimpir-2 220kV Single Circuit Out
Exhibit : 3.10	Jhimpir-2 to KDA-33 220kV Single Circuit Out
Exhibit :3.11	Jhimpir-2 to Jamshoro 220kV Single Circuit Out
Exhibit : 3.12	Jamshoro 500/220kV Single Transformer Out
Exhibit : 3.13	Jamshoro to Dadu 500kV Single Circuit Out
Exhibit : 3.14	Matiari to Dadu 500kV Single Circuit Out

The load flow results of the network in the close vicinity of Noor WPP shown plotted in Exhibits 3.1 to 3.14 indicate that all the power flows on the lines are within the rated limits of this network.

The load flow results show that the network existing before Noor 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 Noor WPP. We will check the adequacy of network after adding Noor WPP in Chapter 6.

4. Development of Interconnection Scheme

4.1 Interconnection of Noor 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 Noor WPP, the nearest substation is the collector substation of Jhimpir-2 220/132 kV which is proposed for evacuation of power from already planned 10 WPPs and will be operational before the commissioning of the said power plant.

4.2 Proposed Interconnection Scheme

The scheme of interconnection of Noor WPP proposes the following reinforcements in place at Jhimpir cluster.

- 220 kV D/C transmission line approx. 18km 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. 88 km long on twin bundled Greeley conductor for connecting all the 8 WPPs including Indus, DHA City,

Noor, Metro-2, Iran Pak, Nasda, Uni-energy to Jhimpir-2 220/132 newly proposed substation. In this scheme the interconnection of Noor WPP includes 132 kV D/C transmission line approx. 2 km long, on twin bundled Greeley conductor for looping in/out on the 132kV single circuit from Indus WPP to Iran Pak WPP.

The connection scheme of Noor WPP for the scenario of August/September 2019 as shown in Appendix - 4 is by interconnecting Noor in the second loop proposed at Jhimpir-2 220/132 kV substation. Noor Wind Power Plant would be connected by a double circuit of 132 kV looping in-out with a sub cluster connecting neighboring Wind Power Plants of Nasda Green 50 MW and Metro-2 60 MW and 5 other WPPs in the second loop to Jhimpir-2 220/132 kV collector substation. The length of circuits assumed in the study is approximate and may change slightly during the implementation of the project. In addition, the connectivity of Noor WPP with neighboring wind power plants may change, depending upon the COD of the project.

5. Modeling of Noor Wind Farm

5.1 Electrical Layout of Wind Farm

5.1.1 Noor WPP Energy Selection

Noor has selected Type-3 Gamesa WTGs which they are considering to install on their Wind Farm at Jhimpir. It is a Doubly Fed Induction Generator. Each WTG would step up from its terminal LV voltage of 0.69 kV to a medium voltage (MV) that will be 22 kV.

5.1.2 Electrical Layout

The WTGs would be connected to MV collector cables of 22 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 1-6	(6 x 2 = 12 MW)
Line – 2	WTGs 7-12	(6 x 2 = 12 MW)
Line – 3	WTGs 13-18	(6 x 2 = 12 MW)
Line – 4	WTGs 19-25	(7 x 2 = 14 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 3 kilo 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 22 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-7 to Farm Substation
Collector Line-3	from WTG-13 to Farm Substation
Collector Line-4	from WTG-19 to Farm Substation

Since each collector would carry a max of approximately 14 MW at normal rating, the 22 kV collector circuits loading capacity should be in the range of 16 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 22 kV Collector Circuits

The MV voltage level selected by Noor for interconnection of collector groups of WTGs in the Farm is 22 kV. Underground cables will be used with length of approx. 3 km. Further details regarding the type of cable is provided in Appendix - 2.

5.2 Wind Farm Substation 132/22 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 22 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 22 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 22 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 22 kV

The single line diagram SLD–1 in Appendix-5 shows the conceptual design of 22 kV (MV) bus bar of the Farm substation. It comprises of

- Two single bus-sections of 22 kV with a bus sectionalizer
- Four breaker bays to connect four collector double circuits of WTG Lines 1-4
- Two breaker bays to connect two transformers of 132/22 kV

- Two breaker bays for connecting two auxiliary transformers of 22/0.4 kV
- Two breaker bays to connect switched shunt capacitor banks

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity = 31.5 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 132/22 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 132/22 kV, 31.5/40/50 MVA ONAN/ONAF1/ONAF2 OLTC transformers, 132±11×1%/22kV, to fulfill N-1 criteria of Grid Code
- Two station auxiliary transformers 22/0.4 kV
- Two switched shunt capacitor banks each of the size of 10 MVAR (5 x 2 MVAR) with contactors and PLC (Programmable Logic Controller).
- Energy meters would be installed on HV side (132 kV) of the 132/22kV transformers.

6. Load Flow Analysis

Load flow analysis has been carried out for the proposed scheme of interconnection of Noor 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 four collector feeders connecting to four groups of WTGs, therefore there are four equivalent WTGs assumed for each collector group in this study report.

The Farm Substation is represented by two bus bars as Noor medium voltage bus named Noor -MV 22 kV and Noor 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

Noor is considering using 2 MW Gamesa Type-3 WTGs, which are doubly fed induction generators, 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 0.69/22 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. 132/22 kV transformers at the Farm substation. In order to meet the Grid Code criteria, we need to install switched shunt capacitor bank at 22 kV bus of the Farm substation of sufficient size capable of delivering approx. 16.4 MVAR at 132 kV bus after VAR loss across 132/22 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 Noor 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 Noor 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 plant such as Thatta, Nooriabad and Kotri-Site at its maximum. Highly Inefficient Jamshoro Power Plant which comes on the bottom of the merit order dispatch was switched off for this study scenario and the 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 Noor WPP, 47.6 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 switched shunt capacitor bank of 20 MVAR at 22 kV bus bar is supplying 14 MVAR at (22.1 kV) voltage and, after VAR loss across 132/22 kV transformers, supplying about 15.6 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	Noor 132/22 kV Single Transformer Out
Exhibit : 6.1.2	Iran PAK to Noor 132kV Single Circuit Out
Exhibit : 6.1.3	Noor to Indus 132kV Single Circuit Out
Exhibit : 6.1.4	DHA-City to Jhimpir-2 132kV Single Circuit Out
Exhibit : 6.1.5	Zulaikha-E to Jhimpir-2 132kV 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 132kV Single Circuit Out
Exhibit : 6.1.8	Jhimpir to Kotri GTPS 132kV Single Circuit Out
Exhibit : 6.1.9	Kotri GTPS to Jamshoro Old 132kV Single Circuit Out
Exhibit : 6.1.10	Jhimpir-1 to TM.KH.RD 220kV Single Circuit Out
Exhibit : 6.1.11	Jhimpir-1 to Jhimpir-2 220kV Single Circuit Out
Exhibit : 6.1.12	Jhimpir-2 to KDA-33 220kV Single Circuit Out
Exhibit : 6.1.13	Jhimpir-2 to Jamshoro 220kV Single Circuit Out
Exhibit : 6.1.14	Jamshoro 500/220kV Single Transformer Out
Exhibit : 6.1.15	Jamshoro to Dadu 500kV Single Circuit Out
Exhibit : 6.1.16	Matiari to Dadu 500kV Single Circuit Out

The results show that power flows on intact 132 kV circuits remain within their rated limits.

The results also show that under all events of outages the switched shunt capacitor banks at 22 kV bus regulates the voltage under all events. The reactive power being supplied by the 20 MVAR switched shunt capacitor banks as proposed by the client connected at 22 kV bus, maintains the supply of VARS to the grid under all contingencies adjusting its output according to the system requirement.

In addition, twin bundled Greeley conductor (368 MVA) is used for the interconnection of all the wind farms coming in this second loop at Jhimpir-2

220/132 kV collector substation. In the load flow simulation, however, the MVA capacity is assumed to be 404 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	Noor 132/22 kV Single Transformer Out
Exhibit : 6.2.2	Iran PAK to Noor 132kV Single Circuit Out
Exhibit : 6.2.3	Noor to Indus 132kV Single Circuit Out
Exhibit : 6.2.4	DHA-City to Jhimpir-2 132kV Single Circuit Out
Exhibit : 6.2.5	Zulaikha-E to Jhimpir-2 132kV 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 132kV Single Circuit Out
Exhibit : 6.2.8	Jhimpir to Kotri GTPS 132kV Single Circuit Out
Exhibit : 6.2.9	Kotri GTPS to Jamshoro Old 132kV Single Circuit Out

Exhibit : 6.2.10	Jhimpir-1 to TM.KH.RD 220kV Single Circuit Out
Exhibit : 6.2.11	Jhimpir-1 to Jhimpir-2 220kV Single Circuit Out
Exhibit : 6.2.12	Jhimpir-2 to KDA-33 220kV Single Circuit Out
Exhibit : 6.2.13	Jhimpir-2 to Jamshoro 220kV Single Circuit Out
Exhibit : 6.2.14	Jamshoro 500/220kV Single Transformer Out
Exhibit : 6.2.15	Jamshoro to Dadu 500kV Single Circuit Out
Exhibit : 6.2.16	Matiari-CS to Dadu 500kV Single Circuit Out

The results show that power flows on intact 132 kV circuits remain within their rated limits.

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	Noor 132/22 kV Single Transformer Out
Exhibit : 6.3.2	Iran PAK to Noor 132kV Single Circuit Out
Exhibit : 6.3.3	Noor to Indus 132kV Single Circuit Out
Exhibit : 6.3.4	DHA-City to Jhimpir-2 132kV Single Circuit Out
Exhibit : 6.3.5	Zulaikha-E to Jhimpir-2 132kV 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 132kV Single Circuit Out

Exhibit : 6.3.8	Jhimpir to Kotri GTPS 132kV Single Circuit Out
Exhibit : 6.3.9	Kotri GTPS to Jamshoro Old 132kV Single Circuit Out
Exhibit : 6.3.10	Jhimpir-1 to TM.KH.RD 220kV Single Circuit Out
Exhibit : 6.3.11	Jhimpir-1 to Jhimpir-2 220kV Single Circuit Out
Exhibit : 6.3.12	Jhimpir-2 to KDA-33 220kV Single Circuit Out
Exhibit : 6.3.13	Jhimpir-2 to Jamshoro 220kV Single Circuit Out
Exhibit : 6.3.14	Jamshoro 500/220kV Single Transformer Out
Exhibit : 6.3.15	Jamshoro to Dadu 500kV Single Circuit Out
Exhibit : 6.3.16	Matiari to Dadu 500kV Single Circuit Out

The results show that power flows on intact 132 kV circuits remain within their rated limits.

6.6 Conclusion of Load Flow Results

The load flow results of the proposed scheme of interconnection of Noor WPP in 2019 shows no bottlenecks or capacity constraints in the adjoining 220 kV and 132 kV network in terms of absorbing all the output of Noor WPP under normal as well as the contingency conditions.

Noor Wind Power Plant would be connected by a double circuit of 132 kV looping in-out with a sub cluster connecting neighboring Wind Power Plants of Iran Pak 50 MW and Indus 50 MW and other five WPPs in the same loop to Jhimpir-2 220/132 kV collector substation.

The twin bundled Greeley conductor used with the capacity of 368 MVA per circuit is assumed to have a thermal limit of 404 MVA taking into account the increase in MVA capacity of the conductors at high wind speed during high wind season.

References:

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

2- *Ibid.* p.3.1

7. Short Circuit Analysis

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 Noor 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 Noor 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 Noor WPP we have

assumed dispatch of 25% of its capacity for the minimum short circuit calculations i.e. just one collector group with partial output of approx. 12 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 Noor 132 kV are 11.30 kA and 11.08 kA for 3-phase and single phase faults respectively for 2022. This is much less than the switchgear rating of 40 kA recommended for Noor Farm Substation as per NTDC requirements for 132 kV.

The fault levels for Noor 22 kV are 24.31 kA and 28.61 kA for 3-phase and single-phase faults respectively for 2022. Therefore the short circuit rating recommended for 22 kV switchgear is recommended as 31.5 kA.

Table-7.1

Maximum Short Circuit Levels with Noor WPP – 2022

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Noor 132 kV	11.30	11.08
Noor MV 22 kV	24.31	28.61
Indus 132 kV	11.51	11.08
Iran Pak 132 kV	11.77	11.61
Noorabad 132kV	12.17	11.50
Thatta 132 kV	6.77	7.20
Jamshoro Old 132 kV	24.32	25.88
Jamshoro New 132 kV	25.72	27.22
Kotri GTPS 132 kV	19.91	21.61
Hala Road 132 kV	22.57	23.61
T.M.KHAN 132 kV	15.34	14.10
Jhimpir 132 kV	11.60	9.65
Jhimpir-1 132 kV	30.06	25.42
Jhimpir-2 132 kV	25.81	25.66
Gharo-New 132 kV	11.16	10.36
Gharo-New 220 kV	12.02	8.89

Jhimpir-1 220 kV	22.92	17.62
Jhmipir-2 220 kV	28.56	22.78
Jamshoro 220 kV	44.04	46.68
Hala Road 220 kV	29.27	26.47
TM.KH.RD 220 kV	22.39	17.80
Jamshoro 500 kV	38.27	35.79

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 Noor WPP 2019

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Noor 132 kV	9.76	10.03
Noor MV 22 kV	20.53	22.12
Indus 132 kV	10.02	10.28
Iran Pak 132 kV	10.13	10.75
Noorabad 132kV	11.47	11.45
Thatta 132 kV	6.92	7.53
Jamshoro Old 132 kV	22.81	25.23
Jamshoro New 132 kV	24.23	26.47

Kotri GTPS 132 kV	18.42	20.14
Hala Road 132 kV	22.42	24.05
T.M.KHAN 132 kV	15.87	15.14
Jhimpir 132 kV	10.17	10.37
Jhimpir-1 132 kV	23.17	23.95
Jhimpir-2 132 kV	21.50	23.86
Gharo-New 132 kV	10.38	10.44
Gharo-New 220 kV	11.40	9.34
Jhimpir-1 220 kV	19.51	17.85
Jhmipir-2 220 kV	23.68	21.61
Jamshoro 220 kV	34.51	34.61
Hala Road 220 kV	26.50	25.12
TM.KH.RD 220 kV	21.06	18.33
Jamshoro 500 kV	23.32	18.78

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 Noor 132 kV are 11.30 kA and 11.08 kA for 3-phase and single phase faults respectively for 2022. This is much less than the switchgear rating of 40 kA recommended for Noor Farm Substation as per NTDC requirements for 132 kV.

The fault levels for Noor 22 kV are 24.31 kA and 28.61 kA for 3-phase and single-phase faults respectively for 2022. Therefore the short circuit rating recommended for 22 kV switchgear is 31.5 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 Noor Wind Power Plant on the System
2. Dynamic impact of the System on Noor Wind Power Plant

8.1 Assumptions & Methodology

8.1.1 Type-3 WTG Dynamic Model

Noor is considering using Doubly Fed Induction Generator which is designated as Type-3 WTG in their Wind Power Plant. We have used the generic Type-3 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 Three Phase Faults, Normal Clearing Time of 5 Cycles & Trip of Circuits

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

Three- phase fault applied at Noor 132 kV bus bar, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 132 kV single circuit between Noor WPP and Indus, which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 8.1.1 indicates the bus voltages in pre and post fault conditions at 132 kV substations in the vicinity of Noor WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

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

The MW and MVAR output of equivalent WTG get back to normal quickly after the fault clearance as shown in **Fig 8.1.3.**

The dynamic response of generator is shown in **Figs 8.1.4** showing the recovery of speed and mechanical power. We find that the WTG is robust enough to damp down transients in the generator speed and Pmech.

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

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

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

Fig. 8.1.8 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG.

The outage of 132 kV single circuit between Noor WPP and Indus causes significant decrease in the loading on the Iran Pak to Noor 132 kV Single Circuit. **Fig. 8.1.9** shows the transients of MW and MVAR flows on Iran Pak to Noor 132 kV circuit which settles the transients quickly and acquires new steady state levels soon.

Fig 8.1.10 shows the MW and MVAR output of the adjacent Indus WPP which get back to normal quickly after the fault clearance.

The angular stability of other conventional generators of the system can be seen in **Fig. 8.1.11**. The relative rotor angles of Kotri GTPS 132 kV, Lakhra 132 kV, Nooriabad 132 kV, Thatta 132 kV and Hub 500 kV are plotted w.r.t. Guddu-New 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.2.2 Three Phase Faults, Clearing Time of 9 Cycles (Stuck Breaker): LVRT Test

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

Three- phase fault applied at Noor 132 kV bus bar, cleared in 9 cycles as normal clearing time i.e. 180 m seconds, followed by trip of 132 kV single circuit between Noor WPP and Indus, which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 8.2.1 indicates the bus voltages in pre and post fault conditions at 132 kV substations in the vicinity of Noor WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in

Fig. 8.2.2 shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG get back to normal quickly after the fault clearance as shown in **Fig 8.2.3.**

The dynamic response of generator is shown in **Figs 8.2.4** showing the recovery of speed and mechanical power. We find that the WTG is robust enough to damp down transients in the generator speed and Pmech.

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

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

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

Fig. 8.2.8 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG.

The outage of 132 kV single circuit between Noor WPP and Indus and causes significant decrease loading on the Noor to Iran Pak 132 kV Single Circuit. **Fig. 8.2.9** shows the transients of MW and MVAR flows on Noor to Iran Pak 132 kV circuit which settles the transients quickly and acquires new steady state levels soon.

Fig 8.2.10 shows the MW and MVAR output of the adjacent Indus WPP which get back to normal quickly after the fault clearance.

The angular stability of other conventional generators of the system can be seen in **Fig. 8.2.11**. The relative rotor angles of Kotri GTPS 132 kV, Lakhra 132 kV, Nooriabad 132 kV, Thatta 132 kV and Hub 500 kV are plotted w.r.t. Guddu-New 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.3 Dynamic Impact of Wind Farm Disturbances

8.3.1 Sudden Loss of a group of WTGs

We have simulated the sudden loss of a group of WTGs, i.e. loss of one equivalent WTG representing a collector group. This happens due to 3-phase fault on the MV bus of Noor Farm substation and cleared by tripping of a collector double circuit. The fault clearing at 22 kV is assumed as 9 cycles (180 ms). The following variables are monitored

Fig 8.3.1 indicates the bus voltages in pre and post fault conditions at 132 kV substations in the vicinity of Noor WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

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

The MW and MVAR output of equivalent WTG get back to normal quickly after the fault clearance as shown in **Fig 8.3.3**.

The dynamic response of generator is shown in **Figs 8.3.4** showing the recovery of speed and mechanical power. We find that the WTG is robust enough to damp down transients in the generator speed and Pmech.

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

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

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

Fig. 8.3.8 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG.

The outage of a collector group causes the power flow through the Noor 132/22 kV Transformers to change. **Fig. 8.3.9** shows the transients of MW and MVAR flows on a 132/22 kV TF at Noor WPP which settle the transients quickly and acquire new steady state levels soon.

Fig 8.3.10 shows the MW and MVAR output of the adjacent Indus WPP which get back to normal quickly after the fault clearance.

The angular stability of other conventional generators of the system can be seen in **Fig. 8.3.11.** The relative rotor angles of Kotri GTPS 132 kV, Lakhra 132 kV, Nooriabad 132 kV, Thatta 132 kV and Hub 500 kV are plotted w.r.t. Guddu-New 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.3.2 Sudden Loss of one 132/22 kV Transformer in the Farm Substation

The sudden trip of 132/22 kV transformer in the Noor Farm is caused after the clearing of 3-phase fault on MV bus of Farm substation.

Fig 8.4.1 indicates the bus voltages in pre and post fault conditions at 132 kV substations in the vicinity of Noor WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

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

The MW and MVAR output of equivalent WTG recover quickly after the fault clearance as shown in **Fig 8.4.3**.

The dynamic response of generator is shown in **Figs 8.4.4** showing the recovery of speed and mechanical power. We find that the WTG is robust enough to damp down transients in the generator speed and Pmech.

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

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

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

Fig. 8.4.8 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG.

The outage of one 132/22 kV Transformer at Noor WPP Substation causes the entire output of Noor WPP to shift to the intact Transformer at Noor WPP Substation. **Fig. 8.4.9** shows the transients of MW and MVAR flows on the 132/22 kV Noor WPP transformer which settles the transients quickly and acquire new steady state levels soon.

Fig 8.4.10 shows the MW and MVAR output of the adjacent Indus WPP which get back to normal quickly after the fault clearance.

The angular stability of other conventional generators of the system can be seen in **Fig. 8.4.11.** The relative rotor angles of Kotri GTPS 132 kV, Lakhra 132 kV, Nooriabad 132 kV, Thatta 132 kV and Hub 500 kV are plotted w.r.t. Guddu-New 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.4 Dynamic impact of Fault on 220 kV Primary System

Three Phase Faults, Normal Clearing Time of 5 Cycles & Trip of 220 kV Circuits

Three- phase fault applied at Jhimpir-2 220 kV bus bar, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 220 kV single circuit between Jhimpir-2 and KDA-33 which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 8.5.1 indicates the bus voltages in pre and post fault conditions at 220 kV and 132 kV substations in the vicinity of Noor WPP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

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

The MW and MVAR output of equivalent WTG get back to normal quickly after the fault clearance as shown in **Fig 8.5.3.**

The dynamic response of generator is shown in **Figs 8.5.4** showing the recovery of speed and mechanical power. We find that the WTG is robust enough to damp down transients in the generator speed and Pmech.

Fig 8.5.5 shows that the aerodynamic torque that dips down after fault is recovered by pitch angle control which responds quickly and restores the aerodynamic torque to normal with good damping of oscillations after fault clearance.

Fig. 8.5.6 shows no impact on shaft twist angle and quick damping of transients in aerodynamic power (Paero) on the rotor blade side.

Fig. 8.5.7 indicates no impact on turbine rotor speed and quick recovery of generator speed.

Fig. 8.5.8 shows the dynamic response of pitch control and pitch compensation that acts quickly to stabilize the WTG.

The outage of 220 kV single circuit between Jhimpir-2 and KDA-33 causes significant loading on the Jhimpir-2 to KDA-33 220 kV Single Circuit. **Fig. 8.5.9** shows the transients of MW and MVAR flows on Jhimpir-2 to KDA-33 220 kV circuit which settles the transients quickly and acquires new steady state levels soon.

Fig 8.5.10 shows the MW and MVAR output of the adjacent Indus WPP which get back to normal quickly after the fault clearance.

The angular stability of other conventional generators of the system can be seen in **Fig. 8.5.11.** The relative rotor angles of Kotri GTPS 132 kV, Lakhra 132 kV, Nooriabad 132 kV, Thatta 132 kV and Hub 500 kV are plotted w.r.t. Guddu-New 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.5 Conclusion of Stability Study

The transient stability analysis performed as discussed above indicates that the NTDC system connecting to Noor WPP through the proposed scheme of

interconnection is strong enough to absorb the worst disturbances on either side i.e. on Noor WPP side or the Grid side.

There are no constraints of connecting Noor 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

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

where

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

S_n is the rated apparent power of the wind turbine;

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

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

PCC is the point of common coupling of WTGs that is MV bus of Noor 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 Noor Wind farm reduced as low as

25 % of its rated capacity. Therefore taking one collector group as one equivalent generator of 6x2 = 12 MW we have calculated as follows;

S_n= 2.22 MVA at 0.90 PF (For 1 WTG)

N_{WT} = 6

S_k for MV bus = 780MVA

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

$P_{St\Sigma}$ =$P_{It\Sigma}$= 0.006972 = 0.06972 %

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

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

For switching conditions of (a) and (b)

$N_{10} = 10$

$N_{120} = 120$

For switching conditions of (c)

$N_{10} = 1$

$N_{120} = 12$

The value of flicker step factor $k_{f,i}$ (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;

$P_{St\Sigma} = 0.16218$

$P_{lt\Sigma} = 0.15572$

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} = 2.22 MVA for the equivalent WTG of a collector group for the minimum case

S_{KE1} for one WTG in collector group = 440 MVA (Exhibit 7.1.2)

S_{KSS} = 740 MVA (Exhibit 7.1.2)

Substituting these values we get

$$\Delta V = 0.002045 = 0.2045\%$$

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 = 0.0045 = 0.45 %

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

10- Conclusions & Recommendations

- Interconnection Study has been carried out for 50 MW Noor WPP which is proposed to be placed in a second loop at newly planned Jhimpir-2 220/132 kV collector substation. The scheme of interconnection of Noor WPP proposes the following reinforcements in place at Jhimpir cluster.
  - 220 kV D/C transmission line approx. 18km 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. 88 km long on twin bundled Greeley conductor for connecting all the 8 WPPs including Indus, Lakeside, DHA City, Noor, Metro-2, Iran Pak, Nasda, Uni-energy to Jhimpir-2 220/132 newly proposed substation. In this scheme the interconnection of Noor WPP includes 132 kV D/C transmission line approx. 2 km long, on twin bundled Greeley conductor for looping in/out on the 132kV single circuit from Indus WPP to Iran Pak WPP.
- The existing grid system of HESCO and NTDC in the vicinity of Noor WPP has been studied in detail by performing load flow, short circuit and dynamic analysis for the conditions prior to commissioning of Noor WPP and no bottlenecks or constraints have been found in the grid system.
- Load flow analysis has been carried out for peak and Off Peak scenarios of August/September 2019 considering the COD targeted by Noor WPP and a future scenario of 2022, for the dispersal of power from Noor WPP into NTDC system at 220 kV level 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. It is proposed that for this High Wind and High Water season, highly inefficient thermal plant of Jamshoro which comes on the bottom of the merit order dispatch should not be operated. With the proposed reinforcements mentioned above and dispatch control the system is found adequate to absorb output power of Noor WPP and other upcoming WPPs in the same loop. The load flow results for peak and Off Peak scenarios also establish that the proposed scheme of interconnection of Noor 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 Noor WPP 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 Noor 132 kV are 11.30 kA and 11.08 kA for 3-phase and single phase faults respectively for 2022. This is much less than the switchgear rating of 40 kA recommended for Noor Farm Substation as per NTDC requirements for 132 kV. The fault levels for Noor 22 kV are 24.31 kA and 28.61 kA for 3-phase and single-phase faults respectively for year 2022.

  Therefore the short circuit rating for 22 kV switchgear is recommended as 31.5 kA. It has been found that the proposed scheme provides maximum SC strength for the evacuation of Noor WPP power to the grid.

  The switchgear ratings for Noor WPP substation are as follows:

  132 kV:

  Short circuit rating = 40 kA (3 sec.)

  Continuous rating = 2500 A

  22 kV:

  Short circuit rating = 31.5 kA (3 sec.)

Continuous rating = 2500 A

- Transient Stability analysis has been carried out for Noor WPP based on their selection of Type-3 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 Noor WTG unit's dynamic characteristics and the grid connectivity is strong enough to maintain stability under all disturbances. In turn, any disturbance from Noor 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 Noor 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.