GHARO SOLAR (PRIVATE) LIMITED

1485/C-2A, Asad Jan Road, Lahore Cantt. Ph: 042 36687823-24, Fax: 042 36687825

The Registrar
National Electric Power Regulatory Authority
Islamabad

Subject: **Application for Generation License for a 50 MWp Solar PV Plant by Gharo Solar (Private) Limited ("GSPL")**

Dear Sir,

I, Musaddiq Rahim, Company Secretary being the duly authorized representative of GSPL by virtue of board resolution dated December 18, 2017, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License, pursuant to Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 in the name of:

GHARO SOLAR (PRIVATE) LIMITED
Incorporated under the Companies Ordinance, 1984
Corporate Universal Identification No. 0100523, dated June 30, 2016
For its Solar PV power plant located near
Gharo, District Thatta, Sindh.
(Installed Capacity: 50MWp)

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 documents-in-support is true and correct to the best of my knowledge and belief.

A bank draft in sum of Rs. 306,064/-(Rupees Three lac six thousand and sixty-four only), being the nonrefundable license application fee calculated in accordance with the Schedule II to the National Electric Power Regulatory Authority (License and Modification Procedure) Regulations, 1999, is also attached herewith.

Date: December 26, 2017

GHARO SOLAR (PVT) LTD.

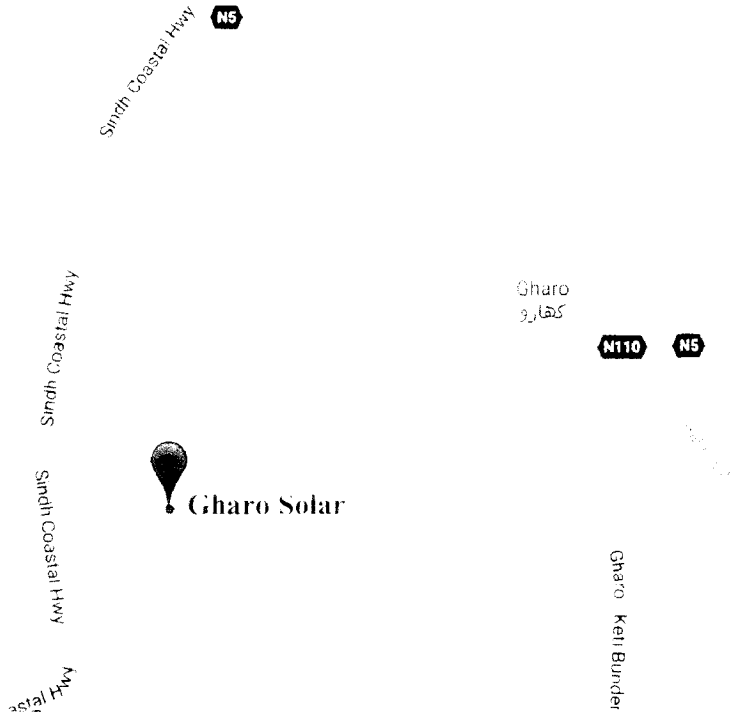
Musaddiq Rahim
Company Secretary

SCHEDULE-I

The Location, Size, Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facility/Solar Farm of the Licensee are described in this Schedule.

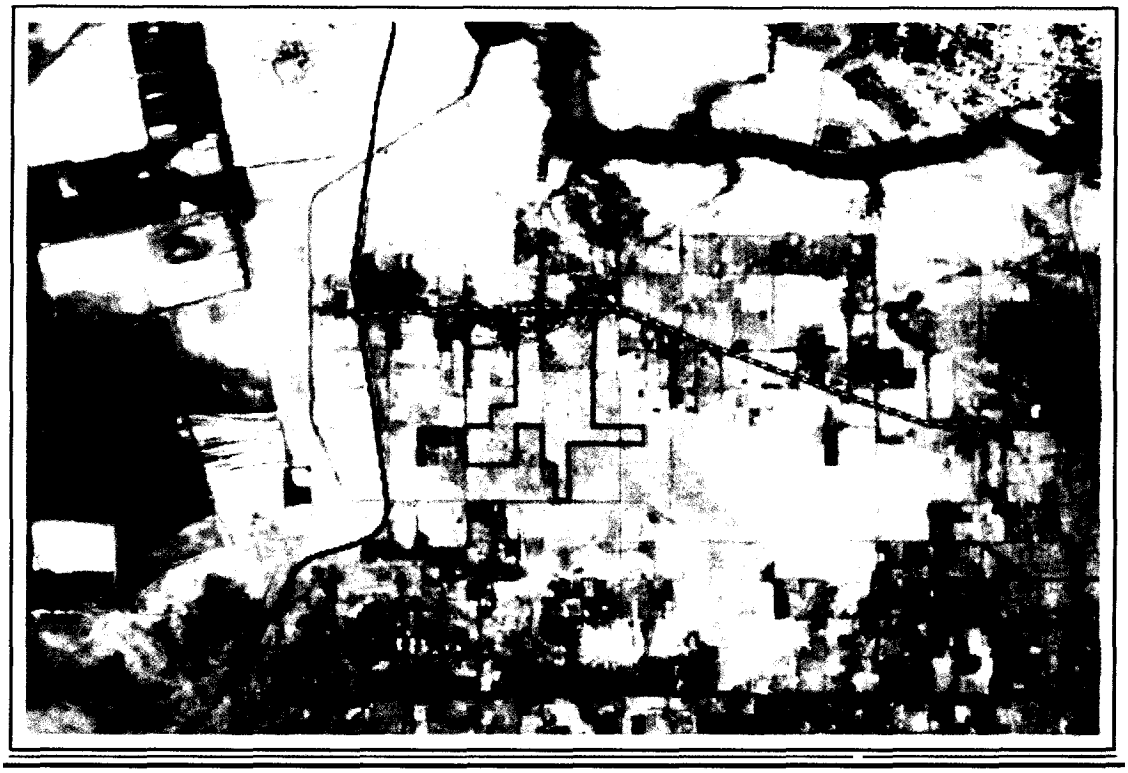
Location of the Generation Facility/Solar Power Plant/Solar Farm

The Project site is located at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh at approximately 6 km along the Sindh Coastal Highway and then 1.25 km via connecting road from the Highway.

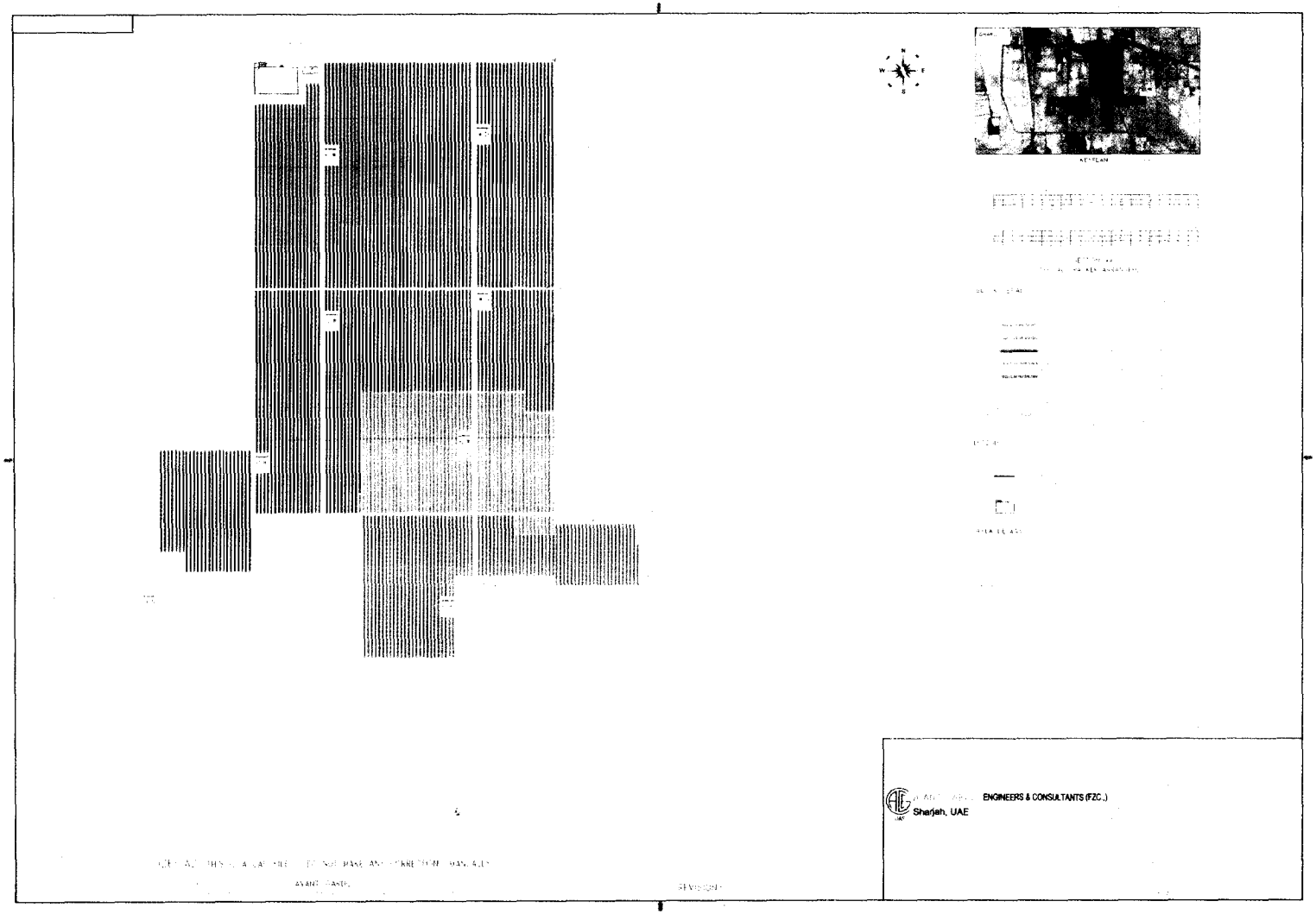


Location Coordinates of the Generation Facility/Solar Power Plant/Solar Farm

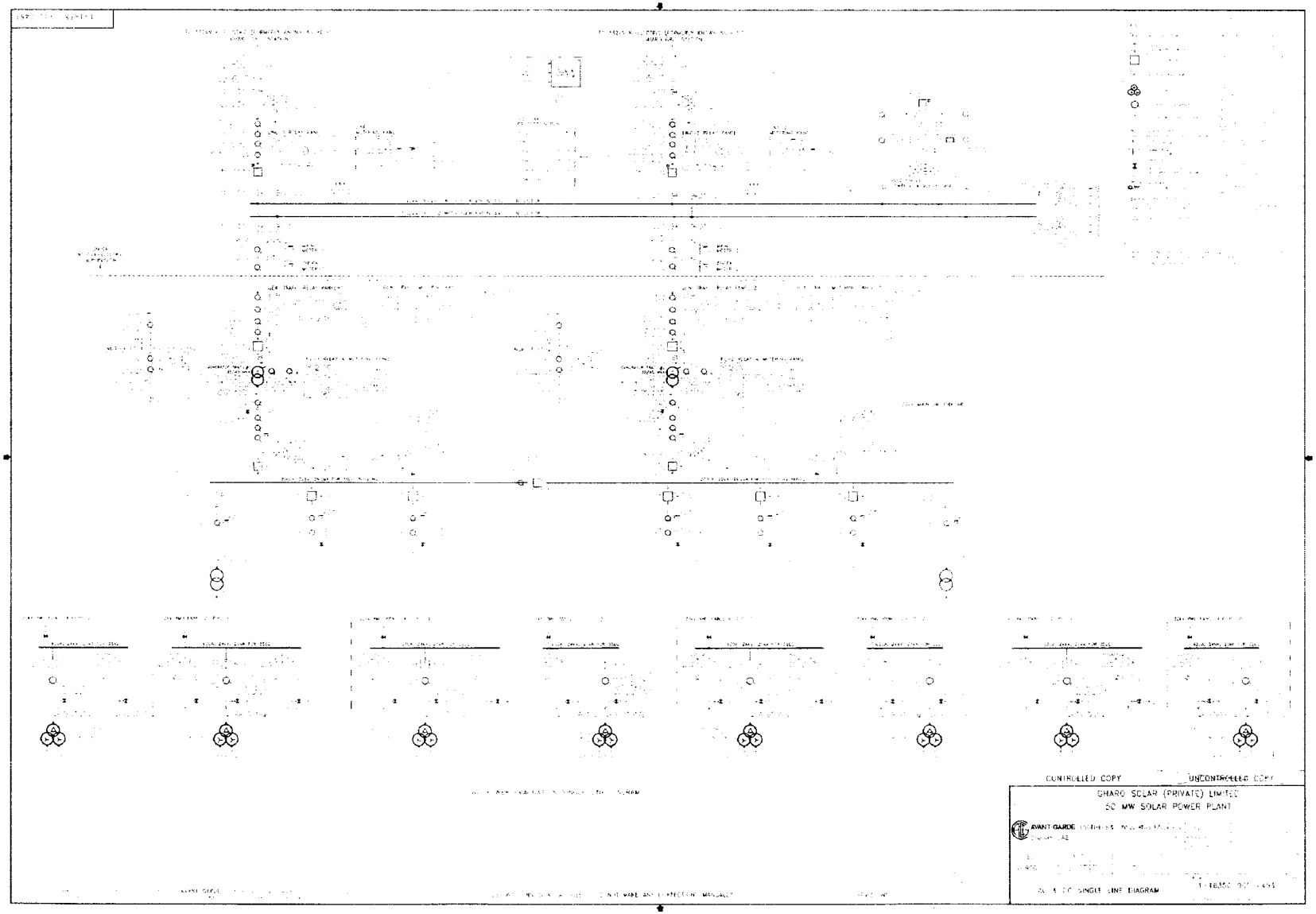
North	East
24°43'18.70"	67°33'6.83"



Layout of the Generation Facility/Solar Power Plant/Solar Farm



Single Line Diagram of Electrical Layout of the Generation Facility/Solar Power Plant/Solar Farm



Interconnection Arrangement / Transmission Facilities for Dispersal of Power from the Generation Facility / Solar Power Plant / Solar Farm of Gharo Solar (Private) Limited (GSPL)

The electric power generated from the Generation Facility/Power Plant/Solar Farm of GSPL shall be sold to K-Electric and dispersed to the load center of K-Electric.

(2). The proposed Interconnection Arrangement/Transmission Facility for dispersal of electric power for the Generation Facility/Solar Power Plant/Solar Farm comprises the following: -

132 kV double circuit (400 sq mm, Cu conductor) of about 0.7 km length to loop in-out the already planned Oursun Solar – Gharo single circuit located near the Gharo Solar Plant.

(3). Any change in the above Interconnection Arrangement/Transmission Facility duly agreed by GSPL and K-Electric, shall be communicated to the Authority in due course of time.

Details of Generation Facility/Solar Power Plant/Solar Farm

(A). General Information

(i).	Name of Company/ Licensee	Gharo Solar (Private) Limited
(ii).	Registered/Business Office	1485/C-2A, Asad Jan Road, Lahore Cantt.
(iii).	Plants Location	The proposed plant is located at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh
(iv).	Type of Generation Facility	Solar PV Power Plant

(B). Solar Power Generation Technology & Capacity

(i).	Type of Technology	Photovoltaic (PV) with single-axis tracking
(ii).	System Type	Grid Connected
(iii).	Installed Capacity of Solar Farm (MW)	50MWp

(C). Technical Details of Equipment

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	325Wp – Phono Solar or equivalent
(ii).	Type of Cell	Poly Crystalline
(iii).	Dimension of each Module	1956mmx992mm
(iv).	Module Surface Area	1.94 m^2
(v).	No. of Panels / Modules	154,224 Nos of 325Wp corresponding to 50 MWp
(vi).	Total Module Area	299249m^2
(vii).	Total Land Area Used	The proposed land is approx. 230 acres, out of which 216 acres will be utilized for installation of PV modules
(viii).	Panel's Frame	Anodised Aluminium Alloy

(ix).	Weight of one Module	24 kgs	
A(x).	Module Output Warranty	For 1st year	For 2nd to 25th year
		97% or above	Not more than 0.7% output reduction each year
(xi).	Number of Solar Cells in each Module	72 Cells	
(xii).	Efficiency of Module	16.70%	
(xiii).	Environment Protection System	Encapsulation and sealing arrangements for protection from environment	
(xiv).	Maximum Power (P_{max})	325 W	
(xv).	Voltage @ P_{max}	37.4V	
(xvi).	Current @ P_{max}	8.69A	
(xvii).	Open Circuit Voltage (V_{oc})	46.5V	
(xviii).	Short Circuit Current (I_{sc})	8.99A	
(xix).	Maximum System Open Circuit Voltage	1000V DC	
(b).	**PV Array**		
(i).	No. of Sub-Arrays	366/368 Strings per inverter	
(ii).	Modules in a String	21 Nos	
(iii).	Total No. of Strings	7344 Nos	
(iv).	Modules in Sub-Array	7,711 Nos	
(v).	Total No. of Modules	154,224 Nos	
(c).	**PV Capacity**		
(i).	Total	50.123MWp	
(d).	**Inverters**		
(i).	Capacity of each unit	2500 kW	
(ii).	Inverter Model	Central Inverter	
(iii).	Manufacturer	Sungrow	

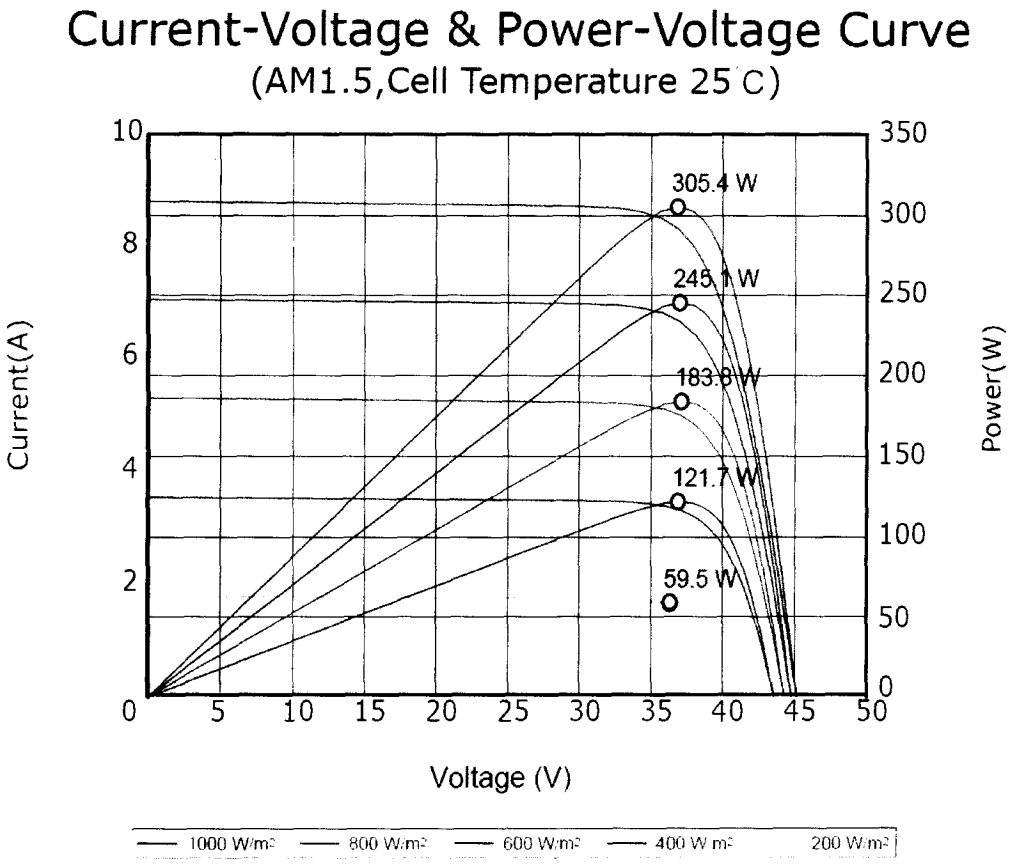
(iv).	Rated Input Voltage	1000V	
(v).	Input Operating Voltage Range	+/- 5%	
(vi).	Number of Inverters	Up to 20 Nos	
(vii)	Total Power	Up to 50.04 MW	
(viii).	Efficiency	99.0% / 98.7% (Euro Eff)	
(ix).	Max. Allowable Input voltage	520-540V	
(x).	Max. Input Current	4880 A	
(xi).	Max. Power Point Tracking Range	520-850V	
(xii).	Output electrical system	2500kW @ 50 Deg C	
(xiii).	Rated Output Voltage	360V	
(xiv).	Rated Frequency	50 Hz	
(xv).	Power Factor	Adjustable >0.99 (at nominal power)	
(xvi).	Power Control	Three Phase Control	
(xvii).	Environmental Enclosures	Protection	IP 54
		Dimension	2991*2591*2438mm
		Cooling Method	Forced Air Cooling
		Altitude	4500 M
		Compliance	CEA, IEC 62109, IEC 61727, IEC 62116, IEC 60068, IEC 61683, CE, G59/3
(xviii).	Grid Operation Protection	(a).	Ground Fault monitoring
		(b).	Grid monitoring
		(c).	Insulation monitoring
		(d).	DC reverse polarity
		(e).	AC & DC short circuit and over current
		(f).	AC & DC overvoltage and temperature
		(g).	Overheat protection

(e).	**Data Collecting System**		
(i).	Weather Data		Global horizontal irradiation pyranometer Tracking irradiation pyranometer Ambient Air Temperature Sensor PV Panel Temperature Sensor Anemometer Relative Humidity Rain Gauge
(ii).	System Data	(a).	DC input voltage(V) & current (A) of each Inverter (Phase, Line)
		(b).	Total DC power (kW) generated by PV array.
		(c).	AC output voltage (V) and current (A) of each Inverter (Phase, Total)
		(d).	AC output power (kW) and energy (kWh) of each Inverter
		(e).	Frequency (Hz)
		(f).	Power Factor (PF)
(f).	**Isolating Transformer**		
(i).	Rating		5500kVA
(ii).	Type of Transformer		Oil Cooled Type
(iii).	Configuration		Dual Secondary Converter Duty Type
(iv).	Output Voltage		22kV
(v).	Purpose of Transformer		For stepping up to intermediate voltage level of 22kV
(vi).	Efficiency		99%

(D). Other Details

(i).	CoD of the Project (Anticipated)	June 2019
(ii).	Expected Life of the Project from CoD	25 Years

V-I Curve of Solar Cell



SCHEDULE-II

The Total Installed Gross ISO Capacity of the Generation Facility/Power Plant/Solar Plant (MW), Total Annual Full Load (Hours), Average Sun Availability, Total Gross Generation of the Generation Facility/Solar Farm (in kWh), Annual Energy Generation (25 years Equivalent Net Annual Production-AEP) KWh and Net Capacity Factor of the Generation Facility/Power Plant/Solar Farm of Licensee is given in this Schedule.

SCHEDULE-II

(1).	Total PV Installed Capacity of Generation Facility	50.123 MWp
(2).	Days per Year	365
(3).	PV Plant Generating Capacity Annually	90,011 MWh
(4).	Expected Total Generation in 25 years Life Span	2,250,275 MWh
(5).	Generation per Year from plant keeping 24 Hours Working	50.123 x 24 x 365 = 439,078 MWh
(6).	Net Capacity Factor (4/6)	20.5%

Note

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

Annexure - 2

Account Payee Only

HBL HABIB BANK حبیب بینک 1242

CORPORATE CENTRE
102 103 UPPER MALL LAHORE

B.C. No. 18646730

Stationary No: 18646730

2	2	1	2	1	7

Pay to NATIONAL ELECTRIC POWER REGULATORY AUTHORITY or Order

PKR ********306,064.00

Rupees Three Hundred Six Thousand Sixty Four Only.

Payable at any HBL Branch in Pakistan
Centralised Cheque Payable Account
30019903902586

Please do not write below this line.

Signatory
PA No. 17595

Signatory
PA No. 13076

⑈18646730⑈ 054300⑆00300199039025866⑈010⑈

Annexure - 3

GHARO SOLAR (PRIVATE) LIMITED

1485/C-2A, Asad Jan Road, Lahore Cantt. Ph: 042 36687823-24, Fax: 042 36687825

CERTIFIED TRUE COPY OF THE RESOLUTION PASSED BY THE BOARD OF DIRECTORS OF GHARO SOLAR (PRIVATE) LIMITED IN MEETING HELD ON DECEMBER 18, 2017

"RESOLVED that Gharo Solar (Private) Limited (the "Company") shall apply to the National Electric Power Regulatory Authority ("NEPRA") for grant of generation licence to the Company for its 50 MWp solar PV power project at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh.

FURTHER RESOLVED that Mr. Rana Uzair Nasim, Chief Executive Officer and Mr. Musaddiq Rahim, Company Secretary, are hereby singly empowered and authorized on behalf of the Company to sign, verify, execute, institute and commence any applications, petitions, affidavits, guarantees or any other oral or written representations or statements, in order to obtain or revise the generation licence, tariff determination and any other necessary approvals and permits from NEPRA.

FURTHER RESOLVED that certified copies of this resolution be communicated and supplied to the concerned quarters as and when so demanded and shall remain in force until notice in writing to the contrary be given."

CERTIFIED TRUE COPY
For GHARO SOLAR (PRIVATE) LIMITED

Musaddiq Rahim
Company Secretary

GHARO SOLAR (PVT) LTD.

A021470

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. 0100523

I hereby certify that **GHARO SOLAR (PVT.) LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is **Limited by Shares**.

Given under my hand at **Lahore** this **Thirtieth** day of **June,** Two **Thousand** and **Sixteen**.

Fee Rs.**60,500/-**

(SHAUKAT HAMEED)
Joint Registrar

No.ARL/31413 DATED: 30/06/16

Annexure - 6

THE COMPANIES ORDINANCE, 1984

--: o: --

(PRIVATE COMPANY LIMITED BY SHARES)

--: o: --

Memorandum of Association

Of

GHARO SOLAR (PRIVATE) LIMITED

I. The name of the Company is **"GHARO SOLAR (PRIVATE) LIMITED"**.

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

III. The sole object of the Company is:-

1. To set up, own, manage, operate, and maintain solar power generation plant(s) anywhere in Pakistan and to carry on the business of electric power generation subject to permission from NEPRA/other regulatory authorities.

2. To achieve the above object, the Company shall be entitled:

a) To design, construct or acquire by way of outright purchase or financial or other lease(s) plant, machinery, equipment and services for setting up the said power plant(s) on turnkey basis or otherwise, under such arrangements, guarantees or warranties as may be considered appropriate.

b) To engage in transmission, distribution and sale of electric power to any entity in the public or private sector to perform all acts directly or indirectly related or incidental to the business of the Company permitted under law.

c) To self-consume or store the electricity generated by the Company.

d) To engage in activities required for compliance with environmental or other laws

e) To purchase, acquire or lease land and or buildings for the purpose of the Company or for other work considered necessary under relevant laws.

f) To borrow or raise money by means of loans or other financing arrangements from local and international banks or other financial institutions or from Directors, in such manner as the Company may think fit and in particular by issue of debentures, debenture-stock, perpetual or otherwise, convertible into shares and to mortgage, assign or charge the whole or any part of the property, rights, assets or revenue of the Company, present or future, by special assignment or to transfer or convey the same absolutely or in trust as may seem expedient and to purchase, redeem or pay off any such financing or securities.

g) To arrange local and foreign currency loans or financing from local and international scheduled banks, industrial banks and other financial institutions for the purpose of purchase and import of machinery, construction of plant, building, raw material and for working capital or for any other purpose of the Company.

h) To draw, accept, make, endorse, discount and negotiate promissory notes, bills of exchange, bills of lading and other negotiable instruments connected with the business of the Company.

i) To open, maintain and operate banking accounts of the Company with one or more banks and to deposit or withdraw money there from.

j) To distribute any of the properties of the Company amongst the members in specie or kind at the time of winding up.

k) To enter into contracts and arrangements of all kinds permitted by law including, without prejudice to the forgoing, contracts with suppliers and manufacturers of machinery, construction, procurement and engineering contractors, turnkey contractors, contractors for operation and maintenance of plant and machinery.

l) To approve and enter into schemes for joint venture agreements or amalgamation, merger and reorganization with such companies or other entities as may be considered appropriate or beneficial.

m) To support and subscribe to any charitable or public object including donations to charitable and benevolent foundations and any institution, society, or club or for any purpose which may be for the benefit of the Company or its employees or may be connected with or for the benefit and welfare of any town or place where the Company carries on business, to give pensions, gratuities or charitable aid to any persons who may have been directors of or may have served the Company, or the wives, children, or other relatives or dependents of such persons to make payments towards insurance, and to form and contribute to provident and benevolent funds for the benefit of any such persons, or of their wives, children or other relatives or dependents.

n) To establish, purchase, maintain and contribute to any pension, provident, gratuity, superannuation, retirement, redundancy, injury, death benefit or insurance funds, trusts, schemes, entities, or policies for the benefit of, and to give or procure the giving of pension, annuities, allowances, gratuities, donation, emoluments, benefits, of any description (whether in kind or otherwise), incentives, bonuses, assistance (whether financial or otherwise) and accommodation in such manner and on such terms as it thinks fit to, and to make payments for or towards the insurance of, any individuals who are or were at any time in the employment of, or directors or officers of (or held comparable or equivalent office in), or acted as consultants or advisers to or agents for, the Company or any company which is its holding company or is a subsidiary of the company or any such holding company.

o) To deal with the surplus monies of the Company not immediately required in such lawful form as may be thought expedient.

p) To enter into contracts or arrangements with any Government or Authority, Federal, Provincial, Municipal, Local or otherwise, public bodies or any corporations, companies or persons that may seem conducive to the Company's objects, or any of them and to obtain any licenses, permits, authorisations as may be required in this regard.

q) To advance money to staff members, customers and others having dealing with the Company, with or without security, upon such terms as may deem expedient not to act banking company.

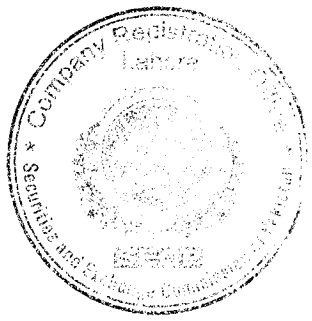
r) To pay for any property or rights acquired by the Company, either in cash or fully paid shares or by the issue of securities, or partly in one mode and partly in another and generally on such terms as may be determined.

3. It is declared that notwithstanding anything contained in the foregoing object clause of this Memorandum of Association nothing contained therein shall be construed as empowering the Company to undertake or to indulge in the business of banking leasing managing agency or insurance business directly or indirectly as restricted under law or to indulge in any other unlawful operations.

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

IV. The liability of the members is limited.

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



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

Name and Surname (present & Former) in Full (in Block Letters) and C.N.I.C	Father's/ Husband's Name (in Full)	Nationality with any former nationality	Occupation	Residential Address (in Full)	Number of Shares Taken by each sub-scriber	Signatures
RANA NASIM AHMED (35202-0464547-7)	Fakir Muhammad Khan	Pakistani	Business	76-B, Street 4, Phase V, DHA, Lahore.	900 Nine Hundred	
RANA UZAIR NASIM (35201-8925121-7)	Rana Nasim Ahmed	Pakistani	Business	76-B, Street 4, Phase V, DHA, Lahore.	100 One Hundred	
				Total Number of Shares Taken	1,000 One Thousand	

Dated this Tuesday the 28 day of June, 2016

Witness to the above signatures:

Full Name: NATIONAL INSTITUTIONAL FACILITATION TECHNOLOGIES (PVT.) LTD.

Full Address: 5TH FLOOR AWT PLAZA I. I. CHUNDRIGAR ROAD, KARACHI.

THE COMPANIES ORDINANCE, 1984

(Private Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF

GHARO SOLAR (PRIVATE) LIMITED

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

PRIVATE COMPANY

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

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

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

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

TRANSFER OF SHARES

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

DIRECTORS

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

1. MR. RANA NASIM AHMED
2. MR. RANA UZAIR NASIM

We, the several persons whose names and addresses are subscribed below, 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 as set opposite to our respective names.

Name and Surname (present & Former) in Full (in Block Letters) and C.N.I.C	Father's/ Husband's Name (in Full)	Nationality with any former nationality	Occupation	Residential Address (in Full)	Number of Shares Taken by each sub-scriber	Signatures
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Annexure - 7

Company Profile

Project Company

The generation facility is being developed by Gharo Solar (Pvt.) Limited (the "GSPL"), a private limited company incorporated under the Companies Ordinance, 1984 for the purpose of setting up, owning and operating the planned 50 MWp solar power project as an independent power producer (IPP).

Project Sponsors

The Project sponsors have a strong track record of development, EPC and O&M of approximately 1,000 MW of projects spanning every major renewable technology in various stages of development across multiple countries. The key sponsors include:

- ***Rana Nasim Ahmed***

Mr. Ahmed is the main sponsor of GSPL. He is the Chief Operating Officer of JDW Sugar Mills Limited. He has helped transform JDW into one of the largest sugar sector enterprises in Pakistan and has spearheaded high-pressure cogeneration by leading the first-ever 53 MW biomass projects on the country's feed-in tariff. He is also the main sponsor of the 18 MWp Harappa Solar Project, which is the first private sector solar IPP in Pakistan and also first with single-axis tracking. He is sponsoring the Project in his personal capacity.

- ***Windforce (Private) Limited***

Windforce is a pioneering Sri Lankan renewable energy generation company. It was the first to introduce state-of-the-art wind power plants in Sri Lanka in 2010. Windforce also owns and operates a portfolio of solar and small hydro projects. Windforce has a very experienced development team along with in-house engineering and project management expertise. The shareholders of Windforce include several prominent business conglomerates of Sri Lanka.

- ***Norsk Solar AS***

Norsk Solar is a Norwegian developer and financier of solar PV parks with a long-term Build-Own-Operate strategy. The company is a subsidiary of the NV Group, which is the largest private developer of wind parks in Norway with a proven track record, expertise and network of established partners. The group has a combined pipeline of 700 MW in renewable energy projects across different geographies.

GSPL shareholders may be added or revised in due course as the project progresses further.

Gharo Solar (Private) Limited

50 MWp Solar Photovoltaic (PV) Power Project
Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh

Feasibility Study

December 2017

Table of Contents

1 Project Background

Gharo Solar (Private) Limited (**"GSPL"**) is a special purpose company incorporated under the Companies Ordinance of 1984 for the purpose of setting up a green field 50 MWp solar photovoltaic (PV) power plant (**"the Project"**). The Project shall be located at Deh Ghariabad, Mirpur Sakro, District Thatta, Sindh at approximately 6km along the Sindh Coastal Highway.

GSPL was issued a Letter of Intent (**"LOI"**) by K-Electric (**"KE"**) for initial development of the planned 50MWp solar PV power plant on July 1, 2016 and subsequently executed a term sheet with KE for continued development of the proposed project on November 10, 2016. GSPL will next execute an Energy Purchase Agreement with KE upon filing for regulatory pre-requisites including determination of Tariff and issuance of Generation License by the National Electric Power Regulatory Authority. The Project shall supply much-needed, affordable renewable energy to KE's grid network spanning Karachi and surrounding areas of Sindh and Balochistan and shall enable continue the process of diversification of its sponsors into the power sector.

The Project sponsors have a strong track record of development, EPC and O&M of approximately 1,000 MW of projects spanning every major renewable technology in various stages of development across multiple countries. The key sponsors include:

Rana Nasim Ahmed

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GSPL shareholders may be added or revised in due course as the project progresses further.

The objective of this feasibility study ("Feasibility") is to assist GSPL in assessing the technical and financial viability of the Project.

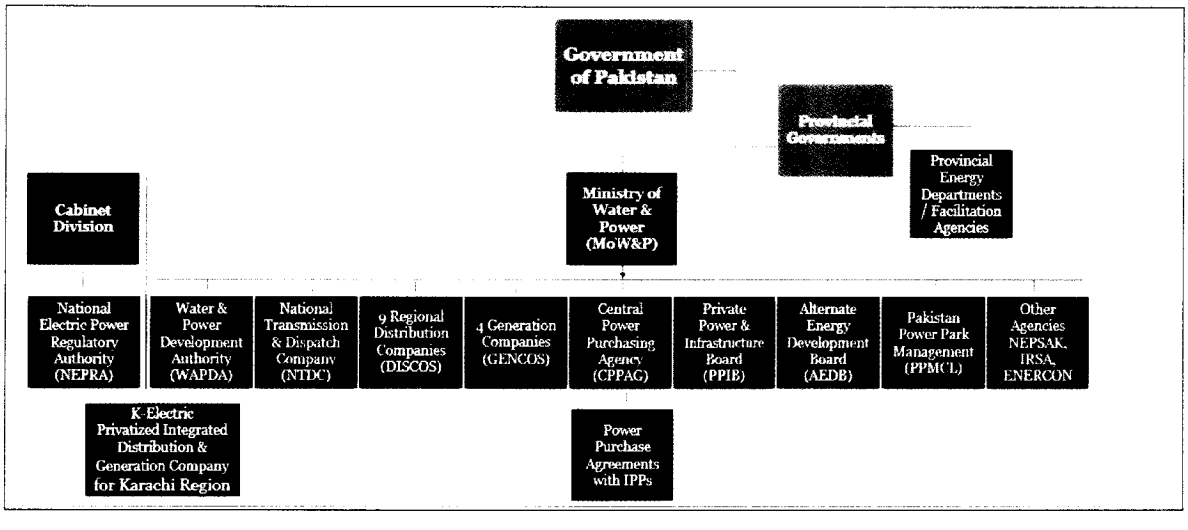
2 Power Market

2.1 Structure of Power Sector in Pakistan

Historically, the power sector in Pakistan has been owned and operated by government entities, primarily the Water and Power Development Authority ("WAPDA") until the drive to unbundle started in the early 1990s. Since then the sector has evolved much with private sector involvement primarily in generation and more recently on the model of a fully vertically integrated utility company. The generation, transmission, distribution and retail supply of electricity in Pakistan is presently undertaken by a number of public and private sector entities comprising of one (1) national transmission company; nine (9) regional public sector-owned distribution companies; four (4) public sector thermal generation companies; one (1) public sector hydropower generation company and many Independent Power Producers ("IPPs"). These entities enable the supply of power to the entire country except for Karachi. The metropolitan city of Karachi and some of its surrounding areas are supplied power by K-Electric, which is the only vertically integrated utility owned by the private sector responsible for the generation, transmission and distribution of electricity in its region.

More recently CPPA, previously residing within NTDC, has been converted into a legal, independent body acting as a central counterparty to power purchase transactions. The present form of the power structure in Pakistan is presented below:

Table 1: Pakistan Power Sector Structure



2.2 Electricity Generation

The total installed capacity of the entire country in 2016 was 25,374 MW, of which 16,619 MW (65.50%) was thermal, 7,116 (28.04%) was hydroelectric, 787 MW (3.10%) was nuclear and 852 MW (3.35%) was renewable energy.

Table 1: Pakistan Power Generation Capacity

As on 30th June	2011	2012	2013	2014	2015	2016
Thermal	15,910	15,969	15,941	15,693	16,619	16,619
Hydropower	6,645	6,730	6,947	7,116	7,116	7,116
Nuclear	787	787	787	787	787	787
Renewables	0	1	50	106	439	852
Total	23,342	23,487	23,725	23,702	24,961	25,374

All figures in MW; Source: NEPRA State of Industry Report, 2016

Historically, Pakistan has relied on hydropower generation to meet its electricity demands, as the ratio of hydel to thermal installed generation capacity in the country in 1985 was about 67% to 33%. However, with the passage of time, the energy mix has shifted towards thermal power generation, which now generates approximately 65% of total power produced in the country. Electrical energy generated in recent years by fuel type is presented in the table below:

Table 2: Pakistan Energy Generation by Source

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Thermal	65,169	64,478	64,034	68,073	69,719	71,215
% Share	*64.79*	*65.94*	*64.91*	*64.40*	*64.01*	*63.59*
Hydel	31,990	28,643	30,033	32,239	32,594	34,544
% Share	*31.80*	*28.85*	*30.44*	*30.50*	*29.93*	*30.85*
Nuclear	3,220	4,872	4,181	4,695	5,349	4,216
% Share	*3.11*	*4.91*	*4.24*	*4.44*	*4.91*	*3.76*
Import	295	296	375	419	443	463
% Share	*0.29*	*0.30*	*0.38*	*0.40*	*0.41*	*0.41*
Renewables	0	6	32	272	811	1,549
% Share	*0.00*	*0.01*	*0.03*	*0.26*	*0.74*	*1.38*
Total	100,584	99,295	98,655	105,698	108,916	111,997

All figures in GWh; Source: NEPRA State of Industry Report, 2016

Given the acute gas shortage in the country, thermal generation has relied mostly on expensive fuels such as Furnace Oil and High Speed Diesel. Increased dependence on expensive thermal fuel sources has not only led to high cost of generation but has also resulted in large amounts of foreign reserves to be spent on the import of fuel. Thermal generation breakdown in the country in recent years is given in the table below:

Table 3: Pakistan Energy Generation by Source (Thermal Fuel Mix)

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Gas	37,076	30,162	28,190	30,769	31,196	27,289
% share of thermal generation	*56.89*	*46.06*	*44.02*	*45.19*	*44.57*	*44.93*
FO + HSD	27,984	35,250	35,804	37,201	38,690	33,296
% share of thermal generation	*42.94*	*53.83*	*55.91*	*54.64*	*55.28*	*54.82*
Coal	109	66	40	112	102	148
% share of thermal generation	*0.17*	*0.10*	*0.06*	*0.16*	*0.15*	*0.24*
Total	65,169	65,478	64,034	68,082	69,988	60,733

All figures in GWh; Source: PSS/NTDC/KE

Due to this skewed energy mix, it has now become imperative upon the power sector in Pakistan to move towards generation technologies that are sustainable and rely on indigenous resources.

2.3 Demand and Supply of Electricity

For the past decade or so, Pakistan has been suffering from an acute energy crisis due to rising demand exacerbated by structural flaws within the sector. Some of the major reasons contributing to this crisis include:

1. Inefficient transmission and distribution
2. Increasing demand due to growing population and industrialization
3. Inadequate focus on energy efficiency measures
4. Expensive energy mix based on imported fuels and
5. Outdated generation plants in public sector.

Generation capability in the NTDC system grew at an average rate of 10% during the period 2012-2016. However, this increase in capability has been unable to meet the demand of electricity leading to a demand-supply gap, which peaked at 6,620 MW during 2012. In 2016, the maximum generation capability remained at 17,261 MW, while the maximum peak demand reached 22,559 MW, resulting in a 5,298 MW gap between supply and demand. Projections by government agencies depict that this shortfall is not going to end till 2018. The tables below show the actual and projected surplus/deficit in demand during system peak hours:

Table 4: Historical Power Supply and Demand in NTDC system

Year	Generation Capability	Peak Demand	Surplus/(Deficit)
2012	12,320	18,940	(6,620)
2013	14,600	18,827	(4,227)
2014	16,170	20,576	(4,406)
2015	16,500	21,701	(5,201)
2016	17,261	22,559	(5,298)

All figures in MW; Source: NEPRA State of Industry Report, 2016

Table 4.1: Projected Power Supply and Demand in NTDC System

Year	Planned Generation Capability	Projected Peak Demand	Surplus/(Deficit)
2017	20,106	23,816	(3,710)
2018	24,640	25,140	(500)
2019	26,663	26,439	224
2020	29,059	27,725	1,334
2021	33,776	29,082	4,694

All figures in MW; Source: NEPRA State of Industry Report, 2016

Within the KE system, the demand and supply gap is not as pronounced as compared to the deficit prevailing in the NTDC system. The following tables highlights KE's historic demand and supply gap and projected figures for the near future.

Table 5: Historical Power Supply and Demand of K-Electric System

Year	Generation Capability	Peak Demand	Surplus/(Deficit)
2012	2,163	2,596	(433)
2013	2,246	2,778	(532)
2014	2,601	2,929	(328)
2015	2,632	3,056	(424)
2016	2,860	3,195	(335)

All figures in MW; Source: NEPRA State of Industry Report, 2016

Table 5.1: Projected Power Supply and Demand in K-Electric System

Year	Planned Generation Capability	Projected Peak Demand	Surplus/(Deficit)
2017	3,128	3,359	(231)
2018	3,666	3,528	138
2019	4,146	3,699	447
2020	5,726	3,894	1,832

Shortage of electricity has become the most critical challenge by not only causing social disruption, but also affecting the economic growth of the country. According to estimates, energy shortages in the country have resulted in approximately 2% reduction in the annual GDP of the country. Therefore, resolving the energy crisis is amongst the top priorities of the government and steps are being taken to attract new investment in the power sector. Moreover, steps are being taken to optimize the generation mix by adding renewable and indigenous energy sources.

2.4 Key Organizations

2.4.1 National Electric Power Regulatory Authority ("NEPRA")

In order to promote fair competition in the industry and to protect the rights of consumers as well as producers/sellers of electricity, the GOP enacted the Regulation of Generation, Transmission and Distribution of Electric Power Regulation Act, 1997 ("NEPRA Act"). Under this Act, the

NEPRA Policy for Power Generation Projects was established for regulating electric power generation, transmission and distribution in Pakistan. In performing its functions under this Act, NEPRA is required to, as far as reasonably possible, protect the interests of consumers and companies providing electric power services in accordance with the guidelines laid down by the government. NEPRA's role in the power business, inter alia, is to issue tariffs and licenses for companies and to regulate their operations according to NEPRA rules and regulations. The prospective applicant will be required to comply with relevant NEPRA rules/procedures while setting up and operating the project.

2.4.2 K-Electric ("KE")

Formerly known as Karachi Electric Supply Company Limited, the organization was established over a hundred years ago and is an integral part of one of the world's most populous cities. In 2009, The Abraaj Group acquired a controlling stake in KES Power Limited, the majority shareholder, beginning a turnaround which has thus far seen investments of over USD 1.4 billion. K-Electric Limited caters to the city's 6,500 square kilometres and supplies electricity to all the industrial, commercial, agricultural and residential areas that come under its network. The organization has over 2.5 million customer accounts in Karachi, Dhabeji and Gharo in Sindh, and Hub, Uthal, Vindar and Bela in Balochistan. K- Electric is the only vertically-integrated power utility in Pakistan, managing all three key stages – generation, transmission and distribution – of producing and delivering energy to consumers of Karachi and adjoining areas.

3 Applicable Framework & Policy

GSPL is a special purpose company incorporated for the purpose of setting up, owning and operating a 50 MWp Solar PV power project near Gharo, District Thatta, Sindh. GSPL intends to sell and KE intends to purchase the electricity generated by the Project, in pursuance of which KE has issued a Letter of Intent dated 1 July 2016 (the "LOI") to GSPL.

Subsequently, GSPL and KE executed a term sheet dated 10th November 2016 (the "Term Sheet") extended vide addendum dated 11th November 2017, setting out the terms and conditions agreed between the parties in relation to the energy purchase agreement. The Term Sheet provides, inter alia, that the parties may opt for the upfront tariff or a negotiated tariff to be approved by NEPRA.

Since NEPRA has discontinued Upfront Tariff regime, GSPL took the initiative of submitting an innovative and competitive tariff petition to NEPRA, which is in final stages of processing. The determined tariff is expected to be one of the lowest in Pakistan for any renewable or thermal technology and shall help reduce KE's power procurement cost.

The determined Tariff shall be valid for 25 years. GSPL shall benefit from fiscal benefits available to IPPs such as exemption from corporate tax on profits, reducing rate of tax on dividends and concessionary rates of duties and taxes available to solar equipment.

KE, as part of its Climate Change Policy, is encouraging renewable energy projects in its licensed territory. GSPL is one of the few companies to have been awarded an LOI by KE in this regard and benefits from having various grid planning, permitting and power purchase functions integrated in a single privately-owned counterparty. In turn, the 50 MWp Gharo Solar Project

helps fulfil KE's imperative of augmenting generation at competitive rates from indigenous and environmentally friendly resources.

4 Solar Power

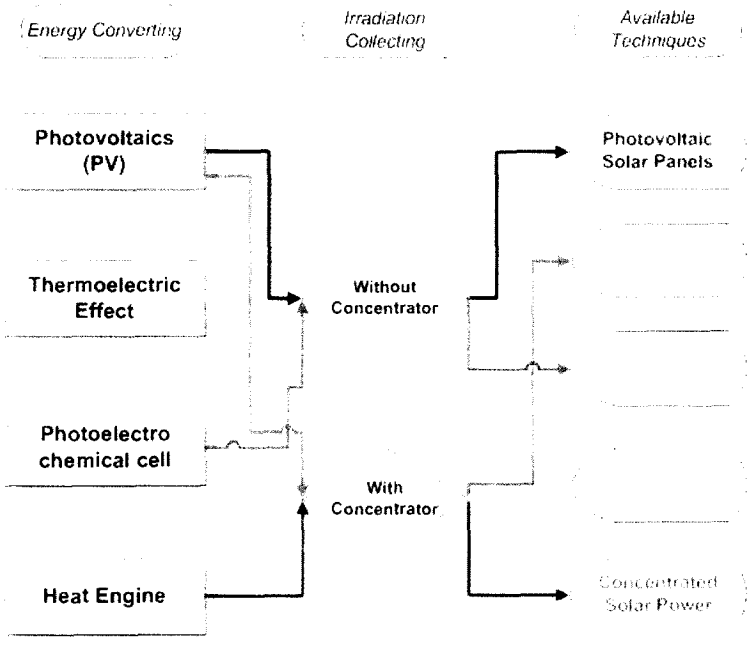
4.1 Solar PV Power Generation

With the increase in awareness of hazards linked to use of fossil fuels as a source of electricity generation, the shift towards alternative and renewable energy sources like wind energy, bio fuels and solar power is becoming essential. Solar energy is the most abundant source of renewable energy on earth.

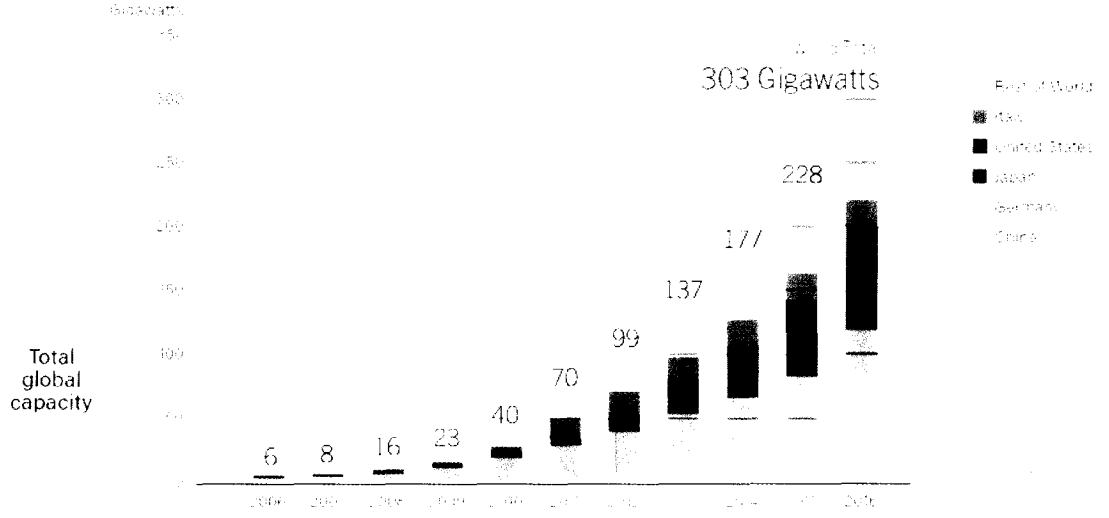
Generally, entire Pakistan has a high potential for solar energy. The annual average horizontal solar irradiation per day in these areas is more than 4.5 kWh/Sq.M. Acute electricity shortage in the country coupled with high solar irradiation in most parts of the country with enough available space provides high opportunity for solar power generation system.

With the downward trend in the cost of solar energy and appreciation for the need of development of solar power, grid-connected solar power projects have recently been implemented in various countries through policy measures such as feed-in tariffs, solar mandates, renewable energy certificates etc.

Theoretically, there are various possible technologies for harnessing solar energy, which are depicted in the diagram below. However, solar photovoltaic (PV) is by far the most commercialized and dominant technology with approximately 97.5% share of total solar sector.



The global installed capacity of solar PV has shown a remarkable increase over the last decade from 6 GW in 2006 to 303 GW in 2016. The initial growth was spurred by Germany whereas in recent years China, United States, India and other developing countries have shown rapid growth. The following chart depicts the global solar PV capacity over the years.



4.2 Project Site and Location

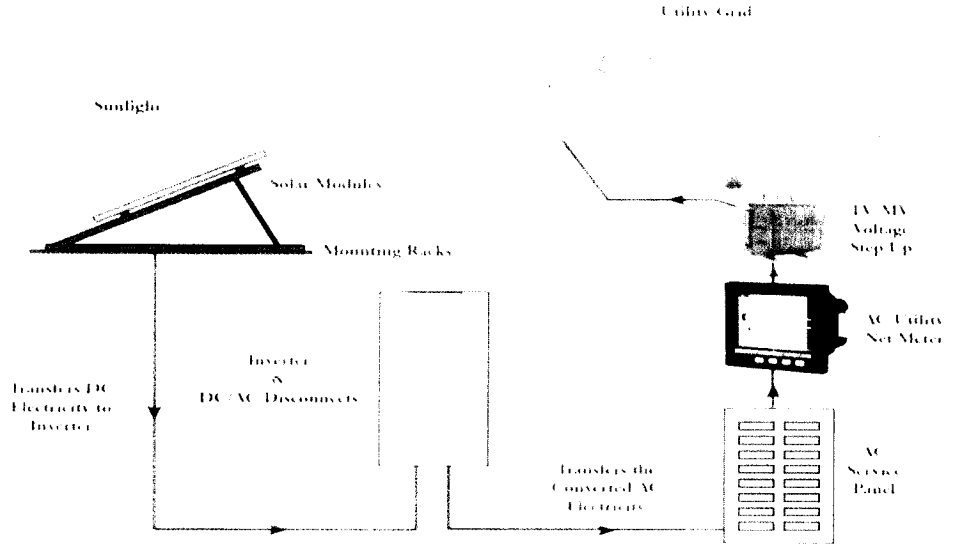
The Project Site is located near the town of Gharo at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh approximately 6 km along the Sindh Coastal Highway and then approximately 1.25 km via connecting road from the Highway. The Site is about 55 km away from Jinnah International Airport, Karachi and is adjacent to the upcoming 50 MW Oursun Solar power plant.

The location map of the Project site map is given below and layout has been attached as Annexure 1:

5 Plant Type and Technology

5.1 General Design

Solar PV plants can be designed for any capacity right from a fraction of kW rating for roof top installation to hundreds of MW capacity for ground mounted plants by repeating modular blocks. The schematic below depicts the typical configuration of a utility-scale solar plant.



Major components of utility-scale systems are:

- Solar Modules / Panels
- Module Mounting Structures (fixed or tracking)
- Solar Inverters
- Balance of Systems (BoS) comprising of
  - DC Cables
  - String Combiner Boxes
  - AC Cables
  - Transformers
  - HT Panels / RMU units
  - SCADA & Monitoring System
  - Earthing system
  - Illumination system
  - Module cleaning system
  - AC / Ventilation System for inverter rooms
- Civil works including foundations, inverter rooms, leveling, grading, fencing, etc.
- Power evacuation system including step-up transformers, switchyard, tariff metering arrangement, transmission line system, etc.

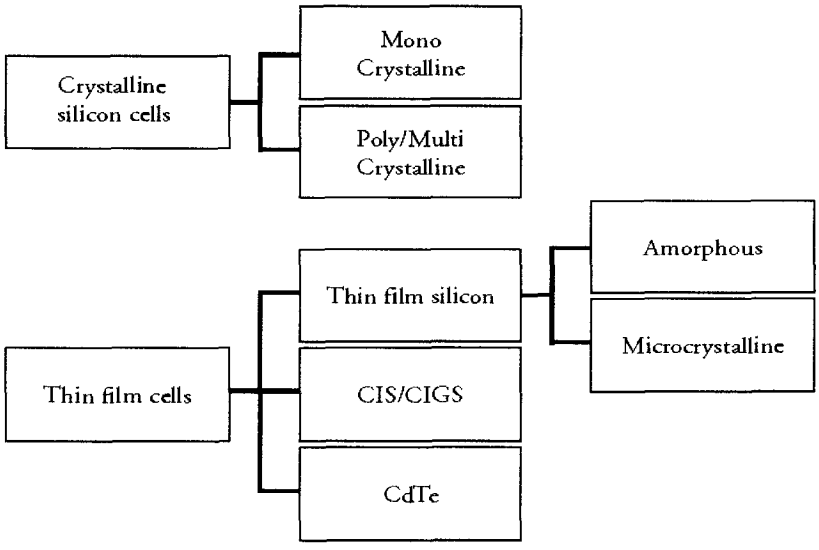
The scheme proposed for evacuation of power from the Gharo Solar project to KE grid comprises 132 kV double circuit (400 sq mm, Cu conductor) of about 0.7 km length looping in-out the already planned Oursun Solar – Gharo singly circuit.

5.2 Technology

In Photovoltaic category, PV panels without concentrators are widely used. These panels are either with fixed tilt or manual seasonal tilt or single axis / dual axis tracking arrangements. Fixed tilt arrangements are in majority; however, single axis trackers are also gaining in popularity due to the gain in generation over fixed tilt systems.

In PV plants, two broad types of panels are used:

- Crystalline (mono or poly) Silicon panels, which will have cells in series assembled in each module / panel.
- Thin film panels, made by depositing extremely thin layers of photosensitive materials in nano-micrometer range on a substrate (mostly glass). Amorphous Silicon (a-Ci) / micromorph silicon (A-Si/μC-Si), Cadmium Telluride (CdTe), Cadmium Indium Selenide (CIS) / Cadmium Indium Gallium Selenide (CIGS) are different types in thin film technology.



6 Design and Specifications of the Plant

It is proposed to install 50 MWp capacity Solar PV plant with polycrystalline solar PV modules with single axis trackers and central inverters. The tracker will be with tilt angle +/- 45 Deg. Generated power shall be stepped-up to 22 kV through inverter transformers and further stepped up to 132kV at bus-bar before connecting to the KE Grid, as shown in the attached Single Line Diagram.

6.1 PV Modules

It is proposed to consider 325Wp polycrystalline modules, from Tier-1 PV module manufacturers (Phono Solar or equivalent). The modules shall be protected by high transmission tempered glass covered with anodized aluminum alloy frames. Serially connected cells shall be terminated to IP65 junction boxes at bottom with 4 Sq.mm multi-strand copper cables. Positive & Negative terminals shall be terminated with MC4 connectors and Y- connectors, for making module interconnections.

Design Parameters:

Typical parameters of the modules:

Electrical Characteristics at STC	Data
Maximum Power (Pmax)	325 W
Module Efficiency	16.70 %
Maximum Power Current (Imp)	8.69 A
Maximum Power Voltage (Vmp)	37.40 V
Short Circuit Current (Isc)	8.99 A
Open Circuit Voltage (Voc)	46.50 V
Temperature Coefficient of Voc	-0.31% / °C
Temperature Coefficient of Isc	0.07% / °C
Temperature Coefficient of Pmax	-0.40% / °C
Nominal Operating Cell Temperature (NOCT)	45°C + 2° C

6.2 Solar Inverters and Auxiliaries

6.2.1 Solar Inverters

Solar inverters represent critical equipment in the Solar PV plant, as the reliability and performance of the inverters greatly influences the overall plant generation. It is proposed to use central inverters of sixteen (16) numbers, with nominal rated capacity of 2520 kW each. Negative earthing in inverters shall be planned to counter PID effect for the modules. Inverter are expected to be from Sungrow or equivalent and shall meet the performance requirements stipulated in the national Grid Code for Solar Power Plants.

Parameters (typical) of the proposed inverter:

Input (DC)

Description	Data
Max. DC power	2820 kWp
Max. input voltage	1000 V
MPP voltage range	520 V – 850 V
Max. input current	5424 A

Output (AC)

Description	Data
Rated normal power	2520kW
Maximum output power	2772kW
Nominal AC voltage	360 V
AC frequency / range	45-65 Hz
Max. output current	4444 A

6.2.2 String Combiner Boxes & DC Cabling

The modules will be connected with DC cables, in series & parallel combinations and hooked-up to Inverters, through string combiner boxes. Total 7344 strings (21 modules per string) shall be connected in sixteen (16) inverters each with 4 inputs. There shall be twenty (20) inputs in String Combiner Boxes (SCBs) with string current monitoring arrangement.

All solar field cables up to SCBs shall be of single core electron beam / UV resistant cables with multi-strand copper conductors.

SCB to inverters shall be with single core armored multi- strand Aluminum cables with XLPE insulation.

6.2.3 Inverter Transformers

It is proposed use twin secondary oil filled transformers for stepping up the power generated from PV system, by connecting one inverter per secondary. The transformers intended for connecting to the Solar Inverters shall confirm to IEC:60076. The transformers will be as per the following specification:

Parameter	Data
Number of transformers and rating	8 Nos. of 5.5 MVA
Cooling	ONAN
Ratio	22/0.36-0.36 kV
Highest system Voltage	25 kV
Power frequency Voltage	50 kV rms
Impulse Withstand Voltage	150 kV peak
Taps and Range	Off-circuit, ± 7.5% in steps of 2.5%
Voltage Vector	Dy11y11
Impedance	6.25% / 6.25%

6.2.4 HT Panels

It is proposed to provide 22 kV Main Switchboard at Plant Main Control building and One (1) more in Inverter Room. Also, eight (8) nos of inverter rooms are planned with 22kV RMU panels

which will be connected to the adjacent RMU panels. Proposed hook-up arrangement is shown in the attached single line diagram. Brief parameters of 22 kV switchboards shall be as given below:

Parameter	Data
Rated Voltage	22 kV, 3 Phase, 50 Hz
Maximum Voltage	22 kV
Power frequency Voltage	24 kV rms
Impulse withstand Voltage	125 kV peak
Short time rating	26.2 kA for 3 Sec
Maximum bus bar temperature	85 Deg. C
Operating Duty	O-0.3sec-CO-3min-CO

Power evacuation to KE grid through plant metering yard shall be planned by providing another step up level of voltage at 132kV level. The power evacuation will be through Two (2) nos of 35/45 MVA power transformers with outdoor substation with double main bus arrangement.

6.3 Cables, Earthing and Illumination System

Power cables for 22 kV system will be with three core aluminum conductor, XLPE insulated, screened, armored and overall PVC sheathed confirming to IEC:502. The power cables of 1.1 kV grade will be XLPE insulated, aluminum conductor with outer sheath of PVC compound conforming to latest version of IEC:227. The control cables for control / protection/ indication circuit of the various equipment will be of 1.1 kV grade, PVC insulated annealed high conductivity stranded copper conductor, inner sheath PVC taped, flat/round wire armored with outer sheath of PVC compound conforming to latest version of IEC: 227.

Non-current carrying parts of all electrical equipment viz. distribution boards, tracker control panels, HT switchgears, and all lighting fittings shall also be earthed rigidly, to ensure safety. Building lightning protection system will be provided as per relevant IEC standards.

Earthing of 132kV system will be through earthing transformer and neutral grounding resistor panel by limiting ground fault current to 200A.

AC supplies of single / three phase, needed for internal use for several functions such as Illumination through lighting inverters, SCADA supply through UPS, Battery Chargers, Transformer tap-changer drives, Power supplies for communication equipment / surveillance system, Breakers / Disconnect switch motors, etc. Auxiliary transformer shall be planned in each inverter area section for catering the auxiliary loads.

Good lighting in the plant will be ensured for maintenance requirement in control buildings and security / surveillances of the boundaries. All lighting supplies shall be extended through lighting inverters. Fence lighting shall be envisaged with low wattage LED lamps. Portable emergency lights shall be planned for security personnel.

6.4 Monitoring System and SCADA

Monitoring of system operation parameters shall be arranged locally and also from remote locations through internet. Weather monitoring station, for irradiance, wind velocity & ambient temperature, String currents, Inverter Parameters, Transformer protections and temperature, HT Panel parameters, Export & import (auxiliary) energy and Perimeter Security through CCTVs & alert systems are hooked-up to SCADA system.

6.5 Module Cleaning System

Module cleaning system shall be envisaged for spraying the soft water over the modules manually by providing storage tanks, water pumps, high pressure piping network & valves. This cleaning process is to be carried out periodically depending upon the intensity of dust deposition over the PV modules. As an alternative, automated cleaning system shall also be evaluated and considered depending on techno commercial viability.

6.6 A/C and Ventilation System

Suitable Air Conditioning or Ventilation (Wet or Dry pressurized) system shall be envisaged for the Inverter & control rooms.

6.7 Water Source

The raw water for the plant is required for meeting the module cleaning requirements (after treatment, if required) will be drawn from Bore wells.

6.8 Civil and Structural Works

The proposed single axis tracker will have 3 modules stacked vertically in landscape orientation, one string comprising 21 modules connected in series (individual tracker dimension will be 42mx3m) and distance between trackers will be 7.5Mtrs (Ground Coverage Ratio, GCR of 45%). The Tracker will be with tilt angle of +/- 45 Deg.

Main columns of these tracker steel panel tables will be with galvanized MS hot rolled sections / GI cold formed sections, while the rafters cross bracing & purlins will be with GI cold formed sections / galvanized steel tubes. Structural materials foundation bolts, fastening bolts, screws, nuts, washers shall conform to the relevant International Standards. All mild steel members (inner & outer surface area) will be electro galvanizing/hot dip galvanizing to 70 microns.

Generally, the soil is found to be grey, silty sand or lean clay or silty clay, as per the report for the first one meter and grey, medium stiff to stiff, traces of stand up to 8 meters. Ground water is encountered at varying shallow depths of 1 meter or more below the existing ground level. To enable timely construction, pile foundations are recommended as they have long lasting life than direct ramming of the structure.

Main control building and security buildings shall be single story buildings with brick work & insulated pre- painted galvanized corrugated sheets. Alternatively, prefabricated rooms may also be planned. Inverters are of outdoor type and shall be placed over slab with elevated arrangement.

Internal roads, fencing & gates shall be planned as in layout drawings.

6.9 Firefighting System

The function of fire-fighting system is to supply water to the main risk areas of the cogeneration power plant.

The fire protection system is required for early detection, containment and suppression of fires. A comprehensive fire protection system shall be provided to meet the above objective and all statutory and insurance requirements of National Fire Protection Association (NFPA).

The fire-fighting system shall consist of the following:

6.9.1 Stand Pipe and Hose System:

Stand pipe and hose system shall be provided to cover the building and structures of the cogeneration plant. The system shall be designed as per the NFPA 14.

Standpipe shall have a hose of 65mm diameter with connection to a large supply of water. The hose connection shall be not less than 0.9m or more than 1.5m above the floor.

6.9.2 Portable Fire Extinguishers:

Dry Chemical Powder, CO^2 and foam type extinguisher system shall be provided. The equipment shall be designed as per NFPA 10.

6.9.3 Fire Alarm & Detection System

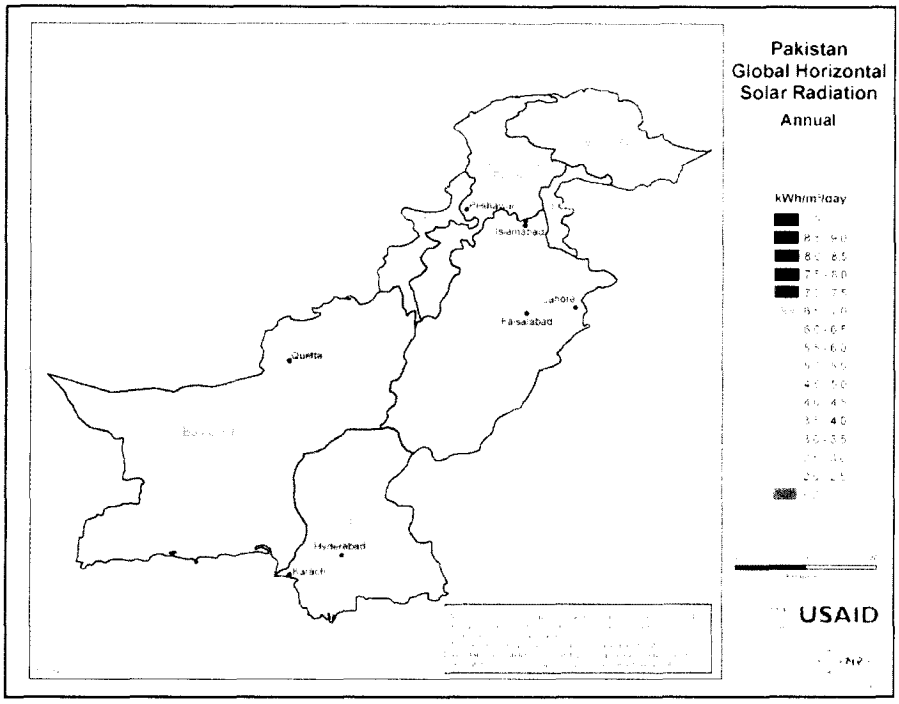
Fire detection system for the power plant will provide early detection of fire and raise alarm. A comprehensive fire protection system shall be planned to meet the above objective and meet all statutory and insurance requirements of National Fire Protection Association (NFPA). A multitude of systems will be provided to combat various types of fires in different areas of the plant and all such systems for various areas shall form a part of a centralized protection system for the entire plant. Fire alarm system detection system shall be provided in following areas:

- Firm alarm and signaling in all electrical/instrumentation panel rooms
- Manual call points and Electric Horns in outdoor areas.

7 Meteorological & Climate Data, Yield & Variability Analysis

7.1 Solar Irradiation

Pakistan lies in an area of one of the highest solar insolation suitable for solar technology. The immense solar resource remains largely untapped. The solar radiation maps of the region (Source: NREL) show the average insolation (Global Horizontal Irradiance in kWH/Sq.M/day) values, as below:



Description	Data
Northern parts of Baluchistan	5.5-6.5 kWH/Sq.M
Central & East Baluchistan, Southern parts of Punjab & North & North- East parts of Sindh	5.0-5.5 kWH/Sq.M
Major parts of Punjab (other than north-west zone), Central parts of Baluchistan & Sindh	4.5-5.0 kWH/Sq.M

Site selection and planning of PV power plants requires reliable solar resource data. The solar resource of location is usually characterized by the values of the global horizontal irradiation, direct normal irradiation and diffuse horizontal irradiation as defined below:

7.1.1 Global Horizontal Irradiation (GHI)

GHI is the total solar energy received on a unit area of horizontal surface. It includes energy from the sun that is received in a direct beam and from all directions of the sky when radiation is scattered off the atmosphere (diffuse irradiation). The yearly sum of the GHI is of particular relevance for PV power plants, which are able to make use of both the diffuse and beam components of solar irradiance.

7.1.2 Direct Normal Irradiation (DNI)

DNI is the total solar energy received on a unit area of surface directly facing the sun at all times. The DNI is of particular interest for solar installations that track the sun and for concentrating solar technologies as concentrating technologies can only make use of the direct component of irradiation.

7.1.3 Diffuse Horizontal Irradiation (DHI)

DHI is the energy received on a unit area of horizontal surface from all directions when radiation is scattered off the atmosphere or surrounding area.

Variability and characteristics of solar radiation are influenced by a number of factors. Many reasons, such as day-night cycle, seasonal cycle, and shading by cloud formations or surrounding terrain, are quite obvious. Others are not so easy to track e.g. content of water vapor and aerosols in atmosphere, thickness of ozone layer, etc. In the past only simple observations were possible.

These obstacles have been overcome by calculation of solar radiation from satellite and atmospheric data. This approach has several benefits:

- Satellite sensors are precisely calibrated and maintained during the whole life-cycle, data delivery is stable (e.g. reliability of MeteoSat is more 99%)
- Geostationary satellites provide near-real-time global coverage data, which allows monitoring, now-casting and forecasting
- Historical sets of satellite and meteorological data enable backward analysis of solar radiation components. Thus a statistically comprehensive dataset (representing 10+ years of data) can be acquired
- Atmospheric data come from physical models, run by leading meteorological institutions; New models are more and more accurate

The first efforts of modeling the solar radiation from satellite data was in the 1980's. Since that time the models have improved considerably.

Long term annual average values of GHI and DNI can be obtained for a site by interpolating measurements taken from ground based sensors or indirectly from the analysis of satellite imagery. Climate data input from Meteonorm (Grid sensor measurement & extrapolation) and Solargis (Satellite imaginary & simulation) have been used, in this report.

7.1.4 Solar Irradiation Data through Meteonorm:

Meteonorm is a comprehensive climatological database for solar energy applications containing comprehensive climatological data for solar engineering applications at every location on the globe. The results are stochastically generated typical years from interpolated long term monthly means. They represent a mean year of the selected climatological time period based on the user's settings. As such the results do not represent a real historic year but a hypothetical year which statistically represents a typical year at the selected location.

Meteonorm is primarily a method for the calculation of solar radiation on arbitrarily orientated surfaces at any desired location. The method is based on databases and algorithms coupled according to a predetermined scheme. It commences with the user specifying a particular location for which meteorological data are required, and terminates with the delivery of data of the desired structure and in the required format.

Solar irradiation data for the proposed site made available in Meteonorm is given below:

Months	Global Horizontal Irradiation	Ambient Temperature	Global Inclined Irradiation
	kWh/m2	°C	kWh/m2
January	127.6	19.52	165.1
February	128.1	22.31	160.5
March	166.2	26.42	202.8
April	183.4	28.97	223.0
May	192.1	30.92	232.1
June	182.0	31.19	213.9
July	150.4	30.41	173.3
August	149.0	29.20	167.7
September	168.9	28.92	206.1
October	160.8	29.06	204.3
November	126.9	24.86	163.2
December	113.8	20.93	142.7
Total	**1849.2**	**26.91**	**2100.2**

Meteonorm data file for Gharo location is attached with this report as Annexure-3 for reference.

7.1.5 Solar Irradiation Data through Solargis:

The Solargis database is a high resolution database recognized as the most reliable and accurate source of solar resource information. The database resides on about 100 terabytes of data and it is continuously updated on daily basis. The data is calculated using in-house developed algorithms that process satellite imagery and atmospheric and geographical inputs

The model runs 24 hours a day and processes data from 4 geo- stationary satellites, which cover almost Earth's entire surface. More than 5 GB of data is processed every day. The database resides on about 100 terabytes of data. This is equivalent to 100,000 times the size of some other solar resource databases.

Solar irradiation data for the proposed site made available in Solargis is given below:

Months	Global Horizontal Irradiation kWh/m2	Ambient Temperature °C	Global Inclined Irradiation kWh/m2
January	135.0	19.80	169.7
February	148.0	22.50	184.6
March	196.0	26.50	244.9
April	213.0	29.80	262.0
May	215.0	32.00	262.7
June	183.0	33.00	212.8
July	154.0	31.70	173.8
August	146.0	30.60	164.3
September	165.0	30.50	197.6
October	172.0	29.50	215.8
November	138.0	25.50	174.3
December	127.0	21.19	157.3
Total	**1992.0**	**27.74**	**2419.7**

Solargis data file for Gharo location is attached with this report as Annexure-4 for reference.

For computation of yield analysis, solar irradiance and other values from both Meteonorm and Solargis have been considered in this report.

7.2 Solar Yield Analysis using PVsyst:

The PVsyst software, widely being used by most of the developers, has been used to ascertain yield and performance of the systems / options considered in this report.

Yield from the Solar system varies depending on the following factors:

- Direct Irradiance
- Tilt and Facing of the module with respect to Sun
- Selection of Solar PV Technology and Make of the module
- Inverter Type and Make
- Cable sizing and cable losses
- Grid availability

7.2.1 Losses considered for Yield Calculation:

PVSYST calculates the direct current (DC) electricity generated from the modules in hourly time steps throughout the year. This direct current is converted to alternating current (AC) in an inverter. A number of losses occur during the process of converting irradiated solar energy into AC electricity. Some of these losses are calculated within the PVSYST software, whilst others are assumed figures based on the performance of similar PV plants. The losses are described in the following subsections.

(a) Incident Angle Losses

The incidence angle loss or "Incidence Angle Modifier" (IAM) accounts for losses in radiation penetrating the front glass of the PV modules due to angles of incidence other than perpendicular. This loss is derived from the ratio of direct and diffuse radiation, sun angles and the tilt of the modules.

(b) Low Irradiance Loss

The conversion efficiency of a PV module reduces at low light intensities. This causes a loss in the output of a module compared with the standard conditions at which the modules are tested (1000 W/Sq.M). This "low irradiance loss" depends on the characteristics of the module and the intensity of the incident radiation.

(c) Module Temperature

The characteristics of a PV module are determined at standard temperature conditions of 25°C. For every °C temperature rise above 25°C there is reduction in performance of modules. This temperature dependent performance differs for different PV technologies. The performance of crystalline silicon module reduces by ~0.45%.

(d) Module Quality

Most PV modules do not match exactly the manufacturer's nominal specifications. Modules are sold with a nominal peak power and a given tolerance within which the actual power is guaranteed to lie. In practice PV modules usually lie below the nominal power but within the tolerance. For this project, it is proposed to use only positive tolerance modules.

(e) Module Mismatch

Due to the inherent inaccuracy of the silicon photovoltaic cell manufacturing process, PV modules, expected to have the same electrical features, will not be identical. This (relatively small) heterogeneity among modules is at the basis of the mismatch loss. The mismatch loss depends both on the specific PV modules used for the project and on the procedure followed to assemble the modules on site.

(f) DC Cable Resistance

Electrical resistance in the wires between the power available at the modules and at the terminals of the array gives rise to ohmic losses (I^2R).

(g) Inverter Performance

The inverters used at any PV plant convert from DC power into AC power with a maximum efficiency of 99%. The same is reflected in the Inverter datasheet. However, depending on the inverter load, they will not always operate at maximum efficiency.

(h) Soiling

In order to produce maximum energy on any given day, it is best to keep the panels clean at all times. The cleaning of modules will depend on the rainfall and cleaning strategy defined in the O&M contract; thus it may not be possible to retain the panels clean all the time. Unless a particularly robust cleaning strategy is employed, the soiling loss for horizontally mounted modules may be expected to be higher than modules that are inclined, as inclined modules will benefit more from the cleaning effect of rainwater run-off.

(i) Degradation

The performance of a PV module can decrease over time. The degradation rate is typically higher in the first year upon initial exposure to light and then stabilizes. The extent of degradation and the process by which it occurs varies between module technologies.

The initial degradation occurs due to defects in the cell, which are activated on exposure to light. The subsequent degradation occurs at the module level and may be caused by:

- Effect of the environment on the surface of the module e.g. pollution
- Mechanical stress and dampness on the contacts
- Cell contact breakdown
- Wiring degradation
- Factors affecting the degree of degradation include the quality of materials used in manufacture, the manufacturing process, and also the O&M regime employed at the site.

7.2.2 The following table indicated the inputs considered for the PVsyst analysis:

Description	Values
Site Co-Ordinate	24.72deg N & 67.53deg E
Plane Tilt	+/- 45 Deg
Pitch	7.50 Mtrs
Collector Band Width	3.00 Mtrs
Meteo Data	Solargis - 1992 kWh/m2
Meteo Data	Meteonorm – 1849 kWh/m2

7.2.3 The following table gives the extract of loss distribution in yield simulation:

Description	Loss – Using GIS	Loss – Using Meteonorm
Horizontal Global Irradiation	1992 kWh/m2	1849 kWh/m2
Incidence angle	(+)21.5%	(+)21.9%
Near Shading	(-) 2.8%	(-) 2.8%
IAM Factor	(-) 2.1%	(-) 2.2%
Soiling Loss	(-) 2.0%	(-) 2.0%
Effective Irradiance on Collector at STC efficiency 16.90%	2257 kWh/m2 on collector area of 299249 m2	2100 kWh/m2 on collector area of 299249 m2
Array Nominal Energy at STC efficiency	114,168 MWh	106,245 MWh
Low Irradiance Performance	(-) 0.2%	(-) 0.3%
Temperature	(-) 9.6%	(-) 8.8%
Light Induced Degradation	(-) 2.5%	(-) 2.5%
Module Quality Loss	(-) 0.5%	(-) 0.5%
Mismatch	(-) 0.5%	(-) 0.5%

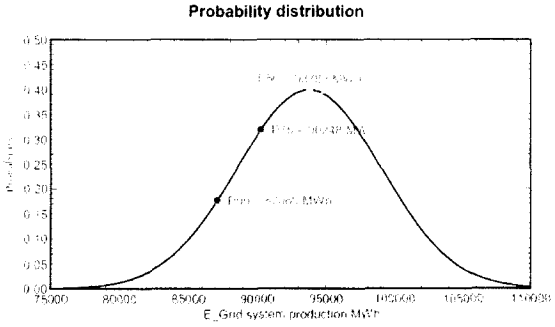
Ohmic Wiring Loss	(-) 1.5%	(-) 1.5%
Array Virtual Energy at MPP	97898 MWh	91832 MWh
Inverter Loss during Operation	(-) 1.1%	(-) 1.1%
Available Energy at Inverter Output	96783 MWh	90787 MWh
AC Ohmic Loss	(-) 0.6%	(-) 0.6%
External Transformer Loss	(-) 1.0%	(-) 1.0%
Auxiliaries (fans, others)	(-) 0.5%	(-) 0.5%
System Unavailbility	(-) 1.0%	(-) 1.0%
Energy Injected into Grid, for 50123 kWp modules	93782 MWh	87915 MWh
Performance Ratio (After the Losses)	77.32%	77.8%
Revenue Yield (kWh/kWp) after First Year degradation	1871	1754

7.2.4 Probabilistic evaluation of forecast production using Solargis & Meteonorm:

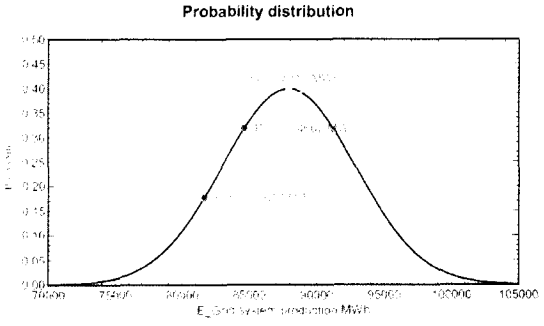
The forecast generation by solar power plants is mainly dependent on the meteo data used for the simulation, which has natural variation due to change in weather patterns from year to year. Additional uncertainty results from variation in system parameters (module degradation, soiling etc.). Simulations for solar generation can be expressed in terms of different probabilities of exceedance e.g. P50, P75, P90. Typically, either P75 or P90 is used for risk / financial analysis or the P50 value is used with conservative assumptions for system losses.

Description	Data (Solargis)	Data (Meteonorm)
Year-Year variability variance	5.0%	5.0%
Deviation of System Parameters		
PV module	2.0%	2.0%
Inverter efficiency	0.5%	0.5%
Soiling and Mismatch	1.0%	1.0%
Degradation	1.0%	1.0%

Global Variability (Meteo+System) Variance	5.6% (Quadratic Sum)	5.6% (Quadratic Sum)
Annual Production Probability	P50 – 93782 MWh P75 – 90248 MWh P90 – 87060 MWh	P50 – 87915 MWh P75 – 84602 MWh P90 – 81613 MWh



Probability Graph – Solargis



Probability Graph - Meteonorm

Note: PVsyst analysis report for the above arrangement and yield is attached with this report as Annexure-3 (Meteonorm) & Annexure-4 (Solargis) with this report.

7.2.5 Module Degradation Table for 25 years

PV modules by virtue of aging have tendency to degrade over the years. The following table indicates the typical degradation in the energy yield for each year of operation:

Year of operation	% of degradation at end of year	Accumulated degradation in %	Energy at the end of year in MWh Solargis	Energy at the end of year in MWh Meteonorm
	Considered in PVSYST	(3% for First Year)		
2	0.88%	0.88%	90.97	85.28
3	0.88%	1.76%	90.17	84.53
4	0.88%	2.64%	89.37	83.78
5	0.88%	3.52%	88.57	83.05
6	0.88%	4.40%	87.81	82.32
7	0.88%	5.28%	87.03	81.59
8	0.88%	6.16%	86.27	80.87
9	0.62%	6.78%	85.76	80.37
10	0.62%	7.40%	85.20	79.87
11	0.62%	8.02%	84.67	79.38
12	0.62%	8.64%	84.15	78.89
13	0.62%	9.26%	83.63	78.40
14	0.62%	9.88%	83.11	77.91
15	0.62%	10.50%	82.59	77.43
16	0.62%	11.12%	82.08	76.95
17	0.62%	11.74%	81.57	76.47
18	0.62%	12.36%	81.07	76.00
19	0.62%	12.98%	80.57	75.53
20	0.62%	13.60%	80.06	75.06
21	0.62%	14.22%	79.56	74.59
22	0.62%	14.84%	79.08	74.13
23	0.62%	15.46%	78.59	73.67
24	0.62%	16.08%	78.10	73.21
25	0.62%	16.70%	77.61	72.76

8 Grid Interconnection

A detailed grid interconnection study for the Project has been carried out by OMS (Pvt) ltd and approved by K-Electric. Key findings of the report are summarized in this section.

- The proposed project lies in the vicinity of the already planned Oursun Solar project. The site of the Gharo Solar project is about 5 km from the Gharo Grid Station, which lies in the vicinity of HT network of K-Electric (formerly known as KESC)

- The data received has been reviewed and processed to make the computerized model of K-Electric network to carry out the system analysis. Considering the requirement of this study, the complete 220kV network and the 132 kV network of K-Electric Grids in the surrounding of 50 MWp Gharo Solar Project have been modeled.

- The scheme proposed for evacuation of Power from 50 MWp Gharo Solar Project to the K-Electric Network is 132 kV double circuit (400 sq mm, Cu conductor) of about 0.7 km length to loop in-out the already planned Oursun Solar – Gharo single circuit located near the Gharo Solar Plant.

- The load flow simulation has been carried out by modeling and closely matching the existing system scenario as received from K-Electric. Simulations and detailed analysis have been carried out on the Base case. In addition to the base case, year wise scenarios w.r.t upcoming future Generation projects and bulk consumers have been modelled for Load Flow and Short circuit studies and their impact on existing HT network of K-Electric.

- Various scenarios / classifications have been modelled on the basis of Firm generation list provided by K-Electric. The various alert settings have been made as per NEPRA grid code to have a better analysis of the entire K-Electric network.
- The load flow simulations revealed that the Power from 50 MWp Gharo Solar Project can be evacuated to the K-Electric network without any overloading.
- The impact of the 50 MWp Gharo Solar Project with the proposed interconnection scheme on K-Electric network has been studied comprehensively. The benefits of 50 MWp Gharo Solar Project to K-Electric have also been computed which mainly include:
    - Additional source of Power supply in the surrounding network of 50MWp Gharo Solar Project.
    - Improvement in voltage profile, especially at grid stations in the surrounding of 50 MWp Gharo Solar Project.
    - Reduction in transmission line losses of K-Electric network.
    - Improvement in system reliability in the surrounding of 50 MWp Gharo Solar Project.
    - Improvement in Power supply position of K-Electric network.
    - Reduction in load shedding per annum as per added future generation.
    - Dependency on NTDC generation is reduced
    - After ample generation the maintenance/overhauling of any generating unit can easily be scheduled.

- It has been concluded on the basis of Load flow, Short circuit and Power Quality studies that the K-Electric network has sufficient capacity to absorb the power from 50 MW Gharo Solar Power Project and the power can reliably be evacuated to the K-Electric network.

9 Environmental Impact Assessment

GSPL commissioned an Initial Environmental Examination ("IEE") report to identify and assess any adverse impacts of the Project, which was reviewed by EPA Sindh and No Objection Certificate was issued on 20th October 2017. As per the IEE report, there is no significant adverse effect of the Project on its surroundings. The Project shall provide much-needed renewable energy to the grid, thereby off-setting greenhouse gas emissions from combustion of fossil fuels, and shall help improve the socio-economic conditions in its vicinity. The land is marginal in nature and suitable for construction of such a Project. Negative impacts which may occur primarily in the construction phase are expected to be temporary and benign in nature and suggested mitigation measures have been identified in the IEE report as summarized below:

Environmental Aspect	Impact	Mitigation / Implementation
Construction Phase		
Air Quality	Chronic Respiratory health effects	- Water spraying will be done to reduce dust emissions; - Covering the stock piles with tarpaulin or plastic sheets to avoid unnecessary dust - emissions. - Use of standard construction equipment and vehicles; - Water sprinkling will be done to reduce dust emissions; - Stand-by generators and vehicles will be properly tuned and tested for gaseous emissions - periodically. - Monitoring of ambient air will be done on monthly basis. - All roads will be paved as soon as possible before construction and installation of Solar PV to reduce the probability of dust dispersion.
Noise	Stress Hypertension Hearing loss Headache	- Construction equipment/machineries will be provided with suitable noise dampening devices; - Vehicles must be tuned and maintained to reduce their noise levels: - Workers on site will be provided with adequate 'Personal Protective Equipment' (PPE); Appropriate noise reduction steps will be taken wherever necessary including scheduling of high noise creating activities simultaneously with low noise generating activities to keep the ambient noise levels within SEQS. - Noise level will be monitored at regular intervals to meet the requirements of SEQS.
Impact on Soil and Land use	Soil erosion / degradation	- Construction activities will be limited to the designated area. - Pitching of soil and silt entrapment near excavated sites must be taken into consideration. - Preventive measures such as secondary containment facility for chemicals and oil containers must be developed to reduce the probability of soil contamination in case of accidental spills of oils/lubricants. - Spill prevention plan and spill kits must be developed as a corrective measure for accidental spills.
Terrestrial Ecology	Impact on Flora and Fauna	- Green areas will be developed in vacant portions of proposed project areas;

		- Plant trees that are indigenous and will mature in short time and support local avifauna. - A horticulturist will be engaged for developing a plantation program on the site.
Waste water generation	Stagnant water can create mosquito nuisance Health problems	- Waste water will be re-utilized in land compaction processes or sprinkling for dust settlement. - Wastewater generated will be collected in a pit, tested and then routed to nearest drain/sewerage system.
Solid Waste Generation	Health hazards Pollute soil Unaesthetic conditions	- Waste should be segregated at construction site by providing separate bins for different type of wastes - plastic, paper, metal, glass, wood, and cotton, for recycling purpose. - A safe and designated area will be selected to store waste, EPA certified contractors will be hired for disposing of waste. - No waste will be dumped at any location beyond the proposed site boundary; - Record of all waste generated during the construction period will be maintained. - Trainings will be provided to personnel for identification, segregation, and management of waste.
Impact of local economy	Impact on local livelihood	- Employment preference will be given to the locals; - People from neighboring areas will be considered for unskilled employment; - Suppliers and Vendors of neighboring areas will be given priority, where feasible.
Traffic	Traffic congestion	- Diversion routes for construction vehicular traffic must be allocated to maintain normal traffic flow by forming a temporary pathway made up of gravel and sand along the proposed solar PV project. - Emergency routes must be kept clear and ensure that they are easily accessible. - The area has very low traffic count and does not need an extensive traffic management plan to be implemented. However, local traffic police and coastal guards must be consulted during works for supervision.
Temporary labor camps	Impact on local area and ecological resources	- A better way to overcome garbage disposal as mentioned previously is by reducing or avoiding the construction of labor camps, thus the selection of majority of skilled and - unskilled workers from the project influence area will be a proper measure in this regard. - Provision of sanitation, and sewage facilities at all sites of the construction/labor camps to avoid or minimize health hazards and environmental pollution. Temporary Soakage pits shall be developed for wastewater disposal. - Basic utilities like potable water for drinking, clean water for basic use and electricity will be provided at the labor camps which shall be done before start of construction activity. - Contractor shall handle and manage waste generated from the construction/ labor camps without contamination to natural environment thus reducing risk to neighbouring community.
Health and Safety	Impact on workers	- Safety and accident prevention program should be organized for employees. - Installation of warning signs at particular locations such as transverse points of local road network. - Provide protective safety belts, footwear, helmets, goggles, eye-shields, and clothes to workers depending on their job specification. - Arrangement of proper first aid unit and emergency vehicle to take affected personnel to the nearest medical facility.

Operational Phase		
Wastewater	Impact on surface and groundwater resources Water scarcity	- The project should utilize planned water piping system instead of bowsers and tanks to minimise water usage and reduce excess wastewater
Solid waste	Fire hazards Property loss Unaesthetic and unhygienic conditions	- The solid waste management plan will be developed and facilities for collection, storage and transportation. - EPA certified contractors will be hired for proper waste disposal.

10 Operations and Maintenance (O&M)

Operation & Maintenance for a Solar PV Plant is relatively straightforward and less intensive compared other power generation technologies. The operations shall be under the management of the Plant Manager who would be in charge of both technical and administrative functions of complex's operation and maintenance. Most O&M functions shall be performed by permanent staff and the operation of the facility will be automated, supervised and controlled by SCADA.

The operation team shall operate and monitor the facility in accordance with Prudent Utility Practices, applicable standards and the manufacturers' recommendations

Operations and Maintenance tasks shall include:

- Periodic cleaning of PV Panels (every 15 – 20 days);
- Periodic operational checks and tests of equipment in accordance with OEM recommendations;
- Regular plant inspections;
- Routine maintenance services;
- Implement and regulate the facility's preventive and corrective maintenance program;
- Critical / non-critical reactive repairs;
- Plant security covering entire fenced area;
- General shift operations for coordinating plant operation, maintenance & liaison with power purchaser; and
- Maintain critical spares for plant & equipment.

11 Key Operating Assumptions

The following sections provide a summary of the general, project cost, operating and financing assumptions related to the Project. The feasibility has been prepared following a detailed discussion of these assumptions with Project sponsors. The proceeding sections discuss the following assumptions:

- Plant Generation
- General & Timeline
- Project Cost
- Financing Assumptions
- Project Tariff & Revenue
- Financial / Economic Analysis

11.1 Plant Generation Parameters

Key generation parameters as per PVsyst simulations are summarized below. The P50 generation varies from approximately 20% to 21.4% depending on the database. An intermediate value for plant factor of 20.5% has been assumed for Tariff and financial projections.

Table 16: Expected Generation at Different Probabilities

Probability Level	Meteonorm		Solargis	
	Generation (MWh)	Plant Factor	Generation (MWh)	Plant Factor
P50	87,915	20.02%	93,782	21.36%
P75	84,602	19.27%	90,248	20.55%
P90	81,613	18.59%	87,060	19.83%

11.2 Project Timeline

Construction period of 12-month following financial close has been assumed for the Project. Financial Close is targeted in September 2018 with a target Project commercial operations date **("COD")** of September 2019. A schedule of activities and key milestones is provided in Table 17 below.

Table 17: Indicative Project Schedule

Period	*Tasks*
July 2016 to September 2016	✓ Issuance of LOI and incorporation of Project Company
	✓ Identification of Project land and initial yield study
	✓ Grid study approval
October 2016 to March 2017	✓ Preliminary technical design
	... Project land negotiations and acquisition
April 2017 to December 2017	✓ Environmental study approval
	... Tariff submission and approval
	... Generation license application and approval
January 2018 to September 2018	☐ Signing of EPA with K-Electric
	☐ Contractor/supplier negotiation and selection
	☐ Lenders' due diligence
	☐ Financial Close
October 2018	☐ Commencement of works and supply
September 2019	☐ Project Commissioning

✓ *Completed* ... *In Progress* ☐ *To be initiated*

11.3 Project Life

As per the standard energy purchase agreement ("EPA") the Project life and EPA term has been assumed as 25 years from COD and all equipment is being procured corresponding to the same.

11.4 Project Cost

The break-down of the estimated Project Cost is provided below in Table 18. The project cost is based on an average PKR/USD exchange rate of PKR 105/USD and does not include any taxes and duties.

Table 18: Estimated Project Cost

Estimated Project Cost	USD million	PKR million
EPC Cost		
Modules	17.00	1,785
Inverters	3.00	315
Mounting System	7.50	787.5
Cable and Transformers	5.00	525
Civil and General Work	5.00	525
Degradation	1.36	142.5
Total	**38.86**	**4080.0**
Non-EPC Cost		
Land Cost	1.19	124.9
Project Development Cost	1.83	192.6
Financing Fee & Charges	0.94	97.6
Interest during Construction (IDC)	0.93	98.9
Total Project Cost	**43.75**	**4593.5**
EPC Cost per MW (USD million)	*0.7772*	
Project Cost per MW (USD million)	*0.8751*	

11.5 Project Financing

The Project financing will be based on a debt to equity ratio of 75:25. Under the base case financial projections, debt is assumed to be 100% foreign financed with debt repayment of 13 years after COD amortized over the period through fixed annuity based installments.

Key parameters of the Project funding are provided in Table 19 below:

Table 19: Project Funding

Project Cost	PKR 4,594.0 million
Debt	PKR 3,445.5 million
Equity	PKR 1148.5 million
Lending Rate	LIBOR (1.22%) + 4.5% fixed
Repayment Period	13 years

11.6 Project Tariff

GSPL has submitted an innovative and competitive tariff petition to NEPRA. The Tariff is expected to be one of the lowest in Pakistan for any renewable or thermal technology and shall help reduce KE's power procurement cost.

The tariff is based on a simplified and transparent structure with limited indexation of certain fixed percentages with USD/PKR exchange rate and local CPI only. There is no separate indexation for interest rate variation or changes in actual debt mix.

The critical assumptions upon which the tariff is based appear in the table below:

Table 20: Key Assumptions for Tariff Petition

Description	Basis
EPC cost per MW	USD 0.7771
Project Cost per MW	USD 0.8750
Construction Period	12 months
Exchange rate (PKR/USD)	105.0
Plant Factor	20.5%
Expected Annual Generation	89,790 MWh
Assumed Degradation per annum	0.5%
O&M Cost per annum including insurance	USD 24,000 per MW
Debt to equity ratio	75:25
Return on Equity (IRR based)	17.0%
Loan Repayment Period	13 years
Repayment Frequency	Quarterly
Debt Cost	LIBOR (1.22%) plus 4.5% (Total 5.72% fixed)

Respective tariff components along with relevant indexations are provided in Table 21 below:

Table 21: Reference Tariff

Description	Reference Tariff PKR per kWh		Indexation
	Year 1-10	Year 11-30	
O&M	1.4030	1.4030	- 65% of the Tariff shall be revised on the basis of the prevailing TT & OD selling rate of US Dollar as notified by the National Bank of Pakistan on the last available day prior to start of the quarter. Reference TT & OD selling rate shall be Rs. 105/USD.
Return on Equity	2.3024	2.3024	
Debt Servicing Component	4.2042	-	

Description	Reference Tariff PKR per kWh Year 1-10	Year 11-30	Indexation
Total Tariff	**7.9098**	**3.7057**	- 35% of the reference Tariff shall be linked to the Consumer Price Index (General) published by the Pakistan Bureau of Statistics for the month prior to the start of the quarter. Reference CPI for the purpose of indexation shall be 216.33 for the month of May 2017.
Levelized Tariff	**6.9957**		

11.7 Project Revenue

The Project shall be exclusively selling all energy generated to K-Electric Limited under a 25-year Energy Purchase Agreement ("EPA"). The EPA shall be based on the tariff determined by NEPRA, which shall be adjusted on a quarterly basis as per the above mentioned indexation mechanism. The financial projections summarized below show that the Project is expected to generate a positive earnings before interest, taxes and depreciation (EBITDA) and net profits throughout its life and have favorable financial ratios.

11.8 Projected Financial Statements

11.9 Projected Income Statement

PKR Millions	1	5	10	15	20	25
Power Sale to K-Electric	710	710	710	333	333	333
Total Revenue	**710**	**710**	**710**	**333**	**333**	**333**
Fuel cost	-	-	-	-	-	-
O&M	126	126	126	126	126	126
Total O&M Cost	**126**	**126**	**126**	**126**	**126**	**126**
Insurance	-	-	-	-	-	-
Depreciation	184	184	184	184	184	184
EBIT	**400**	**400**	**400**	**23**	**23**	**23**
Interest on LT Debt	193	146	70	-	-	-
Working capital Cost	-	-	-	-	-	-
Net Income	**207**	**254**	**330**	**23**	**23**	**23**

11.10 Projected Balance Sheet

PKR millions	1	5	10	15	20	25
Fixed Assets	4,410	3,675	2,756	1,838	919	(0)
Advance	-	-	-	-	-	-
Accounts Receivable	-	-	-	-	-	-
Debt Reserves	-	-	-	-	-	-
Cash	-	-	-	-	-	-
Total Current Assets	-	-	-	-	-	-
Total Assets	**4,410**	**3,675**	**2,756**	**1,838**	**919**	**(0)**
Accounts Payable	-	-	-			
Working Capital	-	-	-			
Debt Current Portion	195	245	325	-	-	-
Current Liabilities	**195**	**245**	**325**	**-**	**-**	**-**
Long-term Debt	3,066	2,165	709	-	-	-
Total Liabilities	**3,261**	**2,410**	**1,034**	**-**	**-**	**-**
Paid-up Capital	1,149	1,149	1,149	1,149	1,149	1,149
Retained Earnings	1	117	574	689	(230)	(1,149)
Total Equity	**1,149**	**1,265**	**1,723**	**1,838**	**919**	**-**
Equity & Liabilities	**4,410**	**3,675**	**2,756**	**1,838**	**919**	**-**

11.11 Projected Cash Flows

PKR millions	1	5	10	15	20	25
Earnings after tax	207	254	330	23	23	23
Add: Depreciation	184	184	184	184	184	184
Change in Advances	-	-	-	-	-	-
Change in A/C Receivable	-	-	-	-	-	-
Change in A/C Payable	-	-	-	-	-	-
Cash Flow from Operations	**391**	**438**	**514**	**207**	**207**	**207**
Cash Flow from Investment	-					
Repayment of LT Debt	184	231	307	-	-	-
Repayment of WC Loan	-	-	-	-	-	-
Disbursement of Equity	-	-	-	-	-	-
Cash Flow from Financing	**184**	**231**	**307**	**-**	**-**	**-**
Net Cash Flow	**207**	**207**	**207**	**207**	**207**	**207**

11.12 Financial / Economic Analysis

PKR Millions	Min.	1	5	10	15	20	25
Revenue	**710**	710	710	710	333	333	333
EBITDA	**584**	584	584	584	207	207	207
Net Income	**207**	207	254	330	23	23	23
Dividends	**207**	207	207	207	207	207	207
Annual Interest	**13**	193	146	70	-	-	-
Debt Servicing	**377**	377	377	377	-	-	-
Debt to Equity	**0.00**	2.84	2.10	0.90	-	-	-
Times Interest	**3.02**	3.02	4.00	8.32	-	-	-
DSCR	**1.55**	1.55	1.55	1.55	-	-	-
Equity IRR	**15.9%**						
Project IRR	**11.4%**						
Project NPV	**181.0**						

CERTIFICATE

19th September, 2016

Subject: **Approval of Grid Connectivity and Simulation Studies of Gharo Solar (Private) Limited**

K-Electric hereby records its approval in respect of Grid Connectivity and Simulation Studies submitted by Gharo Solar (Private) Limited in respect of 50 MWp Solar Power Project of Gharo Solar (Private) Limited. K-Electric further certifies that the Solar based power to be generated by Gharo Solar (Private) Limited will be evacuated in accordance with the project timelines as provided by the Project Company and further that the power injected through the above mentioned project will not have any adverse effect on the K-Electric grid as required under the Grid code.

Name & Signature

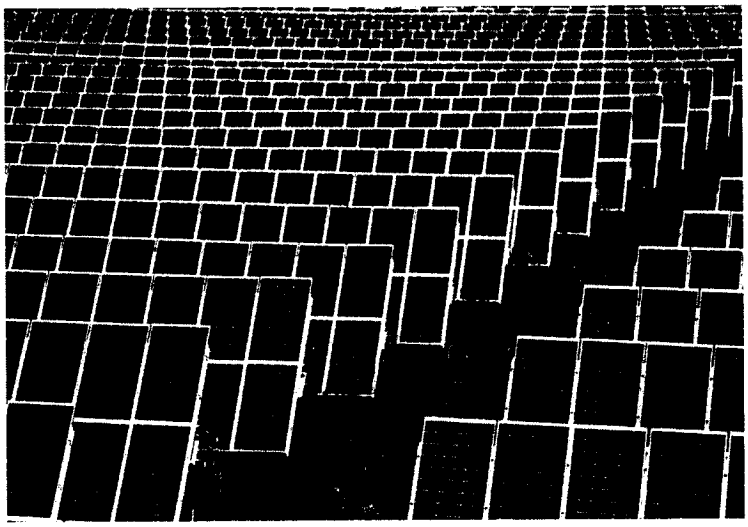
(ADNAN RIZVI)

Formerly Karachi Electric Supply Company Limited
K-Electric Limited, KE House, 3rd Floor, 39-B, Sunset Boulevard, DHA II, Karachi, Pakistan
P: 92-21-32647017, F: 92-21-9920 5165, UAN: 111-537-211 Website: www.ke.com.pk

GRID INTERCONNECTION STUDY

For

50 MWp Gharo Solar Power Project



Revised Report

(Dated August 31, 2016)

Submitted by:

OMS (PVT.) LIMITED

251-CCA, Block FF, Phase IV, DHA, Lahore, Pakistan.

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Executive Summary

1. Gharo Solar (Private) Limited intends to set up a 50 MWp Solar power project at a distance of about 6 km along Sindh Coastal Highway in District Thatta, Sindh. The proposed project lies in the vicinity of the already planned Oursun Solar project. The site of the Gharo Solar project is about 5 km from the Gharo Grid Station, which lies in the vicinity of HT network of K-Electric (formerly known as KESC), whereas the land coordinates of the proposed Gharo Solar Power Project and Oursun Solar Power Project are 24°43'17.03"N, 67°32'44.78"E and 24°43'17.26"N, 67°32'21.49"E respectively,as marked in the maps included at the end of ***Annexure-01***. Gharo Solar (Private) Limited has hired the services of OMS (Pvt.) Limited, to carry out grid interconnection study in order to propose interconnection scheme for evacuation of Power to the K-Electric system network.

2. This is revised report of the grid interconnection study in which the results of the load flow studies have been presented for the connectivity of 50 MWp Gharo Solar Project with the K-Electric network.

3. In order to conduct the grid interconnection study, the required basic input data of the existing K-Electric network including Power plants, grid stations, transmission lines, load demand etc. has been obtained from K-Electric, whereas, the data of the 50 MWp Gharo Solar Project has been provided by client. The data has been reviewed and processed to make the computerized model of K-Electric network in ETAP 14.1 software to carry out the system analysis. Considering the requirement of this study, the complete 220kV network and the 132 kV network of K-Electric Grids in the surrounding of 50 MWp Gharo Solar Project have been modeled.

4. The following scheme has been proposed for evacuation of Power from 50 MWp Gharo Solar Project to the K-Electric Network:

"132 kV double circuit (400 sq mm, Cu conductor) of about 0.7 km length to loop in-out the already planned Oursun Solar - Gharo single circuit located near the Gharo Solar Plant."

5. The load flow simulation has been carried out by modeling and closely matching the existing system scenario as received from K-Electric. Simulations and detailed analysis have been carried out on the Base case. Details provided by K-Electric are attached in ***Annexure-01***. In addition to the base case, year wise scenarios w.r.t upcoming future Generation projects and bulk consumers(shown as Lumped load) have been modelled for Load Flow and Short circuit studies and their impact on existing HT network of K-Electric. The details of Base case and other scenarios are given below:

a) Base Case upto June 2016

The data taken for Base case is of June 18, 2015. However, loading conditions are aptly rhyming with the load flow conditions of K-Electric provided, attached in ***Annexure-01.***

b) July 2018 - June 2019 (Summer peak)

Following generations are included in this scenario, in addition to that as described in (a).

- 52 MW FPCL (132kV)
- 35 MW_{ac} (50_{dc} MW) Oursun Solar (132 kV)
- Al Abbas, Lotte, Engro chemicals & Anoud Power (all interconnection on 11kV)
- 250 MW Korangi Power Complex (132 kV)
- 42 MW_{ac} (50_{dc} MW) Gharo Solar Power Project.
- 40 MW Burj Wind Power Plant.
- 250 MW Tapal energy (132 kV)
- 100 MW SNPC Project (132 kV)
- 200 MW Orient Project (132 kV)
- 50 MWp Wind Project (132 kV)
- 110 MW Tristar Project (132 kV)
- 25 MW Bahria Town Project – Solar (132 kV)
- 35 MW_{ac} (50_{dc} MW) Dawood Project – Solar (132 kV)

In addition, to above mentioned generations TP-1000 scope (as provided by K-Electric) has also been implemented from this year and onwards.

The Winter season classification has been done by taking the winter load of Power trafos as 35% w.r.t that of Summer load. However the Bulk consumer loads are kept same in the winter season as that of Summer.

c) July 2019 - June 2020 & July 20 – June 21

Following generations are included in this scenario, in addition to that as described in (b).

- 450 MW Engro LNG (220 kV)
- 2X350 MW Datang Coal Power Plant (220 kV)
- 220 MW FFBL Power Plant (132 kV)
- 100 MW Tapal – I Extension (132 kV)

d) July 2021 - June 2022

Following generations are included in this scenario, in addition to that as described in (c).

- 200 MW KANUPP II / III Project.

All the above mentioned scenarios / classifications have been modelled on the basis of Firm generation list provided by K-Electric. The various alert settings (attached in ***Annexure – 02***) on ETAP-14.1 have been made as per NEPRA grid code to have a better analysis of the entire K-Electric network.

6. The load flow simulations revealed that the Power from 50 MWp Gharo Solar Project can be evacuated to the K-Electric network without any overloading.

7. The impact of the 50 MWp Gharo Solar Project with the proposed interconnection scheme on K-Electric network has been studied comprehensively. The benefits of 50 MWp Gharo Solar Project to K-Electric have also been computed which mainly include:

- Additional source of Power supply in the surrounding network of 50 MWp Gharo Solar Project.
- Improvement in voltage profile, especially at grid stations in the surrounding of 50 MWp Gharo Solar Project.
- Reduction in transmission line losses of K-Electric network.
- Improvement in system reliability in the surrounding of 50 MWp Gharo Solar Project.
- Improvement in Power supply position of K-Electric network.
- Reduction in load shedding per annum as per added future generation.
- Dependancy on NTDC generation is reduced
- After ample generation the maintenance/overhauling of any generating unit can easily be scheduled.

8. Short circuit study is carried out in the vicinity of the proposed 50 MW Gharo Solar Power Project for all scenarios. From the short circuit study it is found that, with the induction of 50 MW Gharo Solar Power Project, the short circuit levels are well within specified values of 40kA for 3 seconds.
9. Power quality analysis has been conducted to consider issues such as flicker and harmonics and voltage imbalance. The results indicate that the power quality metrics are within the prescribed IEC limits and Grid Code and there are no constraints in this regard.
10. It has been concluded on the basis of Load flow, Short circuit and Power Quality studies that the K-Electric network has sufficient capacity to absorb the power from 50 MW Gharo Solar Power Project and the power can reliably be evacuated to the K-Electric network.

Table of Contents

Annexures:

Annexure-1: K-Electric HT network data

Annexure-2: ETAP Generated Complete Load flow Report with SLDs.

Annexure-3: ETAP Generated Power Quality Analysis Report with SLDs.

Annexure-4: ETAP Generated Complete Contingency Analysis Report with SLDs.

Annexure-5: ETAP Generated Complete Short Circuit Report with SLDs.

I. Introduction

Gharo Solar (Private) Limited intends to set up a 50 MWp Solar power project at a distance of about 6 km along Sindh Coastal Highway in District Thatta, Sindh. The proposed project lies in the vicinity of the already planned Oursun Solar project. The site of the Gharo Solar project is about 5 km from the Gharo Grid Station, which lies in the vicinity of HT network of K-Electric (formerly known as KESC), whereas the land coordinates of the proposed Gharo Solar Power Project and Oursun Solar Power Project are 24°43'17.03"N, 67°32'44.78"E and 24°43'17.26"N, 67°32'21.49"E respectively, as marked in the maps included at the end of ***Annexure-01***. Gharo Solar (Private) Limited has hired the services of OMS (Pvt.) Limited, to carry out grid interconnection study in order to propose interconnection scheme for evacuation of Power to the K-Electric system network.

This is revised report of the grid interconnection study in which the results of the load flow and Short circuit studies have been presented for the connectivity of 50 MWp Gharo Solar Project with the K-Electric network.

The impact of the 50 MWp Gharo Solar Project through the proposed interconnection scheme on the K-Electric network has been studied in detail and presented in this report.

II. Engineering Standards Compliance

E-TAP 14.1 software has complete compliance with the following International standards for Load flow & Short circuit studies

1) ANSI/IEEE C37 series
2) IEC-60056
3) IEC-60282
4) IEC-61363
5) IEC- 62271-100
6) IEC-60781
7) IEC-60909

8) IEC-60947
9) IEEE-141
10)IEEE-399
11)UL-489
12)Short Circuit GOST R 52735

III. Objectives, Scope of Work and Steps in Execution of Interconnection Study

A. Study Objectives

The system studies have been carried out for the interconnection of 50 MWp Gharo Solar Project with K-Electric network with the following objectives:

- To propose an interconnection scheme for reliable evacuation of Power of 42 MWac from 50 MWp Gharo Solar Project.
- To determine the impact of 50 MWp Gharo Solar Project on K-Electric network.
- To evaluate the benefits of 50 MWp Gharo Solar Project to the K-Electric network.

B. Scope of Work

The scope of work of the grid interconnection study for 50 MWp Gharo Solar Project mainly includes:

a) Base Case upto June 2016

The data taken for Base case is of June 18, 2015. However, loading conditions are aptly rhyming with the load flow conditions of K-Electric provided, attached in ***Annexure-01.***

b) July 2018 - June 2019

Following generations are included in this scenario, in addition to that as described in (a).

- 52 MW FPCL (132kV)
- 35 MW_{ac} (50_{dc} MW) Oursun Solar (132 kV)
- Al Abbas, Lotte, Engro chemicals & Anoud Power (all interconnection on 11kV)
- 250 MW Korangi Power Complex (132 kV)
- 42 MW_{ac} (50_{dc} MW) Gharo Solar Power Project.
- 40 MW Burj Wind Power Plant.
- 250 MW Tapal energy (132 kV)
- 100 MW SNPC Project (132 kV)
- 200 MW Orient Project (132 kV)
- 50 MWp Wind Project (132 kV)
- 110 MW Tristar Project (132 kV)
- 25 MW Bahria Town Project – Solar (132 kV)
- 35 MW_{ac} (50_{dc} MW) Dawood Project – Solar (132 kV)

In addition, to above mentioned generations TP-1000 scope (as provided by K-Electric) has also been implemented from this year and onwards.

The Winter season classification has been done by taking the winter load of Power trafos as 35% w.r.t that of Summer load.However the Bulk consumer loads are kept same in the winter season as that of Summer.

c) July 2019 - June 2020 & July 20 – June 21

Following generations are included in this scenario, in addition to that as described in (b).

- 450 MW Engro LNG (220 kV)
- 2X350 MW Datang Coal Power Plant (220 kV)
- 220 MW FFBL Power Plant (132 kV)
- 100 MW Tapal – I Extension (132 kV)

d) July 2021 - June 2022

Following generations are included in this scenario, in addition to that as described in (c).

- 200 MW KANUPP II / III Project.

All the above mentioned scenarios / classifications have been modelled on the basis of Firm generation list provided by K-Electric. The various alert settings (attached in ***Annexure – 02***) on the software are done as per requirement of K-Electric to have a better analysis of the entire K-Electric network.

C. Steps in Execution of this Interconnection Study Report

The steps in execution of this grid interconnection study report for 50 MWp Gharo Solar Project are presented as under:

i. Collection and review of data/information of K-Electric network, received from K-Electric and data of 50 MWp Gharo Solar Project received from Gharo Solar (Private) Limited.

ii. Processing of data of K-Electric network and 50 MWp Gharo Solar Project according to the input format of ETAP 14.1 software.

iii. Load flow simulation to model the existing system scenario of K-Electric network provided by K-Electric.

iv. Load flow studies for all scenarios as described in 'clause B' namely Scope of Work in the report:

- Propose and determine the suitability of the proposed interconnection scheme for reliable evacuation of Power from 50 MWp Gharo Solar Project.
- Determine the impact of 50 MWp Gharo Solar Project on K-Electric network.
- Evaluate the benefits of 50 MWp Gharo Solar Project to the K-Electric network.

v. Conclusions.

vi. Report Writing.

IV. Description of K-Electric System Network

The transmission system of K-Electric mainly comprises of 220 kV and 132 kV networks. The Power plants are located at different parts of the K-Electric network and feed at 220 kV and 132 kV voltage levels. The salient features of K-Electric network are described as under:

- The 220 kV network comprising of six grid stations (KDA, Pipri West, K.C.R, Lalazar, Baldia & Mauripur) and three Power plants (BQPS-1, BQPS-2 & Korangi CCP) form the backbone of K-Electric system. The 220 kV network is operated in a ring formation except the faulty Lalazar - Mauripur Double circuit line.

- The 220 kV grid stations feed the 132 kV network through 220/132 kV Autotransformers. The capacity and status of the installed Auto-transformers are given as under:

KDA	3x250 MVA	Operational
Pipri West	3x250 MVA	2x250 MVA operational & 1x250 MVA out of service
K.C.R	1x250 MVA	Operational
Lalazar	2x250 MVA	Operational
Baldia	2x250 MVA	Operational
Mauripur	1x250 MVA	Operational

- There is an inherent transmission bottleneck in K-Electric network because of the out of service 220/132 kV Autotransformer # 3 at Pipri West. Due to this inherent bottleneck, the outage of any one of the two 220/132 kV Autotransformers at Pipri West may overload and trip the other remaining Autotransformers as well. However, for optimal utilization of upcoming generation projects, we assumed that this bottleneck would be removed from the year 2018 and onwards.
- K-Electric network gets Power import to the tune of 650 MW from NTDC through 220 kV NKI and Jamshoro circuits mentioned below:

  i. NKI- KDA circuit at 220kV KDA grid station.

  ii. NKI-Baldia circuit at 220kV Baldia grid station.

  iii. Jamshooro circuit -1 at 220kV KDA grid station.

  iv. Jamshooro circuit -2 at 220 kV KDA grid station.

- The magnitude of Power flows on 220 kV inter-ties lines vary as per generation dispatch pattern in NTDC and K-Electric systems.

V. Data Collection, Review and Processing

The load flow studies for the grid interconnection of 50 MWp Gharo Solar Project has been carried out by using "Power System Simulator for Engineering (ETAP 14.1)" software, the most widely used software worldwide for transmission system analysis.

In order to conduct the grid interconnection study, the ETAP 14.1 electronic model of the K-Electric system network was not available with K-Electric. Therefore, on the request of OMS (Pvt.) Limited, the required basic input data of the existing K-Electric network including Power plants, grid stations, transmission lines, load demand etc. has been provided by K-Electric. The data of 50 MWp Gharo Solar Project has been provided by Gharo Solar (Private) Limited.

The information / data of K-Electric network was reviewed and through some interactions with K-Electric was finalized wherever there were some missing information and / or clarifications required. This data has been processed to make the computerized model of K-Electric network into the requisite format of ETAP 14.1 software.

Considering requirement of this grid interconnection study, the complete network of K-Electric has been processed and modelled in ETAP 14.1 software.

A. 50 MWp Gharo Solar Design Data

The key design data of the solar project is presented below, which is subject to change at detailed design stage.

- Number of Solar Panels – 416,680 Nos
- Watts / Panel – 120Wp (FS-4120-3 Feb'2016)
- Number of Solar Panels in series – 11 Modules in Series
- Number of Solar Panels in parallel – 37,880 Strings in Parallel
- Volts, DC – 570V-850V DC (based on PVS800-1000kW-C-WS ABB Inverter)
- kW, DC – 50002kWp(@ STC) & 46397kWp (50 Deg C)
- Amperes, DC – 64095A (Impp) @ Umpp of 724V @ 50 Deg C
- Ambient Temperature (°C) – 50 Deg C
- Panel cell Temperature (°C) – May vary from ~40 Deg - ~75 Deg
- Longitude and Latitude – 24.7N, 67.5E
- Declination Angle (°C) – Single Axis Tracker - +50/-50 Deg Tilt
- Manufacturer – Module – First Solar
- Type & Model - (FS-4120-3 Feb'2016)
- Number of Inverters – 40 Units of 1000kW (AC) – PVS800-1000kW-C-

WS ABB Inverter

- DC to AC % Efficiency – AC/DC Ratio – 1.20
- PV Array to Inverter cable details- Shall be of
- PV Cable (Ultra Beam) from module to inverter (size shall vary from 4 Sq.mm CU to 6 Sq.mm CU)
- XLPE DC Armoured Cable of 1.1kV voltage rating (size shall vary from 240 Sq.mm to 400 Sq.mm Al Cable)
- Module Characteristics,
  - Length (cm) – 1200mm
  - Width (cm) – 600mm
  - Depth (cm) – 7.0mm
  - Weight (kg) – 12 kG

B. Interconnection Scheme for 50 MWp Gharo Solar Project

The objective of this grid interconnection study is to propose a reliable transmission scheme for evacuation of Power from 50 MW Gharo Solar Power Project to the K-Electric network reliably under all scenarios. Keeping in view the generation capacity (50 MW) of M/s Gharo Solar (Private) Limited and the existing system network in its neighborhood, the following scheme has been proposed for 50 MWp Gharo Solar Project:

"132 kV double circuit (400 sq mm, Cu conductor) of about 0.7 km length to loop in-out the already planned Oursun Solar - Gharo single circuit located near the Gharo Solar Plant."

VI. Load Flow Studies

In this section, the objectives, assumptions and criteria of the load flow studies are presented. The results of detailed load flow studies have been presented.

A. Study Assumptions

The assumptions in performing load flow studies, in general, are presented as under:

1) The 220 & 132 kV K-Electric network has been modeled and it is assumed in interconnected manner.
2) The 220 kV lines connecting K-Electric network with NTDC network have also been modelled.
3) Loads (MW & MVAR) at 132 kV grid stations as provided by K-Electric.
4) The Bulk consumer loads on 220 & 132 kV fed from grid stations have been modeled by an equivalent lumped load at the respective bus of grids as per list shared by K-Electric and attached in ***Annexure-01***.
5) Generation dispatch and Power flows on the 220 kV lines have been kept as per information / data received from K-Electric.
6) The import of Power from NTDC has been represented by generation sources mainly at NKI and Jamshoro.
7) On the above existing scenario model, load flow analysis has been carried out to determine the suitability, impact and benefits of 50 MWp Gharo Solar Project though the proposed interconnection scheme.

B. Study Criteria

The load flow studies have been carried out keeping in view of the system operating criteria/limits in accordance with Grid Code approved by National Electric Regulatory Authority (NEPRA) in Pakistan. The Grid Code Criteria is given below:

Voltage Limit	±5% under Normal condition

	±10% under N-1 contingency condition.
Frequency Limit	49.8-50.2 Hz under normal condition. 49.4-50.5 under N-1 contingency condition.
Power Factor Limit	0.95 leading & 0.95 lagging at point of coupling
Transmission Line Loading Limit	80% under normal conditions 100% under N-1 contingency condition
Transformer Loading Limit	80% under normal conditions 100% under N-1 contingency condition

C. Study Scenarios

Load flow studies have been carried out for the following system scenarios in addition to that of Base case which is the existing one:

a) Base Case upto June 2016

The data taken for Base case is of June 18, 2015. However, loading conditions are aptly rhyming with the load flow conditions of K-Electric provided, attached in ***Annexure-02.***

b) July 2018 - June 2019

Following generations are included in this scenario, in addition to that as described in (a).

- 52 MW FPCL (132kV)
- 35 MW_{ac} (50_{dc} MW) Oursun Solar (132 kV)
- Al Abbas, Lotte, Engro chemicals & Anoud Power (all interconnection on 11kV)
- 250 MW Korangi Power Complex (132 kV)

- 42 MW_{ac} (50_{dc} MW) Gharo Solar Power Project.
- 40 MW Burj Wind Power Plant.
- 250 MW Tapal energy (132 kV)
- 100 MW SNPC Project (132 kV)
- 200 MW Orient Project (132 kV)
- 50 MWp Wind Project (132 kV)
- 110 MW Tristar Project (132 kV)
- 25 MW Bahria Town Project – Solar (132 kV)
- 35 MW_{ac} (50_{dc} MW) Dawood Project – Solar (132 kV)

In addition, to above mentioned generations TP-1000 scope (as provided by K-Electric) has also been implemented from this year and onwards.

The Winter season classification has also been done by taking the winter load of Power trafos as 35% w.r.t that of Summer load. However the Bulk consumer loads are kept same in the winter season as that of Summer.

c) July 2019 - June 2020 & July 20 – June 21

Following generations are included in this scenario, in addition to that as described in (b).

- 450 MW Engro LNG (220 kV)
- 2X350 MW Datang Coal Power Plant (220 kV)
- 220 MW FFBL Power Plant (132 kV)
- 100 MW Tapal – I Extension (132 kV)

d) July 2021 - June 2022

Following generations are included in this scenario, in addition to that as described in (c).

- 200 MW KANUPP II / III Project.

All the above mentioned scenarios / classifications have been modelled on the basis of Firm generation list provided by K-Electric. The various alert settings (attached in ***Annexure – 02***) on the software are done as

per NEPRA grid code to have a better analysis of the entire K-Electric network.

July 2018 - June 2019 (Summer Season)

RECP- Pipri West 132 kV	0.366 / 49.620	211.8	0.7
Burj-Gharo	21.686 / 25.833	146.8	64.3
Burj-RECP	16.244 / 15.830	98.7	71.6
Gharo Solar-Gharo	4.443 / 13.131	60.5	32.0
Oursun Solar-Gharo Solar	36.050 / 7.499	160.9	97.9
Oursun Solar-Dhabeji	70.947 / 18.783	320.9	96.7

July 2018 - June 2019 (Winter Season)

RECP- Pipri West 132 kV	12.549 / 0.470	53.0	99.9
Burj-Gharo	OUT OF SERVICE		
Burj-RECP	OUT OF SERVICE		

Gharo Solar-Gharo	1.169 / 0.733	5.8	84.7
Oursun Solar-Gharo Solar	39.338 / 5.896	167.0	98.9
Oursun Solar-Dhabeji	39.326 / 10.737	171.2	96.5

July 2019 - June 2020 & July 2020 – June 2021

RECP- Pipri West 132 kV	23.962 / 8.836	108.9	93.8
Burj-Gharo	23.355 / 14.844	118.3	84.4
Burj-RECP	14.578 / 4.736	65.5	95.1
Gharo Solar-Gharo	6.801 / 8.495	46.6	62.5
Oursun Solar-Gharo Solar	33.698 / 19.208	166.2	86.9
Oursun Solar-Dhabeji	68.598 / 31.266	323.2	91.0

July 2021 – June 2022

RECP- Pipri West 132 kV	11.709 / 11.484	72.5	71.4
Burj-Gharo	27.881 / 17.676	146.2	84.5
Burj-RECP	10.048 / 7.777	56.3	79.1
Gharo Solar-Gharo	1.391 / 13.428	60.0	10.3

Oursun Solar-Gharo Solar	39.100 / 22.607	200.7	86.6
Oursun Solar-Dhabeji	73.993 / 33.229	360.6	91.2

The above Power and current flows are well within the de-rated capacities of the transmission lines, except for few transmission lines modelled in SLD attached in ***Annexure-02(Alert list),*** not in the vicinity of the project, as per Transmission lines data provided by K-Electric. This bottle neck of overloading is due to the consideration of optimum utilization of generation projects. However, K-Electric should have their Transmission reinforcement project to get the maximum output or reduce the line loading for well within de rated line ampacity.

The ***Voltage profile*** on the major 220kV and 132kV grid stations in the surrounding of 50 MWp Gharo Solar Project for above mentioned scenarios along with Base case are summarized in below tables:

July 2018 - June 2019 (Summer Season)

GRID STATION	VOLTAGE LEVEL (KV)
Pipri West 132 kV	135.3
Gharo Solar 132 kV Bus	132.1
RECP 132 kV	133.9
Gharo 132 kV	132.3
Dhabeji 132 kV	135
BOC 132 kV	133.7

July 2018 - June 2019 (Winter Season)

GRID STATION	VOLTAGE LEVEL (KV)
Pipri West 132 kV	136.8
Gharo Solar 132 kV Bus	137.5
RECP 132 kV	136.8
Gharo 132 kV	137.5

Dhabeji 132 kV	137.2
BOC 132 kV	136.9

July 2019 - June 2020 & July 2020 – June 2021

GRID STATION	VOLTAGE LEVEL
Pipri West 132 kV	135.4
Gharo Solar 132 kV Bus	134.7
RECP	135.1
Gharo	134.8
Dhabeji	133.9
BOC	135.1

July 2021 – June 2022

GRID STATION	VOLTAGE LEVEL
Pipri West 132 kV	131.3
Gharo Solar 132 kV Bus	129.9
RECP	131.0
Gharo	130.1
Dhabeji	129.0
BOC	130.9

Auto transformers (All have rating of 250 MVA) loading in percentage for all scenarios are present in ***Annexure-02 (Summary Report)*** from which it is apparent that all transformers are within prescribed loading condition of grid code or OEM loading criteria.

VII. Power Quality Analysis

A. Active Power and Frequency Control

As per NEPRA grid code Addendum - II for Solar Power Plants, dated June

2014, mentioned below in the table the Active Power Output of Solar panels in percentages for rated AC power output of 42 MW along with respective change in irradiance level for different climatic conditions. The study has been conducted and found in compliance as per NEPRA grid code. The software generated reports and SLDs are attached in ***Annexure-03***.

ACTIVE POWER OUTPUT IN %	IRRADIANCE (W/m^2)
100	1030
70	482
50	320
30	186
0	0

From the report attached in ***Annexure-03***, it is significant that Voltage and Frequency are well within prescribed range of grid code.

B. Reactive Power and Voltage Control

From Load flow report attached in ***Annexure-02,*** with 100% full active power the reactive power and voltage are well within prescribed range of NEPRA grid code.

C. Harmonics and Flicker

As per IEC standard, the Individual and Total Harmonic distortion on Voltage wave form should be less than 3% and 5% respectively. The Harmonic analysis Load flow report and graph are included in ***Annexure -03***, which demonstrate that there is no issue of Harmonics or Flicker and the inverter is fully capable of supressing harmonics as per IEC standard and NEPRA grid code.

VIII. Contingency Analysis

The load flow studies have also been carried out for contingency (N-1) analysis in K-Electric network with the addition of 50 MWp Gharo Solar Project. The

load flow study Scenarios for N-1 Contingency analysis are attached in ***Annexure-04***, and their results are presented as below:

A. Gharo Solar - Gharo circuit Out

The current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project in this condition as well as de-rated line capacities are presented as below:

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacity (A)
Burj WPP - Gharo	141.7	569
Burj WPP - RECP	89.5	569
RECP - Pipri	210.6	569
Oursun - Dhabeji	330.4	650
Oursun – Gharo Solar	178.6	650

B. Oursun Solar – Gharo Solar circuit Out

The current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project in this condition as well as de-rated line capacities are presented as below:

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacity (A)
Burj WPP - Gharo	126.9	569
Burj WPP - RECP	116.0	569
RECP - Pipri	212.9	569

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacity (A)
Oursun - Dhabeji	160.3	650
Gharo Solar – Gharo	177.6	650

C. Oursun Solar – Dhabeji circuit Out

The current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project in this condition as well as de-rated line capacities are presented as below:

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacity (A)
Burj WPP - Gharo	109.2	569
Burj WPP - RECP	135.0	569
RECP - Pipri	216.3	569
Oursun – Gharo Solar	159.3	650
Gharo Solar - Gharo	327.5	650

D. Gharo 132 kV Bus Out

The current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project in this condition as well as de-rated line capacities are presented as below:

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacities (A)
Burj WPP - RECP	167.0	569
RECP - Pipri	198.5	569
Oursun – Gharo Solar	180.3	650
Oursun Solar - Dhabeji	333.2	650

E. Gharo Solar Panel Out

The current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project in this condition as well as de-rated line capacities are presented as below:

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacities (A)
Burj WPP - Gharo	153.8	569
Burj WPP - RECP	85.0	569
RECP - Pipri	204.5	569
Gharo Solar - Gharo	51.7	650
Oursun - Dhabeji	298.7	650
Oursun – Gharo Solar	138.7	650

F. Oursun Solar Panel Out

The current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project in this condition as well as de-rated line capacities are presented as below:

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacity (A)
Gharo Solar - Gharo	53.8	650
Burj WPP - Gharo	153.1	569
Oursun - Dhabeji	300.1	650
Oursun – Gharo Solar	175.6	650
Burj WPP - RECP	87.6	569

G. Burj WTG Out

The current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project in this condition as well as de-rated line capacities are presented as below:

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacity (A)
Gharo Solar - Gharo	62.6	650
Burj WPP - Gharo	129.1	569
Burj WPP - RECP	89.6	569
Oursun - Dhabeji	309.8	650
Oursun – Gharo Solar	149.9	650

H. RECP 132 kV Bus Out

The current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project in this condition as well as de-rated line capacities are presented as below:

132 KV Transmission Line	Running Amperes (A)	De-rated Line Capacity (A)
Gharo Solar - Gharo	29.4	650
Burj WPP - Gharo	173.1	569
Oursun - Dhabeji	350.9	650
Oursun – Gharo Solar	193.1	650

It is observed in the study Exhibits that during N-1 contingency conditions, the power and current flows on the 132 kV transmission lines in the surrounding of 50 MWp Gharo Solar Project as well as on the 220 kV transmission lines and 220/132 kV auto-transformers in the K-Electric network remain well within their capacity limits (prescribed Grid Code criteria). The voltage profile of the grid stations remain within prescribed Grid Code criteria during contingency conditions.

However, K-Electric should have their Transmission reinforcement project to get the maximum output or reduce the line loading for well within de rated line ampacity.

IX. Short Circuit Studies

1) A short circuit in a Power system can cause very high currents to flow to the fault location. The magnitude of the short circuit current depends on the impedance of system under short circuit conditions. Short circuit calculations are usually carried out whenever a new Power system is designed or an expansion and upgrade of an existing system including a new generation project is being planned.

2) Short circuit studies have been carried out with proposed interconnection scheme of 50 MWp Gharo Solar Project to compute the maximum

balanced three phase and unbalanced single phase short circuit levels in the surrounding grid stations of K-Electric network. This analysis shall provide the basis for choosing the short circuit ratings of the equipment of proposed substation of the Power plant and see if the fault current contributions from the proposed plant increase the short circuit levels to the extent of violating the rated limits of the equipment at the substations in the vicinity.

A. Study and Data Assumptions

1) The short circuit studies have been carried out in accordance with the standard of IEC 60909 Standard which includes the following assumptions: (a) Transformers tap ratios to unity; (b) Shunts to zero in positive sequence; (c) Line charging to Zero; and (d) Voltage magnitude at bus bars to 1.1 p.u. The voltage magnitude of 1.1 p.u. has been selected to compute the maximum three phase and single phase short circuit levels.

2) In the short circuit studies, certain parameters of Power plant & K-Electric network are not shared so standard typical values are being used for simulation. The ETAP 14.1 system model for short circuit analysis has been developed by processing and adding the positive, negative and zero sequence data in the already developed load flow model of K-Electric network.

B. Short Circuit Study Results

The short circuit studies have been carried out for below mentioned scenarios:

e) Base Case upto June 2016

The data taken for Base case is of June 18, 2015. However, loading conditions are aptly rhyming with the load flow conditions of K-Electric provided, attached in ***Annexure-05.***

f) July 2018 - June 2019

Following generations are included in this scenario, in addition to that as described in (a).

- 52 MW FPCL (132kV)
- 35 MW_{ac} (50_{dc} MW) Oursun Solar (132 kV)
- Al Abbas, Lotte, Engro chemicals & Anoud Power (all interconnection on 11kV)
- 250 MW Korangi Power Complex (132 kV)
- 42 MW_{ac} (50_{dc} MW) Gharo Solar Power Project.
- 40 MW Burj Wind Power Plant.
- 250 MW Tapal energy (132 kV)
- 100 MW SNPC Project (132 kV)
- 200 MW Orient Project (132 kV)
- 50 MWp Wind Project (132 kV)
- 110 MW Tristar Project (132 kV)
- 25 MW Bahria Town Project – Solar (132 kV)
- 35 MW_{ac} (50_{dc} MW) Dawood Project – Solar (132 kV)

In addition, to above mentioned generations TP-1000 scope (as provided by K-Electric) has also been implemented from this year and onwards.

g) July 2019 - June 2020 & July 20 – June 21

Following generations are included in this scenario, in addition to that as described in (b).

- 450 MW Engro LNG (220 kV)
- 2X350 MW Datang Coal Power Plant (220 kV)
- 220 MW FFBL Power Plant (132 kV)

- 100 MW Tapal – I Extension (132 kV)

h) July 2021 - June 2022

Following generations are included in this scenario, in addition to that as described in (c).

- 200 MW KANUPP II / III Project.

The summary of maximum three phase and single phase short circuit current levels at the switchyard of 50 MWp Gharo Solar Project and other surrounding 220 & 132 kV grid stations in K-Electric HT network are tabulated as under:

Faulty Bus	July 18 - June 19		July 18 - June 19 (Winter Season)		July 19 - June 20 & July 20 – June 21		July 21 – June 22	
	3-Phase Current (kA)	1-Phase Current (kA)	3-Phase Current (kA)	1-Phase Current (kA)	3-Phase Current (kA)	1-Phase Current (kA)	3-Phase Current (kA)	1-Phase Current (kA)
Gharo 132 kV Bus	11.824	11.440	6.930	5.907	17.728	16.386	18.241	16.676
Dhabeji 132 kV Bus	13.927	12.305	11.435	9.203	19.111	15.475	19.926	15.826
RECP 132 kV Bus	21.785	17.234	19.004	15.087	29.054	24.488	29.805	24.843
Port Qasim 132 kV Bus	31.475	20.549	27.754	19.377	40.887	35.314	41.868	35.804
ROC 132 kV Bus	18.350	12.933	16.605	12.085	24.792	17.204	25.179	17.329
Gharo Solar 132 kV Bus	11.513	11.698	8.438	8.428	15.811	14.942	16.278	15.217

From above table, it is evident that short circuit level from July 2019 onwards at Port Qasim 132 kV (existing grid) exceeds the value 40 kA for 3 seconds, which is due to upcoming generations in the vicinity during this tenure. In order to overcome this issue the upcoming generations should have their CLRs to reduce the impact on the network.

X. Conclusion

1. The impact of the 50 MWp Gharo Solar Project with the proposed interconnection scheme on K-Electric network has been studied comprehensively. The benefits of 50 MWp Gharo Solar Project to K-Electric have also been computed which mainly include:
   - Additional source of Power supply in the surrounding network of 50 MWp Gharo Solar Project.
   - Improvement in voltage profile, especially at grid stations in the surrounding of 50 MWp Gharo Solar Project.
   - Reduction in transmission line losses of K-Electric network.
   - Improvement in system reliability in the surrounding of 50 MWp Gharo Solar Project.
   - Improvement in Power supply position of K-Electric network.
   - Reduction in load shedding per annum as per added future generation.
   - Dependency on NTDC generation is reduced
   - After ample generation the maintenance/overhauling of any generating unit can easily be scheduled.
2. Short circuit study is carried out in the vicinity of the proposed 50 MW Gharo Solar Power Project for all scenarios. From the short circuit study it is found that, with the induction of 50 MW Gharo Solar Power Project, the short circuit levels are well within specified values of 40kA for 3 seconds.
3. Power quality analysis has been conducted to consider issues such as flicker and harmonics and voltage imbalance. The results indicate that the power quality metrics are within the prescribed IEC limits and Grid Code and there are no constraints in this regard.
4. It has been concluded on the basis of Load flow, Short circuit and Power Quality studies that the K-Electric network has sufficient capacity to absorb the power from 50 MW Gharo Solar Power Project and the power can reliably be evacuated to the K-Electric network.

2017/07/25/IEE/162

ENVIRONMENTAL PROTECTION AGENCY
GOVERNMENT OF SINDH

Dated: 20-10-2017

SUBJECT: DECISION ON INITIAL ENVIRONMENTAL EXAMINAITON (IEE).

1.	**Name and Address of Proponent:**	Gharo Solar Pvt. Ltd. House # 148/C-2A, Asad Jan Road, Lahore Cantt, Pakistan
2.	**Description of Project:**	Installation and Operation of 50 MW Solar PV power plant
3.	**Location of Project:**	Dehi Gharabad, Mirpur Sakro, District Thatta, Sindh.
4.	**Date of Filing of IEE:**	25-07-2017

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

(i) M/s Gharo Solar hereinafter referred as proponent shall comply Sindh Environmental Quality Standards (SEQS) for air emission and waste water from the project site.

(ii) Mitigation measures recommended in the IEE report must be strictly adhered to minimize any negative environmental effect on the natural ecology of the project area.

(iii) Gharo Solar will appoint an Independent Monitoring Consultant (IMC) to monitor the project activities, compliance status of mitigation measures suggested in EMMP. The IMC shall ensure that the activities at project site are undertaken in environment friendly manner and the mitigation measures are implemented as per the recommendations of IEE report. The proponent will be liable to submit quarterly environmental monitoring reports by engaging IMC which shall include gaseous emissions, ambient air quality, drinking water and wastewater monitoring results to EPA Sindh during the construction and operation phase of project.

(iv) A comprehensive waste management plan shall be prepared for Solid Waste. All solid waste generated during construction and operation phase of the project will be disposed through EPA Certified Contractors only.

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

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

(vi) Gharo Solar will ensure that a proper emergency evacuation and firefighting plan is implemented which shall be supplemented by frequent mock drills and the record shall be maintained which may be verified by SEPA as and when required.

(vii) Gharo Solar shall ensure that no unfortunate incidents are caused due to construction and operations of the project. The cost of damage to the environment, property or life of the people/workers shall lie on the proponent, any damage caused to any civil structure/properties due to construction of project will be compensated by project proponent.

(viii) Gharo Solar shall maintain a green area within its facility by plantation of Native Tree Species.

6. This approval and any considerations thereof shall be treated as null and void if the conditions, mentioned in para-5 above, are not complied with.

7. The proponent shall be liable for compliance of EIA/IEE Regulations, 2014, which direct for condition for approval, confirmation of compliance, entry, inspection and monitoring.

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

9. The approval is accorded only for the project activity described in the IEE Report. Proponent shall submit separate EIA or IEE as required under regulation for any enhancement or change in the design of project.

10. Implementation Report of all the mitigation measures and EMP laid down in the IEE Report shall be submitted to this office on quarterly basis. No violation of any regulations, rules, instruction and provision of SEP Act, 2014, shall be made and in case of any such violation of the rules/laws in the approval shall stand cancelled without any further notice.

11. All the environmental conditions of this approval shall be incorporated in the terms and conditions of tender document of the project for commitment and compliance.

Muhammad Imran Sabir
Deputy Director (Technical-II)
***For* Director General**

Gharo Solar (Private) Limited (GSPL)

Initial Environmental Examination (IEE)

Of

50 MWp Solar Photovoltaic (PV) Power Plant

June, 2017

Global Environmental Management Services (Pvt.) Ltd
2nd Floor, Aiwan-e-Sanat, ST-4/2, Sector 23, Korangi Industrial Area, Karachi
Ph: (92-21) 35113804-5; Fax: (92-21) 35113806; Email: info@gems-intl.com

ES

EXECUTIVE SUMMARY

The Initial Environmental Examination (IEE) for the proposed project of "50 MWp Solar Photovoltaic (PV) Power Plant" has been conducted by Global Environmental Management Services (Pvt.) Ltd. (GEMS). The Initial Environmental Examination (IEE) has been prepared in compliance with the requirement under Section 17 of Sindh Environmental Protection Act, 2014.

The Sindh Environmental Protection Act 2014 empowers the Sindh EPA as the principal authority for environmental management in Sindh, Pakistan. It has also established the requirement of environmental assessment of any project in place prior to commencement of work.

The proposed project falls under the project Schedule I of Category B: "Solar Project" as per the guidelines issued by the Sindh Environmental Protection Agency (Review of IEE/EIA) Regulations 2014 and Section 17 of Sindh Environmental Protection Agency (SEPA) under the SEPA ACT, 2014. Accordingly an IEE report has been developed and submitted to Sindh EPA for review and approval.

GSPL has planned to conduct Initial Environmental Examination (IEE) for the proposed project prior to construction and installation activities in order to get environmental compliance. The study has taken into consideration, all the relevant national legislations and regulations, followed by site visits and details of constructional and operational activities of proposed project. Environmental and socio-economic baselines are taken through field survey and from previous reports, books and other literature. The baseline has been further investigated and confirmed during visits.

The main purpose of this Initial Environmental Examination (IEE) study is to ensure:

- All major and minor positive and negative impacts on the environment (physical, biological, social and ecological) during the different stages inception as well as pre-construction, construction, installation and operation of 50 MWp Solar Photovoltaic (PV) Power Plant.
- Appropriate and adequate mitigation measures are suggested to reduce or eradicate the possible adverse environmental impacts and provide practical procedures for their implementation.
- Environmental Management Plan (EMP) for sustainable operation of the proposed project forms an essential part of the IEE document.

PURPOSE OF THE PROJECT

Pakistan is an energy-deficit country and has faced a persistent and acute power generation shortage for the last several years. The maximum total demand recorded by KE in 2014-15 stood at 3,056 MW, whereas maximum generation capability including import was 2,632 MW. While the peak deficit of 424 MW or 16% is significantly lower than the National Transmission & Dispatch Company (NTDC) system, KE is continuing to invest substantial resources in enhancing generation capacity, improving its fleet efficiency and launching transmission & distribution enhancement programs such as the TP-1000 initiative.

On the generation side, KE is also entering into new power / energy purchase agreements with Independent Power Producer (IPPs) on diverse fuels including natural gas, Liquefied Natural Gas (LNG), coal, etc. At the same time, the utility as part of its Climate Change Policy (CCP) is also encouraging the development of renewable energy projects including solar and wind in its licensed territory. The 50 MWp Gharo Solar Plant is proposed to fulfill KE twin imperatives of continuously augmenting generation given projected 5-6% annual increase in demand and demonstrating its commitment to harnessing indigenous and environmentally friendly energy resources.

The electricity generated by 50 MWp Solar (PV) Power Plant would be stepped up to 132 kV and dispersed to the KE grid network near the Project. The proposed Project brings in multifold advantages. The Solar PV project will not only produce clean, pollution free energy but it also has the capacity to provide employment to the people living in and around the area.

PROPONENT INTRODUCTION

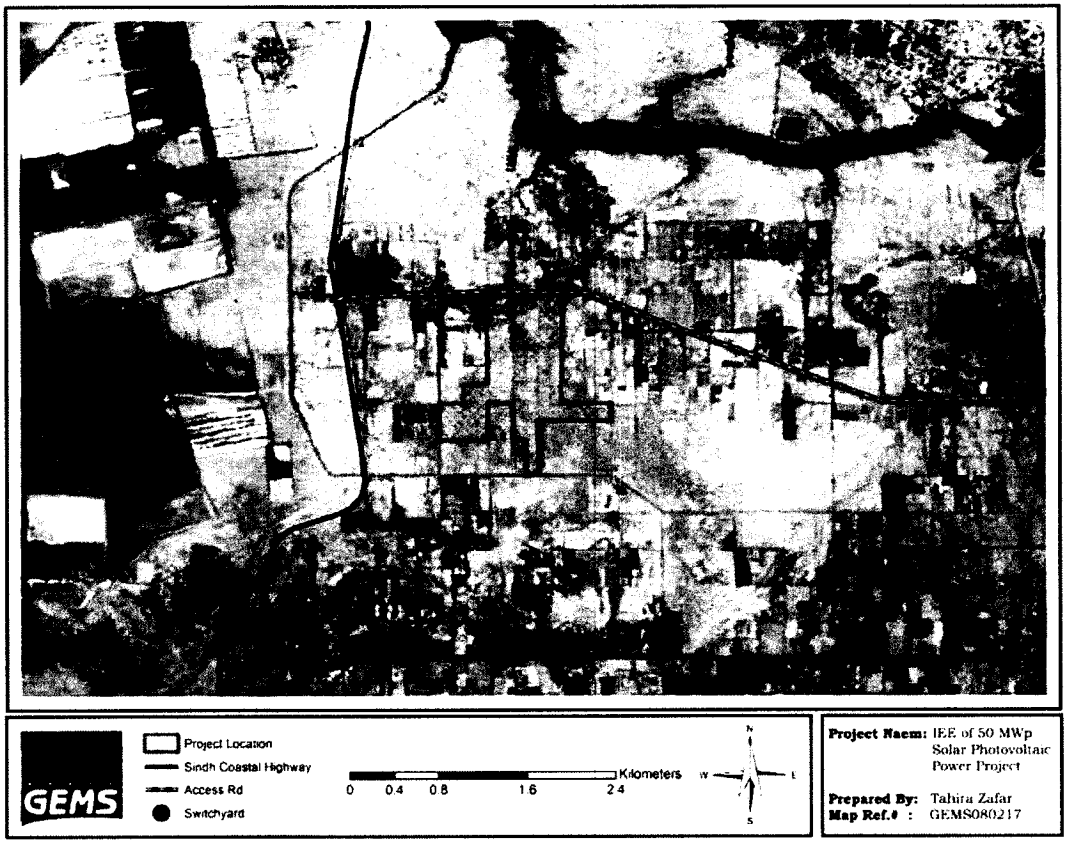
GSPL was issued Certificate of Incorporation on June 30, 2016 under the Companies Ordinance, 1984 by the Securities and Exchange Commission of Pakistan. GSPL was also issued a Letter of Intent (LOI) by KE for initial development of the planned 50 MWp Solar (PV) Power Plant on July 1, 2016 and subsequently executed a term sheet with KE for continued development of the proposed project on November 10, 2016. GSPL shall next execute an Energy Purchase Agreement with KE upon fulfilling regulatory pre-requisites including approval of Tariff and Generation License by NEPRA.

PROJECT AREA

Proponent Address

Solar (PV) Plant is to be located at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh at approximately 6 km along the Sindh Coastal Highway and then 1.25 km via connecting road from the Highway. The site is at about 55 km away from Jinnah International Airport, Karachi and is adjacent to the 50 MWp Oursun Solar Plant, which shall also sell electricity to KE Limited.

Project Location Map



PROJECT DESCRIPTION

Solar PV power plant project comprises the construction, installation and operation of an approximately 50 MWp capacity Solar (PV) Power Plant with crystalline or thin film modules mounted on single axes trackers. The electricity generated by the project would be stepped up to 132 kV and dispersed to the K-Electric grid network near the proposed sites.

PHYSICAL ENVIRONMENT

The proposed project area lies on the main Sindh Coastal Highway where it begins from the National Highway turning. At present, the area is completely barren and is close to the Sindh creek system. Proposed project area is found to be windy and relatively less rainfall is recorded in the region. The area is selected by the Government of Sindh as a viable area for renewable energy projects. The area has both underground and surface water resources where the local people who live in hamlets utilize the water for irrigation, livestock and drinking purposes.

BIOLOGICAL ENVIRONMENT

Data for the IEE was gathered from both primary and secondary sources. Baseline field survey was conducted in March 2017. No endangered or threatened species were found to be existent within the project areas. Since the areas represent semi-rural environment, minimal floral habitat was found that may need special attention, the project will be carefully executed to eliminate unnecessary damage to vegetation. The proposed project area does not seem to provide favorable conditions for ecosystems to flourish. No trees were found along the proposed transmission line route.

SOCIOECONOMIC ENVIRONMENT

The proposed project area can be considered as suburbs of Gharo city as it lies on the main Sindh Coastal Highway. No major settlements were found near the proposed project site, however sparse hamlets were identified during the survey. The people are mostly illiterate and their lifestyle depends on livestock and agriculture. Locals live a simple lifestyle that lack health and other essential facilities. Thereby they look forward for a safe and a better way of living.

IMPACT AND MITIGATION

The assessment has primarily focused on the construction activities and later on the operation activities. During the initial construction phase there can be considerable environmental impacts mainly due to civil works such as site preparation, construction of building, vehicle movement etc. Construction phase impacts are usually temporary and localized phenomenon, while impact sources and the potential impacts on the environment during the construction phase are identified and are evaluated for their mitigation measures.

The operational phase may have some environmental impacts including solid waste and wastewater because of cleaning of solar panel and the removal of defected panel. The mitigations for the identified impacts due to the proposed project are summarized in the Environmental Management Plan given below.

Environmental Monitoring Program

Environmental Aspect	Scope of Monitoring	Method	Location	Frequency of Monitoring	Responsibility
Construction Phase					
Air	Parameters prescribed in SEQS or as per SEPA requirements	Ambient Air Quality Monitoring	Within the proposed project site	Quarterly	Contractor GSPL
	Emissions of CO, NOx, SO_2 from mobile construction equipment and vehicles.	Emission testing will be done by Portable exhaust analyzer when the equipment and vehicle are in use	When and where used as per construction activity	Quarterly	Contractor GSPL
Noise	Construction activity associated noise levels	Noise levels will be recorded by noise meters at a distance of 7.5 m from source point	Representative locations ideally inside and outside of the proposed project site	Weekly	Contractor GSPL
Land and soil	Surface topography	Visual assessment Photographic evidences	Within the proposed project site	Weekly	Contractor GSPL
Terrestrial Ecology	Green area development plan	Plan verification	Within the proposed project site	Quarterly	GSPL

Environmental Aspect	Scope of Monitoring	Method	Location	Frequency of Monitoring	Responsibility
Construction Phase					
Waste Water	Record log of water usage and releases Water drainage system	Check water drainage system Ensure the plan is being implemented	Within the proposed project site	Weekly	Contractor
Solid Waste	Assessment of solid waste quantity and type Safe disposal and segregation Certificate of waste disposal through contractors to be kept in record.	Solid waste management plan is being implemented Records are to be maintained	Within the proposed project site	Monthly	Contractor/ GSPL
Roads and networks	Signs and symbols are being followed	Visual assessment Photographic evidences	Premises of Project area	Monthly	Contractor

Environmental Aspect	Scope of Monitoring	Method	Location	Frequency of Monitoring	Responsibility
Operation Phase					
Noise	Operation activity associated noise levels	Noise levels will be recorded by noise meters	Representative locations ideally inside and outside of the proposed project site	weekly	GSPL
Solid Waste	Solid waste management plan Safe disposal and segregation	Assessment of Solid Waste Quantity and Type	All project locations	Monthly	GSPL
Waste water	Collection of wastewater in the designated pits. Recycling of collected water that can be utilized for watering greenbelt area	Record log of water usage Monitoring of Wastewater	Around the plant.	Twice a month	GSPL

CONCLUSION

Regardless of all development and business initiatives, there is a need of Environmental Management Plan (EMP) to execute the mitigation measures at its actual sense. Therefore, an EMP has been created and compiled for the assistance of the proponent which shall supervise and monitor all the mitigation measures and their effectiveness. It explains and assigns roles & responsibilities of work to the individuals of management and makes it easy to handle the issues with care. Procedures to work on EMP shall be further developed by the developers of the project. The main aspects covered in the EMP includes guidelines for management approach, organizational structure indicting roles and responsibilities. Along with implementation stages of EMP such as planning & design considerations, monitoring and mitigation plans during construction and operation phases.

Global Environmental Management Services (Pvt.) Ltd. (GEMS) have concluded that:

"If the proposed project activities are undertaken as suggested and described in this report, and the recommended mitigations and environmental management plan are adopted, the project will not result in any long-term or significant impacts on the local community or the environment rather it will be a symbolic project of sustainable development".

LIST OF CONTENTS

6.0 ENVIRONMENTAL BASELINE: SOCIO-ECONOMIC CULTURAL ENVIRONMENT

7.0 ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

8.0 ENVIRONMENTAL MANAGEMENT PLAN

9.0 CONCLUSION

LIST OF ABBREVIATIONS

AC	:	Alternating Current
BAT	:	Best Available Technology
BP	:	Before Present
CCP	:	Climate Change Policy
CITES	:	Convention on International Trade in Endangered Species
dB	:	Decibel
DC	:	Direct Current
DG	:	Director Gernal
EMS	:	Environmental Management System
EMP	:	Environmental Management Plan
EA	:	Environmental Assessment
EHS	:	Environment, Health and Safety
ESIA	:	Environmental and Social Impact Assessment
EIA	:	Environmental Impact Assessment
EPA	:	Environmental Protection Agency
EPC	:	Engineering, Procurement and Construction
GEMS	:	Global Environmental Management Services
GSPL	:	Gharo Solar (Private) Limited
HSE	:	Health, Safety and Environment
IEE	:	Initial Environmental Examination
IPPs	:	Independent Power Producer
IT	:	Inverter Transformer
KE	:	Karachi-Electric
kV	:	Kilovolt
LAA	:	Land Acquisition Act
LNG	:	Liquefied Natural Gas

LOI	:	Letter of Intent
MWp	:	Megawatt Peak
NCS	:	National Conservation Strategy
NDIR	:	Non Dispersive Infra-Red
NDRMFP	:	National Disaster Risk Management Framework Pakistan
NEPRA	:	National Electric Power Regulatory Authority
NEAP	:	National Environmental Action Plan
NGOs	:	Non-Governmental Organizations
NRSP	:	National Rural Support Programme
NTDC	:	National Transmission & Dispatch Company
NOC	:	No Objection Certificate
OSHA	:	Occupational Safety and Health Administration
O&M	:	Operation and Maintenance
PEPA	:	Pakistan Environmental Protection Agency
PPAF	:	Pakistan Poverty Alleviation Fund
PPE	:	Personal Protective Equipment
PV	:	Photovoltaic
RMUs	:	Ring Main Units
SAT	:	Singe Axis Trackers
SEPA	:	Sindh Environmental Protection Agency
SEQS	:	Sindh Environmental Quality Standards
SOI	:	Solar Outdoor Inverter
TMP	:	Traffic Management Plan
UAE	:	United Arab Emirates
USAID	:	United States Agency for International Development

LIST OF EXHIBITS

CHAPTER

1 INTRODUCTION

1.1 PROJECT TITLE:

Initial Environmental Examination (IEE) of 50 MWp Solar Photovoltaic (PV) Power Plant located at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh.

➢ **Project Proponent**

Name	Gharo Solar (Private) Limited (GSPL)
Contact person	Mr. Usman Mahmood
Office Address	House # 1485/C - 2A, Asad Jan Road, Lahore Cantt., Pakistan
Contact No:	+92 42 36687824
Email	e.usmanmahmood@gmail.com

➢ **Project Consultant**

Name	Global Environmental Management Services (Pvt.) Ltd. (GEMS)
Contact person	Mr. Saleem-uz-Zaman (Chief Executive)
Office Address	2nd floor Aiwan-e-Sanat, ST-4/2, Sector 23, Korangi Industrial Area, Karachi
Contact No:	+92-2135113804-5
Email	info@gems-intl.com

1.2 PREAMBLE

Gharo Solar (Private) Limited (GSPL) is a special purpose company incorporated for the purpose of developing, commissioning and operating an approximately 50 MWp PV Power project be located at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh, Sindh adjacent to the Sindh Coastal Highway. GSPL intends to sell electricity generated by the Project to K-Electric (KE) Limited through interconnection with its 132 kV grid network located in the vicinity of the proposed Project site.

An Initial Environmental Examination (IEE) was carried out by M/s. Global Environmental Management Services (Pvt.) Ltd. (GEMS), as per legislative requirement under Sindh Environmental Protection Agency (SEPA) Act 2014. This IEE report is consolidation of the finding and assessment carried out during the IEE process.

As stated earlier in the introductory paragraph this IEE study has been undertaken to conform to the requirements of the SEPA Act 2014; the Sindh Initial Environmental Examination; Environmental Impact Assessment Review Regulations 2014. Furthermore, this IEE being an important social and environmental governance tool has gone beyond the legislative requirements. It has incorporated the international best practices, the company's social and environmental policies and compliance and contextual realities to integrate the philosophy and processes of sustainable development.

1.3 THE PROPONENT

GSPL was issued Certificate of Incorporation on June 30, 2016 under the Companies Ordinance, 1984 by the Securities and Exchange Commission of Pakistan. GSPL was also issued a Letter of Intent (LOI) by KE for initial development of the planned 50 MWp Solar Plant on July 1, 2016 and subsequently executed a term sheet with KE for continued development of the proposed project on November 10, 2016. GSPL shall next execute an Energy Purchase Agreement with KE upon fulfilling regulatory pre-requisites including approval of Tariff and Generation License by NEPRA.

1.4 CONSULTANT INTRODUCTION

GEMS is an environmental consultancy firm which provides extensive services like Environmental Audits, Initial Environmental Examinations (IEE), Environmental Impact Assessments (EIA), Baseline studies and Training & Capacity building. GEMS personnel have professional environmental and social experience extending throughout Pakistan and UAE. They are all qualified environmental and social scientists with complementary multi-disciplinary skills covering all major biomes of the environment. As a result GEMS is able to offer accurate, independent and appropriate services to clients and to regulatory bodies. For over a decade GEMS have conducted environmental and social

impact assessments (ESIA) in an expanding range of sectors including the energy (oil and gas industry, power plants etc.), manufacturing industries (e.g. pharmaceutical, mineral fertilizers, textile, paper, food processing etc.), infrastructure (roads, highway's buildings etc.), ports and harbors, tourism, aquaculture and fisheries.

1.4.1 IEE Study Team

Sr. No.	Name	Designation
1.	Mr. Abdul Basit Khan	Project Manager & EIA/IEE Specialist
2.	Engr. M. Zohair Ahmed Khan	EIA/IEE Quality Assurance Manager
3.	Mr. Karim Akbar	Monitoring Officer
4.	Mr. Sikander Ali	Ecological surveyor
5.	Ms. Tahira Zafar	Environmental Officer
6.	Ms. Maria Kausar	Environmental Officer

1.5 PURPOSE OF PROJECT:

Pakistan is an energy-deficit country and has faced a persistent and acute power generation shortage for the last several years. The maximum total demand recorded by KE in 2014-15 stood at 3,056 MW, whereas maximum generation capability including import was 2,632 MW. While the peak deficit of 424 MW or 16% is significantly lower than the National Transmission & Dispatch Company (NTDC) system, KE is continuing to invest substantial resources in enhancing generation capacity, improving its fleet efficiency and launching transmission & distribution enhancement programs such as the TP-1000 initiative.

On the generation side, KE is also entering into new power / energy purchase agreements with Independent Power Producer (IPPs) on diverse fuels including natural gas, Liquefied Natural Gas (LNG), coal, etc. At the same time, the utility as part of its Climate Change Policy (CCP) is also encouraging the development of renewable energy projects including solar and wind in its licensed territory. The 50 MWp Gharo Solar Project is proposed to fulfill KE twin imperatives of continuously augmenting generation given projected 5-6% annual increase in demand and demonstrating its commitment to harnessing indigenous and environmentally friendly energy resources.

The electricity generated by 50 MWp Solar PV Project would be stepped up to 132 kV and dispersed to the KE grid network near the Project. The proposed Project brings in multifold advantages. The Solar PV project not only produce clean, pollution free energy but it also has the capacity to provide employment to the people living in and around that area.

1.6 CATEGORIZATION OF THE PROPOSED PROJECT

The proposed project falls under the project Schedule I of Category B: "Solar Project" as per the guidelines issued by the Sindh Environmental Protection Agency (Review of IEE/EIA) Regulations 2014 and Section 17 of Sindh Environmental Protection Agency (SEPA) under the SEPA ACT, 2014. According to these guidelines, project under this category require an IEE to be conducted at planning stage.

1.7 IEE REPORT STRUCTURE

This IEE report has mapped its structure within nine chapters. Chapter 1 of the report provides the introduction about the proponent and the consultant, overview of the project and structure of the IEE report. Chapter 2 of the report describes the proposed project in detail. Chapter 3 provides an overview of the national and international legislative tools, instruments and guidelines that are relevant to the proposed project; while Chapter 4, 5, 6 describes the project area's existing environmental conditions, including the physical, biological and socio-economic environments. The social, physical and environmental assessment of potential project impacts associated with project related activities have been discussed in Chapter 7. Chapter 8 provides a set of environmental actions, instruments and guidelines to minimize the impacts discussed in earlier sections in the form of environmental management plan. Chapter 9 presents the conclusion of the IEE.

1.8 PURPOSE OF THE IEE STUDY

The purpose of this IEE study is to environmentally evaluate the proposed project activities against the Pakistan Environmental Protection Agency (PEPA) standards, and against international environmental guidelines.

The specific objectives of this IEE are to:

- Study Sustainable Project infrastructure development and production activities;
- Identify and evaluate their potential impacts on environment and determine their significance of these effects;
- Propose appropriate mitigation measure that can be incorporated into the design of the proposed activities. This will minimize any damage effects or lasting negative consequences identified by the environmental assessment;
- Assess the proposed activities and determine whether they comply with relevant environmental regulation in Pakistan;
- Prepare IEE Report for submission to SEPA.

1.9 APPROACH AND METHODOLOGY

The IEE was performed in four main phases, which are described below.

1.9.1 Scoping

The key activities of this phase included:

- ***Project Data Compilation:*** A generic description of the proposed activities within the project area, relevant to environmental assessment, was compiled with the help of Production and HSE Department of GSPL;
- ***Published Literature Review:*** Secondary data on weather, soil, water resources, wildlife, and vegetation was reviewed and compiled;
- ***Legislative Review:*** Information on relevant legislation, regulations, guidelines, and standards was reviewed and compiled;
- ***Identification of Potential Impacts:*** The information collected in the previous steps was reviewed, and potential environmental issues were identified.

1.9.2 Baseline Studies

Following the scoping exercise, the proposed project area was surveyed to collect primary data. During the field visits, information was collected on ecologically important areas, surface and groundwater resources, soils, local communities' livelihood, culture and developmental needs, public services, and sites of archaeological or cultural importance. The following specific studies were conducted as part of the IEE.

Physical Environment: An Environmental Assessment Specialist conducted a physical environmental study which included, soil sampling, water sampling of surface water resources of the area, and groundwater resources of the area. The impact of the project on soil and water resources was also assessed.

Biological Environment: An ecologist conducted the floral and faunal study, which consisted of a thorough literature review and field data collection. As part of the vegetation study, sampling was conducted and the area's floral species were documented. Whereas the part of the faunal species, the diversity of avian, large and small mammals, and reptile species was also determined. Information was collected on the species of concern in the area.

Socioeconomic Study: A team of experts including Social Assessment and Gender Specialist conducted a socioeconomic and cultural study of the proposed project area. The study team collected data through participatory technique from the community of the proposed project area. As a part of this, Locals were consulted

about the proposed project. The profile included livelihood, culture, leadership, gender issues, spiritual and temporal leadership, demographic information based on field data and published sources, the existing use of land resources, community structure, employment, distribution of income, goods and services, public health, local religious and cultural values, and local customs, aspirations and attitudes.

1.9.3 Impact Assessment

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

- Groundwater and surface water quality;
- Ecology of the area, including flora and fauna;
- Local communities;
- Socioeconomic and gender environment.

Wherever possible and applicable, the discussion covered the following aspects:

- The present baseline conditions;
- The change in environmental parameters likely to be affected by proposed project related activities;
- Identification of potential impacts;
- Mitigation measures to reduce impacts to as low as possible;
- Prediction of impacts;
- Evaluation of the importance or significance of impacts;
- Implementation of mitigation measures (i.e. Environmental management).

1.9.4 Documentation

At the end of the assessment, a report was prepared according to the relevant guidelines of PEPA. This report includes the findings of the assessment, proposed project impacts, and mitigation measures to be implemented during the execution of the proposed activities.

CHAPTER

2 PROJECT DESCRIPTION

2.1 INTRODUCTION

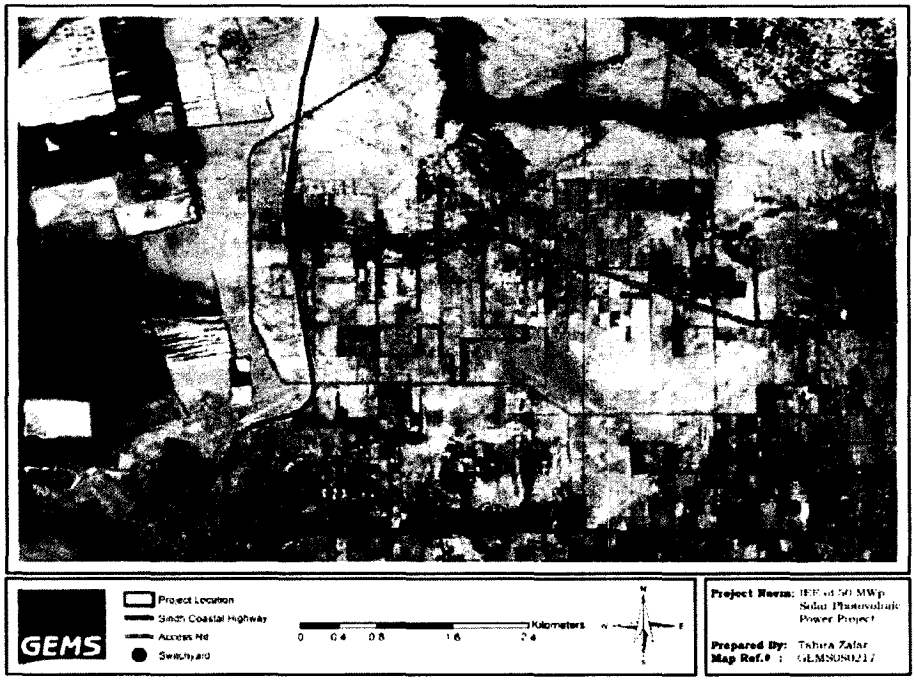
PV Power project comprises the construction, installation and operation of an approximately 50 MWp capacity Solar PV Power Plant with crystalline or thin film modules mounted on single axes trackers. The electricity generated by the project would be stepped up to 132 kV and dispersed to the K-Electric grid network near the proposed sites.

2.2 PROPONENT ADDRESS & LOCATION MAP

The proposed project is to be located at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh at approximately 6 km along the Sindh Coastal Highway and then 1.25 km via connecting road from the Highway. The site is at about 55 km away from Jinnah International Airport, Karachi and is adjacent to the 50 MWp Oursun Solar Plant, which shall also sell electricity to KE Limited. The location map can be seen in **Exhibit 2.1.**

The Layout plan of the proposed project is provided as **Annexure-1**. While the final land demarcation may vary, the project location shall remain the same.

Exhibit 2.1: Location Map of Solar PV Plant



2.3 PROPOSED PROCESS DESCRIPTION

A general schematic diagram of the proposed project can be seen in **Exhibit 2.2** following with a flow diagram which can be seen in **Exhibit 2.3**.Component wise description is given further below.

Exhibit 2.2: Schematic Diagram of the Proposed Project Activities

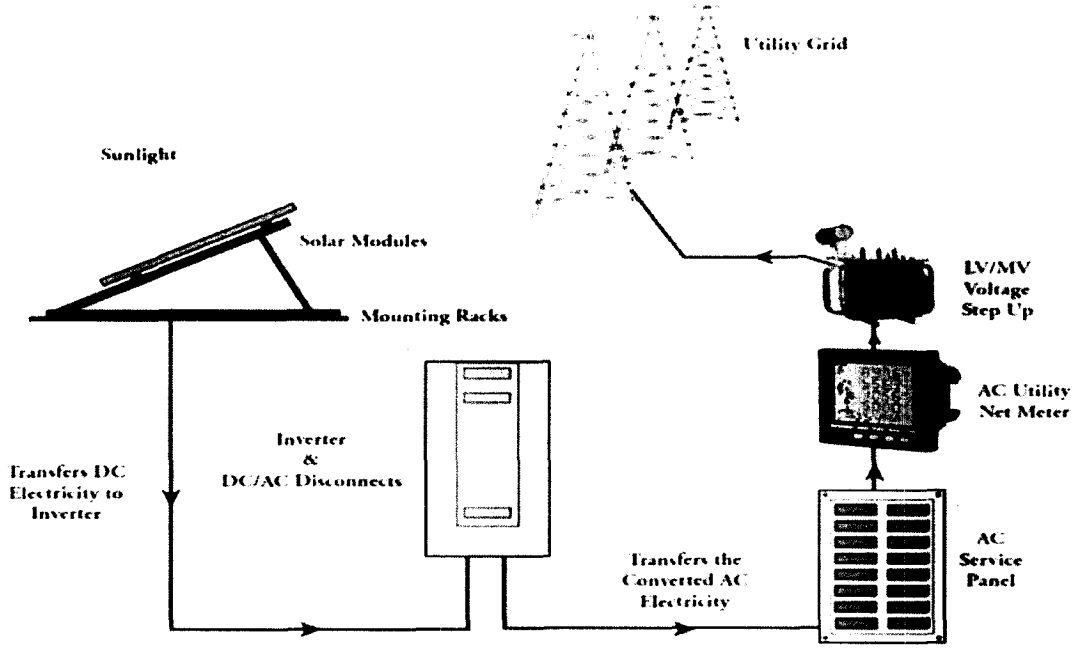
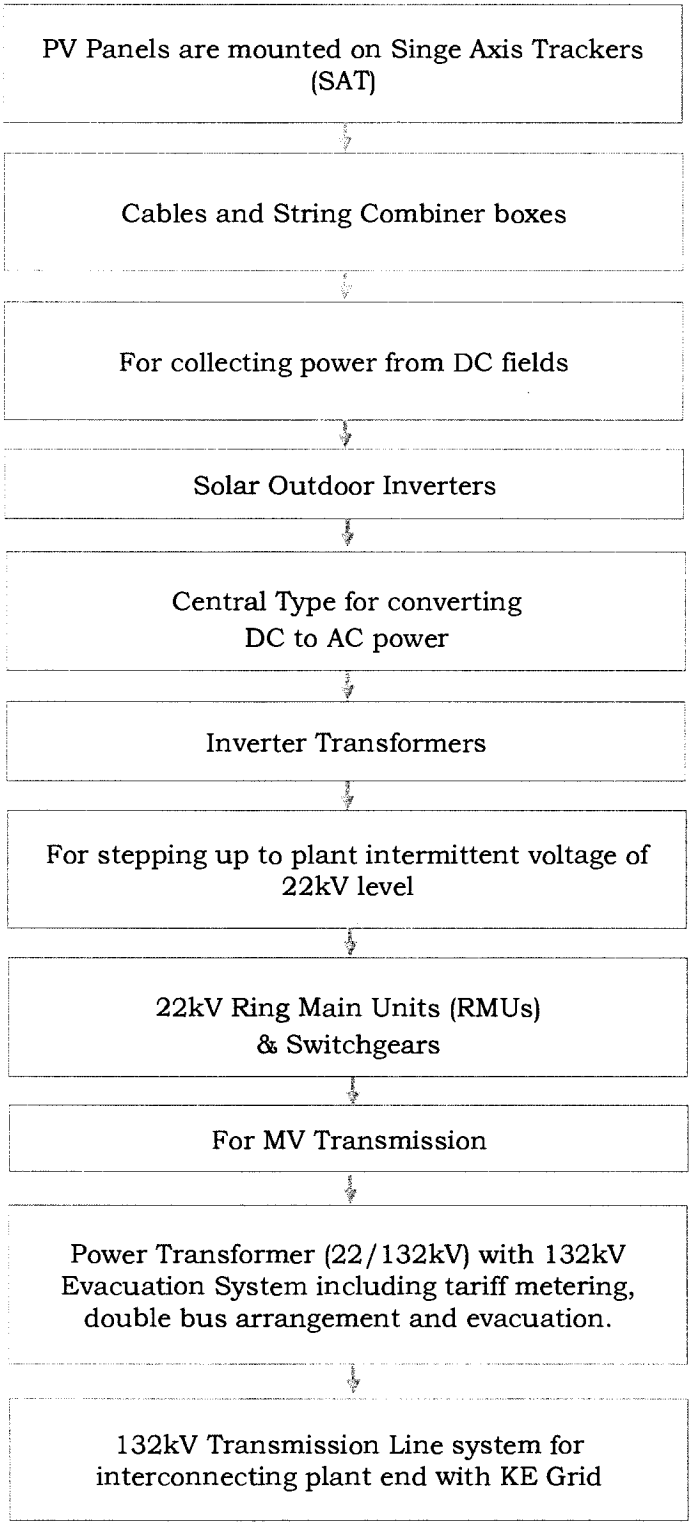


Exhibit 2.3. Flow Diagram of the Proposed Project



2.3.1 Main Components of the Proposed Project

I. Solar PV modules

PV modules convert solar radiation directly into electricity through the photovoltaic effect in a silent and clean process that requires no moving parts. Solar panels are made up of a network (or array) of interconnected solar cells which convert solar radiation into electricity. The output from a solar PV cell is direct current (DC) electricity. A PV power plant contains many cells connected together in modules and many modules connected together in strings to produce the required DC power output.

The effectiveness of solar panels is subject to a number of factors such as the solar irradiation available at a particular location, shade from the surroundings or other panels and dirt or dust on the panels. These factors reduce the effectiveness of the solar panels. Panel degradation also occurs over time where the panels become less effective due to degradation of the components. These factors are taken into account in determining figures for projected production and profits.

II. Tracking System and Mounting Structures

These allow PV modules to be securely attached to the ground at a fixed tilt angle, or on sun-tracking frames. These mounting structures may be set up on piled foundations or directly rammed into the ground, although piled foundations are recommended for a longer life.

III. Inverters

Inverters are a key component of solar farm technology used to convert the direct current (DC) collected from the solar panels into the alternating current (AC) for connection to the utility grid. Many modules in series strings and parallel strings are connected to the inverters.

IV. Step Up Transformers

A simple yet highly efficient and integral component not only on solar farms but in electricity distribution in general, step up transformers take the output from the inverters to the higher voltage level (e.g. 11 kV, 33 kV or 132 kV) required at the grid interconnection point. The higher voltage enables electricity to be transmitted economically over large distances with minimum loss of energy.

V. Cables

PV or DC cables are the means of transportation of electricity from the solar panels to the inverters while AC cables transport electricity from the inverters to the interconnection point. A loss of energy is expected in during the transfer of

electricity via cabling. This is due to electrical resistance present in all conductors. The conversion of electricity to high voltage/low current by transformers for transport keeps this loss to a minimum.

VI. Sub Station

Sub station is the grid connection interface, where the electricity is exported into the grid network. The substation will also have the required grid interface switchgear such as circuit breakers and disconnects for protection and isolation of the PV power plant as well as generation and supply metering equipment.

VII. Balance of Plant

The balance of plant typically comprises string combiner boxes, HT Panels / RMU Units, SCADA System, earthing system, illumination system, module cleaning system and civil works including foundations, inverter and control rooms, fencing, etc.

2.3.2 Salient Features of the Proposed Project*

A. General Information

i.	Name of Company	Gharo Solar (Private) Limited (GSPL)
ii.	Plant location	Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh
iii.	Type of Generation Facility	Solar Photovoltaic (PV) Power Plant

B. Area Details

i.	Total Area of the proposed Project	Up to 250 Acres
ii.	Total PV Solar Used Area	Up to 225 Acres
iii.	Water Treatment and open Storage Yard Area	Up to 6 Acres
iv.	Colony and Guest House Area	Up to 7.5 Acres
v	Labour Camps Area	Up to 02 Acres

C. Description of PV Panels (Type, Capacity and Quantity)

i.	Type of PV Panel	Poly Crystalline

* Note: Area and technical details are subject to change upon project final design

ii.	Capacity of PV Panel	325 Wp
iii.	Number of Panels	1,54,224
iv.	Number of Invertor	16
v.	Number of modules per inverter	9639
vi.	Configuration per inverter	459 strings made of 21 modules connected in series

2.4 PROJECT SCHEDULE

The proponent will proceed with the project's construction and commissioning after obtaining all relevant legislative approvals from respective authorities and agencies including Sindh-EPA. The tentative schedule is as follows:

i	Project Commencement	July of 2018
ii	Project Completion	June of 2019

2.5 MANPOWER

Expected number of persons to work for the proposed project cycle is presented below as **Exhibit 2.4.**

Exhibit 2.4: Employment Details

Phases	No of Employees
During Construction	1000
During Operation	15

2.6 WASTE

Solar PV project is environmental friendly in nature with minimal waste expected to be generated during construction and operation phase. Waste that might be generated during construction phase will be non-hazardous solid wastes including construction materials for buildings as well as concrete and asphalt debris. Installation of the solar plant would be conducted using construction methods that would limit or eliminate the use of hazardous materials. However during

operational phase minimal waste generated due to the environmental friendly nature of the proposed project. The wastewater from cleaning of PV modules would be re-absorbed into the ground. Petroleum, oil and lubricants would be used in the operation and maintenance of heavy construction equipment and vehicles. Other miscellaneous solid wastes such as cardboard packing material, metal scraps are also generated during operational phase.

2.7 UTILITIES

2.7.1 Water

Water is not a primary requirement for the proposed project, it will be only utilized for maintenance (washing) purposes. The main consumption of the water is for cleaning the solar panels. The water requirement will be approximately 30kL per day. Approximately 300kL markup will be required considering 15 days cleaning cycle of the solar panels. The water requirement estimation is based on the following assumptions:

i.	No. of Solar Panels	1,54,224
ii.	Water Required to clean each panel	2 Liters
iii.	Number of cycle	2 times in a month
iv.	Per Day water requirement	~30KL
v.	Total water requirement for each cycle	~450 KL

CHAPTER

3 INSTITUTIONAL, LEGISLATION AND POLICY FRAMEWORK

The IEE of the proposed MWp Solar Photovoltaic (PV) Power Plant of GSPL will be subjected to the pertinent legislative and regulatory requirements of the Government of Pakistan including State laws. This chapter provides an overview of the policy framework and national legislation that applies to the proposed Project. The Project is expected to comply with all national legislations relating to environmental and social issues, and all the required regulatory clearances will be obtained.

The environmental study includes primarily Sindh Environmental Protection Act 2014 (SEPA 2014), Sindh Environmental Protection Agency IEE and EIA review regulations (2014). All other laws and guidelines relevant to the project have also been reviewed. This chapter presents a synopsis of environmental policies, legislation and other guidelines that have relevance to the proposed project.

3.1 NATIONAL ENVIRONMENTAL POLICY, LEGISLATION AND GUIDELINES

The enactment of comprehensive legislation on the environment, covering multiple areas of concern, is a relatively new and ongoing phenomenon in Pakistan. Whereas, a basic policy and legislative framework for the protection of the environment and overall biodiversity in the country is now in place, detailed rules, regulations and guidelines required for the implementation of the policies and enforcement of legislation are still in various stages of formulation and discussion. The following section presents a brief overview of the existing national policies, legislation and guidelines.

3.1.1 National Conservation Strategy (NCS)

The National Conservation Strategy (NCS) is the primary Policy document of the Government of Pakistan on national environmental issues. The Policy was approved by the Federal Cabinet in March 1992. The Strategy also attained recognition by international donor agencies, principally the World Bank. The NCS identifies 14 core areas including conservation of biodiversity, pollution prevention and abatement, soil and water conservation and preservation of cultural heritage and recommends immediate attention to these core areas in order to preserve the country's environment.

A midterm review of the achievements of the NCS in 2000 concluded that achievements under the NCS have been primarily awareness raising and institutional

building rather than actual improvement to environment and natural resources and that the NCS was not designed and is not adequately focused as a national sustainable development strategy [1]. The need therefore arose for a more focused National Environmental Action Plan (NEAP) required to bring about actual improvements in the state of the national environment with greater emphasis on poverty reduction and economic development in addition to environmental sustainability.

The NEAP was approved by the Pakistan Environmental Protection Council under the chairmanship of the President/Chief Executive of Pakistan in February 2001. NEAP now constitutes the national environmental agenda and its core objective is to initiate actions that safeguard public health, promote sustainable livelihoods, and enhance the quality of life of the people of Pakistan.

A National Environmental Policy has been approved by the Federal Cabinet in its meeting held during June 2005[2]. This policy has already been endorsed by the Pakistan Environmental Protection Council during 2004. The new policy has total 171 guidelines on sectoral and cross-sectoral issues. The objectives of new policy include assurance of sustainable development and safeguard of the natural wealth of country. The following are the approved Sectoral Guidelines;

- Water Supply and Management;
- Air Quality and Noise;
- Waste Management;
- Forestry;
- Biodiversity and Protected Areas;
- Climate Change and Ozone Depletion;
- Energy Efficiency and Renewable;
- Agriculture and Livestock;
- Multilateral Environmental Agreements.

3.1.2 Sindh Environmental Protection Act 2014

The Sindh Environmental Protection Act, 2014 (SEPA 2014) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The SEPA 2014 is broadly applicable to air, water, soil, marine and noise pollution. Penalties have been prescribed for those contravening the provisions of the Act.

The two primary deliberations of the Act are the conduct of projects only after approval of environmental assessments from the SEPA and adherence with Sindh Environmental Quality Standards (SEQS).

[1] *Arthur J. Hanson et al, Pakistan's National Conservation Strategy Renewing Commitment to Action, Report of the Mid-Term Review, 2000*
[2] *National Environmental Policy, GoP, 2005*

3.1.3 Approval from Sindh Environment Protection Agency (SEPA)

As per the 2014 Regulations, Proponent will submit an IEE report for their proposed project activities to SEPA, and seek approval on the same from the Agency. Ten (10) hard copies and two (02) soft copies of the IEE report will be need to be submitted to SEPA. It will then grant its decision on the IEE as per the rules and procedures set out in the 2014 Regulations. The following rules will apply:

- A fee is payable to SEPA for review of the EIA& IEE;
- The IEE submission is to be accompanied by an application in the format prescribed in Schedule V of the 2014 Regulations;
- SEPA is to conduct a preliminary scrutiny and reply within fifteen (15) days of the submission of the report a) confirming completeness, or b) asking for additional information, if needed;
- In the review process SEPA may consult a Committee of Experts, which maybe constituted on the request of the DG SEPA;
- On completion of the review process, the decision of SEPA will be communicated to the proponent in the form prescribed in Schedule V;
- Where an IEE is approved, SEPA can impose additional controls as part of the conditions of approval;
- SEPA is required to make every effort to complete the IEE review process within sixty (60) days of the issue of confirmation of completeness. However, SEPA can take up to four(4) months for communication of final decision;
- The approval will remain valid for the project duration mentioned in the IEE but on the condition that the project commences within a period of three (03) years from the date of approval. If the project is initiated after three years from approval date, the proponent will have to apply for an extension in the validity period. The SEPA on receiving such request grant extension (not exceeding 3 years at a time) or require the proponent to submit a fresh IEE if in the opinion of SEPA changes in baseline conditions or the project so warrant;
- After receiving approval from SEPA the proponent will acknowledge acceptance of the conditions of approval by executing an undertaking in the form prescribed in Schedule VI of the 2014 Regulations;
- The 2014 Regulations also require proponents to obtain from SEPA, after completion of the project, a confirmation that the requirements of the IEE and the conditions of approval have been duly complied with;
- The SEPA in granting the confirmation of compliance may impose any additional control regarding the environmental management of the project or the operation, as it deems necessary.

3.1.4 Sindh Environmental Protection Agency Review of IEE and EIA Regulations, 2014

The SEPA Review of IEE and EIA Regulations, 2014 (The 2014Regulations) promulgated under SEPA 2014 were enforced on December, 2014. The 2014 Regulations define the applicability and procedures for preparation, submission and review of IEEs and EIAs. These Regulations also give legal status to the Pakistan Environmental Assessment Procedures prepared by SEPA in 2014.

The Regulation classifies projects on the basis of expected degree of adverse environmental impacts and lists them in two separate schedules. Schedule I lists projects that may not have significant environmental impacts and therefore require an IEE. Schedule II lists projects of potentially significant environmental impacts requiring preparation of an EIA. The Regulations also require that all projects located in environmentally sensitive areas require preparation of an EIA.

The following project falls under the following category:

Schedule I (IEE):

Category B (Solar Project)

3.1.5 The Sindh Environmental Quality Standards

During the construction and post development phase of the project SEQS will be applied where require. SEQS for municipal and industrial effluents, selected gaseous pollutants from industrial sources and motor vehicle exhaust and noise are provided in **Exhibit 3.1**, **Exhibit 3.2**, **Exhibit 3.3**, **Exhibit 3.4 & Exhibit 3.5**.

3.1.6 Land Acquisition Act, 1894

The Land Acquisition Act (LAA) of 1894 amended from time to time has been the defacto policy governing land acquisition, resettlement and compensation in the country. The LAA is the most commonly used law for acquisition of land and other properties for development projects. It comprises of 55 sections pertaining to area notifications and surveys, acquisition, compensation and apportionment awards and disputes resolution, penalties and exemptions.

3.1.7 Pakistan Penal Code (1860)

The Pakistan Penal Code (1860) authorizes fines, imprisonment or both for voluntary corruption or fouling of public springs or reservoirs so as to make them less fit for ordinary use[3].

[3]www.fmu.gov.pk

3.1.8 The Antiquities Act, 1975

The Antiquities Act of 1975 ensures the protection of cultural resources of Pakistan. The Act is designed to protect 'antiquities' from destruction, theft, negligence, unlawful excavation, trade, and export. Antiquities have been defined in the Act as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments, etc. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area that may contain articles of archaeological significance.

Under the Act, the project proponents are obligated to:

- Ensure that no activity is undertaken in the proximity of a protected antiquity;
- Report to the Department of Archeology, Government of Pakistan, any archeological discovery made during the course of a project[4].

3.1.9 The Factories Act, 1934

The clauses relevant to the project are those that concern to health, safety and welfare of workers, disposal of solid waste and effluent and damage to private and public property. The Factories Act also provides regulation for handling and disposal of toxic and hazardous materials[5].

3.1.10 Electricity Act, 1910

The Act provides a legal base for power distribution. A licensee under this Act is enabled to operate supply of electricity. This Act obligate licensee to pay compensation for any damages caused during the constructions and maintenance of any power distribution facilities.

3.1.11 Sindh Wildlife Protection (Amendment) Act 2008

The Sindh Wildlife Ordinance 1972 empowers the government to declare certain areas reserved for the protection of wildlife and to control activities within these areas. It also provides protection to endangered species of wildlife[6].

3.1.12 Sindh Forest Act (2012)

The act empowers the provincial forest departments to declare any forest area as reserved or protected. The Act also empowers the provincial forest departments to prohibit the clearing of forest for cultivation, grazing, hunting, removing forest

[4]pakistancode.gov.pk, 2005
[5]pakistancode.gov.pk,2005
[6]*faolex.fao.org, 2009*

produce; quarrying and felling, lopping and topping of trees, branches in reserved and protected forests[7].

3.1.13 Cutting of Trees (Prohibition) Act, 1975

This Act prohibits cutting or chopping of trees without permission of the Forest Department.

3.1.14 Highways Safety Ordinance, 2000

This ordinance includes provisions for the licensing and registration of vehicles and construction equipment; maintenance of road vehicles; traffic control, offences, penalties and procedures; and the establishment of a police force for motorways and national highways charged with regulating and controlling traffic on the national highways, and keeping the highways clear of encroachments.

3.2 NATIONAL AND INTERNATIONAL GUIDELINES OR STANDARDS

3.2.1 The Pakistan Environmental Assessment Procedures, 1997

The Pakistan Environmental Protection Agency prepared the Pakistan Environmental Assessment Procedures in 1997. They are based on much of the existing work done by international donor agencies and Non-Governmental Organizations (NGO's). The package of regulations prepared by PEPA includes:

- Policy and Procedures for Filing, Review and Approval of Environmental Assessments;
- Guidelines for the Preparation and Review of Environmental Reports;
- Guidelines for Public Consultation;
- Guidelines for Sensitive and Critical Areas; and
- Sectoral Guidelines for various types of projects.

3.2.2 OSHA Standards Health Safety

The Occupational Safety and Health Administration (OSHA) are issuing safety and health program management guidelines for use by employers to prevent occupational injuries and illnesses. The Occupational Safety and Health Act of 1970 (OSHA) representatives have noted a strong correlation between the application of sound management practices in the operation of safety and health programs and a low

[7] *Sindhforests.gov.pk*

incidence of occupational injuries and illnesses. Where effective safety and health management is practiced, injury and illness rates are significantly less than rates at comparable worksites where safety and health management is weak or non-existent.

OSHA have concluded that effective management of worker safety and health protection is a decisive factor in reducing the extent and the severity of work-related injuries and illnesses. Effective management addresses all work-related hazards, including those potential hazards which could result from a change in worksite conditions or practices. It addresses hazards whether or not they are regulated by government standards.

Exhibit 3.1: SEQS for Ambient Air

Pollutant	Time-weighted average	Concentration in Ambient Air	Method of measurement
Sulfur Dioxide (SO^2)	Annual Average*	80 ug/m^3	Ultraviolet Fluorescence method
	24 hours**	120 ug/m^3	
Oxides of Nitrogen as (NO)	Annual Average*	40 ug/m^3	Gas Phase Chemiluminescence
	24 hours**	40 ug/m^3	
Oxides of Nitrogen as (NO^2)	Annual Average*	40 ug/m^3	Gas Phase Chemiluminescence
	24 hours**	80 ug/m^3	
Ozone (O^3)	1 hour	130 ug/m^3	Non dispersive UV absorption method
Suspended Particulate Matter (SPM)	Annual Average*	360 ug/m^3	High Volume Sampling, (Average flow rate not less than 1.1 in 3min/sec).
	24 hours**	500 ug/m^3	
Respirable Particulate Matter PM_{10}	Annual Average*	120 ug/m^3	β-Ray absorption method
	24 hours**	150 ug/m^3	
Respirable Particulate Matter $PM_{2.5}$	Annual Average*	40 ug/m***	Preferably β-Ray absorption method
	24 hours**	75 ug/m^3	
Lead (Pb)	Annual Average*	1 ug/m^3	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	1.5 ug/m^3	
Carbon Monoxide (CO)	8 hours**	5 mg/m^3	Non Dispersive Infra-Red (NDIR) method
	1 hour	10 mg/m^3	

* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly /8 hourly values should be met 98% in a year. 2% of the time, it may exceed but not on two consecutive days.

*** Annual average limit of 40ug/m^3or background annual average concentration plus allowable allowance of 9ug/m^3, whichever is lower.

Exhibit 3.2: SEQS for Municipal and Liquid Industrial Effluents[a]

Parameters	Into Inland Water(mg/l)	Into Sewage Treatment(mg/l)
Temperature 40°C or temperature increase[c]	≤3°C	≤3°C
pH	6-9	6-9
Biochemical Oxygen Demand (BOD5) at 20°C[d]	80	250
Chemical Oxygen Demand (COD)[d]	150	400
Total Suspended Solids (TSS)	200	400
Total Dissolved Solids (TDS)	3,500	3,500
Grease and oil	10	10
Phenolic compounds (as phenol)	0.1	0.3
Chloride (as Cl^-)	1,000	1,000
Fluoride (as F)	10	10
Total cyanide (as CN-)	1.0	1.0
An-ionic detergents (as MBAS)[e]	20	20
Sulphate (SO_4)	600	1000
Sulphide (S-)	1.0	1.0
Ammonia (NH_3)	40	40
Pesticides[f]	0.15	0.15
Cadmium[g]	0.1	0.1
Chromium (trivalent & hexavalent)[g]	1.0	1.0
Copper[g]	1.0	1.0
Lead[g]	0.5	0.5
Mercury[g]	0.01	0.01
Selenium[g]	0.5	0.5

Parameters	Into Inland Water(mg/l)	Into Sewage Treatment(mg/l)
Nickelg	1.0	1.0
Silver[g]	1.0	1.0
Total Toxic metals	2.0	2.0
Zinc	5.0	5.0
Arsenic[g]	1.0	1.0
Barium[g]	1.5	1.5
Iron	8.0	8.0
Manganese	1.5	1.5
Boron[g]	6.0	6.0
Chlorine	1.0	1.0

Notes

[a]All values are in mg/l, unless otherwise defined

[b]Applicable only when and where sewage treatment is operational and BOD5=80 mg/L is achieved by the sewage treatment system

[c]The effluent should not result in temperature increase of more than 3°C at the edge of zone where initial mixing and dilution take place in the receiving body. In case zone is defined, use 100 meters from the point of discharge

[d]Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Sindh Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent

[e]Modified Benzene Alkyl Sulphate; assuming surfactant as biodegradable

[f]Pesticides include herbicide, fungicides and insecticides

[g] Subject to the total toxic metals discharge should not exceed level of total toxic metals

Exhibit 3.3: SEQS for Selected Gaseous Pollutants from Industrial Sources [a]

Parameter	Source of emission	Standard(mg/Nm^3)
Smoke	Any	40% or 2 Ringlemann scale or equivalent smoke number
Particulate matter[b]	Boilers and furnaces:	
	Oil fired	300
	Coal fired	500
	Cement kilns	300
	Grinding, crushing, clinker coolers and related processes, metallurgical processes, converter blast furnaces and cupolas	500
Hydrogen chloride	Any	400
Chlorine	Any	150
Hydrogen fluoride	Any	150
Hydrogen sulfide	Any	10
Sulfur oxides[c]	Sulfuric acid/Sulfonic acid plants	5,000
	Other plants except power plants operating on oil and coal	1,700
Carbon monoxide	Any	800
Lead	Any	50
Mercury	Any	10
Cadmium	Any	20
Arsenic	Any	20
Copper	Any	50
Antimony	Any	20

Parameter	Source of emission	Standard(mg/Nm^3)
Zinc	Any	200
Oxides of nitrogen[d]	Nitric acid manufacturing unit	3,000
	Other plants except power plants operating on oil or coal:	
	Oil Fired	400
	Coal fired	600
	Cement kilns	1,200

Notes:

a All values are in mg/Nm^3, unless otherwise defined

b Based on the assumption that the size of the particulates is 10 micron or more

c Based on 1% sulphur content in fuel oil. Higher content of sulphur will cause standards to be pro-rated

d In respect of the emissions of the sulfur dioxide and nitrogen oxides, the power plants operating on oil or coal as fuel shall, in addition to SEQS specified above, comply with the following standards

Exhibit 3.4: SEQS for Motor Vehicle Exhaust and Noise

Parameter	Standard	Measuring Method
Smoke	40% or 2 on the Ringlemann scale during engine acceleration mode	To be compared with Ringlemann Chart at a distance of 6 meters or more
Carbon Monoxide	6%	Under idling conditions, non-dispersive infrared detection through gas analyzer
Noise	85 dB (A)	Sound-meter at 7.5 meters from the source

Exhibit 3.5: SEQS for Noise

S. No	Category of Area/Zone	Effective from 1st Jan, 2016	
		Limits in dB	
		Day Time	Night Time
1	Residential Area	65	50
2	Commercial Area	70	60
3	Industrial Area	80	75
4	Silence Area	55	45

Note:

1. Day Time hours: 6.00am to 10.00pm
2. Night Time hours: 10.00pm to 6.00am
3. Silence Zone: zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

dB: Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

CHAPTER

4 ENVIRONMENTAL BASELINE: PHYSICAL ENVIRONMENT

This section gives the detailed description about the physical environmental condition of the proposed project site. The data collected includes the information relating to topography and land use, geology, climate, air and water resources. The information and data presented in this part of the report is based on the surveys conducted by the team of experts and supplemented with the secondary data from published literature and previously conducted studies within the proposed project area. The base line data defines the present physical environmental quality of the proposed project site and adjoining areas.

4.1 TOPOGRAPHY AND LAND USE

The proposed project area is located in the district of Thatta of Sindh along the Indus Basin, which is briefly described below.

Thatta is one of the oldest town and the district headquarter of Thatta, it is situated at about 60 mile from east of Karachi on the National Highway. According to the Thatta District Census Report 1998, the district is situated at 23° 43' to 25° 26' north latitudes and 67° 05' to 68° 45' east longitudes. The total area of the district is 17,355 kilometers which constitutes 12.3% of the total geographical area of Sindh.

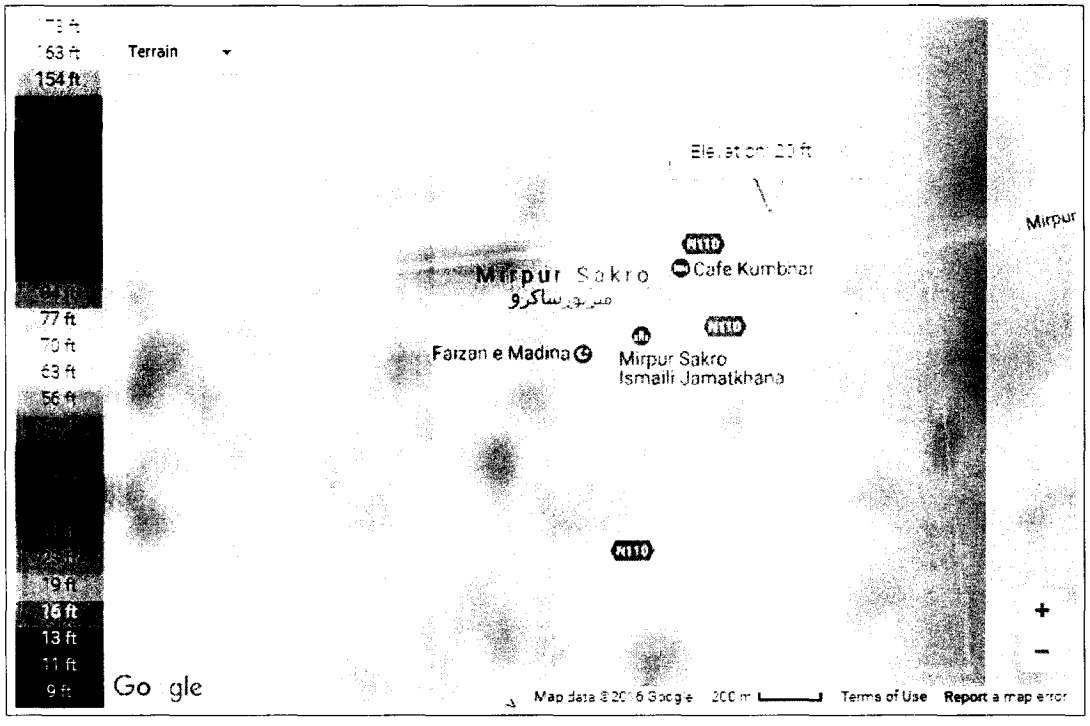
The district of Thatta is bounded by district Badin and Tando Muhammad Khan on the east; district Jamshoro on the north, district Hyderabad on the northeast, district Karachi on the northwest and the Arabian Sea and Rann of Kach on the south.The district is further divided into nine Tehsils which includes

- Thatta
- Mirpur Sakro
- Mirpur Bathoro
- Ghorabari
- Jati
- Sujawal
- Keti Bunder
- Shah Bunder
- Kharochan

Four Tehsils of district are on the right bank of Indus River and four lie on the left bank while one tehsil lies on both sides of the river.

The current project area lies in the tehsil of Mirpur Sakro of Thatta district with an area of 2,958 km² (USAID September 14).

Exhibit 4.1: Topographic Elevation Map of the Proposed Project Area[1]



4.2 GEOLOGY

The district of Thatta is a part of Indus delta and has been formed primarily by deposition of Late Holocene (7000-10,000 years BP) sediments carried by Indus River from Himalaya which host aquifers in the area. The deltaic soil constitutes fine grained sediments, rich in organic matter containing high amount of arsenic, which is supposed to become part of aquifers by various geochemical processes. Indus River has changed its course throughout the ages the abandoned organic matter rich courses of Indus River have been silted up and are under cultivation. This region includes alluvial plains trenched with river channels and river terraces these channels are traceable from Qambar, Dadu and Hala to Tando Allayar and beyond, which are hot spots of arsenic contamination.

Geology of the local area is underlain a lower Indus basin described as Indus river alluvial early eoicene early deposition of sediments includes silt, sand stone, conglomerate, limestone with low compact and cementing materials. Surface feature describe as syncline delta and valley region and anticline ridges exposed. As stratigraphic description, there are two formations Gazij and Manchar formation dip

[1] en-gb.topographic-map.com

gently northeast to southeast in offshore.The coastal region is found to be of tertiary and post-tertiary origin. Blatter et al (1929) dates it as recent as Eocene. The region has been formed by the upheaval of land from the Tethys Sea, which once extended up to the northern border of Pakistan but, gradually withdrew with the rising of the Himalayas. The underlying rocks are mostly of marine origin, highly folded, faulted and fissured everywhere[2].

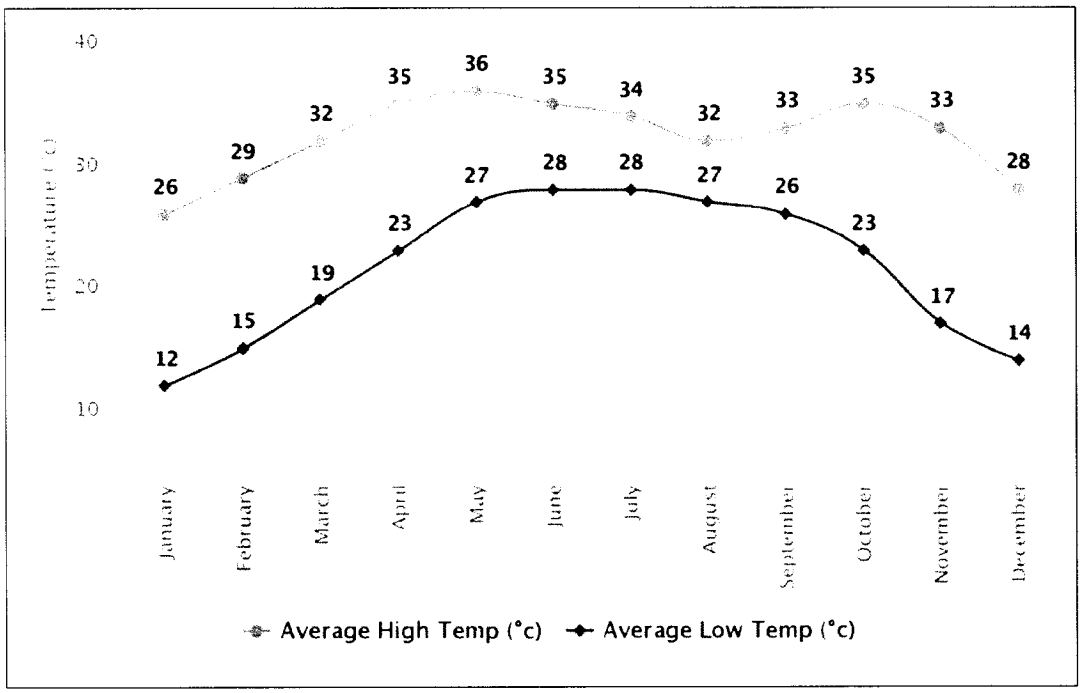
4.3 CHARACTERISTICS OF SOIL

The soil was studied in depth it was found that the soil is yellowish brown in color which is silty, clay and fine coarse.

4.4 CLIMATE

The temperature of the coastal area varies in range between 6 to 40°C near the project area the mean maximum temperature during summer is 35°C whereas the mean minimum temperature during winter is 14 °C. The climate in Mīrpur Sakro is called a desert climate. During the year, there is virtually no rainfall in Mīrpur Sakro. The average annual temperature in Mīrpur Sakro is 26.4 °C and the average precipitation is 206 mm. The average annual temperature of Mirpur Sakro is presented in the form of Graph in **Exhibit 4.2.**

Exhibit 4.2: Average Annual Temperature of Mirpur Sakro, Thatta[3]

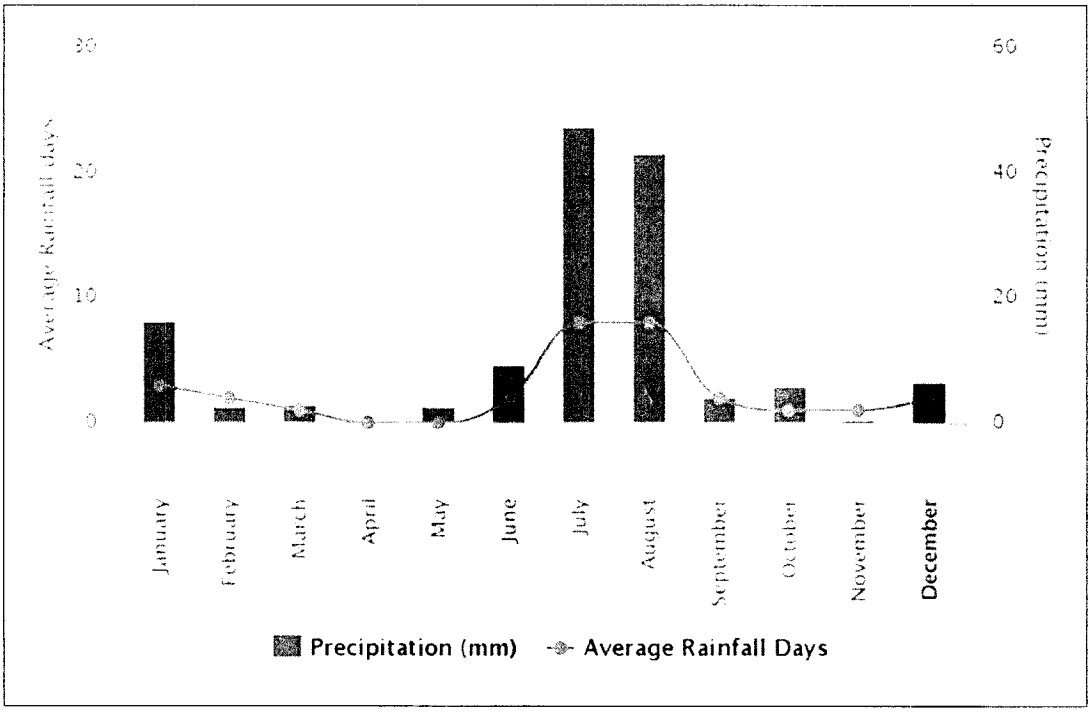


[2] Situation Analysis of Sindh Coast Issues and Options
[3] World Weather Online

4.5 RAINFALL

Rainfall pattern of the proposed project side is low and the same trend of rain fall has been observed in the coastal belt as well as the deltaic regions of Sindh. The average rainfall pattern for Mirpur Sakro is presented in **Exhibit 4.3**.

Exhibit 4.3: Average rainfall pattern for Mirpur Sakro District Thatta[4]



4.6 HUMIDITY

The Low humidity is noted in Thatta district during the months of December to February and maximum humidity during the month of July to September.

Exhibit 4.4: Relative Humidity Observed in Thatta[5]

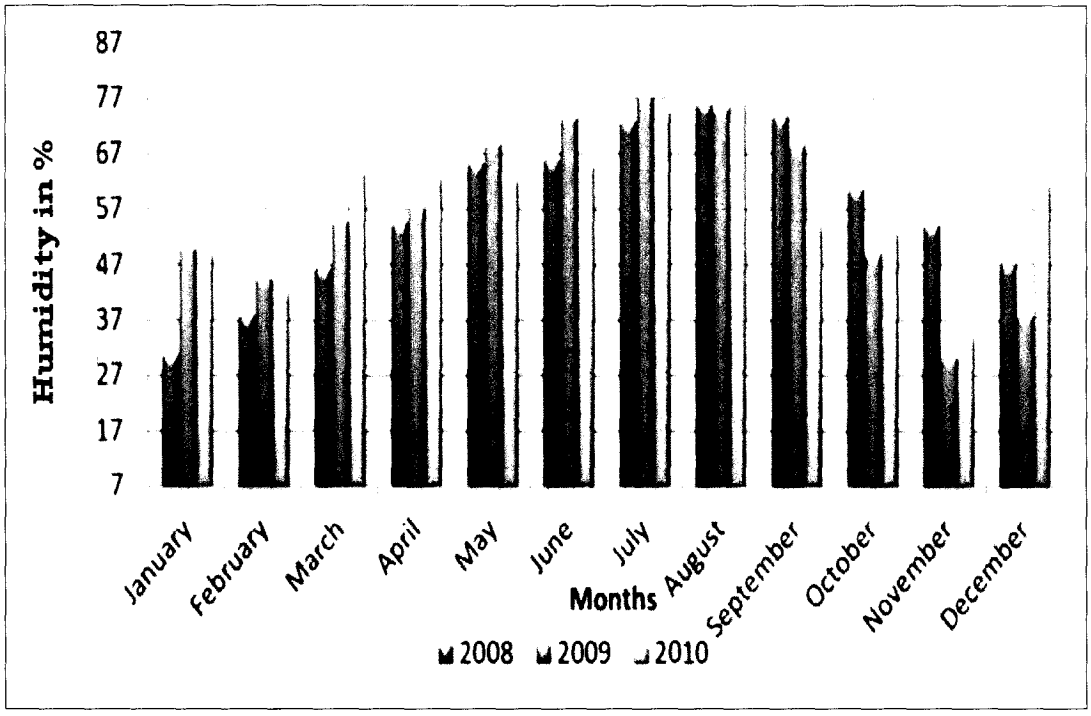
Month/Year	2008 Humidity (%)	2009 Humidity (%)	2010 Humidity (%)
January	30.87	50.19	50
February	38.07	44.9	42.08
March	46.58	54.88	64
April	54.7	57.38	62.86

[4] World Weather Online

[5] Study of sugarcane germplasm varieties for flowering ability under agro climatic conditions of Thatta

May	65.61	69.04	62.66
June	66.07	73.76	65.3
July	72.94	77.78	75
August	76.27	75.44	76.71
September	74.21	69	54
October	60.76	49	53.23
November	54.32	30.31	34.61
December	47.32	38.14	61.9

Exhibit 4.5: Relative Humidity Observed at Thatta[6]



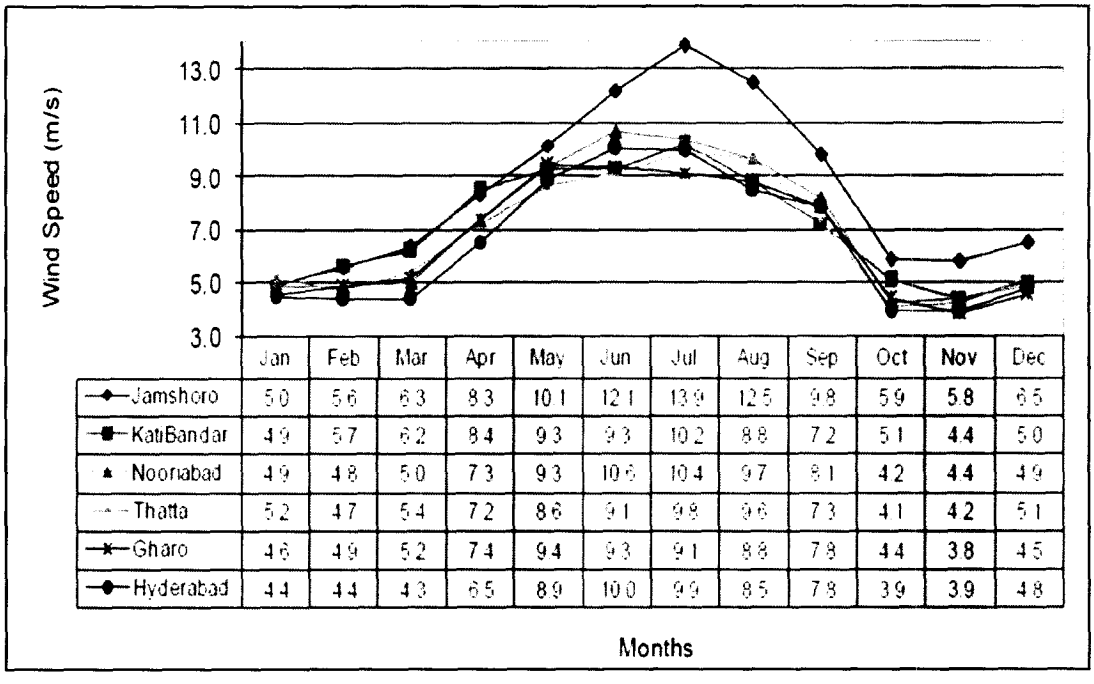
4.7 WIND

In the coastal areas of Sindh, Karachi and its adjoining deltaic areas, the wind blows throughout the year with high velocities during the monsoon season the wind speeds reaches its peak speed. The direction of the wind varies throughout the season but it is mostly observed that during the summer season the direction is west-southwest and during the winter season its direction is mostly from east-northeast.

[6] Study of sugarcane germplasm varieties for flowering ability under agro climatic conditions of Thatta

Exhibit 4.6 represents the monthly average estimated wind speed at 50m heights at six most windy stations of district Thatta. The graph clearly shows that from the month of April to September the wind speed is very high in these coastal areas of Sindh. Moreover the areas closer to the project areas such as Kati Bandar, Nooriabad, Thatta, Gharo, Hyderabad, Sajawal, Jati, Golarchi, Baghan, Talhar, and Chuhar Jamali are also suitable sites for power generation.

Exhibit 4.6: Average Monthly Wind Speed near Project Area[7]



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jamshoro	5.0	5.6	6.3	8.3	10.1	12.1	13.9	12.5	9.8	5.9	5.8	6.5
KatiBandar	4.9	5.7	6.2	8.4	9.3	9.3	10.2	8.8	7.2	5.1	4.4	5.0
Noorabad	4.9	4.8	5.0	7.3	9.3	10.6	10.4	9.7	8.1	4.2	4.4	4.9
Thatta	5.2	4.7	5.4	7.2	8.6	9.1	9.9	9.6	7.3	4.1	4.2	5.1
Gharo	4.6	4.9	5.2	7.4	9.4	9.3	9.1	8.8	7.8	4.4	3.8	4.5
Hyderabad	4.4	4.4	4.3	6.5	8.9	10.0	9.9	8.5	7.8	3.9	3.9	4.8

4.8 AMBIENT AIR & NOISE QUALITY

As the project site is located in a rural area of the district Thatta and it is less populated major of the land area is barren only a few area of the tehsil Sakro is used for agriculture purpose. Keeping in view the SEQS for noise level different sampling sites were selected for sampling air and noise level and it was found that all the results were underlying the SEQS. Air and Noise sampling plan is presented below in **Exhibit 4.7** respectively.

[7]An Investigation on Wind Power Potential of Sindh, Pakistan metrological department

Exhibit 4.7: Air and Noise Quality Monitoring Results

Sampling Location	Parameters	Units	SEQS Limits	Concentrations	Method
1	Suspended particulate matter (SPM)	µg/m³	500	11	EVM-7
	Particulate Matter (PM_{10})	µg/m³	150	6	EVM-7
	Noise	dB(A)	85	67	Noise Meter
2	Suspended particulate matter (SPM)	µg/m³	500	12	EVM-7
	Particulate Matter (PM_{10})	µg/m³	150	6	EVM-7
	Noise	dB(A)	85	70	Noise Meter
3	Suspended particulate matter (SPM)	µg/m³	500	22	EVM-7
	Particulate Matter (PM_{10})	µg/m³	150	10	EVM-7
	Noise	dB(A)	85	84	Noise Meter

4.9 WATER RESOURCES

This section details the water resources of the proposed project area. Both, surface and ground water resources have been summarized in this section of the report. Data was obtained from secondary sources and through field observation and data collection.

4.9.1 Surface water Sources:

Plenty of surface water sources are available in the proposed project area and in the district of Thatta in the form of rivers, streams, tributaries and canals. Gharo creek system is among the main fresh water artery which is used for agriculture purpose while a scanty amount of water is used for domestic purpose. Some of the major surface water sources are listed below.

- Indus River
- Gharo Creek
- Haleji Lake
- Kinjhar Lake
- Dhand Yimini

- Makarvari Lake
- Reen Lake

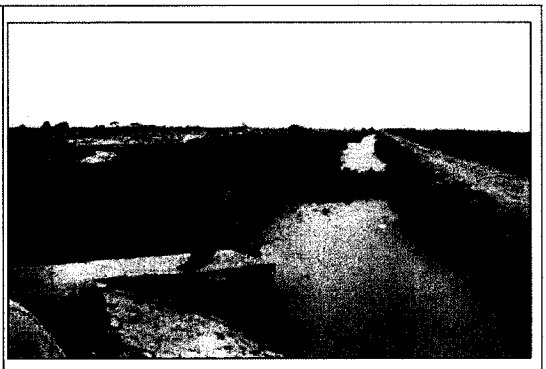
Exhibit 4.8: Chemical Analysis of Surface Water: Goth Mohammad Hassan Khaskhali (SW-1)

S.No	Parameters	Units	SEQS	Concentration	Method
1.	pH value		6.5-8.5	7.05	pH meter
2.	Chloride	mg/l	<250	21.97	APHA 4500 Cl B
3.	Residual chloride	mg/l	0.2-0.5	0.03	Hach Method 8167
4.	Salinity	mg/l	------	408	Conductivity meter
5.	Calcium	mg/l	<500	52.21	APHA 3500 D
6.	Phosphate	mg/l	------	1.94	Hach Method 8048
7.	Total Dissolved Solid	mg/l	<1000	232	APHA 2540 C
8.	Turbidity	NTU	<5	8	Merck Method (077)

Exhibit 4.9: Chemical Analysis of Surface Water: Goth Jangi Khan (SW-2)

S.No	Parameters	Units	SEQS	Concentration	Method
1.	pH value	-----	6.5-8.5	7.58	pH meter
2.	Chloride	mg/l	<250	47.86	APHA 4500 Cl B
3.	Residual chloride	mg/l	0.2-0.5	0.02	Hach Method 8167
4.	Salinity	mg/l	------	611	Conductivity meter
5.	Calcium	mg/l	<500	46.75	APHA 3500 D
6.	Phosphate	mg/l	------	0.07	Hach Method 8048
7.	Total Dissolved Solid	mg/l	<1000	348	APHA 2540 C
8.	Turbidity	NTU	<5	<1	Merck Method (077)

Exhibit 4.10: Surface Water Monitoring

	
Surface Water sample collection	Fresh water Canal near project site

4.9.2 Ground Water Resources

Ground water extraction is one of the expensive process in the proposed project area most of the ground water in the project area is brackish while at some points palatable clean groundwater can be found, as the project area lies in the coastal belt therefore the case of seawater intrusion is common in most of the area. Meanwhile two main sources of groundwater were found in the project area at Jangi Khan and Goth Mohamad Hassan Khaskheli. Samples from both the sources were taken using the standard procedure and analyzed the results are incorporated in **Exhibit 4.11 and 4.12.**

Exhibit 4.11: Chemical Analysis of Ground Water: Goth Mohammad Hassan Khaskhali (UG-1)

S. No	Parameters	Units	SEQS	Concentration	Method	Remarks
1.	pH value		6.5-8.5	7.22	pH meter	OK
2.	Chloride	mg/l	<250	150.41	APHA 4500 Cl B	OK
3.	Residual chloride	mg/l	0.2-0.5	0.02	Hach Method 8167	OK
4.	Salinity	mg/l	------	1197	Conductivity meter	
5.	Calcium	mg/l	<500	82.98	APHA 3500 D	OK
6.	Phosphate	mg/l	------	0.13	Hach Method 8048	OK
7.	Total Dissolved Solid	mg/l	<1000	672	APHA 2540 C	OK
8.	Turbidity	NTU	<5	5	Merck Method (077)	OK

Exhibit 4.12: Chemical Analysis of Ground Water: Goth Jangi Khan (UG-2)

S. No	Parameters	Units	SEQS	Concentration	Method	Remarks
1.	pH value		6.5-8.5	5.71	pH meter	OK
2.	Chloride	mg/l	<250	524.48	APHA 4500 Cl B	
3.	Residual chloride	mg/l	0.2-0.5	0.03	Hach Method 8167	OK
4.	Salinity	mg/l	------	2219	Conductivity meter	
5.	Calcium	mg/l	<500	134.02	APHA 3500 D	OK
6.	Phosphate	mg/l	------	0.24	Hach Method 8048	OK
7.	Total Dissolved Solid	mg/l	<1000	1248	APHA 2540 C	
8.	Turbidity	NTU	<5	7	Merck Method (077)	

4.9.3 Irrigation system of the project area:

Within the proposed project area four main flood drainage exist namely Ghaggar, lath, Jhulay and Dhabeji wala Dora which are seasonally used for irrigation but most of the areas are dependent on Koteri barrage, K.B fed canals and Pinyari canal for irrigation and also the water in the forms of streams are used for domestic and livestock purpose.

Ground Water Sample Collection

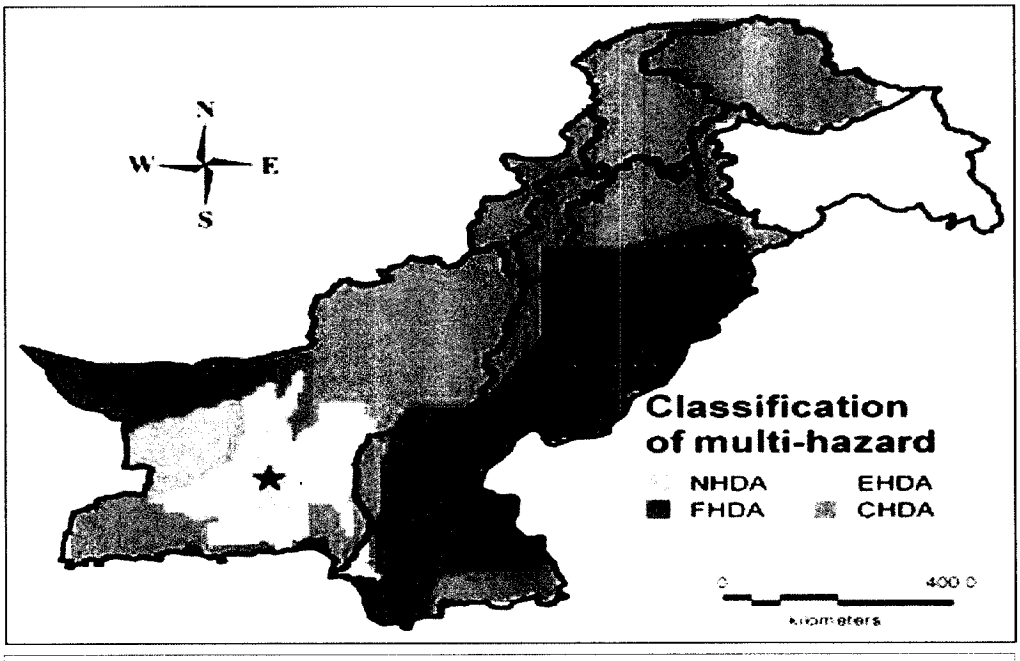
Ground Water Pumps for Filling Local Supply Tankers

4.10 DISASTER RISKS

The district of thatta is vulnerable to a number of natural disasters including frequent cyclones, floods, and droughts. A chronology of disasters over the last five decades reveals that the area has remained in the grip of an uninterrupted cycle of disasters in one form or the other. Cyclones, heavy rainfalls, droughts and floods follow each other with short-lived intervals.[8]

The multi-hazard map that takes into account various natural hazards identifies this area as earthquake dominant. Hence it verifies that the probability of occurrence of a specific natural hazard is correctly shown in the **Exhibit 4.13**.

Exhibit 4.13: Classification of multi-hazard zoning map[9]



NHDA *: No Hazard Dominated Areas*

EHDA: *Earthquake Hazard Dominated Areas*

FHDA : *Flood Hazard Dominated Areas*

CHDA : *Combined Hazard Dominated Areas*

4.10.1 Earthquakes

The Indo-Australian plate upon which Pakistan, India and Nepal lie, is continuously moving northward, colliding with and sub-ducting under the Eurasian plate, thus forming the Himalayan mountains, and triggering earthquakes in the process. Tectonic Plates can be preseted as **Exhibit 4.14.** The history reveals that:

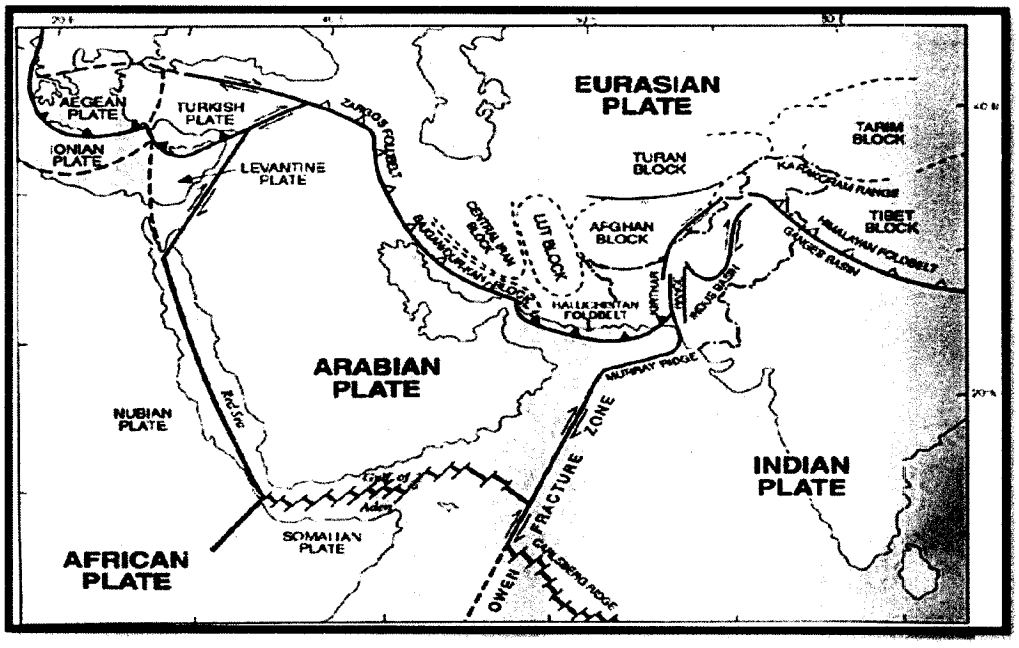
[8] Disaster Risk Management Plan District Thatta Government of Sindh
[9] Siddique, M.S. and Schwarz, J. (2012): Multi-hazard approach to assess vulnerability of the building stock in Pakistan

The areas comprising Pakistan have suffered four major earthquakes in the 20th century including the great Quetta earthquake of 1935, the 1945 earthquake off the coast of Makran, the 1976 earthquake in the Northern areas, and the October 2005 Kashmir earthquake. In between these major events, the Northern areas and Kashmir have experienced many small quakes with localized impact. No appreciable earthquakes have been recorded in Karachi during the recent past. However, on September 24, 2013, a tremendous earthquake struck the Awaran District in the western Balochistan Province of Pakistan. The quake's epicenter was near the Awaran District, but others districts of Balochistan Turbat, Panjgur, Chaghai, Khuzdar and Gwadar were also affected. According to the reports, tremors from the earthquake, which registered 7.8 on the Richter scale, were also felt in Quetta, Hub, Kharan, JhalMagsi, Qalat, Sibi, Mastung, Jafferabad and Karachi Pakistan and as far away as UAE.

The recently developed (post October 2005 earthquake) seismic zone map of Pakistan has divided the country into four seismic zones ranging in term of major, moderate, minor and negligible zones with respect to ground acceleration values. Seismic zone of Pakistan presented in **Exhibit 4.15.**Under this zoning Thatta Division has been identified on the edge of moderate to high hazard zone.

The proposed project is located in the low seismic zone, where a moderate level of seismic activity is believed to exist, but large magnitude earthquakes are very rare. Seismic Zoning Map of Pakistan can be seen in **Exhibit 4.16.**

Exhibit 4.14: Tectonics Map of Pakistan[10]



[10] Scotese et al., 1988, Scotese, 1997

Exhibit 4.15: Seismic Zone of Pakistan[11]

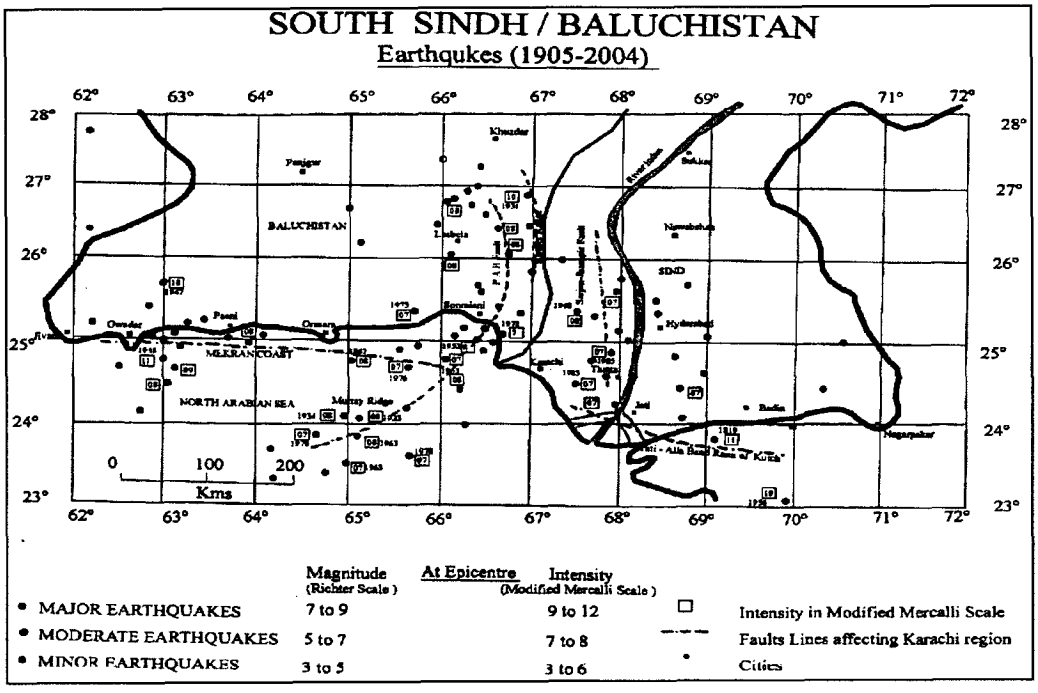
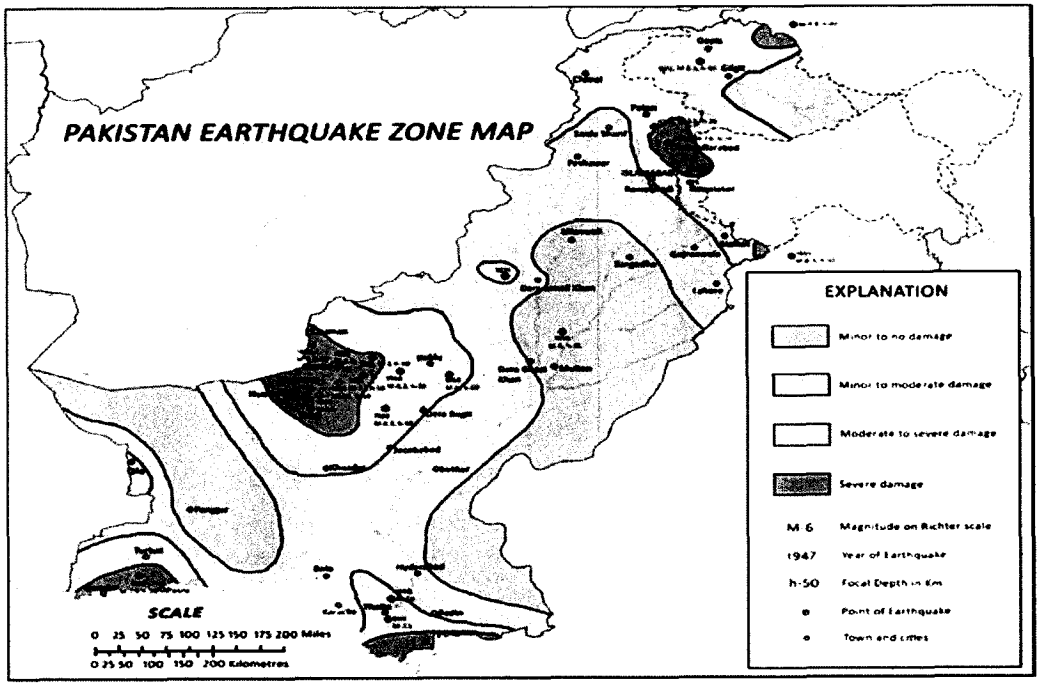


Exhibit 4.16: Seismic Zoning Map of Pakistan



[11] Geological Survey of Pakistan

4.11 FLOOD

In Pakistan, rainy season (monsoon) starts from June and lasts till September. The average rainfall in the district is 100 mm per year. In 2003 the rain started in the first week of June and lasted till August 2003. The total rainfall was more than 250mm and it created an emergency situation in the district, resulting in massive life loss and damage to crops, livestock and infrastructure. The rainfall below 100 mm is not alarming and is found to be manageable, but the rainfall exceeding the limit of 100mm will require immediate action.

The total discharge capacity of the canals to District Thatta is 16000 cusecs. During torrential rains, the canals are closed to allow the accumulated rain water to drain through these canals, apart from normal drainage system. Although there is quite a room for improving our faulty drainage system, however by employing such measures many lives and property was saved during 2003 rains.

4.12 TSUNAMIS

The coastal areas of Thatta might experience the effect of Tsunamis as the coast line of Pakistan has had this natural hazard in the recent past. An earthquake of magnitude 8.3 generated a destructive tsunami wave in the Northern Arabian Sea and the Indian Ocean on 28th November, 1945, producing 12 m to15 m high sea waves that killed at least 4,000 people in Pasni and adjoining areas. The tsunami hit as far as Mumbai in India. Karachi, about 450 km from the epicenter, experienced 2 m high sea waves which affected harbor facilities. Hence, the occurrence of another tsunami in the future cannot be ruled out.

The fact that cities like Karachi lie close to potential epicenters for large submarine earthquakes, demands attention for enhancement of local capacities for disaster risk reduction, early warning and response in order to reduce losses from tsunami events.

Recent studies show that Subduction of Oman oceanic lithosphere northward beneath the Iranian micro-plate and a tri-junction of tectonic plates at Somiani Bay can be a potential source of future tsunami that can be a major threat to the coastal cities of Pakistan such as Karachi, Gawadar, Pasni, Ormara etc.

4.13 TROPICAL STORMS AND CYCLONES

Tropical cyclones also occur periodically in the coastal areas. Coastal belt of Pakistan (especially in Sindh) is highly vulnerable to cyclones and associated storm surges. Fourteen cyclones were recorded between 1971 and 2001 (NDRMFP, 2007). Seldom have these cyclones had high intensities. The cyclone of 1999 in Thatta and Badin districts wiped out 73 settlements and killed 168 people and 11,000 cattle. Nearly 0.6 million people were affected. It destroyed 1800 small and big boats and partially damaged 642 boats, causing a loss of Rs. 380 million. Losses to infrastructure were estimated at Rs. 750 million. Climate change may increase the frequency and intensity of storms and could cause changes in their tracks. Although the frequency of cyclones

along Pakistani coast is low, yet they cause considerable damage, when they occur. Hence the possible occurrence of a future cyclone with severe consequences is quite rare but cannot be ruled out (NDRMFP, 2007).

CHAPTER

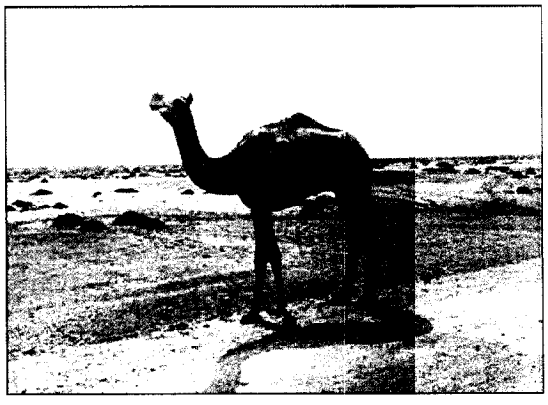
5 ENVIRONMENTAL BASELINE: BIOLOGICAL ENVIRONMENT

The Environmental baseline and biological environment of the proposed project area was evaluated by both primary and secondary means. Surveys were conducted in March 2017. Sampling locations for the identification of floral and faunal assemblages were carefully selected so that the maximum number of species could be observed and significant ecological baseline was generated for the proposed project area. The summary of biodiversity found during the site visit is as under, however detailed sampling methodologies and findings are also incorporated as an essential component of this chapter.

5.1 HABITATION

In general, Sindh Coastal Highway has environmental conditions like a semi-arid desert. The natural faunal and floral species and ecosystems are less significant and less in number because of extreme environmental stressors out of which significant source of stress on natural ecosystems includes high temperatures and less rainfall associated with anthropogenic activities thus underscoring floral and faunal ecosystems. During surveys and assessments it was observed that biodiversity of the project area was insignificant due to the dry land texture of the area. Neither species of flora and fauna was threatened, vulnerable, critically endangered or near to extinction according to IUCN red list or protected under CITES and or SINDH WILDLIFE PROTECTION ORDINANCE etc.

5.2 FLORA OF THE PROJECT AREA



The proposed project area sustains an arid environment. The harsh climate, minimum rainfall, and poor soil conditions limits the growth of floral species. In addition to that, it is important to note that the population of the area is dependent on livestock and agricultural activities for their livelihood. Therefore over grazing is another issue limiting the frequency of floral species within the proposed project area. The detailed description, list of identified species and methodology adopted for sampling are discussed in details below.

5.2.1 List of identified floral species

5.2.1.1 Trees of the Proposed Project Area

S. No	Family	Plant Name	Quantity
1	*Meliaceae*	*Azadirichta indica*	03
2	*Mimosaceae*	*Prosopis juliflora*	30
3	*Mimosaceae*	*Prosopis cineraria*	12
4	*Mimosaceae*	*Parkinsonia aculata*	03
5	*Salvadoraceae*	*Salvadora oleides*	14

5.2.1.2 Shrubs of the Proposed Project Area

S. No	Family	Plant Name	Quantity
1	*Asclepidiaceae*	*Calotropis procera*	06
2	*Rhamanaceae*	*Ziziphus nummularia*	02

5.2.1.3 Herbs of the Proposed Project Area

S. No	Family	Plant Name	Quantity
1	Amranthaceae	*Aerva javanica*	06
2	*Tamaracaceae*	*Tamarix ramosissima*	03

5.2.2 Sampling Methodology

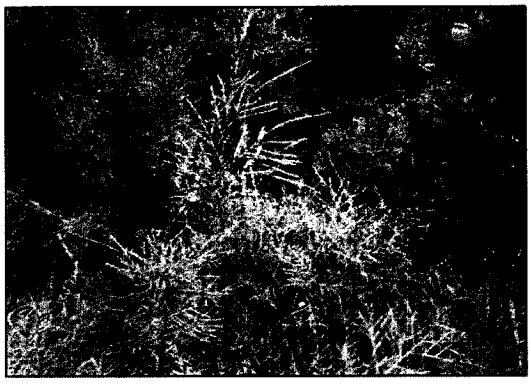
In order to study the dominant vegetation/ floral species of the project area standard line-transact sampling method was used in which different sized quadrats by means of measuring tape were made, the quadrat size ranged between 2-10 meter.

Large shrubs & trees	5 m x 10 m
Small shrubs & Herbs	2 m x 2 m

5.2.2.1 Dominant Vegetation

The dominant floral species of the project area is *Prosopis juliflora* which is one of the wild species in Sindh, rest of the species contributed less in vegetation cover of the project area.

Pictorial Presentation of the Floral Species

	
Tamarix ramosissima	*Prosopis juliflora*

5.3 FAUNA

Proposed project site is located in semi-arid environment, however the faunal species observed during the survey were mainly of desert origin. Moreover, it is important to note that the proposed project site sustains few nocturnal species as well. Detailed sampling protocol and method is presented below after brief description of the species and list of identified avifauna, mammals and reptile species of the proposed project area.

5.3.1 Avifauna

The area was found to be too windy and dry where it was safe to conclude that birds avoid being in such environments therefore very few species could be spotted or reported. The species identified in the proposed project area are of less ecological importance. The detailed sampling methodology and list of identified species during the ecological/ baseline survey is presented below.

5.3.2 Sampling methodology

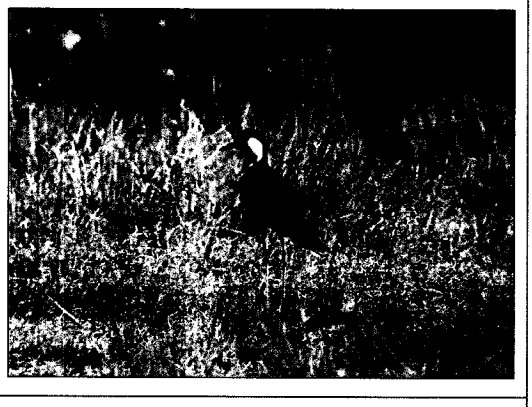
In order to study the avifaunal diversity of the proposed project area individual count technique was used during field surveys and the identified species were immediately recorded and reported accordingly. The detailed list of identified avifaunal species is presented below in **Exhibit 5.1** and pictorial profile also presented below.

Exhibit 5.1: Avifauna (Birds) of the proposed project area

S. No	English Name and Scientific Name		Occurrence					Protection Status	Population Total Count
			Resident	Migratory	Common	Less Common	Scarce	Protected under SWPO	
1	House Crow	*Corvus splendens)*	X		X				21
2	House Sparrow	*(Passer domesticus)*	X		X				18
3	Common Myna	*(Acridotheres tristis)*	X		X				12
4	Desert Lark	*Ammomanes deserti*	X		X				9
5	Little green bee eater	*Merops orientalis*	X		X				11
6	Lapwing	*Hoplopterus indicus*	X		X				10
7	Indian Roller	*Coracias benghalensis*	X		X				05

Pictorial Profile of Avifauna of the project area

Green bee eater



Lapwing

Indian Roller

Desert lark

5.3.3 Mammals

No major mammalian habitats were identified except those of Hedgehog and mongoose habitats but not spotted nor reported. None of the species recorded is protected, threatened or included in the CITES appendices. List of Mammals recorded in the project area is incorporated after the sampling methodology.

5.3.4 Sampling Methodology

Direct count method was adopted to identify total number of identified species during the ecological/baseline surveys. The list of identified mammals is presented below in **Exhibit 5.2.**

Exhibit 5.2: List of Identified Mammals of the Project Area

S. No	English Name	Scientific Name	Occurrence		
			Common	Lass Common	Scarce
1	Roof Rat	Rattus Rattus	x		
2	Small Indian Mongoose	Herpestes javanicus	x		

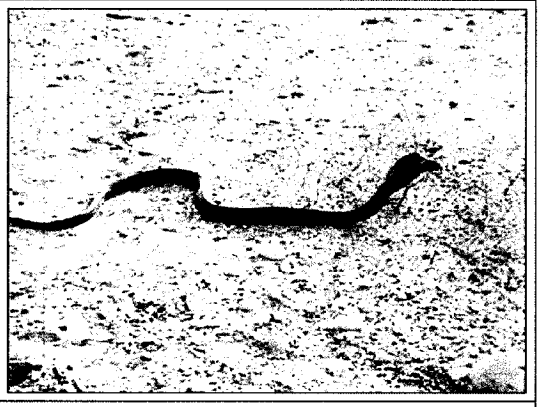
5.3.5 Herpito fauna of the Project area

The site has slightly higher populations of reptiles as the environment favors their existence. Lizards and snakes were observed and reported by locals. None of the species is protected or threatened.

Exhibit 5.3: Reptiles of the project area

S. No.	English Name	Scientific Name	Occurrence		
			Common	Less Common	Scarce
1	Spiny tailed lizard	*Uromastyx*	X		
2	Monitor lizard	Varanus	X		
3	Desert cobra	Naja naja	X		

Pictorial Profile of Reptiles of the Project Area

	
Indian garden lizard	Desert cobra

Conclusion:

As mentioned earlier, the proposed project site is naturally dry and windy which does not provide favourable habitat for floral and faunal species. The species observed are of less ecological importance. No major trees were found however if need be, in case of cutting of trees, one plant should be replaced by 1:3 for immature plants and 1:6 for mature plants. Since the area is already under constant movement of heavy vehicles, animals do not approach the area rather they have migrated more into safe areas where anthropogenic activities do not persist the area has no biological importance.

CHAPTER

6 ENVIRONMENTAL BASELINE: SOCIO-ECONOMIC CULTURAL ENVIRONMENT

6.1 SCOPE AND METHODOLOGY

This chapter presents the assessment of the socio-economic baseline of the entire surroundings of the proposed project area based on social surveys. The assessment includes the administrative, demographic and social structures, amenities, health, education, livelihood, security and economics of the project area. The assessment also includes a focus on the gender aspects.

A brief socio-economic profile of the proposed project area, based mainly on secondary data, is also provided following the needs and requirements of an IEE, incorporating the Pakistan Environmental Assessment Procedures 2000.

6.2 TOOLS FOR DATA COLLECTION

The socio-economic assessment is focused on evaluation of population, languages, literacy rate, education facilities, health facilities, private medical facilities, diseases, number of houses, available utilities, access to social amenities, road access, availability and medium of transport, occupational statistics, livestock, water resources and pressing needs of the people living in the area.

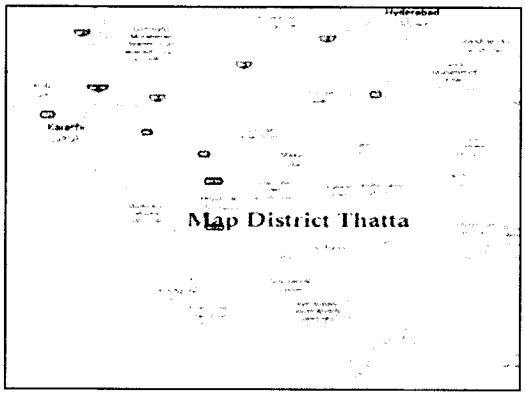
Interviews, focus group discussions and consultative meetings were conducted at community level and with different private and government departments and organizations to gather additional relevant primary data. A brief profile was designed very carefully and administrated to sample the target population of the area.

The information gained helped in the measurement and determination of the impacts (positive and negative) on social services, livelihood and cultural pattern of the population under study.

6.3 LOCATION AND ADMINISTRATIVE SETUP

The proposed project is to be located at Deh Ghairabad, Mirpur Sakro, District Thatta, Sindh at approximately 6 km along the Sindh Coastal Highway and then 1.25 km via connecting road from the Highway. The site is at about 55 km from Jinnah International Airport, Karachi and is adjacent to the 50 MWp Oursun Solar Plant, which shall also sell electricity to KE Limited. Thatta is one of the southern and border district of Pakistan. It is situated at about 60 mile from east of Karachi on the

National Highway, the Thatta district is situated between 23° 43' to 25° 2 6' north latitudes and 67° 05' to 68° 45' east longitudes. The total area of the district is 17,355 square kilometers (sq.km) and is the second largest district of the Sindh province following district Tharparkar.it covers 12.3% area of the province and 12.18 of Pakistan.[1]



6.4 DEMOGRAPHICS OF THE AREA

According to the 1998 census the population of district Thatta was 1,113,194 with an estimated growth rate of 2.26% per annum, the major percentage of population 43.85 percent is of the age below 15 years and 2.94 percent is 65 years or above. The estimated population for 2014 is 1,593,887, showing almost 43% increase in 16 years from 1998 (USAID September. 2014)[2].Out of the estimated population of 2014 53 percent are males and 47 percent are females.

The Mirpur Sakro Taluka covers an area of about 2,982 square kilometers (736,541 acres). The taluka is distributed in 10 unions. The total population according to the 1998 census was 198,852 individuals.

6.5 MAIN SOURCES OF LIVELIHOOD/INCOME

According to ADB (Asian Development Bank) 79% of the population is poor and the district is the poorest district of Sindh, most of the people of district are dependent on agriculture and fisheries and a major population of the district are landless and they depend on landlords and own livestock for living. 59% of the males are engaged in agriculture and the female population also works with men side by side. Wheat and rice is the major crops of the district along with sugarcane and maize.

Wood is used as fuel for cooking in all villages. It is mostly collected from the nearby villages of Kacha area. The animals (Buffalos, Cows, and Goats) usually graze in surrounding areas of the village within a 3 km area. Mostly children herd them.

Other sources of income includes fish farming and also poultry farming in many villages. Non-skilled labor work in the nearby cities and some villagers are also employed in the surrounding industries of Gharo and Dhabeji. A few villagers also work in salt works near Arjina bridge of Gharo Creek.

[1] http://rdpi.org.pk/district-profile-thatta/

[2] http://reliefweb.int/map/pakistan/pakistan-sindh-thatta-population-density-map-september-2014

	
Agricultural land near the project area	Livestock available in villages

6.6 NETWORKING AND COMMUNICATION

During the field visit, many villages were visited. People residing in these villages regularly visit Dhabeji and Gharo cities for shopping, business, documentation, availing health facilities. Small shops are also available in some of the targeted villages. A very few link roads are available in some villages of the proposed project area; all of these villages have easy access to nearby towns and cities.

There is no public transportation available in the targeted villages such as buses, Suzukis, Ching chi (rickshaw) and Tanga. A reasonable number of motorcycles were seen in the proposed project area because this is the cheapest personal transportation for villagers. Cow and donkey carts are also used for transportation by poor villagers.

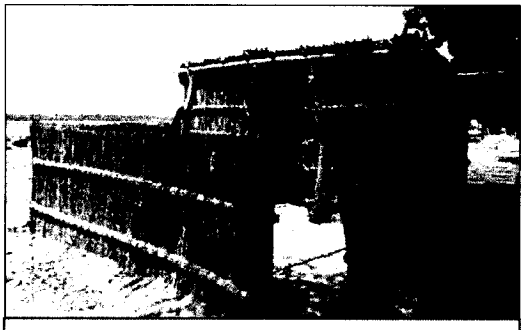
The use of mobile phones was visible in almost all the villages visited. Village people mutually share cell phones. This trend has developed recently.

6.7 LEADERSHIP DYNAMICS

There are different hierarchy of leadership in the project area i.e. village leader, community leader, political leaders and spiritual leaders. The village leader is normally the most influential person of the village in terms of land. Minor conflicts are resolved at village level. However, if the conflict is big and complex, the community leader resolves the conflict through listening to both the parties' point of view. The community approaches to the police in rare cases for resolving their

problems. Mostly conflicts occur due to tribal disputes, disputes on land, theft of animals, arrangements of marriage etc.

Spiritual leadership is also believed in some villagers of the area and a Mazaar (grave of saint) was also found in the route of proposed project near Jangi Khan Goth at safe distance from solar PV plant. People also consult the Moulana of the Masjid to resolve any religious issues.



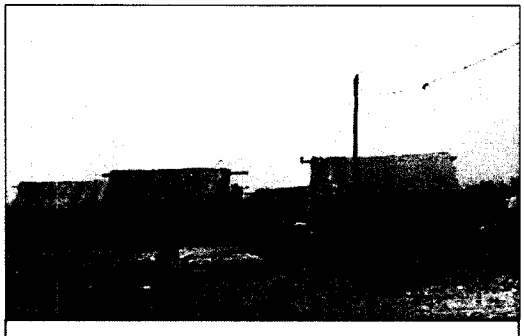
Masjid and Madarsah in a Village

6.8 ROUTINE ACTIVITY OF FEMALES

The women of this area are very hard working and more practical than men. They play a major role as counterpart to carry out household and field activities with their men. Generally the women remain very busy in the proposed project area; women are responsible for cooking food, dish-washing, washing of clothes, and sewing of clothes, making Rillhies, and look after their children. In addition to all above activities, women were also seen working in the agriculture field mostly in harvesting of crop, and feeding and milking the livestock. Almost all the women of the project area are illiterate and have no authority to interfere in domestic decision making; they usually sleep early and wake-up early in the morning to start routine activities.

6.9 HOUSING AND LIVING PATTERN

The area has totally poor rural outlook. There is a presence of separate Otaks system for serving the guests. The living is very simple and is manifested in their eating habits and social ceremonies. People of the project area are very hospitable and caring. Most of the houses in the project area had katcha houses and poor villagers live in huts. No concreted houses were found in the nearby villager of proposed solar PV plant.



Housing Pattern of the Villagers

6.10 DRINKING WATER

The source of drinking water in most of the villages is underground water drawn through motor and hand pumps. Water supply system through pipelines was not available in any village of the project area but people prefer to use the water of hand pump instead of water supply, because hand pumps were reported to have sweet

water as compare to the water supply. In some small villages no hand pumps are available and people use irrigation water from open channels for drinking purpose.

6.11 EDUCATION

The state of education in the area is poorest. Only one government primary school found in the route of proposed project route and another primary school was found which is run by an NGO. Shortage of teachers was observed in government school. Most of the school-age going children were not attending any school due to shortage of schools and lack of interest of their parents in education. Also the schools are available at long distances and due to lack of public transportation, children avoid to go to school regularly. The literacy rate is below 5 % in almost all villages. On the other side in few Masjids of the villages religious education is given to the children by the Imam of the Masjid.

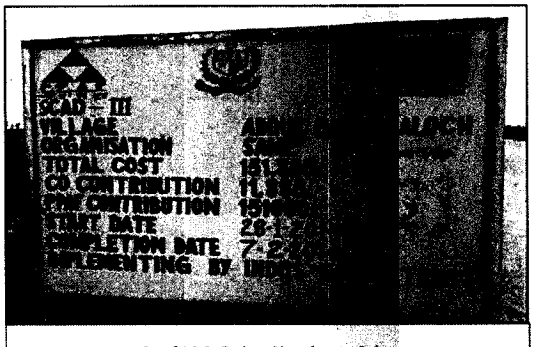
Primary School near the Proposed Project

6.12 HEALTH

There is total shortage of health facilities in the proposed project area. People of these areas suffer huge problems when someone gets sick. The health facilities are only available in Dhabeji and Gharo cities. Major health problems of the area are Malaria, Skin Diseases, Fever Diarrhea, Gastro, Malnutrition in children and mothers, Hepatitis and Diabetes. Few incidents of snake bites were also reported in flood season in villages. The problem is more serious for females especially, in case of pregnancy and delivery due to non-availability of trained female staff/lady Doctor. People travel to Karachi city in case of some serious problem/emergency.

6.13 NON GOVERNMENT ORGANIZATION (NGOS)

The expanding advocacy role of NGOs has been recognized by the State. As intermediaries, NGOs have established channels of communication and cooperation between communities, on one hand, and governments, development institutions and funding agencies, on the other. The NGOs operating in the few villages of the project area are Indus Earth and National Rural Support Programme (NRSP) majorly with collaboration of Pakistan Poverty Alleviation



Board of NGO is displayed in area

Fund (PPAF). The NGOs work for physical infrastructures and social welfare. Through local community we got information regarding social welfare activities in villages of project area.

6.14 CULTURE AND ETHNICITY

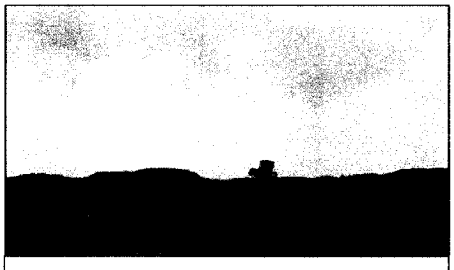
Major castes / tribes in the project area are Kalmati, Rind, Khaskheli, Kohli, All these tribes speak Sindhi as their mutual languages and Balochi is the second biggest language of the project area.

Marriages in most families are arranged by parents preferably in their own caste. The ritual of wedding/ marriage ceremonies usually lasts for two to three days. Usually the people of project area borrow the money to celebrate the marriages/circumcision ceremonies due to poor economic situation of the area.

People of the area have much respect and belief for saints. They usually visit shrines at the time of trouble, misfortune, and pay for birth of sons, and when their wishes come true, this reflects their faith upon them. Depending on which sect one belongs to is determined by the fact that whether or not they visit the shrines or how much they revere the saints. Dressing pattern of the villagers represents common rural Sindhi culture and women of Hindu community also wear Saari as additional dress besides shalwar kamiz.

6.15 ARCHEOLOGICAL AND HISTORICAL SIGNIFICANCE OF THE AREA

There exist a large number of sites of archeological, cultural, historical and religious significance in Thatta district. The major ones include the archeological remains of Makli Hills graveyard, Shah Jahan Mosque and excavations of Debal Fort (Bhamhor) which are at 35 Km distance of proposed solar PV project.



Bhambhor near the project area

6.16 MAJOR PROBLEMS/NEEDS

Following are the main problems/needs of the public of the project area:

- Unemployment;
- Shortage of health facilities;
- Shortage of schools and teachers;
- Lack of sewerage facilities;
- Non-availability of Sui Gas for domestic use;
- Load shedding of electricity/Lack of Electricity
- Lack of Public Transportation

CHAPTER

7 ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

7.1 OVERVIEW

This sub-section of the IEE Report identifies the overall impacts of siting, construction and operation activities of the proposed project on the physical, biological, and socioeconomic environment.

The following environmental aspects have been identified as those likely to produce potential environmental impacts on the physical, biological, and socioeconomic environment during construction and operation phases of the proposed project.

7.2 ASSESSMENT OF IMPACTS DURING CONSTRUCTION PHASE

Establishment of the proposed project is considered to not have any long-term impact on the environment. The impacts of construction phase are to be on localized scale and will not be on a greater magnitude that shall cause any noticeable concerns. The impacts and their mitigation measures of the construction and operation phase are addressed in this section.

7.2.1 Ambient Air Quality

Ambient Air quality will be affected by dust generation and emissions from the heavy vehicles, machinery and stand-by generators. Untrained driving of heavy vehicles as well as improper storage of stock piles and raw material used will contribute to dust dispersion. Dust dispersion will depend on weather conditions; wind velocity, precipitation rate and type of construction work. Improper tuning of machinery and stand-by generators might release elevated levels of gaseous emissions. Dust and gaseous emissions cause impairment of human health which includes chronic respiratory diseases.

Mitigation Measures

- Water spraying will be done to reduce dust emissions;
- Covering the stock piles with tarpaulin or plastic sheets to avoid unnecessary dust emissions.
- Use of standard construction equipment and vehicles;
- Water spraying will be done to reduce dust emissions;

- Stand-by generators and vehicles will be properly tuned and tested for gaseous emissions periodically.
- All roads will be paved as soon as possible before construction and installation of Solar PV to reduce the probability of dust dispersion.

7.2.2 Ambient Noise

The major noise generating sources during the construction phase are vehicular traffic, construction equipment like dozer, concrete mixers, cranes, excavators, lifters, Stand by generators, pneumatic tools, vibrators used for digging, cutting, fabrication works and transfer of raw materials. The operation of this equipment will generate noise ranging between 75 – 90 dB (A). Noise causes negative health effects on the workers such as stress, hypertension, headaches and even hearing loss to those who have prolonged exposure to it. In general it disturbs the general environment which includes the social environment specifically. The major work of the construction is expected to be carried out during the day time.

Mitigation Measures

- Noise levels as per SEQS i.e. 80 dB (A) during day-time and 75dB (A) during night-time;
- Construction equipment/machineries will be provided with suitable noise dampening devices;
- Vehicles must be tuned and maintained to reduce their noise levels;
- Workers on site will be provided with adequate 'Personal Protective Equipment' (PPE);
- Appropriate noise reduction steps will be taken wherever necessary including scheduling of high noise creating activities simultaneously with low noise generating activities to keep the ambient noise levels within SEQS.
- Noise level will be monitored at regular intervals to meet the requirements of SEQS.

7.2.3 Impact on Soil and Land

The project activity may result in disturbance to the topsoil. Loosening of top soil will enhance soil erosion during rainy and windy seasons. Spills of oil used in vehicles and machineries in construction phase may result in soil contamination. Foundation works will require excavation and dislocation of soil, which causes partial land instability.

Mitigation Measures

- Construction activities will be limited to the designated area.
- Pitching of soil and silt entraption near excavated sites must be taken into consideration.
- Preventive measures such as secondary containment facility for chemicals and oil containers must be developed to reduce the probability of soil contamination in case of accidental spills of oils/lubricants.
- Spill prevention plan and spill kits must be developed as a corrective measure for accidental spills.

7.2.4 Impact on Terrestrial Ecology

The existing ecology and natural habitats at the proposed site is described in Chapter 05. It can be noted from the findings of the ecological survey that there are no species within or around the site that are classified as rare, threatened, endangered or of significant conservation value.

Avifauna in the area is very common and is highly adaptable or can easily re-colonized vacant habitats whenever necessary.

The fauna is adaptable to developmental changes and the ecosystem is not purely natural. This ecological trait will permit them to move from other vegetated areas especially the tree communities surrounding proposed project site.

Mitigation Measures:

- Green areas will be developed in vacant portions of proposed project areas;
- Plant trees that are indigenous and will mature in short time and support local avifauna.
- A horticulturist will be engaged for developing a plantation program on the site.

7.2.5 Generation of waste water

Waste water will be generated in form of grey water from construction activities. This water will be in limited amounts and will be re-utilized in land compaction processes or sprinkling for dust settlement. Supervision of construction site will be done such that no stagnant water pools or puddles remain for longer period as the will serve as breeding ground for mosquitoes.

7.2.6 Solid Waste Generation and Management

The construction phase of the proposed project is expected to generate non-hazardous solid wastes including construction materials for buildings as well as concrete, asphalt debris, packing waste etc. Maintenance of heavy construction

equipment and vehicles will utilize oil and lubricants leaving empty containers. Besides being an eyesore, the waste can also pose a health hazard; pollute soil, surface and ground water if disposed of improperly.

Mitigation Measures

A waste management plan will be developed before the start of the construction activities. Key elements of the waste management system will be the following:

- Waste should be segregated at construction site by providing separate bins for different type of wastes - plastic, paper, metal, glass, wood, and cotton, for recycling purpose.
- A safe and designated area will be selected to store waste, EPA certified contractors will be hired for disposing of waste.
- No waste will be dumped at any location beyond the proposed site boundary;
- Record of all waste generated during the construction period will be maintained.
- Trainings will be provided to personnel for identification, segregation, and management of waste.

7.2.7 Impact on Local Economy

The proposed development will create employment during its construction phase. The construction activities will require significant number of local skilled and unskilled workers. However, positive impact on the local livelihood during the construction phase through creating new job opportunity is envisaged.

In addition, local suppliers will also be benefited as they will be contracted for the supply of water, foodstuff etc. Considering the above, beneficial impacts are envisaged from the proposed project on the local employment and economy. Furthermore, the land is to be purchased by the land owners, this will be a stable economical pursuit for the land owners as a long term development.

Mitigations

- Employment preference will be given to the locals;
- People from neighboring areas will be considered for unskilled employment;
- Suppliers and Vendors of neighboring areas will be given priority, where feasible.

7.2.8 Archaeological Resources

No site of archeological, cultural or historical value is known to exist near the project vicinity.

7.2.9 Traffic and Transport Management

Construction material and machinery will be transported through the provincial and local road network to the proposed project site. Heavy transportation vehicles might disturb the local traffic especially during day hours. Visibility is usually minimum during night time where there are less street lights, this will pose as a hazard for the local traffic travelling in night time.

During surveys, very less traffic was observed on the Sindh Coastal Highway but it was also found to be narrow for heavy vehicles to move continuously.

Mitigation Measures:

- Diversion routes for construction vehicular traffic must be allocated to maintain normal traffic flow by forming a temporary pathway made up of gravel and sand along the proposed solar PV project.
- Emergency routes must be kept clear and ensure that they are easily accessible.
- The area has very low traffic count and does not need an extensive traffic management plan to be implemented. However, local traffic police and coastal guards must be consulted during works for supervision.

7.2.10 Health and Safety

Health and safety issues during construction stage can be a major concern. Project activities may cause accidental damage to public as well as the construction workers. Safety and accident prevention program should be organized for employees, these program develop the basic understanding about the general safety rules and procedures in various activities and update their knowledge according to safety and accident prevention, industrial hygiene and emergency equipment.

Mitigation Measures:

- Organize awareness programs relevant to personal safety of the workers in particular and public in the area in general.
- Installation of warning signs at particular locations such as transverse points of local road network.
- Provide protective safety belts, footwear, helmets, goggles, eye-shields, and clothes to workers depending on their job specification.
- Arrangement of proper first aid unit and emergency vehicle to take affected personnel to the nearest medical facility.

7.2.11 Sanitary Waste Disposal at Construction Sites and Labor Camps

The temporary labor camps generating the human excreta will not be significant to cause contamination of ground water. Mostly, labors will be staying near hamlets, which shall use the community services for solid waste, water and sanitation.

Unacceptable solid waste disposal practices such as open dumping of solid waste and poor sanitation facilities will lead to pollution of surrounding environment, contamination of water bodies and increase adverse impact to the aquatic; terrestrial lives and general public inhabited in the area. Surrounding of labor camps, garbage disposal sites and material storage yards provide favorable habitats for vectors of diseases such as mosquitoes, rats and flies.

Mitigation Measures:

Provision of adequate washing and toilet facilities shall be made obligatory. This should form an integral component in the planning stage before commencement of construction activity.

There should be proper solid waste disposal procedure to enhance sanitation of workers who stay in camps. Thus, possibilities of infecting water borne diseases or vector borne diseases (parasitic infections) will be eliminated by adopting proper solid waste disposal procedure.

Following measures are needed to protect and enhance the quality of environment during the construction stage:

- A better way to overcome garbage disposal as mentioned previously is by reducing or avoiding the construction of labor camps, thus the selection of majority of skilled and unskilled workers from the project influence area will be a proper measure in this regard.
- Provision of sanitation, and sewage facilities at all sites of the construction/ labor camps to avoid or minimize health hazards and environmental pollution. Temporary Soakage pits shall be developed for wastewater disposal.
- Contractor shall handle and manage waste generated from the construction /labor camps without contamination to natural environment thus reducing risk to neighboring community.
- Adequate supply of water shall be provided in the temporary urinals, toilets, and washrooms of the workers' accommodation.
- Contractor shall provide garbage bins near workers' accommodation and construction sites, for dumping wastes regularly in a hygienic manner.

7.3 ENVIRONMENTAL IMPACTS AND MITIGATION ASSOCIATED WITH OPERATIONAL ACTIVITIES

The operation phase is not deemed to be an air, water and environmental degrading aspect. Inspite it is considered as an environmental friendly technology. However, similar to the construction phase, the net impact on each environmental element due to various sources aspects is discussed.

7.3.1 Ambient Air Impact

No emissions are expected to be released during the operation phase, due to the fact that solar PV power plants do not release greenhouse gases or any toxic pollutants during their operation, as a result, no impacts on ambient air quality are anticipated during the operation phase.

7.3.2 Ambient Noise

The solar power projects have the unique advantage of producing electricity through silent process using PV panels. although the facility's inverters and transformers emit noise, but this is well within allowable limits and is not considered as an impact. In addition, there are no close by sensitive receptors such as hamlets or residential dwellings within the proposed project site.

In addition, noise generated from inverters is only heard when distance is close (i.e. within 1- 2 m), however, as distance increases, noise will be greatly reduced.

7.3.3 Solid Waste

Solid waste that might be generated from operational phase, only during maintenance, will likely consist of copper, wires, discarded electric panels, metal scrap etc. Mismanagement of these wastes can cause unaesthetic and unhygienic conditions.

Mitigation Measure

- The solid waste management plan will be developed and facilities for collection, storage and transportation.
- EPA certified contractors will be hired for proper waste disposal.

7.3.4 Generation of Waste Water

The only source of wastewater during operation phase will be from the cleaning (washing) of solar panels which will be done twice in a month for which bore well water or canal water will be used. Wastewater, although not expected to be contaminated, can be a potential source of pollution to surface and groundwater if left unattended.

Mitigation Measures

- The project should utilize planned water piping system instead of bowsers and tanks to minimise water usage and reduce excess wastewater.

CHAPTER

8 ENVIRONMENTAL MANAGEMENT PLAN

8.1 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) is a key component of the IEE. It lists all the potential impacts and associated mitigation measures identified in the IEE. For each expected impact, the EMP identifies the following information:

- A comprehensive listing of mitigation measures (actions).
- The party responsible for ensuring the full implementation of the action.
- The parameters to be monitored in order to ensure effective implementation.
- A time scale for implementation to ensure that the objectives of mitigation are fully met.

A mitigation plan concerning the activities of the proposed development is presented in **Exhibit 8.1.**

8.2 INSTITUTIONAL ARRANGEMENT FOR EMP

The EMP is to be implemented by an Environmental Committee formed by the Proponent. The membership of the Environmental Committee consists of:

- Environment, Health, and Safety (EHS) Officer;
- Contractor's Representative.

8.3 TERMS OF REFERENCE

The Environmental Committee will ensure:

- Implementation of the EMP.
- Ensure compliance.
- Monitoring.
- Trouble shooting.
- Coordination and reporting to SEPA.

Exhibit 8.1: Impact Mitigation Plan

Environmental Aspect	Impact	Mitigation / Implementation
Construction Phase		
Air Quality	Chronic Respiratory health effects	Water spraying will be done to reduce dust emissions; Covering the stock piles with tarpaulin or plastic sheets to avoid unnecessary dust emissions. Use of standard construction equipment and vehicles; Water sprinkling will be done to reduce dust emissions; Stand-by generators and vehicles will be properly tuned and tested for gaseous emissions periodically. Monitoring of ambient air will be done on monthly basis. All roads will be paved as soon as possible before construction and installation of Solar PV to reduce the probability of dust dispersion.
Noise	Stress Hypertension Hearing loss Headache	Noise levels as per SEQS i.e. 80 dB (A) during day-time and 75dB (A) during night-time; Construction equipment/machineries will be provided with suitable noise dampening devices; Vehicles must be tuned and maintained to reduce their noise levels; Workers on site will be provided with adequate 'Personal Protective Equipment' (PPE);Appropriate noise reduction steps will be taken wherever necessary including scheduling of high noise creating activities simultaneously with low noise generating activities to keep the ambient noise levels within SEQS. Noise level will be monitored at regular intervals to meet the requirements of SEQS.

Environmental Aspect	Impact	Mitigation / Implementation
Construction Phase		
Impact on Soil and Landuse	Soil erosion/ degradation	Construction activities will be limited to the designated area. Pitching of soil and silt entraption near excavated sites must be taken into consideration. Preventive measures such as secondary containment facility for chemicals and oil containers must be developed to reduce the probability of soil contamination in case of accidental spills of oils/lubricants. Spill prevention plan and spill kits must be developed as a corrective measure for accidental spills.
Terrestrial Ecology	Impact on flora and fauna	Green areas will be developed in vacant portions of proposed project areas; Plant trees that are indigenous and will mature in short time and support local avifauna. A horticulturist will be engaged for developing a plantation program on the site.
Wastewater Generation	Stagnant water can create mosquito nuisance Health problems	Waste water will be re-utilized in land compaction processes or sprinkling for dust settlement. Wastewater generated will be collected in a pit, tested and then routed to nearest drain/ sewerage system.
Solid Waste Generation	Health hazards Pollute soil Unaesthetic conditions	Waste should be segregated at construction site by providing separate bins for different type of wastes - plastic, paper, metal, glass, wood, and cotton, for recycling purpose. A safe and designated area will be selected to store waste, EPA certified contractors will be hired for disposing of waste. No waste will be dumped at any location beyond the proposed site boundary; Record of all waste generated during the construction period will be maintained. Trainings will be provided to personnel for identification, segregation, and management of waste.

Environmental Aspect	Impact	Mitigation / Implementation
Construction Phase		
Impact on Local Economy	Impact on the local livelihood	Employment preference will be given to the locals; People from neighboring areas will be considered for unskilled employment; Suppliers and Vendors of neighboring areas will be given priority, where feasible.
Traffic	Traffic congestion	Diversion routes for construction vehicular traffic must be allocated to maintain normal traffic flow by forming a temporary pathway made up of gravel and sand along the proposed solar PV project. Emergency routes must be kept clear and ensure that they are easily accessible. The area has very low traffic count and does not need an extensive traffic management plan to be implemented. However, local traffic police and coastal guards must be consulted during works for supervision.
Temporary Labor Camps	Impact on the Local area and ecological resources	A better way to overcome garbage disposal as mentioned previously is by reducing or avoiding the construction of labor camps, thus the selection of majority of skilled and unskilled workers from the project influence area will be a proper measure in this regard. Provision of sanitation, and sewage facilities at all sites of the construction/labor camps to avoid or minimize health hazards and environmental pollution. Temporary Soakage pits shall be developed for wastewater disposal. Basic utilities like potable water for drinking, clean water for basic use and electricity will be provided at the labor camps which shall be done before start of construction activity. Temporary sewage drains shall be made either connecting to the existing municipal drain infrastructure with their prior permission or if such infrastructure is not available, the temporary drains shall connect to septic tanks or soakage pits. Contractor shall handle and manage waste generated from the construction/ labor camps without contamination to natural environment thus reducing risk to neighboring community.

Environmental Aspect	Impact	Mitigation / Implementation
Construction Phase		
		Contractor will ensure proper disposal of solid waste either through municipal services or EPA approved contractors and keep records of the waste disposed.
Health and Safety	Impact on workers	Safety and accident prevention program should be organized for employees. Installation of warning signs at particular locations such as transverse points of local road network. Provide protective safety belts, footwear, helmets, goggles, eye-shields, and clothes to workers depending on their job specification. Arrangement of proper first aid unit and emergency vehicle to take affected personnel to the nearest medical facility.

Environmental Aspect	Impact	Mitigation / Implementation
Operation Phase		
Waste Water	Impact on surface and groundwater resources Water scarcity	The project should utilize planned water piping system instead of bowsers and tanks to minimise water usage and reduce excess wastewater.
Solid Waste	Fire hazards Property loss Unaesthetic and unhygienic Condition	The solid waste management plan will be developed and facilities for collection, storage and transportation. EPA certified contractors will be hired for proper waste disposal.

SEQS= Sindh Environmental Quality Standards

PPE's= Personal Protective Equipment's

Exhibit 8.2: Environmental Monitoring Plan

Environmental Aspect	Scope of Monitoring	Method	Location	Frequency of Monitoring	Responsibility
Construction Phase					
Air	Parameters prescribed in SEQS or as per SEPA requirements	Ambient Air Quality Monitoring	Within the proposed project site	Quarterly	Contractor GSPL
	Emissions of CO, NOx, SO_2 from mobile construction equipment and vehicles.	Emission testing will be done by Portable exhaust analyzer when the equipment and vehicle are in use	When and where used as per construction activity	Quarterly	Contractor GSPL
Noise	Construction activity associated noise levels	Noise levels will be recorded by noise meters at a distance of 7.5 m from source point	Representative locations ideally inside and outside of the proposed project site	Weekly	Contractor GSPL
Land and soil	Surface topography	Visual assessment Photographic evidences	Within the proposed project site	Weekly	Contractor GSPL
Terrestrial Ecology	Green area development plan	Plan verification	Within the proposed project site	Quarterly	GSPL
Waste Water	Record log of water usage and releases Water drainage system	Check water drainage system Ensure the plan is being implemented	Within the proposed project site	Weekly	Contractor

Environmental Aspect	Scope of Monitoring	Method	Location	Frequency of Monitoring	Responsibility
Construction Phase					
Solid Waste	Assessment of solid waste quantity and type Safe disposal and segregation Certificate of waste disposal through contractors to be kept in record.	Solid waste management plan is being implemented Records are to be maintained	Within the proposed project site	Monthly	Contractor/ GSPL
Roads and networks	Signs and symbols are being followed	Visual assessment Photographic evidences	Premises of Project area	Monthly	Contractor

Environmental Aspect	Scope of Monitoring	Method	Location	Frequency of Monitoring	Responsibility
Operation Phase					
Noise	Operation activity associated noise levels	Noise levels will be recorded by noise meters	Representative locations ideally inside and outside of the proposed project site	weekly	GSPL
Solid Waste	Solid waste management plan Safe disposal and segregation	Assessment of Solid Waste Quantity and Type	All project locations	Monthly	GSPL
Waste water	Collection of wastewater in the designated pits. Recycling of collected water that can be utilized for watering greenbelt area	Record log of water usage Monitoring of Wastewater	Around the plant.	Twice a month	GSPL

CHAPTER

9 CONCLUSION

The IEE of the proposed 50 MWp Solar PV Power Plant has achieved the following goals:

- Identification of national environmental regulatory requirements that apply to the proposed project and its processes;
- Identification of the environmental features of the project area and the likely impact on the environment as a result of the construction and operation of the proposed project and its processes;
- Recommendation of appropriate mitigation measures that GSPL will incorporate into the project design to minimize all adverse environmental impacts.

Baseline environmental and socio-economic information was collected from a variety of sources, including published literature and field surveys. The information collected was used to compose profiles of the natural and socio-economic environments likely to be affected by the project activities. Information for the section describing the project came mainly from GSPL administration.

An assessment was then made of the potential impacts of the described project on the area's natural and socio-economic environments. The impacts of the proposed activities in the project area and surroundings will be insignificant, provided the generic mitigation measures proposed in this report are implemented. In areas where these activities may have a significant impact, additional mitigation measures are given to reduce impacts to as low as reasonably possible.

After assessing the proposed project activities and investigating the project area, the environmental consultants, GEMS have concluded that:

"If the proposed project activities are undertaken as suggested and described in this report, and the recommended mitigations and environmental management plan are adopted, the project will not result in any long-term or significant impacts on the local community or the environment rather it will be a symbolic project of sustainable development".