

WESTERN ENERGY (PRIVATE) LIMITED

Registered Office: F-25 • Block 5 • Rojhan Street Kehkashan • Clifton • Karachi - 75600 • Pakistan **Tel** : +92-21-35876994 - 7 **Fax** : +92-21-35876991 & 35876993

> Date: 8 June 2016 Ref: WEL/NEPRA/004/16

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

SUBJECT: <u>Application for the grant of Generation License on behalf of</u> <u>Western Energy (Private) Limited in relation to its 50MW</u> <u>Wind Power Generation Project to be located at Jhimpir,</u> <u>District Thatta, Province of Sindh</u>

I, MUSTAFA LAKDAWALLA, being the duly authorized representative of WESTERN ENERGY (PRIVATE) LIMITED (a company incorporated under the laws of Pakistan with its registered office located at F-25, Block 5, Kehkashan, Clifton, Karachi, Pakistan) hereby, pursuant to Rule 3 of the National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, apply to the National Electric Power Regulatory Authority (NEPRA) for the grant of the Generation License to WESTERN ENERGY (PRIVATE) LIMITED.

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 (Generation) Rules 2000, and undertake to abide by the terms and provisions of the same. I further undertake and confirm that the information provided in the attached documents in support is true and correct to the best of my knowledge and belief.

We are submitting with this Generation License Application the required generation license fee through a non-refundable bank draft in the amount of PKR 286,016/- (Pakistani Rupees Two Hundred Eighty Six Thousand and Sixteen) dated June 8, 2016 drawn in favor of NEPRA.

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

Mustafa Lakdawalla Authorised Representative



WESTERN ENERGY (PRIVATE) LIMITED

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<u>CERTIFIED TRUE COPY OF RESOLUTION OF</u> <u>THE BOARD OF DIRECTORS OF</u> <u>WESTERN ENERGY (PRIVATE) LIMITED</u> <u>PASSED BY CIRCULAR UNDER</u> <u>ARTICLE 97 OF THE ARTICLES OF ASSOCIATION</u> <u>ON MARCH 27, 2015</u>

WHEREAS the Company has obtained a Letter of Intent from the Alternate Energy Development Board for the establishment and operation of a 50 MW wind power project proposed to be located at Jhimpir, Thatta, in the province of Sindh (Project).

AND WHEREAS the Company has hired various consultants to undertake the feasibility study, environmental impact assessment and other studies required to be undertaken prior to the construction of the Project and most of the work in respect of the aforesaid has been completed and the Company is moving closer to the financing and construction of the Project.

AND WHEREAS the Company is desirous of filing the Generation License Application with the National Electric Power Regulatory Authority (NEPRA) (required to be filed pursuant to the Regulation of Generation, Transmission and Distribution of Electric Power Act (XL of) 1997 (NEPRA Act) and rules/regulations made thereunder), which generation license would enable the Company to operate the Project and generate electricity therefrom.

AND WHEREAS the Company desires to authorize certain of its officers to file such Generation License Application with the NEPRA and to take all required steps and actions in connection therewith.

"It is hereby unanimously resolved that:

- a) the Company do file an application to the National Electric Power Regulatory Authority for seeking a generation license for the 50 MW wind power project to be constructed at Jhimpir, pursuant to and under Sections 7(2)(a) and 15 of the NEPRA Act read with other enabling provisions of the NEPRA Act, the National Electric Power Regulatory Authority Licensing (Application & Modification Procedure) Regulations 1999, National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, and in accordance with the Policy for Development of Renewable Energy for Power Generation 2006.
- b) Mr. Tabish Tapal, the Chief Executive Officer of the Company and Mr. Mustafa Lakdawala, Director and Company Secretary of the Company, be and each of them are hereby authorized to singly do, execute, transact and perform for and on behalf and in the name of the Company all such acts deeds and things as may be necessary or required or desirable to be done or executed by the

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WESTERN ENERGY (PRIVATE) LIMITED

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Company for or in connection with or in relation to the application to the National Electric Power Regulatory Authority for seeking a generation license under the NEPRA Act and without limiting the generality of the foregoing and in connection therewith to do any or all of the following acts deeds and things, namely, to file applications, swear affidavits, review documents and information, make correspondence, letters, submissions, claims, objections of all kinds and to file or submit them before the National Electric Power Regulatory Authority and to appear and represent the Company before the National Electric Power Regulatory Authority or any other regulatory authority or body and to accept the terms and conditions on which a Generation License is granted by the National Electric Power Regulatory Authority."

Mustafa Lakdawala Company Secretary

1. BACKGROUND TO GENERATION LICENSE APPLICATION

1.1 <u>PROCESS OF ISSUANCE OF LETTER OF INTENT LEADING TO GENERATION</u> <u>LICENSE APPLICATION</u>

1.1.1 Issuance of "Letter of Intent"

WESTERN ENERGY (PRIVATE) LIMITED (a company duly organized and existing under the laws of Pakistan, with its office located at F-25, Block 5, Kehkashan, Clifton, Karachi, Pakistan) (the **Project Company**), was issued a LETTER OF INTENT by the Alternative Energy Development Board (the **AEDB**) on March 6, 2013 vide its letter No. B/3/16/2007 -138 (the **LOI**) to develop and establish a 15 MW wind farm project to be located at Jhimpir, Thatta. The Project Company had also submitted a bank guarantee for an amount equal to US\$ 7,500. The capacity of the wind farm project in the LOI was subsequently increased by the AEDB to 50MW vide its letter No. B/3/1/WEPL/13 on April 15, 2014, upon payment of project facilitation fee of Rs. 500,000/- and submission of a revised bank guarantee for an amount equal to US\$ 25,000 (**Project**). The LOI was subsequently extended by AEDB. vide its letters dated November 5, 2014, March 27, 2015, September 30, 2015 and March 15, 2016. As such, the LOI is currently valid until July 17, 2016.

1.1.2 Submission of the Feasibility Study

Pursuant to the relevant provisions of the Policy for Development of Renewable Energy for Power Generation 2006 (the **RE Policy 2006**) and the LOI, the Project Company hired technical consultants, M/s. Pakistan Alternative Engineering Services (Private) Limited, who completed the detailed technical feasibility study for the Project and the Project Company submitted the same to AEDB for its approval on August 21, 2014 as a consequence of the relocation of our project site our project feasibility study was revised and submitted with AEDB on March 24, 2016(the **Project Feasibility Study**). Upon satisfactory review of our feasibility study AEDB has issued the letter of recommendation no B/3/1/WEPL/13 dated May 3, 2016 for our project A copy of our revised Project Feasibility Study is attached hereto as ANNEXURE A for NEPRA's perusal.

1.1.3 Submission of Initial Environmental Examination.

The Project Company hired consultants, M/s. First Wind (Private) Limited, who completed the initial environmental examination for the Project (the **Initial Environmental Examination**) and the Project Company submitted the same to the Sindh Environmental Protection Agency (the **SEPA**) on May 05, 2014.



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After careful review and analysis of the Initial Environmental Examination, the SEPA accorded its approval for the Project through its decision (Ref: EPA/2014/05/05/IEE/33) dated May 10, 2014 (the **IEE Approval Decision**). The report has been revised to give effect of the relocation of our project site and resubmitted to the EPA. A copy of the IEE Approval Decision is attached hereto at ANNEXURE B for NEPRA's perusal.

1.1.4 Grid Interconnection Studies

The Project Company engaged independent consultants, M/s. Power Planners International for, who are currently undertaking the grid interconnection studies (the **Grid Interconnection Studies**). The Grid Interconnection Studies was submitted to NTDC and Alternative Energy Development Board on August 7 and August 3, 2015 respectively. Pursuant to the recent directive from the Ministry of Water & Power, that all Grid Interconnection Studies are to be carried out by NTDC for the recently approved projects and accordingly the Grid Interconnection Study carried out by NTDC has been released vide letter no GMPP/CEMP/TRP-380/2419-23 dated June 3, 2016 A copy of the new Grid Interconnection Study is attached as Annexure C

1.1.5 Request for grant of a generation license

Based on the matter provided in Section 1.1.1, 1.1.2, 1.1.3 and 1.1.4 above whereby the Project Company, on its part, has undertaken and completed all activities required for procurement of approvals of the relevant matters from various stakeholders – including the procurement of approvals of its IEE Report from SEPA – it is submitted that the requirements of the regulatory process for applying to NEPRA for grant of a generation license for the Project Company are complete.

1.2 SUBMISSION

- 1.2.1 Under the Regulation of Generation, Transmission and Distribution of Electric Power Act (XL of) 1997 (the **NEPRA Act**) and the National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, the National Electric Power Regulatory Authority (**NEPRA**) is responsible for and has the authority to, *inter alia*, grant licenses for the generation of electric power and other terms and conditions for the supply of electricity through generation.
- 1.2.2 **PURSUANT TO** the Sections 7 (2) (a) and 15 of the NEPRA Act read with other enabling provisions of the NEPRA Act, the National Electric Power Regulatory Authority Licensing (Application & Modification Procedure) Regulations 1999, National Electric Power Regulatory Authority Licensing

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(Generation) Rules 2000, <u>AND</u> in accordance with the RE Policy 2006: <u>WESTERN ENERGY (PRIVATE) LIMITED HEREBY SUBMITS</u>, for NEPRA's kind and gracious consideration, the application for the grant of a generation license along with supporting documents (the **Generation License Application**) for its 50 MW power generation facility to be located at Jhimpir, District Thatta, Sindh, Pakistan.

- 1.2.3 In order to highlight the advanced stage of the progress made by the Project Company with regard to the EPC arrangements, financing arrangements and other activities necessary to culminate the generation facility to its commercial operation, the Project Company hereby encloses as ANNEXURE K a copy of the 'Project Progress Report' dated June 7, 2016 submitted by the Project Company to the AEDB.
- 1.2.4 Given the advanced stage of the Project, NEPRA is kindly requested to process this Generation License request at the earliest, thereby enabling the Project Company to proceed further with the development process.
- 1.2.5 This Generation License Application is submitted in triplicate.
- 1.2.6 The generation license fee, payable by the Project Company, in respect of this Generation License Application is also enclosed in the form of a pay order for an amount of PKR 286,016/- (Pakistani Rupees Two Hundred Eighty Six Thousand and Sixteen) drawn in favor of NEPRA.



2. APPLICANT – WESTERN ENERGY (PRIVATE) LIMITED

- 2.1 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.
- 2.2 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**).
- 2.3 For the purposes of designing, engineering, procuring, constructing, installing, testing, completing, commissioning, operation and maintenance of the Project, the Project Company has finalized the following detailed contracts: (i) the offshore supply and services agreement with globally reputable contractor, SHANGHAI MARINE DIESEL ENGINE RESEARCH INSTITUTE (the **SMDERI**), a fully owned subsidiary of *China Shipbuilding Industry Corporation* (the **CSIC**); and (ii) the onshore supply and services agreement and the operations and maintenance agreement with an affiliate of SMDERI in Pakistan, SINO-QIYAO INTERNATIONAL (PRIVATE) LIMITED, (the **EPC and O&M Terms & Arrangements**). The profile of SMDERI is attached herewith as ANNEXURE J.
- 2.4 The following supporting documents relating to the Project Company are attached herewith as follows:

DOCUMENTS	ANNEXURE
Shareholding Pattern	ANNEXURE D
Memorandum and Articles of Association	ANNEXURE E
Certificate of Incorporation	ANNEXURE F

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3. FACILITY UTILIZATION

3.1 ELECTRICITY DEMAND & WIND CORRIDOR

- 3.1.1 Pakistan is a developing economy having a constant growth in industrialization coupled with a constantly rising demand for electricity. The non-availability of natural resources for expansion of the power sector has widened the gap between demand and supply, which has resulted in excessive and frequent load shedding. The shortfall in supply could be the major cause for stunned growth in the industrial sector in Pakistan. The total installed capacity of Pakistan as on June 30, 2013 was 23,663 MW; of which 16,000 MW (67.62%) was thermal, 6,826 MW (28.85%) was hydroelectric, 787 MW (3.33%) was nuclear and 50 MW (0.21%) was wind.
- The demand for electricity has continued to increase by out pacing the growth 3.1.2 rate of the economy. The shortfall at times crosses 6,000MW and this is the time when urban areas have 8-12 hours of load shedding and small cities/ rural areas have 18 hours of load shedding. The industry, having its self- generation on gas, has a suspended supply of gas for 2-3 days a week during winters. As mentioned above, Pakistan's major electricity sources at present are thermal and hydro generation, meeting approximately 97% of the country's annual electricity demand. The primary thermal generation fuels employed are furnace oil and gas. While both fuels are produced domestically, demand for them already outstrips supply by a considerable amount. Oil imports are already a significant burden on the national exchequer and the increasing import bill continues to exert further pressure on the foreign exchange reserves. Therefore, securing alternative fuels and the technical management should be strengthened to solve these problems and wind power can play a very important role in overcoming Pakistan's growing energy crisis.
- 3.1.3 The wind power program in Pakistan was initiated around ten (10) years ago by installation of wind measuring stations in the coastal areas of Sindh, Pakistan. The energy potential of 346,000 MW in the country is estimated by National Renewable Energy Laboratory, USA and only the Gharo – Keti Bander – Hyderabad wind corridor (the **Wind Corridor**) has a potential of 43,000 MW of wind power generation. If harnessed adequately, wind energy alone would eradicate energy shortages in the country. The Government of Pakistan is currently looking to build wind farms in the Wind Corridor, some of which are regions where electricity supply through the national grid has been a challenge.
- 3.1.4 The Government of Pakistan has clearly articulated its support for the development of renewable energies. Due to the fact that the use of wind energy is actually the most economical renewable energy production technique, the focus is on supporting the development of wind farms through wind based independent power producers (the **Wind IPPs**).



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- 3.1.5 In light of compliance by the Project Company of all requirements under the RE Policy 2006 for eligibility of an application for a generation license and following grant of a generation license and approval of Project Company's reference generation tariff, in each case, by NEPRA, the Project Company will finance, design, engineer, procure, construct, install, test, complete, commission, insure, operate and maintain the Project at Site.
- 3.1.6 The proposed Project has the advantage of being located in the Wind Corridor and thus will, following its completion, contribute towards relieving the shortage of electric power in the country.
- 3.1.7 Based on a thorough analysis of the national electricity generation structure and in light of technical parameters, it is anticipated that the Project shall operate as one of the most competitive independent power producers in Pakistan.

3.2 **POWER OFF-TAKE**

Following commercial operation date of the Project, the electricity generated will be sold to National Transmission and Despatch Company Limited (through its central power purchasing agency) on behalf of ex-Wapda distribution companies (the **Power Purchaser**) pursuant to an energy purchase agreement (the **EPA**), which in turn will distribute and modulate the electricity generated by the Project Company.

The EPA will be finalized and executed by and between the Project Company and the Power Purchaser following NEPRA's approval of the Project Company's twenty (20) years reference generation tariff, the grant of a generation license to the Project Company and the issuance by the Government of Pakistan of the Letter of Support.



4. THE SPONSORS

4.1 AN INTRODUCTION

The primary sponsor financing the Project is the **TAPAL GROUP**, principals of AMEEJEE VALEEJEE & SONS (PRIVATE) LIMITED and major shareholders of TAPAL ENERGY (PRIVATE) LIMITED (which is a 126 MW diesel engine based power project in operation and under the management of the owners of the Project Company for the past 17 years).

AMEEJEE VALEEJEE & SONS (PRIVATE) LIMITED is a business house established in 1867 dealing in engineering and construction related products, chemicals and consumer products. It represents some of the most renowned international companies like Steinmuller, Lurgi, Standard, Chint, Buhler, Kessel, Henkels, Dorr Oliver, Atlas Copco etc. dealing in engineering equipment and has been a key player in installation of several power plants in public utility companies and various industries in Pakistan.

TAPAL ENERGY (PRIVATE) LIMITED is a Karachi based company that owns a 126 MW power generation project formed under the Power Policy of 1994 at a project cost of US\$ 130 million. The development of the project was jointly done by Tapal Group and Wartsila Corporation who was also the EPC contractor. Tapal Energy (Private) Limited has the privilege of being one of the first projects to start its operations under the Power Policy of 1994.

Tapal Energy (Pvt) Limited has internationally acclaimed companies like Sithe Mauritius Limited, Mauritius, a subsidiary of Marubeni Corporation, Japan and Wartsila Corporation of Finland as its joint venture partners and shareholders.

The management of Tapal Energy (Private) Limited is with the Tapal Group, with Mr. Tabish Tapal as the Chief Executive. Tapal Energy (Private) Limited has been successfully providing reliable, uninterrupted power to the public utility K-Electric Limited (former Karachi Electric Supply Corporation) for the past seventeen (17) years. Tapal Energy (Private) Limited is one of the few independent power producers in Pakistan that are operated and maintained by its sponsors without any external operations and maintenance contractor.

4.2 THE TAPAL GROUP BUSINESS

Tapal Group has been in business for the past 145 years. The reason for its successful existence in the highly competitive corporate sector for such a long period is its good standing as a professionally managed group. Tapal Group follows a strict code of conduct regulated by properly documented policy guidelines, which are periodically reviewed and modified according to the changing times.



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Tapal Group is proud of its dependable human resource pool comprising of highly qualified professionals in the field of engineering, business administration and finance. All Tapal Group companies have a defined set of organograms, documented job descriptions and a clearly defined hierarchy. New projects are taken up by our group after forming a committee from within our resource pool to do the development work.

Tapal Group's development team members are experienced developers of power projects. Induction of additional resources for the expansion of Tapal Group's development team are done as and when the projects progress.

The pride of the Tapal Group is its technical resource pool which comprises of highly qualified engineers who are capable to operate and maintain all kinds of plant and machinery.

Besides Tapal Group's in house resource pool, it has alliances with engineering firms of repute around the world. In addition, it is are also aligned with various local construction companies who can undertake the local construction works on all Tapal Group's projects.

The key board of directors in various companies and concerns forming the Tapal Group are as follows:

- (a) Mr. Moiz Tapal;
- (b) Mr. Tajwar Tapal; and
- (c) Mr. Tabish Tapal.

The key financial figures of the Tapal Group are illustrated below for reference:

			Rupees in '000	 		Rupees in '000
		Tapal Energy	/		AVS	
	2015	2014	2013	2015	2014	2013
Revenue	11,468,783	14,373,264	12,336,960	557,521	478,406	374,129
Profit	1,530,208	1,833,081	1,523,498	16,083	12,111	23,975
Taxation	39,679	28,105	9,736	35,410	24,920	28,350
Total						
Assets	6,701,224	7,336,535	7,094,431	572,058	480,791	510,693
Total						
Liabilities	1,070,391	1,421,809	1,399,016	156,690	81,506	123,518



4.3 **FINANCIAL HIGHLIGHTS**

Tapal Group's main financial highlights for the year ended June 30, 2015 include a turnover of Rs. 12.03 billion and its cost of assets nearing Rs.7.3 billion. The Tapal Group has contributed to a yearly income tax of Rs. 75 Million.

4.4 <u>COMMITMENT TO PROJECT</u>

Having an annually increasing group turnover of more than Rs.14 billion, the Tapal Group is committed to playing its part in the development of Pakistan's various sectors. Realizing the role of clean energy in the development of the nation, the Tapal Group has now ventured into the wind power generation sector by planning to install the Project through the Project Company.

The unmatched standards of corporate governance, efficiency, safety and operations established by Tapal Group in its diversified businesses are expected to be replicated in its wind power generation venture – thus raising the bar for all future wind power projects.



5. **Resources**

5.1 SENIOR MANAGEMENT & PERSONNEL

- 5.1.1 The Project Company has access to and has engaged the highly qualified personnel of Tapal Group for the development of the Project. The Project Company is presently under the process of appointing various personnel and details of the same will be provided upon finalization of the terms and conditions of their appointment.
- 5.1.2 In addition, the curriculum vitae of the following individuals currently engaged by the Project Company are attached herewith at ANNEXURE **E**.

	NAME OF INDIVIDUALS	POSITION	ANNEXURE
1.	TABISH TAPAL	CHIEF EXECUTIVE OFFICER	G
2.	MUSTAFA LAKDAWALA	CHIEF OPERATING OFFICER & COMPANY SECRETARY	G
3.	SYED RAZA ABBAS	PROJECT MANAGER	G
4.	IMRAN ADHI	MANAGER FINANCE	G

5.2 THE O&M CONTRACTOR

5.2.1 In addition to recruitment of its own management, staff and personnel for the purposes of the Project, the operations and maintenance (the **O&M**) of the Project will be performed by the SINO-QIYAO INTERNATIONAL (PRIVATE) LIMITED, an affiliate of SMDERI in Pakistan (the **Operator**), for ten (10) years following Commercial Operations Date. The Project Company has finalized with the Operator the operations and maintenance agreement for the Project, following detailed negotiations and development of a comprehensive contractual structure, that contains all commercial, technical and legal terms and arrangements with the Operator for the **turn-key O&M** of its Project.

5.3 <u>LEGAL ADVISER</u>

5.3.1 HAIDERMOTABNR & Co. has been selected by the Project Company to provide legal support on all legal aspects of the Project including Project documentation, regulation and financing matters. HaidermotaBNR & Co. has been actively involved in the power sector and projects and has advised various project companies / sponsors, lenders and the Government of Pakistan on various transactions and matters. It is ranked by Chamber & Partners as a "Band 1" firm in Pakistan for Projects, Banking & Finance and Corporate & Commercial.



6. CAPITAL BUDGET

- 6.1 The estimated total Project cost (the Total Project Cost), expressed in United States Dollars, has been calculated after thorough analysis, evaluation and understanding of the dynamics that affect the development and operation of a wind farm. The Total Project Cost comes to approximately US\$ 116,200,000 (United States Dollars One Hundred Sixteen Million Two Hundred Thousand).
- 6.2 The capital structure of the Project is proposed as follows:

ſ	USD IN THOUSANDS
DEBT	87,151
EQUITY	29,049
TOTAL PROJECT COST	116,200

7. FINANCIAL PLAN

The Total Project Cost of US\$ 116,200,000 (United States Dollars One Hundred Sixteen Million Two Hundred Thousand) is to be financed in a debt to equity ratio of 75:25, which is in accordance with the RE Policy 2006.

7.1 <u>Debt</u>

- 7.1.1 The entire debt for the Project (the **Debt**) will be secured from ICBC Bank, China (the **ICBC**), which will provide foreign financing in United States Dollars to the Project Company.
- 7.1.2 The terms and conditions for the Debt are finalized and term sheet is signed ensuring that the same are within the scope of the tariff.

7.2 <u>EQUITY</u>

- 7.2.1 Based on the Debt to Equity ratio of 75:25, the equity required to be injected, by the sponsors, amounts to USD 29.049 Million (the **Equity**). The Tapal Group together with CSIC Group will subscribe to the total amount of the Equity required for the Project from time to time.
- 7.2.2 The financial strength and net worth of Tapal Group (being the primary sponsor of the Project Company) is illustrated by the Auditor's Report attached at ANNEXURE H of Ameejee Valeejee & Sons and Tapal Energy (Private) Limited the same being the flagship concerns of the Tapal Group. Further, the recent financial statements of the Project Company are also attached hereto at ANNEXURE I.



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8. THE FACILITY

8.1 <u>TECHNOLOGY</u>

8.1.1 <u>Technology Selection Criteria</u>

The technology for the Project has been selected after detailed analyses of various power generation technologies available internationally for the purposes of power generation through wind. Various factors were considered in selection of equipment and technology which included:

- (a) equipment to be of latest proven technology, megawatt class and high efficiency;
- (b) safe transportation of equipment to the wind farm site;
- (c) maintainability of the equipment and availability of OEM service personnel;
- (d) energy output with warranted power curve and performance warranty;
- (e) grid compatibility with proposed Energy yields and grid code requirements; and
- (f) suitability of operation and maintenance concept for the size and location of projects with suitable availability of spare parts, consumables and main components.

8.1.2 <u>The Selected Technology</u>

After a consummate search, an elaborate process and thorough due diligence, the following WTGs have been selected for the Project:

MANUFACTURER	CSIC (CHONGQING) HAIZHUANG WINDPOWER EQUIPMENT CO., LTD.
WIND TURBINE GENERATOR	H111-2.0 MW
HUB HEIGHT	80 M
NUMBER OF TURBINES	25 (Twenty Five)
TOTAL INSTALLED CAPACITY	50 MW



The Facility configuration consists of 25 numbers of H-111-2.0 WIND TURBINE GENERATORS (the WTG); 75 (seventy five) blades (55.2m length); electrical equipment, together with ancillary equipment and other goods and machinery.

All functions of the selected H-111-2.0 WTG are monitored and controlled by a micro-processor based control system. In addition the wind turbines are equipped with a remote monitoring system.

The design used by the H-111-2.0 WTG is aimed at achieving high safety and environment mechanisms. Moreover, as per the Project Company's analyses, the equipment is suited to the conditions at the Project's Site.

The 2 MW series is SMDERI's most widely deployed wind turbine i.e. more than 500 WTGs contracted globally and is known for its:

- conformance and compliance to the International Electrotechnical Commission (the IEC) standards;
- high availability in a variety of wind classes;
- continual investment for achievement of highest capacity factor in its class; and
- sharing of components that ensures consistent workhorse reliability, ease of maintenance planning and high commonality in spare parts.

8.1.3 WTG System Specifications

Rotor		
Diameter	1111 M	
Swept Area	9677 M2	
Number of Blades	3	
Blade Length	55.2 M	
Airfoil	SR55.2	
Blade Material	FIBERGLASS	
Rotor Speed	13.7 RPM	
Aerodynamic Brake	FULL FEATHERING	
Direction of Rotation	ROTOR CLOCKWISE (FRONT VIEW)	



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BLADE		
Type description	H111	
Blade length	55.2 M	
Material	FIBERGLASS	
Type of rotor	SPHEROIDAL GRAPHITE CAST IRON	
Blade profiles	HORIZONTAL AXLE, UP-WIND	

HUB	
Type description	CAST BALL SHELL HUB
Material	SPHEROIDAL GRAPHITE CAST IRON
Corrosion protection	CORROSION PROTECTIVE COATING

GEARBOX	
Type description	PLANETARY LEVEL WITH TWO
	BALANCE SHAFT
Gear house material	QT400-18AL
Ratio	128
Mechanical power	2282
Shaft seals	MECHANICAL SEAL

YAWSYSTEM		
Type description	ELECTRICAL DRIVE	
Number of units	4	
Yaw speed	0.66 °/s	
Voltage	400V	

NACELLE	
Nacelle Cover	GFRP

Tower		
Material	STEEL	
Corrosion protection	CORROSION PROTECTIVE COATING	
Access conditions	CLIMBER /ELEVATOR	



GENERATOR	
Type description	DOUBLE FED ASYNCHRONOUS
Type description	GENERATOR
Rated power	2150 Kw
Rated voltage	690 V
Frequency	50 HZ
Number of poles	4
Synchronous speed	1500 RPM
Speed at rated power	1755 RPM
Operation speed range	950-2050 RPM
Speed range for constant power	1755-2050 RPM
Rated speed	1755 RPM
Max rotor slip	37%
Power factor	0.95 LEAD / 0.95 LAG
Nominal current	1760
Winding connection stator	Δ DELTA CONNECTION
Winding connection rotor	Y TYPE CONNECTION
Protection class (Generator)	IP54
Protection class (Slip ring-unit)	IP23
Thermal classification	Н

8.2 <u>The Project Site</u>

The Site of the Project is located near the village of Jhimpir, District Thatta, Sindh. The Jhimpir area has been selected for implementing the Project on the basis of its exceptional wind regime, flat terrain and nearness to the national and local grid. The area has been extensively surveyed and is identified as having strong potential for the proposed wind farm. The following other parameters have also been considered for the implementation of the Project at the proposed Site:

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

Western Energy has received allocation of land from Government of Sindh (GoS) for the development of 50 MW wind power project. The project site is located about 111 km (aerial distance) northeast of Karachi. The nearest settlement to the proposed site is Nooriabad (28km southwest). The site is located in a strong and partly rocky area at 44m to 82m above sea level. The size of the project land is 428 acres.



The coordinates of Western Energy wind farm site are given under:

	Geodetii Latiinde	Coordination Coordination Coordination Coordination
1	25° 11' 12.32" N	68° 02' 44.02" E
2	25° 11' 7.61" N	68° 02' 40.98" E
3	25° 10' 0.35" N	68° 04' 29.78" E
4	25° 09' 59.66" N	68° 04' 30.91" E
5	25° 09' 42.21" N	68° 05' 8.50" E
6	25° 09' 38.41" N	68° 05' 5.14" E
7	25° 09' 0.13" N	68° 05' 4.99" E
8	25° 08' 55.40" N	68° 05' 1.84" E
9	25° 09' 33.30" N	68° 04' 11.44" E
10	25° 09' 33.99" N	68° 04' 10.28" E
11	25° 10' 39.92" N	68° 02' 23.60" E
12	25° 10' 35.90" N	68° 02' 20.53" E

The satellite image of the project site is given below:









9. Environmental and Social Soundness

9.1 INVESTIGATION SUMMARY

The investigations at Site have shown that in general the realization of the Project is possible at the Site from an environmental point of view and no adverse impact on the existing flora and fauna at Site is expected. The Facility will not emit any solid, liquid and gaseous waste during the entire life of the Project and thus the power will be generated without polluting the environment of the surroundings.

A data collection survey 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 was undertaken based on available secondary information or data collected in the field. Primary data was collected to establish baseline conditions for the soil, water (surface and ground) quality, flora and fauna, and noise. Secondary data was collected for land, ecology, climate, and socioeconomic factors.

It was observed that the area is highly underdeveloped and there is no industrialization in the area and thus the baseline emissions are very low. The nearest settlements of human habitats are located 2 Km away from the Project Site. There is very sparse vegetation in the forms of herbs and shrubs, there being no reserved forest site or sanctuary located within the Project land area that needs to be demolished. The Site is located in remote areas with very little social and commercial activity and thus limiting the long term social impact.

Noise impacts will be around 60 DB(A) which are within the range as per National Environmental Quality Standards (NEQs) of Pakistan. There are no exceeds of shadow from the permissible limits calculated for all WTG type scenarios. The environmental disturbance normally associated with construction activities will be minimized through an Environment Management Plan (EMP), implementation of which will continue during Project operation and which includes monitoring arrangements.

There exist high potential of wind energy at the Project Site and the proposed Project will help in tapping this potential without impairing the environmental conditions of the area. It is envisaged that the more is the wind power generation from the Facility, the less is the GHG gases emissions – thus resulting in cleaner environment.



9.2 <u>IEE Report Approval from the Environmental Protection</u> <u>Agency, Sindh</u>

As already submitted in Section 1 (*Background to Generation License Application*) above, the Sindh EPA has already accorded its **approval** to the IEE Report for the Project through its decision dated May 10, 2014.

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10. SAFETY

The Project will be implemented in accordance with internationally accepted health and safety standards and in-line with the acclaimed practices and procedures. Tapal Group's vision, being the primary sponsor of the Project Company, entails introducing and establishing its unmatched safety standards and procedures in the business operations of the Project Company, so as to establish an enviable benchmark in the country's wind energy sector.



11. TRAINING AND DEVELOPMENT

- 11.1 While the Project Company has engaged professional and competent contractors to undertake the operations and maintenance of the Facility for a period of up to ten (10) years following commercial operations of the Project, training of the Project Company's own staff forms an essential part of the Project Company's twenty (20) year plan for the Project.
- 11.2 The executed EPC and O&M Terms & Arrangements contemplate on-site and off-site training of the Project Company's staff. Such training, as per the scope of the contractors set out in the EPC and O&M Terms & Arrangements, will aim at preparing the Project Company's staff in operating and maintaining the Facility in accordance with international standards. The training will be conducted with an aim to teach the Project Company's staff the functions of each Facility system so that the staff is informed of the Facility's (or any part thereof) functions in question.

12. PROJECT FEASIBILITY STUDY

- 12.1 The Project Company engaged leading technical consultants for elaborating the Project Feasibility Study and for supervising the wind measurements and preparing conceptual design of the Facility.
- 12.2 A copy of the Project Feasibility Study is attached hereto at ANNEXURE A.



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13. IMPLEMENTATION SCHEDULE

13.1 The following provides the key milestones and dates for the Project's development to date:

MILESTONES ACHIEVED TO DATE	
Activities	Completion Date
Issuance of first Letter of Intent (for 15MW)	March 6, 2013
Issuance of Second Letter of Intent (Upgraded to 50 MW)	April 15, 2014
Installation of Wind Mast & Instruments	January 2014 and site specific data from the wind mast is being collected since February 2014
Initial allocation of Land by Additional Deputy Commissioner-I, Thatta	August 19, 2013
Allocation of relocated Land by Energy Department Government of Sindh	April 5, 2016
IEE approval by Sindh EPA	May 10, 2014
Revised IEE Report	January 9, 2016
Grid Interconnection Study released by NTDC	June 3, 2016
Topography Survey	October 3, 2013
Topography Survey of relocated site	January 8, 2016
Issuance of the Recommendation letter by AEDB	May 3, 2016
Signing of Offshore EPC Agreement	December 15, 2014
Signing of Onshore EPC Agreement	January 30, 2015
Signing of O&M Agreement	January 30, 2015



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14.2 The following provides the key upcoming milestones and dates for the Project's development:

MILESTONES TO BE ACHIEVED		
ACTIVITIES	COMPLETION DATE	
Grant of Generation License	Upon NEPRA's approval	
Reference Tariff Determination	Upon NEPRA's determination	
Submission of Performance Guarantee by Project Company for issuance of LOS	15 days after Tariff determination by NEPRA	
Issuance of LOS to Project Company by Government of Pakistan	7 days after submission of Performance Guarantee	
Site Lease agreement with Government of Sindh	In Progress Prior to Project Financial Close and in accordance with Government of Sindh requirements	
EPA Signing with NTDC	Within the time period allowed under the LOS	
IA Signing with Government of Pakistan	Within the time period allowed under the LOS	
Project Financial Close & ordering of equipment	Within the time period allowed under the LOS	
Commercial Operation Date	18 months following Financial Close	
Adjustment of reference tariff by NEPRA	Following Commercial Operations Date	



CONCLUSION

In light of the submissions, the relevant financial analysis and information contained in this Generation License Application, along with the Annexures attached hereto, this Generation License Application is submitted for NEPRA's kind consideration and grant of the Generation License to the Project Company.

Respectfully submitted for and on behalf of: WESTERN ENERGY (PRIVATE) LIMITED

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MR. MUSTAFA LAKDAWALA CHIEF OPERATING OFFICER & AUTHORIZED REPRESENTATIVE OF WESTERN ENERGY (PRIVATE) LIMITED

National Transmission and Despatch Company Limited (NTDCL)



Grid Interconnection Study for Evacuation of Power from 50 MW Western Energy Wind Power Project to the National Grid



Planning (Power) Department 4th Floor, PIA Tower, Egerton Road, Lahore. The Cont

May 2016

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Appendices

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Appendix-1: Western Energy WPP Data Received from Project Sponsor

Appendix-2: Proposed Interconnection Diagram for Western Energy WPP

Appendix-3: Load Flow Study Exhibits

Appendix-4: Short Circuit Study Exhibits

Appendix-5: Dynamic Data of Western Energy WPP for Stability Analysis

Appendix-6: Transient Stability Study Exhibits



Executive Summary

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- 1. Ministry of Water and Power in association with AEDB, Energy Department, Government of Sindh, in April 2016, decided to allocate the 500 MW wind power capacity vacated by M/s NBT Wind Power Pakistan-II & III to the 10 Wind Power Projects (WPPs) of approx. 50 MW each at Jhimpir, district Thatta, Sindh. The 10 WPPs comprise of ACT-2, Gul Ahmad Electric, Trans Atlantic, , Din Energy, Zulaikha Energy, Artistic, Harvey (Cacho), Norinco, Shaheen Foundation and Western Energy. These 10 WPPs are in addition to the already planned/under construction WPPs in Jhimpir and Gharo clusters. Afterwards, the list of the selected 10 WPPs was communicated to CPPA-G and NTDCL for information and further action at their ends.
- The sponsor of Western Energy WPP, i.e., M/s Western Energy (Pvt.) Limited, has engaged Planning Power department of NTDCL to carry out interconnection studies and to propose interconnection scheme for its power evacuation to the National Grid.
- 3. The project sponsor of Western Energy WPP, as per requirements of NTDCL Planning Power, provided the project site location/coordinates, and other necessary technical data/information of Western Energy WPP, i.e., number, generation capacity, voltage, p.f. & type of WTGs, collector group configuration, gross & net output capacity of the plant, No. & rating of transformers, switchyard voltage levels, single line diagram & equipment rating etc.
- 4. As per information provided by the project sponsor, Western Energy WPP comprises of 25 No. WTGs and each WTG is of CSIC make, Type-3 with 2 MW gross capacity. The total gross generation capacity of Western Energy WPP is 50 MW and total net capacity that will flow to the grid, after subtracting project losses/auxiliary consumption, is 48.11 MW.
- 5. This is the interconnection study report which has been prepared only to propose interconnection scheme for power evacuation from Western Energy WPP in integration with other WPPs in its vicinity. In this report, he results of load flow, short circuit, transient stability and power quality studies have been



presented with the proposed interconnection scheme for evacuation of power from Western Energy WPP to the National Grid in the light of NEPRA Grid Code.

- 6. Considering the capacity, locations, existing/planned system network in the area, the following integrated interconnection scheme of the 3 WPPs lying in northern part of Jhimpir including Shaheen Foundation, Norinco, and Western Energy, has been proposed for their reliable power evacuation to the grid:
 - i) 132 kV double circuit (D/C) transmission line, approx. 30 km long on Greeley conductor for connecting all the 3 WPPs including Western Energy WPP with 132 kV single circuit from Master WPP to under construction Jhimpir New (Jhimpir-1). In this scheme, the interconnection of Western Energy WPP includes 132 kV D/C transmission line, approx. 3 km long, on Greeley conductor for looping In/Out on the 132 kV single circuit from Shaheen WPP to Jhimpir-1.
 - ii) Addition of 4th 220/132 kV transformer at the under construction Jhimpir-1 220/132 kV substation 220/132 kV substation.

The following interconnection schemes/network reinforcement proposed with the other 7 WPPs lying in southern part of Jhimpir, will also be required for the reliable power evacuation of 3 WPPs including Western Energy WPP to the grid:

- 220 kV D/C transmission line, approx. 18 km long, on twin-bundled Greeley conductor for looping In/Out of one circuit of the existing Jamshoro – KDA-33 D/C transmission line at Jhimpir-2.
- iv) 220 kV D/C transmission line, approx. 7 km long, on twin-bundled Greeley conductor for looping In/Out of one of the planned Jhimpir-1 – Gharo New D/C transmission line at Jhimpir-2.
- 7. The above proposed interconnection scheme is expected to be completed in Dec. 2019. It is added that the expected timeline of the proposed interconnection scheme may be extended depending on variation in completion



of the related activities, i.e., preparation and approval of PC-1, funding arrangement, tendering process, contract award, land acquisition, ROW availability and construction etc.

- 8. Detailed load flow studies have been carried out for various operating scenarios with maximum dispatch from all the existing/underconstruction/planned WPPs in Jhimpir and Gharo clusters to evaluate the adequacy of the above proposed interconnection schemes of the 10 WPPs including Western Energy WPP for their reliable power evacuation to the grid.
- 9. The proposed interconnection scheme for Western Energy WPP has been found adequate after performing the load flow studies to assess the steady state system performance under normal and N-1 contingency conditions. The voltage profile, line loading, frequency and active/reactive power flow etc. from the Western Energy WPP and on the grid are within the NEPRA Grid Code criteria. It has been found on the basis of the study results that the power from Western Energy WPP can be dispersed to the National Grid in a reliable manner during normal and N-1 contingency conditions without any constraints.
- 10. The short circuit studies have been carried out with proposed interconnection of Western Energy WPP to compute the maximum three phase and single phase short circuit levels at the switchyard of Western Energy WPP and other substations in its vicinity. The minimum three phase and single phase short circuit levels have also been carried out at the 132 kV switchyard of Western Energy WPP for various number of WTGs in operation and reduced generation in its vicinity. It is found that the induction of Western Energy WPP with the proposed interconnection scheme has no adverse impact on the existing and proposed substations in its vicinity.
- 11. The maximum three phase and single phase short circuit levels at the 132 kV switchyard of Western Energy WPP are 8.14 kA and 5.40 kA respectively in the year 2021-22 but these are expected to rise due to future grid system expansion and a lot of wind power potential in Jhimpir, Gharo and surrounding

areas. Therefore, the short circuit rating of 40 kA would be adequate for the 132 kV switchyard equipment of Western Energy WPP.

- 12. Transient stability analysis has been carried out for Western Energy WPP with the proposed interconnection scheme. The stability of the Western Energy WPP and the power system has been checked with application of different disturbances on the wind farm and at the substations in its vicinity. It has been found that the Western Energy WPP and the power system remain stable with no adverse effects after subjected to faults as per Grid Code requirement.
- 13. The LVRT requirements for Western Energy WPP have been tested against contingency conditions of 100 ms (5 cycles) under normal clearing time and 180 ms (9 cycles) for delayed fault clearing. The stability simulations have proved that Western Energy WPP fulfills the LVRT criteria as mentioned in the NEPRA's Grid Code Addendum for WPPs.
- 14. The impact of induction of Western Energy WPP on power quality has also been analyzed. The study results indicate that the power quality indices including flicker and voltage unbalance, remain within the permissible limits as mentioned in the IEC and other international standards. It is clearly mentioned that it is the responsibility of developer of the Western Energy WPP to install the plant and necessary compensating equipment at its switchyard on the basis of detailed design/field testing studies to meet the power quality standards as per requirements of NEPRA Grid Code Addendum for WPPs.
- 15. It is added that the Grid Code Addendum for WPPs is currently under revision and the project sponsor of Western Energy WPP will be required to follow/implement the requirements/recommendations given in the revised Grid Code, after its approval from NEPRA and make necessary modifications in the equipment/substation of Western Energy WPP, if any, in this regard.
- 16. It is concluded on the basis of the results of the detailed system studies that the proposed interconnection scheme has no transmission system constraints in power evacuation from Western Energy WPP to the National Grid.
1 Introduction

There is huge potential of wind power at Jhimpir, Gharo and in their surrounding areas in Southern Part of Pakistan. At present, about 308 MW of Wind Power Projects (WPPs) in operation, whereas, some WPPs are in testing/commission phase and many other WPPs are at different stages of implementation. In 2013, a PC-1 was prepared to propose evacuation scheme of 1756 MW of WPPs, located at Jhimpir, Gharo and near Jamshoro, to the National Grid. Out this wind capacity, a total of 500 MW WPPs located near Jamshoro was planned to be inducted by two companies, i.e., 250 MW each by M/s NBT Wind Power Pakistan-II (Pvt.) Ltd. and NBT Wind Power Pakistan-III (Pvt.) Ltd. The LOIs of these two WPPs were cancelled later due to non-achievement of the required milestones.

Ministry of Water and Power in association with AEDB, Energy Department, Government of Sindh, in April 2016, decided to allocate the 500 MW wind power capacity vacated by M/s NBT Wind Power Pakistan-II & III to the 10 Wind Power Projects (WPPs) of approx. 50 MW each at Jhimpir, district Thatta, Sindh.

The 10 WPPs comprise of ACT-2, Gul Ahmad Electric, Shaheen Foundation, Din Energy, Zulaikha Energy, Artistic, Harvey (Cacho), Norinco, Western Energy and Trans Atlantic. These 10 WPPs are in addition to the already planned/under construction WPPs in Jhimpir and Gharo clusters. Afterwards, the list of the 10 WPPs was communicated to NTDCL through CPPA-G Ltd. for their information and further action at their ends.

The sponsor of Western Energy WPP, i.e., M/s Western Energy (Pvt.) Limited, has engaged NTDCL to carry out interconnection studies and to propose interconnection scheme for its power evacuation to the National Grid.

The site location/coordinates and other necessary technical data/information of the Western Energy WPP, i.e., number, generation capacity, voltage, p.f. & type of WTGs; collector group configuration; gross & net output capacity of the plant; number & rating of transformers; single line diagram; switchyard voltage levels &

equipment rating etc., have been provided by its sponsor and is attached in Appendix-1.

As per information provided by the project sponsor, Wastern WPP comprises of 25 No. WTGs and each WTG is of CSIC make, Type-3 with 2 MW gross capacity. The total gross generation capacity of Western Energy WPP is 50 MW and total net capacity that will flow to the grid, after subtracting project losses/auxiliary consumption, is 48.11 MW.

This is the interconnection study report which has been prepared only to propose interconnection scheme for power evacuation from Western Energy WPP in integration with other WPPs in its vicinity. In this report, he results of load flow, short circuit, transient stability and power quality studies have been presented with the proposed interconnection scheme for evacuation of power from Western Energy WPP to the National Grid in the light of NEPRA Grid Code.



2 Technical Data of Western Energy WPP

The project sponsor has provided the location/site coordinates, micro-siting arrangements of WTGs, proposed sketch of the WPP and detailed technical data/parameters of WTG and switchyard equipment etc. for Western Energy WPP which is attached in Appendix-1. The salient parameters of Western Energy WPP are given as under:

a) WTG Generator Data:

- Number of WTGs = 25
- Manufacturer/Model = CSIC (Chongquig) Haizhuang Wind Power Equipment Co. Ltd.
- Gross capacity = 2 MW
- Type = 3
- Voltage = 0.69 kV
- Power factor = 0.95 (Lagging/Leading)

b) WTG Arrangement in Wind Farm

- No. of collector groups = 4
- No. of WTGs in one collector group = 3 X 6 WTGs + 1 x 7 WTGs
- Length of each collector group with the switchyard = 5.6, 2.41, 3.91 & 2.82 km

c) Total Wind Farm Capacity:

- Total gross capacity= 50 MW
- EBOP Losses = 1.637 MW
- Auxiliary Consumption = 0.25 MW
- Total net output capacity that will flow to the Grid = 48.11 MW

d) Generator Step-up Transformer Data:

- No. of step-up transformers = 25
- Voltage ratio = 0.69/35 kV





- MVA rating = 2.4 MVA
- Percentage Impedance = 6.5%
- e) Proposed Switchyard of Wind Power Project:
 - High Voltage (HV) Level = 132 kV
 - Medium Voltage (MV) Level = 35 kV
 - Bus Bar Scheme = Double bus single breaker
 - Bus Bar capacity = 2500 Amp.
 - Power (HV/MV) transformer:
 - No. of transformers = 2
 - Voltage ratio = 132/35 kV
 - MVA rating = 50 MVA
 - Percentage Impedance = 10.5%
 - Switchgear data, single line diagram and layout of switchyard attached in Appendix-1.
- f) Proposed Reactive Power Compensation

2x10 MVAR SVG

The other technical data/information about switchyard equipment is attached in Appendix-1.



3 Study Objectives, Assumptions and Criteria

3.1 Study Objectives

The objectives of the interconnection study are given as under:

- To propose the transmission scheme for reliable dispersal of power from Wester Energy WPP to the National Grid under normal and N-1 contingency conditions.
- To evaluate adequacy of the proposed interconnection scheme and to assess the impact of Western Energy WPP on the grid system and vice versa through load flow, short circuit, transient stability studies and power quality analyses.

3.2 Study Assumptions

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The system studies are based on the following assumptions:

- Latest load forecast.
- Latest generation expansion plan.
- Latest transmission expansion plans of NTDC and DISCOs, especially HESCO.
- Export of power from NTDC to K-Electric is assumed as 650 MW.
- Interconnected transmission system has been assumed, however, split bus has been assumed at 132 kV bus bars of Hala Road and T.M. Khan Road 220/132 kV substations as per system requirements.
- The existing, under-construction and already planned WPPs at Jhimpir and Gharo clusters with their interconnection arrangements. The underconstruction 220/132 kV substations, i.e., Jhimpir New (Jhimpir-1) and Gharo New, with their allied transmission lines are assumed to be commissioned.
- As per information provided by project sponsor, the total gross & net capacity of Western Energy WPP have been assumed as 50 MW & 48.11 MW

respectively. The modeling of Western Energy WPP in PSS/E software has been made as under:

- There are a total number of 25 WTGs and four collector groups in the wind farm with each WTG having gross capacity of 50 MW and generating power at 0.69 kV which has been stepped up to 35 kV through 2.4 MVA transformer.
- Out of four collector group , three collector groups comprising of 6 WTGs have been modeled with 2 x 6 = 12 MW capacity each and equivalent 0.69/35 kV transformers and one collector group comprising of 7 WTGs has been modeled with 2 x 7 = 14 MW capacity and equivalent 0.69/33 kV transformer.
- Each of the four collector groups have been connected through individual 35 kV cables with 35 kV bus bar of the 132/35 kV substation.
- The ±20 MVAR SVG has been modeled at MV bus bar of Western Energy WPP.
- At 132/33 kV substation, the 2 No. 132/33 kV transformers have been modeled separately.
- Other WPPs in the vicinity of Western Energy WPP have also been modeled according to their own WTG capacities and collector group configuration.
- This interconnection study report is based on the information supplied by M/s Western Energy (Pvt.) Limited and NTDCL is not responsible for the study results on account of any deficiency and/or inaccuracy of the supplied information.

3.3 Study Criteria

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The interconnection studies have been carried out keeping in view of the following system operating criteria/limits in accordance with NEPRA Grid Code:

Voltage Limits ±5% under normal and ±10% under contingency



conditions. However, voltages at some generation buses and some substations may be kept upto +8% under normal operating conditions as per network configuration and/or system requirements.

Transmission Line80% under normal and 100% under N-1Loading Limitscontingency conditions.

Transformer Loading80% under normal and 110% under N-1Limitscontingency conditions.

Frequency Limits49.8 – 50.2 Hz under normal condition and49.4 – 50.5 Hz under N-1 condition.

Stability CriteriaSystem stability must be maintained after
subjected to the following disturbances

- 3-phase fault at bus bar cleared in 5-cycles/ 100 ms (normal clearing condition) and tripping of the associated circuit.
- 3-phase fault at bus bar cleared in 9 cycles/180 ms (delayed clearing or stuck breaker condition) and tripping of the associated circuit.

Low Voltage Ride Through (LVRT) Requirements

- A wind power plant must withstand a voltage dip down to 30% of retained voltage for a duration of at least 100 ms for a normal clearing case, and at least 180 ms in the case of stuck breaker contingency event.
- The wind power plant shall manage active power restoration, after the voltage recovery, at a rate of at least 20% of nominal output power per second, subject to availability of adequate wind speed at site.



4 Proposed Interconnection Scheme

Considering the capacity, locations, existing/planned system network in the area, the following integrated interconnection scheme of the 3 WPPs lying in northern part of Jhimpir including Shaheen Foundation, Norinco, and Western Energy, has been proposed for their reliable power evacuation to the National Grid:

- i) 132 kV D/C transmission line, approx. 30 km long on Greeley conductor for connecting all the 3 WPPs including Western Energy WPP with 132 kV single circuit from Master WPP to under construction Jhimpir New (Jhimpir-1). In this scheme, the interconnection of Western Energy WPP includes 132 kV D/C transmission line, approx. 3 km long, on Greeley conductor for looping In/Out on the 132 kV single circuit from Shaheen WPP to Jhimpir-1.
- ii) Addition of 4th 220/132 kV transformer at the under construction Jhimpir-1 220/132 kV substation.

The following interconnection schemes/network reinforcement proposed with the other 7 WPPs lying in southern part of Jhimpir, will also be required for the reliable power evacuation of 3 WPPs including Western Energy WPP to the grid:

- 220 kV D/C transmission line, approx. 18 km long, on twin-bundled Greeley conductor for looping In/Out of one circuit of the existing Jamshoro – KDA-33 D/C transmission line at Jhimpir-2.
- iv) 220 kV D/C transmission line, approx. 7 km long, on twin-bundled Greeley conductor for looping In/Out of one of the planned Jhimpir-1 – Gharo New D/C transmission line at Jhimpir-2.

It is intimated that lengths of the above mentioned lines are approximate and will be finalized after route survey.



The geographical diagram showing above proposed interconnection scheme for power dispersal of Western Energy WPP is attached as Figure #1 (Appendix-2). The google earth diagram indicating the locations/layout of the WPPs in Jhimpir area including Western Energy WPP is also attached in Appendix-2.



5 Load Flow Studies

The detailed load flow studies have been carried out with the proposed interconnection scheme for various operating scenarios with maximum dispatch from all the existing/under-construction/planned WPPs in Jhimpir and Gharo clusters to evaluate the adequacy of the proposed interconnection scheme for Western Energy WPP for its reliable power evacuation to the National Grid. In this regard, peak load system scenarios of years 2019 and 2021 have been simulated to evaluate the adequacy of the proposed interconnection scheme and performance of Western Energy WPP on the system under normal and N-1 contingency conditions. In addition, the load flow studies have also been carried out for off-peak load scenario in 2019 to analyze the impact of the Western Energy WPP on the system.

It is to be noted that all the load flow study Exhibits referred in the following sections are attached in Appendix-3. The results of the load flow studies for dispersal of power from Western Energy WPP to the National Grid are described as under:

5.1 Peak Load 2019 Scenario

Load flow study for the peak load scenario in 2019 under normal system condition has been carried out with net output of 48.1 MW from Western Energy WPP and is attached as Exhibit #1.0 & 1.0A. As per load flow study, the power flows on the transmission lines/transformers at/around Western Energy Energy WPP and on the surrounding southern network are given as under:

Transmission Line/Transformers	Power Flow (MW)
Western-E WPP Norinco WPP 132 kV S/C	27.0
Western-E WPP – Shaheen-F WPP 132 kV S/C	21.2
Norinco WPP – Master WPP 132 kV S/C	74.4



Transmission Line/Transformers	Power Flow (MW)
Shaheen-F WPP – Jhimpir-1 132 kV S/C	68.4
Jhimpir-1 – T.M. Khan 132 kV D/C	227.2
Jhimpir-1 – Jhimpir-2 220 kV S/C	167.5
Gharo New – Jhimpir-1 220 kV S/C	23.2
Jhimpir-1 – T.M. Khan Road 220 kV D/C	504.2
4x250 MVA, 220/132 kV transformers at Jhimpir-1	648.4

The active and reactive power flows from Western Energy WPP and other WPPs in its vicinity remain within limits.

a. N-1 Contingency Analysis

The load flow analysis has also been carried out for N-1 contingency conditions during peak load scenario of 2019. The results of contingency studies are attached as Exhibit# 1.1 to 1.10 and are summarized as under:

Exhibit #	Contingency Conditions	Remarks
1.1	Western-E WPP – Norinco WPP 132 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
1.2	Western-E WPP – Shaheen-F WPP 132 kV S/C out	-do-
1.3	1x50 MVA, 132/35 kV transformer at Western-E WPP out	-do-
1.4	One collector group (7 WTGs) at Western-E WPP out	-do-



Exhibit #	Contingency Conditions	Remarks
1.5	Master WPP – Jhimpir-1 132 kV S/C out	-do-
1.6	1x250 MVA, 220/132 kV transformer at Jhimpir-1 out	-do-
1.7	Jhimpir-1 – T.M. Khan 132 kV S/C out	-do-
1.8	Jhimpir-1 – T.M. Khan Road 220 kV S/C out	-do-
1.9	Jhimpir-1 – Jhimpir-2 220 kV S/C out	-do-
1.10	Jhimpir-1 – Gharo New 220 kV S/C out	-do-

b. Comments on Normal and N-1 Contingency Analysis

As per load flow study result, the power flows on transmission lines and transformers at/in the vicinity of Western Energy WPP are well within their capacities. In general, the study depicts that the voltage profile of the system and at the switchyard of Western Energy WPP is within limits and there would be no transmission system constraints in the flow of power from Western Energy WPP to the system under normal and N-1 contingency conditions.

5.2 Off-peak Load 2019 Scenario

Load flow study for the off-peak load scenario in 2019 under normal system condition has been carried out with net output of 48.1 MW from Western Energy WPP and is attached as Exhibit #2.0 & 2.0A. As per load flow study, the power flows on the transmission lines/transformers at/around Western Energy WPP and on the surrounding southern network are given as under:

Transmission Line/Transformers	Power Flow (MW)
Western-E WPP – Norinco WPP 132 kV S/C	27.0
Western-E WPP – Shaheen-F WPP 132 kV S/C	21.2
Norinco WPP – Master WPP 132 kV S/C	74.4
Shaheen-F WPP – Jhimpir-1 132 kV S/C	68.4
Jhimpir-1 – T.M. Khan 132 kV D/C	206.4
Jhimpir-1 – Jhimpir-2 220 kV S/C	183.9
Gharo New – Jhimpir-1 220 kV S/C	19.4
Jhimpir-1 – T.M. Khan Road 220 kV D/C	504.8
4x250 MVA, 220/132 kV transformers at Jhimpir-1	669.6

It is evident from the above table that the power flows on the 132 kV interconnection circuits of 3 WPPs including Western Energy WPP remain the same, however, the power flows on the 220 kV circuits and on other part of the system has varied mainly due to lower demand during off-peak load condition in 2019. The active and reactive power flows from Western Energy WPP and other WPPs in its vicinity remain within limits.

a. N-1 Contingency Analysis

The load flow analysis has also been carried out for N-1 contingency conditions during off-peak load scenario in 2019. The results of contingency studies are attached as Exhibit #2.1 to 2.10 and are summarized as under:

Exhibit #	Contingency Conditions	Remarks
2.1	Western-E WPP – Norinco WPP 132 kV S/C out	Power flows on the other transmission lines and transformers as well as the



Exhibit #	Contingency Conditions	Remarks	
		voltage profile of the system remain within limits.	
2.2	Western-E WPP – Shaheen-F WPP 132 kV S/C out	-do-	
2.3	1x50 MVA, 132/35 kV transformer at Western-E WPP out	-do-	
2.4	One collector group (7 WTGs) at Western-E WPP out	-do-	
2.5	Master WPP – Jhimpir-1 132 kV S/C out	-do-	
2.6	1x250 MVA, 220/132 kV transformer at Jhimpir-1 out	-do-	
2.7	Jhimpir-1 – T.M. Khan 132 kV S/C out	-do-	
2.8	Jhimpir-1 – T.M. Khan Road 220kV S/C out	-do-	
2.9	Jhimpir-1 – Jhimpir-2 220 kV S/C out	-do-	
2.10	Jhimpir-1 – Gharo New 220 kV S/C out	-do-	

b. Comments on Normal and N-1 Contingency Analysis

As per load flow study result, the power flows on transmission lines and transformers in the vicinity of proposed Western Energy WPP are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the



proposed Western Energy WPP to the system under normal and N-1 contingency conditions.

5.3 Peak Load 2021 Scenario

Load flow study for the peak load scenario in 2021 under normal system condition has been carried out with net output of 48.1 MW from Western Energy WPP and is attached as Exhibit #3.0 & 3.0A. As per load flow study, the power flows on the transmission lines/transformers at/around Western Energy WPP and on the surrounding southern network are given as under:

Transmission Line/Transformers	Power Flow (MW)
Western-E WPP – Norinco WPP 132 kV S/C	27.0
Western-E WPP – Shaheen-F WPP 132 kV S/C	21.2
Nonnco WPP – Master WPP 132 kV S/C	74.4
Shaheen-F WPP – Jhimpir-1 132 kV S/C	68.4
Jhimpir-1 – T.M. Khan 132 kV D/C	267.0
Jhimpir-1 – Jhimpir-2 220 kV S/C	111.5
Gharo New – Jhimpir-1 220 kV S/C	36.2
Jhimpir-1 – T.M. Khan Road 220 kV D/C	533.4
4x250 MVA, 220/132 kV transformers at Jhimpir-1	608.8

The active and reactive power flows from Western Energy WPP and other WPPs in its vicinity remain within limits.

a. N-1 Contingency Analysis

The load flow analysis has also been carried out for N-1 contingency conditions for peak load condition in 2021. The results of contingency studies are attached as Exhibit #3.1 to 3.10 and are summarized as under:

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Exhibit #	Contingency Conditions	Remarks
3.1	Western-E WPP – Norinco WPP 132kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
3.2	Western-E WPP – Shaheen-F WPP 132 kV S/C out	-do-
3.3	1x50 MVA, 132/35 kV transformer at Western-E WPP out	-do-
3.4	One collector group (7 WTGs) at Western-E WPP out	-do-
3.5	Master WPP – Jhimpir-1 132 kV S/C out	-do-
3.6	1x250 MVA, 220/132 kV transformer at Jhimpir-1 out	-do-
3.7	Jhimpir-1 – T.M. Khan 132 kV S/C out	-do-
3.8	Jhimpir-1 – T.M. Khan Road 220 kV S/C out	-do-
3.9	Jhimpir-1 – Jhimpir-2 220 kV S/C out	-do-
3.10	Jhimpir-1 – Gharo New 220 kV S/C out	-do-

b. Comments on Normal and N-1 Contingency Analysis

As per load flow study results, the power flows on transmission lines and transformers in the vicinity of proposed Western Energy WPP are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of



power from Western Energy WPP to the system under normal and N-1 contingency conditions.

5.4 Conclusions of Load Flow Analysis

The proposed interconnection scheme for evacuation of power from 50 MW Western Energy WPP to the National Grid has been found reliable in various operating scenarios under normal and N-1 contingency conditions with no transmission system constraints.



6 Short Circuit Studies

The short circuit studies have been carried out with proposed Interconnection scheme of Western Energy WPP to compute the maximum three phase and single phase short circuit levels at the switchyard of Western Energy WPP and substations in its vicinity. The studies have been carried out with all the existing and planned generation in operation and with interconnected transmission system. The minimum three phase and single phase short circuit levels have also been carried out at the 132 kV switchyard of Western Energy WPP for various number of WTGs in operation and reduced generation in its vicinity.

6.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in short circuit analysis for which provision is available in the PSS/E software used for these studies. The maximum and minimum short circuit currents have been calculated with the following assumptions under IEC 909 standard:

- Set tap ratios to unity
- Set line charging to Zero
- Set shunt to zero in positive sequence
- The voltage magnitude at bus bars set equal to 1.10 p.u for maximum short circuit analysis and 0.9 p.u for minimum short circuit analysis.

In the short circuit analysis, the parameters of generator and step-up transformer for Western Energy WPP, have been assumed as per information provided by its sponsor, attached in Appendix-1. The results of maximum and minimum short circuit studies with necessary details are presented in Appendix-4.

6.2 Short Circuit Study Results

The short circuit studies have been carried out with proposed Interconnection scheme and by using the above parameters for generator and step-up transformer to compute the maximum three phase and single phase short circuit levels at the



switchyard of Western Energy WPP and other substations in its vicinity. The studies have been carried out for the year 2021-22 with all the existing and planned generation in operation and with interconnected transmission system except 132 kV split buses at 220/132 kV substations of Hala Road and T.M. Khan Road. The results of maximum short circuit studies for the year 2021-22 are summarized as under:

	Maximum Short Circuit Levels		
Name of Faulted Bus Bars	Three Phase (kA)	Single Phase (kA)	
Western Energy WPP 132 kV	8.14	5.40	
Norinco WPP 132 kV	9.48	5.56	
Shaheen Foundation WPP 132 kV	8.14	5.42	
Jhimpir-2 220 kV	18.96	11.47	
Jhimpir-2 132 kV	15.48	12.01	
Jhimpir-1 220 kV	19.89	11.66	
Jhimpir-1 132 kV	27. <u>5</u> 9	13.56	

Maximum Short Circuit Levels

The minimum three phase and single phase short circuit levels have also been computed for system scenario of 2019 at the 132 kV switchyard of Western Energy WPP with all WTGs and one WTG in operation; and with reduced generation in operation in its vicinity. The minimum short circuit levels at the 132 kV switchyard of Western Energy WPP are tabulated as under:

WIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Minimum	Short Circu	t Levels	at Western	Energy	132 kV	Bus
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	Minimum Short Circuit Levels		
WTGs in Operation at Western Energy WPP	Three Phase (kA)	Single Phase (kA)	
All WTGs	6.48	4.23	
One WTG	5.85	3.39	

6.3 Conclusions of Short Circuit Analysis

It is evident from the short circuit analysis that the induction of Western Energy WPP and its surrounding WPPs have no adverse impact on the existing and proposed substations in their vicinity as far as short circuit levels are concerned. The maximum three phase and single phase short circuit levels at the 132 kV switchyard of Western Energy WPP are 8.14 kA and 5.4 kA respectively in the year 2021-22 but these are expected to rise due to future grid system expansion and a lot of wind power potential in Jhimpir, Gharo and surrounding areas. Therefore, the short circuit rating of 40 kA would be adequate for the 132 kV switchyard equipment of Western Energy WPP.



7. Transient Stability Studies

Transient stability studies have been carried out with the proposed interconnection scheme to evaluate the dynamic response of generators and the power system after occurrences of faults. The transient stability simulations are used to check in time domain whether the generators at and in the vicinity of Western Energy WPP as well as the power system remain stable after subjected to severe disturbances as per Grid Code requirement.

7.1 Study Methodology

The dynamic simulation model of the entire network has been developed in the PSS/E software. The dynamic model parameters of WTG Type-3 used for Western Energy WPP, in the studies are attached in Appendix-5. On the other hand, the dynamic models/parameters of generators, exciters and governors of all the other power plants, already available in Planning (Power) NTDCL, have been used in the studies.

Two worst types of disturbances have been simulated to assess the stability of the Western Energy WPP and the power system as per NEPRA grid code criteria which are given as under:

- 3-phase fault at bus bar cleared in 5-cycles (100 ms) and tripping of the associated circuit.
- 3-phase fault at bus bar cleared in 9 cycles (180 ms) (delayed clearing or stuck breaker condition) and tripping of the associated circuit.

The simulations have been run in the time domain in the following sequence:

- Running simulation for initial one second for pre-fault steady state condition.
- Fault application at 1.0 second and running the simulation upto 1.1 second for 5 cycle fault (up to 1.18 second for 9 cycle fault).
- Fault clearance at 1.1 second for 5 cycle fault (1.18 second for 9 cycle fault) and tripping of the associated circuit.







• Running simulation up to 10 seconds after fault clearance.

The following generator and network parameters are monitored in the simulations and have been presented in the report through the following stability plots for each type of disturbance:

- i. Bus frequency and voltage
- ii. WTG (Pmechanical, Generator & Turbine Rotor speed deviation, Pitch, Aero Dynamic Torque, Paero, active and reactive power output etc.)
- iii. Line power flows, i.e., P (MW) & Q (MVAR)
- iv. Conventional thermal generator rotor angle

In order to interpret the stability plots, the bus numbers assigned to the bus bars and the voltage levels, are given as under:

Bus Number	Bus Name / Voltage
81119	Western-E/132 kV
811191	Western-E MV/35 kV
811196, 811197, 811198 & 811199	Western-E LV-1 to LV-4 / 0.69kV
81120	Shaheen-F/132 kV
81118	Norinco/132 kV
9428	Jhimpir-1 / 132 kV
9429	Jhimpir-1 / 220kV
811	Jhimpir-2 / 220kV
800	Jamshoro / 220 kV
900	KDA-33 / 220 kV
530	M.Garh / 220 kV
90	Hub / 500 kV



7.2 Transient Stability Analysis Results

The transient stability analysis for Western Energy WPP with the proposed interconnection scheme has been carried out for peak load 2019 scenario. The stability of the Western Energy WPP and the power system has been tested with application of different disturbances on the wind farm and at the substations in its vicinity. The plotted results of the stability simulations are attached in Appendix-6 and described as under:

(i) For Normal Clearing Time (100 ms)

The transient stability studies for faults with normal clearing time of 100 ms corresponding to 5 cycles, have been carried out. The details of the faults & the associated outages, monitored variables, respective exhibits and stability behavior of Western Energy WPP & other generators as well as the power system are mentioned and presented in the following table:

Sr. #	3-Phase Fault Location	Circuit Outage	Exhibit #	Monitored Variable	Remarks
1	1 Western-E Western-E WPP –	Western-E WPP -	1.1	Bus Frequency	Western
	WPP 132kV	WPP 132kV Norinco WPP 132kV 1.2	Bus Voltage	Energy WPP	
	Bus S/C	1.3	WTG Collector Group Output (P&Q)	system remain stable.	
		1.4	Pmechanical & Speed of WTG		
		1.5	Pitch & Aero Dynamic Torque of WTG		
		1.6	Paero on Rotor Blade & Shaft Twist Angle		
		1.7	Turbine Rotor Speed Deviation & Gen. Speed Deviation		





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Sr. #	3-Phase Fault Location	Circuit Outage	Exhibit #	Monitored Variable	Remarks
			1.8	Pitch Compensation & Pitch Control	
			1.9	Line Power Flows (P&Q)	
			1.10	Rotor Angle	
2	Western-E	Western-E WPP -	1.11	Bus Frequency	Western
	WPP 132 kV Bus	Shaheen-F WPP 132kV S/C	1.12	Bus Voltage	and NTDCL
		1.13	WTG collector group Output (P&Q)	system remain stable.	
			1.14	Pmechanical & Speed	
			1.15	Pitch & Aero Dynamic Torque of WTG	
			1.16	Paero on Rotor Blade & Shaft Twist Angle	
			1.17	Turbine Rotor Speed Deviation & Gen. Speed Deviation	
			1.18	Pitch Compensation & Pitch Control	
			1.19	Line Power Flows (P&Q)	
			1.20	Rotor Angle	
3	Western-E	One 132/35 kV T/F	1.21	Bus Frequency	Western
	WPP 132 kV at Western Bus	at Western-E WPP	1.22	Bus Voltage	Energy WPP and NTDCL
			1.23	WTG collector group Output (P&Q)	system remain stable.
			1.24	Pmechanical & Speed	
			1.25	Pitch & Aero Dynamic Torque	



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Sr. #	3-Phase Fault Location	Circuit Outage	Exhibit #	Monitored Variable	Remarks
				of WTG	
			1.26	Paero on Rotor Blade & Shaft Twist Angle	
			1.27	Turbine Rotor Speed Deviation & Gen. Speed Deviation	
			1.28	Pitch Compensation & Pitch Control	
			1.29	Line Power Flows (P&Q)	
			1.30	Rotor Angle	
4	Western-E	One Collector Group	1.31	Bus Frequency	Western
	WPP 35 kV comprisin MV Bus WTGs at WPP	comprising of 7	1.32	Bus Voltage	Energy WPP
		WPP	1.33	WTG collector group Output (P&Q)	system remain stable.
			1.34	Pmechanical & Speed	
			1.35	Pitch & Aero Dynamic Torque of WTG	
			1.36	Paero on Rotor Blade & Shaft Twist Angle	
			1.37	Turbine Rotor Speed Deviation & Gen. Speed Deviation	
			1.38	Pitch Compensation & Pitch Control	
			1.39	Line Power Flows (P&Q)	
			1.40	Rotor Angle	
5	Jhimpir-1	Jhimpir-1	1.41	Bus Frequency	Western
	220 kV Bus	T.M.Khan Road	1.42	Bus Voltage	Energy WPP







Sr. #	3-Phase Fault Location	Circuit Outage	Exhibit #	Monitored Variable	Remarks
		220kV S/C	1.43	Line Power Flow (P & Q)	and NTDCL system
			1.44	Rotor Angle	remain
			1.45	WTG collector group Output (P&Q)	Stadle.
6	Jhimpir-1	Jhimpir-1 — Jhimpir-2	1.46	Bus Frequency	Western
	220 kV Bus	220 kV Bus 220 kV S/C	1.47	Bus Voltage	Energy WPP and NTDCL
			1.48	Power Flow (P & Q)	system remain stable.
			1.49	Rotor Angle	
			1.50	WTG collector group Output (P&Q)	
7	Jhimpir-1	Jhimpir-1 – Gharo	1.51	Bus Frequency	Western
	220 KV DUS	New ZZURV S/C	1.52	Bus Voltage	and NTDCL
			1.53	Power Flow (P & Q)	remain stable.
			1.54	Rotor Angle	
			1.55	WTG collector group Output (P&Q)	

It is evident from the above stability Exhibits that Western Energy WPP meets LVRT requirements as mentioned in the NEPRA Grid Code Addendum for WPPs.

(ii) For Delayed Clearing Time (180 ms)

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The transient stability studies for faults with delayed clearing time of 180 ms corresponding to 9-cycle fault (stuck breaker condition) have been carried out. The details of the faults & the associated outages, monitored variables, respective exhibits and stability behavior of Western Energy WPP & other generators as well as the power system are mentioned and presented in the following table:



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Sr. #	3-Phase Fault Location	Circuit Outage	Exhibit #	Monitored Variable	Remarks
1	Western-E WPP 132kV	Western-E WPP – Norinco WPP 132 kV	2.1	Bus Frequency	Western Energy WPP
	Bus	Bus S/C	2.2	Bus Voltage	and NTDCL
			2.3	WTG collector group Output (P&Q)	stable.
			2.4	Pmechanical & Speed	
			2.5	Pitch & Aero Dynamic Torque of WTG	
			2.6	Paero on Rotor Blade & Shaft Twist Angle	
			2.7	Turbine Rotor Speed Deviation & Gen. Speed Deviation	
			2.8	Pitch Compensation & Pitch Control	
			2.9	Line Power Flows (P&Q)	
			2.10	Rotor Angle	
2	Western-E	Western-E WPP -	2.11	Bus Frequency	Western
	WPP 132 kV Bus	Shaheen-F WPP 132	2.12	Bus Voltage	Energy WPP and NTDCL
		2.13	WTG collector group Output (P&Q)	system remain stable.	
			2.14	Pmechanical & Speed	
			2.15	Pitch & Aero Dynamic Torque of WTG	
			2.16	Paero on Rotor Blade & Shaft Twist Angle	



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Transient Stability Studies

Sr. #	3-Phase Fault Location	Circuit Outage	Exhibit #	Monitored Variable	Remarks
			2.17	Turbine Rotor Speed Deviation & Gen. Speed Deviation	
			2.18	Pitch Compensation & Pitch Control	
			2.19	Line Power Flows (P&Q)	
			2.20	Rotor Angle	
3	Western-E	One 132/35 kV T/F at	2.21	Bus Frequency	Western
	Bus		2.22	Bus Voltage	and NTDCL
			2.23	WTG collector group Output (P&Q)	system remain stable.
			2.24	Pmechanical & Speed	
			2.25	Pitch & Aero Dynamic Torque of WTG	
			2.26	Paero on Rotor Blade & Shaft Twist Angle	
			2.27	Turbine Rotor Speed Deviation & Gen. Speed Deviation	
			2.28	Pitch Compensation & Pitch Control	
			2.29	Line Power Flows (P&Q)	
			2.30	Rotor Angle	
4	Western-E	One Collector Group	2.31	Bus Frequency	Western
	WPP 35 kV	comprising of 7	2.32	Bus Voltage	Energy WPP

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Sr. #	3-Phase Fault Location	Circuit Outage	Exhibit . #	Monitored Variable	Remarks
	MV Bus	WTGs at Western-E WPP	2.33	WTG collector group Output (P&Q)	and NTDCL system remain stable.
			2.34	Pmechanical & Speed]
			2.35	Pitch & Aero Dynamic Torque of WTG	
			2.36	Paero on Rotor Blade & Shaft Twist Angle	
			2.37	Turbine Rotor Speed Deviation & Gen. Speed Deviation	
			2.38	Pitch Compensation & Pitch Control	
			2.39	Line Power Flows (P&Q)	
			2.40	Rotor Angle	
5	Jhimpir-1	Jhimpir-1 – T.M.Khan	2.41	Bus Frequency	Western
	220 kV Bus Road 220 kV S/C	2.42	Bus Voltage	Energy WPP and NTDCL	
			2.43	Power Flow (P & Q)	system remain stable.
			2.44	Rotor Angle	
			2.45	WTG collector group Output (P&Q)	

It is evident from the above stability Exhibits that Western Energy WPP meets LVRT requirements as mentioned in the NEPRA Grid Code Addendum for WPPs.

7.3 Conclusions of Transient Stability Analysis

The results of transient stability analysis indicate that Western Energy WPP & other

generators in its vicinity and the power system remain stable with no adverse effects after subjected to severe disturbances either on Western Energy WPP or at the other substations in its vicinity. The stability simulations also proved that the Western Energy WPP fulfills the LVRT criteria as mentioned in the NEPRA's Grid Code Addendum for WPPs.



8 Power Quality Analysis

The power quality analysis is very important for a wind power plant that may cause flicker and distortions in the power supply. These issues become more significant for weak power systems having low short circuit strength. Therefore, power quality analysis including flicker and voltage unbalance, has been carried out with the proposed interconnection scheme of 50 MW Western Energy WPP for the worst case scenario of minimum system short circuit levels in 2019.

8.1 Flicker

IEC61400-21 standard have been used for the calculation of flicker levels for steadystate continuous operation. The probability of 99th percentile flicker emission from a single inverter during continuous operation for short time $P_{st\Sigma}$ and long time flicker level $P_{It\Sigma}$ are assumed same and calculated by the following formula:

$$\boldsymbol{P}_{st\Sigma} = \boldsymbol{P}_{lt\Sigma} = \frac{1}{s_k} \cdot \sqrt{\sum_{i=1}^{N_{wt}} (\boldsymbol{c}_i(\boldsymbol{\psi}_k, \boldsymbol{\upsilon}_a), \boldsymbol{S}_{n,i})^2}$$
(A)

Where

 $\mathbf{S}_{\mathbf{n}}$ is the rated apparent power of the WTG

S_k is the short-circuit apparent power at PCC

 N_{wt} is the number of WTGs connected to the PCC

The value of c (φ_k) may not be greater than 1, therefore for the present analysis, the value of 1 for the worst case has been assumed. PCC is the point of common coupling which is 132 kV bus of the switchyard of 50 MW Western Energy WPP.

For the minimum short circuit case, the system network in the vicinity of 50 MW Western Energy WPP has been modeled with minimum generation in operation. The short circuit calculations have been done at 0.9 p.u. voltage. The values used in the calculation of flicker are as below:

S_n = 2.105 MVA N_{WT} = 25 S_k = 1481.26 MVA

Using the above data in Equation (A), we get

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$$P_{St\Sigma} = P_{It\Sigma} = 0.007105 = 0.71 \%$$

Whereas, the acceptable value in IEC Standard is less than 4%. Therefore, the flicker level is far less than the maximum permissible limit which implies that the inverters at 50 MW Western Energy WPP would not cause any flicker problem during steady state operation even in the weakest system conditions.

8.2 Voltage Unbalance

(i) Voltage Step-Change

The voltage step-change occurs when only a single WTG is energized. The value of voltage change depends on the impedance of the network from the connection point to Point of Common Coupling (PCC). The PCC is 132 kV bus of Western Energy WPP. The Voltage step-change should be less than or equal to 3% and this condition is evaluated by using the following formula:

$$\Delta V = \sum Swka \left[\left(\frac{1}{Ske} \right) - \left(\frac{1}{Skss} \right) \right] \le 3\%$$
 (B)

Where

S_{wka} is the MVA rating of the inverter
S_{ke} is the Short Circuit MVA at connection point
S_{kss} is the Short circuit MVA at PCC

The values used in the calculation of voltage step-change are as below:

 $S_{wka} = 2.105 \text{ MVA}$ $S_{ke} = 389.58 \text{ MVA}$ $S_{kss} = 1338.2 \text{ MVA}$

Using the above data in Equation (B), we get

 $\Delta V = 0.003830 = 0.38$ %

The voltage step-change is less than the maximum permissible limit of 3% which implies that the WTG would not cause any voltage step-change problem.

(ii) Voltage Fluctuation

The voltage fluctuation has been calculated assuming only one WTG in operation, using the following equation and it is found to be within permissible limits.

Volatge Fluctuation =
$$\sqrt{\sum (\frac{Pwka}{Ske})^2} \le 1/25$$
 or 4% (C)

Where

Pwka is the MW rating of WTG

Ske is the Short Circuit MVA at connection point

The values used in the calculation of voltage fluctuation are as below:

 $P_{wka} = 2 MW$ $S_{ke} = 389.58 MVA$

Using the above data in Equation (C), we get

Voltage Fluctuation = 0.005134 = 0.51 %

The value of voltage fluctuation is less than the maximum permissible limit of 4% which implies that the WTG would not cause any voltage step-change problem.

8.3 Conclusions of Power Quality Analysis

The important power quality indices like flicker and voltage unbalance have been computed with Western Energy WPP and compared with limits given in IEC and other international standards. The study results indicate that the levels of flicker and voltage unbalance are within permissible limits, with the interconnection of subject WPP.

It is added that it is the responsibility of developer of the Western Energy WPP to install the plant and necessary compensating equipment at its switchyard on the basis of detailed design/field testing studies to meet the power quality standards as per requirements of NEPRA Grid Code Addendum for WPPs.

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9 Overall Conclusions and Recommendations

- i) On the basis of detailed interconnection studies, the following integrated interconnection scheme of the 3 WPPs lying in Northern part of Jhimpir including Western Energy WPP, has been found reliable for power evacuation to the National Grid:
 - 132 kV D/C transmission line, approx. 30 km long on Greeley conductor for connecting all the 3 WPPs including Western Energy WPP with 132 kV single circuit from Master WPP to under construction Jhimpir New (Jhimpir-1). In this scheme, the interconnection of Western Energy WPP includes 132 kV D/C transmission line, approx. 3 km long, on Greeley conductor for looping In/Out on the 132 kV single circuit from Shaheen WPP to Jhimpir-1.
 - Addition of 4th 220/132 kV transformer at the under construction Jhimpir New (Jhimpir-1) 220/132 kV substation.

The following interconnection schemes/network reinforcement proposed with the other 7 WPPs lying in southern part of Jhimpir, will also be required for the reliable power evacuation of 3 WPPs including Western Energy WPP to the grid:

- 220 kV D/C transmission line, approx. 18 km long, on twin-bundled Greeley conductor for looping In/Out of one circuit of the existing Jamshoro – KDA-33 D/C transmission line at Jhimpir-2.
- 220 kV D/C transmission line, approx. 7 km long, on twin-bundled Greeley conductor for looping In/Out of one of the planned Jhimpir-1
 – Gharo New D/C transmission line at Jhimpir-2.
- ii) The above proposed interconnection scheme is expected to be completed in Dec. 2019. It is added that the expected timeline of the proposed interconnection scheme may be extended depending on variation in

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funding arrangement, tendering process, contract award, land acquisition, ROW availability and construction etc.

- iii) The results of detailed load flow studies for various operating scenarios indicate that the power from Western Energy WPP can be dispersed to the National Grid in a reliable manner during normal and N-1 contingency conditions without any constraints. The voltage profile, line loading, frequency and active/reactive power flow etc. from Western Energy WPP and on the grid are within the NEPRA Grid Code criteria.
- iv) The results of short circuit studies indicate that Western Energy WPP and its surrounding WPPs have no adverse impact on the existing and proposed substations in their vicinity as far as short circuit levels are concerned. The maximum three phase and single phase short circuit levels at the 132 kV switchyard of Western Energy WPP are 8.14 kA and 5.4 kA respectively in the year 2021-22 but these are expected to rise due to future grid system expansion and a lot of wind power potential in Jhimpir, Gharo and surrounding areas. Therefore, the short circuit rating of 40 kA would be adequate for the 132 kV switchyard equipment of Western Energy WPP.
- v) The results of transient stability analysis indicate that Western Energy WPP & other power plants in its vicinity and the power system remain stable with no adverse effects after subjected to severe disturbances either on Western Energy WPP or at the other substations in its vicinity. The stability simulations also proved that Western Energy WPP fulfills the LVRT criteria as mentioned in the NEPRA's Grid Code Addendum for WPPs.
- vi) The important power quality indices like flicker and voltage unbalance have been computed with Western Energy WPP. The study results indicate that the levels of flicker and voltage unbalance are within permissible limits as mentioned in the IEC and other international standards, with the proposed interconnection of Western Energy WPP. It is clearly mentioned that it will be the responsibility of developer of the Western Energy WPP to install the plant and necessary compensating equipment at its switchyard on the basis



plant and necessary compensating equipment at its switchyard on the basis of detailed design/field testing studies to meet the power quality standards as per requirements of NEPRA Grid Code Addendum for WPPs.

- vii) It is concluded on the basis of the results of the detailed system studies that the proposed interconnection scheme has no transmission system constraints in power evacuation from Western Energy WPP to the National Grid.
- viii) It is added that the Grid Code Addendum for WPPs is currently under revision and the project sponsor of Western Energy WPP will be required to follow/implement the requirements/recommendations given in the revised Grid Code, after its approval from NEPRA and make necessary additions/modifications in the equipment/substation of Western Energy WPP, if any, in this regard.
- ix) In view of the huge wind potential at Jhimpir & in its surrounding areas, the power system network around Western Energy WPP will be developed in future. Therefore, there may be possibility of modification in the interconnection arrangement of Western Energy WPP in future, if needed necessary as per system requirements.

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THE COMPANIES ORDINANCE, 1984

(A Company Limited by Shares)

MEMORANDUM OF ASSOCIATION

OF

WESTERN ENERGY (PRIVATE) LIMITED

- The name of the company is WESTERN ENERGY (PRIVATE) LIMITED. **l**.
- The Registered office of the company will be situated in the province of Sindh. II.
- The main and exclusive object for which the company is established is to set up an III. industrial undertaking in power sector to carry on the business of electric power generation, accumulation, transmission and distribution thereof in all its branches and aspects by the use of such forms of energy and in such manner as may be deemed feasible for that purpose. To achieve the main and exclusive object the Company shall be authorized:
 - To market, sell, transmit and deliver the electric power generated by the 1. Company any where in Pakistan.
 - To arrange for buying all kinds of plant and machinery, equipments, tools and 2. other raw material, whether local or imported, on cash, loan, deferred credit, pay-as-earn or non-repatriable investment basis.
 - To acquire by purchase, exchange, hire, assignment or otherwise, tenements, 3. of any kind whatsoever, machinery, trade marks, patents or inventions, or other properties, plants and stock-in-trade and to employ, sell, exchange mortgage, get on lease, license to use or otherwise. buildings, easements, rights, advantages, moveable and immoveable property

- 4. To purchase, or acquire by some other means, any land or lands and build, erect, construct, furnish, equip, maintain or improve any building, structure and edifice and to carry on construction thereof for the purposes of the Company.
- 5. To arrange electricity, water, gas, sewerage and other utilities required for efficient running of the project
- 6. To appoint agents, sub-agents, attern to consultants, brokers and contractors in connection with the business of the Company but not to act as managing agents.

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- 7. To adopt such means of making knows, the product of the Company as may seem expedient, and in particular by advertising in the press and electronic media, by circulars, by purchase and exhibition of works of art or interest, by publication of books and periodicals, and by rewards, stipends and donations.
- 8. To enter into any arrangement with any governments or authorities (Federal, Provincial, Municipal, Local or otherwise), or any corporations, companies, firms or persons that may seem conducive to the Company's exclusive object, and to obtain from any such government, authority, corporation, company, firm or person any charters, contracts, decrees, rights, privileges and concessions which the Company may think desirable, and to carry out, exercise and comply with any such charters, contracts, decrees, rights, privileges and concessions.
- 9. To sell or otherwise dispose off all goods, materials, articles and things belonging to the Company either on cash or on credit and either for immediate or future delivery and to send the same for sale or export to any place that may be deemed necessary or expedient, in the event of winding up of the Company.
- 10. To get insured against losses, damages, risks, accidents and liabilities of all kinds which may affect the company whether in respect of its contracts, agreements, advances or securities or in respect of servants or employees of the company, or in respect of property belonging to or leased to or hired by the company, either by setting apart funds of the company or by effecting such insurance.
- 11. To open, close and operate bank accounts with scheduled banks or financial institutions and to draw, make, accept, endorse, discount, execute and issue promissory notes, bills of exchange, cheques, bills of lading, warrants, debentures and other negotiable or transferable instruments, concerning the business of this Company.
- 12. To borrow or procure on mark-up, profit or return in any form, money or finances, in local or any foreign currency from any bank or financial institution and to receive money on mark-up by issuing debentures, and on

security of any such money so borrowed or received to mortgage, pledge, charge or hypothecate whole or any part of property, assets or revenue of the Company (both present and future) including its capital by special assignment or otherwise, to transfer or convey the same conditionally, absolutely or in trust and to give, tender power to sell and other powers as may seem expedient, and to purchase or redeem such securities and pay for such borrowing and loans for the purpose of achieving the main and exclusive object.

- 13. To procure or arrange finances from scheduled banks and financial institutions under any mode of Islamic financing scheme like, redeemable capital including modaraba and musharaka and to procure, raise or secure the money in such manner as the company may deem fit and particularly by mortgage of its property in full or in part on both the present and future assets in accordance with the Islamic Laws and/or by the issue of shares, bonds, debentures, participation term certificates, Term Finance Certificates, or redeemable capital or any other securities charged or based upon the undertaking of the company, on any part of its property, both present and in future and generally to borrow money for achievement of the main and exclusive object of the company in such manner as the company shall deem fit. To issue debentures or participation term certificates, term finance certificates, redeemable capital, either permanent or redeemable or repayable or convertible into shares and to secure any securities of the company by a trust or other assurances.
- 14. To distribute any of the property of the Company amongst the members in specie or kind and in particular any shares, debentures or securities of other companies belonging to this Company, or of which this Company may have Karachillon the power of dispose of, in the event of winding up of the Company.

to create any depreciation fund, provident fund, reserve fund, sinking fund, insurance fund, or any other special fund conducive to the interest of the company.

To establish and maintain branches, receiving offices and distribution centers and to enter into contracts or agency agreements (other than managing agency) with any other persons or firms or companies or for the distributing centers for achievement of the main and exclusive object of the Company.

- 17. To undertake and execute any trusts which the Company may think fit and expedient to undertake for the benefit of the employees.
- 18. To apply for, purchase, or other wise acquire, and protect and renew any patents, patent rights, trade marks, designs, licenses, concessions and the like, conferring any exclusive or non-exclusive or limited right to their use.
- 19. To train personnel and workers, in Pakistan and/or abroad, to obtain technical proficiency in various specialities connected with the business of the Company.

- 20. To give any indemnity, guarantee or security or enter into any bond and, without restricting the generality of the foregoing, to indemnify any person or company, and guarantee or otherwise become liable for the performance by any person or company of any obligation, contract or undertaking as may be required in connection with the business.
- 21. To carry on any other business or activity and do any act or thing which in the opinion of the Company is or may be capable of being conveniently carried on or done in connection with the objects of the Company and or any of the above powers, or likely directly or indirectly to enhance the value of or render more profitable all or any part of the Company's property or assets or otherwise to advance the interests of the Company or its members.
- 22. To carry out joint venture agreements with other companies or countries within the scope of the objects of the Company.
- 23. To amalgamate, merge with, absorb, reconstruct, de-merge, acquire or take over any other company or the whole or part of any undertaking having objectives altogether or in part similar to those of the Company or carrying on any business capable of being conducted so as directly or indirectly to benefit this Company, whether by sale or purchase of the assets, property or undertaking, or divestiture of the whole or part of the undertaking of the company or by partnership or any arrangement in the nature of partnership or in any other manner or to enter into and carry into effect any arrangement, or for sharing of profits, with any partnership undertaking or person carrying on business within the objects of this Company.

To do and perform all other acts and things as are incidental or conducive to acts and things as are incidental or conducive to acts are incidental or conducive to acts are incident.

Notwithstanding anything contained in the foregoing object clause of this Mentorandum of Association, nothing herein shall be construed as empowering the Company to undertake or indulge in the business of a banking company, a financial institution, a leasing company, an investment company, an insurance company or an investment advisory company. directly or indirectly, as restricted under law or in any unlawful operation and that nothing in the object clause shall be construed to entitle it to engage in such business. The Company shall not launch multilevel marketing, pyramid and ponzy schemes.

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

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IV. The liability of the Members is limited.

V. The authorized share capital of the Company is Rs. 300,000 (Rupees Three Hundred thousand only) divided into 30,000 (Thirty Thousand) ordinary shares of Rs. 10 (Rupees Ten) each with powers to increase and reduce the capital of the Company in such manner as may be consistent with the provisions of the Companies Ordinance, 1984.



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We, the serveral persons whose names and address are subscribed below, are desirous of being formed into a Company persaunt of this Memorandum of Association, and we agree to take number of shares in the

Name and surname (present and former in full and block letters)	Father's/Husband's name in full	Nationality with any former Nationality if any	Occupation	Residential address	Number of shares taken by each subscriber	Signature
MR. TAJWAR TAPAL CNIC No.35201-2649288-5	Mr. Moiz Ali Tapal	Pakistani	Business	6-A, 1st Gizri Lane, D.H.A., Karachi	2,500 (Two Thousand Five Hundred)	
MR. TABISH TAPAL CNIC No. 42301-2385059-9	Mr. Moiz Ali Tapal	Pakistani	Business	33-B, 3rd Gizri Street, Phase IV, D.H.A., Karachi	4,500 (Four Thousand Five Flunred)	
MR. MUHAMMAD SADIQ TAPAL CNIC No. 35201-2785819-5	Mr. Tajwar Tapal	Pakistani	Business	73/6A, Munir Road, Lahore, Pakistan	2,500 (Two Thousand Five Hundred)	
Total	Mr. Abid Hussain Lakdawala	Pakistani	Service	94/1, Bahadur Yar Jang Society, Karachi, Pakistan	500 (Five Hundred)	Howshy
					10,000 (Ten Thousand)	

Dated this 17th day of June 2013

Full Name, Father's/Husband's Name

Mr. Imran S/o Mr. Aba Umar



Occupation

Full Address

Private Service F-25

F-25, Block 5, Kehkashan Clifton, Karachi.

Certified to be True Copp Joint Registrar of Companies

THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

WESTERN ENERGY (PRIVATE) LIMITED

PRELIMINARY

1. Table A not to apply

The regulations contained in the Table 'A' in the First Schedule to the Companies Ordinance 1984, shall not apply to the Company except so far as the same are repeated, contained or expressly made applicable in these Articles or by the Ordinance.

- 2. The headings hereto shall not affect the construction hereof and in these presents, unless there is something in the subject of context for the time being in force.
 - i) *The Ordinance'* means the Companies Ordinance, \$984, or any sentrory modification or re-enactment thereof for the time being proces.

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- ii) *The Articles* means the Articles of Association as originally tanked or as from time to time altered by Special Resolution;
- iii) 'The Company' means WESTERN ENERGY (PRIVATE)
- iv) *Special Resolution* has the same meaning as assigned thereto by Section 2(1)(36) of the Ordinance;
- v) *'Member'* means member of the Company in accordance with the provisions of Section 2(1)(21) of the Ordinance.
- vi) *'The Directors'* means the Directors, including alternate director for the time being of the Company.
- vii) *The Chief Executive* means the Managing Director of the Company, by whatever name called, appointed pursuant to Section 198 of the Ordinance.

- viii) 'The Board' means the Board of Directors for the time being.
- ix) 'The Secretary' means the Secretary for the time being of the Company.
- x) *'The Register'* means the Register of Members to be kept pursuant to Section 147 of the Ordinance.
- xi) *'The Office'* means the Registered Office for the time being of the Company.
- xii) 'Dividend' includes bonus shares.
- xiii) *Seal* in relation to a Company means the Common Seal of the Company.
- xiv) 'Month' means calendar month.
- xv) *Proxy* includes an attorney duly constituted under a power of attorney.
- xvi) '*The Registrar*' means a Registrar, an Additional Registrar, a Joint Registrar, a Deputy Registrar or an Assistant Registrar of Companies.
- xvii) *'In Writing and Written'* includes printing, lithography, typewriting and other modes of representing or reproducing words in a visible form.
- xviii) Words importing the singular number shall include the plural number and vice versa.
- xix) Words importing the masculine gender shall include the feminine gender.
- *xix)* 'Person' includes Corporations.
- xxi) 'Family Members' mean and include Parents, Husband,
- 3. Unless the context otherwise requires or unless expressly defined work or expressions, contained in these Articles shall bear the same meaning as in the Ordinance of the statutory modification thereof in force at the date at which these present are binding on the Company.

BUSINESS

4. The business of the Company shall be the main and exclusive object provided in the Memorandum of Association.

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CAPITAL

5. The authorized share capital of the Company is Rs. 300,000 (Rupees Three Hundred Thousand only) divided into 30,000 (Thirty Thousand) ordinary shares of the nominal value of Rs. 10 (Rupees Ten) each.

The share capital of the Company may comprise of different classes of shares, issued from time to time, including ordinary shares, cumulative and non-cumulative preference share, and shares having different rights and privileges attached to them, subject to requirement and conditions mentioned in Companies Share Capital (Variation in Rights and Privileges) Rules, 2000. Subject to the aforesaid, shares of different classes and kinds may have different rights and privileges attached to them, however all shares of a particular class shall have same rights and privileges attached to them.

SHARES

6. The Company shall not issue partly paid shares.

- 7. Except to the extent and in the manner allowed by Section 95 of the Ordinance, no part of the funds of the Company shall be employed in the purchase of, or in loans upon the security of, the Company's shares.
- 8. The Directors may increase the share capital by such sum as they think fit, to be divided into shares of such amount as the resolution may prescribe, subject, nevertheless, to the provisions of Section 92 of the Ordinance.
- 9. Where the Directors decide to increase the Issued Capital of the Company by the Issue of ordinary or preference shares, either at a premium or at par, such shares, shares offer don such terms and conditions and for such consideration, and at such time is the starter of shares in proportion to the existing shares held by each member of shares to which the accuracy offer shall be made by notice specifying the number of shares to which the accuracy of the declined; and after the expiration of such time or on receipt of an intimation for the shares offer the shares of the same in such manner as they think most beneficial to the Company.
- 10. The Company may at any time pay commission to any person for subscribing or agreeing to subscribe (whether absolutely or conditionally) for any shares, debentures or debenture stock of the Company, or procuring or agreeing to procure subscriptions (whether absolutely or conditionally), for any shares, debentures, debenture stock of the Company, but if the commission in respect of shares shall be paid or payable out of capital, the conditions and requirements laid-down in Section 82 of the Ordinance shall be observed. The amount or rate of commission shall not exceed any statutory limit thereon. The commission may be paid or satisfied in cash or in shares, debentures or debenture-stock of the Company.

- 11. Any capital raised by the creation of new shares, subject to the capital structure stipulated in these present shall be considered part of the original capital and shall be subject to the provisions herein contained with reference to the payment, transfer and transmission, surrender, voting and otherwise.
- 12. The Company may from time to time by Special Resolution reduce its share capital in any way and in particular (without prejudice to the generality of the power) by paying off capital or canceling capital which has been lost or is unrepresented by available assets or reducing the liability on the share or otherwise as may seem expedient and capital may be paid off which is in excess of the needs of the Company or otherwise, and paid up capital may be cancelled as aforesaid without reducing the nominal amount of the shares by the like amount to the extent that the capital shall be increased by the like amount.
- 13. Save as herein otherwise provided, the Company shall be entitled to treat the registered holder of any share as the absolute owner thereof and accordingly shall not, except as ordered by a court of competent jurisdiction, be bound to recognize any equitable, contingent or partial interest in or any other right in respect of such share on the part of any other person.
- 14. Shares may be registered in the name of any limited Company or other corporate body but not in the name of a firm. Not more than four persons shall be registered as joint holders of any shares.
- 15. If any share stands in the name of two or more persons, the person first named in the Register shall, as regards receipt of dividend or bonus or service of notice, and all or any other matters connected with the Company except voting at the meeting and the transfer of shares, be deemed the sole holder.
- 16. In the case of the death of any one or more of the persons named in the Register as the joint-holder of any share, the survivor or survivors shall be the only person or persons recognized by the company as having any title to or interest in successfue, but nothing herein contained shall be taken to release the estate of a joint holder strong the state of a joint holder.
- 17. Every shareholder shall name to the Company a place in Pakistan to be reashered as his address and such address shall for all purposes be deemed to ball is place the sidence.
- 18. Subject to the provisions of Section 92 of the Ordinance the Company may by special Resolution:
 - a) consolidate and divide the whole or any part of its share capital into shares of larger amount than its existing shares;
 - b) sub-divide its shares or any of them into shares of smaller amount than is fixed by the Memorandum of Association;

c) cancel any shares which at the date of passing of the resolution have not been taken or agreed to be taken by any person.

The Resolution by which any share is sub-divided or consolidated may determine that as between holders of shares resulting from sub-division or consolidation, rights of profits, votes and other benefit attaching to them will be proportionate to their paid up value and where shares issued as sub-divided or consolidated shares are of same class as those previously issued that rights attaching to them, subject as aforesaid, shall be the same as those attaching to the shares previously held.

19. Subject to the provisions of the Ordinance and these Articles, the Directors may allot and issue shares in the capital of the Company as payment or part payment of any property, sold or transferred, discharge of any indebtedness or obligations of the company, goods or machinery supplied or for services rendered to the Company in or about the formation or promotion of the Company or conduct of its business, and any shares which may be sold or allotted may be issued as fully paid-up shares, and, if so issued, shall be deemed to be fully paid up shares

CERTIFICATE

- 20. Every person whose name is entered as Member in the Register shall without payment be entitled to receive, after allotment or registration of transfer, one certificate for all his shares or several certificates each for one or more of his shares and upon payment of such charges, if any, as the Directors may determine for every certificate after the first.
- 21. The certificates of title of share and duplicates thereof when necessary shall be issued under the seal of the Company and signed by two Directors, or by one Director and the Secretary.
- 22. The Company shall not be bound to issue more than one share certificate in respect of a share or shares held jointly by two or more persons, and delivery of a certificate for a share to any one of joint holders shall be sufficient delivery to all.
- 23. The Company shall, within ninety days, after the allotinent of any of its shares, and within 45 days after the date on which the instrument of transfer has been lodged, complete and have ready for delivery the certificates of all shares, allotted or transferred, unless the conditions of issue of the shares otherwise provide.
- conditions of issue of the shares otherwise provide.
 24. If any certificate be worn out, defaced, destroyed or if there is no further space on he back thereof for endorsement of transfer, it may be renewed or replaced of saves of such sum, not exceeding five Rupees, as the Directors may from time to time to time to the provided, however, that such new certificate shall not be granted exceeding five Rupees of the trorn out or defaced or used up certificate for the purpose of cancellate for upon proof of destruction or loss to the satisfaction of the Directors and on such indemnity as the Directors may deem adequate in case of certificate having been lost or destroyed. Any renewed certificates shall be marked as such.

TRANSFER AND TRANSMISSION OF SHARES

- 25. In the event of sale or transfer of shares as permitted under the Ordinance, the transferee of shares shall, if not already a member become a member and shall be bound by the terms of the Articles in the same manner and to the same extent as the transferor of shares.
- 26. A share may, subject to the provisions of Section 76 of the Ordinance, at any time be transferred, by a Member or other person entitled to transfer, provided it is approved by the Board in accordance with the provisions contained in these present
- 27. If the Directors refuse to register the transfer of any shares they shall within one month from the date on which the transfer was lodged with the Company send to the transferee and the transferor notice of such refusal indicating the defect or invalidity to the transferee, who shall, after removal of such defect or invalidity, be entitled to re-lodge the transfer deed with the Company. No transfer of shares in any case be made to an insolvent or person of unsound mind.
- 28. The transfer of shares shall be effected by an instrument in writing in the usual common form modified so as to suit the circumstances of the parties and shall be executed both by the transferor and the transferee and duly stamped according to law, whose execution be attested by at least one witness, who shall add his address and occupation, and the transferor shall be deemed to remain the holder of such shares until the name of transferee shall have been entered in the Register of members in respect hereof.
- 29. Every instrument of transfer shall be left at the office for registration, duly stamped and accompanied by the certificate of the shares to be transferred and such other evidence as the Company may require to prove the title of the transferor or his right to `transfer the shares'. All instruments of transfer which will be registered shall be retained by the Company, but any instrument of transfer which the Directors may decline to register shall, on demand, be returned to the person depositing the same.
- 30. Where it is proved to the satisfaction of the Directors that an instrument of illinities signed by the transferor and the transferee has been lost, the Company mays if the Directors shall think fit, by an application in writing made by the transferee and teating the transfere and teating the transfer on such terms as to memory as the Directors may think fit.
- 31. Nothing contained in Articles 26 and 29 shall prejudice any power of the company to register as shareholder any person to whom the right to any shares of the company has been transmitted by operation of law.
- 32. No fee will be charged for registering transfer of shares.
- 33. The transfer books and register of members may be closed for any time or times not exceeding in the whole forty five days in each year, but not exceeding thirty days at a time, in accordance with the manner specified in Section 151 of the Ordinance.

- 34. The nominees of a deceased member as specified in Section 80 of the Ordinance, or executors or administrators of a deceased member shall be the only persons recognized by the Company as having title to his share except in case of joint holders in which case the surviving holders or the executors or administrators of the last surviving holder shall be the only person entitled to be so recognized; but nothing herein contained shall release the estate of a deceased joint holder from any liability in respect of any share jointly held by him. The Company shall not be bound to nominee of deceased member or executor or administrator unless he shall have obtained probate or letters of administration or other legal representation, as the case may be, from a duly constituted court in Pakistan or from any court or authority authorized by any Act of the legislature or by any order or notification of the Federal or Provincial Government, to grant such probate or letters of administration. Provided nevertheless that in special cases, and in such cases only, it shall be lawful for the Directors to dispense with the production of probate or letters of administration or such other legal representation upon such terms as to indemnity or otherwise as the Directors may deem fit.
- 35. A person becoming entitled to a share by reason of the death or insolvency of the holder shall be entitled to the same dividends and other advantages to which he would be entitled if he were the registered holder of the share, except that he shall not, before being registered as a member in respect of the share, be entitled in respect of it to exercise any right conferred by membership in relation to meetings of the Company.
- 36. Neither the Company nor its Directors shall incur any liability or responsibility whatsoever in consequence of their registering or giving effect to any transfer of shares made or purporting to be made by an apparent legal owner thereof to the prejudice of persons having or claiming any equitable right, title or interest to or in the same, notwithstanding that the Company may have had notice of such equitable right, title or interest, or notice prohibiting registration of such transfer, and may have entered such notice or referred thereto in any book of the Company and shall not be bound or required to attend or give effect to any notice which may be given to them of any equitable right, title or interest or be under any liability whatsoever for refusing or neglecting so to do, though it may have been entered or referred to in some book of the Company; but the Company shall nevertheless be at liberty to regard and attend to any such notice and give effect thereto if the purpose shall so think fit.

GENERAL MEETINGS



- 37. A general meeting, to be called Annual General Meeting, shall be held within eighteen months from the date of incorporation and thereafter once at least the reach calendar year within a period of four (4) months fullowing the close of its financial year at such time and place as the Directors may determine, provided, however, that no greater interval than fifteen months shall be allowed to clapse between two Annual General Meetings. All general meetings of the Company other than Annual General Meeting shall be called Extraordinary General Meetings.
- 38. The Directors may, whenever they think fit, call an Extraordinary General Meeting and Extraordinary General Meeting shall also be called on the requisition of the holders of not

less than 10% of the issued capital of the Company on the date of deposit of requisition, the directors shall forthwith proceed to convene an Extraordinary General Meeting of the Company and in case of such requisition, the provisions of Section 159 of the Ordinance shall apply.

If at any time sufficient number of directors capable of acting to form a quorum are not 39. present in Pakistan, the directors may convene an extra ordinary general meeting in the same manner as nearly as possible in the manner in which the Meeting may be convened by the Directors

NOTICE OF MEETING

- 40. Subject to the provisions of Sections 158 and 159 of the Ordinance twenty-one days' notice at least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given) specifying the place, the day the hour of meeting and, in case of special business the general nature of that business, shall be given in the manner provided by the Ordinance for the general meeting, to such persons as are under the Ordinance or the regulations of the Company, entitled to receive such notice from the Company. With the consent in writing of all the members entitled to receive notice of some particular meeting, that meeting may be convened by such shorter notice and in such manner as those members may deem fit.
- 41. The accidental omission to give notice of a meeting to or the non-receipt of notice of a meeting by, any member or person entitled to receive notice shall not invalidate the proceedings at any general meeting.

PROCEEDINGS AT GENERAL MEETINGS

- The business of the Annual General Meeting shall be to reperce Rands by sider the balance 42. sheet and profit and loss account, the reports of the Directors and of the Austrors, to elect Directors, to declare dividends and to appoint Auditors, and fix their remuterations. All other business transacted at an Annual General Meeting and an business transacted at Extraordinary General Meetings, shall be deemed special
- No business shall be transacted at any General Meeting toless augrum of members is 43. present at the time when the meeting proceeds to business. Suffect to the provisions of the Ordinance, two (2) members present personally who represent more than twenty five percent of the total voting power, either of their own account or as proxies, shall be a quorum.
- If within half an hour from the time appointed for the meeting, a quorum is not present, the 44. meeting if called upon requisition of members shall be dissolved; in any other case it shall stand adjourned to the same day in the next week at the same time and place, and, at the adjourned meeting the quorum shall be two (2) members present in person.
- 45. The Chairman, if any, of the Board shall preside as Chairman at every General Meeting of the Company, but if there is no such Chairman, or if he shall not be present within fifteen minutes after the time appointed for the holding of the meeting or is unwilling to act, the

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Directors present shall elect one of the members present to be Chairman of the meeting, or if no Directors be present or if Directors present decline to take the chair, the members present shall choose one of their member to be Chairman of the meeting.

- 46. The Chairman may with the consent of any meeting at which a quorum is present (and shall, if so directed by the meeting), adjourn the meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place. When a meeting is adjourned for thirty days or more, notice of adjourned meeting shall be given as in the case of original meeting. Save as aforesaid, it shall not be necessary to give any notice.
- 47. At a General Meeting a resolution put to the vote of the meeting shall be decided on a show of hands, unless a poll is (before or on the declaration of the show of hands) demanded in accordance with provisions of Section 167 of the Ordinance:
 - a) by the Chairman of the meeting of his own motion; or
 - (b) by one Member having the right to vote on the resolution and present in person or by proxy if not more than seven such members are personally present, and by two such Members present in person or by proxy if more than seven such Members are personally present; or
 - (c) by any Member or Members present in persons or by proxy and having not less than onetenth of the total voting power in respect of the resolution; or
 - (d) by any Member or Members present in person or by proxy and holding shares in the company conferring a right to vote on the resolution, being shares on which an aggregate sum has been paid up which is not less than one-tenth of the total sum paid up on all the shares conferring that right.

shares conferring that right. Unless a poll is so demanded, a declaration by the Chairman of the meeting that a resolution has on a show of hands been carried or carried unanimously by proceeding that a resolution lost, and an entry to that effect in the book containing the minutes of the meeting that are proportion of the votes recorded in favour of or against that resolution.

48. Any poll duly demanded on the election of a Chairman of a meeting of on any question of adjournment shall be taken at the meeting and without adjournment.

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- 49. If a poll is duly demanded, it shall be taken in accordance with the manner laid down in section 168 of the Ordinance and the results of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded.
- 50. The demand of a poll shall not prevent the continuance of the meeting for the transaction of any business other than the question on which the poll has been demanded. The demand for a poll may be withdrawn at any time by the person or persons who made demand.

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- 51. The Chairman of any meeting shall be the sole judge of the validity of every vote tendered at such meetings. The Chairman present at the time taking of a poll shall be the sole judge of the validity of every vote tendered at such poll.
- 52. The following matters shall be resolved only by Special Resolution of the Company in General Meeting.
 - a) Increase or reduction in the Authorized Share Capital;
 - b) lssue of debentures;
 - c) Sale or disposal or leasing out of a substantial part of the undertaking of the Company;
 - d) Sale of the whole of the undertaking of the Company;
 - e) Amendment to the Memorandum and Article of Association; and
 - f) the redemption or repurchase by the Company of outstanding shares of the Company to the extent so authorized by law.

VOTES OF MEMBERS

- 53. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands every member present in person or by proxy and every corporation present by proxy or by a representative duly appointed pursuant to Article 64 shall have one vote except for election of Directors in which case the provisions of Section 178 of the Ordinance shall apply. On a poll every member shall have voting rights as laid down in Section 160 of the Ordinance.
- 54. In the case of joint holders the vote of the senior member present whether in person or by proxy shall be accepted to the exclusion of the votes of the other joint holders, and for the purpose seniority shall be determined by the order in which their manes stand in the Register.
- 55. A member of unsound mind, or in respect of whom an order has been inade by any court is having jurisdiction in lunacy, may vote, whether on a show of hands up on a polit, by his committee or other legal guardian and any such committee or guardian not committee or guardian n
- 56. No member shall be entitled to vote at any General Meeting unless all sums presently payable by him in respect of shares in the Company have been paid.
- 57. No objection shall be raised to the qualification of any voter except at the meeting or adjourned meeting at which the vote objected to is given or tendered, and every vote not disallowed at such meeting shall be valid for all purposes. Any such objection made in due

time shall be referred to the Chairman of the Meeting, whose decision shall be final and conclusive.

58. On a poll votes may be given either personally or by proxy or in the case of a corporation by a representative duly authorized in accordance with Article 64.

59. The instrument appointing a proxy shall be in writing under the hand of the appointer or of his attorney duly authorized in writing, or if the appointer is a corporation, under its common seal or the hand of an officer or attorney so authorized and in default the instrument of proxy shall not be duly authorized. A proxy must be a member of the Company.

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

Signed this day of.....

- 62. The instrument appointing a proxy shall be deemed to confer authorith domand of demanding a poll.
- 63. A vote given in accordance with the terms of an instrument or proxy the best of notwithstanding the previous death or insanity of the principal or revocation of the proxy or of the authority under which the proxy was executed, or the transfer of the shares in respect of which the proxy is given, provided that no intimation in writing of such death, insanity, revocation or transfer as aforesaid shall have been received by the Company at the office before the commencement of the meeting or adjourned meeting at which the proxy is used.
- 64. Subject to the provisions of Section 162 of the Ordinance, a company or other body corporate which is a member of the Company may by resolution of its Directors or other governing body authorize such person as it thinks fit, to act as its representative at any meeting of the Company or of any class of members of the Company, and the person so authorized shall be entitled to exercise the same power on behalf of the company which he represents as that company could exercise if it were an individual member of the Company

present in person. A corporation or company attending a meeting through such representative shall be deemed to be present at the meeting in person.

DIRECTORS

- 65. The number of Directors to be elected shall be fixed, according to the provisions of Section 178 of the Ordinance, from time to time by the Board, subject to the condition that there shall not be less than two (2) directors nor more than ten (10) directors, and until otherwise determined by the Company by a Special Resolution in a general meeting, the number of Directors including the Directors nominated by the Company's creditors or other special interest by virtue of contractual obligation in accordance with the provisions of the Ordinance, shall not be more than ten (10), including the Chief Executive of the Company.
- 66. The following shall be the first Directors of the Company:
 - 1. Mr. Tajwar Tapal
 - 2. Mr. Tabish Tapal
 - 3. Mr. Muhammad Sadiq Tapal
 - 4. Mr. Mustafa Lakdawala
- 67. Except in the manner and to the extent provided for nomination in Article 65 hereof, the appointment, election, tenure of office and removal of directors shall be made and/or carried out in accordance with provisions of the Ordinance.
- 68. Save as provided in Section 187 of the Ordinance and Article 65 hereof, no person shall be appointed as a director unless he is a member of the Company.
- 69. The first directors shall stand retired at the first annual general meeting, and directors shall be nominated in accordance with Article 65 hereof, be elected in their place in accordance with Article 72 hereof.
- 70. Any person who seeks to contest an election to the office of Director shall, whether we is a retiring Director or otherwise, file with the Company, not later than four endage before the date of the meeting at which elections are to be held, a notice of his intention to offer himself for election as a Director. Provided that any such person may any time, before the holding of elections withdraw such notice.
- 71. Retiring Directors shall be eligible for re-election.
- 72. The Directors shall be elected in accordance with the provisions of the Ordinance by the Members in General Meeting from amongst the candidates eligible for election in the following manner:
 - a) every member present in person or by proxy or by representative shall have such number of votes as is equal to the product of the number of voting shares held by him and the number of Directors to be elected:

- b) the number of votes calculated in accordance with the preceding clause (a) may be given to a single candidate or may be divided between any two or more candidates in such manner as the person voting may choose; and
- c) the candidate who gets the highest number of votes shall be declared elected as Director and then the candidate who gets the next highest number of votes shall be so declared and so on until the total number of Directors to be elected has been so elected.
- 73. The Company in General Meeting may remove a Director from office by a resolution passed with the requisite number of votes determined in accordance with the provisions of Section 181 of the Ordinance.
- 74. Retiring directors shall continue to perform their functions until their successors are elected.
- 75. A Director elected by the members in General Meeting shall hold office for a period of three years following the date from which his election is effective unless he earlier resigns, becomes disqualified from being a Director or otherwise ceases to hold office.
- 76. A casual vacancy occurring among the elected Directors may be filled up by the directors, but a person so appointed in lieu of an elected Directors shall hold office for the remainder of term of the Director in whose place he is appointed.
- When any director intends to be, or is absent for a period of not less than three (3) months **7**7. from Pakistan, he may with the approval of the directors appoint any person to be his alternate director, and such alternate director during the absence of the appointer from Pakistan, shall be entitled to receive notice of and to attend and vote at meeting of directors and shall be subject to and entitled to the benefit of the provisions contained in these Articles with reference to directors and may exercise and perform all such powers, directions and duties as his appointer could have excreised or performed including the power of appointing another alternate director. An alternate director so appointed shall not be entitled to receive any remuneration from the Company nor be required to hold any qualification. Such appointment shall be recorded in the directors' minute book. A director may at any time by notice in writing to the Company remove an alternate director appointed by him upon the return of the appointer to Pakistan, or the death of, or the returnment or resignation as director of the appointer, the alternate director shall cease to be such provided that if any director retires but is re-elected at the meeting at which such retirement toole effect any appointment made by him pursuant to this Article which was not force immediately prior to this retirement and re-election and which has not the wine censed to be effective shall continue to operate after his re-election as if he hatenot so retired. An alternate director shall not be deemed to be the agent of the director appressing him but shalk be reckoned as one with his appointer. All appointments and removals of atternate directors shall be effected by writing under the hand of the director making or recoking out appointment and left at the office. For the purpose of assessing a quorum in accordance with the provisions of Article 94 hereof an alternate director shall be deemed to be director. Any director may act an alternate director for any one or more directors, as well as being able to act as a director in his own right. An alternate director may resign as such upon giving thirty (30) days prior notice to the Board to this effect. An alternate director need not be a member of the Company.

- 78. The remuneration to be paid to any Director for attending meetings of the Board shall, from time to time, be determined by the Board of Directors. It shall not exceed Rs. 500 per meeting. The directors shall be paid such traveling expenses as may be fixed by the directors from time to time or in or about the performance of their duties as directors or if a director has to come to attend the Board meeting from outstation.
- 79. Any Director appointed to any executive office, including for purpose of this Article, the office of chief executive or chairman, who serves on any committee or who devotes special attention to the business of the Company or who otherwise performs extra services which in the opinion of the Board are outside the scope of the ordinary duties of a Director, may be paid such extra remuneration whether by way of salary, fees, percentage of profits or otherwise, as the Board may determine, which shall be charged as part of the Company's ordinary working expenses; subject to the provision of any law for the time being in force.
- 80. The Directors shall elect one of their number as the Chairman of the Board.
- 81. The Directors may from time to time delegate any of their powers to a committee or committees consisting of two (2) or more members of their body as they think fit. Any committee so formed shall conform to any regulations that may by imposed upon it by the Directors and shall be governed, in the exercise of the powers so delegated, by the provisions herein contained for regulating meetings and proceedings applicable to the Directors.

POWERS AND DUTIES OF DIRECTORS

- 82. The business of the Company shall be managed by the Directors, who may pay all expenses incurred in setting up and registering the Company, and may exercise all such powers of the Company as are not by the Ordinance or any Statutory modification thereof for the time being in force, or by any other law or these Articles, required to be exercised by the Company in General Meeting subject, never-the-less, to any regulations of these Articles, to the provisions of the Ordinance, and to such regulations being not inconsistent with the aforesaid regulations or provisions, as may be prescribed by the Company in General Meetings, but no regulation made by the Company in General Meeting shall invalidate any prior act of the Directors which would have been valid if that regulation had not been made.
- 83. The Directors may exercise all the powers of the Compare to bortone more and to mortgage its undertaking, property and capital or any part thereof, and to any part thereof, and to debentures, Participation or Term Finance Certificates or any once, instrument, whether outright or as security for any debt, liability or obligation of the Compare or of any third party.
- 84. The Directors may from time to time and at any time by power or attorner oppoint any company, firm or person or body of persons, whether nominated directly or indirectly by the Directors, to be the attorney or attorneys of the company for such purposes and with such powers, authorities and discretion (not exceeding those vested in or exercisable by the Directors under these Articles) for such period subject to such conditions, if any, as they may think fit, and any such powers of attorney may contain such provisions for the

protection and convenience of persons dealing with any such attorney to delegate all or any of the powers, authorities, and discretion vested in him.

- 85. A Director of the Company or a firm of which such Director is a partner or private company of which such Director is a Director may with the consent of the Company in General Meeting hold any office of profit in the Company.
- Subject to the provisions of Section 195 and 196 of the Ordinance, the Directors shall not be 86. disqualified from contracting with the Company either as vendor, purchaser, or otherwise, nor shall any such contract or agreement entered into by or on behalf of the company or partnership of or in which any Director of the Company shall be a member or otherwise interested be avoided nor shall any such Director so contracting or being such member or so interested be liable to account to the Company for any profit realized by any such contract or arrangement by reason of such Director holding that office or of the fiduciary relation thereby established, but the nature of his interest must be disclosed by him at the meeting of the Directors at which the contract or arrangement is determined on, if the interest then exists, or in any other ease at the first meeting of the Directors after the acquisition of the interest. A General Notice that any Director of the Company is a Director or a member of any other company or is a member of any named firm and is to be regarded as interested in any subsequent transaction with such company or firm shall, as regards any such transaction, be sufficient disclosure under this Article and after any such general notice it shall not be necessary to give any special notice relating to any particular transaction with such firm or company. In the case of a contract for the appointment of a manager of the company, the provisions of Section 218 of the Ordinance shall be observed and performed.
- 87. In accordance with the provisions of Section 219 of the Ordinance a Register shall be kept by the Directors in which shall be entered particulars of all contracts or arrangements and which shall be open for inspection by any member at the office during business hours.
- 88. All cheques, promissory notes, drafts, bills of exchange and other negotiable instruments, and all receipts for moneys paid to the Company, shall be signed, drawn, accepted, endorsed, or otherwise executed, as the case may be, in such manner as the Directors shall from time to time by resolution determine.
- 89. The Directors shall duly comply with the provisions of the Ordinance or any statutory modification thereof for the time being in force, and in particular with the provisions in regard to the registration of the particulars of mortgages and charges affecting the property of the Company or created by it, and to keep a Register of the Directors and Managers, and to send to the Registrar an annual list of members and a summary of particulars relating thereto and notice of any consolidation or increase of share capital and copies of special resolutions and a copy of the Register of Directors and notification of any changes therein.
- 90. The Directors shall cause minutes to be made in books provided for the purpose:
 - a) of all appointments of officers made by the Directors;
 - b) of the names of the Directors present at each meeting of the Directors and of any committee of the Directors:

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

DISQUALIFICATION OF DIRECTORS

- 91. The Office of Director shall be vacated if:
 - a) he is found to be of unsound mind by a court of competent jurisdiction, or
 - b) he is adjudged an insolvent, or

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- c) he ceases to be a member of the Company; as specified in section 187 of the Ordinance, or
- d) he or any firm of which he is a partner or any private company of which he is a director without the sanction of the company in general meeting accepts or holds any office of profit under the Company, or
- e) he absents himself from three consecutive meetings of the Directors or from all meetings of the Directors for a continuous period of three months whichever is the longer without leave of absence from the Board of Directors, or
- f) he acts in contravention of Section 195 of the Ordinance, or
- g) he resigns his office by notice in writing to the Company, or
- h) he suffers from any of the disabilities or disqualifications mentioned in Section 187 of the Ordinance, or
- i) he has been convicted by a Court of competent jurisdiction for an affence me moral turpitude, or
- j) he has betrayed lack of fiduciary behavior and a declaration to this eff made by the Court under Section 217 of the Ordinance.
- If the nomination of the relevant Director by the Shareholder whose presented by such Director has been revoked or withdrawn in writing

PROCEEDINGS OF DIRECTORS

92. The Directors may meet together for the despatch of business, adjourn and otherwise regulate their meetings, as they think fit. Questions arising at any meeting shall be decided by a majority of votes. A Director may, and the Secretary on the requisition of Director shall, at any time, summon a meeting of Directors. It shall not be necessary to give notice of

a meeting of directors to any director for the time being absent from Pakistan unless such Director has appointed alternate director.

- 93. The quorum necessary for the transaction of the business of the Directors shall not be less one third of their number or three Directors whichever is greater, actually present in person or by an alternate director. For the purposes of this Article, an Alternate appointed by a Director shall be counted in a quorum at a meeting at which the Director appointing him is not present.
- 94. All questions arising at any meeting of Directors shall be decided by a simple majority of votes.
- 95. The continuing Directors may act notwithstanding any vacancy in their body, but if and so long as their number is reduced below the number fixed by or pursuant to the regulations of the Company as the necessary quorum of Directors, the continuing Directors may act for the purpose of filling vacancies in their body or summoning a General Meeting of the Company, but for no other purpose.
- 96. All acts done at any meeting of the Directors or by any person acting as a Director shall notwithstanding that it shall afterwards be discovered that there was some defect in the appointment or continuance in office of any such Director or person acting as aforesaid, or that they or any of them were disqualified or had vacated office, or were not entitled to vote, be as valid as if every such person had been duly appointed or had duly continued in office and qualified and had continued to be a Director and had been entitled to be a Director.
- 97. Except as otherwise provided in the Ordinance, any action which may be taken at a meeting of the Board of Directors shall be validly taken without such meeting if a resolution in writing approving such action is excuted by the Directors. For this purpose, it shall be permissible to circulate the text of the proposed resolution duly signed by the Chief Executive or any Director and obtain the signatures of all the other Directors thereon separately by fax and such resolution shall be effective as soon as the text of the resolution signed by each of the other Directors shall have been faxed to and received by the Company.
- 98. If at any meeting the Chairman is absent, the Directors may elect any Director to act as the Chairman for the meeting.
- 99. The Directors may delegate any of their powers not required to be exercised in their meeting to committees consisting of such member or members of their body as they though the any committee so formed shall, in the exercise of the powers so delegates, confident to any restrictions that may be imposed on them by the directors.
- 100. A committee may elect a chairman of its meeting; but if no such chairman's decree of it at any meeting the chairman is not present within ten minutes after the time appointed for holding the same or is unwilling to act as chairman, the members present may choose one of their number to be chairman of the meeting.

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101. A committee may meet and adjourn, as it thinks proper.

CHIEF EXECUTIVE

- 102. The Directors shall within fourteen days after the constitution of the Board or from the date of election of Directors or the office of the Chief Executive falling vacant, as the case may be, appoint, subject to the provisions of Section 198 of the Ordinance, a person to be the Chief Executive of the Company who may be a Director or not. The period for which a Chief Executive shall be appointed shall not exceed three years from the date of appointment unless he earlier resigns or his services as Chief Executive have been terminated by the Board in accordance with the provisions of the Ordinance. On the expiry of his term of office, a Chief Executive shall be eligible for reappointment if nominated in the manner provided in this Article. The terms and conditions of appointment of a Chief Executive including his powers and remuneration shall be determined by the Directors, subject to the provisions of the Ordinance.
- 103. The Chief Executive shall, if not already a Director, be deemed to be a member of the Board and shall be entitled to such remuneration, benefits and allowances as the Board may specify from time to time. Subject to supervision of the Board, the Chief Executive shall be responsible, and hold the powers and authorities, for the implementation of policies, decisions, guidelines and directive of the Board for achievement of the objectives of the Company and shall have, full powers to execute the same, including powers for conducting day to day management and business of the Company, appointment and termination of personnel , he will inform the Board subsequently at the earliest possible opportunity and the Board may review it if it considers necessary, powers to carry out sale, production and distribution, import, export and operation of bank account and to make payment and powers to appoint distributors, authorized sub-contractors, dealers or agents. The Chief Executive may further delegate any of his powers to any other persons or committee as he may think fit subject to the overall approval of the Board.
- 104. The Chief Executive shall devote a substantial part of his time exclusively to the management of the Company except that he may, with the prior consent of the Board, devote lesser time to the Company or become a Director of such company or companies as are not engaged in any business in direct competition with that of the Company.
- 105. The Chief Executive and/or other personnel appointed by the Company shall be entitled to remuneration and benefits comparable to the best performance Company shall be done by the Board.

SECRETARY



106. The Secretary shall be appointed by the Directors for such term, at such remuneration and upon such conditions as they may think fit, and any Secretary so appointed they be removed by them. Where there is no Secretary capable of acting, the Directors they appoint an Assistant or Deputy Secretary or any other officer of the Company to perform the duties of the Secretary.

THE SEAL

107. The Directors shall provide for the safe custody of the Seal which shall only be used by the authority of the Directors; and every instrument to which the Seal shall be affixed shall either be signed by two Directors and countersigned by Secretary or only by two Directors.

DIVIDENDS AND RESERVES

- 108. The Company in General Meeting may declare dividends, but no dividend shall exceed the amount recommended by the Directors. No dividend shall be paid by the company otherwise than out of the profits of the company or in contravention of Section 248 (2) of the Ordinance.
- 109. The Directors may from time to time pay to the members such interim dividend as appear to the Directors to be justified by the profits of the Company.
- 110. The Directors may, before recommending any dividends, set aside out of the profits of the Company, such sums as they think proper as a reserve or reserves, which shall, at the discretion of the Directors, be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the Company may be properly applied, and pending such application may, at the like discretion, either be employed in the business of the Company or be invested in such investments (other than shares of the Company) as the Directors may from time to time think fit.
- 111. When any shareholder is indebted to the Company, all dividends payable to him, or a sufficient part thereof, may be retained and applied by the Directors in or towards satisfaction of the debt.
- 112. Any dividend, interest or other moncys payable in cash in respect of shares may be paid by cheque or warrant sent through the post direct to the registered address of the holder or, in the case of joint holders, to the registered address of that one of the joint holders who is first named on the Register or to such persons and to such address as the holder or joint holders may in writing direct. Every such cheque or warrant shall be made payable to the order of the person to whom it is sent. Any of two or more joint holders may give effectual receipts for any dividends, bonuses, or other moneys payable in respect of the share-held by them as joint holders. The dividend shall be paid within the period laid down jetter.
- 113. Unpaid dividends shall not bear interest as against the Company.

CAPITALIZATION OF PROFITS

114. The Company in General Meeting may upon the recommendation of the Direction resolve that it is desirable to capitalize any part of the amount for the time being standing at the credit of any of the Company's reserve accounts or to the credit of the profit and loss accounts or otherwise available for distribution and accordingly that such sum be set free for distribution amongst the members who would be entitled thereto if distributed by way of dividend and in the same proportion on condition that the same be not paid in cash but be applied either in or towards paying up any amounts for the time being unpaid on any shares held by such members respectively or paying up in full un-issued shares of the Company to be allotted and distributed/credited as fully paid up to and amongst such members in the proportion aforesaid, or partly in the other, and the Directors shall give effect to such resolution.

ACCOUNTS

- 115. The Directors shall cause to keep proper books of account as required under Section 230 of the Ordinance.
- 116. The books of account shall be kept at the registered office of the Company or at such other place as the directors shall think fit and shall be open to inspection by the Directors during business hours.
- 117. The Directors shall from time to time determine whether and to what extent and at what time and places and under what conditions or on regulations that accounts and books or papers of the Company or any of them shall be open to the inspection of members not being directors, and no member (not being a director) shall have any right of inspecting any account and book or papers of the Company except as conferred by law or authorized by the Directors or by the Company in General meeting.
- 118. The Directors shall as required by sections 233 and 236 of the Ordinance cause to be prepared and to be laid before the Company in general meeting such profit and loss account and balance sheets duly audited and reports as are referred to in those sections.
- 119. The balance sheet, profit and loss account, and other reports referred to in Article 116 shall be made out in every year and laid before the Company in annual general meeting made up to a date not more than four months before such meeting. The balance sheet and profit and loss account shall be accompanied by a report of the auditors' of the Company and the report of directors.
- 120. A copy of balance sheet and profit and loss account and reports of directors and auditors shall, at least twenty one days preceding the meeting, be sent to the persons entitled to receive notices of general meetings in the manner in which notices are to be given hereunder.

121. The Directors shall in all respect comply with the provisions of scales 230(10,236). Ordinance.

AUDIT

122. Auditors shall be appointed and their duties regulated in accordance with sections 252 255 of the Ordinance or any statutory modifications thereof for the time being in force

NOTICES

123. (a) A notice may be given by the Company to any member either personally or by sending it by post to him to his registered address or (if he has no registered address

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in Pakistan) to the address, if any, within Pakistan supplied by him to the Company for the giving of notices to him.

- (b) Where a notice is sent by post, service of the notice shall be deemed to be effected by properly addressing, prepaying, and posting a letter containing the notice and, unless the contrary is proved, to have been effected at the time at which the letter would be delivered in the ordinary course of post.
- 124. A notice may be given by the Company to the joint holders of a share by giving the notice to the joint holder named first in the Register in respect of the share and a notice so given shall be sufficient notice to all the holders of such shares.
- 125. A notice may be given by the Company to the persons entitled to a share in consequence of the death or insolvency of a member through the post in a prepaid letter addressed to them by name or by the title or representatives of the deceased, or assignee of the insolvent or by any like description, at the address (if any) in Pakistan supplied for the purpose by the persons claiming to be entitled, or (until such an address has been so supplied) by giving the notice in any manner in which the same might have been given if the death or insolvency had not occurred.
- 126. Notice of every General Meeting shall be given in the manner hereinbefore authorized to (a) every member of the Company, except those members who have no registered address or have not supplied to the Company an address for the giving of notice to them, and also (b) every person entitled to a share in consequence of the death or insolvency of a member, who but for his death or insolvency would be entitled to receive notice of the meeting, and (c) to the auditors of the company for the time being.

WINDING UP

- 127. (a) If the Company is wound up, the liquidator may, with the sanction of special resolution of the Company and other sanction required by the Ordinance, divide amongst the members, in specie or kind the whole or any part of the assets of the Company, whether they consist of property of the same kind or not.
 - (b) For the purpose aforesaid, the liquidator may set such value as the former fair theon any property to be divided as aforesaid and may determine how such division shall be carried out as between the members or different classes of macmbers
 - (c) The liquidator may, with the like sanction, vest the whole of any part of the benefit of the contributories as the liquidator, with the vice sanction, unots fit but so that no member shall be compelled to accept any shares of other, securities whereon there is any liability.

SECRECY

128. Save as otherwise provided in the Ordinance no member or other person (not being a Director) shall be entitled to visit and inspect any of the Company's premises or properties of the Company without the permission of the Directors of the Company for the time being

or any person authorized in this behalf by the Directors or to require discovery of or information respecting any detail of the Company's trading or any matter which is or may be in the nature of a trade secret, mystery of trade or secret process or of any matter whatsoever which may relate to the conduct of the business of the Company and which in the opinion of the Directors will be inexpedient in the interest of the members of the Company to communicate to the public.

INDEMNITY

129. Every Director or officer of the Company and every person employed by the Company as auditor shall be indemnified out of the funds of the Company against all liability incurred by him as such Director, officer or auditor in defending any proceeding, whether civil or criminal, in which judgment is given in his favour, or in which he is acquitted, or in connection with any application under section 488 of the Ordinance in which relief is granted to him by the court.

RECONSTRUCTION

On any sale of the undertaking of the Company, the Directors or the Liquidator on a 130. winding-up may, if authorized by Special Resolution, accept fully paid or party paid-up shares, debentures or securities of any other company, whether incorporated in Pakistan or not either then existing or to be formed for the purchase in whole or in part of the property of the Company, and the Directors (if the profits of the Company permit) or the Liquidator (in a winding-up) may distribute such shares, or any other property of the Company amongst the members without realization, or vest the same in trustees for them, and any special Resolution may provide for the distribution or appropriation of the cash, shares, or other securities, benefits or property, otherwise than in accordance with the strict legal rights of the members or contributories of the Company, and for the valuation of any such securities or property at such price and in such manner as the meeting may approve, and all holders of shares shall be bound by any valuation or distribution se authorized and waive all rights in relation thereto, save only in case the Company is proposed to Be his in the course of being wound up, such statutory rights if any, under section 367 of the entimance as are incapable of being varied or excluded by these Articles

ARBITRATION

131. Whenever any difference arises between the Company on the one hand, and any of the members, their executors, administrators, or assigns on the other hand, touching the true intent or construction, or the incidents or consequences of these presents, or of the statutes, or touching anything then or thereafter done, executed, omitted or suffered in pursuance of these presents, or of the statutes or touching any breach or alleged breach of these presents, or the presents, or to these presents, or to any statute affecting the Company, or to any of the

affairs of the Company, every such difference shall be referred under the Arbitration, Act, 1940, to the decision of an arbitrator to be appointed by the parties in differences, or if they cannot agree upon a single arbitrator, to the decision of two arbitrators, of whom one shall be appointed by each of the parties in difference, or an umpire to be appointed by the two arbitrators. The cost of, and incident to, any such reference and award shall be in the discretion of the arbitrators, or umpire respectively, who may determine the amount thereof, or direct the same to be taxed as between attorney and client or otherwise, and may award by whom, and to whom, and in what manner the same shall be borne and paid.

MISCELLANEOUS

132. If the provisions of these Articles are in any way inconsistent with the provisions of the Ordinance or any other law for the time being in force, the provisions of that Ordinance or other law shall prevail, and these Articles shall be read subject to that Ordinance or that other Law.



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

Name and surname (present and former in full and block letters)	Father's/Husband's name in full	Nationality with any former Nationality	Occupation	Residential address	Number of shares taken by each subscriber	Signature
MR. TAJWAR TAPAL CNIC No.35201-2649288-5	Mr. Moiz Ali Tapal	Pakistani	Business	6-A, 1st Gizri Lane, D.H.A., Karachi, Pakistan	2,500 (Two Thousand Five Hundred)	Al
MR. TABISH TAPAL CNIC No. 42301-2385059-9	Mr. Moiz Ali Tapal	Pakistani	Business	33-B, 3rd Gizri Street, Phase IV, D.II.A., Karachi, Pakistan	4,500 (Four Thousand Five Hunred)	-14
MR. MUHAMMAD SADIQ TAPAL CNIC No. 35201-2785819-5	Mr. Tajwa r Tapal	Pakistani	Business	73/6A, Munir Road, Lahore, Pakistan	2,500 (Two Thousand Five Hundred)	A CI
MR. MUSTAFA LAKDAWALA CNIC No. 42201-3140375-9	Mr. Abid Hussain Lakdawala	Pakistani	Service	94/1, Bahadur Yar Jang Society, Karachi, Pakistan	500 (Five Hundred)	Hoursey
Total					10,000 (Ten Thousand)	

Dated this 17th day of June 2013

Witness to the above Signatures:

 Full Name, Father's/Ilusband's Name
 Signature
 Occupation
 Full Address

 Mr. Imran S/o Mr. Aba Umar
 Mr. Sell/Unogrammer Sell/Uno

001777



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. 0084483

I hereby certify that <u>WESTERN ENERGY (PVT.) LIMITED</u> is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is <u>limited by shares.</u>

Given under my hand at <u>Karachi</u> this <u>Ninth</u> day of <u>July</u>, Two <u>Thousand</u> and <u>Thirteen</u>.







PROJECT FEASIBILITY REPORT

50 MW WIND POWER PROJECT AT JHAMPIR, THATTA



Project Company

WESTERN ENERGY PRIVATE LIMITED



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Acknowledgements

The management of Western Energy Private Limited (Western Energy) is thankful to Ministry of Water & Power & Alternative Energy Development Board for generous support at all stages of project development and looks forward to continue for future milestones.

The management of Western Energy also recognizes the cooperation and support of Energy Department Government of Sindh which was extended at every stage of the project.

Disclaimers

This report has been prepared for the benefit of Western Energy (the "Client"), and may not be relied upon or disclosed to any other person for any purpose, other than as stated below, without the prior written consent of the Client 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.

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COMPANY CONTACT INFORMATION

The Company's office is located at:

Western Energy Private Limited				
Address	F-25, Block 5, Rojhan Street Kehkashan, Clifton Karachi, Pakistan. Tel: 0092 21 35876994 Fax: 0092 21 35876991			
Contact Person	Mr. Mustafa Lakdawala mustafa@tapalenergy.com.pk			

CONSULTANT CONTACT INFORMATION

The Company's office is located at:

Pakistan Alternative Engineering Services Private Limited			
Address	107-C, Mezzanine Floor, Jami Commercial Street No. 11 Phase-VII, DHA Karachi, Pakistan. Tel: 0092 21 35311736-8		
Contact Person	Mr. Salman Ahmed, CEO		
Email	salman@paespl.com		



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Document Information

Purpose and Scope

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



1 EXECUTIVE SUMMARY

1.1 PROJECT OVERVIEW

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

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

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

Wind resource studies conducted by the Government of Pakistan (GoP) through Pakistan Metrological Department (PMD) and Alternative Energy Development Board (AEDB) have shown very encouraging results. Based on these studies, GoP has offered private investors the opportunity to develop Independent Power Producer (IPP) companies for generating power through wind in the coastal regions of the Sindh province.

Western Energy intends to develop, own and operate a 50MW Wind Farm in Jhampir, Thatta. This feasibility study, deals with the 50 MW Western Energy Project at Jhampir, will serve the purpose for making the executive decision based on the technical viability of the project by Western Energy authorities regarding project implementation.



The Jhampir area has been selected for implementing the project on the basis of its exceptional wind regime, flat terrain and closeness to the National and local grid. The area has been extensively surveyed and is identified as having strong potential site for the proposed wind farm.

The electricity generated from the 50 MW wind farm would be sold to Central Power Purchase Agency (CPPA) on the 132/220kV grid. The Energy Purchase Agreement (EPA) would be signed with the Central Power Purchase Agency (CPPA) for a project life of 20 years.

1.2 ENERGY PRODUCTION ESTIMATION

Western Energy intends to develop, own and operate a 50 MW Wind Farm in Jhampir, Thatta (the "Project"). The energy yield calculations for the 50 MW wind farm have been calculated using the wind turbine generator (WTG) of CSIC H111L-2.0 MW having hub height of 80m.

Four wind measuring masts have been considered for this study namely, FFC Energy Mast (14 km in the southwest of Project site), Yunus Energy Mast (8 km in the southwest of Project site), Master Energy Mast (11.5 km in the southwest of Project site) and the wind measuring mast of Western Energy.

The wind measuring mast of Yunus Energy Limited (YEL) has been selected for the calculation of annual energy yield at the wind farm site of Western Energy due to the following reasons:

- Installation arrangements of the mast are of IEC compliance
- Measnet Calibrated Anemometers
- Long term data
- Good data coverage for all the instruments during the measurement period
- Time series is good enough to generate a bankable wind resource assessment report
- Computed regression coefficient for anemometers installed at FFC Energy mast with legends V85-a and V85-b is very good (r² = 0.9895) & correlation with other neighboring masts is also very good.
- Site conditions of project site are similar to that of YEL mast site.
- In close proximity of the project site than the other neighboring wind measuring masts.



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In addition to above, the annual energy yield has also been calculated on the wind measuring mast of Western Energy. However, it is suggested that the energy yield estimates calculated using the time series of YEL mast should be considered due to following reasons:

- i. YEL mast has long term time series as compared to Western Energy mast;
- ii. Site conditions of both the wind measuring masts and the project site are similar;
- iii. Both the wind measuring masts are located approx. at a same distance from Western Energy project site.

The annual energy productions for 50 MW wind farm, using long term time series developed at YEL Mast and time series of Western Energy Mast, on the proposed wind turbine generator have been estimated using WAsP. The summary of estimated annual energy productions of the 50 MW wind farm using YEL mast & Western Energy mast are shown in Table 1-1 and 1-2 respectively.



Western Epergy Wind Form	Wind Turbine Generator
Western Energy wind Farm	CSIC H111L-2.0MW
Turbine Capacity (kW)	2000
Number of WTG	25
Installed Wind Farm Capacity (MW)	50
Hub Height (meters)	80
Rotor Diameter (m)	111
Gross Electrical Output of Wind Farm (GWh)	224.352
Wake Losses (GWh)	15.891
Net Electrical Output of Wind Farm (GWh)	208.461
Power Curve density correction Losses (3.5%) - (GWh)	7.296135
Availability (95%) - (GWh)	10.05824
Power Curve Losses (2%) - (GWh)	3.822132
Blade Degradation (0.5%) - (GWh)	0.936422
Temperature Losses (2%) – (GWh)	3.726961
Electrical Losses (3%) - (GWh)	5.478633
Scheduled maintenance/ Miscellaneous (1.0 %) - (GWh)	1.771425
P50 Wind Farm Yield (GWh/annum)	175.371
P50 Capacity Factor (%age)	40.04

Table 1-1: Summary of Estimated Annual Energy Production Calculated Using Time Series of YEL Mast



Western Frankright Frankright	Wind Turbine Generator
western Energy wind Farm	CSIC H111L-2.0MW
Turbine Capacity (kW)	2000
Number of WTG	25
Installed Wind Farm Capacity (MW)	50
Hub Height (meters)	80
Rotor Diameter (m)	111
Gross Electrical Output of Wind Farm (GWh)	253.418
Wake Losses (GWh)	15.753
Net Electrical Output of Wind Farm (GWh)	237.665
Power Curve density correction Losses (3.5%) - (GWh)	8.318
Availability (95%) - (GWh)	11.467
Power Curve Losses (2%) - (GWh)	4.358
Blade Degradation (0.5%) - (GWh)	1.068
Temperature Losses (2%) - (GWh)	4.249
Electrical Losses (3%) - (GWh)	6.246
Scheduled maintenance/ Miscellaneous (1.0%) - (GWh)	2.020
P50 Wind Farm Yield (GWh/annum)	199.939
P50 Capacity Factor (%age)	45.648

Table 1-2: Summary of Estimated Annual Energy Production Calculated Using Time Series of Western Mast



1.3 UNCERTAINITY ANALYSIS

The uncertainties associated with the wind speed measurement accuracy, long term wind speed predictions, wind flow model, array loss modeling, instruments, topography, simulation software have been estimated. Annual Energy production of the wind farm is calculated at different probability level. The results obtained for different confidence levels are summarized in Table 1-2 & 1-3 below:



P50 Wind Farm Yield (GWh/annum)	175.371
P50 Capacity Factor (%age)	40.04
P70 Wind Farm Yield (GWh/annum)	156.86
P70 Capacity Factor (%age)	35.81
P80 Wind Farm Yield (GWh/annum)	145.47
P80 Capacity Factor (%age)	33.31
P90 Wind Farm Yield (GWh/annum)	129.80
P90 Capacity Factor (%age)	29.63

Table 1-2: Energy Production Estimates for proposed 50 MW Wind Farm using Yunus Energy Mast

Table 1-3: Energy Production Estimates for proposed 50 MW Wind Farm using Western Energy Mast

P50 Wind Farm Yield (GWh/annum)	199.939
P50 Capacity Factor (%age)	45.648
P70 Wind Farm Yield (GWh/annum)	178.83
P70 Capacity Factor (%age)	40.83
P80 Wind Farm Yield (GWh/annum)	165.85
P80 Capacity Factor (%age)	37.86
P90 Wind Farm Yield (GWh/annum)	147.99
P90 Capacity Factor (%age)	33.79
 P70 Wind Farm Yield (GWh/annum) P70 Capacity Factor (%age) P80 Wind Farm Yield (GWh/annum) P80 Capacity Factor (%age) P90 Wind Farm Yield (GWh/annum) P90 Capacity Factor (%age) 	178.83 40.83 165.85 37.86 147.99 33.79



2 PROJECT SITE

2.1 GENERAL AREA

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



Figure 2-1: Pakistan wind map¹



¹ www.aedb.org

2.2 SELECTION OF PROPOSED SITE

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

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

2.3 LOCATION OF THE PROJECT SITE

Western Energy has received the project land from Government of Sindh (GoS) on lease basis for the development of 50 MW wind power project. The project site is located about 111km (aerial distance) northeast of Karachi. The nearest settlement to the proposed site is Nooriabad (28km southwest). The site is located in a strong and partly rocky area at 44m to 82m above sea level. The size of the whole wind farm is 417.176 acres. The coordinates of Western Energy wind farm site are given under:



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10 | P a g e

				en e	
1	403831.084	2785968.085	25° 11' 12.32" N	68° 02' 44.02" E	
2	403744.965	2785823.802	25° 11' 7.61" N	68° 02' 40.98" E	
3	406776.139	2783733.534	25° 10' 0.35" N	68° 04' 29.78" E	
4	406807.627	2783712.091	25° 09' 59.66" N	68° 04' 30.91" E	
5	407856.312	2783168.127	25° 09' 42.21" N	68° 05' 8.50" E	
6	407761.452	2783051.873	25° 09' 38.41" N	68° 05' 5.14" E	
7	407749.256	2781874.367	25° 09' 0.13" N	68° 05' 4.99" E	
8	407660.071	2781729.466	25° 08' 55.40" N	68° 05' 1.84" E	
9	406256.968	2782904.978	25° 09' 33.30" N	68° 04' 11.44" E	
10	406224.639	2782926.427	25° 09' 33.99" N	68° 04' 10.28" E	
11	403252.411	2784975.478	25° 10' 39.92" N	68° 02' 23.60" E	
12	403165.592	2784852.430	25° 10' 35.90" N	68° 02' 20.53" E	

Table 2-1: Land Coordinates

Project Feasibility Study Western Energy 50MW Wind Power Project in Jhampir, Thatta



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

Figure 2-2: Site Location on Map

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



Figure 2-3: Western Energy Wind Farm Site Location on Map



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2.4 CLIMATIC CONDITIONS

The climate of southern parts of the Sindh province is characterized by fluctuating temperatures and sparse rainfall. The summers are hot and humid with average temperature ranging between 33 °C to 37 °C. The temperature in summers may reach up to 45 °C. The winters are pleasant with average temperature in the range of 12 °C to 15 °C. The months of July and August generally observe the annual monsoon rainfalls. The climatologically information of Karachi is shown in table 2-2 below. The recorded monthly temperature data at 85m height from the neighboring mast of Yunus Energy Limited (YEL) to the project site is given in table 2-3 below. The monthly mean temperature at the YEL site which is on the same plane of the project site and is located at a distance of ~7.0 km in the south-west, ranges between 18.24 °C to 32.1 °C. Maximum temperature at the neighboring mast of YEL is recorded as 44.67 °C.

Table 2-2:	<u>Karachi</u>	Climatological	Information
------------	----------------	-----------------------	-------------

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



2008	Nov	23.94	19.05	31.21
2008	Dec	19.82	12.65	29.94
2009	Jan	18.6	10.62	25.81
2009	Feb	23.24	14.67	34.08
2009	Mar	26.88	19.53	35.4
2009	Apr	30.77	21.86	42.35
2009	May	31.93	25.92	43.39
2009	Jun	31.29	25.68	41.91
2009	Jul	30.22	22.91	42.2
2009	Aug	29.04	23.74	38.12
2009	Sep	28.16	24.4	34.77
2009	Oct	29.5	22.44	40.32
2009	Nov	25.17	16.11	35.39
2009	Dec	20.87	13.55	27.54
2010	Jan	19.64	9.14	27.38
2010	Feb	22.34	11.51	33.54
2010	Mar	29.04	19.77	39.75
2010	Apr	30.7	21.89	40.57
2010	May	32.1	25.75	44.28
2010	Jun	30.3	22.24	40.03
2010	Jul	30.24	25.3	40.78
2010	Aug	29.01	23.99	37.9
2010	Sep	29.16	23.68	36.81
2010	Oct	29.78	22.15	38.61
2010	Nov	25.46	16.89	33.16
2010	Dec	19.94	12.81	27.75
2011	Jan	18.24	5.85	27.38
2011	Feb	21.16	14.55	29.29
2011	Mar	27.17	14.89	39.01
2011	Apr	29.77	21.67	39.11
2011	May	30.59	24.4	43.35
2011	Jun	31.04	27.2	44.67
2011	Jul	30.01	26.49	38.47

Table 2-3: Monthly Temperature conditions at Neighboring Mast of YEL



2011 Aug 28.67 23.54 35.71 2011 Sep ---2011 Oct ---2011 Nov ---2011 Dec ---2012 Jan 9.92 18.49 26.53 2012 Feb 19.74 9.06 31.05 2012 Mar 25.89 17.56 40.39 2012 29.68 20.91 40.03 Apr 2012 25.38 May 31.13 43.27 2012 Jun 30.42 26.49 41.88 2012 29.59 Jul 26.38 37.87 2012 Aug 29 25.89 36.93 2012 Sep 28.66 24.34 36.42 2012 Oct 28.98 23.18 37.31 2012 Nov 26.34 18.16 34.25 2012 Dec 20.89 10.62 30.39 2013 Jan 19.62 10.31 28.52 2013 Feb 20.89 12.27 28.64 2013 26.87 Mar 16.39 34.97 2013 29.13 Apr 19.85 39.46 2013 31.48 41.78 May 24.83 2013 Jun 31.57 26.87 37.87 2013 Jul --•• 2013 27.78 25.51 31.1 Aug 2013 29.91 24.81 38.88 Sep 2013 Oct 30.07 23.21 38.89 2013 Nov 25.76 18.54 33.37

Project Feasibility Study Western Energy 50MW Wind Power Project in Jhampir, Thatta



3 WIND DATA ANALYSIS

3.1 WIND DATA SOURCES

A total of five(05) wind measuring masts have been considered for this study namely:

- ✤ Karachi Airport Weather Station
- ✤ 81.5m High Wind Measuring Mast of FFC Energy Limited
- 85m High Wind Measuring Mast of Yunus Energy Limited
- * 80m High Wind Measuring Mast of Master Wind Energy Pvt. Limited
- * 85m High Wind Measuring Mast of Western Energy Private Limited

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



3.2 KARACHI AIRPORT WEATHER STATION

3.2.1 WEATHER STATION OVERVIEW

The weather station close to the wind farm site of Western Energy is the weather station in Karachi airport, which is located in the southwest side of the Project site in Karachi, the center of the observation field has a coordinate of 24° 54'N and 67° 08'E, with an altitude of 21m above sea-level, and the height of wind instrument is 7m. The weather station was built in 1928, and now is one of the stations participating in the global meteorological information exchange of the World Meteorological Organization (WMO), the unified number of which in WMO is 41780.

The weather station is located in the southwest of the site of the Western Energy wind farm site, and the linear distance between the center of the Project site and the weather station is about 98km. The Project site is an open and flat terrain, with a good topography and climate consistency.

Observing parameters including mainly the temperature (°C), precipitation (mm), wind speed (knot), and wind direction has been observed and recorded for three times every day, respectively at 5:00/8:00 a.m. and 5:00 p.m. local time before the year of 20112 in the airport weather station. From the beginning of 2012, these observing parameters were recorded hourly.

3.2.2 ANALYSIS OF METEOROLOGICAL DATA

3.2.2.1 Meteorological Element Statistics

Meteorological parameters of Karachi airport weather station are shown in Table 3-1.

Table 3-1: Meteorological Parameters Statistics of Karachi Airport Weather Station

Item	Unit	Index	Remark
Average temperature of many years	°C	26.6	
Maximum temperature	°C	47.8	
Minimum temperature	°C	0.0	
Average precipitation of many years	mm	204	
Relative humidity of many years	%	76	
Annual average of wind speed	m/s	2.38	



3.2.2.2 Mean Wind Speed

Statistics results of daily mean wind speed at 5:00/8:00 a.m. and 5:00 p.m. in the weather station of Karachi airport from 1980 to 2011 are shown in Table 3-2 and Fig. 3-1. Average wind speed of years at 5:00 a.m. is 1.69 m/s; Average wind speed of many years at 8:00 a.m. is 1.72 m/s; Average wind speed of years at 5:00 p.m. is 3.75 m/s, and average wind speed of many years is 2.38 m/s.

Statistics results of monthly mean wind speed from 1980 to 2011 in the airport weather station are shown in Table 3-3 and Fig. 3-2. Yearly mean wind speed from April to September is higher, and lower from October to March of the following year. Maximum mean wind speed is in August, which is 3.87 m/s, and minimum mean wind speed is in November, which is 1.10 m/s.

Year	5:00 a.m.	8:00 a.m.	5:00 p.m.	Average
1980	1.41	1.62	3.57	2.20
1981	1.53	1.69	3.91	2.38
1982	1.29	1.69	3.76	2.25
1983	1.50	1.59	3.71	2.27
1984	1.23	1.52	3.61	2.12
1985	1.14	1.86	3.53	2.18
1986	1.05	1.41	3.32	1.93
1987	1.39	1.83	3.79	2.34
1988	1.72	1.74	3.35	2.27
1989	1.26	1.69	3.36	2.10
1990	1.66	1.17	3.63	2.35
1991	1.45	1.51	3.46	2.14
1992	1.26	1.44	2.94	1.88
1993	1.19	1.33	3.11	1.88
1994	1.63	1.56	3.01	2.07
1995	1.58	1.53	3.38	2.16
1996	1.65	1.42	3.85	2.31
1997	1.98	1.79	4.06	2.61
1998	1.80	1.83	3.59	2.41
1999	1.95	2.16	3.80	2.64
2000	2.44	2.15	4.55	3.05

Table 3-2: Annual Mean Wind Speed Statistics



2001	2.07	1.90	3.98	2.65
2002	2.36	2.22	4.54	3.04
2003	2.04	1.84	4.12	2.67
2004	2.27	2.02	4.46	2.92
2005	2.00	1.81	4.01	2.61
2006	2.01	1.75	3.94	2.57
2007	1.29	1.25	3.78	2.11
2008	1.96	1.71	4.09	2.53
2009	1.85	1.72	4.02	2.47
2010	2.02	1.72	3.67	2.61
2011	2.03	1.81	3.97	2.38
Average	1.69	1.72	3.75	2,38

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Table 3-3: Monthly Mean Wind Speed Statistics (m/s)

Month	5:00 a.m.	8:00 a.m.	5:00 p.m.	Average
January	0.73	0.73	2.57	1.35
February	0.93	0.74	3.27	1.65
March	1.02	0.86	3.81	1.90
April	1.41	1.67	4.12	2.40
May	2.40	2.86	4.92	3.39
June	3.06	3.22	5.01	3.77
July	3.32	3.32	4.98	3.87
August	3.16	3.12	4.48	3.59
September	2.38	2.45	4.12	2.98
October	0.71	0.66	3.03	1.47
November	0.45	0.42	2.42	1.10
December	0.69	0.55	2.21	1.15
Average	1.69	1.72	3.75	2.38



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Figure 3-1: Annual Wind Speed Statistics



Figure 3-2: Monthly Wind Speed Statistics



3.2.2.3 Wind Direction

Statistics results of wind direction and mean wind direction at 5:00/8:00 a.m. and 5:00 p.m. from 2010 to 2011 in the airport weather station are observed. Prevailing wind direction at 5:00 a.m. is W (west), followed by N (north); Prevailing wind direction at 8:00 a.m. is N (north), followed by W (west); Prevailing wind direction at 5:00 p.m. is SW (southwest). Annual average prevailing wind direction is SW, followed by W/N.

3.2.2.4 Air Temperature

Karachi has a high temperature in its whole region, which is a hotter area, with the obvious temperature variation of tropical regions.

Statistics results of annual average air temperature from 1980 to 2009 in the airport weather station are shown in Table 3-4 and Fig. 3-3. Annual average temperature of many years is 26.6 °C in the airport weather station, with a trend of gradually increasing; annual average temperature is 26.2 °C between 1980 and 1998, and 27.3 °C between 1998 and 2009, with an obvious trend.

Statistics results of monthly average temperature from 1980 to 2009 in the airport weather station are shown in Table 3-5 and Fig. 3-4. Monthly average temperature change is relatively small; the average temperature from April to October is high, with an average temperature of 30 °C; Minimum average temperature is in January, which is 18.6 °C; Maximum average temperature is in July, which is 31.9 °C.

Year	Average Temperature	Year	Average Temperature
1980	26.4	1995	26.6
1981	26.3	1996	26.4
1982	26.2	1997	26.2
1983	25.9	1998	27.3
1984	25.6	1999	26.7
1985	26.1	2000	27.1
1986	25.8	2001	27.9
1987	26.5	2002	26.8
1988	27.2	2003	27
1989	26.1	2004	27.3
1990	25.9	2005	27
1991	26.21	2006	27.4
1992	26.3	2007	27.5
1993	27.2	2008	26.8
1994	26.1	2009	27.6

Table 3-4: Annual Average Temperature Statistics of the Karachi Weather Station



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Figure 3-3: Annual Average Temperature Change of the Airport Weather Station over the Years

Table 3-5:	Monthly	Average	Temperature	Statistics of	f Airport	Weather	Station
			•				

Month	Average Temperature		
Jan	18.6		
Feb	21.2		
Mar	25.3		
Apr	28.9		
May	31		
Jun	31.9		
Jul	30.5		
Aug	29.2		
Sep	29.4		
Oct	28.8		
Nov	24.6		
Dec	20.4		
Average	26.6		



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Figure 3-4: Average Monthly Temperature at Karachi Airport Weather Station

3.2.2.5 Tropical Cyclone

Tropical cyclone weather occurs in the Arabian Sea in the south of Pakistan, the incidence of which is about 1% of the global total cyclones. Tropical cyclones occurred in recent years in the Arabian Sea region are shown in Table 3-6.



No.	Date	Туре	Location	Maximum Wind
				Speed (m/s)
1	1993.11.05~11.16	A typhoon	Northeast of Arabian Sea	41
2	1994.07.05~07.09	Tropical Storm	South of Arabian Sea	23
3	1995.10.11~10.18	Tropical Storm	Southeast of Arabian Sea	26
4	1996.06.15~06.25	A typhoon	Mideast of Arabian Sea	33
5	1996.10.14~11.02	A typhoon	Southeast of Arabian Sea	33
6	1998.06.01~06.09	C Typhoon	Southeast of Arabian Sea	54
7	1998.10.15~10.18	Tropical Storm	Mideast of Arabian Sea	18
8	1999.05.15~05.21	C Typhoon	Mideast of Arabian Sea	57
9	2001.09.26~09.28	C Typhoon	Mideast of Arabian Sea	57
10	2001.09.29~09.28	Tropical Storm	Mideast of Arabian Sea	18
11	2002.05.10~05.15	Tropical Storm	Mideast of Arabian Sea	23
12	2004.05.04~05.09	Tropical Storm	Southeast of Arabian Sea	23
13	2004.09.30~10.10	Tropical Storm	Northeast of Arabian Sea	18
14	2006.09.19~09.26	Tropical Storm	Middle of Arabian Sea	28
15	2007.05.30~06.08	Typhoon of level 5	Northwest of Arabian Sea	74
16	2007.06.20~06.27	Tropical Storm	Northeast of Arabian Sea	26
17	2009.11.09~11.11	Tropical Storm	Southeast of Arabian Sea	26
18	2010.05.30~05.06	Typhoon of level 4	West & North East of Arabian	62
			Sea	
19	2011.06.09~06.21	Tropical Storm	Southeast of Arabian Sea	18
20	2011.11.25~12.01	Tropical Storm	Midwest of Arabian Sea	18

Table 3-6: Arabian Sea Tropical Cyclone Statistic in Recent Years



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3.3 NEIGHBORING WIND MEASURING MAST OF FFC ENERGY LIMITED

3.3.1 GENERAL INFORMATION OF MAST

The 81.5m high FFC Energy Limited (FFCEL) wind measuring mast was installed in June 2007 and has started collecting the wind data since then. FFCEL Mast is located at distance of 14 km in the southwest of Western Energy wind farm site as shown below in figure 3-5. The mast is of lattice structure with triangular cross section having side width of approx. 2 ft. The view of FFCEL wind measuring mast can be seen from the figure 3-6 whereas the installation arrangement at the mast can be seen from the figure 3-7 given below.



Figure 3-5: Neighboring Mast of FFCEL and Project Site





Figure 3-6: View of FFCEL Wind Measuring Mast





Figure 3-7: Installation Arrangements of Sensors installed at FFCEL Mast



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3.3.2 INSTALLED SENSOR INFORMATION

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

The roughness of the FFCEL mast site is 0.0513m whereas the power law exponent calculated using the 4.9 year's data is 0.16. The specifications of FFCEL mast are shown in table 3-7 given below.

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

Table 3-7: Specification of FFCEL Mast

3.3.3 WIND DATA ANALYSIS

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



10m anemometer (V10)	89.81%
30m anemometer (V30)	89.65%
60m anemometer (V60)	89.38%
80m anemometer (V80b)	89.81%
81.5m anemometer (V80a)	89.81%
28.5m Wind Vane	89.81%
78.5m Wind Vane	89.81%

Table 3-8: Wind Data Acquisition ratio of FFCEL Mast

Data is analyzed using time series starting from 1st June 2007 to 8th May 2012. The computed regression coefficient for anemometers installed at 80 meters with legends V80-a and V80-b is 98.81% (r2 = 0.9881) without gaps filling whereas the regression coefficient after filling the missing gaps comes to 98.95% (r2 = 0.9895).

The computed regression coefficient for Dir78.5 and Dir28.5 is 91.82% (r2 = 0.9182) without the filling of gaps present in the data whereas the regression coefficient after filling the missing gaps comes to 82.76% (r2 = 0.8276)



3.3.3.1 MEAN WIND SPEED ANALYSIS

The wind data recoded at FFCEL Mast during the period i.e. June 2007 to May 2012 has been analyzed to determine the monthly mean wind speeds. The results are shown in table 3-9 and Figure 3-8 and 3-9 respectively.

Table 3-9: Monthly Mean Wind Speeds Calculated at FFCEL Mast

		a sana ang Ang Sanag Magazartan Magazartan		· · · ·	in the second second	
And the way are a set of	e weer to	(m/s)	(m/s)	(m/s)	(m/s)	(m/s)
2007	Jul	8.711	8.608	8.514	7.942	6.9401
2007	Aug	8.973	8.75	8.737	8.122	7.1509
2007	Sep	8.348	8.191	8.078	7.414	6.3901
2007	Oct	6.064	6.066	5.716	4.837	3.6908
2007	Nov	5.243	5.25	4.925	4.062	2.9694
2007	Dec	7.145	7.184	6.715	5.499	4.1698
2008	Jan	7.115	7.144	6.727	5.61	4.3263
2008	Feb	5.243	5.238	5.047	4.338	3.3311
2008	Mar	6.631	6.613	6.333	5.594	4.5813
2008	Арг	7.5	7.357	7.222	6.536	5.5958
2008	May	11.852	11.526	11.597	10.893	9.7052
2008	Jun	9.035	8.876	8.87	8.369	7.4259
2008	Jul	10.243	9.872	10.07	9.539	8.5358
2008	Aug	9.464	9.127	9.257	8.706	7.7539
2008	Sep	8.173	7.944	7.912	7.249	6.3176
2008	Oct	6.88	6.833	6.553	5.705	4.577
2008	Nov	7.332	7.349	6.925	5.824	4.5347
2008	Dec	6.396	6.417	6.104	5.295	4.2777
2009	Jan	7.862	7.916	7.445	6.315	5.173



2009	Feb	6.121	6.09	5.82	5.036	4.0463
2009	Mar	6.472	6.412	6.209	5.508	4.577
2009	Apr	7.202	7.133	6.909	6.209	5.2341
2009	May	9.192	9.01	8.974	8.378	7.3794
2009	Jun	9.913	9.688	9.681	9.052	7.9439
2009	Jul	8.509	8.396	8.273	7.676	6.6652
2009	Aug	9.031	8.762	8.79	8.19	7.0768
2009	Sep	8.488	8.19	8.134	7.442	6.4088
2009	Oct	5.505	5.487	5.185	4.463	3.4949
2009	Nov	6.738	6.78	6.299	5.185	3.8398
2009	Dec	6.837	6.885	6.379	5.223	3.9339
2010	Jan	6.363	6.394	5.954	4.96	3.8057
2010	Feb	6.236	6.259	5.88	5.036	3.9362
2010	Mar	6.759	6.687	6.433	5.75	4.727
2010	Apr	8.234	8.058	7.877	7.252	6.2567
2010	May	10.134	9.901	9.786	9.184	8.1104
2010	Jun	10.065	9.695	9.748	9.212	8.1409
2010	Jul	8.125	7.969	7.864	7.393	6.5232
2010	Aug	7.111	6.935	6.799	6.246	5.391
2010	Sep	7.113	7.037	6.789	6.117	5.1597
2010	Oct	5.912	5.916	5.551	4.79	3.6567
2010	Nov	6.582	6.637	6.175	5.183	3.9453
2010	Dec	6.892	6.932	6.429	5.398	4.0969
2011	Jan	6.678	6.702	6.26	5.258	4.0449
2011	Feb	6.193	6.213	5.832	5.002	3.9636
2011	Mar	6.624	6.585	6.291	5.611	4.6392
2011	Apr	6.565	6.517	6.251	5.642	4.7625

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2011	May	10.317	10.048	9.987	9.46	8.3834
2011	Jun	10.61	10.303	10.281	9.813	8.7191
2011	Jul	9.509	9.455	9.178	8.487	7.2776
2011	Aug	8.89	8.867	8.558	7.775	6.5086
2011	Sep	7.535	7.535	7.244	6.542	5.4291
2011	Oct	5.566	5.544	5.247	4.483	3.3614
2011	Nov	5.76	5.768	5.382	4.511	3.325
2011	Dec	6.918	6.958	6.432	5.252	3.7895
2012	Jan	6.335	6.351	5.978	5.004	3.7694
2012	Feb	6.591	6.615	6.168	5.179	4.0331
2012	Mar	6.736	6.682	6.372	5.65	4.5694
2012	Apr	6.972	6.898	6.636	5.994	5.0811
2012	May	6.888	6.83	6.589	5.943	4.9917







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Figure 3-9: Monthly mean wind speeds at FFCEL Mast during 2007 - 2012

3.3.3.2 DIURNAL VARIATION

The monthly and annual diurnal variation of wind speed, for the wind data recorded during the period of Jun 2007 to May 2012 at 10, 30, 60, 80 and 81.5m are shown below in figure 3-10 and 3-11 respectively.

