振发新能源
ZHENFA NEW ENERGY

振发巴基斯坦新能源有限公司

ZhenfaPakistan New Energy Company(Private) Limited

The RegistrarDate :17 June 2016

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

Subject: **Application for Generation License**

Dear Sir,

I, MrsHuiyingJu,director, being the duly authorized representative of Zhenfa Pakistan New Energy Company Limited by virtue of Board Resolution dated2nd June 2016 hereby apply to National Electric Power Authority for the Grant of Generation License to Zhenfa Pakistan New Energy Company Limited pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999 and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge in belief.

A BANK DRAFT in sum of Rupees 357,520.00 being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

The application is filed in triplicate with all annexure appended with each set of the application.

Sincerely,

Zhenfa Pakistan New Energy Company (Pvt) Ltd.

MrsHuiyingJu
Director/CEO
Zhenfa Pakistan New Energy Company Limited.

Add : 01,6th Floor, 10-C, Liberty Gate Plaza, MM Alam Road, Gulberg III, Lahore, 54660
Tel:+92-42-3577 1571, Fax: +92-42-35874001, Email: Sales@zhenfa.com

EXTRACT OF THE RESOLUTION PASSED BY THE BOARD OF DIRECTORS OF ZHENFA PAKISTAN NEW ENERGY COMPANY (PRIVATE) LIMITED ON June 2, 2016

RESOLVED THAT Mrs Huiying Ju, be and is hereby authorized to file applications for a Generation License and Upfront Solar Tariff (Applications) including any motions, applications, review motions, re-filings or fresh applications for and on behalf of Zhenfa Pakistan New Energy Company (Private) Limited (Company) solar 100 MW power project in Chaubara-Layyah, Punjab, Pakistan.

Mrs Huiying Ju, director of the Company, be and is hereby authorized by and on behalf of the Company to do all actions and take all measures as may be necessary or appropriate in connection with the filing, presentation, pursuit and determination of the Applications, including, without limitation:

i. to sign, file, amend or withdraw the Applications, affidavits, powers-of-attorney, statements forms, applications, deeds, certificates, interrogatories, correspondence, replies to information directions, interrogatories, discovery directions or any other documents and instruments as may be necessary or appropriate;

ii. make all filings and pay all applying fees in connection with the Applications;

iii. to appoint and remove any consultants, attorneys and advisers and generally to do all other things and take all actions as may be required in connection with the Applications including any revisions, modifications and all matters necessary or incidental thereto;

iv. represent the Company in person or through attorneys, advocates or representatives in all negotiations, representations, presentations, hearings, conferences or meetings of any nature whatsoever with any entity (including, but not limited to NEPRA, private parties, companies, partnerships, individuals, governmental or statutory authorities and agencies, ministries, boards and departments, regulatory authorities or any other entity of any nature whatsoever).

Certified that the above resolution (i) was duly passed on June 2 2016 in Lahore at a meeting of the Board of Directors of Zhenfa Pakistan New Energy Company (Private) Limited at which a quorum of directors was present; and (ii) has not been rescinded and is in operation and that this is a true

copy of the said resolution.

CERTIFIED TO BE A TRUE COPY

Mr Zhengfa Zha
Director, Zhenfa Pakistan New Energy Company (Private) Limited.

Dated: June 2 2016

DOCUMENT STRUCTURE

The document is Generation License Application for Solar Power Projects of a capacity of 100 MW at Chaubara-Layyah, Punjab by Zhenfa Pakistan New Energy Company Limited (the "**Applicant**").

The document comprises of Executive Summary and Annexures.

Following documents of the Project are annexed to this application in pursuant to Section -5 of Article -3 of NEPRA Licensing (Application & Modification Procedure) Regulation, 1999;

Annexure - I: Project Information

Annexure –IA: Technology of Panels.
Annexure –IB: Technology of Inverters.

Annexure - II: Certificate of Incorporation

Annexure - III: Memorandum and Articles of Association

Annexure - IV: Last Filed Annual Return

Annexure – V Curriculum Vitae of Senior Management, Technical and Professional Staff

Annexure – VI Evidence regarding availability of adequate Financial and Technical Resources –including relevant excerpts of balance sheets of the Sponsors

Annexure – VII Charge or encumbrances attached to the company assets

Annexure – VIII Executive summary of Electrical and Grid Interconnection Study

Annexure – IX Feasibility Report for ZPNECL

Annexure – X Initial Environmental Examination Report for ZPNECL

Prospectus:

Zhenfa Pakistan New Energy Company (Private) Limited was set up in 2014 and specializes in investing, developing, installation and commissioning of solar power projects in Pakistan as well as provides EPC service. Its business scope includes business of generating, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and machinery, equipment, products and services, and setting up and operating electric power generation project for generating and supply of electric power as well as renewable energy projects.

The Sponsor of this project company is Zhenfa Energy Group Co., Ltd , which is one of the leading system integration companies in China. It focuses on investing, developing, installation and commissioning of solar projects as well as does merger & acquisition of other valuable projects or companies. So far it has accumulative installation of 2.7GW solar projects in china, among them self-invested and owned 1.3GW solar projects with total assets of around USD 1.6 billion . With our 10 years solar engineering experience, up today we have installed and completed commissioning of 6units 100W solar projects in china. We're continuing with developing our solar projects in china and oversea countries as well, our target is to complete 10GW in next 5 years , among them 1GW is oversea projects.

100MW solar project in Pakistan is our first and biggest project at oversea countries, we pay close attention to this project, we will use our advanced technology to build up best performance of projects and make good reference project in Pakistan, after this project has successfully put into operation, we plan to develop another 300MW to 500MW solar projects in Pakistan to make our contribution for Pakistan nations in relieving energy –shortage such social problem.

The total investment of this 100MW solar project is around USD150Million, we're sought for generation license of 100MW solar project as IPP

Our solar project use clean and renewable solar resource with zero emission, When put into operation, the project can provide power supply to the central Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. By estimating, after the completion of the station, it is expected to provide electricity grid each year about 144.561 million kWh, compared with the same capacity of thermal power, equivalent to annually save about 54947 t of standard oxide (SO2) of about 5151 t, nitrogen oxide (NOx) about 2576 t.coal, reducing various atmospheric pollutant emissions, which reduce carbon dioxide (co2) about 170000 t, sulfur dioxide (SO2) of about 5151 t, nitrogen oxide (NOx) about 2576 t.

Therefore our solar project has no impact for surrounding society and environment.

Annexure I:

PROJECT DETAILS

Project Background

Since the issuance of the LOI in 2015,the Applicant conducted various studies to assess the feasibility of the Project. These studies included the SolarResource Assessment, Geo Technical investigation, Digital topographic map, Initial Environmental Examination and Grid interconnection Study. Based on the studies conductedbythe Project technical consultant (Renewable Resources (Pvt) Ltd), the complete feasibility study was submitted by the Applicant to AEDB for its review.

Project Site

The Project Site is acquired at Rakh, Chaubara, and District Layyah-Punjab. The project site is located around 08 kilometers away from Chaubara city.

The total land area of the project site is about 650 acres owned by the project owners for the implementation of 100 MW Solar PV project. The proposed site located at latitude of 30°54'11.86"N and longitude of 71°33'36.21"E with elevation of around 150 meters.

The location is shown in Figure: 1.

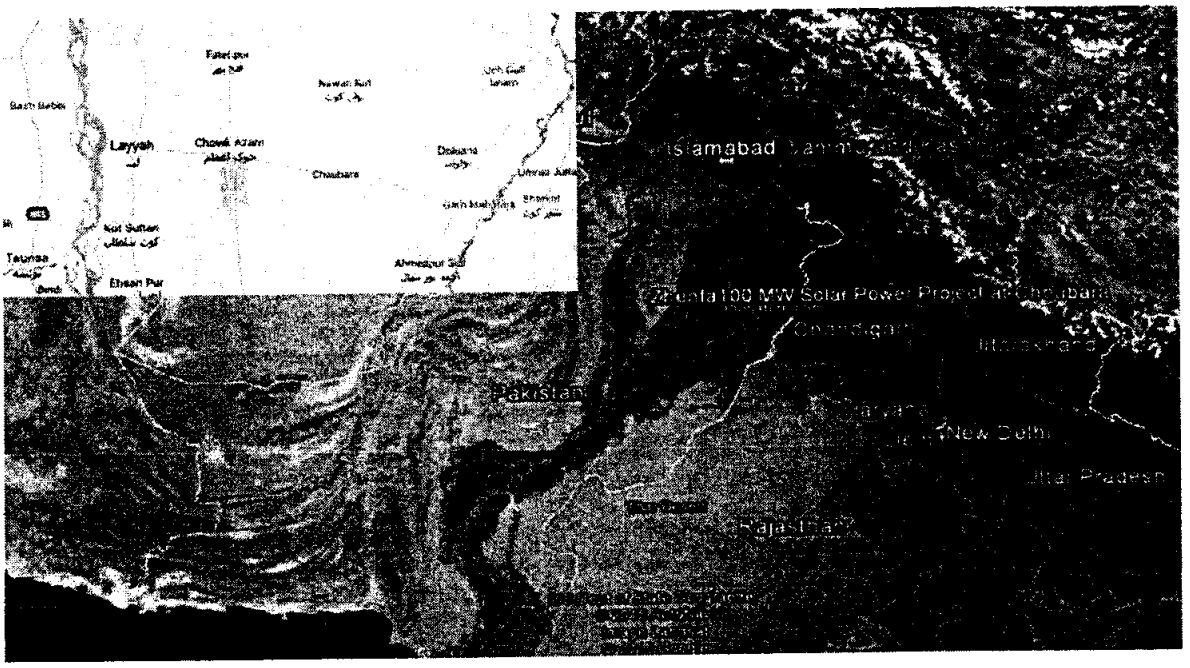


Figure 1: Geographical Location of the Project

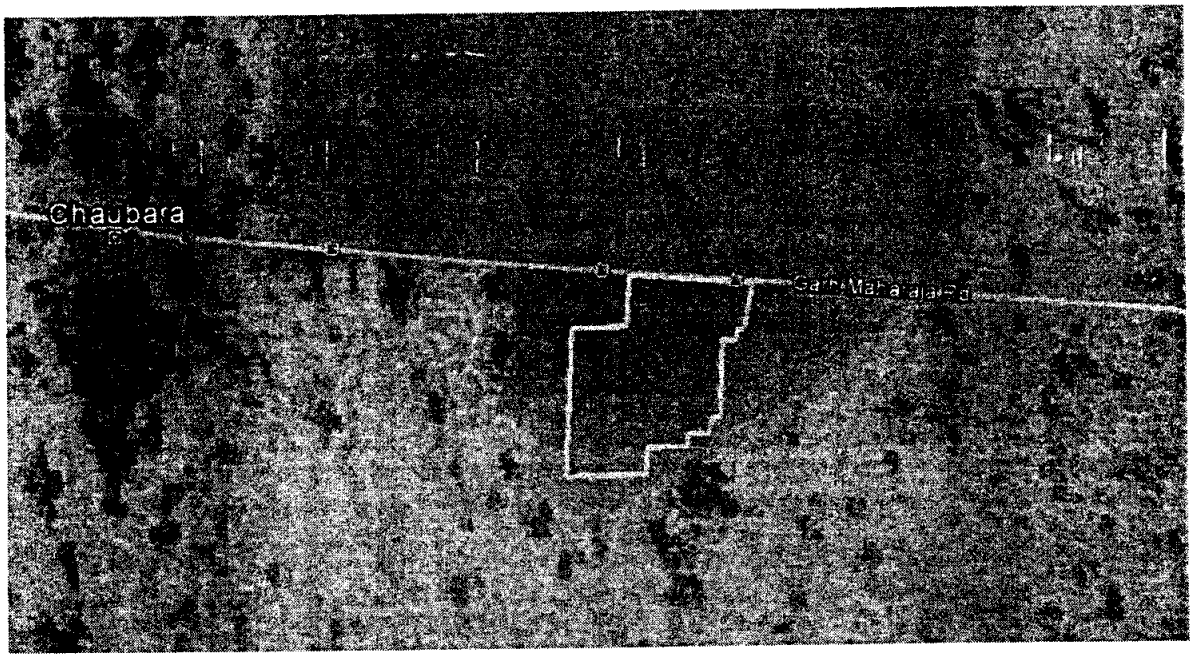


Figure 2: Site Boundary Layout

The project site coordinates are as listed in Table below:

The water level in this area is higher than in the upland. The soil is sandy. The upland is flat plains sloping from north-west to south-west. The general height of the area is from 150 to 180 meters above the sea level.Layyah District is mostly a desert area and some plan agricultural fertile area and there is not any kind of minerals found in the district Layyah.

Site Accessibility:

The Project is located on Chaubara Road Layyah. The machinery for the Project will be routed from Multan Dryport, as that is closest to the Project site. The distance of Project site from Multan Dryport is 148 km. The proposed route to the Project site is given in the Figure 4.

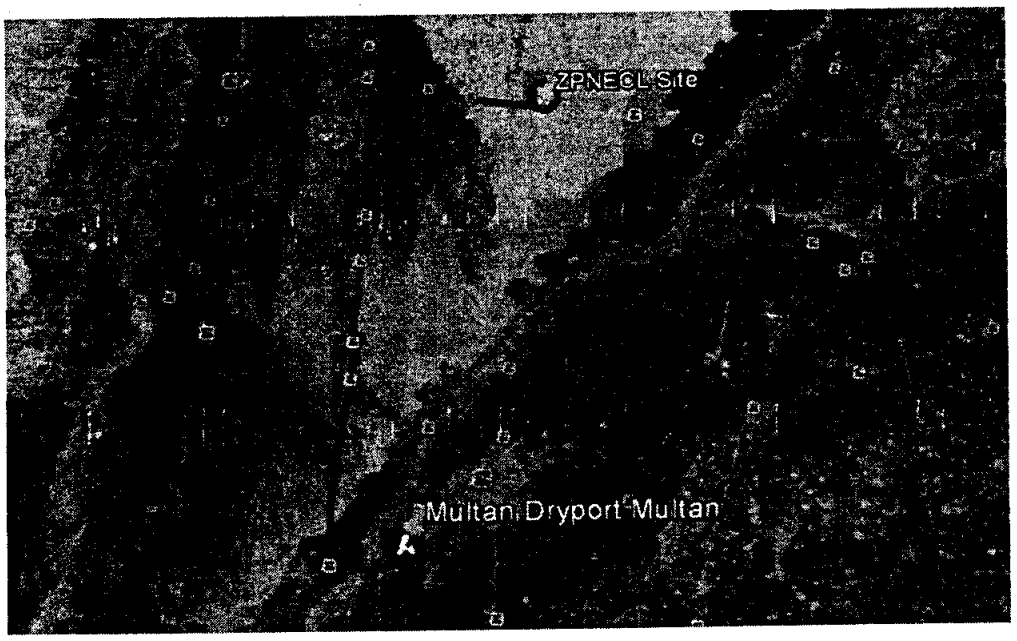


Figure 4: Multan Dryport to Project Site

Telecommunication at the Project Site:

PTCL telephone services are not available but mobile services are available at village levels only.

Availability of Semi-Skilled and Skilled Labor:

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

Project Site Security:

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

Grid Connectivity:

The Project would be connected by a double circuit of 132kV.

Annual Energy production:

Annual Energy Production of the project is144.561GWh. The tables below show key details relating to power generation from the Project.

	154,561 (MWh/yr)
	16.5%

EPC Bidding Process:

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

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

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

The Applicant received interest from various international equipment suppliers and EPC contractors. After considerable effort and receipt of proposals from many suppliers, the Applicant took this input as a starting point and started negotiations with the vendors for EPC proposals.

Based on the thorough due diligence and following an intense negotiations process with the various suppliers and contractors, the Applicant selected Zhangjiagang SEGP6-60 255 W panels and Sungrow SG630MX inverter.

Technology of Panels:

The Solar panel selected for the project isSi-PolyZhangjiagang SEGP6-60 255 W.

The details of panel are given in table below.

PV Module Characteristics	Zhangjiagang
Module Model	SEG-P6 255W
Manufacturer	Zhangjiagang PV Co.
Nominal Power [W]	255.0
Efficiency [%]	15.7
Power Tolerance [%]	0/+3
Cell Type	Si-poly
Open Circuit Voltage [V]	37.7
Short Circuit Current [A]	8.31
MPP Voltage [V]	30.7
MPP Current [A]	8.99
Power Coefficient of Temperature [%/C]	0.46
Nominal Operating Cell Temperature (NOCT)	45.00
Height X Width X Thickness [mm]	1640 X 992 X 35

Technology of Inverters:

Sungrow manufactures power supply equipment for solar PV and wind power projects. The company's products range from grid-connected PV inverters, wind power converters, and distributed power supply. It also provide development, construction, and operation management for renewable energy projects.Sungrow was ranked the 2nd largest PV inverter manufacturer in the world in 2013 by MW shipped. Sungrow has 8000MW installed globally, and in 2013, Photon Magazine ranked its 30kW inverter asbest of all string inverters over 20kW, and among top 5 of all inverters tested.

Inverter Characteristics	Sungrow Power Supply Co. Ltd.
Inverter Model	SG 630MX
Manufacturer	Sungrow
Nominal AC Capacity	630 kW
Maximum PV input Power (DC)	714 kW
MPP voltage range	460 V – 850 V
Nominal AC Voltage	315 V
Maximum AC current	1280 A
Nominal AC output Power	630 kW
Maximum Efficiency	0.987
European Efficiency	0.985
Operating ambient temperature range	-30°C to +55°C

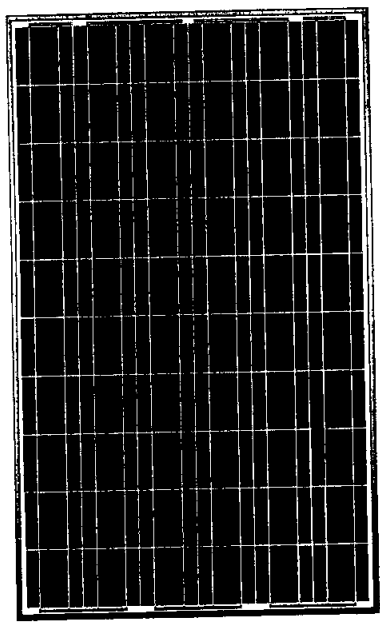
Annexure I-A:

Data Sheet of Panels

振发新能源 ZHENFA NEW ENERGY

SEG P6-60(240W-260W)

Polycrystalline Solar Module



SEG P6-60 Polycrystalline series solar modules are made of 60 pcs 156× 156mm Polycrystalline solar cells in series with high efficency, high transmission rate and low iron tempered glass, anti-aging EVA and high flame resistant back sheet, and anodized aluminum alloy. The modules have advantages of high efficiency, long service life, easy to install as well as high wind and hail impact resistance.

Features and Benefits

- Member of PV CYCLE
- Power tolerance 0-+3%
  Three bypass diodes
- High efficiency
  Outstanding low-light performance
- Pass 5400 Pa Pressure Test
- Power warranties:
  10 years (90%),
  25 years (80%)
- 10 years product guarantee

Electrical Specifications

Type / Model	SEGP6-60 240W	SEGP6-60 245W	SEGP6-60 250W	SEGP6-60 255W	SEGP6-60 260W
Open Circuit Voltage at STC (VOC)	37.4V	37.5V	37.6V	37.7V	37.8V
Rated Voltage at STC (VMP)	30.1V	30.3V	30.5V	30.7V	30.9V
Rated Current at STC (IMP)	8.67A	8.71A	8.87A	8.99A	9.03A
Short Circuit Current at STC (ISC)	8.00A	8.09A	8.20A	8.31A	8.42A
maximum power at STC Pmax (WP)	240W	245W	250W	255W	260W
module effciency	14.60%	15.00%	15.40%	15.70%	16.00%
operating temperature	-40℃to 85℃	-40℃to 85℃	-40℃to 85℃	-40℃to 85℃	-40℃to 85℃
maximum system voltage	1000V	1000V	1000V	1000V	1000V
Hail Test	25mm diameter ice ball at 23m/s, directed at 11 inpact locations				

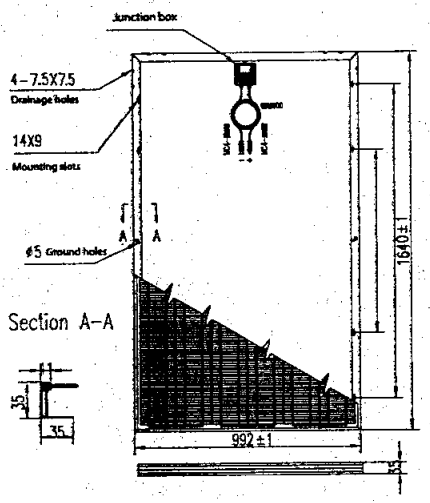
The electrical specifications are typical average value from historical production data.
The electrical data relates to standard test conditions [STC]: 1,000W/m² ; AM 1.5; 25°C

Zhenfa New Energy Science & Techonology Co., Ltd
Address : 20th Floor BaoTong Mansion, No. 567 JianZhu Western Road, Jiangsu, China 214072
Tel : 0086-510-82706662 Fax: 0086-510-85108856 Website : www.zhanfa.com E-mail : sales@zhenfa.com

SEG P6-60(240W-260W)

Polycrystalline Solar Module

ALL DIMENSIONS IN mm



Mechanical Characteristics

Solar Cell	Polycrystalline silicon solar cell 156x156(mm)
No.of Cells	60 (6x10)
Dimensions	1640 x992x35(mm)
Weight	20kg
Front Glass	3.2mm (0.13 inches) tempered glass
Frame	Anodized aluminum alloy

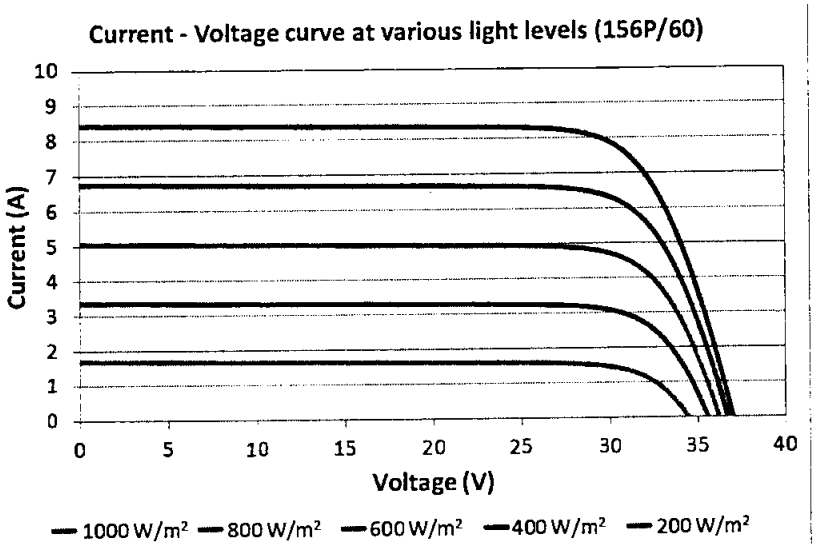
Output

Cable Type	4mm²
Lengths	L=900mm
Junction Box	Above IP65
Connectors	MC4 compatible

Over-current protection rating[A] : 15A

Temperature Coefficients

Nominal Operating Cell Temperature (NOCT)	45±2°C
Temperature Coefficient of Pmax	-0.40%/°C
Temperature Coefficient of Voc	-0.35%/°C
Temperature Coefficient of Isc	+0.033%/°C



Ave. efficiency reduction of <5% at 200W/m² according to IEC 60904-1:2006

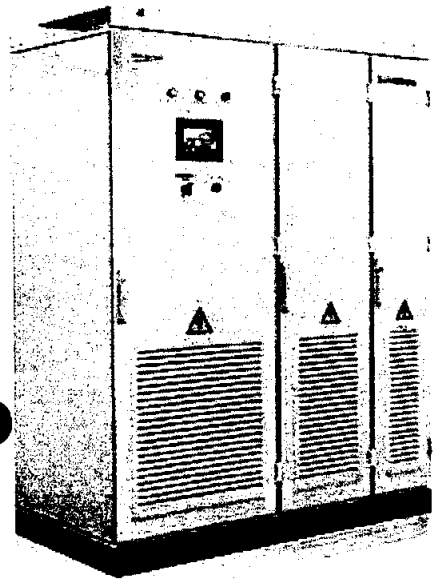
Clean Energy Council

Annexure I-B:

Data Sheet of inverter.

SUNGROW
www.sungrowpower.com

SG 630MX



Grid-friendly

- LVRT/ZVRT
- Active power continuously adjustable (0~100%)
- Reactive power control with power factor adjustment from 0.9 overexcited to 0.9 underexcited
- Give reactive power compensation to the grid at night according to directive

Efficient

- Max. efficiency at 98.7%
- DC input voltage up to 1000V

Adaptable

- -30℃~+55℃ continuously operating at rated power
- Continuously and stably working in high altitude environment
- Auxiliary heater (opt.)

Qualified

- Highly reliable thin-film capacitor, product's lifetime is more than 20 years
- TÜV, CGC certified, compliance with BDEW

Input (DC)

Max. PV input power	714kW
Max. PV input voltage	1000V
Start voltage	500V
Min. operation voltage	460V
Max. PV input current	1552A
MPP voltage range	460~850V
Number of MPPTs	1
Number of DC inputs	2 x 4

Output (AC)

Nominal AC output power	630kW
Max. AC output apparent power	700kVA
Max. AC output current	1280A
THD	<3 % (nominal power)
Nominal AC voltage	315V
AC voltage range	252~362V
Nominal grid frequency	50/60Hz
Grid frequency range	47~52/57~62Hz
Power factor	>0.99@default value at nominal power, adj. 0.9 overexcited~0.9 underexcited
Isolated transformer	No
DC current injection	<0.5% In

General Data

Dimensions (W*H*D)	1606*2034*860mm
Weight	1250kg
Operating ambient temperature range	-30~55℃
Night power consumption	<20W
External auxiliary supply voltage	380V, 3A
Cooling method	Temperature controlled air-cooling
Ingress protection rating	IP21
Allowable relative humidity range	0~95%, no condensing
Max. operating altitude	6000m (>3000m derating)
Fresh air consumption	4500m³/h
Display	Colored touch screen
Communication	RS485/Modbus, Ethernet (opt.)
Quolified	CE, CGC certified, compliance with BDEW

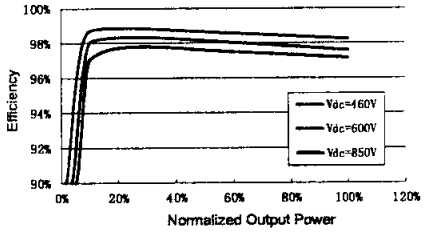
Protection

Input side disconnection device	DC Breaker
Output side disconnection device	AC Breaker
DC overvoltage protection	Yes
AC overvoltage protection	Yes
Grid monitoring	Yes
Ground fault monitoring	Yes
Over temperature protection	Yes
Insulation monitoring	Yes

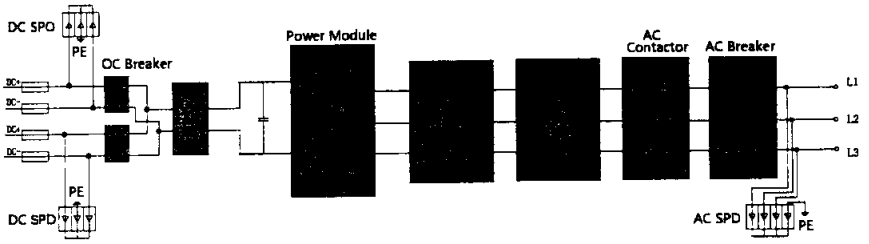
Efficiency

Max. efficiency	98.70%
European efficiency	98.50%

Efficiency Curve



Circuit Diagram



Printed in September 2014 E/W

Annexure II:

CERTIFICATE OF INCORPORATION

A004301

SECP

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, LAHORE

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. 0089745

I hereby certify that **ZHENFA PAKISTAN NEW ENERGY COMPANY (PRIVATE) LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is **Limited by Shares.**

Given under my hand at **Lahore** this **Fourth** day of **September,** Two **Thousand** and **Fourteen.**

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

CERTIFIED TO BE TRUE COPY

DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE

(LIAQAT ALI DOLLA)
Additional Registrar of Companies

No. ARL/4761 DATED: 4-9-14

FORM 29

THE COMPANIES ORDINANCE, 1984

(Section 205)

PARTICULARS OF DIRECTORS AND OFFICERS, INCLUDING THE CHIEF EXECUTIVE, MANAGING AGENT, SECRETARY, CHIEF ACCOUNTANT, AUDITORS AND LEGAL ADVISER, OR OF ANY CHANGE THEREIN

Please complete in typescript or in bold black capitals.

1. CUIN (Incorporation Number) | | | | | | | | 719419 4/9/14

2. Name of the Company: ZHENFA PAKISTAN NEW ENERGY COMPANY (PRIVATE) LIMITED

3. Fee Paid (Rs.): | | | 11 | 000 | Name & Branch of the Bank: MCB, AGHA KHAN ROAD, LAHORE

Date: Day 1 8 | Month 0 8 | Year 2 0 1 4

M-2014-074475

5. Mode of payment (Indicate): CASH

6. Particulars*:

Present Name in Full	NIC No or passport No. in case of Foreign National	Father's/ Husband's Name	Usual residential address	Designation	Nationality**	Business Occupation*** (if any)	Date of present appointment or change	Mode of appointment / change / any other Remarks
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
6.1 New appointment/election:								
MR ZHENGFA ZHA	E02501782	MINGYI ZHA	NO.316, JINXIU AVENUE, HEFEI, ANHUI, CHINA 230601	DIRECTOR	CHINESE	BUSINESS MAN	SINCE INCORP-ORATION	
MRS HUIYING JU	G57773209	LIXIN CHEN	ROOM 402, NO. 43 BLDG, VANKE JIAYUAN,WU	DIRECTOR	CHINESE	BUSINESS WOMAN	SINCE INCORP-ORATION	

			XI, JIANGSU, CHINA 214028					

6.2 Ceasing of office/Retirement/Resignation:

6.3 Any other change in particulars relating to columns (a) to (g) above:

CERTIFIED TO BE TRUE COPY

DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE

28/X/14

7. Name of Signatory	HUIYING JU	**8. Designation**	DIRECTOR
9. Signatures of Chief Executive/ Secretary	凡惠英	**10. Date**	Day: 18 Month: 08 Year: 2014

Annex-III:

Memorandum & Articles of Association

THE COMPANIES ORDINANCE, 1984

(A PRIVATE COMPANY LIMITED BY SHARES)

Memorandum of Association

of

ZHENFA PAKISTAN NEW ENERGY COMPANY (PRIVATE) LIMITED

I. The name of the Company is "Zhenfa Pakistan New Energy Company (Private) Limited".

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

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

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

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

3. To set up and operate electric power generation project for generating and supply of electric power and to carry out the construction and manufacture of hydroelectric, thermal, gas and renewable energy projects such as solar, wind energy, bio-thermal energy and to construct, establish and fix necessary power stations, cables, wires, lines and works to generate, accumulate and supply electricity and to light industries, cities, towns, buildings and places both public and private and for all other purposes for which electric energy can be employed subject to permission from NEPRA and other regulatory authorities.

4. To take on lease, hire purchase or acquire by license or otherwise, any land, rights over or connected with lands, buildings, mills, factories, plant, machinery apparatus, works, lorries, wagons, carts, live-stock, stock-on-trade, rights, privileges and movable or immovable property of any description which may be deemed convenient or necessary for business which the Company is authorized to carry on.

5. To enter into any arrangements with any government or authorities, supreme, municipal, local otherwise, that may seem conducive to the Company's objects and to obtain from any such government or authority, any rights privileges and concessions which the Company may think desirable to obtain, and to carry out, exercise, and to comply with any such arrangements, rights, privileges, and the concessions.

6. To acquire, construct, improve, develop, exchange, mortgage, charge, pledge, sell or otherwise dispose of the whole or any part of the Company or any lands, business, property rights of any kind in the Company or any share or interest therein respectively in such manner and for such consideration as the Company may think fit and in particular for shares, debentures of any other corporation or company having object altogether or in part similar to those of the Company.

7. To provide services relating to engineering procurement and construction to companies and projects in Pakistan including to act as an engineering procurement & construction contractor of power projects.

8. To distribute any of the Company's property among the members in specie or in kind or in any manner whatsoever, in case of winding up or dissolution of the Company.

9. To carry on all or any of the businesses of wholesalers, retailers, traders, importers, exporters, suppliers, distributors, designers, developers, manufacturers, installer, filters, testers, repairers, maintainers, contractors, constructors, operators, users, inspectors, reconditioners, improvers, alterers, protectors, removers, hirers, replacers, importers and exporters of and dealers in, electrical appliances, systems, products and services used for energy conservation, equipments, machinery, materials and installations, including but not limited to solar modules, mounting structures, inverters, connection box, cables, wires, meters, pylons, tracks, rails, pipelines and any other plant, apparatus equipment, systems and things incidental to the efficient generation, procurement, transformation, supply and distribution of electricity.

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

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

(a) to purchase/import machinery, equipment, components, raw materials and allied items and services required in connection thereto in any manner the company may think fit;

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

(c) to own, establish or have and maintain shops, branches and agencies all over Pakistan or elsewhere for sale and distribution of solar modules, solar system kits, cables, wires, meters, pylons, tracks, rails, pipelines and any other plant, apparatus equipment,

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

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

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

(f) to borrow money in local or in any foreign currency from any person(s), corporation(s), company(ies), bank(s), financial and other entities for carrying on the business of the Company including on the Company's account or on account of the other constituents in such manner as the Company may think fit and in particular by issue of debenture, perpetual or otherwise, convertible into shares or non-convertible of this or any other Company, Redeemable Capital, such as Participation Term Certificates Musharika arrangements, Term Finance Certificate, Long Term Running finance under mark-up or other securities, or perpetual annuities and as security for any such money so borrowed, raised, or received and to mortgage, pledge or charge whole or any part of the property, assets or revenue of the Company, present or future by special assignment or otherwise or to transfer or convey the same absolutely or in trust as may seem expedient and to purchase, redeem or pay off any such securities;

(g) to appoint trustees (whether individuals or corporations) to hold securities on behalf of and to protect the interest of the Company;

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

(i) to purchase or by any other means acquire or sell any freehold or other property and take on lease or in exchange or under amalgamation, license or concession or otherwise, absolutely or conditionally, solely or jointly with others and make, construct,

maintain, work, hire, hold, improve, alter, manage, let, sell, dispose of, exchange, roads, canals, water courses, ferries, piers, wharves, aerodromes, airports, lands, buildings, warehouses, works, factories, mills, workshops, railways, sidings, tramways, engines, machinery and other apparatus, water rights, ways, licences, trade marks, privileges or rights of any description or kind;

(j) to purchase or by any other means acquire and protect, prolong and renew, whether in Pakistan or elsewhere, any patent, rights, inventions, licences, trade marks, protections and concessions which may appear likely to be advantageous or useful to the Company and turn to account and to manufacture under or grant licences or privileges in respect of the same and to spend money in experimenting upon and testing and improving or seeking to improve any patents, inventions or rights which the Company may acquire or propose to acquire;

(k) to acquire and undertake the whole or any part of the business, property and liabilities of any person or company carrying on any business which the Company is authorized to carry on or possessed of property suitable for the purposes of this Company;

(l) to appoint representatives or agents and constitute agencies of the Company in any part of the world;

(m) to make, draw, accept, endorse, discount, execute or negotiate and issue cheques and other securities and promissory notes, bills of exchange, bills of lading, warrants, debentures and other negotiable or transferable instruments or securities concerning this Company;

(n) to invest or deposit monies of the Company, not immediately required, in such shares, stocks, debentures, debenture stocks or in any investments, movable or immovable, in such manner as may from time to time be decided by the directors but not to act as an investment or banking company;

(o) to undertake and execute any trusts, undertaking whereof may seem desirable and either gratuitously or otherwise;

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

(q) to own land or rent land on a long-term basis;

(r) To remunerate the directors, officials, and employees of the Company or any other person or firm or company for rendering services to the Company out of or in proportion to the returns or profit of the Company or otherwise as the Company may think proper, either by cash payment or by the allotment to him or them of shares or securities of the Company credited as paid up in full or otherwise as may be thought expedient;

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

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

13. To facilitate and encourage the creation, issue or conversion of debentures, debenture stock, bonds, obligations, shares, stocks and securities and to take part in the conversion of business concerns and undertakings into companies.

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

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

IV. The liability of the members is limited.

V. The authorized capital of the company is Rs. 100,000 (Rupees One Hundred Thousand only) divided into 10,000 ordinary shares of Rs. 10 each per share with power to enhance, reduce or consolidate the share capital and to divide the shares of the company into different classes and kinds subject to the provisions of the Companies Ordinance, 1984.

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

S. NO.	NAME AND SURNAME (PRESENT & FORMER) IN FULL (IN BLOCK LETTERS)	NIC NO. (IN CASE OF FOREIGNER , PASSPORT NO.)	FATHER'S/ HUSBAND 'S NAME IN FULL	NATIONAL ITY (IES) WITH ANY FORMER NATIONAL ITY	OCCUPA-TION	RESIDENTIAL ADDRESS IN FULL	NUMBER OF SHARES TAKEN BY EACH SUBSCRIBER	SIGNATURES
1	**ZHENGFA ZHA**	**E02501782**	**MINGYI ZHA**	**CHINESE**	**BUSINE SS MAN**	**NO.316 JINXIU AVENUE, HEFEI, ANHUI, CHINA 230601**	**1**	
2	**HUIYING JU**	**G57773209**	**LIXIN CHEN**	**CHINESE**	**BUSINE SS MAN**	**ROOM 402, NO.43 BLDG WUXI , JIANGSU, CHINA 214028**	**1**	
3	**ZHENFA ENERGY GROUP CO. LTD THROUGH ITS LEGAL REPRESENTA -TIVE MR ZHENGFA ZHA**	**E02501782**	**MINGYI ZHA**	**CHINESE**	**BUSINE SS MAN**	**NO.316 JINXIU AVENUE, HEFEI, ANHUI, CHINA 230601**	**7998**	
4	**ZHENFA NEW ENERGY SCIENCE & TECHNOLOGY CO., LTD THROUGH ITS LEGAL REPRESENTA-TIVE MR ZHENGFA ZHA**	**E02501782**	**MINGYI ZHA**	**CHINESE**	**BUSINE SS MAN**	**NO.316 JINXIU AVENUE, HEFEI, ANHUI, CHINA 230601**	**2000**	
						TOTAL NUMBER OF SHARES TAKEN	**10,000**	**(TEN THOUSAND)**

DATED THE 18th **DAY OF** August, **2014**

WITNESS TO ABOVE SIGNATURES.

申小波

SIGNATURE

FULL NAME : XIAOBO SHEN

PASSPORT NUMBER: E04862517

FATHER'S/HUSBAND'S NAME : SHIZHONG SHEN

FULL ADDRESS : NO 24, JIANGYAN DISTRICT, TAIZHOU CITY, JIANGSU, CHINA 225534

OCCUPATION: TECHNICAL ENGINEER

CERTIFIED TO BE TRUE COPY

DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE

THE COMPANIES ORDINANCE, 1984

(Private Company Limited by Shares)

ARTICLES OF ASSOCIATION

ZHENFA PAKISTAN NEW ENERGY COMPANY (PRIVATE) LIMITED

PRELIMINARY

1. The Regulations contained in Table 'A' in the First Schedule to the Companies Ordinance, 1984 shall not apply to the Company except to the extent and as hereinafter, expressly incorporated. In case of any conflict between the provisions referred to and the provisions herein contained and the incorporated Regulations of Table 'A', the provisions herein contained shall prevail.

Company to be governed by the Articles & Table 'A' not to apply.

INTERPRETATION

2. In the interpretation of these Articles, words importing the singular shall include the plural, and vice versa and words importing the masculine gender shall include feminine gender and words importing persons shall also include corporate bodies.

The 'Articles' means these Articles as originally framed or as from time to time altered in accordance with law.

Articles

The 'Commission' means the Securities and Exchange Commission of Pakistan.

Commission

The 'Board' means Board of Directors for the time being of the company.

Board

The 'Chief Executive' means an individual who subject to the control and directions of the directors, is entrusted with the whole or substantially the whole, of the powers of management of the affairs of the company and includes a director or any other person occupying the position of a chief executive, by whatever name called, and whether under a contract of service or otherwise.

Chief Executive

The name of the Company is Zhenfa Pakistan New Energy Company (Private) Limited	Company
The 'Directors' means the Directors for the time being of the company.	Directors
'Dividend' includes bonus.	Dividend
'Document' includes summon, notice, requisition, order, other legal process, voucher and register.	Document
'Month' means the calendar month according to the English Calendar.	Month
The 'Office' means the Registered Office for the time being of the Company.	Office
The 'Ordinance' means the Companies Ordinance, 1984	Ordinance
'Proxy' includes Attorney duly constituted under a Power of Attorney.	Proxy
The 'Register' means the Register of Members to be kept in pursuance to Section 147 of the Ordinance.	Register
The 'Registrar' means the Registrar of Joint Stock Companies having jurisdiction on the Company.	Registrar
'Redeemable Capital' includes finance obtained on the basis of Participation Terms Certificate (PTC), Musharika Certificate, Term Finance Certificate (TFC) or any other security or obligation not based on interest, other than an ordinary share of a company representing an instrument or a certificate of specified denomination, called the face value or nominal value evidencing investment of the holder in the capital of the company on terms and conditions of the agreement for the issue of such instrument or certificate or such other certificate or instrument as the Federal Government may, by notification in the official Gazette, specify for the purpose.	Reedeemable Capital
'Section' means Section of the Ordinance.	Section
The 'Seal' means the common seal of the Company.	Seal

'Security' means any share, script, debenture, participation term certificate, modaraba certificate, musharika certificate, term finance certificate, bond, pre-organization certificate or such other instrument as the Federal Government may, by notification in the official Gazette, specify for the purpose. Security

'In Writing' and written include printing, lithography and other modes of representing or reproducing words in a visible form. Writing

Words and phrases used herein but not defined shall be assigned the same meaning as given to them in the Ordinance. Expressions

BUSINESS

3. The business of the company shall include the several objects expressed in the various clauses of the Memorandum of Association or any of them. Object

4. The business of the Company shall be commenced after incorporation of the Company. Commencement

PRIVATE COMPANY

5. The Company is private company within the meaning of Section 2 (1) Clause (28) and accordingly: Private Company

a) No invitation shall be issued to public to subscribe for any share or debenture of the Company.

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

c) The right to transfer shares of the Company is restricted in the manner and to the extent hereinafter provided.

6. The Capital of the Company is Rs.100,000/- (Rupees One Hundred Thousand only) divided into 10,000 (Ten Thousand) Ordinary shares of Rs.10/- each with power to increase or reduce the capital and to divide the share in the capital for the time being into several classes. Share C

7. The Shares shall be under the control of the Directors who may allot or otherwise dispose of the same or any of them to such persons, on such terms and conditions and at such times as the Directors think fit and with full power to give to any person the right to call for the allotment of any shares at a premium or at par or (subject to the provisions of the Ordinance) at a discount and for such time and for such consideration as the Directors think fit. However while issuing further shares, requirements of Section 86 shall be observed. Allotment shares ur Director's Control

8. No share shall be offered for subscription except upon the term that the amount payable on application shall be the full amount of the nominal value of the share. Offer for Subscripti

9. The directors shall, as regards any allotment of shares, duly comply with such provisions of Section 73, as may be applicable thereto. Return of Allotment

10. Every person whose name is entered as member in the register of members shall, without payment, be entitled to receive, within ninety days after allotment or within forty-five days of the application of registration of transfer, a certificate under the seal specifying the share or shares held by him and the amount paid up thereon. Certificate

11. In respect of a share or shares held jointly by several persons, the company shall not be bound to issue more than one certificate and delivery of a certificate for a share to one of several joint holders shall be sufficient delivery to all. Joint holde

12. As provided in Section 87, the Directors may issue ordinary shares or grant option to convert into ordinary shares, the outstanding balance of any loans, advances or credits or other non-interest bearing securities and obligations outstanding or having a terms of not less than three years in the manner provided in any contract with any schedule bank or a financial institution to the extent of twenty percent of such balance. Issue of sh to banks an financial institutions

13. The Director may issue to banks or financial institution either severally, jointly or through a syndicate, Redeemable Capital in consideration of any funds, moneys, accommodations received or against promise, guarantee, undertaking or indemnity issued to or in favour or benefit of the company.

Issue of Redeem Capital

14 If a share certificate is defaced, lost or destroyed, it may be renewed on payment of such fee, if any, not exceeding one rupee, and on such terms, if any, as to evidence and indemnity and payment of expenses incurred by the company in investigating title, as the directors think fit. Within forty-five days of application, directors shall issue certificate to the applicant.

Duplicate Certificate

TRANSFER OF SHARES

15. No transfer of any share shall be made or registered without previous sanction of the majority of Directors who may after assigning any reason decline to give any such sanction and shall so decline in the case of the transfer of shares, the registration of which will involve a contravention of Article 5.

Restriction c Shares

16 The instrument of transfer of any share in the company shall be executed both by the transferor and the transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the register of members in respect thereof. No transfer shall be made to an infant or persons of unsound mind.

Execution of Transfer

17. Shares in the company shall be transferred in any usual or common form which the directors shall approve.

Form of Transfer

TRANSMISSION OF SHARES

18. The executors, administrators, heirs or nominees, as the case may be, of a deceased sole holder of share shall be the only persons recognised by the company as having any title to the share, in the case of share registered in the name of two or more holders the survivors or survivor, or the executors or administrators of the deceased survivor, shall be the only persons recognised by the company as having any title to the share. Shares of Deceased

19. A member/shareholder may deposit with the company a nomination conferring on one or more persons the right to acquire the interest in the shares therein specified in the event of his death. Regulation of Section 80 will apply in case of all such nominations. Nomination by Members

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

21. 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 was the registered holder of the share, except that he shall not, before being registered as 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. Entitlement of Dividend

ALTERATION OF CAPITAL

22. The company may, from time to time by special resolution increase the share capital by such sum to be divided into shares of such amount, as the resolution shall prescribe. The new shares shall be subject to same provisions with reference to transfer, transmission and otherwise as the shares in the original share capital.

Increase in Share Capit

23. The company, by special resolution:

Consolidation Division, Sub-divisions and Cance of Shares

a) consolidate and divide its share capital into shares of larger amount than its existing shares;

b) sub-divide its existing shares or any of them into shares of smaller amount than is fixed by the memorandum of association, subject nevertheless, to the provisions of clause (d) of sub-section (1) of Section 92; and

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.

24. The company may by special resolution, reduce its share capital in any manner and with, and subject authorized and consent required by Sections 96 to 106.

Reduction of Capital

GENERAL MEETINGS

25. A general meeting to be called annual general meeting shall be held as may be determined by the directors in accordance with the provisions of Section 158, within eighteen months from the date of incorporation of the company and thereafter once at least in every calendar year within a period of four months following the close of its financial year and not more than fifteen months after the holding of its annual general meeting.

Annual General Meeting

26. All general meetings of a company other than annual general meeting shall be called extraordinary general meetings.

Extra Ordinary General Mee

27. The directors may, whenever they think fit, call an extraordinary general meeting. Extraordinary general meeting shall also be called on such requisitions, or in default, may be called by such requisitions, as is provided by Section 159. If at any time there are not within Pakistan sufficient directors capable of acting to form a quorum, any director of the company may call an extraordinary general meeting in the same manner as nearly as possible as that in which meetings may be called by the directors.

Calling of an Extra Ordinary General Meeting

NOTICE AND PROCEEDINGS OF GENERAL MEETINGS

28. Twenty-one days' notice at the least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given) specifying the place, day and the hour of meeting and, in case of special business, the general nature of that business, shall be given in manner provided by the Ordinance for the general meeting, to such persons as are, under the Ordinance or the regulations of the company, entitled to receive such notices from the company; but the accidental omission to give notice to, or the non-receipt of notice by, any member shall not invalidate the proceedings at any general meeting. In case of extraordinary meeting a shorter notice may be given with the consent of Registrar as provided in Section 159 and for passing a special resolution, meeting may be conveyed on a shorter notice with the consent of all the members as provided in Section 2 (1) (36).

Notice

Special Business

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

03/09/2014

Quorum

30. No business shall be transacted at any general meeting unless a quorum of two members is present at that time when the meeting proceeds to business; save as herein otherwise provided, members having not less than twenty five per cent of the voting power present in person or through proxy, shall be a quorum.

Adjourned Meeting

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

Chairman

32. The chairman of the board of directors, if any, shall preside as chairman at every general meeting of the company, but if there is such chairman, or if at any meeting he is not present within fifteen minutes after the time appointed for the meeting, or is unwilling to act as chairman, any one of the directors present may be elected to be chairman, and if none of the directors is present, or willing to act as chairman, the members present shall choose one of their number to be chairman.

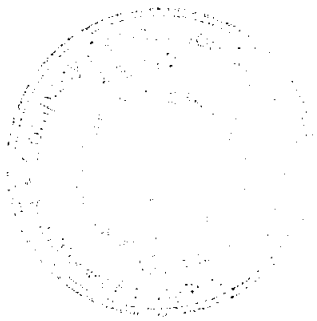
Power to Adjourn General meeting

33. The chairman may, with the consent of any meeting at which quorum is present (and shall if so directed by the meeting), adjourn the meeting from time to time but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the

adjournment took place. When a meeting is adjourned for ten days or more, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid, it shall not be necessary to give any notice of an adjournment or of the business to be transacted at an adjourned meeting.

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

Adoption of Resolution



35. A poll may be demanded only in accordance with the provisions of Section 167.

Demand for Poll

36. If a poll is duly demanded, it shall be taken in accordance with manner laid down in Section 168 and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded. A poll demanded on the election of chairman or on a question of adjournment shall be taken at once.

Manner and Time of Taking Poll

37. In the case of an inequality of votes, whether on a show of hands or on a poll, the chairman of the meeting at which the show of hands takes place, or at which the poll is demanded, shall have and exercise a second or casting vote.

Casting Vote

VOTES OF MEMBER

38. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands every member present in person shall have

Right to Vote

the provisions of Section 178 shall apply. On a poll every members shall have voting rights as laid down in Section 160.

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

Vote of Joint holder

40. On a poll votes may be given either personally or by proxy; Provided that no body corporate shall vote by proxy as long as a resolution of its directors in accordance with the provisions of Section 162 is in force.

Vote by Proxy and by Corporate Representative

41. The instrument appointing a proxy shall be in writing under the hand of the appointor or of his attorney duly authorised in writing. A proxy must be a member.

Proxy to be in writing

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

Deposit of instrument of Proxy

43. An instrument appointing a proxy may be in any usual or common form as near thereto as may be which the directors shall approve.

Form of Proxy

DIRECTORS

44. The first directors of the Company shall be the following:

First Directors

1. Zhengfa Zha
2. Huiying Ju

45. Subject to the provisions of the Ordinance, the

Number of Directors

Company may from time to time in general meeting increase or decrease the number of directors. However such number shall not in any case be less than two.

Directors

46. The company may have directors nominated by the company's creditors or other special interest by virtue of contractual arrangements..

Nominated Directors

47. A Director who is about to leave or is absent from Pakistan may with the approval of the Directors appoint any person to be an Alternate Director during his absence from the country provided such absence shall not be less than for a period of three months and such appointment shall have effect and such appointee whilst he holds office as an Alternate Director, shall be entitled to notice of the meeting of the Directors, and to attend and vote thereat accordingly but shall ipso facto vacate office when his appointer returns to the country or vacates office as Director, if the company in General Meeting removes the appointee from office and any appointment and removal under the clause shall be affected by notice in writing under the hand of director making the same.

Alternate Director

48. The remuneration of director for performing extra services, including holding of the office of Chairman, and the remuneration to be paid to any director for attending the Meeting of the Directors or a committee of Directors shall from the time to time be determined by the Board of Directors in accordance with the law.

Remuneration of Directc

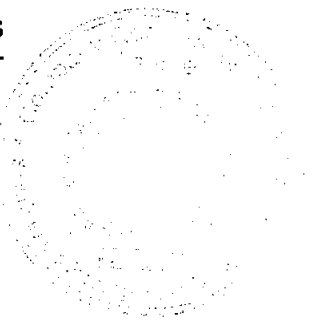
49. The business of the company shall be managed by the directors, who may pay all expenses incurred in promoting and registering the Company and may exercise all such power of the company as are not, by the Ordinance or any statutory modification thereof for the time being in force, or by these regulations, required to be exercised by the company in general meeting subject nevertheless to the provisions of the Ordinance or to any of these regulations, and such regulations being not inconsistent with the aforesaid provisions, as may be prescribed by the company in general meeting but

Management of Business

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.

50. The Directors may from time to time by power of attorney under the Company's Seal, appoint any person or persons to be the attorney(s) of Company for such purposes and with such powers, authorities and discretions (not exceeding those vested in, or exerciseable by the Directors under these presents) and for such period and subject to such conditions as the Directors may from time to time think fit. Any such attorney (s) may, if authorised by the Directors, delegate all or any of the powers vested in him/them.

Power to appoint Attorney



51. 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 to the keeping of a register of the directors and to the sending to the registrar of an annual list of members, and a summary of particulars relating thereto and notice of any consolidation or increase of share capital, or sub-division of shares, and copies of special resolutions and a copy of the register of directors and notification of any changes therein.

Filing of Returns

52. Subject to the provisions of Section 196, the Directors may from time to time at their discretion borrow such sum or sums as they may think fit for the purpose of the company including from any banks and financial institutions and secure the payment or repayment of such sum or sums in such manner and upon such terms and conditions as they think fit by mortgage or charge upon the whole or any part of the property, present and future or any such other way as the Directors may think expedient. The company may raise and secure payment of any sum by issue of Redeemable Capital. The Redeemable Capital may be issued at a discount, premium or otherwise with special privilege as to redemption, conversion into share with voting rights and their subsequent reconversion to Redeemable Capital.

Power to Borrow

53. The Directors shall cause a proper register to be kept in accordance with Section 135 of all mortgages and charges specifically affecting the property of the company and shall duly comply with the requirements of Sections 121, 122 and 129 in regard to registration of mortgages and charges and shall also duly comply with the requirements of Section 130 as to keeping a copy of every instrument creating any mortgage or charge and requirements of Section 132 as to giving intimation of the payment or satisfaction of any charge or mortgage created by the company.

Mortgages and Charges

54. Every director or his relative who is in any way, whether directly or indirectly, concerned or interested in any contract or arrangement entered into, or to be entered into, by or on behalf of the company shall disclose the nature of his concern or interest at a meeting of the directors, as required by Section 214.

Disclosure of Interest by Directors

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

Minutes to be made

a) of all appointments of officers made by the directors

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

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

and every director present at any meeting of directors or committee of directors shall sign his name in a book to be kept for that purpose.

DISQUALIFICATION OF DIRECTORS

56. No person shall become director of the Company if he suffers from any of the disabilities or disqualifications mentioned in Section 187 and if already a director, shall cease to hold such office from the date he so becomes disqualified or disabled: Provided, however that no director shall vacate his office by reason only of his being a member of any company which has

Ineligibility

entered into contracts with, or done any work for the company of which he is director, but such director shall not vote in respect of any such contract or work, and if he does so vote, his vote shall not be counted.

PROCEEDINGS OF DIRECTORS

57 The directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings, as they think fit. The quorum for the meeting shall be fixed by the directors and unless so fixed shall be two. Questions arising at any meeting shall be decided by a majority of votes. In case of an equality of votes, the chairman shall have and exercise a second or casing vote. 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.

Meetings of Directors

58. 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 think fit; any committee so formed shall, in the exercise of the powers so delegated, conform to any restrictions that may be imposed on them by the directors.

Delegation of Power to Committees

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

Chairman

60. A committee may elect a chairman of its meetings; if no such chairman is elected, or if at any meeting the chairman is not present within fifteen 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.

Chairman of Committee Meetings

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.

61. A committee may meet and adjourn as it thinks proper. Questions arising at any meeting shall be determined by a majority of votes of the members present. In case of an equality of votes, the chairman shall have and exercise a second or casting vote.

Proceedings of Committee Members

62. All acts done by any meeting of the directors or of a committee of directors or by any person acting as a director, shall, notwithstanding that it be afterwards discovered that there was some defect in the appointment of any such directors or persons acting as aforesaid, or that they or any of them were disqualified, be as valid as if every such person had been duly appointed and was qualified to be a director.

Validity of Director's Act

63. A resolution in writing signed by all the directors or affirmed by them through telex or telegram shall be as valid and effectual as if it had been passed at a meeting of directors duly convened and held.

Resolution in Writing

ELECTION AND REMOVAL OF DIRECTORS

64. The First Directors of the Company shall retire from their offices at the first Annual General Meeting of the Company, and directors shall be elected in their place in accordance with Section 178 for a term of three years, unless they resign earlier, become disqualified for being Directors or otherwise cease to hold office.

Period of Office

65. The Directors shall comply with the provisions of Section 174 to 178, 180 and 184 relating to election of directors and matters ancillary thereto.

Election

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

Eligibility

67. Any casual vacancy occurring on the board of directors may be filled up by the directors but the person so chosen shall be subject to retirement at the

Casual Vacancy

68. The number of directors determined by the Board shall be elected to hold office by the members in general meeting in the following manner: Mode of Election

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

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

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

69. The Company may by resolution in general meeting remove a director appointed under Section 176 or Section 180 or elected in the manner provided for in Section 178. Removal

Provided that a resolution for removing a director shall not be deemed to have been passed unless the number of votes cast in favour of such a resolution is not less than:

i) he minimum number of votes that were cast for the election of a director at the immediately preceding election of directors, if the resolution relates to removal of a director elected in the manner provided in sub-section (5) of Section 178; or

ii) the total number of votes for the time being computed in the manner laid down in sub-section (5) of Section 178 divided by the number of directors for the time being, if the resolution relates to removal of a director appointed under Section 176 or Section 180.

70. A director shall ipso facto cease to hold office if: Vacation of

A director shall ipso facto cease to hold office if: Vacation of Office

a) he becomes ineligible to be appointed a director on any one or more of the grounds enumerated in Section 187.

b) he absents himself from three consecutive meetings of the directors or from all the meetings of the directors for a continuous period of three months, whichever is the longer, without leave of absence from the directors;

c) he or any firm of which he is a partner or any private company of which he is director:

i) without the sanction of the company in general meeting accepts or holds any office of profit under the company other than that of chief executive or legal or technical adviser or a banker; or

ii) accepts a loan or guarantee from the company in contravention of Section 195.

CHIEF EXECUTIVE

71. The directors of the company as from a date not later than the fifteenth day after the date of its incorporation appoint any individual to be the chief executive of the company First Appointment

73. Within fourteen days from the date of election of directors under Section 178 or the office of the Chief Executive falling vacant, as the case may be, the directors of a company shall appoint any person, including an elected director, to be the chief executive, but such appointment shall not be for a period exceeding three years from the date of appointment. Subsequent Appointment and Term of Office

74. On the expiry of his term of office under Section 198 or 199, a chief executive shall be eligible for Eligibility for Reappointment

successor is appointed unless non-appointment of his successor is due to any fault on his part or his office is expressly terminated.

75. The terms and conditions of appointment of a chief executive shall be determined by the directors. — Terms and Conditions

76. The chief executive shall, if he is not already a director of the company, be deemed to be its director and be entitled to all the rights and privileges, and subject to all the liabilities, of that office. — Deemed to be Director

77. No person who is ineligible to become a director of a company under Section 187 shall be appointed or continue as the chief executive of the company. — Ineligibility

78. The directors of a company by resolution passed by not less than three fourths of the total number of directors for the time being or the company by a special resolution may remove a chief executive before the expiration of his term of office notwithstanding anything contained in these articles or in any agreement between the company and such chief executive. — Removal

SEAL

79. The company shall have a common seal and the director shall provide for the safe custody thereof. The seal shall not be affixed to any instrument except by the authority of a resolution of the board of directors or by a committee of directors authorised in that behalf by the directors and two directors or one director and the secretary of the company shall sign every instrument to which the common seal is affixed. — Common Seal

80. The directors may provided for the use in any territory, district or place not situated in Pakistan of an official seal which shall be facsimile of the common seal of the Company with addition on its face of the name of every territory, district or place where it is to be used. The provisions of Section 213 shall apply to the use of such official seal. — Official Seal

DIVIDENDS AND RESERVES

81. The company in general meeting may declare dividends but no dividend shall exceed the amount recommended by the directors. — Declaration of Dividend

82. The directors may from time to time pay to the members such interim dividends as appear to the directors to be justified by the profits of the company. — Interim Dividend

83. No dividends shall be paid otherwise than out of profits of the year or any other undistributed profits. — Dividend out of Profits only

84. No dividend shall be declared or paid out of profits made from sale or disposal of any immovable property or assets of capital nature comprised in the undertaking except after such profits are set off or adjusted against losses arising from the sale of any such immovable property or assets of capital nature. — No dividend out of Capital Profits

85. Subject to the rights persons (if any) entitled to shares with special rights as to dividends, all dividend shall be declared and paid according to the amounts paid on the shares, if and so long as nothing is paid upon any of the shares in the company, dividends may be declared and paid according to the amounts of the shares. — Dividend in proportion to amount paid

86. Any general meeting declaring a dividend may resolve that such dividend be paid wholly or in part by the issue of paid up shares or debentures. — Dividend in Specie

87. The directors may, before recommending any dividend, set aside out of the profits of the company such sums as they think proper as a reserve or reserves which shall, at the discretion of the directors be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the company may be properly applied, and pending such application may, at the like discretion, either be employed in the business of company or be invested in such investments (other than shares of the company) as the directors, may — Transfer to Reserve

subject to the provisions of the Ordinance, from time to time, think fit.

88. The directors may carry forward any profits which they may think prudent not to distribute, without setting them aside as a reserve. Retention of Profits

89. If several persons are registered as joint-holders of any shares, any one of them may give effectual receipt for any dividend payable on the share. Dividend to Joint-holders

90. The dividend shall be paid within thirty days of the declaration or otherwise in accordance with Section 251 of the Companies Ordinance, 1984. Time of Payment

BOOKS AND ACCOUNTS

91. The directors shall cause to be kept proper books of account as required under Section 230. Books of Account

92. 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. Place where Books of Account kept

93. The directors shall from time to time determine whether and to what extent and at what time and place and under what conditions or regulations the 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. Inspection by Members

94. The directors shall as required by Sections 233 and 236 cause to be prepared and to be laid before the company in general meeting such profit and loss accounts or income and expenditure accounts and balance sheet duly audited and reports as are referred to in those sections. Annual Accounts

95. A balance sheet, profit and loss account, income and expenditure account and other reports referred to in clause 96 above shall be made out in every year and laid Presentation of Annual Accounts before Annual General Meeting

before the company in the annual general meeting made up to date not more than four months before such meeting. The balance sheet and profit and loss account or income and expenditure account shall be accompanied by a report of the auditors of the company and the report of directors.

96. Every account of the Company when audited and approved by a general meeting shall be conclusive except as regard any errors discovered therein within three months next after the approval thereof. Whenever any such error is discovered within that period, the account shall forthwith be corrected and thenceforth shall be conclusive.

When Accounts Settled

97. A copy of the balance sheet and profit and loss account or income and expenditure 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.

Copies to be sent to Members

98. The directors shall in all respects comply with the provisions of Sections 230 to 236.

Compliances with Ordinance

AUDIT

99. Auditors shall be appointed and their duties regulated in accordance with Sections 252 to 255.

Audit

NOTICES

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

Mode of Service of Notice

101. If a member has no registered address in Pakistan, and has not supplied to the company an address within Pakistan for the giving of notices to him, a notice addressed to him or to the shareholders generally and advertised in a newspaper circulating in the province of
the registered office of the company shall be deemed to be duly given to him on the day on which the advertisement appears.

Notice by Newspaper

102. 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.

Notice to Joint-holders

103. A notice may be given by the company to the person entitled to a share in consequence of the death or insolvency of a member by sending it through the post in a prepaid letter addressed to them by name, or by the title of representatives of the deceased or assignee of the insolvent or by any like description, at the address (if any) in Pakistan supplied for the purpose by the person claiming to be so entitled or (until such an address as 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.

Notice to person entitled to transmission

104. Notice of every general meeting shall be given in some manner hereinbefore authorized to:

Notice of General meeting

a) every member of the company except those members who, having no registered address within Pakistan, have not supplied to the company an address within Pakistan, for the giving of notice to them, and also to

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.

SECRECY

105. Every Director, Chief Executive, Secretary, Auditor, Trustee, Member of Committee, Officer, Servant, Agent, Accountant or other person employed in business of the Company shall, if so required by the directors before entering upon this duties, sign a declaration pledging himself to observe a strict secrecy respecting all transactions of the Company with its customers and the state of accounts with individuals and in matters relating thereto and shall by such declaration pledge himself not to reveal any of the matters which may come to his knowledge in the discharge of his duties except when required to do so by the directors or by any meeting or by a court of law or by the person to whom such matters relate and except so far as may be necessary in order to comply with any of the provisions in these presents.

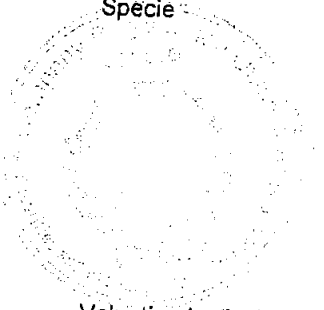
Secrecy

106. No member or other person (not being a director) shall be entitled to enter the property of the company or examine the company's premises or properties without the permission of a director, subject to Article 107, to require discovery of or any information respecting any detail of the Company's trading or any matter which is or may be in the nature of a trade secret, mystery of trade or secret process or of any matter whatsoever which may relate to the conduct of the business of the company and which in the opinion of the directors will be inexpedient in the interest of the members of the company, to communicate.

Members' Access to Company Premises

107. If the company is wound up, the liquidator may, with the sanction of a special resolution of the company and any other sanction required by the Ordinance, divide amongst the members, in specie or kind, the whole or any part of the assets of the company, whether they consist of property of the same kind or not.

Division of assets in Specie



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

Valuation by liquidator

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

Assets in Trust

INDEMNITY

110. Every officer or agent for the time being of the company may be indemnified out of the assets of the company against any liability incurred by him in defending any proceedings, whether civil or criminal, arising out of his dealings in relation to the affairs of the company, except those brought by the company against him, in which judgment is given in his favour or in which he is acquitted or in connection with any application under Section 488 in which relief is granted to him by the Court.

Director's and other's right to indemnify

ARBITRATION

Differences to be referred to Arbitrator(s)

111. 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 incident or consequences of these Articles or of the statutes, or touching anything there or thereafter done, executed, omitted or suffered in pursuance of these Articles or of the statutes or touching any breach or alleged breach of these Articles, or any claim on account of any such breach or alleged breach, or otherwise relating to the premises, or to these Articles or to any statute affecting the company or to any of the affairs of the Company, every such difference shall, as a condition precedent to any other action at law be referred in conformity with the Arbitration Act, 1940 or any statutory modification thereof and any rules made thereunder, 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 in the event of the two arbitrators not agreeing, then of an umpire to be appointed by the two arbitrators, in writing before proceeding on the reference, and such decision shall be final and binding on the parties.

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

S. NO.	NAME AND SURNAME (PRESENT & FORMER) IN FULL (IN BLOCK LETTERS)	NIC NO. (IN CASE OF FOREIGNER, PASSPORT NO.)	FATHER'S/ HUSBAND 'S NAME IN FULL	NATIONALITY (IES) WITH ANY FORMER NATIONALITY	OCCUPATION	RESIDENTIAL ADDRESS IN FULL	NUMBER OF SHARES TAKEN BY EACH SUBSCRIBER	SIGNATURES
1	**ZHENGFA ZHA**	**E02501782**	**MINGYI ZHA**	**CHINESE**	**BUSINESS MAN**	**NO.316 JINXIU AVENUE, HEFEI, ANHUI, CHINA 230601**	**1**	
2	**HUIYING JU**	**G57773209**	**LIXIN CHEN**	**CHINESE**	**BUSINESS MAN**	**ROOM 402, NO.43 BLDG WUXI, JIANGSU, CHINA 214028**	**1**	
3	**ZHENFA ENERGY GROUP CO. LTD THROUGH ITS LEGAL REPRESENTATIVE MR ZHENGFA ZHA**	**E02501782**	**MINGYI ZHA**	**CHINESE**	**BUSINESS MAN**	**NO.316 JINXIU AVENUE, HEFEI, ANHUI, CHINA 230601**	**7998**	
4	**ZHENFA NEW ENERGY SCIENCE & TECHNOLOGY CO., LTD THROUGH ITS LEGAL REPRESENTATIVE MR ZHENGFA ZHA**	**E02501782**	**MINGYI ZHA**	**CHINESE**	**BUSINESS MAN**	**NO.316 JINXIU AVENUE, HEFEI, ANHUI, CHINA 230601**	**2000**	
						TOTAL NUMBER OF SHARES TAKEN	**10,000**	**(TEN THOUSAND)**

DATED THE 18th **DAY OF** August, **2014**

WITNESS TO ABOVE SIGNATURES.

申小波

SIGNATURE

FULL NAME : XIAOBO SHEN

PASSPORT NUMBER: E04862517

FATHER'S/HUSBAND'S NAME : SHIZHONG SHEN

FULL ADDRESS : NO 24, JIANGYAN DISTRICT, TAIZHOU CITY, JIANGSU, CHINA 225534

OCCUPATION: TECHNICAL ENGINEER

CERTIFIED TO BE TRUE COPY

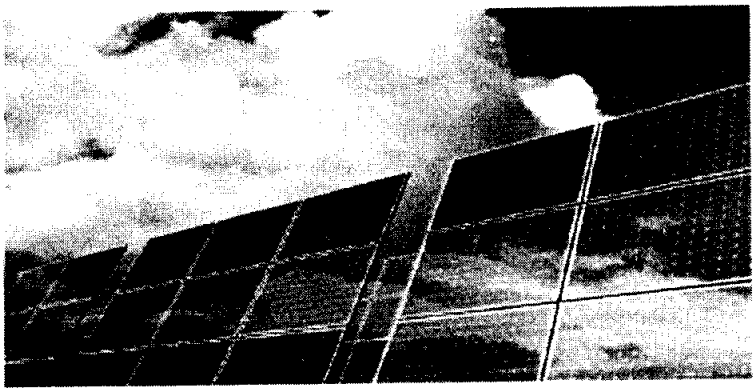
DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

Report No. PPI-174.1-Draft/15

INTERCONNECTION STUDY

For

100 MW Solar Power Project by Zhenfa Pakistan New Energy Company (Pvt) Limited at Chaubara, Punjab



Draft Report
(October 2015)

POWER PLANNERS INTERNATIONAL LTD.

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Executive Summary

- The study objective, approach and methodology have been described and the plant's data received from the client Zhenfa Solar PP has been validated.
- The expected COD of the project is January 2017. Therefore, the month of January 2017 has been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load forecast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-380/4453-54 dated 22-10-2015 as referred to in CPPA letter no. CPPA(G)L/CEO/CE-II/MT-IV/ZEGCL 4679-81
- The nearest substation of MEPCO is Chaubara 132 kV. The scheme of interconnection has been developed by looping Zhenfa Solar in-out of the single 132 kV circuit between Chaubara and Chokmnda and studied in detail to evacuate the maximum power of 100 MW.
- Detailed load flow studies have been carried out for the peak load conditions of January 2017 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 100 MW of the plant under normal and contingency conditions for the contingencies performed.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Zhenfa Solar Power Plant at 132 kV, and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from the Zhenfa Solar Power Plant.
- The maximum short circuit level of 132 kV bus bar of Zhenfa Solar Power Plant is 4.35 kA and 2.74 kA for 3-phase and 1-phase faults respectively and the maximum short circuit level of 33 kV bus bar of Zhenfa Solar Power Plant is 9.02 kA and 6.96 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate

with enough margins for future increase in fault levels due to future reinforcements in this area.

- The dynamic stability analysis of proposed scheme of interconnection has been carried out for January 2017. The stability check for the worst case of three phase fault on the 132 kV bus bar of the Zhenfa Solar power plant substation followed by the final trip of 132 kV circuit connected to this substation has been performed for fault clearing of 9 cycles (180 ms) as understood to be the maximum fault clearing time of 132 kV protection system. The system is found to retain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Chokmnda 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

Report Contents

1. Introduction

1.1 Background

Zhenfa Solar (Private) Limited is setting up a 100 MW solar power plant at Chaubara, Punjab. The site of the proposed project is located in the concession area of Multan Electric Power Company Limited (MEPCO). The peak AC net output planned to be generated from the project is about 95 MW which will start commercial operations by January 2017. The electricity generated from this project will be supplied to the MEPCO network through the 132 kV grid located in the vicinity of this project.

1.2 Objectives

The overall objective of the Study is to develop an interconnection scheme between Zhenfa Solar Power Plant and MEPCO network, for stable and reliable evacuation of 95 MW of electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives are:

1. To develop a scheme of interconnections at 132 kV for which right of way (ROW) and space at the terminal substations would be available.
2. To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
3. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 132 kV and that voltage levels are within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at the Zhenfa Solar Power Plant.
4. To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping after 3-phase faults on the system.

1.3 Planning Criteria

The planning criteria as per Grid Code required to be fulfilled by the proposed interconnection is as follows:

Steady State:

Voltage	± 5 %, Normal Operating Condition
	± 10%, Contingency Conditions
Frequency	50 Hz, Continuous, ± 1% variation steady state
	49.2 - 50.5 Hz, Short Time
Power Factor	0.95 Lagging; 0.95 Leading (for conventional synchronous generators but would not be applicable to solar PP)

Dynamic/Transient:

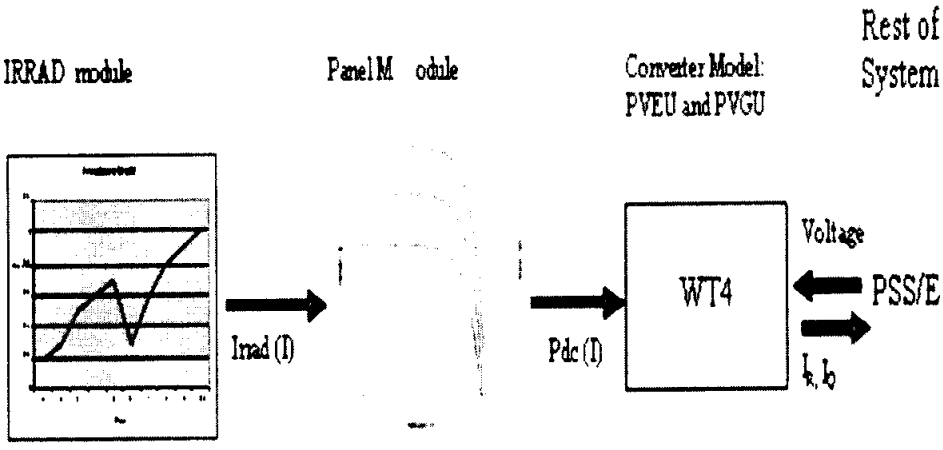
- The system should revert to normal condition after the transients have died down without losing synchronism with good damping. For 33 kV the total maximum fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 180 ms (9 cycles).
- For the systems of 132 kV and above the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles).
- For the systems of 132 kV and above, in case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles).

2. Assumptions of Data

The detailed electrical parameters would be designed at the EPC stage. However for the purposes of this study, following assumptions have been made:

2.1 Solar Power Plant data

The Solar Power plant has been modeled according to the following block diagram



The way this works is that the irradiance profile from the sun is used as an input to the panel module which then calculates the DC power at that value of the irradiance. This value is then input to the electrical model of the solar power plant (inverter module) which then goes on to calculate the AC power supplied by the solar power plant.

Due to the presence of the inverter module, from the point of view of the network, the solar power plant is considered a voltage source convertor.

Dynamic Data:

Converter time constant for IQcmd seconds = 0.02 s

Converter time constant for IQcmd seconds = 0.02 s

Voltage sensor for LVACR time constants = 0.02 s

Voltage sensor time constant = 1.1 s

2.2 Network data

The 132 kV networks available for interconnection to Zhenfa Solar Power Plant are as shown in Sketches 1 and 2 in Appendix-B.

The latest generation, transmission plan and load forecast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-380/4453-54 dated 22-10-2015 as referred to in CPPA letter no. CPPA(G)L/CEO/CE-II/MT-IV/ZEGCL 4679-81

3. Study Approach and Methodology

3.1 Understanding of the Problem

The 100 MW Solar Power Plant by Zhenfa Solar (Pvt.) Limited is going to be a Photovoltaic (PV) based solar project embedded in the 132 kV distribution network of Chaubara. It would run almost all the months of the year though with some variation in its output due to variation in the intensity of light during winter and rainy season.

The existing nearest grid station available for interconnection is Chaubara 132 kV Substation. The addition of this source of power generation embedded in local distribution network of this area shall provide relief to the substations feeding the local network. The 132 kV network surrounding Chaubara has significant load demand, therefore most of the power from the Zhenfa Solar Power Plant will be utilized locally in meeting this load demand.

The adequacy of the MEPCO network of 132 kV in and around the proposed site of Zhenfa Solar Power Plant has been analysed in this study for absorbing and transmitting this power, fulfilling the reliability criteria.

3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for January 2017 considering maximum AC out of 95 MW for the solar plant by Zhenfa Solar (Pvt.) Limited, comprising all 500 kV, 220 kV and 132 kV system and envisaging the load forecast, the generation additions and transmission expansions for that year particularly in MEPCO.
- The project is expected to be completed by January 2017. Therefore the month of January 2017 has been selected to carry out the study as it will allow the maximum impact of the project to be judged.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, has been developed.
- Performed technical system studies for peak load conditions to confirm technical feasibility of the interconnections. The scheme has been subjected to

standard analysis like load flow and short circuit and transient stability study to check the strength of the plant and the proposed interconnection scheme under disturbed conditions.

- Determine the appropriate equipment for the proposed technically feasible scheme.
- Recommend the technically most feasible scheme of interconnection.

4. Development of Scheme of Interconnection

4.1 The Existing Network

The nearest existing MEPCO interconnection facilities at the time of commissioning of Zhenfa Solar Power Project would be Chaubara 132 kV Substation.

The existing 132 kV network available around the study solar power plant is shown in Sketch-1 in Appendix-B.

The single line diagram of the substation, as a conceptual design, is shown in SLD-1 in Appendix-B for 33 kV and 132 kV.

Given the physical proximity of Chaubara to Zhenfa Solar power plant and the fact that the other facilities are at a considerable distance from the plant, the most feasible interconnection of the Zhenfa Solar Power Plant will be with Chaubara 132 kV substation.

4.2 The Scheme of Interconnection of Solar Power Plant

Keeping in view the above mentioned 132 kV network available in the vicinity of the site of the Zhenfa Solar Power Plant, the interconnection scheme has been developed as shown in Sketch-2 in Appendix B. The nearest substation of MEPCO is Chaubara 132 kV. The scheme of interconnection has been developed by looping Zhenfa Solar in-out of the single 132 kV circuit between Chaubara and Chokmnda to evacuate the maximum power of 100 MW.

5. Detailed Load Flow Studies

5.1 Load Flow without Zhenfa Solar Power Plant, January 2017

A base case has been developed for the peak load case of January 2017, using the network data of Zhenfa Solar-PP and MEPCO network.

The results of load flow for this case are shown in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit shows 132 kV network around the location of the study Solar Power Plant.

The load flow results show that the power flows on all circuits are within their specified normal current carrying rating and the voltages are also within the permissible limits for the contingencies performed.

For N-1 contingency conditions we have performed the following contingencies.

Exhibit 0.1	Chokmnda to Chaubara 132 kV Single Circuit Out
Exhibit 0.2	Chokazam to Chaubara 132 kV Single Circuit Out
Exhibit 0.3	Chokazam to Fatehpur 132 kV Single Circuit Out
Exhibit 0.4	T-Cmunda to Chokmnda 132 kV Single Circuit Out
Exhibit 0.5	KotAdu-O to ChokAzam 132 kV Single Circuit Out
Exhibit 0.6	KotSultan to Layyah 132 kV Single Circuit Out
Exhibit 0.7	KotAdu-O to KotSultan 132 kV Single Circuit Out
Exhibit 0.8	ChokAzam to Layyah 132 kV Single Circuit Out

In both cases the power flows on all circuits remain within their ratings for the contingencies covered. Thus we find that there are no capacity constraints in terms of the MW or MVAR flows in the 132 kV network available in the vicinity of Zhenfa Solar Power Plant for its connectivity under normal and contingency conditions prior to its connection.

5.3 Load Flow with Zhenfa Solar Power Plant, January 2017

The nearest substation of MEPCO is Chaubara 132 kV. The scheme of interconnection has been developed by looping Zhenfa Solar in-out of the single 132

kV circuit between Chaubara and Chokmnda and studied in detail to evacuate the maximum power of 100 MW.

The results of load flow with Zhenfa Solar Power Plant interconnected as per the proposed scheme are shown in Exhibit 1.0 in Appendix-C. The power flows on the circuits are well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits for the contingencies performed

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – B as follows;

Exhibit 1.1	Zhenfa Solar to Chokmanda 132 kV Single Circuit Out
Exhibit 1.2	Zhenfa Solar to Chaubara 132 kV Single Circuit Out
Exhibit 1.3	Chaubara to ChokAzam 132 kV Single Circuit Out
Exhibit 1.4	Chokazam to Fatehpur 132 kV Single Circuit Out
Exhibit 1.5	Chokmnda to T-Cmunda 132 kV Single Circuit Out
Exhibit 1.6	KotAdu-O to ChokAzam 132 kV Single Circuit Out
Exhibit 1.7	KotSultan to Layyah 132 kV Single Circuit Out
Exhibit 1.8	KotAdu-O to KotSultan 132 kV Single Circuit Out
Exhibit 1.9	Ch1okAzam to Layyah 132 kV Single Circuit Out

We see that the power flows on all circuits remain within their ratings for the contingencies covered. Thus we find that after the connection of Zhenfa Solar PP there are no capacity constraints in terms of the MW or MVAR flows in the 132 kV network available in the vicinity of the Solar Power Plant for its connectivity under normal and contingency conditions.

5.4 Conclusion of Load Flow Analysis

From the analysis carried out above, we conclude that the proposed interconnection scheme ensures its reliability and availability under all events of contingencies i.e. planned or forced outages.

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been adopted in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies.

The maximum fault currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2017 i.e. all the generating units have been assumed on-bar in fault calculation simulations.

6.2 Fault Current Calculations without Zhenfa Solar Power Plant, January 2017

In order to assess the short circuit strength of the network of 132 kV without the Solar Power Plant for the grid of MEPCO in the vicinity of the site of the Plant near Chaubara, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will not only give us an idea of the fault levels without Zhenfa Solar Power Plant and later on how much the contribution of fault current from the Solar Power Plant may add to the existing levels, but we are also able to assess the strength of the proposed node to connect this Power Plant depending on its relative short circuit strength.

The results are attached in Appendix – D.

The short circuit levels have been represented graphically on the bus bars of 132 kV along with fault current contributions from the incoming circuits, which are shown in the Exhibit 2.0 attached in Appendix-D.

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

The tabular output of the short circuit calculations is also attached in Appendix-D for the 132 kV bus bars of our interest i.e. 132 kV circuits lying close to Zhenfa Solar. The tabular output is the detailed output showing the contribution to the fault current from the adjoining sources i.e. the lines and transformers connected to that bus. The phase currents, the sequence currents and the sequence impedances are shown in detail for each faulted bus bar.

The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 6.1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 132 kV substations which are normally 40 kA.

Table - 6.1
Maximum Short Circuit Levels without Zhenfa Solar PP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Chaubara 132kV	**4.34**	**2.74**
Nawakot 132kV	**2.79**	**1.75**
Chokazam 132kV	**7.38**	**4.99**
Chokmunda 132kV	**5.0**	**3.23**
T-Cmunda 132kV	**5.06**	**3.27**
Kotadu old 132kV	**31.85**	**31.5**
KotSultan 132kV	**7.2**	**4.82**
Layyah 132kV	**6.12**	**4.30**
Karor L.E 132kV	**3.15**	**2.42**

6.3 Fault Current Calculations with Zhenfa Solar Power Plant, January 2017

Fault currents have been calculated for the electrical interconnection of the proposed scheme. Fault types applied are three phase and single-phase at 132 kV bus bar of Zhenfa Solar Power Plant itself and other bus bars of the 132 kV substations in the electrical vicinity of Chishtian - New. The graphic results are shown in Exhibit 2.1.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV bus bars of the network in the electrical vicinity of Zhenfa Solar Power Plant are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.2.

Comparison of Tables 6.1 and 6.2 shows slight increase in short circuit levels for three-phase and single-phase faults due to connection of Solar Power Plant on the 132 kV bus bars in its vicinity. This increase is limited considering the fact that the Solar Power Plant is a voltage source convertor. We find that even after some increase, these fault levels are much below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of 132 kV bus bar of Zhenfa Solar Power Plant is 4.35 kA and 2.74 kA for 3-phase and 1-phase faults respectively and the maximum short circuit level of 33 kV bus bar of Zhenfa Solar Power Plant is 9.02 kA and 6.96 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.

Table-6.2
Maximum Short Circuit Levels with Zhenfa Solar PP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Zhenfa-MV 33kV	9.02	6.96
Zhenfa Solar 132kV	4.35	2.74
Chaubara 132kV	4.45	2.80
Nawakot 132kV	2.89	1.81
Chokazam 132kV	7.49	5.06
Chokmunda 132kV	5.05	3.27
T-Cmunda 132kV	5.11	3.30
Kotadu old 132kV	31.96	31.60
KotSultan 132kV	7.26	4.86
Layyah 132kV	6.19	4.35
Karor L.E 132kV	3.19	2.45

6.5 Conclusion of Short Circuit Analysis

The short circuit analyses results show that for the proposed scheme of interconnection of Zhenfa Solar Power Plant with Chaubara 132 kV distribution network, we don't see any violations of short circuit ratings of the already installed equipment on the 132 kV equipment of substations in the vicinity of the Solar Power Plant due to fault current contributions from this plant due to three-phase faults or single phase faults.

The maximum short circuit level of 132 kV bus bar of Zhenfa Solar Power Plant is 4.35 kA and 2.74 kA for 3-phase and 1-phase faults respectively and the maximum short circuit level of 33 kV bus bar of Zhenfa Solar Power Plant is 9.02 kA and 6.96 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.

7. Transient Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Stability Models

The assumptions about the generator and its parameters are the same as mentioned in Ch.2 of this report.

We have employed the generic stability models available in the PSS/E model library for dynamic modelling of the PV-Solar power generator, its electrical model and the panel as follows;

Generator	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1

We have done studies with the inverter which has reactive support capability of ± 0.95 PF.

7.1.2 System Conditions

We have used the system conditions of January 2017 given the COD of the subject Solar Power Plant in January 2017.

The nearest substation of MEPCO is Chaubara 132 kV. The scheme of interconnection has been developed by looping Zhenfa Solar in-out of the single 132 kV circuit between Chaubara and Chokmnda.

All the power plants of WAPDA/NTDC from Tarbela to HUBCO have been dynamically represented in the simulation model.

7.1.3 Presentation of Results

The plotted results of the simulations are placed in Appendix - E. Each simulation has been run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish that the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for ten seconds. Usually all the transients due to non-linearity die down within 2-3 seconds after disturbance is cleared in the system.

7.1.4 Worst Fault Cases

Three phase faults are considered to be the worst disturbance in the system. We have considered 3-phase fault in the immediate vicinity of the Solar Power Plant i.e. right at the 132 kV bus bar of the solar power plant substation, cleared in 9 cycles, as normal clearing time for 132 kV i.e. 180 ms, followed by permanent trip of 132 kV single circuit connected to this substation.

7.2 Transient Stability Simulation Results, January 2017

7.2.1 Fault at 132 kV Zhenfa Solar Power Plant

We applied three-phase fault on the Zhenfa Solar 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by a trip of 132 kV circuit between the Zhenfa Solar and Chaubara 132kV. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 132 kV bus bars of Zhenfa Solar, Chaubara, Chokmnda, Chokazam, T-Chokmnda and 33 kV bus bar of Zhenfa Solar are plotted. The results show quick recovery of the voltages after clearing of fault

Fig. 1.2 Frequency

We see the system frequency recovers its normal condition quickly after clearance of the fault.

Fig. 1.3 MW/MVAR Output of Zhenfa Solar Power Plant

The pre-fault output of Zhenfa Solar Power Plant was 95 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 1.4 Voltage Sensor for LVACR

The value for LVACR restores its pre-fault value after the fault clears.

Fig. 1.5 MW /MVAR flow from Zhenfa Solar to Chokmnda 132kV

Followed by clearing of fault, the trip of 132 kV circuit between the Zhenfa Solar Power Plant and Chaubara causes the entire output of Zhenfa Solar to flow through the intact 132 kV circuit between Zhenfa Solar and Chokmnda. We plotted the flows

of MW and MVAR on this intact circuit and see that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Engro-Energy 220 kV, Guddu 220 kV and Foundation-P 220 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is stable and very strong in damping the post fault oscillations.

7.2.2 Fault at 132 kV Zhenfa Solar Power Plant (Stuck Breaker Case)

We applied three-phase fault on the Zhenfa Solar 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by a trip of 132 kV circuit between the Zhenfa Solar and Chaubara 132kV. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 132 kV bus bars of Zhenfa Solar, Chaubara, Chokmnda, Chokazam, T-Chokmnda and 33 kV bus bar of Zhenfa Solar are plotted. The results show quick recovery of the voltages after clearing of fault

Fig. 2.2 Frequency

We see the system frequency recovers its normal condition quickly after clearance of the fault.

Fig. 2.3 MW/MVAR Output of Zhenfa Solar Power Plant

The pre-fault output of Zhenfa Solar Power Plant was 95 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 2.4 Voltage Sensor for LVACR

The value for LVACR restores its pre-fault value after the fault clears.

Fig. 2.5 MW /MVAR flow from Zhenfa Solar to Chokmnda 132kV

Followed by clearing of fault, the trip of 132 kV circuit between the Zhenfa Solar Power Plant and Chaubara causes the entire output of Zhenfa Solar to flow through

the intact 132 kV circuit between Zhenfa Solar and Chokmnda. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Engro-Energy 220 kV, Guddu 220 kV and Foundation-P 220 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is stable and very strong in damping the post fault oscillations.

7.2.3. Fault at 33 kV Zhenfa Solar

We applied three-phase fault on the Zhenfa Solar 33 kV bus bar, cleared fault in 9 cycles (180 ms) followed by a trip of Zhenfa Solar 132/33 kV single transformer. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 132 kV bus bars of Zhenfa Solar, Chaubara, Chokmnda, Chokazam, T-Chokmnda and 33 kV bus bar of Zhenfa Solar are plotted. The results show quick recovery of the voltages after clearing of fault

Fig. 3.2 Frequency

We see the system frequency recovers its normal condition quickly after clearance of the fault.

Fig. 3.3 MW/MVAR Output of Zhenfa Solar Power Plant

The pre-fault output of Zhenfa Solar Power Plant was 95 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 3.4 Voltage Sensor for LVACR

The value for LVACR restores its pre-fault value after the fault clears.

Fig. 3.5 MW /MVAR flow on Zhenfa Solar 132/33 kV Single Transformer

Followed by clearing of fault, the trip of one Zhenfa Solar 132/33 kV transformer causes the entire output of Zhenfa Solar to flow through the intact 132/33 kV transformer. We plotted the flows of MW and MVAR on this intact circuit and see

that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Engro-Energy 220 kV, Guddu 220 kV and Foundation-P 220 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is stable and very strong in damping the post fault oscillations.

7.2.4 Fault at 132kV Chokmnda (Stuck Breaker Case)

We applied three-phase fault on the Chkmnda 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by a trip of 132 kV circuit between the Zhenfa Solar and Chokmnda 132kV. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 4.1 Bus Voltages

The bus voltages of 132 kV bus bars of Zhenfa Solar, Chaubara, Chokmnda, Chokazam, T-Chokmnda and 33 kV bus bar of Zhenfa Solar are plotted. The results show quick recovery of the voltages after clearing of fault

Fig. 4.2 Frequency

We see the system frequency recovers its normal condition quickly after clearance of the fault.

Fig. 4.3 MW/MVAR Output of Zhenfa Solar Power Plant

The pre-fault output of Zhenfa Solar Power Plant was 95 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 4.4 Voltage Sensor for LVACR

The value for LVACR restores its pre-fault value after the fault clears.

Fig. 4.5 MW /MVAR flow Zhenfa Solar to Chaubara 132kV

Followed by clearing of fault, the trip of 132 kV circuit between the Zhenfa Solar Power Plant and Chokmnda causes the entire power to flow through the intact 132 kV circuit between Zhenfa Solar and Chaubara. We plotted the flows of MW and MVAR

on this intact circuit and see that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 4.6 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Engro-Energy 220 kV, Guddu 220 kV and Foundation-P 220 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is stable and very strong in damping the post fault oscillations.

7.4 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed scheme for the severest possible faults of 132 kV systems near and far away from the Zhenfa Solar Power Plant. Therefore there are no issues of dynamic stability for interconnection of this Solar Power Plant; it fulfils all the criteria of transient stability. The reactive support from the inverter also helps the system stability.

8. Conclusions

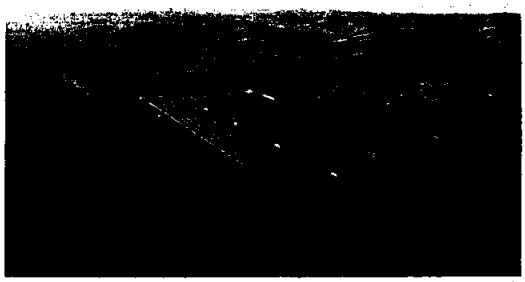
- The study objective, approach and methodology have been described and the plant's data received from the client Zhenfa Solar PP has been validated.
- The expected COD of the project is January 2017. Therefore, the month of January 2017 has been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load forecast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-380/4453-54 dated 22-10-2015 as referred to in CPPA letter no. CPPA(G)L/CEO/CE-II/MT-IV/ZEGCL-4679-81
- The nearest substation of MEPCO is Chaubara 132 kV. The scheme of interconnection has been developed by looping Zhenfa Solar in-out of the single 132 kV circuit between Chaubara and Chokmnda and studied in detail to evacuate the maximum power of 100 MW.
- Detailed load flow studies have been carried out for the peak load conditions of January 2017 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 100 MW of the plant under normal and contingency conditions for the contingencies performed.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Zhenfa Solar Power Plant at 132 kV, and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from the Zhenfa Solar Power Plant.
- The maximum short circuit level of 132 kV bus bar of Zhenfa Solar Power Plant is 4.35 kA and 2.74 kA for 3-phase and 1-phase faults respectively and the maximum short circuit level of 33 kV bus bar of Zhenfa Solar Power Plant is 9.02 kA and 6.96 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate

with enough margins for future increase in fault levels due to future reinforcements in this area.

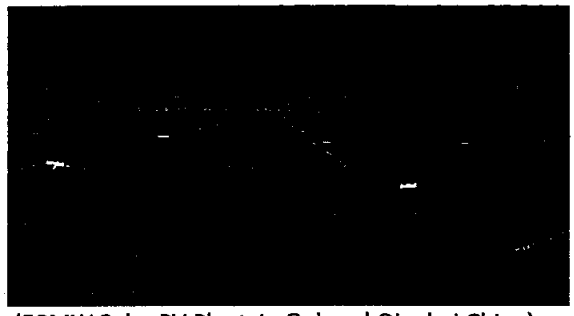
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for January 2017. The stability check for the worst case of three phase fault on the 132 kV bus bar of the Zhenfa Solar power plant substation followed by the final trip of 132 kV circuit connected to this substation has been performed for fault clearing of 9 cycles (180 ms) as understood to be the maximum fault clearing time of 132 kV protection system. The system is found to retain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Chishtian - New 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

FEASIBILITY STUDY REPORT

100 MW SOLAR PV POWER PROJECT FOR ZHENFA PAKISTAN NEW ENERGY COMPANY (PVT.) LIMITED (ZPNECL) AT CHAUBARA, PUNJAB

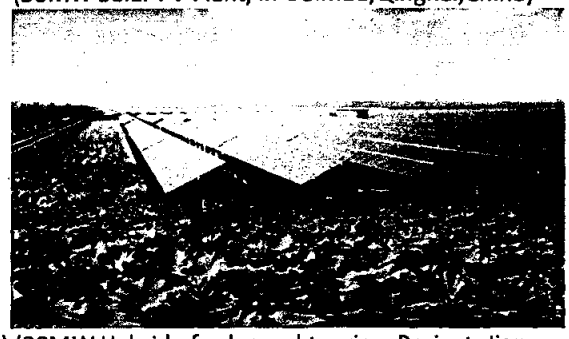


(20MW Golden Sun project-2012, Shanxi, China)



(50MW Solar PV Plant, in Golmud,Qinghai,China)

(100MW Sun Tracking Power Plant -Gansu, China)



(30MW Hybrid of solar and tourism Project- Jiangsu, China)

PROJECT COMPANY:

Zhenfa Pakistan New Energy Company (Pvt.) Ltd

PROJECT CONSULTANTS:

RENEWABLE RESOURCES (Pvt.) Ltd

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SYNOPSIS

This document is a feasibility study report of a 100 MW ZPNECL Solar PV Power Project sponsored by Zhenfa Energy Group Co., Ltd. It contains the resource assessment, hardware specifications, power production analysis, electrical interface, civil works design, project cost. It also includes initial environment examination and other site specific information. This report has been prepared by Renewable Resources (Pvt.) Ltd of Pakistan.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXURES

LIST OF ABBREVIATIONS

AC	Alternate Current
AEDB	Alternate Energy Development Board
CDM	Clean Development Mechanism
CFCs	Chlorofluoro Carbons
Cm	Centimeter
CO_2	Carbon dioxide
CPPA	Central Power Purchasing Agency
DC	Direct Current
DISCOs	Distribution Companies
EE	Energy Efficiency
EMP	Environment Management Plan
EPA	Energy Purchase Agreement
EPC	Engineering Procurement Construction
GDP	Gross Domestic Product
GHG	Green House Gas
GIS	Geographic Information System
GoP	Government of Pakistan
IEE	Initial Environmental Examination
IPPs	Independent Power Producers
JI	Joint Implementation
MEPCO	Multan Electric Power Company
Km	Kilometer
kV	Kilovolt

KW	Kilowatt
LOI	Letter of Intent
LPG	Liquefied Petroleum Gas
LOS	Letter of Support
m^2	Meter square
MTDF	Medium Term Development Framework
MW	Megawatt
N_2O	Nitrous Oxide
NCS	National Conservation Strategy
NEPRA	National Electricity Power Regulatory Authority
NEQS	National Environmental Quality Standards
NOCs	No Objection Certificates
NREL	National Renewable Energy Laboratories
NTDC	National Transmission and Dispatch Company
O & M	Operation & Management
PEPA	Pakistan Environment Protection Act
PMD	Pakistan Meteorological Department
PPDB	Punjab Power Development Board
RE	Renewable Energy
RE2	Renewable Resources (Pvt.) Ltd.
WAPDA	Water And Power Development Authority

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The management of ZPNECL also looks forward to the cooperation of Government of Punjab and other Government departments (NEPRA, NTDC, SEPCO) which is being extended to the Project.

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Sponsor / Holding Company	Zhenfa Energy Group Co., LTd;
Address	Office #1, 6th Floor, 10C, Liberty Gate Plaza, MM Alam Road, Gulberg III, Lahore, PK Tel : +92-42 3577 1571, fax : +92 42 3587 4001
Website	www.zhenfa.com
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Email	irfanmirza@renewableresources.com.pk

DOCUMENT INFORMATION

Purpose and Scope:

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

This document presents the technical, financial and commercial viability of this project within Pakistan's economic and regulatory framework.

1 EXECUTIVE SUMMARY

Located on the western stretch of the South Asian Continent, Islamic Republic of Pakistan is largely under the influence of tropical desert climate. The relative shortage of conventional energy resources in Pakistan, when coupled with the hiking energy prices worldwide, leads to a tension in the power supply of the country. It has become a top agenda of Pakistan government to find alternative energies, including solar power.

Government of Pakistan has formulated a policy to encourage the participation of private sector in the development and application of renewable energies. A Government organization called Punjab Power Development Board (PPDB) has been established to facilitate the implementation of renewable energy projects.

Zhenfa Energy Group Co., Ltd is one of the leading system integration companies in China. It focuses on investing, developing, installation and commissioning of solar projects as well as does merger & acquisition of other valuable projects or companies. So far it has accumulative installation of 2.7GW solar projects in china, among them self-invested and owned 1.3GW solar projects with total assets of around USD 1.6 Billion. With their 10 years solar engineering experience, up today they have installed and completed commissioning of 6 units 100W solar projects in china. They are continuing with developing our solar projects in China and oversea countries as well, their target is to complete 10GW in next 5 years.
Follow with Chinese national strategy "One Belt, One Road", they are actively going abroad and develop our solar projects along ancient Silk Road, they have set up companies in Australia, Singapore, Turkey, Pakistan and other emerging markets. They plan to develop 1GW oversea solar projects in next five years.

This document is the complete feasibility study of the project including complete proposed design and O& M, Initial Environmental report, Electrical and Grid Interconnection studies.

1.1 PROJECT OVERVIEW

The Project Site is acquired at Rakh, Chaubara, and District Layyah-Punjab. The project site is located around 08 kilometers away from Chaubara city.

The total land area of the project site is about 650 acres leased by the project owners for the implementation of 100 MW Solar PV project. The proposed site located at latitude of 30°54'11.86"N and longitude of 71°33'36.21"E with elevation of around 150 meters.

The geographical location of the project is shown in **Figure 1.1**

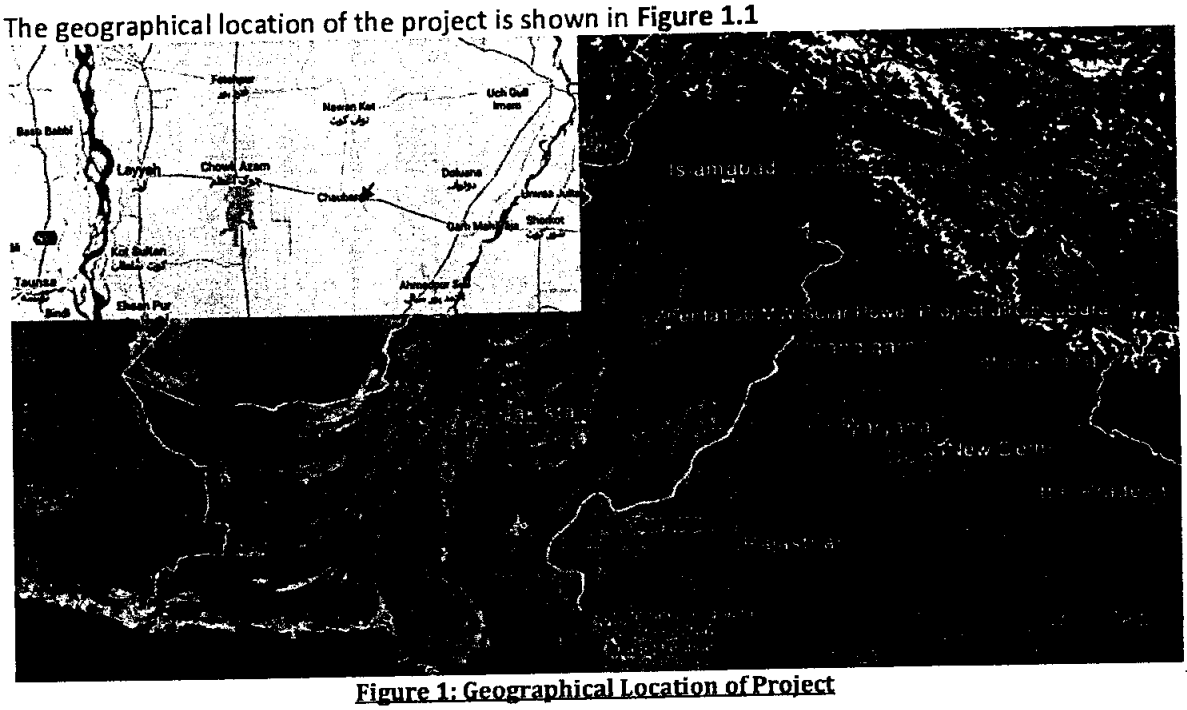


Figure 1: Geographical Location of Project

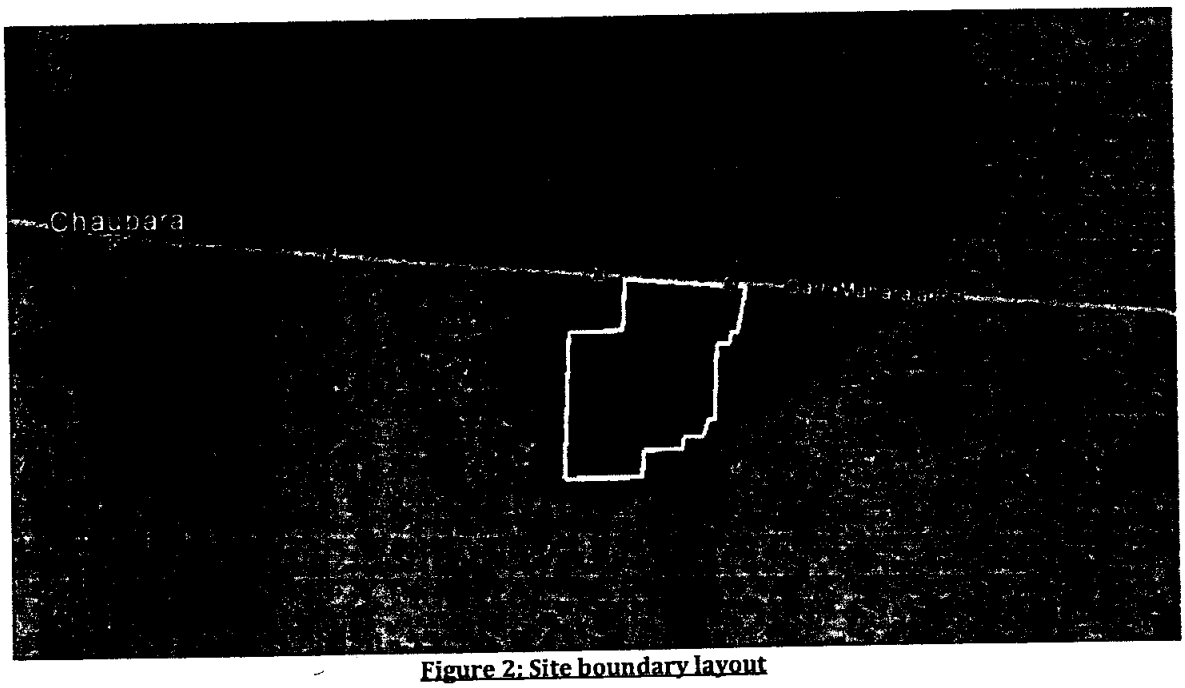


Figure 2: Site boundary layout

The project site coordinates are as listed in Table below:

Table 1: Project site coordinates

Boundary Point	Geodetic	
	Latitude	Longitude
1	30°54'11.86"N	71°33'36.21"E
2	30°53'55.07"N	71°33'35.19"E
3	30°53'54.59"N	71°33'13.89"E
4	30°53'5.81"N	71°33'11.43"E
5	30°53'5.98"N	71°33'42.08"E
6	30°53'14.86"N	71°33'42.96"E

7	30°53'15.18"N	71°33'58.07"E
8	30°53'18.98"N	71°33'58.82"E
9	30°53'19.16"N	71°34'6.43"E
10	30°53'24.73"N	71°34'8.65"E
11	30°53'24.82"N	71°34'11.15"E
12	30°53'50.08"N	71°34'12.40"E
13	30°53'50.04"N	71°34'17.54"E
14	30°53'53.91"N	71°34'18.24"E
15	30°53'53.93"N	71°34'20.81"E
16	30°54'8.61"N	71°34'24.10"E

1.1.1 Project Size

The Project size will be 100 MW.

1.1.2 Project Status and Calendar

The complete feasibility study is being submitted. From here onwards, the Project shall pursue approval of feasibility and other project development tasks from the concerned stakeholders. In parallel, the Project shall also pursue determination of tariff and signing of EPA / IA.

Table 2: Project Planned Milestones

Feasibility Study						
Approval of Feasibility Study						
Tariff Determination						
Approval of Electrical Studies						
Signing of EPA						
Signing of IA						
Financial Close						
Project Construction						
Project COD						

The project construction shall take 10 months from the date of planning till the COD.

Table 3: Project Construction Scheduling

Table 3: Project Construction Scheduling										
Designing and Planning										
Import of Equipment & Machinery										
Land levelized, Site Civil Works										
Mounting structure installation										
Module Installation										
Electrical Equipment Installation										
Interconnections with grid line										
Commissioning and Testing										
Grid Connection										

1.1.3 Geological Conditions

The town was founded around 1550 by Kamal Khan, a Mirani Balooch and a descendant of Ghazi Khan who laid foundation of Dera Ghazi Khan. Around 1610, the town was taken from the Mirani Rulers by the Jaskani Balochs, who held it until 1787. Abdun Nabi Sarai was appointed Governor by Timur Shah Durrani, but three years later it was included in the Governorship of Muhammad Khan Sadozai, who transferred his seat of Government to Mankera.

In 1794, Humayun Shah, the rival claimant to the throne of Kabul, was captured near Leiah and brought into the town, where his eyes were put out by order of Zaman Shah. Under the Sikh Government, the town once more became the centre of administration for the neighbouring tract, and after the British occupation in 1849, was for a time the headquarters of a Civil Administrative Division. This administrative status of Layyah was short-lived and the British reduced it to the level of Tehsil headquarters, making it a part of Dera Ismail Khan. Previously a Tehsil of Muzafargarh, Layyah gained the status of being a district in 1982. The district of Layyah comprises of three tehsils which include Layyah, Chaubara and Karor Lal Eason.

District Layyah is situated in the south-west (rather west) of Punjab. In its north, lies the district Bhakkar while to its west flows River Indus. Across the river there is Dera Ghazi Khan which is also a district and division of Punjab. District of Jhang is located in the East and Muzafargarh is located in the south of district Layyah.

The area consists of a semi-rectangular block of sandy land between the Indus River and the Chenab River in Sindh Sagar Doab. The total area covered by the district is 6,291 km^2 with a width from east to west of 88 km and a length from north to south of 72 km. The deposits are composed of flood plain mud, mixed with salt clay and fine to medium sandy point bars. The project area is barren land and there is also some agricultural land available along the side of project area with variety of crops growing.

Two villages Basti Malana and Basti Hafizabad are located at around 02 kilometers and 2.2 kilometers from the project boundary. Local people of the villages have access to urban areas through link roads and available public transport. Electricity is not available in the area. However, the facility of Sui gas is also not yet available in the area and people are using wood as a source of alternate fuel. PTCL telephone services are not available and only mobile services are available at village level. Only Primary schools are available for boys and girls in the villages. The nearest hospital is available in Chaubara city.

The present main source of water supply system in the town is tube wells with a depth of 25 - 30 ft.

No authentic data is available regarding air quality measurements specifically of Rakh Chaubara. As the city is surrounded by agricultural land, a number of trees and vegetation is there to minimize the impacts of gaseous emissions.

The challenge posed by flood is pronged in Layyah i.e, High level flood (500,000 cusec) in the River Indus has inundated 150 villages of 70 mouzas in 11 riverine union councils of the district. The flood-hit union councils include Warrah Seharan, Baseera, Sahowala, Shahpur of Karor tehsil, Shadu Khan, Kotla Haji Shah, Lohanch Nashaib, Jhakkar, Bait Wasawa Shumali, Bhakri Ahmed Khan and Paharpur of Layyah tehsil. Warrah Seharan, union council of karor tehsil where Basti Khayee and Makori were inundated by floodwater. Flood had destroyed villages from this portion. Flood had destroyed large number of population who were living near river.

Layyah District is mostly a desert area and some plan agricultural fertile area and there is not any kind of minerals found in the district Layyah.

1.1.4 Summary of Power Production Estimate & Equipment Details

The power production estimates have been calculated in detail based on the regional solar irradiance data, performance characteristics of solar panels and local weather conditions. The summary of power production estimates is given in **Table 4.**

Table 4: Summary of Power Production Estimate & Equipment Details

Inverter Details		
Inverter Parameters PV Array Side		
Minimum MPP Voltage	Vmin (Volts)	460
Nominal PV Power	Pnom DC (kW)	630
Maximum PV Current	Imax DC (A)	1552
Minimum Voltage for Pnom	Vmin Pnom (Volts)	460
Inverter Parameters (AC Grid Side)		
Grid Frequency	Freq (Hz)	50/60
European Average Efficiency	Euro Eff	98.5
Maximum AC Power	Pmax AC (kWac)	700
Maximum AC Current	Imax AC (A)	1280

Module Details	
Module Size (Watt)	255.0
Efficency (%)	15.69
Nominal Operating Cell Temperature NOCT (C)	45.0
Slope (Degree)	25.0
Albedo	0.2
Total Area of Modules (Sq meters)	637997.3
Plant Details	
Irradiation on horizontal plane (kWh/m²)	1754.0
Near Shadings: irradiance loss	2.6%
Soiling loss factor	3.0%
Gross Production MWh/yr	177457.0

Loss Factors	
PV loss due to irradiance level	0.0%
Module quality loss	0.0%
Module array mismatch loss	1.5%
AC line Losses	1.0%
Inverter Loss during operation (efficiency)	1.4%
Overall Conversion Factor	18.5%

1.1.5 EPC Contractor Selection

EPC Offers from multiple EPC contractors are currently under review. Details of the offers are as shown in Table 6.

Table 5: Solar Power Equipment from lead EPC Bidders

Lead Bidder	Manufacturer	
	Module	Inverter
Zhenfa New Energy Science & Technology Co., Ltd	SEGP6-60 255W module	Sungrow SG630MX
China Construction 3rd Engineering Bureau		
CEGC Tianjing Company	Jingko JC 255W module	Jingfuyuan SP-1000KTL

1.1.6 Electrical Grid Interconnection

The Electrical Grid Interconnection study has been done and is attached as Annexure 2 of this document.

1.1.7 Design of Mechanical Works

Steel Support Structures will be designed and used to install solar panels. The steel structures with galvanized coating shall be directly imported from china. The mechanical design shall bear the required level of corrosion and winds / gusts.

1.1.8 Design of Civil Works

The civil works will be required for the following purposes:

- Construction of Foundations for mounting of Solar Arrays.
- Construction of Power House.
- Construction of Office Building.

The design of civil works shall be according to the soil and seismic conditions; and to bear high winds / gusts.

1.1.9 Construction Management

The imported equipment shall come via Karachi Sea Port. The civil work materials shall be arranged from the nearest local markets / dealers. Certain items (steel accessories, local cables, electrical accessories shall come from appropriate cities including Islamabad, Karachi and Lahore.

No heavy machinery is required for construction and erection. There is semi finished road access to the Site, which easily serves for 10 ton trucks with little leveling. The site will be restored to the original landscape in the later phase of construction.

1.1.10 O & M Management

After the completion of its construction, the Project shall be jointly managed with the principle of requiring "few on-duty staff".

The Project Site is separated into the production section and utility area. The production area includes the solar power equipment and accessories including power house. The offices are located in the production section. The location of support staff shall be arranged such that mutual communication and access is easy. The utility section is for daily living, including dormitories, dining rooms and the kitchen.

There will be on Site support for routine maintenance and troubleshoot. For un-expected faults, maintenance resource and procedures shall be laid.

The project company shall be responsible for O & M service.

1.1.11 Environmental Management

A separate environment study has been carried out. There are no hazards. The minor adjustments required during construction phase have been addressed and mitigation plan is provided.

The Initial Environment Examination is attached as Annexure 3

1.1.12 Health and Safety

During the construction and operation of the Project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied

to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personal safety of workers.

A comprehensive safety system will be established during the preparation phase, and carefully implemented during the construction process. The systems of work sheet, operation sheet, shift relief, patrol inspection, operation guardianship, maintenance and over-haul will be strictly implemented.

A safety and health supervision department will be established, which is to be in charge of the education, training and management of safety and health related issues after the Project is put into operation.

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

1.1.13 CDM Aspect

The Project is a power generation project with renewable resource and zero emission. When put into operation, the project can provide power supply to the national power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. By Estimating, using solar photovoltaic (PV) to generate 1 KWH electricity means saving 0.32 kg of standard coal, at the same time reduce the discharge of 0.272 kg of carbon dust pollution, 0.997 kg of carbon dioxide (CO2), sulfur dioxide (S02) 0.03 kg, 0.015 kg nitrogen oxide (NOx).

After the completion of the station, it is expected to provide electricity grid each year about 144.561million kWh, compared with the same capacity of thermal power, equivalent to annually save about 54947T of standard coal, reducing various atmospheric pollutant emissions, which reduce carbon dioxide (co2) about 170000 T, sulfur dioxide (SO2) of about 5151T, nitrogen oxide (NOx) about 2576 T.

It is also consistent with the spirit of the Kyoto Protocol and qualifies for the application of CDM projects. NEPRA is allowing almost the same return on equity (RoE) to the thermal and the renewable energy projects. The Sponsors of the Project require CERs to bring the RoE at a level where they can invest in renewable energy projects in Pakistan in future as well. If the Project is approved and registered as a CDM project, CERs can provide extra financial resource for the Project. It will provide favorable conditions for the project financing, improve competitiveness of the project, and reduce investment risk during the project implementation process.

1.1.14 Key Project Figures

Table 6: Key Project Figures

No	Item Description	Value
2	Funding Plan:	20% equity, 80% debt
4	Grace Period	1 year

1.2 RATIONAL FOR SOLAR POWER

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

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

Alternatives to further fuel imports for electricity generation are the use of domestic coal, or generation from hydro-electric or other renewable sources, such as wind and solar power. These options will assist in reducing Pakistan's reliance on imported oil, and consequent vulnerability to changes in global oil prices which will in turn have a positive effect on the current trade deficit and inflating import bill. As with gas, securing future supplies of coal and hydro-electric power would rely on significant spending on infrastructure. Pakistan has domestic reserves of coal. However, coal currently makes up a very small proportion of total generation, largely the result of most of the reserves being located in one area, the Thar Desert. Exploiting the reserves would require huge and costly upfront investment in local infrastructure (including provision of water supplies), development of mines, housing and related infrastructure, and investment in transmission lines before power plant development could commence. Hydro electric power already supplies almost 30% of electricity, and numerous sites for future investment exist, but due to their locations, this would also require significant investment in transmission to meet the expected power needs. Moreover, there are varying political stands on hydro-electric power options.

Looking at how the country's future electricity needs might be met in a way that supports the environmental objectives of the Government of Pakistan; solar power generation has the potential of being a strong contributor.

The development of solar power generation projects could reduce dependence on fuels for thermal power generation, increase diversity in Pakistan's electricity generation mix, and reduce greenhouse gas (GHG) emissions avoiding thermal power generation.

Solar energy, on the other hand, has excellent potential in areas of Pakistan that receive high levels of solar radiation throughout the year. Every day, for example, the country receives an average of about 19 Mega Joules per square meter of solar energy

Pakistan being in the Sun Belt is ideally located to take advantage of solar energy technologies. This energy source is widely distributed and abundantly available in the country. The mean global irradiation falling on horizontal surface is about 200-250 watt per sq.m in a day. This amounts to about 2500-3000 sun shine hours and 1.9 - 2.3 MWh per sq.meter in a year. It has an average daily global isolation of 19 to 20 MJ/sq.meter per day with annual mean sunshine duration of 8 to 8.5 hours (6-7hrs in cold and 10-12 hrs in hot season) and these values are among the highest in the world. For daily global radiation up to 23MJ/m2, 24 (80%) consecutive days are available in this area for solar energy. Such conditions are ideal for solar thermal applications.

Pakistan receives about 15.5x1014 kWh of solar irradiance each year with most regions receiving approximately 8 to 10 sunlight hours per day. The installed capacity of solar photovoltaic power is estimated to be 1600 GW per year, providing approximately 3.5 PWh of electricity (a figure approximately 41 times that of current power generation in the country).

To summarize, the sun shines for 250-300 days per years in Pakistan with an average sun shine hours of 8-10 per day. This gives huge amount of energy to be used for electricity generation by solar photovoltaic and solar thermal power plants.

A quick idea for the potential of solar energy in Pakistan can be obtained from the satellite map of solar radiation released by National Renewable Energy Lab (NREL) of USA.

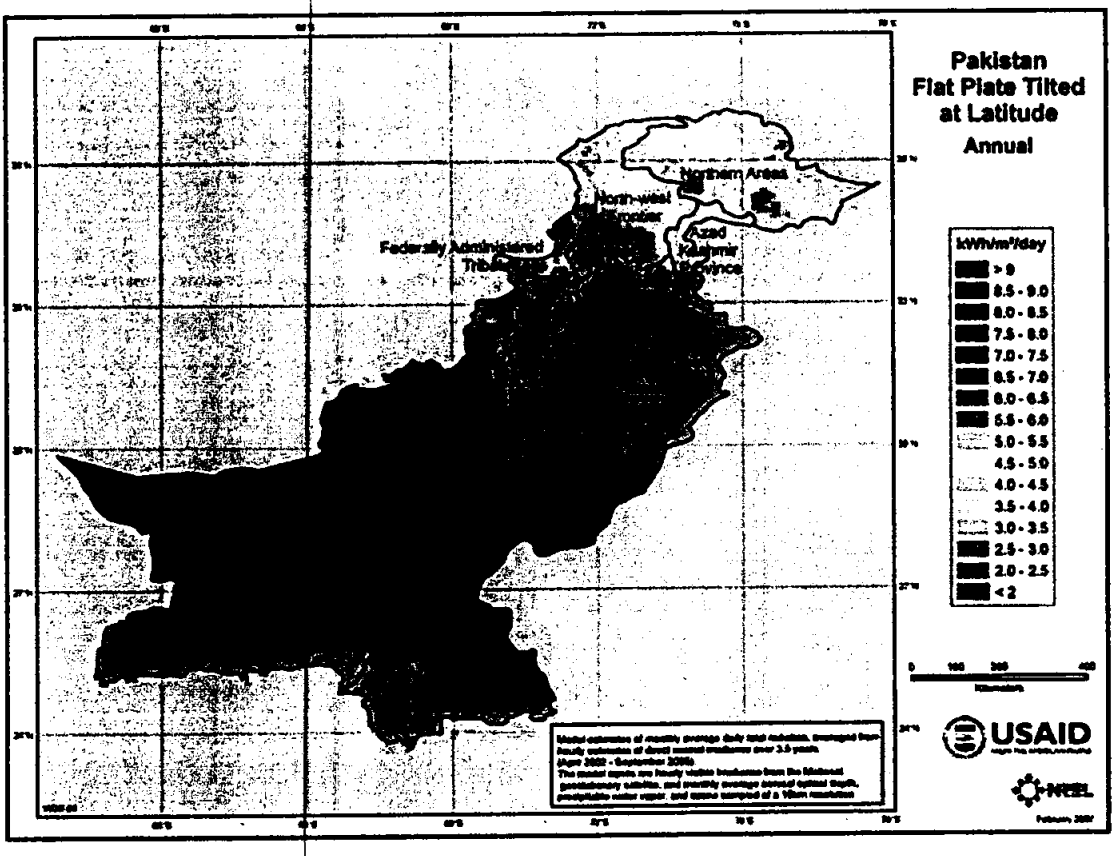
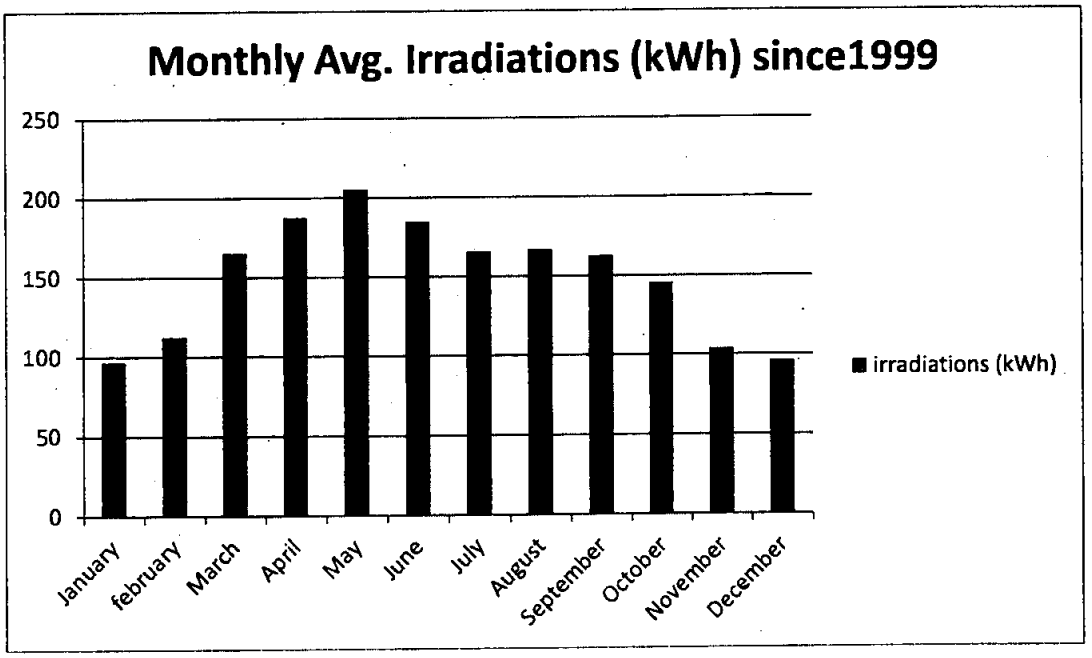


Figure 3: NREL Solar Map of Pakistan

Table 7: Monthly avg. Irradiations at Chaubara site



1.3 COUNTRY OVERVIEW

Pakistan is located on the western stretch of South Asian Subcontinent with Arabian Sea in the south, China in the north, India on the east, Afghanistan and Iran on the west. It covers an area of 796,000 km^2 and has a coastal line of 980km. Almost $3/5^{th}$ of Pakistan's total area is mountains and hills, deserts spreading along the southern coastal areas, and plateau pastures and fertile agricultural land stretching north. The Indus River, which originates from China, traverses 2300km from north to south into the Arabian Sea.

Pakistan has a tropical climate. It is hot and dry in most of its areas, with relatively high average annual temperature. The southern coastal areas have an average yearly temperature of 26°C. Most areas show temperatures higher than 40°C around noon in June and July.

Some parts of Sindh and Baluchistan even have temperatures higher than 50°C. The yearly precipitation in Pakistan is less than 250mm, with $1/4^{th}$ of Pakistan having annual rainfall less than 120mm. Pakistan is under great influence of monsoon from Indian Ocean, which brings both precious rain and abundant wind energy resources.

1.4 INDUSTRY OVERVIEW

Every day the sun showers Earth with several thousand times as much energy as we use. Even the small amount that strikes our roof is many times as much as all the energy that comes in through electric wires. With the sun straight overhead, a single acre of land receives some four thousand horsepower, about equivalent to a large railroad locomotive. In less than three days the solar energy reaching Earth more than matches the estimated total of all the fossil fuels on Earth. It's all about converting maximum of it to useful energy. At an average solar power systems amortize themselves within 4 years, meaning after four years they have produced as much energy as it took to manufacture them. The expected lifetime of a system is 25-30 years.
The world solar insulation is given in **Figure 4.**

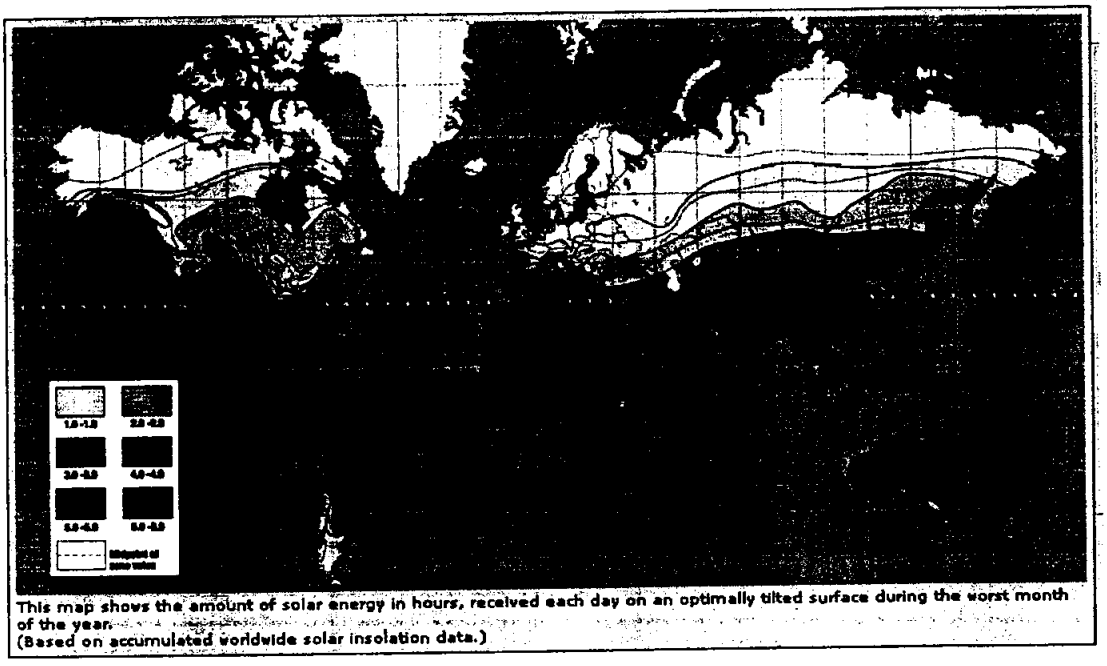


Figure 4: World Solar Insulation Values

Top 10 solar power producers in the world are shown in **Table 8**

Table 8: Top 10 solar power producers in the world

PV power station	Country	Total power(MW)
Agua Caliente	USA	397
Antelope Valley Solar Ranch	USA	230
Golmud Solar Park	China	200
Centinela Solar Energy Project	USA	170
[illegible]	Germany	166
Mesquite Solar 1	USA	150

1.5 PROJECT TEAM

1.5.1 The Project Company: **Zhenfa Pakistan (ZPNECL)**

Zhenfa Pakistan New Energy was set up in 2014 and specializes in investing, developing, installation and commissioning of solar power projects in Pakistan as well as provides EPC service. Its business scope includes business of generating, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and machinery, equipment, products and services, and setting up and operating electric power generation project for generating and supply of electric power as well as renewable energy projects.

100MW solar project in Pakistan is our first and biggest project at oversea countries, we pay close attention to this project, we will use our advanced technology to build up best performance of projects and make good reference project in Pakistan, after this project has successfully put into operation, we plan to develop another 300MW to 500MW solar projects in Pakistan to make our contribution for Pakistan nations in relieving energy –shortage such social problem.

1.5.2 The Sponsor: Zhenfa Energy Group Co., Ltd

Zhenfa Energy Group Co., Ltd is one of the leading system integration companies in China. It focuses on investing, developing, installation and commissioning of solar projects as well as does merger & acquisition of other valuable projects or companies. So far it has accumulative installation of 2.7GW solar projects in china, among them self-invested and owned 1.3GW solar projects with total assets of around USD1.6 Billion. With our 10 years solar engineering experience, up today we have installed and completed commissioning of 6 units 100W solar projects in china. We're continuing with developing our solar projects in china and oversea countries as well, our target is to complete 10GW in next 5 years.

Follow with Chinese national strategy "One Belt, One Road", we're actively going abroad and develop our solar projects along ancient Silk Road, we have set up companies in Australia, Singapore, Turkey, Pakistan and other emerging markets. We plan to develop 1GW oversea solar projects in next five years.

1.5.2.1 *List of Key Projects by* **Zhenfa Energy Group Co.**

Below is given the list of ventures of Zhenfa Energy Group Co.

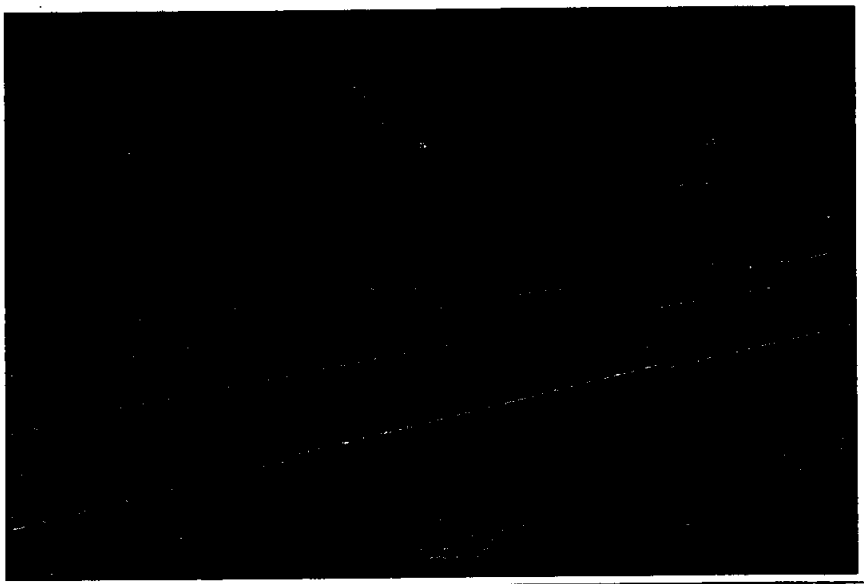
Table 9: List of ventures of Zhenfa Energy Group Co.

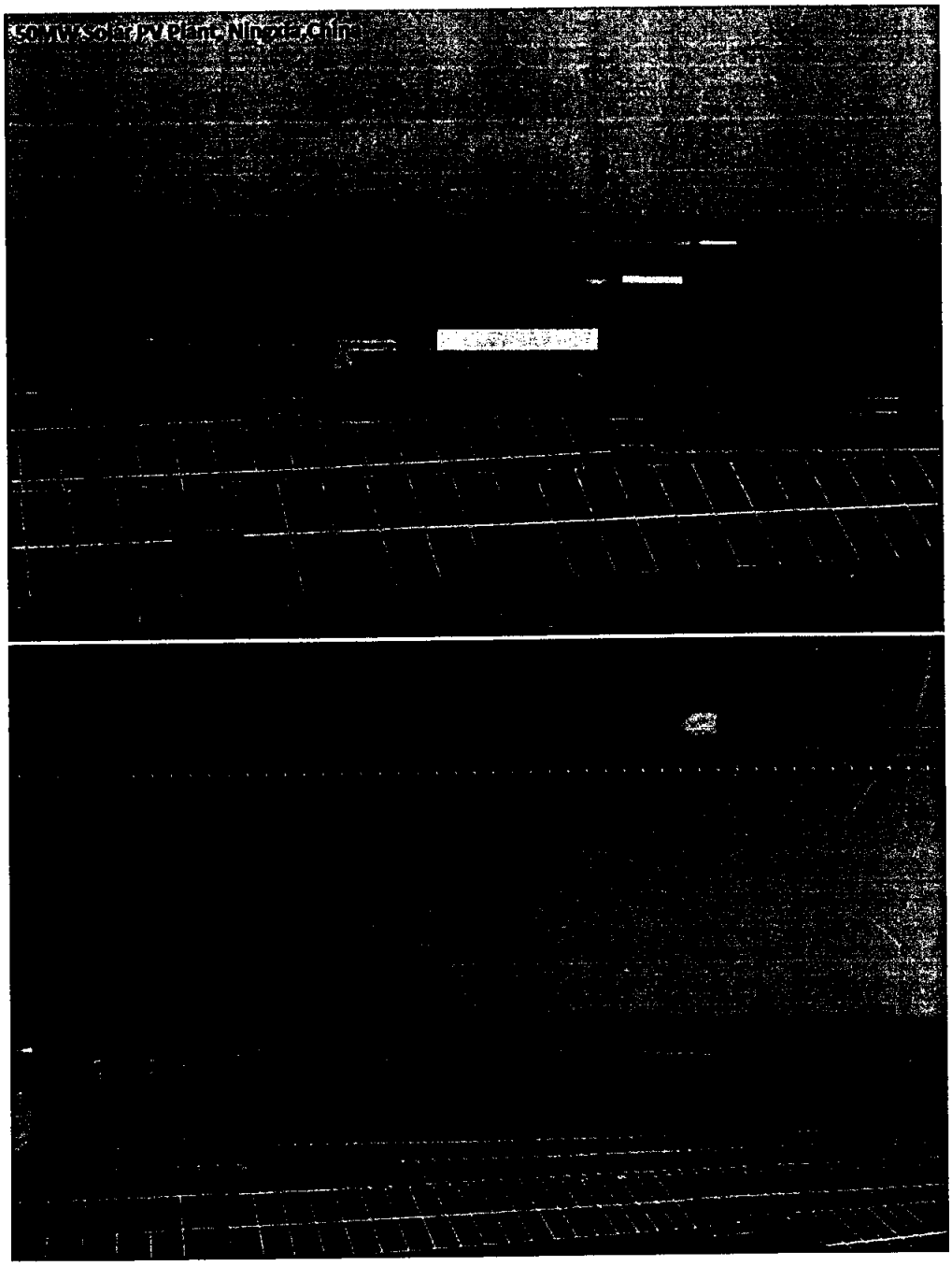
Jiangsu Sheyang Photovoltaic Power Plant	China	20	in Dec 2009
Jiangsu Dongtai Photovoltaic Power Plant	China	60	in August 2010
Ningxia Wuzhong Photovoltaic Power Plant	China	50	in Feb 2011
Qinghai Geermu Photovoltaic Power Plant	China	50	in Sept 2011
Gansu Wuwei Photovoltaic Power Plant	China	30	in Sept 2011
Ningxia Zhongwei Jinyang Photovoltaic Power Plant	China	30	in Oct 2011
Shanxi Pinglu Photovoltaic Power Plant	China	20	in May 2011
Jiangsu Hongze Photovoltaic Power Plant	China	20	in Dec 2011
Jiangsu Jianhu Photovoltaic Power Plant	China	20	in Nov 2011
Shandong Zoucheng Photovoltaic Power Plant	China	10	in May 2011
Zhejiang Linping Photovoltaic Power Plant	China	10	In Aug 2011
Anhui Huangshan Photovoltaic Power Plant	China	10	In July 2011
Jiangxi Houtian Photovoltaic Power Plant	China	10	in Dec 2011
Gansu Zhangye Photovoltaic Power Plant	China	50	in Aug 2012
Gansu Jinchang Photovoltaic Power Plant	China	20	in Sept 2012

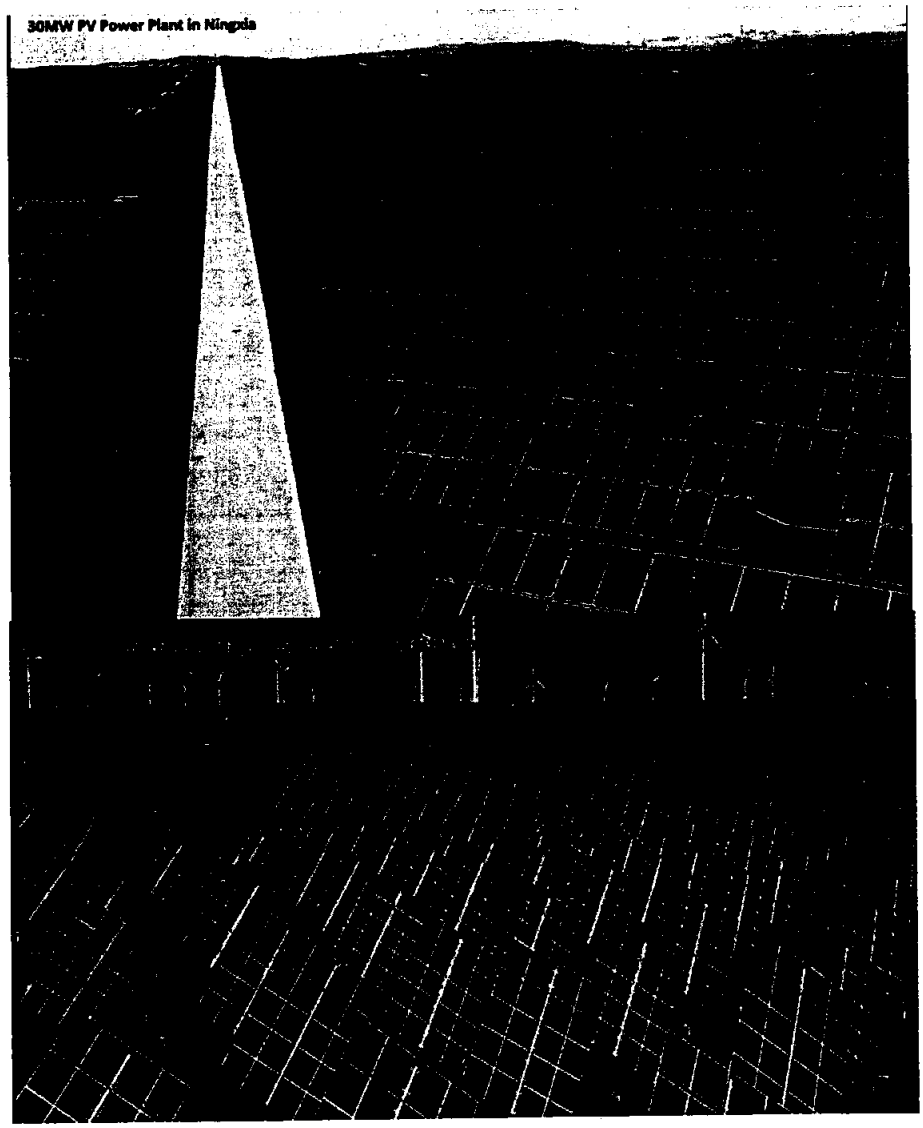
Ningxia Qingyang Photovoltaic Power Plant	China	100	in Sept 2013
Gulang Photovoltaic Power Plant Phase II	China	100	in Nov 2013
Jinchang Zhenxin Photovoltaic Power Plant	China	100	in Aug 2013
Ningxia Zhenluo Photovoltaic Power Plant	China	50	in Nov 2013
Neimeng Sanxin Photovoltaic Power Plant	China	50	in Dec 2013
Jinchang Guoneng Photovoltaic Power Plant	China	50	in Oct 2013
Gulang Photovoltaic Power Plant Phase I	China	50	In Nov 2013
Jiayuguan Guoneng Photovoltaic Power Plant	China	50	In Nov 2013
Shanxi Dingbian Photovoltaic Power Plant	China	50	in Dec 2013
Ningxia Guyuan Photovoltaic Power Plant	China	30	in Aug 2013
Ningxia Haiyuan Photovoltaic Power Plant	China	30	In Aug 2013
Xinjiang Huocheng Tukai Photovoltaic Power Plant	China	30	In Sept 2013
Jianghu Jinhu Photovoltaic Power Plant	China	20	In Sept 2013
Jianghu Gaoyou Photovoltaic Power Plant	China	20	In Oct 2013
Jiangsu Binhai Photovoltaic Power Plant	China	20	In Dec 2013
Jiangsu Xuyu Photovoltaic Power Plant	China	20	In Nov 2013
Ningxia Sikouzi Photovoltaic Power Plant	China	10	In Nov 2013
Jiangsu Sihong Photovoltaic Power Plant	China	109.9	in June 2014
Jiangsu Jinhu Photovoltaic Power Plant	China	100	in June 2014

Jiangsu Gaoyou Photovoltaic Power Plant	China	100	In June 2014
Minqin Guoneng Photovoltaic Power Plant	China	50	In June 2014
Ningxia Zhenqi Photovoltaic Power Plant	China	30	In June 2014
Jiangsu Jiyang Photovoltaic Power Plant	China	60	Phase I completed in 2011, phase II in 2013
Shanxi Yulin Jinyang Photovoltaic Power Plant	China	100	Underconstruction, expect complete in 2016
Kulunqi Photovoltaic Power Plant	China	30	Under construction, expect complete on 30th Nov.2015
Zhongwei Zhenluo Photovoltaic Power Plant	China	20	Under construction, expect complete on 30th Oct.2015
Ningxia Haiyuan Ganyanchi Photovoltaic Power Plant Phase I	China	50	Under construction, expect complete on 30th Sept 2015

Figure 5: Pictures from some of the Projects of Zhenfa Group






30MW PV Power Plant in Ningxia

1.5.3 Project Consultant: Renewable Resources (Pvt.) Ltd

www.renewableresources.com.pk

REnewable REsources (RE2) is the overall Project Consultant and coordinated all the project development activities. The scope of work for RE2 in Project includes the feasibility study, coordination with all project development teams, tariff petition and energy purchase agreement.

RE2 provides consultancy services in the fields of Renewable Energy (RE), Energy Efficiency (EE) and Environment. RE2 offers services for "green" business innovation, customer education, project appraisal, project planning, design and management, development of feasibility studies and environmental studies, as well as client-specific research & surveys. The company has been incorporated as a private limited company in Pakistan under Companies Ordinance 1984.

RE2 provides high quality energy engineering and management consulting services to enable rapid deployment of efficient, cost-effective, reliable, and environment-friendly renewable energy systems. The customized technical solutions and services are dedicated to investment firms, energy groups, industries, financing institutions and public authorities involved in the development and / or acquisition of renewable and thermal power plants.

In the area of project development, RE2 possesses the entire, necessary expertise including power production analysis, selection of technology / power equipment, comprehensive bankable feasibility, government approvals, overseeing / monitoring the EPC activities etc. For conducting feasibility studies, RE2 has the capabilities to conduct site based investigations like soil analysis, surface contouring, grid evaluation etc. In addition to planning, RE2 also covers the economics, i.e. the project financial model and subsequent generation cost of leading up to tariff in terms of value per kWh.

These services are backed with in-depth grip on technical, financial and administrative aspects at every stage that enables us to employ best practices in project development. This ultimately leads to implementation in accordance with the most efficient planning, which is a vital element in power projects in order to save unnecessary and huge overheads during execution.

The RE2 team also has the expertise to deal with the legal aspects of power projects including Generation License, Tariff Application & justification, Energy Purchase Agreement and Implementation Agreement. The professional team of RE2 is well acquainted with the policies, regulations, methodologies and standards of the complete power projects cycle.

2 COUNTRY & INDUSTRY PROFILE

The detailed stats and situation of energy in Pakistan, specific information and prospects of coal and international trends in coal based power sector is explained in Annex I.

At this juncture, Pakistan is encountering the worst electricity crises of the history resulting in extended load shedding to an extent which virtually suspends social life. The situation has further forced Government of Pakistan to again take decisions like early market shutdown, power cut off to industry, and two holidays per week thus affecting all business activities.

Pakistan's major electricity sources are thermal and hydro generation, meeting approximately 70% and 28% (respectively) of the country's annual electricity demand. The primary thermal generation fuels employed are furnace oil and gas. Oil import is a significant burden on the national exchequer. Import of gas could be seen as a viable option to overcome the depleting domestic reserves, but gas import has significant issues, mainly the need for substantial capital investment in infrastructure, security difficulties and physical terrain concerns. Moreover, it would still be an imported product.

Alternatives to further fuel imports for electricity generation are the use of domestic coal, or generation from hydro or other renewable sources, such as wind / solar power. These options will assist in reducing Pakistan's reliance on imported oil, and consequent vulnerability to changes in global oil prices which will in turn have a positive effect on the current trade deficit and inflating import bill.

Looking at how the country's future electricity needs might be met, coal has the potential of being a strong contributor in future because of being an indigenous resource and available in huge quantities in the country. The per kWh tariff for coal projects over the life cycle are now comparatively less than that of furnace oil tariff. Also, at international level, coal based power generation is a tested and proven technology.

3 REGULATORY REGIME

The Pakistan Power Sector has a ministry overlooking the electricity business in the country and a regulatory authority, independent of the ministry, to control the business practices in the market. There are a number of stakeholders involved in the cycle:

- Ministry of Water and Power
- National Electricity Power Regulatory Authority (NEPRA)
- National Transmission and Dispatch Company (NTDC)
- Punjab Power Development Board (PPDB)
- Central Power Purchase Agency Guarantee Limited (CPPA-GL)
- Government of Punjab

3.1 MINISTRY OF WATER AND POWER

The federal Ministry of Water and Power is the GoP's executive arm for all issues relating to electricity generation, transmission and distribution, pricing, regulation, and consumption. It exercises these functions through its various line agencies as well as relevant autonomous bodies. It also serves to coordinate and plan the nation's power sector, formulate policy and specific incentives, and liaise with provincial governments on all related issues.

3.2 NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA)

NEPRA has been created to introduce transparent and judicious economic regulation, based on sound commercial principles, in the electric power sector of Pakistan. NEPRA regulates the electric power sector to promote a competitive structure for the industry and to ensure the coordinated, reliable and adequate supply of electric power in the future. By law, NEPRA is mandated to ensure that the interests of the investor and the customer are protected through judicious decisions based on transparent commercial principles.

NEPRA remains to be the same platform for federal as well as provincial projects.

3.3 NATIONAL TRANSMISSION AND DISPATCH COMPANY (NTDC)

NTDC shall be the power purchaser.

National Transmission & Dispatch Company (NTDC) Limited was incorporated on 3rd August 1998 and commenced commercial operation on 1st March 1999. It was organized to take over all the properties, rights and assets obligations and liabilities of 220kV and 500kV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA). The NTDC operates and maintains nine 500kV Grid Stations, 4,160km of 500kV transmission line and 4,000km of 220kV transmission line in Pakistan.

For low voltage power such as 11 kV, the autonomous distribution companies (commonly called as DISCOS) are the power purchasers. Functionally, DISCOS fall at a step lower than NTDC and are looking after low voltage assets.

3.4 PUNJAB POWER DEVELOPMENT BOARD (PPDB)

Pakistan, like other developing countries of the region, is facing a serious challenge of energy deficit. Renewable Energy (RE) resources can play an important role in bridging this deficit. More importantly, RE can also play an important role in rural electrification. Realizing the importance of RE, Government of the Punjab established Energy Department so that the province could contribute in the generation, transmission, distribution and conservation of power. Punjab Power Development Board (PPDB), working under Energy Department, provides a 'One-Window Facility' to private investors for implementation of IPPs in the Province under Punjab Power Generation Policy, 2009. Punjab Power Development Board Act, 2011 has been promulgated to provide legal cover to the activities of PPDB. The main objective of this Organization is to facilitate, promote and encourage development of Renewable Energy in Pakistan with a mission to introduce Alternative/Renewable Energy at an accelerated rate to achieve 10 percent share of RE in the energy mix of the country.

The current initiative is directed towards creating a market-based environment that is conducive to private sector investment and participation. The PPDB provides a one-window point of operations for investors in the alternate energy sector. This is done in order to reduce the timeframe required for the completion of these projects, which are deemed essential to meet Pakistan's short term and long-term energy requirements.

3.5 CENTRAL POWER PURCHASE AGENCY GUARANTEE LIMITED (CPPA-GL)

CPPA-GL is an agency to purchase power from solar power plants on behalf of NTDC. CPPA-GL acts as a one window for all affairs related to NTDC for the Project including signing of the Energy Purchase Agreement (EPA), establishment of Operating Committee (OC), development of Operating Procedures (OP), appointment of Independent Engineer (IE) and testing of the Project leading to declaration of commercial operations. CPPA-GL also handles payments to the Project against sale of electricity and all sort of Non Project Missed Volume (NPMV) under the EPA.

3.6 GOVERNMENT OF PUNJAB (GOP)

GOP is in the process of leasing land to the Project for the entire life. GOP is also in process of approval the IEE for the Project and issuance a No Objection Certificate (NOC) in this regard through its Environment Protection Agency.

4 CARBON CREDITS

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

The Protocol's first commitment period started in 2008 and ended in 2012. A second commitment period was agreed on in 2012, known as the Doha Amendment to the protocol, in which 37 countries have binding targets: Australia, the European Union (and its 28 member states), Belarus, Iceland, Kazakhstan, Liechtenstein, Norway, Switzerland, and Ukraine. Belarus, Kazakhstan and Ukraine have stated that they may withdraw from the Protocol or not put into legal force the Amendment with second round targets. Japan, New Zealand and Russia have participated in Kyoto's first-round but have not taken on new targets in the second commitment period. Other developed countries without second-round targets are Canada (which withdrew from the Kyoto Protocol in 2012) and the United States (which has not ratified the Protocol). As of July 2015, 36 states have accepted the Doha Amendment, while entry into force requires the acceptances of 144 states.

Negotiations were held in Lima in 2014 to agree on a post-Kyoto legal framework that would obligate all major polluters to pay for CO_2 emissions. China, India, and the United States have all signaled that they will not ratify any treaty that will commit them legally to reduce CO_2 emissions.

The ultimate objective of the UNFCCC is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would stop dangerous anthropogenic interference with the climate system. Even if Annex I Parties succeed in meeting their first-round commitments, much greater emission reductions will be required in future to stabilize atmospheric GHG concentrations.

For each of the different anthropogenic GHGs, different levels of emissions reductions would be required to meet the objective of stabilizing atmospheric concentrations. Carbon dioxide (CO_2) is the most important anthropogenic GHG. Stabilizing the concentration of CO_2 in the atmosphere would ultimately require the effective elimination of anthropogenic CO_2 emissions.

Some of the principal concepts of the Kyoto Protocol are:

- Binding commitments for the Annex I Parties. The main feature of the Protocol is that it established legally binding commitments to reduce emissions of greenhouse gases for Annex I

Parties. The commitments were based on the Berlin Mandate, which was a part of UNFCCC negotiations leading up to the Protocol.

- Implementation. In order to meet the objectives of the Protocol, Annex I Parties are required to prepare policies and measures for the reduction of greenhouse gases in their respective countries. In addition, they are required to increase the absorption of these gases and utilize all mechanisms available, such as joint implementation, the clean development mechanism and emissions trading, in order to be rewarded with credits that would allow more greenhouse gas emissions at home.
- Minimizing Impacts on Developing Countries by establishing an adaptation fund for climate change.
- Accounting, Reporting and Review in order to ensure the integrity of the Protocol.
- Compliance. Establishing a Compliance Committee to enforce compliance with the commitments under the Protocol.

4.1 EMISSION REDUCTION MECHANISMS

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

4.1.1 EMISSIONS TRADING

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

4.1.2 CLEAN DEVELOPMENT MECHANISM (CDM)

Clean Development Mechanism (CDM) allows richer countries to offset their CO_2 emission against the emissions prevented when technology that cuts down on greenhouse gas emissions is deployed in poor countries.

4.1.3 JOINT IMPLEMENTATION (JI)

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

4.2 ROLE OF CDM IN ZHENFA PAKISTAN (ZPNECL) PROJECT

The Project is a power generation project with renewable resource and zero emission. When put into operation, the project can provide power supply to the central Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. By estimating, using solar photovoltaic (PV) to generate 1 KWH electricity means saving 0.32 kg of standard coal, at the same time reduce the emission of 0.272 kg of carbon dust pollution, 0.997 kg of carbon dioxide (CO_2), sulfur dioxide (SO_2) 0.03 kg, 0.015 kg nitrogen oxide (NO_2).

After the completion of the station, it is expected to provide electricity grid each year about 144.561 million kWh, compared with the same capacity of thermal power, equivalent to annually save about 54947 tons of standard coal, reducing various atmospheric pollutant emissions, which reduce carbon dioxide (CO_2) about 170000 tons, sulfur dioxide (SO_2) of about 5151 tons, nitrogen oxide (NO_2) about 2576 tons.

It is also consistent with the spirit of the Kyoto Protocol and qualified for the application of CDM projects. If the project is approved and registered as a CDM project, CERs can provide extra financial resource for the project. It will provide favorable conditions for the project financing, improve competitiveness of the project, and reduce investment risk during the project implementation process. The CDM benefits in the Project (if incurred) shall be availed according to the provision in the Policy.

5 SOLAR PV INDUSTRY & OPPORTUNITIES IN PAKISTAN

Solar energy has excellent potential in areas of Pakistan that receive high levels of solar radiation throughout the year. Every day, for example, the country receives an average of about 19 Mega Joules per square meter of solar energy

Pakistan being in the Sun Belt is ideally located to take advantage of solar energy technologies. This energy source is widely distributed and abundantly available in the country. The mean global irradiation falling on horizontal surface is about 200-250 watt/m^2/day. This amounts to about 2500-3000 sun shine hours and 1.9 - 2.3 MWh/m^2/ year. It has an average daily global insulation of 19 to 20 MJ/m^2/day with annual mean sunshine duration of 8 to 8.5 hours (6-7hrs in cold and 10-12 hrs in hot season) and these values are among the highest in the world. For daily global radiation up to 23MJ/m^2, 24 (80%) consecutive days are available in this area for solar energy. Such conditions are ideal for solar thermal applications.

Pakistan receives about 15.5x1014 kWh of solar irradiance each year with most regions receiving approximately 8 to 10 sunlight hours per day. The installed capacity of solar photovoltaic power is estimated to be 1600 GW per year, providing approximately 3.5 PWh of electricity (a figure approximately 41 times that of current power generation in the country).

To summarize, the sun shines for 250-300 days per years in Pakistan with an average sun shine hours of 8-10 per day. This gives huge amount of energy to be used for electricity generation by solar thermal power plants.

Solar PV was considered as an expensive option in the early times. During last 05-10 years, the continuously increasing oil prices and the continuously decreasing PV prices have really created worth of it. Particularly for non-oil producing country like Pakistan, there is immense potential.

An overview for the potential of solar energy in Pakistan can be obtained from the satellite map of solar radiation released by National Renewable Energy Lab (NREL) of USA.

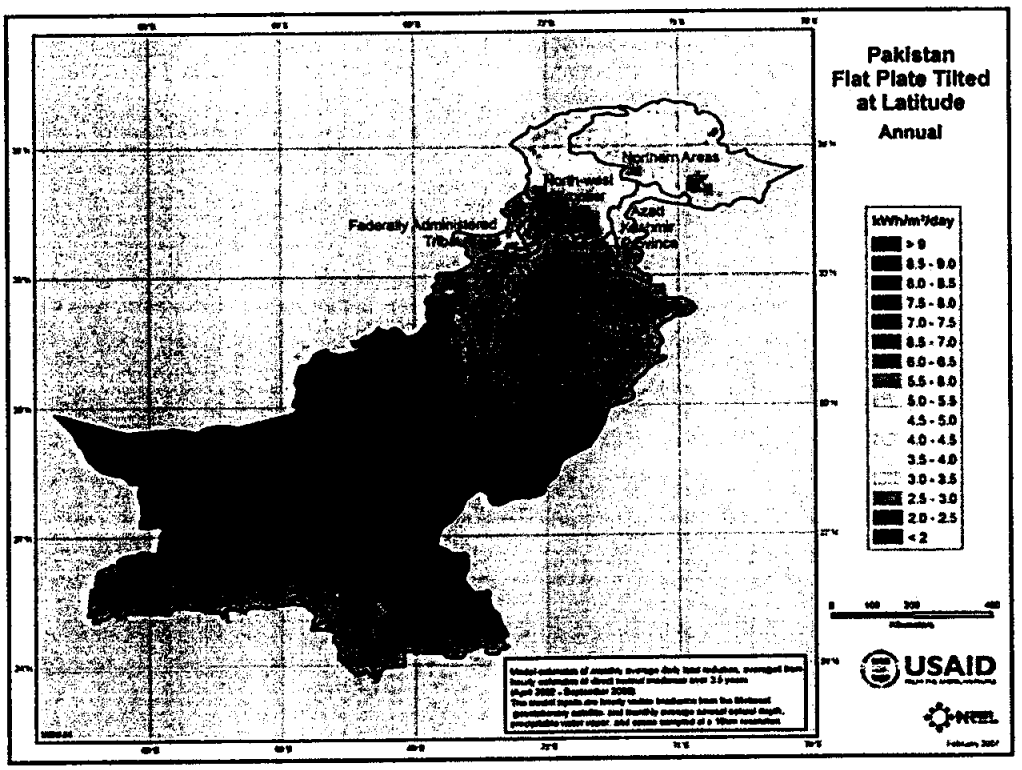


Figure 6: NREL Solar Map of Pakistan

The off grid solar applications are seen since 1980's in Pakistan. In the current decade, there have been some installations for captive needs for commercial and industrial uses.

The learning curve in wind power sector has helped in devising effective implementation strategy for solar power projects in Pakistan. Government of Pakistan is offering excellent incentives to investors for solar power development in the country. Investors have been offered lucrative fiscal and financial incentives that are of key interest for them to come to this market. Provincial governments, particularly Punjab Government, are also facilitating development of solar power in Pakistan. Though we started late to develop solar PV power projects, i.e. in 2009, however, now we are at stages where serious projects are coming up.

5.1 Projects initiated under federal LOIs

At present, 29 projects of 709.6 MW capacity and are under development within the framework of AEDB policies and procedures. These projects are at various stages of development. Following are the projects with LOIs from AEDB and their expected CODs:

Table 10: List of LOIs issued by AEDB

Sr. #	Company	Project Capacity (MW)	Location	Date of Issuance of LOI	Date of Expiration of LOI	Expected COD
1	M/s Access Electric Pvt. Ltd. 10 MW Capacity	10	Punjab	30-Jul-11	30-Jan-13	Nov-15
2	M/s Bukhsh Energy (Pvt.) Ltd.	10	Punjab	11-Jul-12	11-Jan-14	Jan-16
3	M/s Wah Industries Ltd.	5	Punjab	18-Jan-13	17-Jul-14	Nov-15
4	M/s Integrated Power Solution	50	Sindh	3-Jul-13	2-Dec-14	Oct-16
5	M/s Jafri & Associates	50	Sindh	3-Jul-13	2-Dec-14	Oct-16
6	M/s Solar Blue Pvt. Ltd.	50	Sindh	3-Jul-13	2-Dec-14	Oct-16
7	M/s Safe Solar Power Pvt. Ltd	10	Bahawalpur, Punjab	13-Jan-14	13-Jul-15	Mar-15
8	M/s Access Solar Pvt. Ltd. 10 MW Capacity	10	Pind Dadan Khan	13-Feb-14	13-Aug-15	Feb-18
9	M/s R.E. Solar I Pvt. Ltd.	20	QSP, Punjab	21-Apr-14	10-Oct-15	Apr-18
10	M/s R.E. Solar II Pvt. Ltd.	20	QSP, Punjab	21-Apr-14	10-Oct-15	Apr-18
11	Hanergy Global Solar Asia Pacific Ltd.	50	QSP, Punjab	12-May-14	4-Nov-15	May-18
12	Hanergy Global Solar Asia Pacific Ltd. 2	10	QSP, Punjab	12-May-14	4-Nov-15	May-18
13	Janpur Energy Limited	10	QSP, Punjab	27-May-14	26-Nov-15	May-18
14	Janpur Energy Limited	10	QSP, Punjab	27-May-14	26-Nov-15	May-18

15	Blue Star Hydel Pvt. Ltd.	1	Pind Dadan Khan	27-May-14	26-Nov-15	May-18
16	Nizam Power Pvt. Ltd.	11.3	Hub, Balochistan	24-Jun-14	24-Dec-15	Jun-18
17	Fauji Foundation	10	Gharo, Thatta, Sindh	10-Jul-14	9-Jan-16	Jul-18
18	Sino Pak Energy Development Company (Private) Limited	10	Mardan KPK	23-Jul-14	22-Jan-16	Jul-18
19	Nizam Energy Pvt. Ltd. 1	5.65	Balochistan	3-Sep-14	2-Mar-16	Sep-18
20	Nizam Energy Pvt. Ltd. 2	5.65	Balochistan	3-Sep-14	2-Mar-16	Sep-18
21	Ayan Energy Pvt. Ltd.	50	QSP, Punjab	22-Sep-14	21-Mar-16	Sep-18
22	Blue Star Electric Pvt. Ltd.	1	Pind Dadan Khan	28-Nov-14	28-May-16	
23	Total Energies Nouvelles Ventures	100	QSP, Punjab	28-Nov-14	28-May-16	
24	Siddiqsons Energy Karachi	50	Jehlum	5-Dec-14	10-May-16	
25	Harappa Solar (Pvt.) Ltd.	10	Sahiwal	31-Dec-14	30-Jun-16	
26	AJ Power (Pvt.) Ltd.	10	Pind Dadan Khan	6-Feb-15	5-Aug-16	
27	Adamjee Power Generation Pvt. Ltd.	5	QSP, Punjab	2-Mar-15	26-Nov-16	
	Total Capacity (MW)	**584.6**				

Upfront Tariff has been awarded to 07 IPPs for 147.52 MW by NEPRA; 100 MW by QA Solar (Pvt.) Ltd. is installed under the LOI issued by AEDB; project documents are being negotiated for commercial operation of the project. Following 06 projects of 47.52 MW projects are being issued LoS binding them to achieve financial close by December 31, 2015.

Table 11: Tariff award

11.52 MW M/s Access Solar (Pvt.) Ltd.	Upfront Tariff US Cents 17.01/kWh
10 MW M/s Access Electric (Pvt.) Ltd.	Upfront Tariff US Cents 17.01/kWh
10 MW M/s Bakhsh Solar (Pvt.) Ltd.	Upfront Tariff US Cents 16.30/kWh
5 MW M/s Sanjwal (Pvt.) Ltd.	Upfront Tariff US Cents 17.01/kWh
10 MW M/s Safe Solar (Pvt.) Ltd.	Upfront Tariff US Cents 16.30/kWh
1 MW M/s Blue Star Hydro (Pvt.) Ltd.	Upfront Tariff US Cents 17.01/kWh

NEPRA has announced amendment in Grid Code for solar PV power projects on June 30, 2014 and Standard Project Security Documents (EPA, IA) have been approved by the ECC on March 19, 2015. The templates of standard EPA and IA are available at download section.
New Upfront Tariff for Solar PV Power Projects NEPRA, vide its determination dated January 22, 2015 has announced revised new upfront tariff for solar PV power projects at following rates.

Table 12: Levelized Tariff

Levelized Tariff for Solar PV Power Projects (US Cents/kWh)					
[illegible]					
1 - 20MW	21 - 50 MW	51 - 100 MW	1 - 20MW	21 - 50 MW	51 - 100 MW
15.0279	14.8953	14.7588	14.4096	14.2825	14.1516

NEPRA has given its determination against the review petitions against this tariff on May 25, 2015 in which NEPRA has allowed SINOSURE coverage, bring more clarity on degradation, revised the tariff sharing mechanism after achieving the benchmark energy numbers to bring on more efficiencies and has issued clear directions to NTDC and DISCOs to approve the grid connectivity and simulation studies to the effect that solar based power will be evacuated in accordance with the project timeline and further that the power injected through the project will not have any adverse effect on the national grid as required under the Grid Code. The upfront tariff will remain available till six months from the date of gazette notification of the revision in the upfront tariff announced on May 25, 2015.

5.2 Projects initiated under Provincial LOIs by PPDB.

PPDB is offering Federal Govt. Guarantee to projects initiated under provincial LoIs, provided they obtain a tripartite LoS (PPDB, Prov. Govt. and IPP). Required amendment in the RE Policy 2006 has been approved by ECC on May 21, 2015. Standard Templates of TLOS, PG, Facilitation Agreement and Coordination Agreement have also been approved by the ECC.

The developments in the solar sector, the demand for new generation and GoP's plans to harness clean sources of energy have resulted in creating interest from several local and foreign investors for developing solar power projects in Pakistan. There is a huge interest developed for investment in the solar sector.

Government of Punjab owns the Quaid e Azam solar park which is a complete 1000 MW project out of which first phase of 100 MW has been completed in May 2015 and the other 900 MW phase is planned to be complete by the end of 2016.

Following is the list of LOIs issued by PPDB:

Table 13: List of LOIs issued by PPDB

Sr. No	Company	Project Capacity (MW)	Location
1	Zonergy Co Ltd.	900	QASP, BWP, Punjab
2	Storm Harbour	100	QASP, BWP, Punjab
3	Solution de Energy	100	QASP, BWP, Punjab
4	Zhenfa Energy Group Co.	100	Punjab
5	CWE & Welt Konnect (Pvt) Ltd.	50	N/A
	Total	1250	

5.3 PPDB's SUPPORTING MEASURES

Several measures have been undertaken by PPDB to create an enabling environment for development of Solar power in Pakistan. A snapshot of the same is given below:

- Amendment of Grid Code for Solar Power projects has been initiated with the support of CPPA/NTDC;
- Standard project documents are developed;
- Building lenders' confidence through supportive measures and introduction of almost all leading manufacturers of the world in the local market to supply ARE equipment;
- Work with NEPRA on offering an Upfront tariff for RE projects in line with other countries of the world for quick development of RETs;
- Capacity building of provincial governments through technical assistance / facilitation;
- Duty / tax exemptions on RE equipment;
- Development of private businesses in RE technology;
- Promotional activities through international and local conferences, exhibitions and road shows with active participation of media, undertaken to address the issues of consumer shyness and acceptability of RE technologies;
- Development of local capacities for EPC services and for manufacturing of towers locally;
- Supporting private sector in addressing their administrative issues;
- Building capacities of the public sector institutions in solar power projects

5.4 Projects initiated under Provincial LOIs by GOS

Government of Sindh (GOS) is also taking steps like PPDB to enable solar power development in the province of Sindh. GOS has issued some LOIs for Solar power projects and those project are at different stages of feasibility studies.

6 PROJECT IN TERMS OF POLICY FRAMEWORK

The project is being developed under the Government of Pakistan's Policy for Development of Renewable Energy for Power Generation, 2006.

The project has now reached the stage of submitting the revised feasibility study.

All pre-requisites of submitting the feasibility study are complete.

The project shall either follow the negotiated (cost plus) tariff regime with NEPRA or apply for the upfront tariff (subject to announcement of upfront tariff for Solar by NEPRA). Currently the project is preferring the prevailing upfront tariff. The tariff petition/application shall be filed upon approval of feasibility study.

During determination/application review of the tariff, the Project Company shall begin discussions of EPA / IA and debt arrangement. In fact, the preliminary round of discussions with lenders has already been completed while making the feasibility study.

Upon determination of tariff, the Project Company shall submit the Performance Guarantee (PG) and seek for issuance of Letter of Support (LOS).

Thereafter, the Project Company shall pursue the financial close.

7 PROJECT SITE

7.1 SITE DETAILS

The Project Site is acquired at Rakh, Chaubara, and District Layyah-Punjab. The project site is located around 08 kilometers away from Chaubara city.

The total land area of the project site is about 650 acres owned by the project owners for the implementation of 100 MW Solar PV project. The proposed site located at latitude of 30°54'11.86"N and longitude of 71°33'36.21"E with elevation of around 150 meters.

Project Site coordinates and location are shown in Table 14 and Figures 7 & 8.

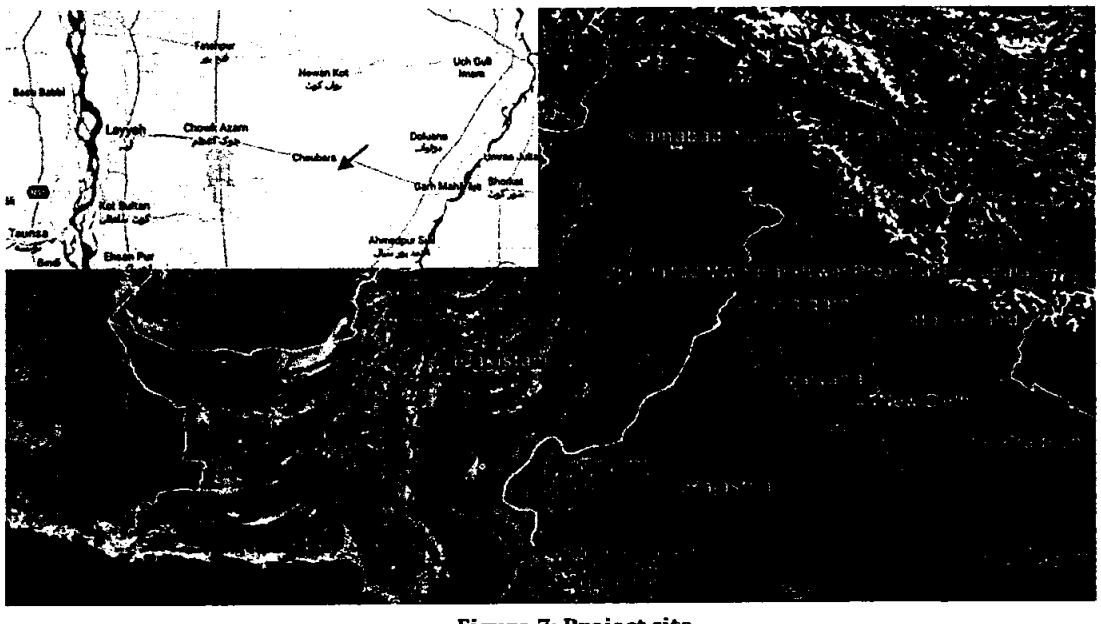


Figure 7: Project site

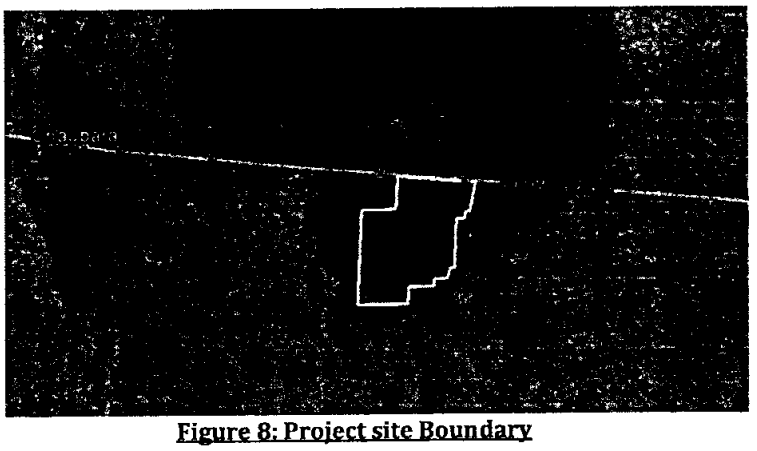


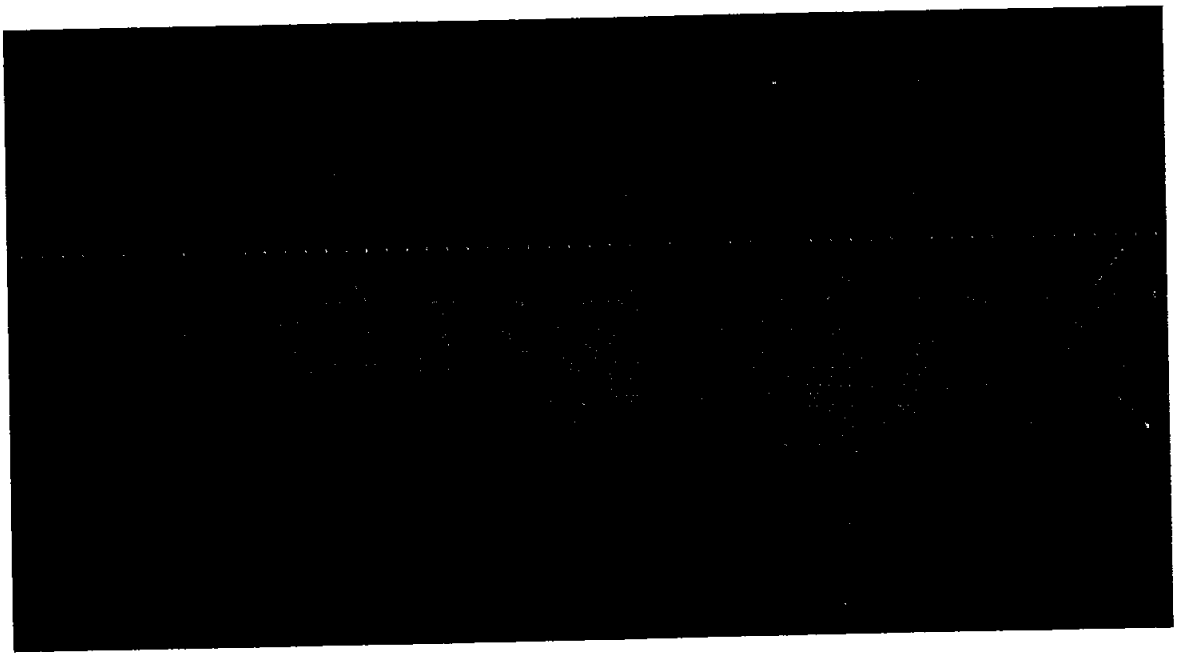
Figure 8: Project site Boundary

Table 14: Geographical Coordinates of Project Site

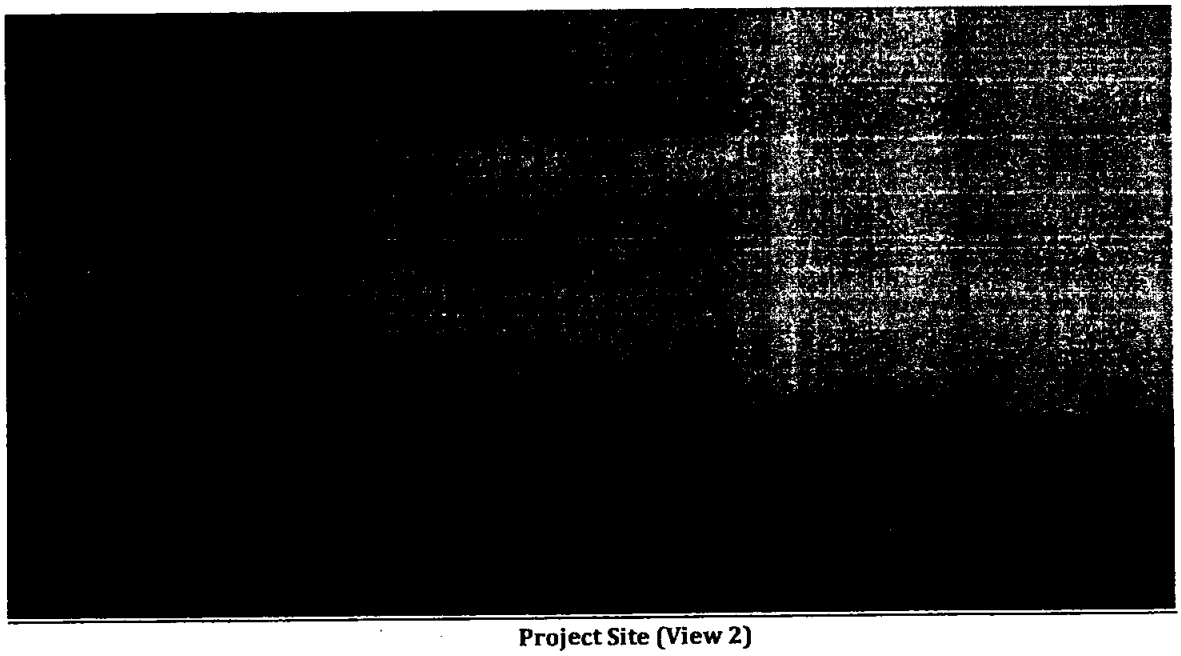
Boundary Point	Geodetic	
	Latitude	Longitude
1.	30°54'11.86"N	71°33'36.21"E
2.	30°53'55.07"N	71°33'35.19"E
3.	30°53'54.59"N	71°33'13.89"E
4.	30°53'5.81"N	71°33'11.43"E
5.	30°53'5.98"N	71°33'42.08"E
6.	30°53'14.86"N	71°33'42.96"E
7.	30°53'15.18"N	71°33'58.07"E
8.	30°53'18.98"N	71°33'58.82"E
9.	30°53'19.16"N	71°34'6.43"E
10.	30°53'24.73"N	71°34'8.65"E

11.	30°53'24.82"N	71°34'11.15"E
12.	30°53'50.08"N	71°34'12.40"E
13.	30°53'50.04"N	71°34'17.54"E
14.	30°53'53.91"N	71°34'18.24"E
15.	30°53'53.93"N	71°34'20.81"E
16.	30°54'8.61"N	71°34'24.10"E

The area is open and can be seen from the images below;



Project Site (View 1)



Project Site (View 2)

Figure 9: Project Site Views

7.2 LOCATION OF GRID

Pakistan has a vast transmission and distribution system ranging from Northern areas to the farthest corner of Balochistan and Sindh. National Transmission and Dispatch Company (NTDC) is the main authority which manages all the transmission facilities and the National Grid with the help of 08 distribution companies, the MEPCO.

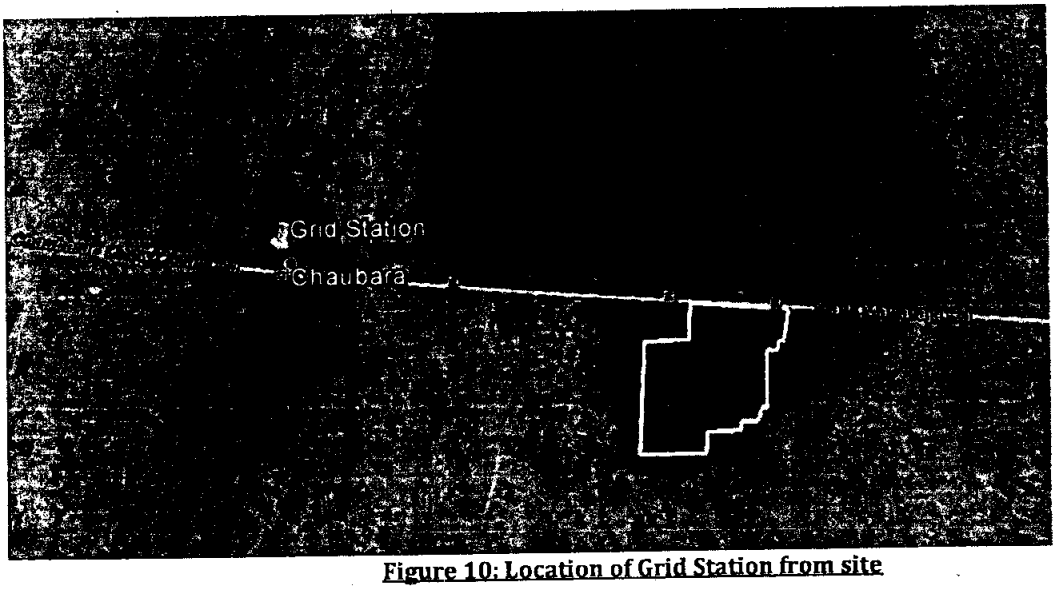


Figure 10: Location of Grid Station from site

The project site is located around 4.2 km from the nearest 132 kVA Chaubara Grid Station. A separate electrical and grid interconnection study will be conducted for the project including Power Quality, Load Flow, Short Circuit and Power Evacuation.

7.3 TRANSPORTATION AND ACCESS ROADS

The major track from Multan to site is two-way road. The terrain is flat. Generally, no maintenance of the road is required from Multan to the Site. Complete transportation study is attached as Annexure 5.

The Multan dry port is the one of the major dry ports in Punjab province and is the point of de-livery of equipment for the proposed solar power project. It is located towards south of the site.

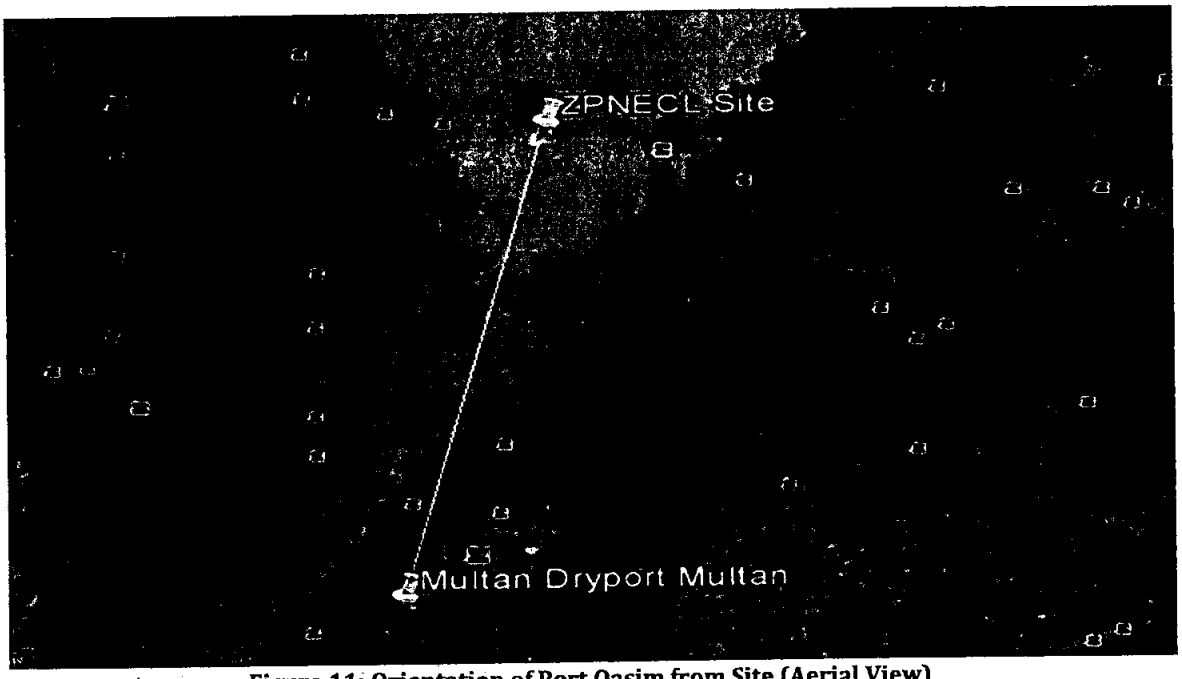


Figure 11: Orientation of Port Qasim from Site (Aerial View)

Ariel distance of the port from the site is 88 Km. Total track length between Multan dry port and site is approximately 148 km. The track from dry port to site is good and till the Site and no development is required. The load bearing capacity of the bridges in between the dry port and the site is good and is enough to bear the load of trucks carrying heavy equipment. EPC con-tractor will carry out details of such investigations during construction.

Ariel view of track is given. Track starts from Multan dry port, which is located on Multan southern bypass road. After 2 km it joins Muzaffargarh Road and then after moving about 11 km it becomes on Muzaffargarh Bypass. From Muzaffargarh Bypass take right turn to get on MM Road. After moving about 5 km turn left on Mianwali – Muzaffargarh road. After moving 105 Km, track turns right from Chowk Azam to Chaubara Road. After 16 km on the same road the track reaches the the site. Details of the track are given in the undergoing sections. Total track length is 148 km from Dry Port Multan.

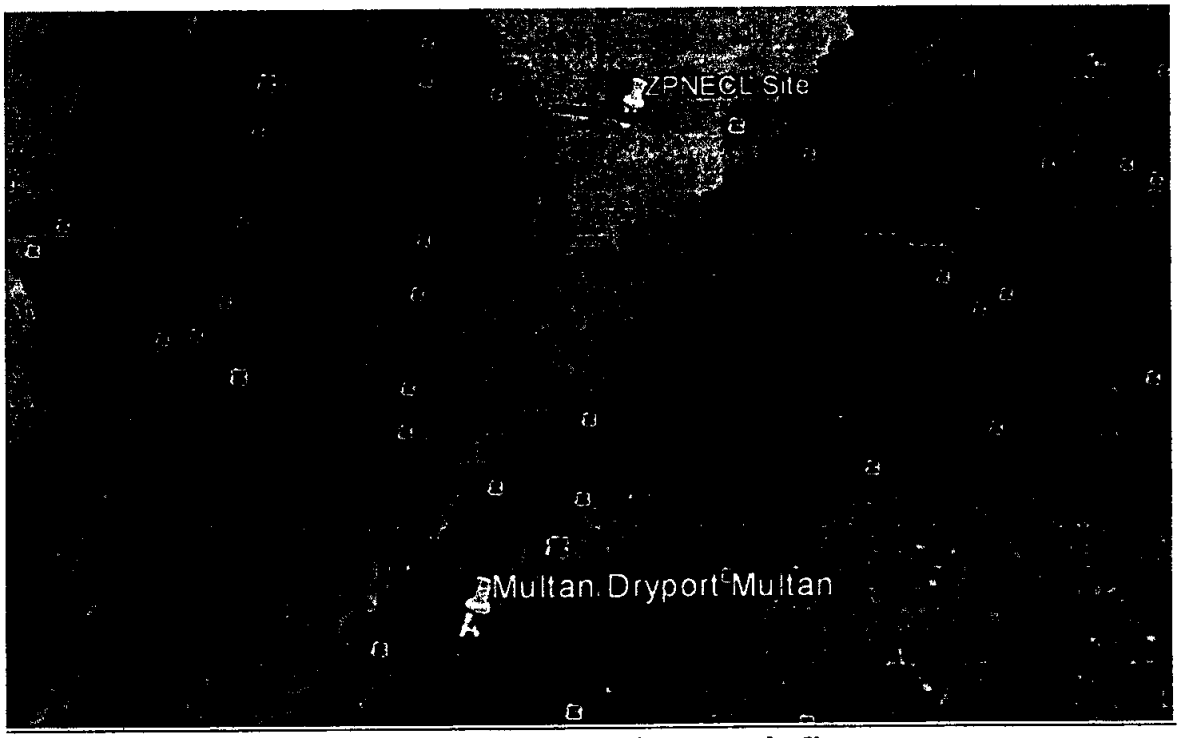


Figure 12: Detailed Access to the Site

7.4 CLIMATIC CONDITIONS

Layyah has extremes of climate; the summer season begins from April and continues till October. June and July is the hottest month in Layyah with its average high temperatures at 34.8°C, maximum temperatue goes to near 50°C, The coldest month is January with average highs at 11.1°C, minimum temperature is 2°C. The average high temperatures rise to 34.8°C here in Jun and fall to 25.2 °C with an average 21 mm of rainfall. Layyah has 8.3 hours of sunshine daily on average. The mean maximum and minimum temperatures for the coldest month are 12 and 5 degree Celsius respectively. Rainfall Towards the end of June monsoon conditions appear and during the following two months the rainy season alternates with humid weather. The winter rain falls during December, January and February ranging from 18 to 21 millimeters. Maximum and Minimum Temperature Regime Map of Pakistan is shown in **Figure 13, Figure 14** & rainfall map in **Figure 15.**

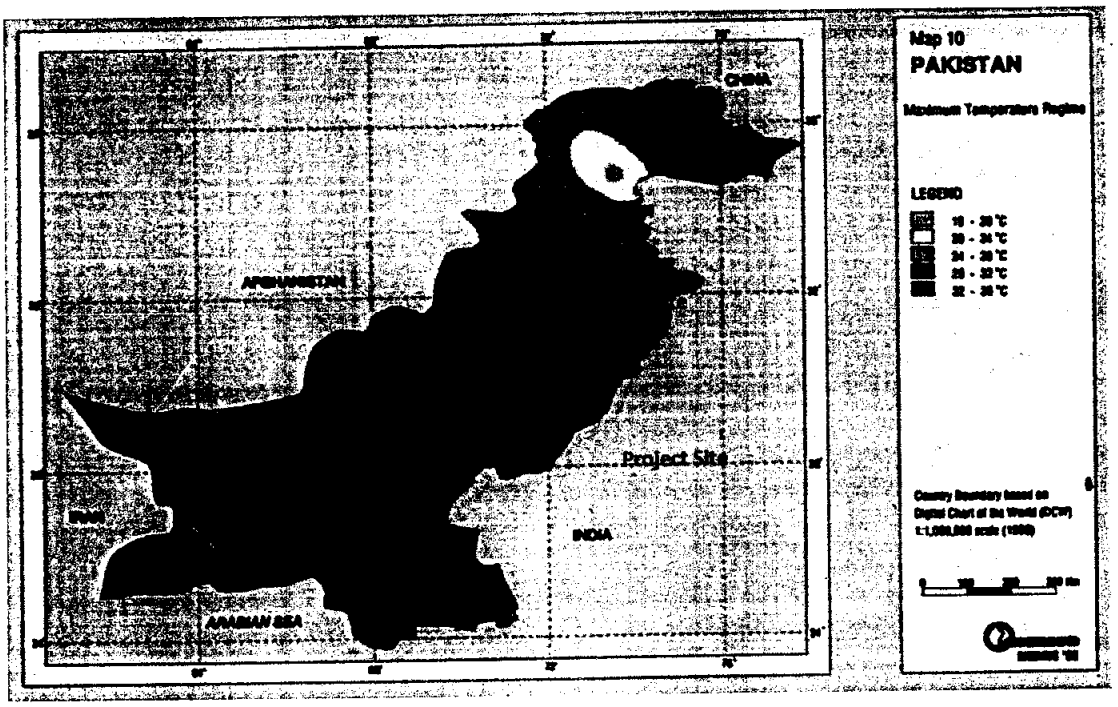
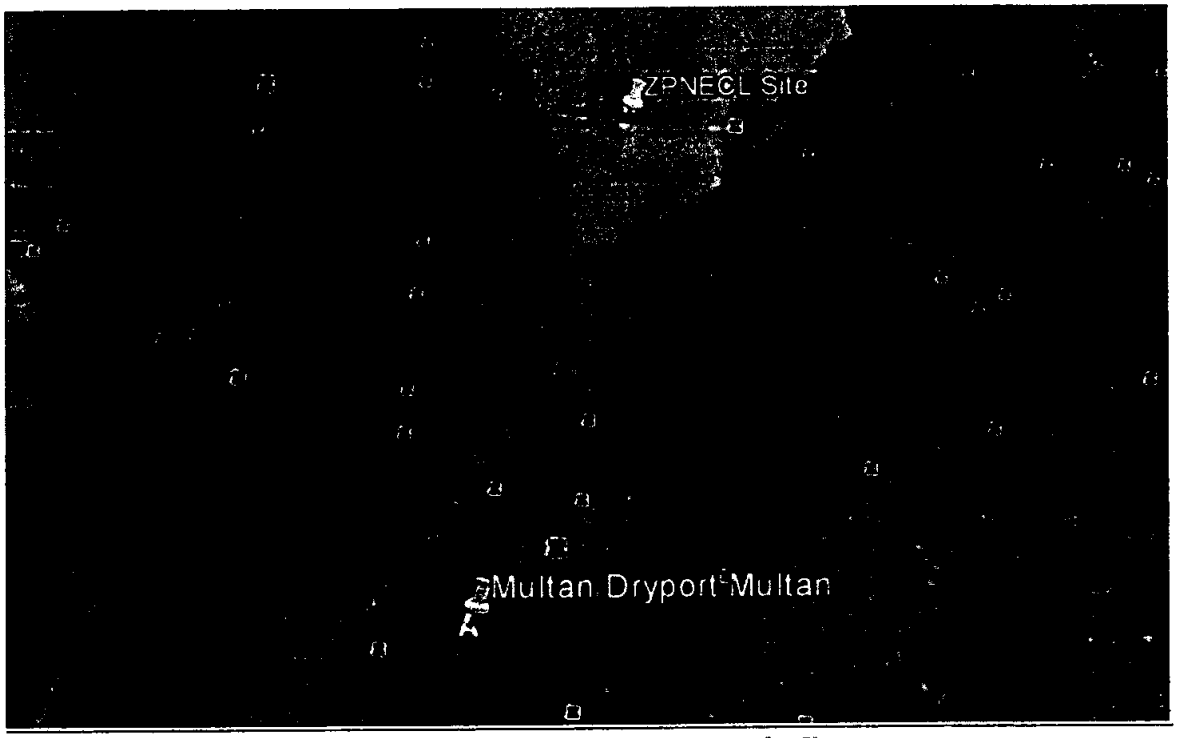


Figure 13: Maximum Temperature Regime Map of Pakistan



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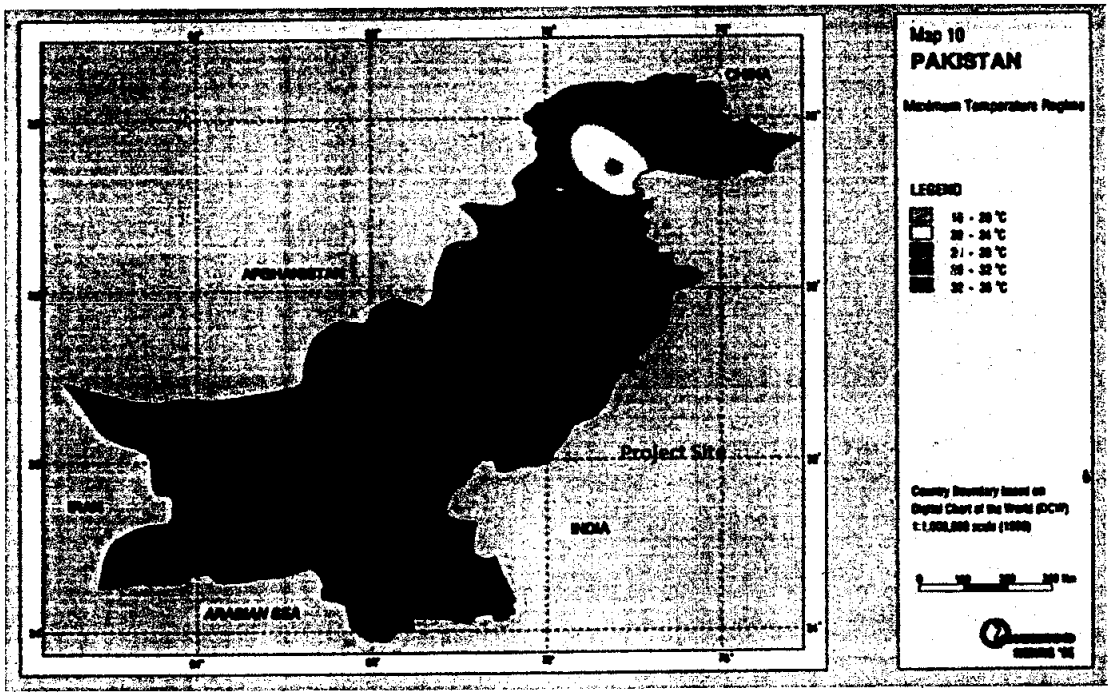


Figure 13: Maximum Temperature Regime Map of Pakistan

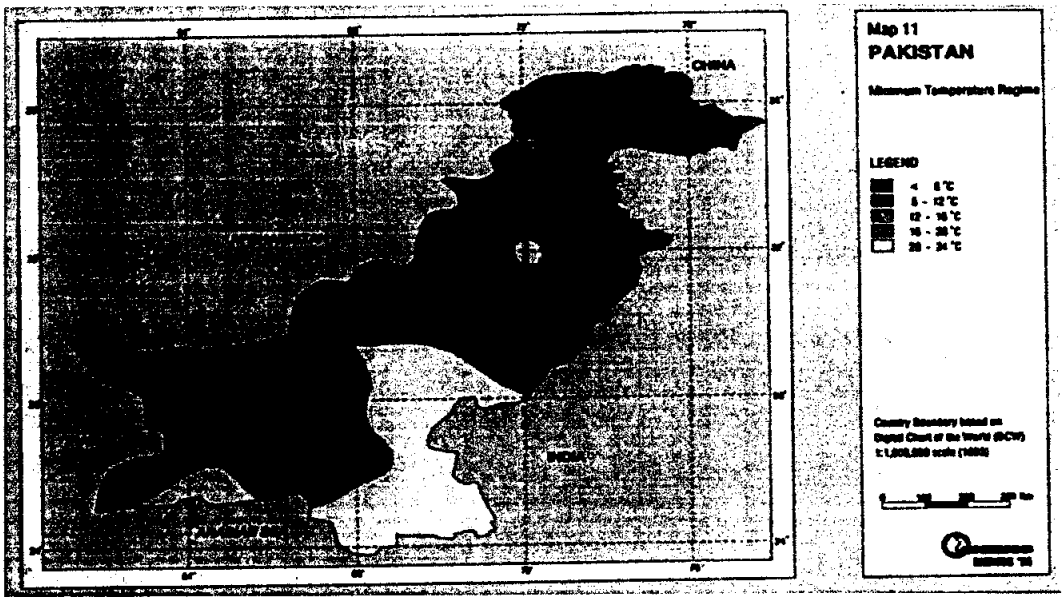


Figure 14: Minimum Temperature Regime Map of Pakistan

Figure 15: Rainfall Map of Pakistan

7.5 TELECOMMUNICATION

PTCL telephone services are not available but mobile services are available at village level only.

8 SELECTION OF EPC CONTRACTOR

After the approval of feasibility study, the Project Company will take open tending procure to choose right EPC company with rich international engineering experience.

Though they have their own design team and EPC company under one roof in China. Their EPC Company has involved EPC work for more than 8 years in China and have installed about 3GW solar projects, they lack international experience.

For Pakistan 100MW solar project, the sponsor is planning to chose one big and strong EPC company with international experience, especially in Pakistan with more than 10 years, design job will be done by their company, key components like modules, inverter, cables and transformer will be chosen by the sponsor. They will provide technical support and supervise this construction work.

9 GEOLOGICAL CONDITIONS

The town was founded around 1550 by Kamal Khan, a Mirani Balooch and a descendant of Ghazi Khan who laid foundation of Dera Ghazi Khan. Around 1610, the town was taken from the Mirani Rulers by the Jaskani Balochs, who held it until 1787. Abdun Nabi Sarai was appointed Governor by Timur Shah Durrani, but three years later it was included in the Governorship of Muhammad Khan Sadozai, who transferred his seat of Government to Mankera.

In 1794, Humayun Shah, the rival claimant to the throne of Kabul, was captured near Leiah and brought into the town, where his eyes were put out by order of Zaman Shah. Under the Sikh Government, the town once more became the centre of administration for the neighbouring tract, and after the British occupation in 1849, was for a time the headquarters of a Civil Administrative Division. This administrative status of Layyah was short-lived and the British reduced it to the level of Tehsil headquarters, making it a part of Dera Ismail Khan. Previously a Tehsil of Muzafargarh, Layyah gained the status of being a district in 1982. The district of Layyah comprises of three tehsils which include Layyah, Chaubara and Karor Lal Eason.

District Layyah is situated in the south-west (rather west) of Punjab. In its north, lies the district Bhakkar while to its west flows River Indus. Across the river there is Dera Ghazi Khan which is also a district and

division of Punjab. District of Jhang is located in the East and Muzafargarh is located in the south of district Layyah.

The area consists of a semi-rectangular block of sandy land between the Indus River and the Chenab River in Sindh Sagar Doab. The total area covered by the district is 6,291 km2 with a width from east to west of 88 km and a length from north to south of 72 km. The deposits are composed of flood plain mud, mixed with salt clay and fine to medium sandy point bars. The project area is barren land and there is also some agricultural land available along the side of project area with variety of crops growing.

Two villages Basti Malana and Basti Hafizabad are located at around 02 kilometers and 2.2 kilometers from the project boundary. Local people of the villages have access to urban areas through link roads and available public transport. Electricity is not available in the area. However, the facility of Sui gas is also not yet available in the area and people are using wood as a source of alternate fuel. PTCL telephone services are not available and only mobile services are available at village level. Only Primary schools are available for boys and girls in the villages. The nearest hospital is available in Chaubara city.

The present main source of water supply system in the town is tube wells with a depth of 25 - 30 ft.
No authentic data is available regarding air quality measurements specifically of Rakh Chaubara. As the city is surrounded by agricultural land, a number of trees and vegetation is there to minimize the impacts of gaseous emissions.

The challenge posed by flood is pronged in Layyah i.e, High level flood (500,000 cusec) in the River Indus has inundated 150 villages of 70 mouzas in 11 riverine union councils of the district. The flood-hit union councils include Warrah Seharan, Baseera, Sahowala, Shahpur of Karor tehsil, Shadu Khan, Kotla Haji Shah, Lohanch Nashaib, Jhakkar, Bait Wasawa Shumali, Bhakri Ahmed Khan and Paharpur of Layyah tehsil. Warrah Seharan, union council of karor tehsil where Basti Khayee and Makori were inundated by floodwater. Flood had destroyed villages from this portion. Flood had destroyed large number of population who were living near river.

Layyah District is mostly a desert area and some plan agricultural fertile area and there is not any kind of minerals found in the district Layyah.

10 SOLAR RESOURCE ASSESMENT

Detailed site assessment is carried out that includes deliberation of Land layout, Plant layout design, Grid Conditions, availability of Grid within appropriate vicinity of project site, Site topology as well as calculation of performance ratio along with Energy Numbers.

For Calculations of Irradiance at site, Metonorm and Solar GIS have been used. Whereas long term time series data of GeoModel Solar operates high-resolution meteorological database – SolarGIS is purchased for site. The calculations are performed in PVSyst software and all losses have been taken into account. At present, the Project Company are not submitting SRA with the feasibility study to PPDB because the Project momentarily plans to go for the upcoming upfront tariff being determined by NEPRA.

11 CIVIL WORKS

The detailed geotechnical survey report and topographical survey map for the site of Chaubara are attached as Annexure 4. The civil works include the following structures:

- Foundation of Solar Arrays
- Foundation of substation and grid interconnection apparatus, i.e. transformer, switchgear.
- Civil Works for construction of office building at site.

Regarding the foundation of solar array, we plan to use screw pile, this kind of pile uses hot dip galvanized steel C which is stable and strong enough in our sand region. It can stand the wind of 100km/h with 25 years life time by using this kind of pile, it can shorten the installation time on site to get COD at earlier period.
Below is the picture of screw pile.


Figure 16: Screw Piles

The design of construction mainly includes center control building (consisting center control room, secondary electrical equipment room, SVG room, 36.5kV distribution device room, station-use wire room, etc), complex, water pump house, inverter room, etc. Both the complex and the inverter room are of single-floor brick-concrete structure.

(1) Complex building

The complex building is of single-floor brick-concrete structure. The storey height is 3.3m and the total area is 1024 ㎡.

The exterior wall is composed by 370mm thick bricks and the interior wall is made of 240mm thick bricks. The height difference of exterior and interior wall is 240mm.

The complex has center control office, dormitory, kitchen and dining room, etc.

Door and windows: The external windows of offices are to use white double-layer plastic steel windows. The doors will be wooden doors and burglarproof doors. The external windows will be equipped with anti-thief barriers.

Decoration: the surface of exterior wall is to be covered by grayish white unglazed tiles, and the surface of interior wall will be brushed with white coating except bathroom and kitchen which are to be covered with regular ceramic tiles. The bathroom and kitchen floor is to be paved with 300*300 abrasive tiles and the rest rooms will use 600*600 regular tiles to pave the floor.

Sunlight shadow analysis: The complex is located in the center of the station's directorial area and is away from the solar arrays, so the shadow will not impact the performance of the solar arrays. The shadow analysis hence is not required.

(2) Foundation for inverter and transformer

The inverter and transformer are both container style, so there is no need to build the room for inverter and transformer. We build the foundation for inverter and transformer, the height is about 2 meters.

Sunshine shadow analysis: The foundation is in the center of each power generation unit and near the road. We leave enough room for the foundation and is away from the solar arrays, so the shadow will not impact the performance of the solar arrays. The shadow analysis is not required.

(3) Center control building

The center control building includes secondary electrical equipment room, SVG room, 36.5kV distribution device room, station-use wire room, center control room, spare part storage room, etc.

The center control room is of single-floor brick-concrete structure, and the construction area is 472.5m^2.The exterior wall is composed by 370mm thick bricks and the interior wall is made of 240mm thick bricks. The height difference of exterior and interior wall is 300mm.The storey height is 5.2m.

Door and windows: The external windows of offices are to use white double-layer plastic steel windows. The doors will be wooden doors and burglarproof doors. The external windows will be equipped with anti-thief barriers.

Decoration: The surface of the exterior wall will be grayish white unglazed tiles; the surface of interior wall will be white emulsion varnish; the ceiling will be covered by white coating.

Sunlight shadow analysis: The center control building is located in the center of the station's directorial area and is away from the solar arrays, so the shadow will not impact the performance of the solar arrays. The shadow analysis hence is not required.

(4) Guard room

The guard room will use the monolayer brick-concrete structure. The area is 30.7m^2. The outer wall is 370mm thickness; the interior wall is 240mm thickness. The altitude difference of the interior and outdoor is 150mm. There is duty room and restroom.

Door and windows: The external windows of offices are to use white double-layer plastic steel windows. The doors will be wooden doors and burglarproof doors. The external windows will be equipped with anti-thief barriers.

Decoration: The surface of the exterior wall is inorganic construction coating, the exterior wall and the rooftop steel structure are to adopt dry-hanging aluminum plastic plates, the surface of interior wall is to be painted with white coating, and room floor is to be paved with 600*600 regular tiles.

(5) Water pump house

The underground part of the water pump house is reinforced concrete structure. The area is 60m^2. The over ground part is brick-concrete structure. Decoration: the plat fond, the wall and the ground will use the cement mortar.

Sunlight shadow analysis: the location of the water pump house is in the east. There is no solar module, so there is no shadow.

12 ELECTRICAL WORKS

The detailed report on Electrical and Grid Interconnection Studies performed by Power Planners International (PPI) is attached as Annexure 2.

The detailed design activity of the electrical works shall be carried out by the Sponsor prior to start of construction. This sequence is in accordance with industrial practices.

A brief overview of the plant interconnection is given here.

12.1 PV PLANT ELECTRICAL OVERVIEW

The key electrical components of the plant shall include the PV panels, connection box, cabling, inverter, step up transformer and switchgear.

The conversion of solar radiation into electrical energy (DC power) shall be performed using the PV panels. The PV panels shall be split in multiple groups since that will allow for the use of lower current carrying capacity cables, and shall offer more redundancy in contingency conditions.

The DC electricity from the panels shall be converted into 50 Hz AC via the inverters. There may be some support apparatus such as junction boxes between the inverter and the panels.

The output voltage of the inverter can be classified as low voltage (LV), and therefore, shall require stepping up to medium voltage level (MV) i.e. 36.5 kV. This shall be achieved using step up transformers.

Once stepped up to 36.5 kV through a step up transformer, the power shall be transferred to the main power transformer, then the output voltage will become 132kV(High Voltage, HV). After the 132kV booster substation, the power can be transmitted to the purchaser.

1. **Primary Electrical Engineering**

The PV power station's connection to the electric power system shall consider the station's installation capacity, the condition of local supply network and power quality so as to select appropriate voltage class. This is a large-scale grid-connected PV power station whose capacity reaches 100MW, and hence requires a 132kV voltage for the grid connection.

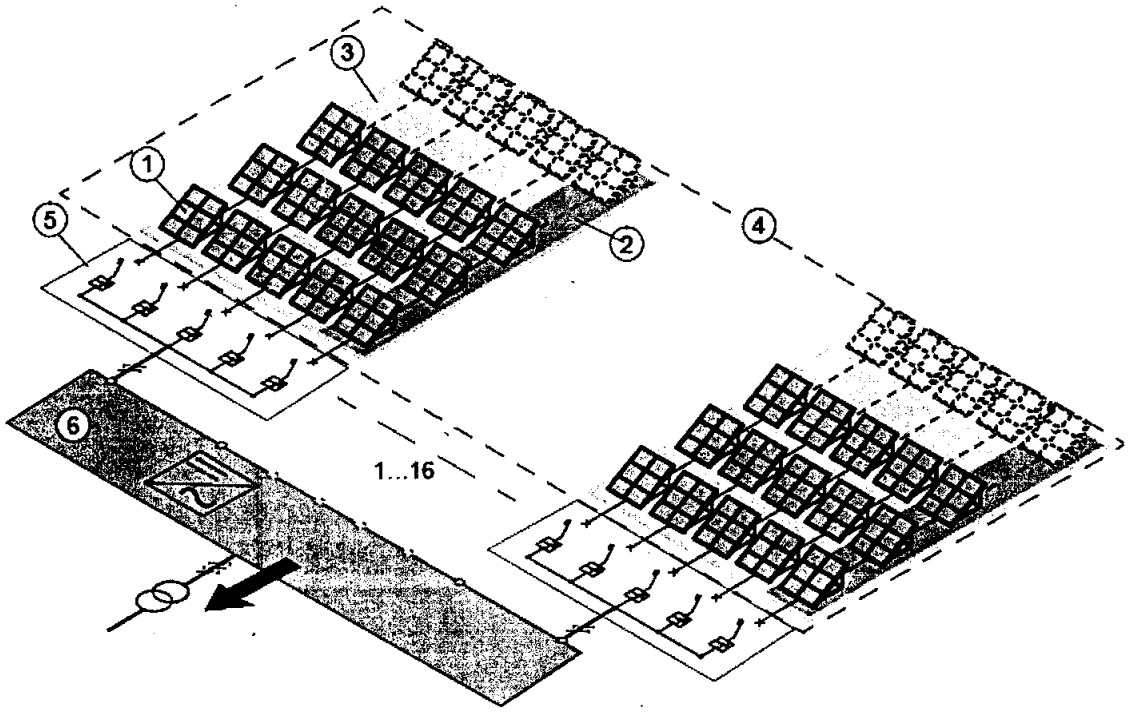
2. Booster stations

The project capacity is 100 MWP, totally 36 units approximately, of power generation system, each unit is about 2.78MW. The transformer in each power generation unit will be connected in parallel by cable to the 36.5kV distribution cabinet, which is in the booster substation. Each 36.5kV distribution cabinet can be connected to 6 units of power generation system. The 36.5kV distribution cabinet can has any number of incoming line and 2 outlet line. 36.5kV distribution cabinet will choose sectionalized single bus connection scheme. The main transformer is 132kV transformer; it will choose the single-bus configuration. Once stepped to 132kV, the power will be transferred to the purchaser.

3. PV power station area

This project adopts the fixed mounting system. A number of step up transformers will be used to raise the voltage to 36.5kV and then deliver the power to the 36.5kV distribution cabinet.

A graphical representation of the plant is given below:



1	Solar module (photovoltaic module)	3	Solar array	5	Solar array junction box
2	Solar string	4	Solar generator	6	Inverter

Figure 17: Block Diagram of Single PV Group

12.2 SINGLE LINE DIAGRAM

A single line diagram as described in the previous section is presented here. The detailed design may include other balance of plant (BOP) equipment such as capacitor banks, earthing transformers etc.

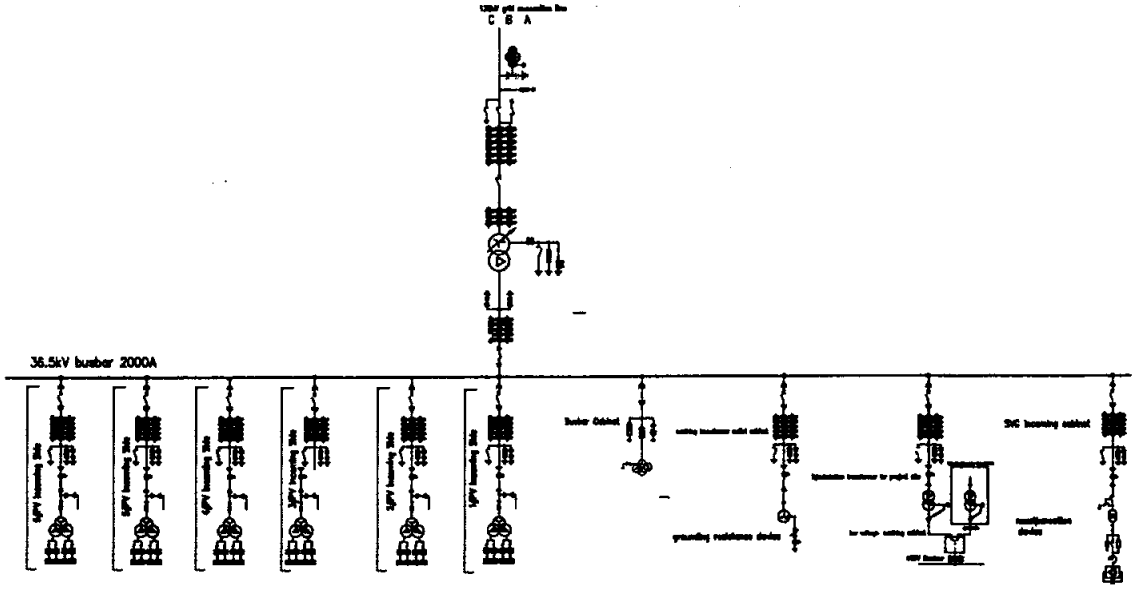


Figure 18: Single Line Diagram

12.3 INTERCONNECTION OF PV MODULES AND FORMATION OF ARRAYS

With 100MW project size, through technical and economic comparison, we consider to use 255Wp poly-silicon module with total quantities of 392156pcs.

With comprehensive considering of radiation distribution, project location and other factors such as wind speed, temperature, etc., suppose this 100MW project uses the fixed mounting system with tilt angel of 25 degree, 7.5mm pitch.

Each photovoltaic power generation system consists of 228 units of fixed structure. The layout for each power generation system is 29*8. Each fixed structure has 2 strings, each string has 24 pcs modules. So 114 strings are connected to one 630KW inverter. Hence each power generation system has 10944pcs 255W modules, 29 pcs junction box, 4 x 630KW inverters and 2 x step-up transformer.

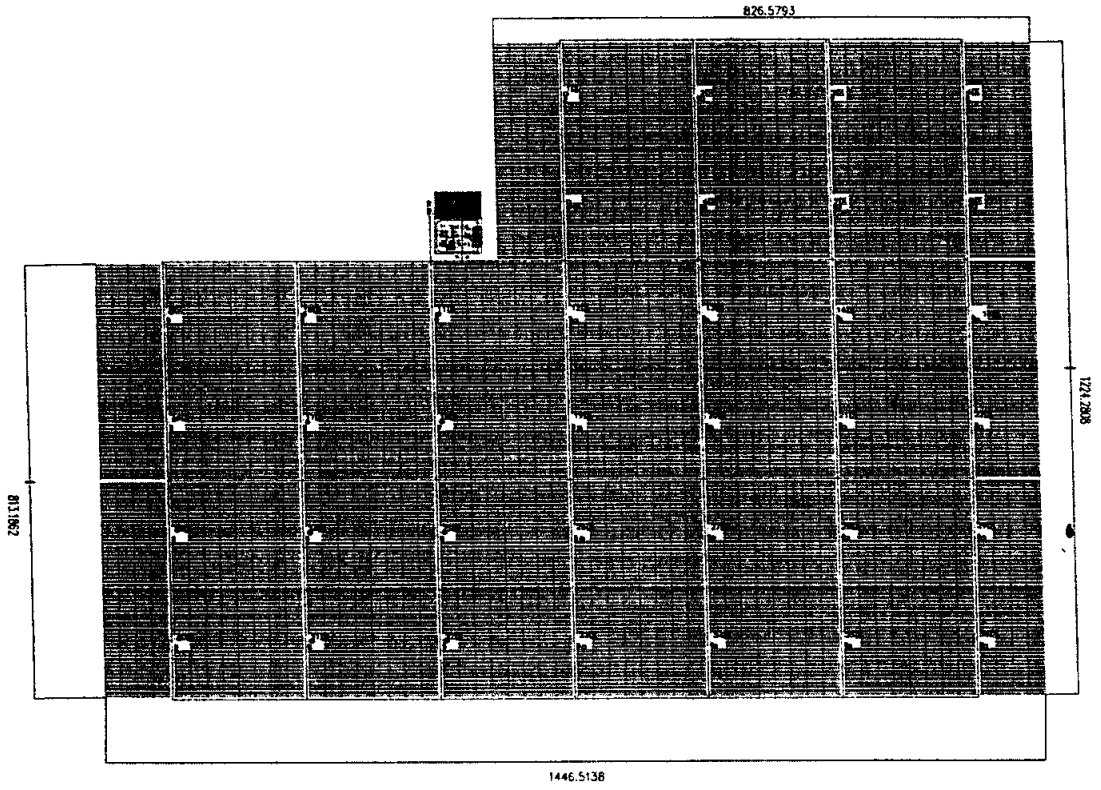


Figure 19: Overall Layout

13 MECHANICAL WORKS

The mechanical engineering design mainly includes following structures:

- Steel Structures to support the Solar Arrays

We consider to use the fixed mounting system with material of hot dip galvanized steel C , this kind of the mounting system has the advantage of free maintenance and strong windproof. It can be used in complicated district and installation is easy.

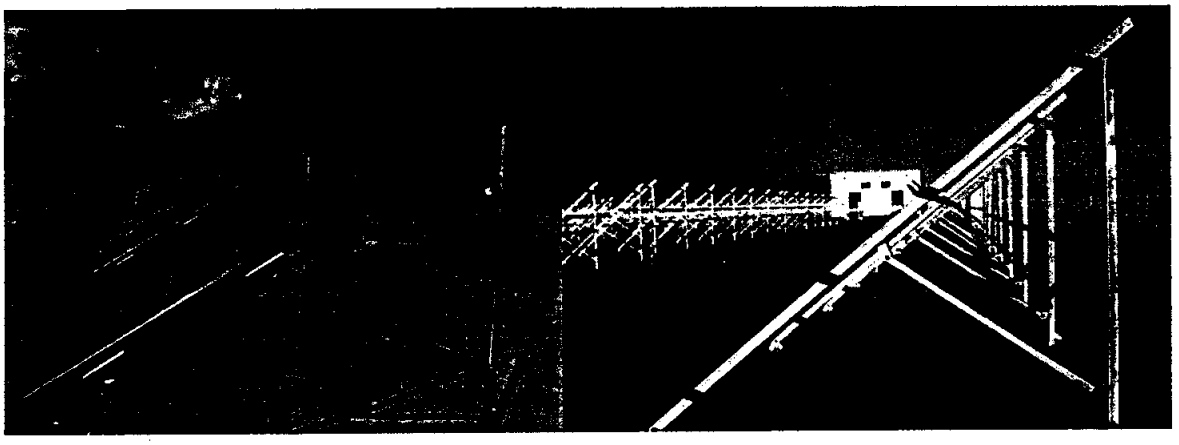


Figure 20: Fixed Mounting systems

The mechanical works (installation) are included in the scope of EPC contract. The detailed design activity of the mechanical works shall be carried out by the project company prior to start of construction. This sequence is in accordance with international and Pakistani power sector practices.

14 CONSTRUCTION MANAGEMENT

Like many power projects in Pakistan, the structure of EPC contract shall be on a "turnkey" basis. Everything shall be managed from one platform (one window) of the EPC contractor. The partners of EPC contractor shall be underneath that platform through "joint and several arrangements" such that the guarantees and warranties mechanism does not deviate from the basic concept and international practices. In this way, the role of Project Company shall become to supervise and monitor everything.

The arrangement of EPC contract shall be back-to-back with the requirements of Energy Purchase Agreement (EPA).

The Project Company personnel will supervise construction activities right from the beginning. The team will monitor construction schedule, owner's engineers and the EPC contractor to complete the project within given time frame and in-line with HSE guidelines.

The Project Company shall prepare a Construction Management Master Plan, which shall be the basis that shall take into account all relevant aspects. The master plan shall be regularly reviewed, updated and shared with all project stakeholders.

In order to properly manage all the above operations correctly, the Project Company shall have the services of a professional consultant or a consulting company to act as a "Construction Supervisor" which shall monitor the quality and progress of all contractors and give approvals of milestones.

15 O&M MANAGEMENT

After the project put into operation, the Project company will be responsible for O & M services. The plan is to develop a local team for O&M services, which will be employed and supervised by the project company.

Once the project put into operation, project company shall set up O&M team including 2 or 3 Chinese engineers and dozens of local engineers to monitor whole system and coordinate with local electrical power company. The job of cleaning the modules shall hire other local works or appoint local company to do, cleaning frequency every month shall be decided based on the dirty status of the modules.

16 INITIAL ENVIRONMENT EXAMINATION

This study of Initial Environmental Examination (IEE) of 100MW solar PV feasibility is conducted by Renewable Resources (Pvt.) Ltd and is attached at Annexure 3.

The report is prepared as requirement of Government of Pakistan for the development of all power projects and as per guidelines published by Pakistan Environmental Protection Agency (Pak-EPA), guidelines followed by Asian Development Bank, World Bank guidelines as well as the best practices followed at international level.

The summary of report is presented in this section; however detailed report is submitted to concerned authorities for approval.

A solar PV plant will occupy a significant area, about 650 Acres, and unless it is well-shielded, it is likely to be a prominent visual feature.

While the solar technology itself is considered to be relatively benign, it is likely to require consideration of similar environmental issues as a small gas-fired power station and the issues raised by the large land area required. Some specific issues to be considered are area required for the solar field and the consequent impacts on visual amenity and local flora and fauna; reflections from the solar field.

However, further consideration will be given to the impacts on any residences, facilities and transport within line of sight of the reflector field.

The highlights of the study are given below:

16.1 OVERVIEW

A detailed Initial Environmental Examination (IEE) of the project is conducted for approval from the concerned Environmental Protection Agency of Pakistan. This chapter is a summary IEE of 100MW solar power project.

This chapter presents the results and conclusion of environmental assessment of Layyah, Chaubara, Multan and Muzaffargarh which are in near vicinity to the project site for the installing of 100 MW solar power project. The study was conducted by Renewable Resources Pvt. Ltd.

16.2 REQUIREMENT OF ENVIRONMENTAL ASSESSMENT

Under GoP regulation, the Pakistan Environmental protection agency review of initial environmental examination and environmental impact assessment regulation (2000) categorize development projects in two schedules according to their potential environmental impacts. The proponents of the project that have to reasonably foreseeable impacts are required to submit an IEE for their respective project (schedule I). This 100 MW solar power project has no adverse environmental impacts (Schedule I) and required to submit IEE.

16.3 SCOPE OF THE IEE STUDY

The study was conducted using standard methodology prescribes by national and international agencies. The IEE comprises of baseline data on existing conditions on physical and biological environment, and social environment together with the anticipated environmental impacts and proposed mitigation measures. Detailed assessment of the social and biological environment of the area was conducted through field survey for the distance up to 10 Km radius of the project site, however the influence zone of the environmental impacts is considered as 5 Km.

Data was also collected through secondary sources such as published literature and internet to support the findings of the field survey.

The present document reports the finding of Initial Environmental Examination (IEE) carried out to identify potential environmental issues associates with the project and ensures appropriate mitigation measures to cope with those issues.
The IEE report stands on following strings:

- Relevant Project Information
- Project Alternatives
- Baseline Environmental Conditions
- Possible Impacts
- Mitigation Measures
- Environment Management Plan

16.4 DESCRIPTION OF THE PROJECT

Type and category of project

- 100 Mega Watt Solar power project, Renewable energy, Schedule B.

16.5 OBJECTIVE OF THE PROJECT

The objectives of the project are;

i. To promote solar PV technology in Pakistan
ii. By using indigenous renewable resources of power generation, avoid depletion of natural resources for future generation and environmental stability.
iii. Contribute to improved electricity supply service delivery to a limited extent specifically having a wide rural outreach.
iv. Improve microeconomic efficiency of the power sector by reducing fossil fuel usage.
v. Reduce greenhouse gas emissions from power generation and contribute to negligible emission, effluent, and solid waste intensity of power generation in the system.
vi. Conserve natural resources including land, forests, minerals, water, and ecosystems.
vii. Develop the local economy and create employment, particularly in rural areas and in a district that is designated a backward area, a priority concern of the Government of Pakistan.

16.6 ALTERNATIVES CONSIDERED

Project alternative fuels and "with and without" Project consequences are also discussed.

16.7 DESCRIPTION OF ENVIRONMENT

The Project Site is acquired in Rakh Chaubara, District Layyah-Punjab. The project site is located around 60 Kilometers away from Layyah city.

The total land area for the implementation of 100 MW Solar PV project is about 650 acres and the land is leased by the Government of Punjab to the project owners. Layyah is one of the oldest cities of Pakistan and is located at 60 km away from project site. Layyah is a part of Thal Desert and it is situated on the left bank of Indus River. Layyah is considered a backward and undeveloped district of Pakistan.

Basti Malana is located near the project site which is visited to get the environmental and social baseiine information. An Area of 5 Km from the project site is considered as influence zone and hence it has been taken as study area during site survey and collection of primary and secondary environmental and social data.

Layyah has extremes of climate; the summer season begins from April and continues till October. June and July is the hottest month in Layyah with its average high temperatures at 34.8°C. The coldest month is January with average highs at 11.1°C. The average high temperatures rise to 34.8°C here in Jun and fall to 25.2 °C with an average 21 mm of rainfall. Layyah has 8.3 hours of sunshine daily on average. The mean maximum and minimum temperatures for the coldest month are 12 and 5 degree Celsius respectively. Rainfall Towards the end of June monsoon conditions appear and during the following two months the rainy season alternates with humid weather. The winter rain falls during December, January and February ranging from 18 to 21 millimeters.

Flora of the district has been greatly modified by human agency of the old open forests of small trees and shrubs; there remains only a few Rakhs or portions of forest which are kept as gazing ground for cattle etc. Amongst trees the most important are Kikar (Acacia Nilotica), Shisham or Tahli (Dalbergia sissoo), Sharin (Albizzia lebbek, Dharek (Malia azerdaracb), Phulahi (Acacia modesta), and Bair (Zizyphus Mauritiana), Frash (Tamasix Aphylla), Pillu (Salvadora Oleoides) are planted for shade.

Jackal is the only wild animals of any importance. The former being met with occasionally in the low land wastes of Chaubara Tehsil but jackal are found everywhere.

16.8 PHYSICAL RESOURCES

16.8.1 Topography and Geology

Topographically speaking, District Layyah is situated in Southern Punjab, Pakistan, on the eastern bank of River Sindh (River Indus), which runs from north to south. Its topography comprises sand dunes that are sparingly dotted with wild bushes. Owing to scanty rainfall the vast expanse of land remains largely uncultivated, but the banks of the river are lined with forest and vegetation. Some areas have been made cultivatable by means of canals and tube wells. The Chaubara tehsil is almost barren and consists of forest and sand dunes. It is a 'Rakh' under the control of the Forest Department.

The water level in this area is higher than in the upland. The soil is sandy. The upland is flat plains sloping from north-west to south-west. The general height of the area is from 150 to 180 meters above the sea level.

16.8.2 Soil

In general, subsurface stratigraphy at the site consists of three basic litho logical units as given below:
a) Lean Clay/Silty Clay
b) Sandy Silt/Silt
c) Silty fine Sand/fine Sand

The soil is alluvial with sandy textured sand dunes covering 50 to 60 percent of the area. These soils are the alluvial deposits of the recent geologic times. The subsurface stratigraphy is as discussed below:
a) The first soil unit of brown silty clay/lean clay forms the topsoil cover at the site at all the locations and generally continues to a depth of 1 .0 m-3.5m below top of ground. This stratum contains trace fine sand and trace to little concretions at places. It is present in a soft to a stiff state of consistency and has low to medium plasticity.

b) The second soil unit of brownish grey sandy silt/silt underlies the upper silty clay/ lean clay stratum. This layer has a thickness of 1.0 to 3.0m and is present in a firm state.

c) The third soil unit of brownish grey non-plastic fine silty sand underlies the silt/silty sand stratum. It is present in a loose to medium-dense state.

The average water table in Basti Malana is 25-30 feet. The water of shallow wells present in the expansion areas contains higher values of TDS and therefore is not suitable for human consumption. The normal quality of water in the town is having TDS value of about 2220 mg/l.
The depth of water table is also depleting over the period. Due to increased number of private tube wells being installed in the location of sub project, the ground water is depleting. Recharge from surface /rain water is helping in reduction of depth of sub soil water table. During dry periods, the situation sometimes becomes quite serious.

16.8.3 Climate

Layyah has extremes of climate; the summer season begins from April and continues till October. June and July is the hottest month in Layyah with its average high temperatures at 34.8°C. The coldest month is January with average highs at 11.1°C. The average high temperatures rise to 34.8°C here in Jun and fall to 25.2 °C with an average 21 mm of rainfall. Layyah has 8.3 hours of sunshine daily on average. The mean maximum and minimum temperatures for the coldest month are 12 and 5 degree Celsius respectively. Rainfall Towards the end of June monsoon conditions appear and during the following two months the rainy season alternates with humid weather. The winter rain falls during December, January and February ranging from 18 to 21 millimeters.

16.8.4 Water

The present main source of water supply system in the villages near the site is through the wells which are 25 to 30 meters deep.

16.8.5 Biodiversity

Jackal is the only wild animals of any importance. The former being met with occasionally in the low land wastes of Chaubara Tehsil but jackal are found everywhere.

16.8.6 Forest

Flora of the district has been greatly modified by human agency of the old open forests of small trees and shrubs; there remains only a few Rakhs or portions of forest which are kept as gazing ground for cattle etc. Amongst trees the most important are Kikar (Acacia Nilotica), Shisham or Tahli (Dalbergia sissoo), Sharin (Albizzia lebbek, Dharek (Malia azerdaracb), Phulahi (Acacia modesta), and Bair (Zizyphus Mauritiana), Frash (Tamasix Aphylla), Pillu (Salvadora Oleoides) are planted for shade.
Layyah is famous for Kitchen use vegetables. While wheat, corn, MungBean, Channa, Bajra (Pennisetum Lyphoideum), Gawara (Cyamopsis Psoralides) and Jawar (Sorghum Vulgare) are famous field products. Cotton is also produced in very low quantity now. Major fruits are Citrus, Mango and Dates.

16.8.7 Human Settlement Patterns

Layyah is a district in the province of Punjab, Pakistan. This district was established in 1982. In 1901, Layyah was transferred to the new District of Mianwali. Later on, it was made part of the Muzaffargarh District. In 1982, Layyah Tehsil was upgraded to District headquarters comprising three Tehsils: Layyah, Karor and Chaubara.

District Layyah is situated in the south-west (rather west) of Punjab. In its north, lies the district Bhakkar while to its west flows River Indus. Across the river there is Dera Ghazi Khan which is also a district and division of Punjab. District of Jhang is located in the East and Muzafargarh is located in the south of district Layyah.

The Layyah has population growth rate of 3.10 % as per 1998 Population Census, which is quiet similar to the provincial average. The population of Layyah was 1,121,951(1.1 Million) individuals in 1998. The population near to the project site in Basti Malana was 450-500 peoples and in Basti Hafizabad was an about 80-100 person living approximately 02 kilometer away from the project site.

16.8.8 Socio Economic Conditions

Main occupation of the residents of Layyah district is agriculture. The agricultural area of District is 155,648 acres. The main crops grown in the district are Cotton, Gram, Wheat, Sugar cane and Guar seeds etc. Industries include Bricks Factories, Cold Storage, Cotton Ginning & Pressing, Flour Mills, and Sugar Mills. There is no significant industrial activity in the Layyah city and people mainly rely on agriculture and agriculture related activities. The land use pattern is characterized by almost entire residential and limited commercial activities in majority of the central area while institutional and commercial activities are located along main roads.

16.9 CONCLUSION

Prime benefit of the Project will be the replacement of conventional power generation with renewable energy. Solar energy will replace fossil fuel powered generation, and therefore reduce suspended particulate matter and greenhouse gas emissions into the atmosphere.

Impacts are manageable and can be managed cost effectively - Environmental impacts are likely to result from the proposed Power project. Careful mitigation and monitoring, specific selection criteria and review/assessment procedures have been specified to ensure that minimal impacts take place. The detailed design would ensure inclusion of any such environmental impacts that could not be specified or identified at this stage are taken into account and mitigated where necessary. Those impacts can be reduced through the use of mitigation measures such as correction in work practices at the construction sites, or through the careful selection of sites and access routes. Since proposed land is covered with shrubs, thus there is no need for removal for the construction of the Solar PV project.

The proposed project will have number of positive impacts and negligible negative impacts to the existing environment as follows:

- Significantly improvement in the economic activities in the surrounding areas due to generation of direct and indirect employment opportunities.
- The Project Area does not fall under any sensitive, protected area.
- No threatened / Near-Threatened species of wildlife was recorded in the Project Area.
- There is negligible removal of trees for the project, which is the main positive impact to the proposed project area.
- Environment pollution due to cut and fill operations, transportation of construction materials, disposal of debris, nuisance from dust, noise, vehicle fumes, black smoke, vibration are the short term negative impacts due to proposed project with mitigations being properly taken care.

LIST OF ANNEX

Annexure 1. **Country and Industry Profile**