MdeCC

Solution de Energy

The Goldman Consortium

The IVY Company

15 August 2019

Project Vehicle: **"Solution de Energy"**

The Registrar
National Electric Power Regulatory Authority
NEPRA Tower Attaturk Avenue (East),
Sector G-5/1,Islamabad.
Ref. no.:SdeE/GL/S100MW

Subject: **Application for a Generation License**

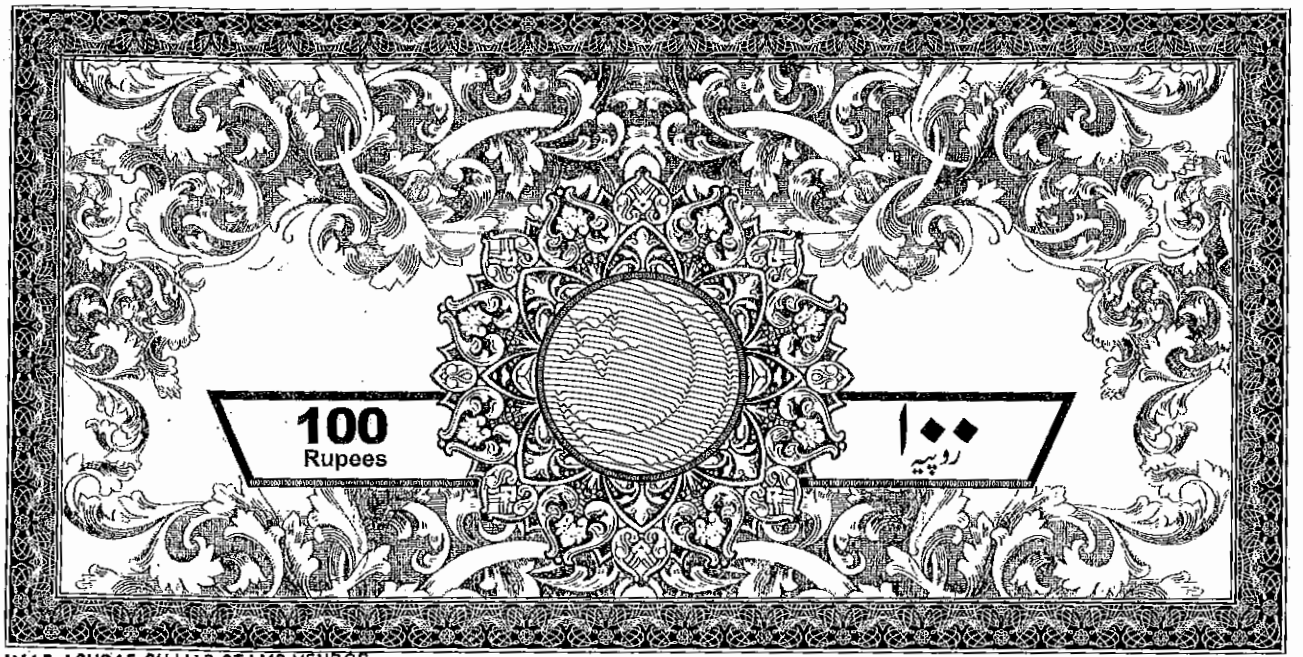
I, MrIshtiaq-Ur-Rehman Malik, Director, being the duly authorized representative of Solution De Energy (Private) Limited by virtue of Board Resolution dated June 3rd, 2019 hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation Licence to Solution De Energy (Private) Limited pursuant to the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

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

Bank drafts in the sum of Rs 467,980.00 (No. 7794007 for Rs.100,000.00, No .4576710 for Rs.326870.00, No.4791078 for Rs.41,110.00) being the non-refundable Generation License application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

MrIshtiaq Ur-Rehman Malik,
Director,
Solution De Energy (Private) Limited

Q607411



MUHAMMAD ASHRAF GUJJAR STAMP VENDOR
Licence No. 48, House No. 1085, Street No.1,
Liaquat Ashraf Colony No.3, Mehmoodabad No. 6, Karachi
S. NO. DATE 258 11 JUL 2019
ISSUED TO WITH ADDRESS Solution De Energy (Pvt) Ltd
THROUGH WITH ADDRESS
PURPOSE
VALUE Rs/ 100
STAMP VENDOR'S SIGNATURE

RUPEES ONE HUNDRED ONLY

Power of Attorney

Mr Ishtiaq-Ur-Rehman Malik, be and is hereby authorized to file applications for a Generation License and Cost-Plus Solar Tariff (Applications) including any motions, applications, review motions, re-filings or fresh applications for and on behalf of Solution De Energy (Private) Limited's solar 100 MW power project in Chishtian DHARANWALA Punjab, Pakistan.

Mr Ishtiaq-Ur-Rehman Malik, Director of the Company, be and is hereby authorized by and on behalf of the Company to do all actions and take all measures as may be necessary or appropriate in connection with the filing, presentation, pursuit and determination of the Applications, including, without limitation:

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

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

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

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

MdeCC

Solution de Energy

The Goldman Consortium

The IVY Company

Solution de Energy (PVT) Limited

Prospectus

PROTECT SPONSORS

1) Crescent Steel & Allied Products Limited Pakistan: Main Sponsor
2) Management de Consortium Capital (MdeCC) sponsors: Developer
3) Total EREN France- Funding Partners

Executive Summary

BACKGROUND

Crescent Steel and MdeCC (the "Project Sponsors") signed an agreement to establish the PV Project. For the purpose an SPV was established as a private limited company and the registered with SECP; The Government of Punjab (the "GOP") issued the LOI for the Project on February 2, 2013 and land for the Project was awarded at QASP in the main slot of 1000MW Lal Suhanra by the Cholistan Development Authority land revenue department of the Government of Punjab. This was the first LOI issued for Quaid e Azam solar park, even before the 100MW Punjab Government Plant.

After the allocation of land and award of LOI, the Project Sponsors mobilized development funds and resources to move the Project towards financial close. The project sponsors appointed reputed financial, technical and legal consultants for completion of the technical ground studies analysis. The Project SPV expeditiously carried out all the required studies to complete the feasibilities, including geo-tech , topographic and Environmental studies. The project was submitted with PPDB for PoE committee for approval. The POE approved the project on 08-07-15 subject to approval of interconnectivity by NTDC.

We had mobilized our sources and substantial amount of development phase was wasted as the new site was located around 250 KM from the main QASP Bahawalpur.

PPDB offered new land coordinates in Dahranwala District Bahawalnagar.

Head Office : 96-A, Khyaban-e-Iqbal F8/2 Islamabad (Pakistan) Tel: +92 2250061-62 Direct +923345255147
Email iirmalik@goldmanconsortium.comt Web: www.mdecc.net

We had had to start from scratch and our development budget was increased. In the meanwhile, we submitted new performance guarantee with Energy department for 300,000 dollars On October 15, 2015, the Project SPV submitted Grid Interconnection study to the Central Power Purchasing Agency ("CPPA")/ NTDC for their review. In the meanwhile, NTDC policy was changed and concerned DISCO was to approve the study and in our case there was a considerable delay by NTDC despite our regular approach to the GM Planning NTDC for early approval. After one year of delay our study was approved by MEPCO on 8 September 2017.
The feasibility study and all new pre-technical studies were submitted with PPDB on 6 January 2017 after grid interconnection approval from MEPCO/CPPA/NTDC) that was approved by the PoE on January 6, 2018. The Project's environmental study was completed and submitted to Environment Protection Agency, Punjab on December 2015 and \vas approved on December 30, 2015
After MEPCO approval the interconnections studies were reviewed by NTDC interconnection approval from NTDC was issued on September 26, 2017

The project involves some of the leading companies both locally and abroad. Crescent Steel and Allied products and MdeCC are experienced in the Energy sector in Pakistan. Our technology, management and funding partner Total Eren from France has extensive experience in renewable energy projects in Europe and in Asia. Total EREN France is part of the world famous French multinational Total.

MdeCC

The project developer and co-sponsor MdeCC is a founding partner and member of the Ivy Company and Goldman Consortium which are unique ventures with some of the best human capital in the world. This allows MdeCC to access some of the most resource rich networks in the world and allow MdeCC to execute deals in diverse industries globally.

The Ivy Company brings together over 4700 alumni from the ivy league schools namely Brown, Columbia, Cornell, Dartmouth, Harvard, Princeton, University of Pennsylvania (Penn) and Yale. Alumni of Oxford, Cambridge, MIT, Stanford, Caltech, Berkeley, Chicago, Duke and Northwestern are also members of the Ivy Company. This gives the Ivy Company exceptional expertise across industries globally and markets The Ivy Company one of the most human capital rich companies in the world.

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MdeCC

Solution de Energy

The Goldman Consortium

The IVY Company

Project Vehicle:-Solution de Energy (PVT) Limited

Consultants for the Project

Qureshi Law Associates

Goldman Capital Consortium

Ivy Engineering (pvt) Ltd.

Power Planner International

SpecMar USA

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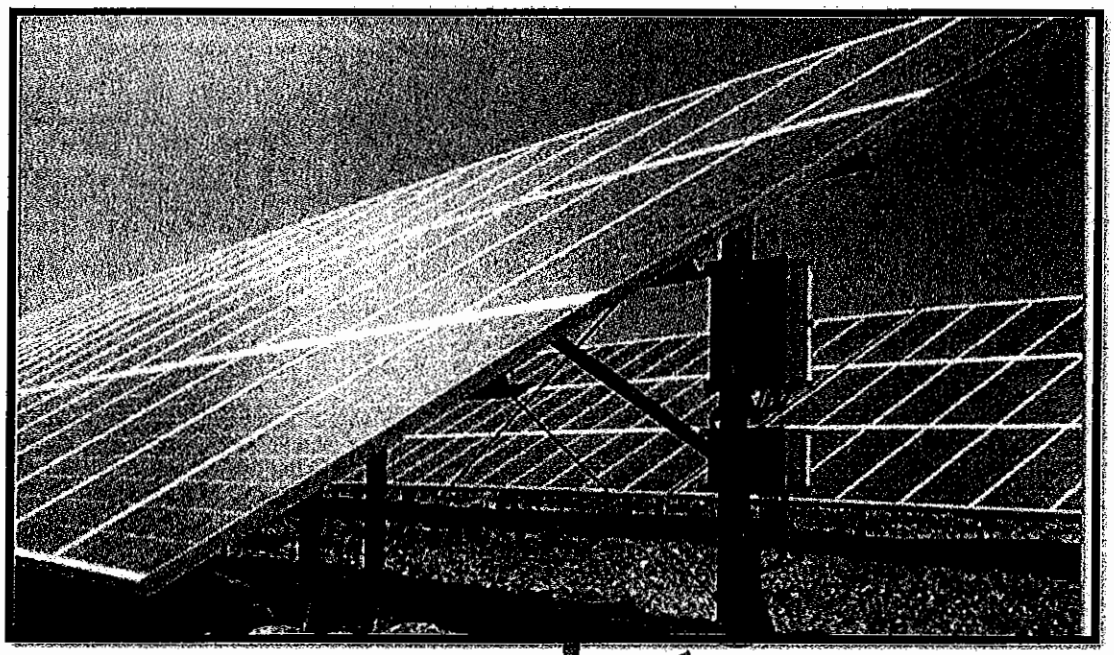

Tracking Type	Linked Horizontal Single Axis Tracker
High Reliability	Backup of critical components- Motor, Control Board, Tilt Sensor and Wind Sensor
Redundancy Design	
Drive Type	Slewing Drive
Motors per Tracker	2 (1 for backup)
System Voltage	1500V
Max No. of Module per Tracker	Up to 1100 (72 cells)
Structure Material	Hot Dip Galvanized/ Pre Galvanized/ Stainless steel/ Composite/ Aluminum
Power Supply	380V / 415V/ 480V, 4 Wire, 3-Phase, 1KW
Modules Configuration	1 in Portrait
Module Supported	All commercially available including Frameless, Glass/Glass, Bi-facial and Thin Film
Stow Wind Speed	40 mph (approx. 64kmph)
Standard Wind Design	105 mph (approx. 170kmph), configurable for higher wind speed. Wind Tunnel Tested
Operation Temperature	-22oF (-30°C) to 140oF (60°C)
Foundation Options Ramming,	Concrete, Screw or Helical Pier
Codes and Standards UL	Certified (2703 and 3703), ASCE 7-10

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Project Vehicle:-Solution de Energy (PVT) Limited

Location maps, site maps, land

The site of Project is located In the southern region of the Punjab province Chishtian Dharanwala about 28 km south east of Bahawalnagar (geographical coordinates 72.°east/ 29.4 ° north) in the Cholistan Desert. Quaid-e-Azam Solar Park (Extension) the altitude is 150 meters above sea level

M/s IVY Engineering Services (Pvt.) Ltd.	Consultant:	M/s IVY Engineering Services (Pvt.) Ltd.	Location Plan of Site	FIGURE:	1
	Project No:	AJK/GT/101-1222	100 MW Solar Photovoltaic Plant, Block A of Quaid-e-Azam Solar Park, Chistian.	REVISION:	0
	Date:	19th October, 2015			

The Initial Site plan calling for Block J&Ghas been moved to BLOCK A, which has been platted as part of the QASP Solar Park extension. The project site is located at about 28 Km east of

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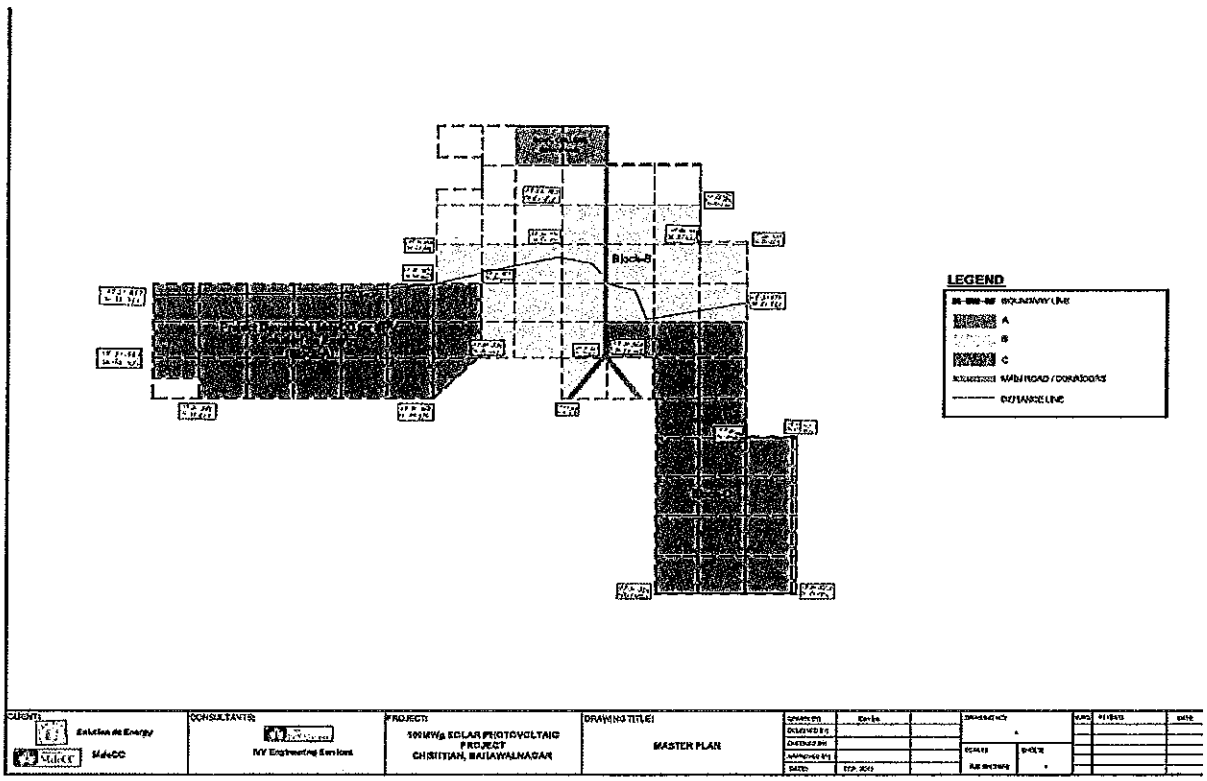
Bahawalpur; near 1st existing 100MW Solar Power Plant. The Project site is located in Cholistan Desert area.



Details are covered in the Feasibility Study

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003778

SECP

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE
LAHORE

Company Registration Office Lahore * Securities and Exchange Commission of Pakistan *

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No.**0085716**

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

Given under my hand at **Lahore** this **Seventh** day of **November,** Two **Thousand** and **Thirteen**.

Fee Rs.**62,000/-**

CERTIFIED TO BE TRUE COPY
24/6/16
DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

(LIAQAT ALI DOLLA)
Additional Registrar of Companies

No.ARL/ 8304 **DATED:** 7/11/2013

(2)

The Companies Ordinance, 1984

(Company Limited by Shares)

MEMORANDUM OF ASSOCIATION

OF

Solution de Energy (Private) Limited

I. **NAME:**

The name of the Company is "**Solution de Energy (Private) Limited**"

II. **REGISTERED OFFICE:**

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

III. **OBJECTS:**

The Objects for which the Company is established are:

1. To design, construct, own, operate, invest, operate, run, build and maintain power generation complexes for solar, wind, hydel and thermal energy in any part of Pakistan and to carry on the business of electricity generation, transmission and distribution after obtaining approval from relevant authorities.

2. To provide advisory, consultancy, operational and maintenance (O & M) services, whatsoever in nature, including but not limited to operational, technical etc. to power projects, hydel, thermal, solar, wind or otherwise.

3. To set up undertakings for electricity/power generation plants and to generate, accumulate, distribute, sell and supply electricity/power for all purposes and to sell electricity to WAPDA under agreement with Government of Pakistan or to any other consumer as permitted under the law.

4. For the purpose of achieving the above objects, the Company is authorized:-

   i) To borrow or raise money by means of local and foreign currency loans from scheduled banks, industrial banks, investors, private equity and financial institutions including HBFC and other specialized institutions or non-bank finance companies for the purpose of purchase, manufacture, market, supply, export and import of machinery, development of real estates, construction activities and improvements, repair and renovations of buildings, warehouses, factories, sheds, offices, hospitals, ports, parks, clubs, entertainment and recreation areas, industrial zones, bridges,

flyovers and sub-ways, roads, highways and motorways, high rise residential and commercial complexes, residential towns, building and for the purpose of working capital or for any other purpose.

ii) To arrange money by issue of debentures, debenture stock, perpetual or otherwise convertible into shares and to mortgage, or charge the whole or any part of the property or assets 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 payoff any such securities.

iii) To purchase/import raw materials, machinery, equipment and allied items required in connection thereto in any manner the company may think fit;

iv) To purchase, take on lease or in exchange, hire, apply for or otherwise acquire and hold for any interest, any rights, privileges, lands, building, easements, trademarks, patents, patent rights, copyrights, licences, machinery, plants, stock-in-trade and any movable and immovable property of any kind necessary or convenient for the purposes of or in connection with the Company's business or any branch or department thereof and to use, exercise, develop, grant licences in respect of or otherwise turn to account any property, rights and information so acquired, subject to any permission required under the law.

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

vi) To own, establish or have and maintain shops, branches and agencies all over Pakistan or elsewhere of the products of the company.

vii) To acquire by concession, grant, purchase, barter, licence either absolutely or conditionally and either solely or jointly with others any lands, buildings, machinery, plants, equipment, privileges, rights, licences, trademarks, patents, and other movable and immovable property of any description which the Company may deem necessary or which may seem to the Company capable of being turned to account, subject to any permission as required under the law.

viii) To invest surplus money of the Company in shares, stocks or securities of any company, debentures, debenture stocks or in any investments, short term and long term participation, term finance certificates or any other government securities in such manner as may from time to time be decided by the directors, without indulging non-banking finance business, banking business or an investment company or any other any lawful

business.

ix) To guarantee the performance of contracts, agreements, obligations ,or discharge of any debt of the company or on behalf of any other company or person subject to the provisions of section 195 of the Companies Ordinance, 1984 in relation to the payment of any financial facility including but not limited to loans, advances, letters of credit or other obligations through creation of any or all types of mortgages, charges, pledges, hypothecations, on execution of the usual banking documents or instruments or otherwise encumbrance on any or all of the movable and immovable properties of the company, either present or future or both and issuance of any other securities or sureties by any mean in favour of banks, Non-Banking Finance Companies (NBFCs) or any financial institutions and to borrow money for purpose of the company on such terms and conditions as may be considered proper.

x) To purchase, hold and get redeemed, debentures, bonds of any company, financial institution or any Government institutions;

xi) To enter into arrangements with the government or authority (supreme, municipal, local or otherwise) or any corporation, company, or persons that may seem conducive to the Company's objects or any of them and to obtain from any such government, authority, corporation, company or person any charters, contracts, rights, privileges and commission which the Company may think desirable and to carry on, exercise and comply with any such charters, contracts, decrees, rights, privileges and concessions.

xii) To act as representatives, for any person, firm or company and to undertake and perform sub-contracts, and also act in the business of the Company through or by means of agents, sub-contractors and to do all or any of the things mentioned herein in any part of the world and either alone or in collaboration with others and by or through agents, sub-contractors or otherwise.

xiii) To sell, transfer, mortgage, pledge, exchange or otherwise dispose of the whole or any part of the property or the undertaking of the Company, either together or in portions for such consideration as the Company may think fit and in particular, for shares, debenture-stock or securities of any Company purchasing the same or to any other legal entity or person, by other means, permissible under the law.

xiv) To conduct, encourage, promote, support, arrange and organize seminars, symposiums, exhibitions, fairs, conferences, lectures, demonstrations and other similar activities for promotion of sales or other business interests of any person, companies, firms, individuals, associations, local or

government bodies, foreign governments, and international agencies, in Pakistan and any part of world for and on behalf of customers and for that purpose to carry out market surveys, researches, training programs and other activities.

xv) To carry out joint venture agreements with technology suppliers, other companies or countries within the scope of the objects of the company.

xvi) To make known and give publicity to the business and products of the company by means the company may think fit.

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

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

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

xx) To give any servant or employee of the Company commission on the sale of the products and for that purpose to enter into any agreement or scheme of arrangement as the Company may deem fit and to get any servant or employee of the Company insured against risk of accident in the course of their employment.

xxi) To establish and support or aid in the establishment and support of associations, institutions, funds and conveniences calculated to benefit the directors employees, ex-employees of the Company or any dependent thereof and to grant pensions, gratuities, allowances, relief and payments in any manner calculated to benefit the persons described herein.

xxii) To apply for and obtain necessary consents, permissions and licenses from any Government, State, Local and other Authorities for enabling the Company to carry on any of its objects into effect as and when required by law.

xxiii) To cause the Company to be registered or recognized in any foreign country and carry on its business activities in any part of the world.

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

Name and Surname (Present & Former) In Full (in Block Letters)	*Father's/ Husband 's Name In Full*	*Nationality with any former Nationality*	*Occupation*	*Residential Address (in full)*	*Number of Shares taken by each subscriber*	*Signature*
MUHAMMAD SAAD THANIANA CNIC # 42301-9687818-1	*TAYYAB THANIANA*	*PAKISTANI*	*SERVICE*	*HOUSE # 69/2/1, 13TH LANE, KHAYABAN-E-BADAR, PHASE-7, DHA, KARACHI*	*1*	
ISHTIAQ UR REHMAN MALIK CNIC # 36302-2400377-9	*SHOUQ MUHAMMAD MALIK*	*PAKISTANI*	*SERVICE*	*HOUSE NO. 25/3, QUAID E AZAM ROAD, MULTAN CANTT.*	*1*	
ASRAR AHMAD CNIC# 35202-2803139-1	*SHER BAHADAR*	*PAKISTANI*	*SERVICE*	*MOHALLAH ABU BAKAR SIDDIQUE, SANDA KALAN, BUND ROAD, LAHORE*	*1*	
SHAKARGANJ ENERGY (PVT.) LIMITED (THROUGH MUHAMMAD SAAD THANIANA CNIC# 42301-9687818-1)		*PAKISTANI*	*COMPANY*	*10TH FLOOR, BOP TOWER, 10-B, BLOCK E-2, GULBERG-III, LAHORE*	*1*	

Company Registration Office Lahore Securities and Exchange Commission of Pakistan

CERTIFIED TO BE TRUE COPY

DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

Total number of shares taken: 4 (Four)

WITNESS to the above signatures:

Dated: November 4, 2013

Signature: _____
Name: National Institutional Facilitation Technologies (Pvt) Ltd Father Name: N/A
NIC: N/A Occupation: NIFT
Full Address: 5th Floor AWT Plaza I. I. Chundrigar Road Karachi

THE COMPANIES ORDINANCE. 1984

COMPANY LIMITED BY SHARES

Articles of Association
Of
Solution de Energy (Private) Limited

I. PRELIMINARY

1. The regulations in Table 'A' in the First Schedule to the Companies Ordinance, 1984 shall not apply to the Company except as reproduced herein.

2. In these Articles, unless the context or the subject-matter otherwise requires:

(a) "**Articles**" mean these Articles as originally framed or as from time to time altered in accordance with law.

(b) "**Board**" means a meeting of the Directors duly called and constituted or as the case may be the Directors assembled at a Board.

(c) "**Company**" means **Solution de Energy (Private) Limited**.

(d) "**Directors**" means the Directors of the Company appointed from time to time pursuant to these Articles including alternate Directors.

(e) "**Month**" means calendar month according to the English Calendar.

(f) "**Office**" means the registered Office for the time being of the Company.

(g) "**Ordinance**" means the Companies Ordinance, 1984 or any modification or re-enactment thereof for the time being in force.

(h) "**Register**" means, unless the context otherwise requires, the register of members to be kept pursuant to Section 147 of the Ordinance.

(i) "**Seal**" means the common or official seal of the Company.

(j) "**Section**" means section of the Companies Ordinance, 1984.

(k) "**Special Resolution**" means the special resolution of the Company as defined in Section 2 (1) (36) of the Ordinance.

(l) Words importing masculine gender include the feminine gender.

(m) Words importing singular number include the plural number and vice versa.

(n) Expression referring to writing shall, unless the contrary intention appears, be construed as including references to printing, lithography; photography and other modes of representing or reproducing words in a visible form.

(o) Words importing persons shall include bodies corporate.

(p) The head notes are inserted for convenience and shall not affect the construction of these Articles.

(q) Unless the context otherwise requires words or expressions contained in these Articles shall bear the same meaning as in the Ordinance.

II. BUSINESS

The business of the Company shall include the several objects expressed in its Memorandum of Association

3. The Company is a private company and accordingly the following provisions shall have effect:

(a) The number of the members of the Company (exclusive of persons who are for the time being in the employment of the Company) shall not at any time exceed fifty. Provided that where two or more persons hold one or more shares in the Company jointly, they shall for the purposes of this Article be treated as a single member.

(b) The Company shall not at any time offer any of its shares or debentures, or debenture stock to the public for subscription.

(c) The right to transfer shares of the Company is restricted as hereinafter provided.

III. SHARES

4. The Directors shall, as regard any allotment of shares, duly comply with the provisions of Section 73 of the Companies Ordinance 1984.

5. Every person whose name is entered as a member in the Register shall, without payment, be entitled to receive within three months after allotment or within forty-five days of the application for registration of transfer, a certificate under the Seal specifying the share or shares held by him and the amount paid up thereon. Provided that, in respect of a share or shares held jointly by several persons, the Company shall not be, bound to issue more than one certificate, and delivery of a certificate for a share to one of several joint holders shall be sufficient delivery to all.

6. If a share certificate is defaced, lost or destroyed, it may be renewed on payment of such fee if any, not exceeding one rupee and on such terms, if any, as to evidence and indemnity and payment of expenses incurred by the Company in investigating title as the Directors think fit.

7 The Company may issue A-Class ordinary shares which shall have all the rights and privileges which are usually attached to the ordinary shares.

8. The Company may also issue B-Class ordinary shares which shall be entitled to dividend only with no other rights.

IV. TRANSFER OF SHARES

9. Subject to the provisions of Article 7 and 8, the instrument of transfer of any share in the Company shall be executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the Register in respect thereof.

10. Shares in the Company shall be transferred in the following form, or in any usual or common form which the Directors shall approve.

I, _____ of _____ in consideration of the sum of Rupees _____ paid to me by _____ of _____ (the "Transferee"), do hereby transfer to the Transferee _____ the share(s) numbered _____ to _____ inclusive, in Solution de Energy (Private) Limited, to hold unto the Transferee, his executors, administrators and assigns, subject to the several conditions on which I held the same at the time of the execution hereof, and I, the Transferee, do hereby agree to take the said share (or shares) subject to the conditions aforesaid.

As witness our hands this _____ day of _____ 20___

Transferor	Transferee
Signature	Signature
Witness:	
1. Signature	Full Name, Father's/Husband's
Full Address	Name
	Nationality
	Occupation
2. Signature	Full Address of Transferee
Full Address	

11. Subject to the provisions of Article 7 and 8, the Directors shall subject to the limitations and restrictions imposed herein these Articles, not refuse to transfer any fully paid shares unless the transfer deed is defective or invalid. The Directors may also suspend the registration of transfers during the ten days immediately preceding a general meeting or prior to the determination of entitlement or rights of the shareholders by giving seven days' previous notice in the manner provided in the Ordinance. The Directors may decline to recognise any instrument or transfer unless:

(a) a fee not exceeding two rupees as may by the Directors is paid to the Company in of ; and be determined respect thereof; and

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

If the Directors refuse to register a transfer of shares, they shall within one Month after the date on which the transfer deed was lodged with the Company send to the transferee and the transferor notice of the refusal indicating the defect or invalidity to the transferee, who shall, after removal of such defect or invalidity be entitled to re-lodge the transfer deed with the Company.

12. Any member desiring to transfer any of his shares must, by irrevocable notice in writing, notify the Board of the number of shares, the price and the name of the proposed transferee and the Board shall offer to the other members or any other person, the number of shares offered at the price and if the offer is accepted, the shares shall be transferred to the acceptors, and if the shares or any of them are not so accepted within 30 days of the holder's notice to the Board, the holder may sell or transfer them or any of them at the same or higher price to the original proposed transferee.

V. TRANSMISSION OF SHARES

13. The executors, administrators, heirs or nominees, as the case may be, of a deceased sole holder of a share shall be the only persons recognized by the Company as having any title to the share. In the case of a share registered in the name of two or more holders, the survivors or survivor, or the executors or administrators of the deceased survivor, shall be the only persons recognized by the Company as having any title to the share.

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

15. A person becoming entitled to a share by reason of the of insolvency of the holder shall be entitled to the same dividends and other advantages to which he would be entitled if he were the registered holder of the share, except that he shall not before being registered as a member in respect of the share, be entitled in respect of it to exercise any right conferred by membership in relation to meetings of the Company.

VI. ALTERATION OF CAPITAL

16. The Company may, from time to time, by ordinary resolution increase the share capital by such amount, to be divided into shares of such amount, as the resolution shall prescribe.

17. Subject to the provisions of the Ordinance, all new shares shall before issue, be offered to such persons as at the date of the offer are entitled to receive notices from the Company of general meetings in proportion, as nearly as the circumstances admit, to the amount of the existing shares to which they are entitled. The offer shall be made by notice specifying the number of shares offered, and limiting a time within which the offer, if not accepted, will be deemed to be declined, and after the expiration of that time, or on the receipt of an intimation from the person to whom the offer is made that he declines to accept the shares offered, the Directors may dispose off the same in such manner as they think most beneficial to the Company. The Directors may likewise so dispose off any new shares which (by reason of the ratio which the new shares bear to shares held by persons entitled to an offer of new shares) cannot in the opinion of the Directors, be conveniently offered under this regulation.

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

IX. VOTES OF MEMBERS

35. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands every member present in person shall have one vote except for election of directors in which case the provision of Section 178 shall apply. On a poll every member shall have voting rights us laid down in Section 160.

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

37. A member, of unsound mind, or in respect of whom an order has been made by any Court having jurisdiction in lunacy, may vote, whether by show of hand or on a poll, by his committee or other legal guardian, and any such committee or guardian may, on a poll, vote by proxy.

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

39. The instrument appointing a proxy shall be in writing under the hand of the appointer or of his attorney duly authorised in writing. A proxy need not be a member of the Company.

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

41. An instrument appointing a proxy may be in the following form, or a form, as near thereto as may be:

> I _____ of _____ in the district of _____ being a member of Solution de Energy (Private) Limited, hereby appoint _____ of _____ as my proxy to vote for me and on my behalf at the annual/extraordinary general meeting of the Company to be held on the _____ day of _____ 20 ___ and at any adjournment thereof.

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

X. DIRECTORS

43. The number of Directors may be increased or decreased in the annual general meeting. However, the number of Directors shall not be in any case less than three (3). Following shall be the first Directors of the Company:

1. Mr. Asrar Ahmad
2. Mr. Muhammad Saad Thaniana
2. Mr. Ishtiaq ur Rehman Malik

44. The remuneration of the Directors shall from time to time be determined by the Board of Directors. The remuneration of a Director for performing extra services, including holding of the office of Chairman, and the remuneration to be paid to any Directors for attending the meetings of the Directors or a Committee of Directors shall from time to time be determined by the Board of Directors.

45. Save as provided in Section 187, no person shall be appointed as a Director unless he is a member of the Company.

XI. POWERS AND DUTIES OF DIRECTORS

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

47. The directors shall duly comply with the provisions of the Ordinance and in particular with the provisions in regard to the registration of the particulars of mortgages and charges affecting the property of Company or created by it, to the keeping of a register of the Directors, and to the sending to the registrar or an annual list of members, and a summary of particulars relating, thereto, and notice of any consolidation or increase of share capital, or sub-division of shares, and copies of Special Resolutions and a copy of the register of Directors and notifications of any changes therein.

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

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

(b) the names of the Directors present at each meeting of the Directors and of any committee of the Directors; and every Director present at any meeting of Directors or committee of Directors shall sign his name in a book to be kept for that purpose;

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

49. The Directors shall appoint a chief executive in accordance with the provisions of Sections198 and 199.

XII. DISQUALIFICATION OF DIRECTORS

50. No person shall become the Director of the Company if he suffers from any of the disabilities or disqualification's mentioned in Section 187 and if already a Director, shall cease to hold such office from the date he so becomes disqualified or disabled. Provided, however, that no Director shall vacate his office by reason only of his being a member of any Company which has entered into contracts with, or done any work for, the Company but such Director shall not vote in respect of any such contract or work, and if he does so vote, his vote shall not be counted.

XIII. PROCEEDINGS OF DIRECTORS

51. The Directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings, as they think fit. Questions arising at any meeting shall be decided by a majority of votes. In case of an equality of votes, the Chairman shall have and exercise a second or casting vote. A Director may, and the Secretary on the requisition of a Director shall, at any time, summon a meeting of Directors. It shall not be necessary to give notice of a meeting of Directors to any Director for the time being absent from Pakistan.

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

53. The Directors may delegate any of their powers not required to be exercised in their meeting to committees consisting of such member or members of their body as they think fit. Any committee so formed shall, in the exercise of the powers so delegated, conform to any restrictions that may be imposed on it by the Directors.

54. A committee may elect a chairman of its meetings, but, if no such chairman is elected, or if at any meeting the chairman is not present within ten minutes after the time appointed for holding the same or is unwilling to act as chairman. the members present may choose one of their number to be chairman of the meeting.

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

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

57. A resolution in writing signed by all the Directors for time being entitled to receive notice of a meeting of the Directors of affirmed by them through telex or telegram shall

be as valid and effectual as if it had been passed at a meeting of the Directors duly convened and held.

XIV. ELECTION AND REMOVAL OF DIRECTORS

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

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

60. The Directors shall comply with the provisions of sections 174 to 178 and Section 180 relating to the election of Directors and matter ancillary thereto.

61. Any casual vacancy occurring on the Board or Directors may be filled up by the Directors, and person so appointed shall hold office for the remainder the term of the Director, in whose place he is appointed.

62. The Company may remove a Director but only in accordance with the provisions of the Ordinance.

XV. THE SEAL

63. The Directors shall provide a common seal of the Company which shall not be affixed to any instrument except by the authority of a resolution of the Board or by a committee of Directors authorized in that behalf by the Directors, and two Directors or one Director and the secretary of the Company shall sign every instrument to which the common seal is affixed.

64. The Directors may provide for the use in any territory, district or place not situated in Pakistan, of an official seal which shall be a facsimile of the common seal of the Company, with the addition on its face of the name of every territory, district or place where it is to be used. The provisions of Section 213 shall apply to the use of the official seal.

XVI. DIVIDENDS AND RESERVE

65. The Company in general meeting may declare dividends but no dividend shall exceed the amount recommended by the Directors.

66. The Directors may from time to time pay to the members such interim dividends as appear to the Directors to be justified by the profits of the Company.

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

68. Subject to the rights of person (if any) entitled to shares with special rights as to dividends, all dividends shall be declared and paid according to the the amount paid on the shares, but if and so long as nothing is paid upon any of the shares in the company, dividends may be declared and paid according to the amount of the shares.

69. The Directors may, before recommending any dividend, set aside out of the profits of the Company such sums as they think proper as a reserve or reserves which shall, at the discretion of the Directors, be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the Company may be properly applied, and pending such application may, at the like discretion, either be employed in the business of Company or be invested in such investments (other than shares of the Company) as the Directors may subject to the provisions of the Ordinance, from time to time think fit.

70. The Directors may carry forward any profits which they prudent not to distribute, without setting them aside as a reserve.

71. If several persons are registered as joint-holders of any share, anyone of them may give effectual receipt for any dividend payable on the share.

72. Notice of any dividend that may have been declared shall be given in the manner hereinafter mentioned to the persons entitled to share therein.

73. The dividend shall be paid within the period laid down in Section 251.

XVII. ACCOUNT

74. The Directors shall cause to be kept proper books of account as required under Section 230.

75. The books of account shall be kept at the Office or all such other places as the Directors shall think fit and shall be open to inspection by the Directors during business hours.

76. The Directors shall from time to time determine whether and to what extent and at what time and place and under what conditions or regulations the accounts and books or papers of the Company or any of them shall be open to the inspection of members not being Directors and no member (not being a Director) shall have any account and book or papers of the Company Inspected except as conferred by law or authorized by the Directors or by the Company in general meeting.

77. The Directors shall as required by Sections 233 and 236 cause to be prepared and to be laid before the Company in general meeting such profit and loss accounts and balance sheets duly audited and reports as are referred to in those sections.

78. A balance-sheet, profit and loss account and other reports referred to in the preceding Articles shall be made out in every year and laid before the Company in the annual general meeting made upto a date not more than four months before such meeting. The balance sheet and profit and loss account shall be accompanied by a report of the auditors of the Company and the report of Directors.

79. A copy of the balance sheet and profit and loss account and reports of Directors and Auditors shall, at least twenty one days preceding the meeting, be sent to the persons entitled to receive notices of general meeting, in the manner in which notices are to be given as hereinafter provided.

80. The Directors shall in all respect comply with the provisions of Sections 230 to 236.

81. Auditors shall be appointed and their duties regulated in accordanee with Section 252 to 255.

XVIII. NOTICES

82. Notice shall be given by the Company to members and auditors of the Company and other persons entitled to receive notice in accordance with Section 50.

XIX. WINDING UP

83. If the Company is wound up, the liquidator may, with the sanction of a Special Resolution of the Company and any other sanction required by law, divide amongst the members in specie or kind the whole or any part of the assets of the Company (whether they shall consist of properly of same kind or not) and may, for such purpose, set such value as he deems fair upon any property to be divided as aforesaid and may determine how such division shall be carried out as between the members of different classes of members. The liquidator may, with like sanction, vest the whole or any part of such assets in trustees upon such trust for the benefit of the contributories, as the liquidator with the like sanction, shall think fit, but so that no member shall be compelled to accept any shares or other securities whereon there is any liability.

XX. INDEMNITY

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

We, the several persons whose names and addresses are subscribed below, are desirous of being into a Company in pursuance of these Articles of Association and we respectively agree to take the number of Shares in the Capital of the Company set opposite our respective names.

Name and Surname (Present & Former) In Full (in Block Letters)	*Father's/ Husband 's Name In Full*	*Nationality with any former Nationality*	*Occupation*	*Residential Address (in full)*	*Number of Shares taken by each subscriber*	*Signature*
MUHAMMAD SAAD THANIANA CNIC # 42301-9687818-1	*TAYYAB THANIANA*	*PAKISTANI*	*SERVICE*	*HOUSE # 69/2/1, 13TH LANE, KHAYABAN-E-BADAR, PHASE-7, DHA, KARACHI*	*1*	
ISHTIAQ UR REHMAN MALIK CNIC#36302-2400377-9	*SHOUQ MUHAMMAD MALIK*	*PAKISTANI*	*SERVICE*	*HOUSE NO. 25/3, QUAID E AZAM ROAD, MULTAN CANTT.*	*1*	
ASRAR AHMAD CNIC# 35202-2803139-1	*SHER BAHADAR*	*PAKISTANI*	*SERVICE*	*MOHALLAH ABU BAKAR SIDDIQUI, SANDA KALAN, BUND ROAD, LAHORE*	*1*	
SHAKARGANJ ENERGY (PVT.) LIMITED (THROUGH MUHAMMAD SAAD THANIANA CNIC# 42301-9687818-1)		*PAKISTANI*	*COMPANY*	*10TH FLOOR, BOP TOWER, 10-B, BLOCK E-2, GULBERG-III, LAHORE*	*1*	

Company Registration Office Lahore — Securities & Exchange Commission of Pakistan

CERTIFIED TO BE TRUE COPY

24/6/16

DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

Total number of shares taken: 4 (Four)

WITNESS to the above signatures:

Dated: November 4, 2013

Signature: _____

Name: National Institutional Facilitation Technologies (Pvt) Ltd — Father Name: N/A

NIC: N/A — Occupation: NIFT

Full Address: 5th Floor AWT Plaza I. I. Chundrigar Road Karachi

Project Vehicle:-Solution de Energy (PVT) Limited

Technical Proposal

IEC60364	Electrical installations of buildings Part 7-712 Requirements for special installations or locations- Solar photovoltaic (PV) power supply systems
IEC 50262	Cable Glands for Electrical Installations
IEC 60898 overcurrent protection for household and similar installations	Electrical Accessories - Circuit-breakers for
IEC 60364-4-41 Protection for safety - protection against shock	Low-voltage plants installation. Part 4-41 -
IEC 10222-5-1 5-1-3)	Electrical Security Installations (Part 5-1-1 to

Also all the technical standards and agreements which the EPC Contractor must comply with must include:

TBC NTDC/ MEPCO Distribution Standard for the Interconnection of Embedded Generation

NEPRA Pakistan Grid Code for Renewable Under Energy Purchase Agreement (Negotiation Pakistan Building Code

Technical Description.

In order to summarize the arrangement of the PV power plant, we are adding the following table:

PV modules 277800

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Email iirmalik@goldmanconsortium.comt Web: www.mdecc.net

The cable used for the DC buses, however, will be referenced by 0.6/1 KV copper cross Linked Polyethylene and made of unarmored tinned soft annealed conductor with XLPE compound insulation and PVC compound sheath. This kind of cable is shown in the following figure:

Figure: Type of Wire more used: Copper, Cross Linked Polyethylene, SCT, SWA, Anti-termite Cable .

MV Conductors will be Copper, Cross Linked Polyethylene, SCT, SWA, Anti-termite Cable.

This type of cable shall be designed, manufactured and tested according to IEC 60502-2. This kind of cable shall be suitable for fixed installations, indoor, outdoor and buried installations or under conduit. It shall be appropriate for transport and distribution of electric power in medium voltage networks.

The MV cables of the PV plant will be directly buried or installed in underground ducts in case of road crossing.

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Structure Single Axis Tracker

Total amount trackers tables
4630
(60 modules per table)

Module power 360 Wp

Number of inverters 34

Power of inverters 34 x 2500kVA at 50°C

Transformer 34 x 2500kVA Oil Type Hermetical

The installation will be divided into 34 blocks of 2500MW each. Each 2500MW installation consist of 1 inverter of 2500 kVA of power at 50 °C and 2750kVA at 40 °C and PF = 1.

The maximum input voltage of inverter is 1500VDC. The MPP voltage range for nominal power of inverter is 800~1300V. The number of modules in one string depends on the two parameters above. The optimized number of modules in one string is 30 because the Maximum Open-Circuit Voltage of such string should within the limit of inverter's maximum input DC voltage which is 1500VDC taking temperature affect into account.

Electrical Diagram.

Low Voltage installation of the Plant comprises all the components from the PV modules to the inputs of the transformers.

Photovoltaic modules will be grouped in series (strings), in a convenient number to provide for maximum inverter output, while ensuring that the power or current limits set by the inverter manufacturer are not exceeded.

As required, The Plant will have a total of 277800 modules with a power of 360 Wp each, grouped into 34 modules in series per string.

Strings will be connected in parallel in a string combiner box with the required

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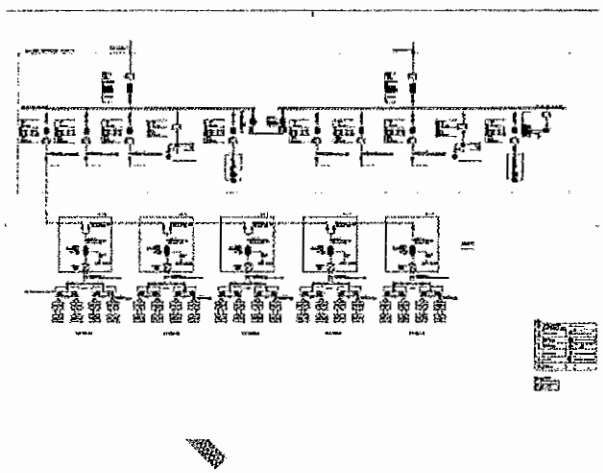
fused protection. From the string combiner boxes conductors will be run to the inverters. Inverters will be interconnected with parallel switch gear.

There will be a total of 34 inverters of 25000 kVA each at 50 °C and PF of 1.

Electrical installation will ensure people's security that work in the PV plant and will comply with all local standards.



Grounding System.

System grounding design includes intentional electric interconnections between the electric system conductor and ground. The design of the grounding system is in accordance with all applicable regulations as well as the requirements of the local utility company.

A unique common grounding system will be provided to which all metallic parts of electrical system will be connected

A grounding grid loop system will be installed consisting of adequately sized direct buried bare copper conductors. All connections and wire will be rated appropriately for the installation.

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The support structure of the photovoltaic modules is earthed in order to reduce the risks associated with the accumulation of static charges. This measure limits the voltage that exposed conductive metal parts could have with respect to earthing. It also enables the differential switches to detect current leakage, as well as facilitating the passage to earth of defective currents or atmospheric discharges.

The grounding system of the PV plant will be arranged with a continuous ground conductor, bare copper type, directly buried and laid in the LV and MV cable trenches at depth not less than 800 mm, surrounding the entire area of the PV plant. The following system groundings, as required, have been taken into account:

• Grounding of LV AC system (upstream the inverters on PV block and in the LV auxiliary distribution system of the PV plant);

• Grounding on MV AC system side (from the inverter to the feeder switchgear, and up to the output switchgear and step-up transformer).

An IT system will be used for the grounding of the inverters side.

The planned system has a TT configuration. The facilties have different types of earthing networks:

- Low-voltage earthing network: consisting of 75 mm² bare copper stranded wire.
- Earthing of metal structures: consisting of 75 mm² bare copper stranded wire.
- Medium-voltage ironwork earthing network: consisting of a rectangular ring system with four copperclad steel rods joined to a 75 mm² bare copper cable.

The rooms where the low-voltage panels are located have equipotential boxes where all earthing networks converge as shown in the attached plans.

Low-voltage panels, exposed conductive parts and metal pipework will be connected to the earthing protection circuit.

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a) Lighting Protection.

A lighting rod will be installed on each building in order to protect the security system and the SCADA system. In this way, the building is going to be protected from lighting strike. Additionally, surge protections will be installed in string combiner boxes to protect the main equipment. Both the solar modules and the inverters are surrounded by metal conductors. This reason leads us to affirm that they are inside a Faraday's cage, which is the best protection against electrical discharges.

SCADA

The plant will include a SCADA system that provides for remote monitoring and operation of the plant. The system will provide a visual representation of the entire "energy pathway". Plant Monitoring System will integrate the communication with the inverters, trackers, meteorological stations and electrical switch station to be installed in the plant.

The computer hardware will be installed in a climate controlled room with UPS. The plant server will be suitable for remote access and will give the owner the capability of change the type of data monitored.

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Plant Monitoring System will provide a visual representation of the entire "energy pathway".

The system will be configured to display with adequate precision the following parameters:

- String Current
- String Voltage
- Energy Tariff Meter.
- Circuit Breaker Status Information.
- Inverter Information

1.Input Voltage

2.Input Current

3.Calculated Input Power

4.Output Voltage

5.Output Current

6.Power Factor Angle

7.Output Power

8.Accumulated Energy Output

9.Ambient Temperature

10. Inverter efficiency

11. Inverter alerts and alarms

- Weather Information:

1.Irradiation data

2.Ambient Temperature

3.Panel Temperature

4.Wind Speed and Direction

5.Barometric Pressure

6.Relative Humidity

The SCADA will be designed in order to attain all requirements found in monitoring and communication system specification with specification's code IEC 61850.`

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Equipment.

Characteristics of main equipment are shown in this chapter. We have taken into account all local standards.

a) PV Modules.

The PV module is the element capable of converting solar energy into electrical energy using photovoltaic technology.

Currently, given the advance of photovoltaic technology, there is a tendency to use high power photovoltaic modules. In this case, we have chosen a photovoltaic module 360 Wp with polycrystalline silicon cells.

All modules that will be used are of polycrystalline silicon technology. Cells will be encapsulated with tempered glass under in iron and sheet of Ethylene-Vinyl Acetate amended (EVA)

The back sheet consisting of several layers, each one with a specific function, either adhesion, electrical insulation, or insulation against the inclemency weather.

The junction box will have a protection degree of IP67 at least, that it's ensuring insulation against humidity and weather inclemency.

They will comply with all Safety Class II (TUV) requirements, on flexibility, as on double insulation as on high resistance to UV. All this makes them suitable cable to use in exterior applications.

The resistant anodized aluminum frame provides high wind resistance and will be designed to facilitate the mounting on the support structure.

Only Modules that have the TÜV Rheinland Class II certification will be installed for using them in systems up to 1500V DC, and IEC 61215 in all points.

The PV modules will be polycrystalline type, of 72 cells and rated power of 360 Wp each. A total of 277800 PV modules will be installed into the Plant.

b) Cables.

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All installed wiring will comply with standards and regulations and will be selected based on the maximum transmission loss expected. The low-voltage outdoor wiring should be compatible with the specifics of the PV system. They will be rated for outdoor use and shall be able to withstand environmental hazards including direct solar radiation and temperatures of 90°C. They must also be rated to last at least 25 years.

All LV cables installed will be auto extinguishing, withstand temperatures up to (90 °C), provide high resistance to chemical attack.

PV cables connecting the modules of a string with the single core cables with a copper conductor and will be listed and identified as PV wire in accordance with all applicable standards.

Cables connecting the modules of a string will be routed out of direct sunlight wherever possible.

The wires for closing the panels´ series corresponding to the continuous circuit will run fixed to the structure support.

This type of cable is solar cable according to local and customer specifications. The cable used to connect the different strings with the DC cable will be of solar quality, referenced by 1.5 KV DC; 1.5 KV ,FRLS and made of unarmored copper conductor with insulation and sheath made of PE thermosetting rubber capable of withstand high temperatures.

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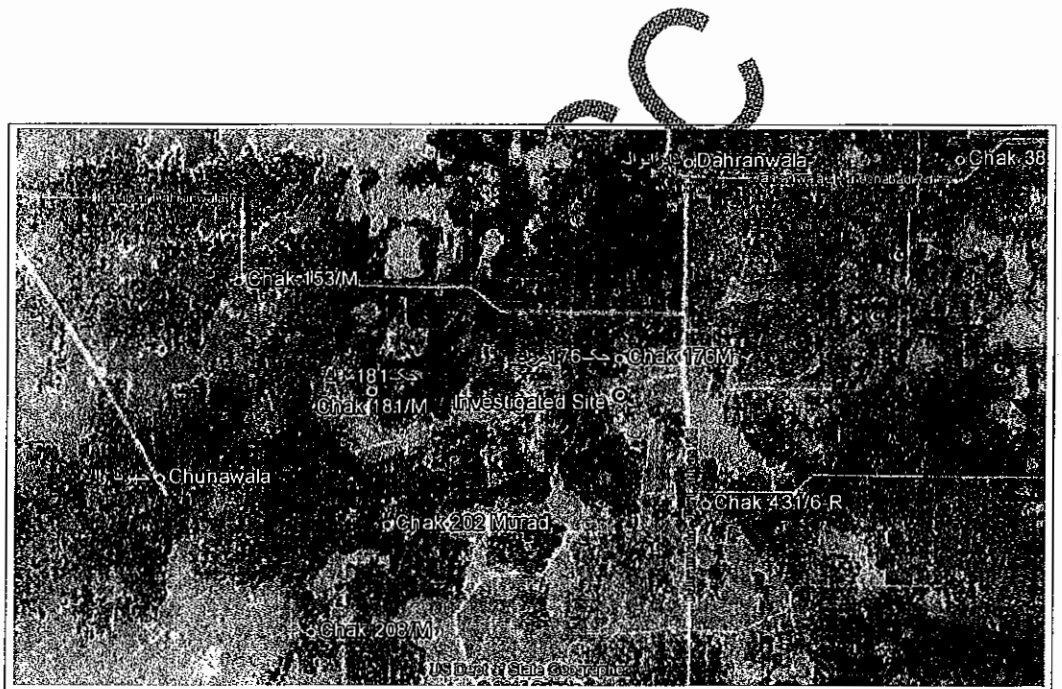
Project Vehicle:-Solution de Energy (PVT) Limited

Location maps, site maps, land

The site of Project is located In the southern region of the Punjab province Chishtian Dharanwala about 28 km south east of Bahawalnagar (geographical coordinates 72.°east/ 29.4 ° north) in the Cholistan Desert. Quaid-e-Azam Solar Park (Extension) the altitude is 150 meters above sea level



M/s IVY Engineering Services (Pvt.) Ltd.	Consultant:	M/s IVY Engineering Services (Pvt.) Ltd.	Location Plan of Site	FIGURE:	1
	Project No:	AJK/GT/101-1222	100 MW Solar Photovoltaic Plant, Block A of Quaid-e-Azam Solar Park, Chistian.	REVISION:	0
	Date:	19th October, 2015			

The Initial Site plan calling for Block J&Ghas been moved to BLOCK A, which has been platted as part of the QASP Solar Park extension. The project site is located at about 28 Km east of

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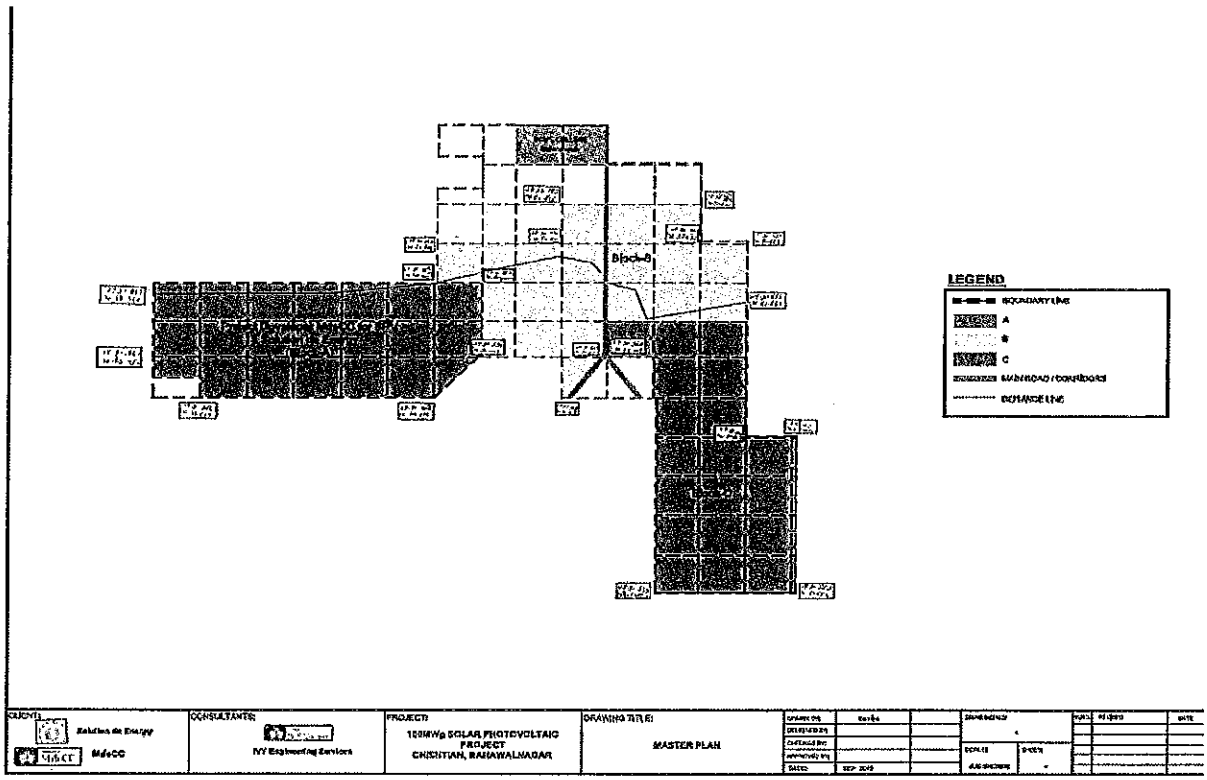
Bahawalpur; near 1st existing 100MW Solar Power Plant. The Project site is located in Cholistan Desert area.



Details are covered in the Feasibility Study

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NATIONAL TRANSMISSION & DESPATCH COMPANY

General Manager Power System Planning, NTDC

No. GMPP/CEMP/TRP-380/ 6330-33 Dated: 26-10-2017

Chief Executive Officer (CPPA-G) Ltd.
Ground Floor, Enercon Building
G-5/2, Islamabad.
Fax #: 051-9216949

Subject: Approval of Grid Interconnection Study Report of 100 MW Solution De Energy Solar Power Project at District Bahawalnagar, Punjab

Ref: (i) CPPA-G Ltd. letter No. CPPAGL/DGMT-II/MT-V/SEDPL/34666-70 dated 28-09-2017.
(ii) M/s MdeCC (Solution De Energy) letter No. Nill dated 19-09-2017.

This office received the Final Grid Interconnection Study (GIS) report of the subject 100 MW Solar Power Project vide above referred letter (ii). After review of the GIS report, it was found that most of our comments communicated previously had been incorporated by the consultant M/s PPI. However, it was also observed that some corrections in the studies were still needed which were communicated to M/s PPI. Accordingly, M/s PPI submitted the GIS report after the required corrections on 19-10-2017. Therefore, the final Interconnection study report of 100 MW Solar Power Project by M/s Solution De Energy has been approved at NTDC end as per assumptions and study results presented in the subject report.

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

Moreover, it is intimated that the subject report has been approved/vetted only for interconnectivity aspect. Any commitment regarding project execution or for any other purpose should be discussed with CPPA-G and relevant organizations.

26/10

(Maqsood Ahmad Qureshi)
General Manager Power System Planning

CC:

- Chief Engineer (P&E), MEPCO HQ, Multan.
- M/s Solution De Energy, 96 A, Khyaban-e-Iqbal7 Sector F-8/2, Islamabad, Pakistan.
- M/s PPI, 95-H/2, Wapda Town, Lahore.
- *Master File (MP)*

ENVIRONMENT PROTECTION DEPARTMENT

Government of the Punjab
National Hocky Stadium, Lahore.

NO. DD (EIA)/EPA/F-868(IEE)/2511/2015/1072
Dated: 30/12/2015

To

Mr. I.R. Malik,
Chief Executive Officer,
M/s Solution De Energy (SVP)/Project Developer MdeCC,
96-A, Khyaban-e-Iqbal 7 Sector F-8/2,
Islamabad

Subject: **DECISION OF EPA PUNJAB FOR THE INSTALLATION OF 100-MW SOLAR PHOTO – VOLTAIC PROJECT AT BLOCK-A, QUAID-E-AZAM SOLAR PARK, (EXTENSION) CHISHTIAN, BAHAWALNAGAR**
(Under Section 12 of PEPA, 1997 (Amended 2012) read with IEE/EIA Regulations, 2000)

Reference: Board of Revenue Punjab letter No. 3339-2015-1220-CS(III) dated 13.10.2015, PPDB letter No. PPDB/1437/2015 dated 01.10.2015 and EPA Punjab letter No. DD(EIA)/EPA/F-633(IEE)/0707/2015/899 dated 10.07.2015

1. Description of Project: Installation of 100-MW Solar Photo-Voltaic (PV) Power Project.

2. Location of Project: The site is located at Block-A, Quaid-e-Azam Solar Park, (Extension) Chishtian, Bahawalnagar

3. Date of filing of IEE: 28.09.2015

4. After careful review of Initial Environmental Examination (IEE) Report, Site Inspection Report of District Officer (Environment), recommendations of Committee of Experts constituted under Regulation 11(2) of IEE / EIA Regulations, 2000 read with Section 12 of the Act ibid on 11.11.2015 and other relevant record, the Environmental Protection Agency, Punjab has decided to accord its approval for the installation of the above mentioned project to safeguard the environmental issues subject to the following conditions:

i. The proponent shall ensure compliance of National Environmental Quality Standards (NEQS).
ii. Mitigation Measures suggested in the IEE report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area.
iii. Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on monthly basis.
iv. Camping sites shall be located at suitable distance away from any settlement to avoid disturbance to the local people. Sewage generated from camping sites shall be treated in septic tanks.
v. The proponent shall take measures to control dust.
vi. The area around the project site shall be kept clean.
vii. The proponent shall dispose of solid waste, electronic waste, discarded solar panels and condemn batteries etc. in a proper scientific way in consultation with TMA / District Government.
viii. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.
ix. The proponent shall avoid cutting of trees.
x. The proponent shall plant at least 5000 trees of indigenous species of minimum height 6 to 7 feet around the project area in consultation with District Officer (Environment) on available space within six months and shall take measures for the protection of these trees.
xi. The proponent shall do proper landscaping after completion of the project.
xii. The construction material shall be piled / stored in such a way that it shall not destroy the

xv. The proponent shall provide compensation to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the rates that are agreed upon. All conflicting issues regarding compensation, etc. shall be settled amicably before the start of the project activities.

xvi. The proponent shall obtain NOC / clearance from all other concerned departments before commencement of work.

xvii. The proponent shall appoint Environmental Manager having (at least qualification of B.S. Environmental Sciences / B.Sc. Environmental Engineering) for the project and shall convey his name along with his complete Mailing Address and Phone Numbers.

xviii. Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environmental friendly way at a suitable disposal facility.

xix. The proponent shall ensure that strict and efficient health and safety measures are in place for protection of workers backed by a comprehensive emergency response system while working on super structure.

xx. At least 90% unskilled and to the extent possible skilled jobs shall be given to locals after providing them proper training.

xxi. The proponent shall take effective measures for safe transportation of Photovoltaic Cell / Solar Panel.

xxii. The proponent shall dispose of wastewater after treatment.

xxiii. The proponent shall adopt latest techniques for the cleanliness of the solar panels to minimize water use as much as possible.

xxiv. The proponent shall ensure all necessary measures for the protection of sensitive / protected areas in the vicinity.

xxv. The proponent shall prepare a Community Development Plan and implement it for the benefit of communities of the project area.

xxvi. The proponent shall follow the SOPs regarding dengue larvae eradication and shall ensure removal of stagnant water on daily basis.

xxvii. The proponent will adopt the technology after carrying out feasibility of concentrated solar power (CSP) and its comparison with photovoltaic technology for harvening solar power.

5. The proponent shall be liable for correctness and validity of information supplied to this department by the environmental consultant.

6. The proponent shall be liable for compliance of Regulations 13, 14, 18 and 19 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

7. This approval is accorded only for the construction phase of the project. The proponent shall apply for confirmation of compliance under Regulation 14 of IEE / EIA Regulation, 2000 by submitting Environmental Management Plan for operational phase along with compliance status report of the Environmental Approval of the construction phase of the project.

8. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.

9. This approval shall be treated as null and void if all or any of the conditions mentioned above, is/are not complied with. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force and is subjudice to legal proceedings in any legal fora / court.

10. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under Regulation 17 of IEE / EIA Regulations, 2000.

11. This approval can be withdrawn at anytime without any prior notice if deem necessary in the public / national interest.

(AMEN HANIF)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab
Ph: # 042-99232228

NO. & DATE EVEN.

A copy is forwarded for information to:

The District Officer (Environment), Bahawalnagar w.r.t his letter No.4631/DOE/BWN, dated 06.11.2015. He is requested to ensure compliance of the above mentioned conditions / measures under intimation to this office.

ENVIRONMENT PROTECTION DEPARTMENT

Government of the Punjab
National Hocky Stadium, Lahore.

NO. DD (EIA)/EPA/F-868(IEE)/2511/2015/1072
Dated: 30/12/2015

To

Mr. I.R. Malik,
Chief Executive Officer,
M/s Solution De Energy (SVP)/Project Developer MdeCC,
96-A, Khyaban-e-Iqbal 7 Sector F-8/2,
Islamabad

Subject: **DECISION OF EPA PUNJAB FOR THE INSTALLATION OF 100-MW SOLAR PHOTO – VOLTAIC PROJECT AT BLOCK-A, QUAID-E-AZAM SOLAR PARK, (EXTENSION) CHISHTIAN, BAHAWALNAGAR**
(Under Section 12 of PEPA, 1997 (Amended 2012) read with IEE/EIA Regulations, 2000)

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(AMEN HANIF)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab
Ph: # 042-99232228

NO. & DATE EVEN.

A copy is forwarded for information to:

The District Officer (Environment), Bahawalnagar w.r.t his letter No.4631/DOE/BWN, dated 06.11.2015. He is requested to ensure compliance of the above mentioned conditions under intimation to this office.

No. DD(EIA)/EPA/868(IEE)/2015/ 345
GOVERNMENT OF THE PUNJAB
ENVIRONMENTAL PROTECTION AGENCY
NATIONAL HOCKEY STADIUM FEROZEPUR ROAD, LAHORE
Dated: 21 /05/2019

To,

Mr. I.R. Malik,
Chief Executive Officer,
M/s Solutions De Energy (SVP) Project Developer MdeCC,
96-A, Khayaban-e-Iqbal 7 Sector F-8/2,
Islamabad.

Subject: **EXTENSION IN THE VALIDITY PERIOD OF ENVIRONMENTAL APPROVAL ISSUED TO M/S QUAID-E-AZAM SOLAR PARK (100-MW SOLAR PHOTO VOLTIC EXTENSION PROJECT), CHISTIAN, BAHAWALNAGAR.**

Please refer to Environmental approval issued vide letter No. DD(EIA)/EPA/F-868(IEE)/2511/2015/1072 dated 30.12.2015 to you for the subject project and your application vide No. Nil, dated 28.02.2019 for the extension of the above referred environmental approval.

2. I am directed to intimate that validity period of environmental approval issued vide letter quoted under reference is hereby extended for another period of three years from 30.12.2018 to 30.12.2021 with the same terms & conditions mentioned in the above referred environmental approval for construction of Solar Park (Extension Project).

ASSISTANT DIRECTOR
EIA WING, EPA PUNJAB

C.C.

A copy is forwarded to the Assistant Director (Environment) Bahawalnagar w.r.t. his letter No. 1170/AD/EPA/BWN dated 02.05.2019. He is requested to ensure compliance of the above mentioned conditions.

ASSISTANT DIRECTOR
EIA WING, EPA PUNJAB

TBEA

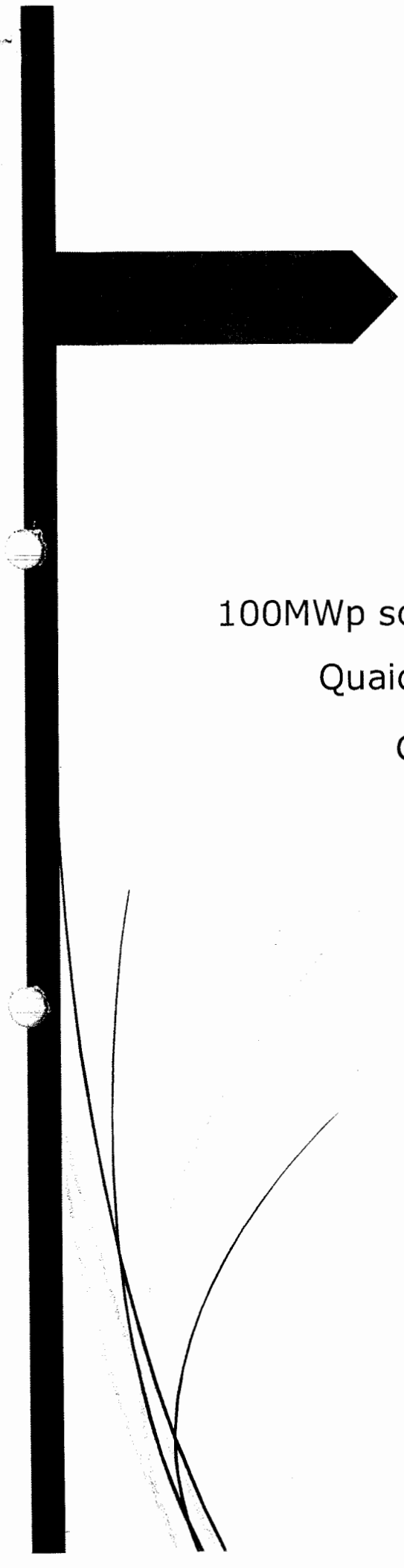
Proposal for

100MWp solar power project to be set up at

Quaid-e-Azam Solar Park (Extension),

Chishtian, Bahawalnagar, Punjab,

Pakistan



TECHNICAL PROPOSAL

FOR

100MW SOLAR POWER PROJECT

TO BE SET UP AT QUAID-E-AZAM SOLAR PARK (EXTENSION),
CHISHTIAN, BAHAWALNAGAR, PUNJAB

TABLE OF CONTENT

1 Description of Project

1.1 Object

The object of this document is to define the technical configuration and scope of supply that allows the execution of Engineering, Procurement of equipment and Construction of the project "QASP(EXTENSION) CHISHTIAN BAHAWALNAGAR 100MW SOLAR POWER PROJECT"

The Solar Park is located nearby Chishtian in the following coordinates:

- Latitude: 29°31'34.81"N
- Longitude: 72°49'26.85"E

The proposed installed generation capacity for the Plant is 100 MWp with a total of 277,800 PV modules of 360 Wp each, and the plant shall deliver a maximum of 85 MWac at 45℃ and PF of 1 to the existing electricity supply network.

1.2 Scope of Work

In order to do this tender, a turnkey model has been taken into account. Design and equipment gathered in this document have a preliminary role and will be adjusted to eventual conditions of execution complying with local standards.

In relation to the scope of the necessary infrastructure for the execution of the work with this configuration the project execution will be performed adapting the dimensions and characteristics of foundations, platforms, required roads.

SOW for two parties of TBEA and TOTAL EREN is proposed below:

	ITEMs	TBEA's SOW	TOTAL EREN's SOW
1.	**Permits and Approvals**		
	Land Rights		X
	Easements		X
	Environmental Impact Study / Compliance		X
	Building / Construction Permits		X
	All Permits related to grid interconnection		X
	All other Permits / Approvals for Project Execution and Completion	X	
2.	**Pre-Construction / Engineering**		
	Geological and Geotechnical Study	X	
	Topographical and Hydrological Studies & Soil Investigation	X	
	Preliminary Design & Engineering	X	
	Single Line Diagrams (DC- and AC)	X	
	Preliminary Project Planning	X	
	PVSyst-Simulation, incl. P50, P75 and P90 at the Point of Delivery for 25 years of Operation	X	
3.	**Procurement**		
	PV-Modules	X	
	Mounting Structures	X	
	Inverter Stations	X	
	DC Collector (Cabling, Combiner Boxes, and other Electrical Components / Equipment)	X	
	AC Collector (Cabling, Transformer, Switchgear, Auxiliary Equipment)	X	
	Plant Substation (220kV/35kV/2x43MVA), incl. Capacitor Banks (2x20MVAR SVC)	X	
	132kV Interconnection Line to NTDC/MEPCO Grid at 132kV Busbar (2x2km SC Rail Circuit)		X
	132kV Bay to NTDC/MEPCO Grid at 132kV Busbar (2x)		X
	Fencing and Security System	X	
	Meteo Stations and SCADA System	X	
	Grounding System	X	
	Spare Parts	X	

4.	**Transportation / Logistics**		
	Transportation and Delivery to Site (incl. Modules)	X	
	Transit & Freight Insurance	X	
	Custom Clearance of All Parts and Components (incl. Modules)	X	
	Transportation of All Parts and Components (incl. Modules) to Site, Unloading & Testing	X	
	Import Duties and Taxes		X
5.	**Civil & Electrical Works**		
	Site Preparation and Civil Works (Leveling, Compacting)	X	
	Cable Trenches and Internal Roads	X	
	Foundations	X	
	Ramming / Piling, Mounting of Structures and Installation of Modules	X	
	DC- and AC-Cabling	X	
	Grounding System	X	
	Drainage	X	
	MV Switchgear Room and Main Control Room	X	
	132kV Switchgear Yard	X	
	All Civil works related to 132kV Interconnection Line to NTDC/MEPCO Grid at 132kV Busbar (2x2km SC Rail Circuit)		X
	All Civil works related to 132kV Bay to NTDC/MEPCO Grid at 132kV Busbar (2x)		X
	Storage Room and Guard House (if required)	X	
	Water (incl. Supply System for Module Cleaning) and Power Supply	X	
	Communication System	X	
6.	**Project Management / Construction**		
	Lodging and Catering	X	
	Transportation	X	
	Construction Office	X	
	Utilities (Water, Energy, Internet) during Construction	X	
	Insurance during Construction	X	
	Security during Construction	X	
7.	**Post-Construction Activities**		
	Testing and Commissioning	X	
8.	**Operations / Maintenance**		
	Monitoring 24/7/365	X	
	Coordination with all Parties required	X	
	Warranty Administration (Organization and Documentation)	X	
	Preventive and Corrective Maintenance (scheduled & unscheduled)	X	
	Performance and Availability Guarantees	X	
	Spare Parts Management	X	
9.	**Operations / Maintenance**		
	Withholding Taxes related to SOW and Services provided	X	
	Any / All other applicable Taxes related to SOW and Services provided		X

2 Basis of Design

2.1 Codes, Standards and Regulations

All the equipment, materials, design and works to be performed in this project must be in line with latest edition of Pakistan and International standards and regulations.

When these norms and standards do not cover a specific issue, other widely accepted standards will be applied.

Additionally, all the related material, equipment and services must also comply with all applicable local regulation, codes and standards of the State/County where they will be installed. They must also meet their particular technical specifications for the project ensuring compliance with safety and efficient performance in the field. The design and installation must be fully in conformity with the standards and codes as applicable but not limited to the following.

ANSI : American National Standard Institute

ASME : American Standard of Mechanical Engineers

AWS : American Welding Society

ASTM : American Standards for Testing Material

ISO : International Organization for Standardization

ASA : American Standard Association

DIN : Deutsche Industrie Normen

EN : European Standards

BS : British Standards

IEC : International Electro-technical Commission

IEEE : Institute of Electrical and Electronics Engineers

ISA : Instrument Society of America

SI : International System of Units

The following standard will be included:

Number	Applies to: (PV, Electrical, and Security)
IEC61215	Design and Type Approval of Crystalline Silicon Terrestrial PV Modules
IEC61730	Photovoltaic (PV) module safety qualification (Parts 1 and 2)
IEC60904	Photovoltaic Devices (Parts 1-9)

IEC60364	Electrical installations of buildings Part 7-712 Requirements for special installations or locations -- Solar photovoltaic (PV) power supply systems
IEC 50262	Cable Glands for Electrical Installations
IEC 60898	Electrical Accessories – Circuit-breakers for overcurrent protection for household and similar installations
IEC 60364-4-41	Low-voltage plants installation. Part 4-41 - Protection for safety – protection against shock
IEC 10222-5-1	Electrical Security Installations (Part 5-1-1 to 5-1-3)

Also all the technical standards and agreements which the EPC Contractor must comply with must include:

Reference	Applies to: (General)
TBC	NTDC/ PESCO Distribution Standard for the Interconnection of Embedded Generation
NEPRA	Pakistan Grid Code for Renewables
Under negotiation	Energy Purchase Agreement (EPA)
	Pakistan Building Code

2.2 Technical Description.

In order to summarize the arrangement of the PV power plant, we are adding the following table:

MAIN PARAMETERS	
PV modules	277800
Power	100MWp
Structure	Single Axis Tracker
Total amount trackers tables (60 modules per table)	4630
Module power	360 Wp

Number of inverters	34
Power of inverters	34 x 2500kVA at 50℃
Transformer	34 x 2500kVA Oil Type Hermetical

The installation will be divided into 34 blocks of 2500MW each. Each 2500MW installation consist of 1 inverter of 2500 kVA of power at 50 ℃ and 2750kVA at 40 ℃ and PF = 1.

The maximum input voltage of inverter is 1500VDC. The MPP voltage range for nominal power of inverter is 800~1300V. The number of modules in one string depends on the two parameters above. The optimized number of modules in one string is 30 because the Maximum Open-Circuit Voltage of such string should within the limit of inverter's maximum input DC voltage which is 1500VDC taking temperature affect into account.

2.2.1 Electrical Diagram.

Low Voltage installation of the Plant comprises all the components from the PV modules to the inputs of the transformers.

Photovoltaic modules will be grouped in series (strings), in a convenient number to provide for maximum inverter output, while ensuring that the power or current limits set by the inverter manufacturer are not exceeded.

As required, The Plant will have a total of 277800 modules with a power of 360 Wp each, grouped into 34 modules in series per string.

Strings will be connected in parallel in a string combiner box with the required fused protection. From the string combiner boxes conductors will be run to the inverters. Inverters will be interconnected with parallel switch gear.

There will be a total of 34 inverters of 25000 kVA each at 50 ℃ and PF of 1.

Electrical installation will ensure people's security that work in the PV plant and will comply with all local standards.

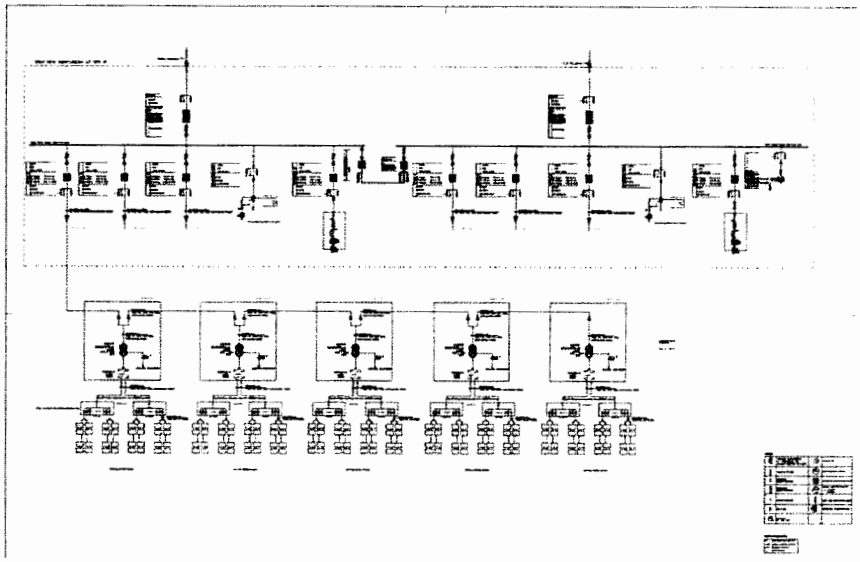


Figure.1 Singles line diagram

2.2.2 Grounding System.

System grounding design includes intentional electric interconnections between the electric system conductor and ground. The design of the grounding system is in accordance with all applicable regulations as well as the requirements of the local utility company.

A unique common grounding system will be provided to which all metallic parts of electrical system will be connected

A grounding grid loop system will be installed consisting of adequately sized direct buried bare copper conductors. All connections and wire will be rated appropriately for the installation.

The support structure of the photovoltaic modules is earthed in order to reduce the risks associated with the accumulation of static charges. This measure limits the voltage that exposed conductive metal parts could have with respect to earthing. It also enables the differential switches to detect current leakage, as well as facilitating the passage to earth of defective currents or atmospheric discharges.

The grounding system of the PV plant will be arranged with a continuous ground conductor, bare copper type, directly buried and laid in the LV and MV cable trenches at depth not less than 800 mm, surrounding the entire area of the PV plant. The following system groundings, as required, have been taken into account:

- Grounding of LV AC system (upstream the inverters on PV block and in the LV auxiliary distribution system of the PV plant);
- Grounding on MV AC system side (from the inverter to the feeder switchgear, and up to the output switchgear and step-up transformer).

An IT system will be used for the grounding of the inverters side.

The planned system has a TT configuration. The facilties have different types of earthing networks:

- Low-voltage earthing network: consisting of 75 mm² bare copper stranded wire.
- Earthing of metal structures: consisting of 75 mm² bare copper stranded wire.
- Medium-voltage ironwork earthing network: consisting of a rectangular ring system with four copper-clad steel rods joined to a 75 mm² bare copper cable.

The rooms where the low-voltage panels are located have equipotential boxes where all earthing networks converge as shown in the attached plans.

Low-voltage panels, exposed conductive parts and metal pipework will be connected to the earthing protection circuit.

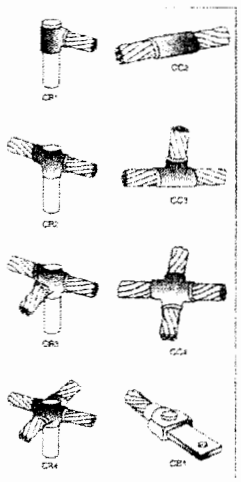


Figure2: Ground connection for across connection

Figure3: Earthing electrode

a) Lighting Protection.

A lighting rod will be installed on each building, in order to protect the security system and the SCADA system. In this way, the building is going to be protected from lighting strike. Additionally, surge protections will be installed in string combiner boxes to protect the main equipment. Both the solar modules and the inverters are surrounded by metal conductors. This reason leads us to affirm that they are inside a Faraday's cage, which is the best protection against electrical discharges.

2.2.3 SCADA

The plant will include a SCADA system that provides for remote monitoring and operation of the plant. The system will provide a visual representation of the entire "energy pathway". Plant Monitoring System will integrate the communication with the inverters, trackers, meteorological stations and electrical switch station to be installed in the plant.

The computer hardware will be installed in a climate controlled room with UPS. The plant server will be suitable for remote access and will give the owner the capability of change the type of data monitored.

Plant Monitoring System will provide a visual representation of the entire "energy pathway".

The system will be configured to display with adequate precision the following parameters:

- String Current
- String Voltage
- Energy Tariff Meter.
- Circuit Breaker Status Information.
- Inverter Information
    1. Input Voltage
    2. Input Current
    3. Calculated Input Power
    4. Output Voltage
    5. Output Current
    6. Power Factor Angle
    7. Output Power
    8. Accumulated Energy Output
    9. Ambient Temperature
    10. Inverter efficiency
    11. Inverter alerts and alarms

- Weather Information:
    1. Irradiation data
    2. Ambient Temperature
    3. Panel Temperature
    4. Wind Speed and Direction
    5. Barometric Pressure
    6. Relative Humidity

The SCADA will be designed in order to attain all requirements found in monitoring and communication system specification with specification's code IEC 61850.

2.2.4 Equipment.

Characteristics of main equipment are shown in this chapter. We have taken into account all local standards.

a) PV Modules.

The PV module is the element capable of converting solar energy into electrical energy using photovoltaic technology.

Currently, given the advance of photovoltaic technology, there is a tendency to use high power photovoltaic modules. In this case, we have chosen a photovoltaic module 360 Wp with polycrystalline silicon cells.

All modules that will be used are of polycrystalline silicon technology. Cells will be encapsulated with tempered glass under in iron and sheet of Ethylene-Vinyl Acetate amended (EVA)

The back sheet consisting of several layers, each one with a specific function, either adhesion, electrical insulation, or insulation against the inclemency weather.

The junction box will have a protection degree of IP67 at least, that it's ensuring insulation against humidity and weather inclemency.

They will comply with all Safety Class II (TUV) requirements, on flexibility, as on double insulation as on high resistance to UV. All this makes them suitable cable to use in exterior applications.

The resistant anodized aluminum frame provides high wind resistance and will be designed to facilitate the mounting on the support structure.

Only Modules that have the TÜV Rheinland Class II certification will be installed for using them in systems up to 1500V DC, and IEC 61215 in all points.

The PV modules will be polycrystalline type, of 72 cells and rated power of 360 Wp each. A total of 277800 PV modules will be installed into the Plant.

b) Cables.

All installed wiring will comply with standards and regulations and will be selected based on the maximum transmission loss expected. The low-voltage outdoor wiring should be compatible with the specifics of the PV system. They will be rated for outdoor use and shall be able to withstand environmental hazards including direct solar radiation and temperatures of 90℃. They must also be rated to last at least 25 years.

All LV cables installed will be auto extinguishing, withstand temperatures up to (90 °C), provide high resistance to chemical attack.

PV cables connecting the modules of a string with the single core cables with a copper conductor and will be listed and identified as PV wire in accordance with all applicable standards.

Cables connecting the modules of a string will be routed out of direct sunlight wherever possible.

The wires for closing the panels´ series corresponding to the continuous circuit will run fixed to the structure support.

This type of cable is solar cable according to local and customer specifications. The cable used to connect the different strings with the DC cable will be of solar quality, referenced by 1.5 KV DC; 1.5 KV ,FRLS and made of unarmored copper conductor with insulation and sheath made of PE thermosetting rubber capable of withstand high temperatures.

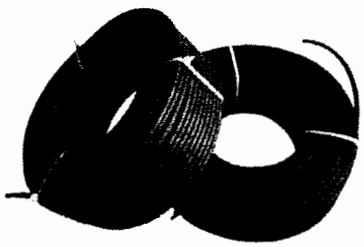


Figure4: Solar Cable

The cable used for the DC buses, however, will be referenced by 0.6/1 KV copper cross Linked Polyethylene and made of unarmored tinned soft annealed conductor with XLPE compound insulation and PVC compound sheath. This kind of cable is shown in the following figure:

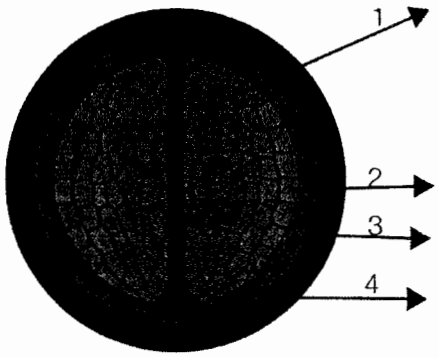


Figure5: SCB Cable

Figure: Type of Wire more used: Copper, Cross Linked Polyethylene, SCT, SWA, Anti-termite Cable .

MV Conductors will be Copper, Cross Linked Polyethylene, SCT, SWA, Anti-termite Cable.

This type of cable shall be designed, manufactured and tested according to IEC 60502-2. This kind of cable shall be suitable for fixed installations, indoor, outdoor and buried installations or under conduit. It shall be appropriate for transport and distribution of electric power in medium voltage networks.

The MV cables of the PV plant will be directly buried or installed in underground ducts in case of road crossing. Cable is shown in the following figure:

Figure6: MV Cable .

c) String Combiner Boxes.

The string combiner boxes will be connected in strings, joining in the inverter. There will be two grouping levels (first level and second level). The first level boxes will be monitored by the SCADA System. The second level boxed will be integrated into the inverters

(1) The sting combiner boxes

The string combiner boxes will go to the second level boxes in groups of 11. From each second level box, an independent line will run to the inverter's building.

The strings will be connected in parallel in a string combiner box with the required fused protection. The 1,500 Vdc first level box shall have the following parts:

- disconnector switch
- fuse
- communication module

All on load switch disconnector boxes will be weatherproof (IP65) and include protection against UV radiation.

The string combiner boxes will be located at the back of the structure, in a central location among the series from which it collects.

The output of the string combiner boxes will be taken underground until the inverter location.

(2) Second level boxes

Second-level boxes will collect the branches of independent lines from the first-level boxes. Each inverter will have the combiner box with 10 inputs, 10 Inputs with current breaker.

d) Center Inverter

In order to clarify the offer, we are describing a technical solution that could be installed:

There are 34 inverters with a capacity 2.5MW.

DC input	
Voltage range (MPPT)(1)	1500Vdc
Max. input voltage	1500Vdc
Max. Input current	3508A
AC output	
Nominal AC Voltage	2*550Vac
AC voltage range(2)	440-632kVac
Frequency	50/60Hz
Frequency operation range	45/55Hz
Rated AC power @ 50℃ (122 oF)	2500kVA

Rated AC power @ 35℃ (95 oF)	2750kVA
Maximum output current	2668A
Total Harmonic Distortion (THD)	< 3%
Power factor	0.8 leading-0.8 laggin
Galvanic Isolation	No
Efficiency	
European efficiency, ƒÅe	98,7%
CEC efficiency, ƒÅCEC	99%
Self-consumption in standby	<= 4745W
Self-consumption in operation (3)	<= 90kW
Ambient conditions	
Operation ambient temperature	-31oF / 140oF (-20oC / 60oC)
Operation ambient temperature (without de rating)	-31oF / 95oF (-20oC / 50oC)
Maximum relative humidity	0-95% without condensation
Max. altitude above sea level	4500m
Mechanical Characteristics	
Dimensions (H x W x D) Indoor model	2991*2591*2438
Dimensions (H x W x D) Outdoor model	117.76*102.01*95.98

(e) Inverter Duty Transformers.

Transformers to be used will be 34 x 2500 kVA. The following tables summarize their main features:

2500kVA Technical characteristics	
Type	3-phase ONAN Type, single LV winding
Power of High Voltage Winding (HV)	2500kVA@50ºC

Power of Low Voltage Windings (LV)	2500kVA@50ºC
Connection Group	DY11
Frequency	50-60 Hz
Primary Nominal Voltage	35 kV
Primary Insulation Level	38.5 kV
High Voltage Taps	35kV± 4*2.5%
Secondary Nominal Voltage (single winding)	550V
Cooling class	ONAN
Maximum Ambient Temperature	-35-60 ºC
Relative Humidity Range	0 -95 %
Height	>1000 m.a.s.l.

Primary Nominal Voltage and Primary Insulation Voltage depends on PV plant requirements The oil collection pool will be integrated into the design of the building itself and will have capacity enough to retain inside itself all transformer oil without spilling it over the base.

Transformer will comply with international standards and requirements as well as with other Local Regulation.

(f) Ring Main Unit.

Medium Voltage Main Gear consists in two to four modular metal-enclosed cabins containing fixed, disconnectable or withdrawable metal enclosed switchgear AIS inside transformation building and equipped with the necessary gear. All control functions will be centralized on the front plate, thus simplifying operation. The units may be equipped with a number of accessories (relays, toroids, instrument transformers, surge arrester, control and monitoring, etc.).

The main features of MV cells are detailed in the following table:

TECHNICAL CHARACTERISTICS	
Type	2LP (2 lines + 1 protection)
Feeder cubicle (L)	Manoeuvre: Isolator switch

Protection cubicle (P)	Manoeuvre: Isolator switch Protection: Fuses
Insulation	AIR
IP	65
Number of phases	3
Nominal frequency	50-60 Hz
Service Voltage	35 kV
Assigned Voltage	38.5 kV
Rated busbar current	1250 A
Rated admissible short-time current (1s)	20 kA
Maximum Ambient Temperature	45 ºC
Minimum Ambient Temperature	-10ºC
HR range	0 -95 %
Reference standards	IEC60265-1 y IEC 62271 parts 1, 100, 102, 105, 200

Service voltage and assigned voltage depends on PV plant requirements.

There will be two types of cabins:

- Line cabin (L): receives the MV line coming from other containerized Inverter duty transformer in the same circuit and it is equipped with a switch protection and a disconnector-earthing switch.
- Protection cabin (P): Protects the transformer by switch-disconnector fuse and a disconnector earthing switch.

Grounding Switch-Disconnector with manual handle with interlock; copper plate for grounding installation is included.

There is the possibility of installing protection relays on MV switchgear and the remote control of it (with motorized switch-disconnectors)

g) Meteorological Station.

The meteorological stations will have the following main components:

- Class I Pyronometer.
- Anemometer and Vane.
- Three Ambient Temperature Sensors.
- Three Calibrated Cells (Atersa).
- Calibrated Horizontal Cell.
- Rain Gauge.
- Interactive LED Display.
- Barometer
- RS485 Interconnection.
- Moisture Meter.
- Data Logger.

Some pictures of the main meteorological equipment are attached. TBEA has experience in mounting these equipment.

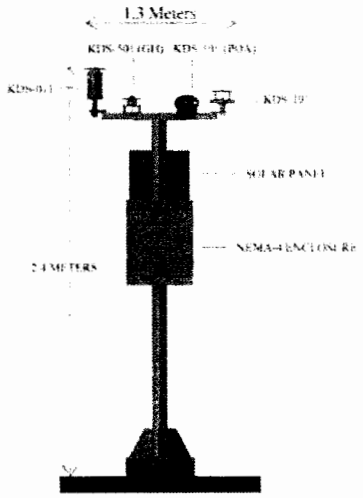


Figure7: Meteorological Station.

2.2.5 Interconnection to grid

For the interconnection with the existing NTDC/MEPCO substation it is required to design, build and commissioning a new 35/132 kV substation with two 43 MVA Transformer Bays and two 132kV Line Bays.

The transformer substation of the photovoltaic plant will make possible to raise the voltage from the generation level (35 kV) to the transport level (132 kV).

The interconnection point of the OHL shall be made in a 132 kV line. For that, a double circuit line shall be delivered to the busbars of the new photovoltaic substation.

Design, equipment procurement and installation of approximately 2 km double circuit 132 kV transmission line and remote 2x132kV bays for interconnection are outside of the SOW of TBEA.

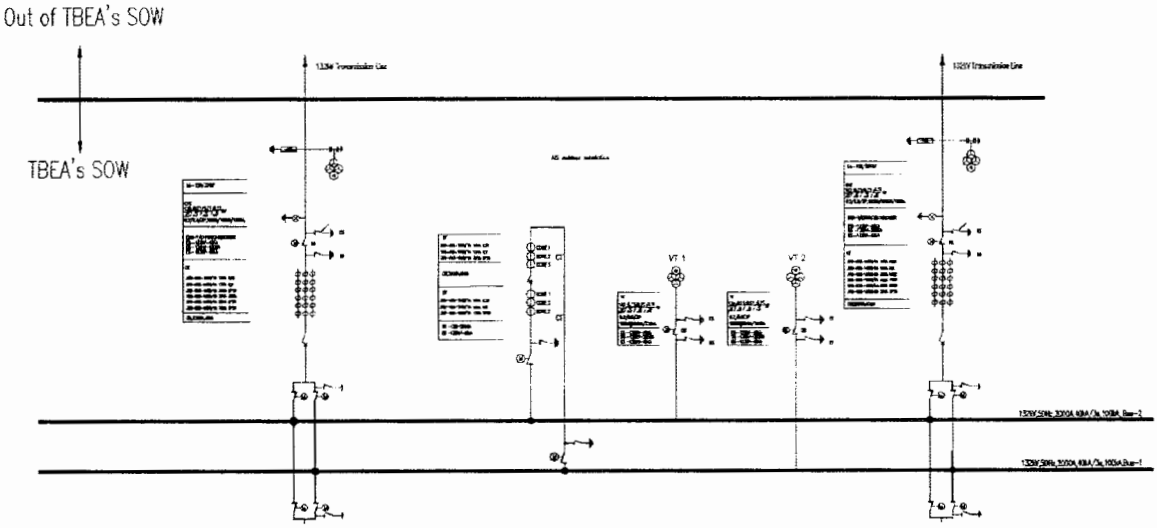


Figure8: Interface of grid connection

2.2.6 Environmental Conditions

All the restrictions imposed by local, state jurisdictions will apply.

2.2.7 Civil Works

2.2.8.1 PV Module Support

The power generation of PV array is proportional to the total irradiation that the surface of PV modules receives. Horizontal Single axis tracker can greatly enhance the annual total irradiation received on the surface of PV modules by tracking the movement of the sun. Compared to fixed tilt mounting structure, Horizontal Single-axis tracker can increase 15% of annual power generation, depending on the location. Therefore, it has been widely used in large solar power plant.

Currently, the mainstream horizontal Single-axis tracker in the market are linked horizontal single axis tracker and independent horizontal single axis tracker. In comparison to linked single axis tracker, Independent horizontal single axis tracker has better adaptability to complicated terrain. It can be installed to the area with up to 20% of N-S slope and there is no limit for E-S direction. Therefore, utilizing the independent horizontal single axis tracker will reduce lower leveling volume and save construction investment cost greatly. However, its manufacturing cost is higher than linked single axis tracker. The figure below shows a typical independent horizontal single axis tracker.

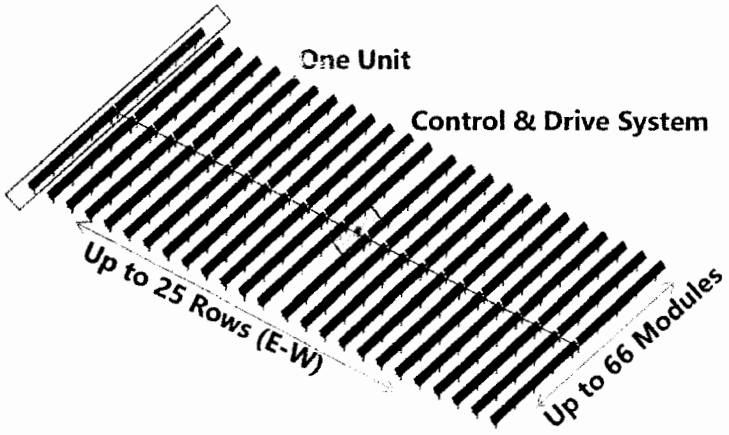


Figure9.Horizontal single axis tracker

Table 4-1Tracker specifications

Tracking Type	Linked Horizontal Single Axis Tracker
High Reliability	Backup of critical components- Motor, Control
Redundancy Design	Board, Tilt Sensor and Wind Sensor
Drive Type	Slewing Drive
Motors per Tracker	2 (1 for backup)
System Voltage	1500V
Max No. of Module per Tracker	Up to 1100 (72 cells)
Structure Material	Hot Dip Galvanized/ Pre Galvanized/ Stainless steel/ Composite/ Aluminum
Power Supply	380V / 415V/ 480V, 4 Wire, 3-Phase, 1KW
Daily Energy Consumption per Tracker	<1.5 kWh
Modules Configuration	1 in Portrait
Module Supported	All commercially available including Frameless, Glass/Glass, Bi-facial and Thin Film
Stow Wind Speed	40 mph (approx. 64kmph)

Standard Wind Design	105 mph (approx. 170kmph), configurable for higher wind speed. Wind Tunnel Tested
Operation Temperature	-22oF (-30°C) to 140oF (60°C)
Foundation Options	Ramming, Concrete, Screw or Helical Pier
Codes and Standards	UL Certified (2703 and 3703), ASCE 7-10

2.2.8.2 Foundation of PV Module Support

The selection of the PV mounting structure foundation usually need to comprehensively take the characteristics of soil, corrosivity of soil, the level of underground water and etc. into consideration. In order to reduce the impact of corrosion on the foundation, concrete pile is the best solution of PV mounting structure for this project.

Taking in consideration the geotechnical report, drilling the rock and ramming the piles into that hole appear suitable for the site conditions.

For each pile that we have to install, we will drill a hole in the rock and the structure foundation should be rammed into that hole. The pile system has been designed to ensure a correct support of the structure. After the study of the results obtained from the ground test, we will be able to know the depth of driven piles.

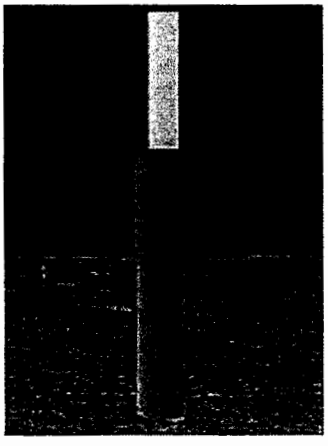


Figure 10. Concrete pile foundation for PV module support

We design concrete pile with C shape steel as the tracker foundation. For horizontal single axis tracker, there're five micro concrete pile with C shape steel for each string, and the arrangement of foundation and module are shown in the figure below. Concrete pile section size: 1.5m underground depth, 0.2m upper length, 1.7m total length, C shape steel section size: C160(mm)×85(mm)×25(mm)×3(mm), 1.3m underground depth, 1.3m upper length.

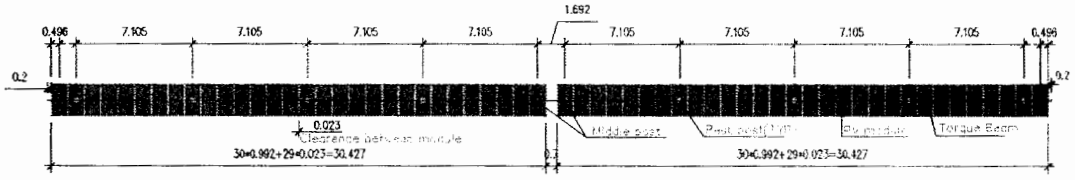


Figure 10.Tracker module & foundation arrangement plan

2.2.8.3 Site Preparation

There're some purposes for site preparation in this project. According to relevant information, there're palm and rubber trees within the site boundary. Thus, trees and vegetation removal will be made in the first place. Secondly, the elevation of the field will meet the design and use requirements after leveling works. Afterwards, the site condition will meet the construction requirements of water supply and drainage, electricity, roads, temporary buildings and other infrastructure. Finally, it will ensure the speed of construction process and quality control as well.

General conditioning of the terrain (clearing, grubbing, removal of topsoil when necessary, etc.) will be performed on site according to the requirements of the geotechnical survey.

2.2.8.4 Cable Trenches

LV cabling trenches will have a minimum depth of 0.6 m and width of 0.6 m.

MV cabling trenches will have a minimum depth of 1.00 m and width of 0.60 m.

The bed of the trench should be flat and free from sharp edges, stones, etc. Washed river sand is deposited to a thickness of 10 cm, on which the cable will be laid. A further layer of H-125 concrete with a thickness of 10 cm will be deposited on top and a mechanical protection will be installed along the entire length of the cable, consisting of a 63 mm or 160 mm plastic tube.

Then, a 20 cm-thick layer of soil from the site is spread over and packed down by hand, ensuring that it does not contain stones or rubble. On this layer of soil and at a minimum distance from the ground of 10 to 30 cm, a signalling tape, is placed to warn about electrical cables presence. The operation is completed filling in with soil, which is then compacted by mechanical means.

All regulations and legal stipulations will be taken into consideration.

Pictures of the main trenches required, are shown below:

Figure 11. LV & MV cable trench

2.2.8.5 Plant buildings

Several facility buildings such as office building, residential building, guardhouse and warehouse has been preliminarily designed for this project. The switchgear and SCADA room will be prefabricated cabinets.

The office building will be a single floor concrete structure with area of about 374 square meter. As per the owner's requirements and the operation's needs, the following room must be configured in the office building. The floor plan of office building is shown in figure below.

-Control room

-offices

-Security office

-Meeting room

-First aid

-battery room

-metering room

-toilet with separate showers for male and female

-kitchen and dining room

-Pray room

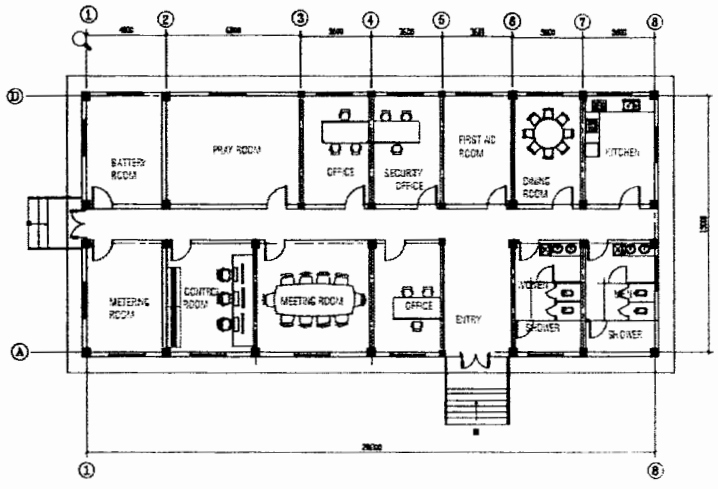


Figure 12. Office building floor plan

A guardhouse with automatic expansion gate will be configured for the substation for security guard to stay. The guardhouse will be a single store concrete frame. The size will be about 20m2.

Pumping room is also proposed for the substation. The proposed pumping room will be a single brick-concrete structure configured with a 10m3 fresh water tank、pump control screen、water purification system and all the other related equipment. The size will be around 50m2.

The floor plan of the guardhouse and pumping room is shown in figure below.

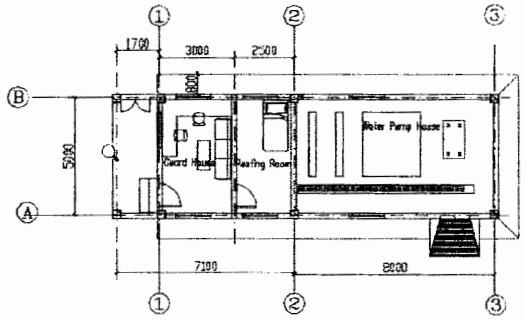


Figure 13. Guardhouse and pumping room floor plan

2.2.8.6 Fences and Main Gate

Around the perimeter of the site, we will supply and install all elements required for the 2 m high perimeter fencing with a 50 cm high anti-climb system using three rows of barbed wire.

As a main access we will supply and install a double swing gates made from heat galvanized conduits, according to local standards, for a frame with dimensions 4 x 2 m including hinges (8 in total), and security locks. The mounting posts should not allow the gates to become un-hinged. We will also install a pedestrian gate for a frame with dimensions 1 x 2 m.

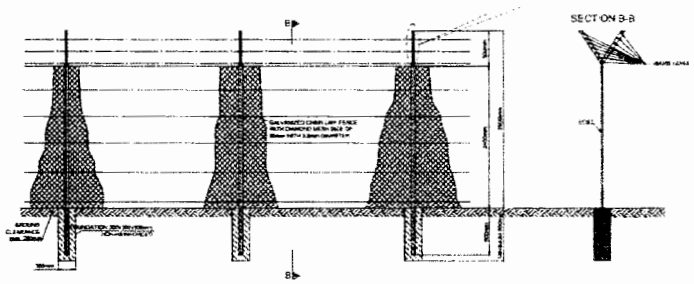


Figure 14. Perimeter fence

2.2.8.7 Roads.

Access road from the municipal road network to the power plant gate. The constitution of pavement profiles of access roads: 0.75m road shoulder + 6.0m carriageway + 0.75 road shoulder. Straight road camber is adopted on the cross section, the transverse slope of the road camber is 2.0%, Pavement structure: 150mm gravel surface course + 200mm soil aggregate base course,

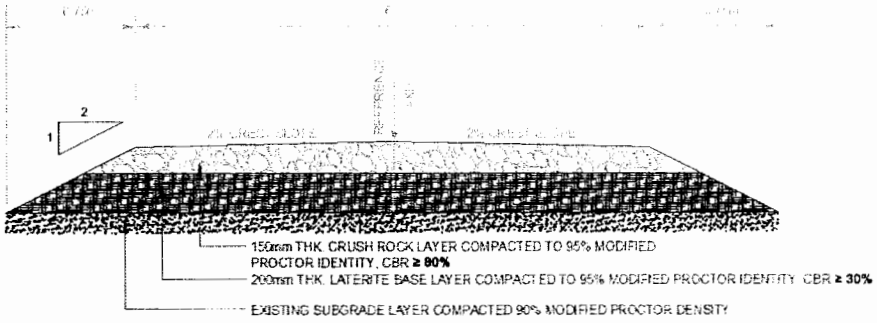


Figure 15. Access road

Internal road will be 5m wide with 0.75m shoulder on each side. The pavement structure will be the same as access road. Figure below shows the cross section of access road and internal road.

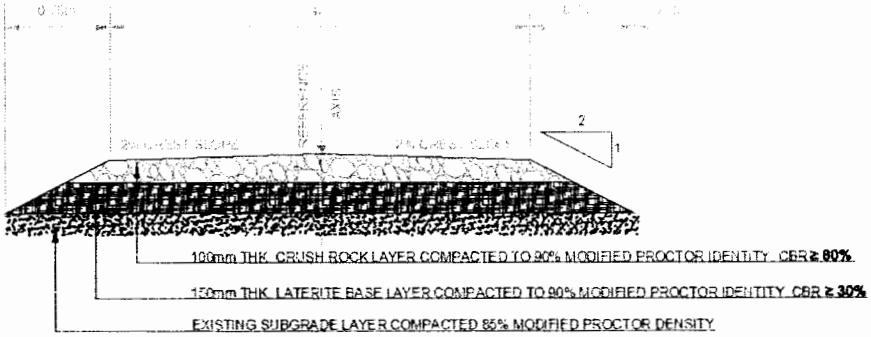


Figure 16. Internal road

2.2.8.8 Drainage System

For the drainage system design, it will ensure reasonable drainage and site tiling complying with the applicable laws, requirements of the relevant government entity and best practices, and resulting in to natural water outside rather than catchment within the site boundary. Storm water management and erosion control requirements will be taken into consideration when designing of the site grading.

In our proposal, the storm drainage system such drain ditch and detention pond will be provided and convenient for surface runoff draining away and temporary storage. Sloping roof design lead to drainage away from the equipment and buildings as well.

Surface drainage on site consist of overland, open channel, and trench flow. Drainage through a catch basin and underground pipe system are considered to provide in some areas to avoid trenches placing within these area, as may be required.

Culverts or trenches will be placed where roads cross storm drainage facilities. Wheel and crawler loads will be included in design loading conditions.

The retention ponds will be designed to retain water for a minimum of 1 day from the heaviest rainfall recorded in a 25 year history.

The drainage system of solar farm will be constructed to last for a minimum of 25 years. If an open ditch system is proposed, the open ditch will have a lining concrete, brick rip-rap, or others.

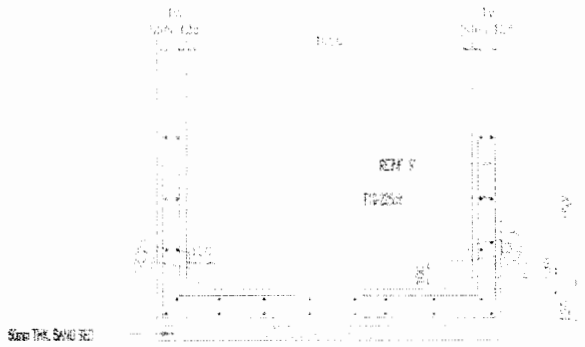


Figure 17. Typical drainage ditch section

2.2.8.9 Fire alarm and Fire protection

For control room, guest room, there will install two Dry Powder fire extinguishers, six Halogen fire extinguishers at the internal room and two 1m^3 fire sandbox outside the house. For invert room, it will set four Dry Powder fire extinguishers, four Halogen fire extinguishers at the internal room and two 1m^3 fire sandbox outside the house. For security room, it will set two Dry Powder fire extinguishers. The measure can be taken when fire emergency happens.

As per National Fire Protection Association (NFPA) standard, fire alarm and detection & fire-fighting system design must include, but not be limited to, fire alarm and detection & fire-fighting system.

It will classify possible flammable dangerous areas according to IEC standard, isolate the electrical equipment and the dangerous area, and use different fire control system based on specific area and the running characteristics of buildings from which are to be protected.

The number of times that the fire disaster happens in electrical plant at the same time should be considered for one time, the fire-fighting pattern will be mainly on chemical fire extinguisher, and set common used fire control instruments such as sandbox and sandbags. At the same time, it will adopt fire prevention measures and fire extinguishing measures according to different protection objection. The buildings in this project are mainly Booster station, complex building, transformer room, accessory occupancy, box-type transformer, box-type inverter room etc. It will adopt effective preventive measures on arranging, installation the fire equipment fire equipment at the place where potentially will happen fire disaster.

1) Design scheme of fire fighting

Removable chemical fire extinguisher

Centralized fire disaster auto alarm system

2) Fireproofing distance and fire lane between adjacent building

The fire lane must be setup in such manner that can meet transport, fire-fighting, maintenance and other requirements. In consideration of actual condition of power station, roads within power station is of mesh-shaped arrangement, with width of 3.6 m, at road end, there is T shape turning lane with turning radius of 6m, which meets the fire-fighting requirements.

When laying cable in cable trench exceeded 100 m, apply fire-proof material to local part of cable, Fire extinguisher for buildings (structures) of the project will be located at an prominent place and easy to reach without causing any emergency evacuation problem. Fire extinguishers of the same type provided at the same fire-fighting area will be selected as per the fire classes of power station and dry powder phosphate fire extinguisher will be selected.

The design calculation procedure of fire extinguisher:

a. Determine the type of fire disaster and hazard level of the field where fire extinguishers are installed;

b. Divide the calculation element and calculate the protective area of each calculation element;

c. Calculate the minimum firefighting grade in each element;

d. Determine the location and number of configuration fire extinguisher in each calculation element.

e. Calculate the minimum firefighting grade in each point.

f. Determine the type, the number, the size of the fire extinguisher at each point;

g. Determine the setting mode and requirement of each extinguisher.

h. Note the model, quantity, and location of each extinguisher as well as extinguisher legend in the drawings.

Automatic fire alarm system

The project will provide fire disaster automatic alarm system in key areas and set fire alarm detector in main control room, switching room, relay room, capacitor room, relay protection room, communication device cubicle. Moreover, we will set detection device (point type photoelectric smoke detector, manual alarm), fire alarm controller, intelligent monitoring control module, power supply devices and etc. near inverter station and step-up transformer. The alarm signal will be transmitted to fire alarm controller at the main control room via communication device. The installation of fire alarm system equipment should follow the codes.

			Protection Radius (R) and Protection Area (A)

Type of fire Detector	Ground area, S/m2	Ceiling heights h/m	Ceiling slope θ					
			θ≦15°		15°<θ≦30°		θ>30°	
			A/m²	R/m	A/m²	R/m	A/m²	R/m
Smoke detector	S≦80	h≦12	80	6.7	80	7.2	80	8
	S>80	6<h≦12	80	6.7	100	8	120	9.9
		h≦6	60	5.8	80	7.2	100	9
Heat detector	S≦30	h≦8	30	4.4	30	4.9	30	5.5
	S>30	h≦8	20	3.6	30	4.9	40	6.3

Protection Radius and Protection Area of smoke detector and heat detector

Installation height of detector, h/m	The distance from the lowest point of detector to the ceiling （d/mm）					
	Ceiling slope θ°					
	θ≦15°		15°<θ≦30°		θ>30°	
	Min.	Max.	Min.	Max.	Min.	Max.
h≦6	30	200	200	300	300	500
6< h≦8	70	250	250	400	400	600
8< h≦10	100	300	300	500	500	700
10< h≦12	150	350	350	600	600	800

The distance from the lowest point of detector to the ceiling

The smoke detector and heat detector will be installed following the requirements below:

a) The detector must be installed in the center of the ceiling.

b) The minimum distance from the detector to the wall or edge of the beam is 0.5m.

c) There must be no shelters within 0.5m around the detectors.

d) The minimum horizontal distance from detector to air-conditioning vents must be 1.5 m, and installed closely to the return-wind exit.

e) The detector should be installed horizontally. The slope should not be more than 45°if it has to be installed obliquely.

When there is fire alarm in inverter station, smoke detector or manual fire alarm will upload the signal to the monitoring modules via signal cable. After converting RS485 communication signal to optical signal via Ethernet/serial converter, the signal will be uploaded to the main control room and convert back to communication signal and finally uploaded to fire alarm controller which will send out siren and visual signal at once. After identifying the encode address of the detectors, the monitoring module would trigger the

alarm of specific inverter station and the operation crew would activate the firefighting equipment manually to put out the fire.

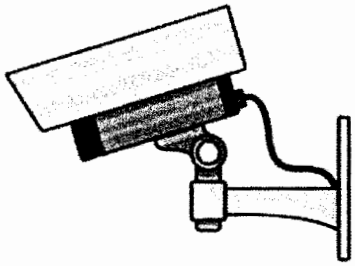
2.2.8.10 HVAC

In this project it will consider measures to prevent temperature fluctuation. So we suggest that air condition and ventilation system are used in this project. From the professional view, it needs keeping constant temperature and humidity in control room and electricity equipment room, so these room needs to install air condition and ventilation system. For inverter room, it only needs ventilation system according to heat loading. For administration office room, security room, guest room, guard room, it needs to set air condition to adjust the temperature and air flow.

2.2.8 Security System

A security system will be installed within the facility.

The perimeter security system consists on thermal cameras with video analysis. The whole system will be connected to an alarm center CRA.



The security system comply with the RFP or Technical Specification for Security and Surveillance System.

2.2.9 Workplace Health And Safety

All current standards regarding to health and safety in Pakistan, will be meet.

3 WARRANTY

3.1 Facility Warranties

The overall guarantee of the facility shall be two (2) years since its commissioning.

During this period, the breakdowns will be tried to be repaired at the installation site, if not possible it will be sent to the factory and the shipping costs are borne by the supplier.

The warranty will be void if the installation has been modified or removed by outsiders from TBEA, or received inadequate treatment.

Nor the damage due to natural causes (fire, lightning, floods, etc.), stealing or any circumstance out of the rational use of the systems is included.

Once the warranty period is ended TBEA will move the guarantee of the equipment to the Promoter.

3.2 Equipment Warranties

• Modules	12 Years product warranty on materials and workmanship and 25 Years performance warranty
• Civil Works and Structures	10 Years
• Inverter	5 Years
• Transformer	5 Years
• 35kV Switchgear	2 Years
• 132kV Switchgear	2 Years
• Junction Box(String Combiner Box)	2 Years
• AC Cable	2 Years
• Rest of BOM	2 Years

4 Appendix

Appendix 1 Technical Specification

Appendix 1.1 Pvsyst report QASP extension Chishtian Bahawalnagar

Appendix 1.2 PVSyst Calculation Parameters QASP extension Chishtian Bahawalnagar

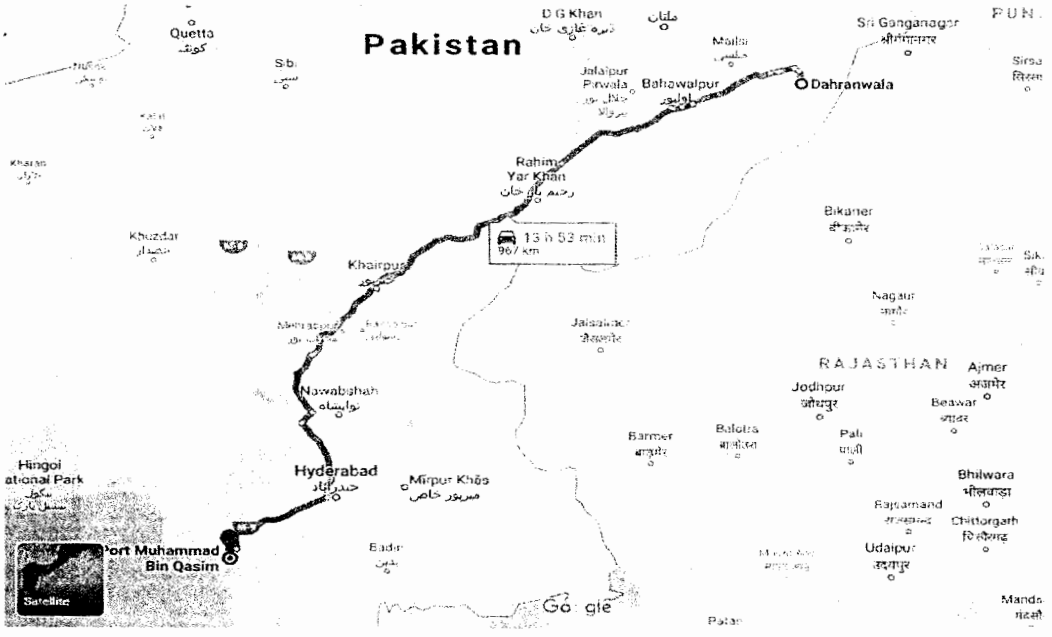
Appendix 1.3 Information on energy yield prediction

Appendix 1.4 Performance Guarantees

Appendix 1.5 Technical Deviations QASP extension Chishtian Bahawalnagar

Appendix 1.6 BOM QASP extension Chishtian Bahawalnagar

The site of Quaid-e-Azam Solar Park Extension in Chishtian Dharanwala is located at **29° 31' 368", 72° 50' 615"**the altitude is 150 meters above sea level. The approach to site is easily accessible through wide road,



The major track from Karachi port to Chishtian is multi-lane road and also linked through mainline Railways track. The terrain is flat in general. The Road track is flat and newly built and in excellent condition a very good option for site accessibility. Ariel distance of the port from the site is 860 kilometers. Total track length between Port Qasim and site is 967 kilometers. There are few bridges on the way from Bin Qasirn port to the site. The load bearing capacity of the bridges in between the site and the port is good considering track is already been used for heavy transportation therefore road conditions are reasonable for transportation of equipment. Over and above, the road

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conditions from Chishtian to the site, the load bearing capacity of culverts is also suitable enough for transportation to site

Staff Colony & Amenities:-

The proposed site development is inclusive of the necessary staff housing complex with a model school and a community hospital facility and potable water treatment plant as well..

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MdeCC

Solution de Energy

The Goldman Consortium

The IVY Company

Project Vehicle: **"Solution de Energy"**

Regulation 3(6) (A) (a) (9)

Expected COD from the date of allocation of Generation Licence

The project will require the following lead time required to reach project commissioning. From the date of issuing of Generation License:

Tariff Petition with NEPRA

Our local financial and legal consultants will then complete the tariff petition and file it with NEPRA for tariff approval. we expect the process will take approximately 3 weeks. This is dependent on any delays on part of NEPRA.

LOS
Once tariff is determined, our consultant shall approach for EPA with concerned purchaser CPPA and at the same time a tri-part agreement shall be signed between project vehicle NEPRA and PPDB for letter of support. Award of LOS depends on how long PPDB will take we expect this to take approximately 2 week. Once the LOS is awarded performance guarantee will be submitted to PPDB for financial close

6. Financial close Based on the approved tariff, Generation license and LOS our investment financing partner Total EREN France will present the project to Proparco France with equity already in place. This should take approximately 3 weeks.

EPA & Evacuation plan with MEPCO/CPPA
Getting the EPA with MEPCO/CPPA and inter connectivity on national grid will be largely dependent on the speed at which NTDC/CPPA work. We make sure that our

part of the job is done as quickly as possible. We expect this should be within 4 weeks after financial Close

8. Construction and Shipment Phase
Once we have been awarded generation license and the above mentioned milestones achieved we will start construction phase of the project. Shipment of the equipment will be in parallel with construction. We expect to
construct the site on fast track and should be completed in 16 weeks

. **Substation**
Substation construction will commence at beginning of the construction phase and this will take approximately 16 to 18 weeks in parallel with the plant construction.

.**Commercial Operation Date**

Commissioning of the project will then be approximately 35 weeks from date of award of generation licence subject to speed of government permissions.

EXECUTIVE SUMMARY

Name of the Project: **Feasibility Study of QASP at Cholistan: 100 MW Solar Project, Block A, near Chishtian, Bahawalnagar**

Consultants: **IVY Engineering Services (Pvt.) Limited**

1. Introduction

To cope with the growing global energy demands, present energy generation system needs to undergo a major transformation from fossil-fuel to renewable energy efficient technologies. In this regard global investment in clean energy generation is continuously increasing where solar power is amongst the top alternative energy generation option.

Cholistan Desert is the major potential site for solar power generation and Government of the Punjab has taken initiative to establish Quid-e-Azam Solar Park (QASP) to generate 1000 MWp. As per NTDC energy supply capacity, QASP is divided in many segments, like 300 MWp at Bahawalpur and the same at District Bahawalnagar. The proposed 100MWp Solar Power Plant near Chishtian, will be a photovoltaic power station and will be erected on the same footprint as planned for District Bahawalpur. As per Punjab's foreign investment policy, Solution de Energy (SVP) is a British company which is ready to invest for the construction of 100MW Solar Power Plant at Block-A.

This IEE study establishes various environmental and social impacts of the proposed project and devises mitigation measures for the adverse impacts accordingly if any, based on its size and location. This Project falls into environmental category C, which reflects that there will be no significant long term adverse impacts during foreseeable future.

MdeCC Private Limited is concept leader of the solar power generation in the deserts in Pakistan. This company has entrusted IVY Engineering Services (Pvt.) Limited to prepare Initial Environmental Examination (IEE) in accordance with the Punjab-EPA guidelines

2. Legal & Administrative Laws

Installation of the proposed power plant needs a detailed study and enactment of environment policy as well as the legal framework in accordance with the Pakistan Environmental Protection Act (PEPA, 2000) as basic legislation.

The further legislation and the laws/policy are also triggering due to this project viz. National Environment Policy (2005), Pakistan Labor Policy (2010), Punjab Environmental Protection Act (1997), National Environmental Quality Standards (NEQS), Cutting of Trees (Prohibition) Act (1975), Punjab Wildlife (Protection, Preservation, Conservation and Management) Act (1974), etc.

After the ratification of 18th amendment, the mandate of Federal Environment Protection Agencies (Pak-EPA) was devolved and all provincial EPAs of the country were empowered to treat the issuance of NOC for the development projects as provincial subject which carry out construction activities. This IEE report has been prepared with due concern of all legal requirements.

3. Approach and Methodology

Following is the approach and methodology for the execution of environmental examination:

- Collection and review of secondary information from various sources.
- Regulatory review was undertaken to understand the applicable, local and national legislation and regulatory frameworks.
- Criteria for CDM Projects was taken into account and considered.
- Studying Project and Study Areas as per environmental checklist and social survey questionnaires in order to collect detailed field information. Also environmental and social baseline information of the project area was collected.
- Discussion with the local communities and identification of key issues of the area.
- Gathering information on social aspects of the area, supplemented by consultations with the local communities to understand community perception regarding project and its activities.

The approach included:

- Stakeholder mapping and identification
- Focused group consultations with selected land losers and other Project Affected Persons (PAP).
- Data compilation and analysis.
- Assessment of impacts based on project activities and existing baseline status.
- Preparation of Environment and Social Management Plan

- Monitoring of Mitigation Measures

4. Project Description

Following are the key features of the Project:

Parameter	Feature
Nature of region	Desert
Project range	100 MWp
Solar energy producing zone New services establishment Overall terrestrial site for suggested project area	400 acres 100 acres 500-530 acres
Form of technology	Photovoltaic (PV)
Project completion time	Around 10 months
Grid connection	Chishtian Grid Station
Kind of apparatus to be used	Fixed installation type X-Si solar cells

5. Socio-Environmental Baseline Conditions

The area of Cholistan Desert is 480 km in length and between 32 and 192 km in breadth. Human and livestock population in the desert is 0.1 and 2.0 million, respectively. There is no river or canal flowing through the desert area. The main profession of the people in this area is livestock rearing. There are some sand dunes in small area but overall the area is plain with slopes.

The Cholistan Desert comprises of maximum wasteland which receives maximum solar radiation. Vicinity of project area is almost sandy & barren. A floristic survey of Cholistan desert was carried out during 2009-2011 and total of 38 families, 106 genera and 154 species were documented from the area. Among families, 33 families belonging to di-cotyledons, 79 genera and 115 species, while 38 species of 26 genera belong to 4 families of monocotyledons and 1 family of gymnosperms with 1 genus and 1 species.

There is lack of almost all social amenities in the settlements nearby, like hospital, post office, grocery shops, graveyards, electricity and public water supply, etc.

6. Environmental Impacts and Mitigation Strategies

This Chapter thus identifies the potential impacts due to the application of QASP 100 MW Solar PV Project on the physical, biological and social environment of Project area. The chapter also identifies measures that will help mitigate the Project's adverse environmental effects and enhance positive impacts.

To resolve or identify the main impacts, various practices can be used, but, their choices should be in such a way, to meet the suitability of circumstances.

These can be based upon:

- Professional judgment with adequate reasoning and supporting data. This technique requires high professional experience
- Experiments or tests. These can be expensive
- Past experience
- Numerical calculations & mathematical models. These can require a lot of data and competency in mathematical modeling without which hidden errors can arise
- Physical or visual analysis and detailed description is needed to present the impact
- Geographical information systems
- Risk assessment, and
- Economic valuation of environmental impacts

7. Environmental Management and Monitoring Plan

An environmental management and monitoring plan provides a delivery mechanism to address the potential environmental impacts of a Project during its construction and operational phases, to enhance project benefits and to introduce health and safety standards of good practice to be adopted for proposed Project.

This process requires proper monitoring to report any performance or any mitigation measurement during the construction and operational phases. The proponent will ensure the proper implementation of mitigation measures for the concerned operation and maintenance phase through adequate monitoring.

8. Stakeholder Consultation

Stakeholder consultations were carried out as part of the IEE study. The main objectives of the consultations were to:

- Disclose information about the proposed project, as well as, to apprise the stakeholders about the proposed Project activities;
- Obtain their views, concerns and recommendations; and
- Address/incorporate them in the Project design thus enhancing the environmental

and social performance of the Project.

On the basis of the consultations so far, it appears that the Project will have no insurmountable environmental and social impacts.

9. Conclusions and Recommendations

Specific social and environmental benefits have been mentioned in this report, which depend upon the strict compliance of the mitigation measures suggested in EMMP and best engineering practices.

The IEE Report of QASP 100MW Solar Power Project, Block A concludes that the Project is acceptable from an environmental perspective. Mitigation measures are taken into consideration and are enhanced in an Environmental Management Plan (EMP) to make final design, construction and operation of the Solar Power Plant.

- Since there will be side by side multiple construction activities by various Proponents, thus it is recommended that they should adopt an integrated construction and environmental approach.
- NOC will be issued by the rangers for the defence line dislocation.
- The Proponent should obtain an environmental approval (no objection certificate) from the Punjab-EPA before proceeding further into the construction activities.

1. INTRODUCTION

1.1 Background

Most of the countries on the globe have realized that the key to attaining and maintaining prosperity and sovereignty is having independence and self-reliance in access to energy. Major changes in the world's established energy supply systems are being driven by growing energy demands, energy security concerns, rising greenhouse gas emissions, local environmental issues, increasing oil prices, and international competition to lead in the emerging clean energy technologies.

To address the global challenges, the energy system needs to undergo a transformation from fossil-fuels to renewable energy and energy efficient technologies. Global investments in clean energy generation are continuing to increase and arguably the world is undergoing a clean energy revolution.

Pakistan is ideally located in the Sunbelt to take advantage of solar energy. This energy source is widely distributed and abundantly available in the country. The development and adaptation of solar energy technology, that is, to use both light and heat energy of sun to produce electricity can help reduce the short fall and meet the demands. Thus, the country has begun diversifying its energy producing capacity by investing in wind and solar energy parks to help offset the energy shortage.

In this regard Government of the Punjab has taken initiative for solar power generation, where major plan is to use Cholistan Desert for QASP1000 MWp. As per NTDC energy supply capacity, QASP is divided in many segments, like 300 MWp at Cholistan Desert near Bahawalpur and the same near Chishtian, District Bahawalnagar. The proposed 100MWp solar power plant near Chishtian will be a Photovoltaic (PV) Power Station and erected on the same footprint as planned for District Bahawalpur. As per Punjab's foreign investment policy, Solution de Energy is a British company which is ready to invest for 100MW Solar Power Plant at Block-A.

The Initial Environment Examination (IEE) report is prepared to initially assess potential impacts likely to occur from the Project's entire life cycle on the local environmental quality and communities. The assessment came up with a set of impact mitigation measures as well as monitoring programs for the Project to pursue in order to ensure minimize the adverse impacts on the environment and nearby communities.

1.2 Project Location, Nature and Size

The proposed site for the construction of QASP 100MW Solar Power Plant is located 33 km away from Chishtian District Bahawalnagar, a sub-division of Bahawalpur Division. The Project Area is situated at 150 meters above sea level.

Project site was selected by the Punjab Power Development Board (PPDB), Energy Department, Government of the Punjab, in view of availability of abundant land with adequate sunshine. Government of the Punjab (GOPb) has allocated 530 acres of land to the Client, MdeCC, which is allocated a name as 'Block-A), The location coordinates of the proposed project are given in Table 1.1:

Table 1.1: Coordinates Showing Project Location

Direction	North	East
Corner I	29.31.449	72.48.752
Corner II	29.31.368	72.48.959
Corner III	29.31.368	72.49.994
Corner IV	29.31.531	72.50.201
Corner V	29.31.857	72.50.201
Corner VI	29.31.857	72.49.994
Corner VII	29.31.857	72.48.752

The map showing Project area is given below as Figure 1.1.

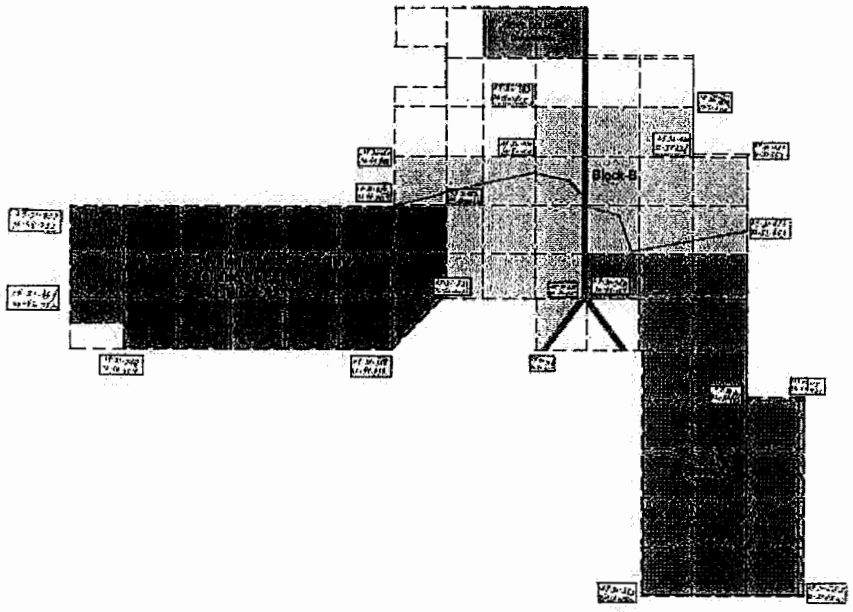


Figure 1.1: Proposed Project Area (Purple is Block-A)

1.3 Scope of the IEE Study

The scope of this study is based on various environmental and social impacts of the proposed Project and devises mitigation measures accordingly, based on its size and location. For this purpose; the published and unpublished data was collected for the assessment of the environmental conditions besides primary data collection from the field.

The environment team visited the proposed Project Area and adjoining Study Area to collect primary baseline data and to investigate physical, biological, and socio-economic conditions. In addition, meetings were held with the stakeholders and community members in the Project Area to collect primary information about the Project and recorded their views and concerns.

The ultimate objective of this study is to assess realistically whether or not the Project is environmentally manageable. This would make the Project environmentally sound and socially acceptable. Specific objectives of this study can be identified as follows:

- To collect the baseline data regarding physical, biological and social environment within the Project Area of influence (as discussed in Chapter 5).
- To carry out environmental assessment (physical, biological and socio-economic) of the proposed Project.
- To identify mitigation measures for any potential adverse environmental

impact.

- To carry out public consultation.
- To propose institutional responsibilities and methods of monitoring the mitigation measures and monitoring procedures.
- To prepare Environment Management Plan (EMP) for adverse environmental impacts.

1.4 Key features of Project

Following are key features of proposed QASP 100MW Solar PV Project at Block-A;

- The proposed project's location is one of the "hot and dry" places of Pakistan and comprises extreme weather conditions of hot desert.
- According to requirements of 100MWp Photovoltaic Power Plant, the land should be flat where the plant has to be installed. Therefore, the land of this proposed Project is flat and soil constituency is hard and sandy.
- The area is shadow free, there are no elements that create hurdle between direct sunlight and solar panels like mountains, large sand dunes etc.
- There is no village in Project Area, so resettlement issues do not exist.

1.5 Environmental Sensitivity of the Project

Solar energy technologies provide obvious environmental advantages as compared to other conventional energy resources, but, if it is used inappropriately, can also interfere with existing land uses, animals, burro management, military uses and mineral production.

Photovoltaic panels may contain hazardous materials, therefore as a safety measure, they are sealed under normal operating conditions; but if they are damaged or improperly disposed of, they can contaminate the environment.

This Project falls into environmental category C; which reflects that this Project has no long term significant adverse impacts. There may be some short term or temporary adverse impacts but they can be minimized with good engineering practices as recommended in this IEE.

1.6 Limitations of Study

In Pakistan, no regulations relevant to solar power are available with Environment Protection Agency (EPA). EPA regulations for thermal power may be used in this report being the closer ones.

The Pakistan Environment Protection Act (PEPA 2000) states that installation of below 200 MW project require IEE study before applying for environmental approval to Punjab-EPA. The environmentally benign nature of Solar Energy have ever compelled the Client to request the Consultants for carrying out an IEE study of "100MW Solar PV Project at Block-A" and the Proponent is not required to go for EIA study.

Professional judgment and subjective interpretation of facts has been applied for analysis of various aspects. All information and inferences presented herein are based on the details currently available as per the scope of work, information provided by the Client or its representative.

1.7 Purpose of the Report

The purpose of this IEE report is to examine and assess the environmental impacts of the proposed Projects and to devise mitigation measures for the expected impacts that are likely to occur during the construction and operational phases. The proposed Project must comply with both the EPA and PEPA regulations prior to issuing a permit for the proposed Project.

The main purpose of this IEE is to work closely with the Project engineers to ensure that the Project design reflects environmental sensitivities and meets the social needs of the beneficiaries and the people living in the surroundings.

1.8 Details of Consultant

IVY Engineering Services (Pvt.) Limited has prepared this final IEE as an Environmental and Social study on behalf of the project proponent in accordance with the Punjab-EPA guidelines.

The primary contact for IVY Consultant is:

Dr. Tahir Rashid (CEO)

168 H Commercial Area DHA Phase-I LAHORE

Phone: +92 423 7392661, +92 423 7392663

Fax: +92 423 7392662

Email: info@trc.org.pk

1.9 Details of Proponent

MdeCC – Project Vehicle for SVP (Solution de Energy) is the Proponent for the proposed QASP 100MWp Solar Photovolatic Project, Block-A, Chishtian, District Bahawalnagar. The contact detail for the proponent is given below:

IR Malik

Chief Executive Officer

M/s Solution de Energy (SVP) Project Developer MdeCC

Corporate Office; 96-A, Khiyaban-e-Iqbal 7,

Sector F-8/2, Islamabad

Phone: 03345255147

Email: irmalik@goldmanconsortium.com

2. LEGAL / REGULATORY FRAMEWORK

In this section, the environmental and social regulations are described which are applicable to the proposed solar power project.

Under Clause 12 of the Pakistan Protection Act 1997 (PEPA, 1997), it has been mentioned that it is mandatory to carry out an Initial Environment Examination (IEE) or Environment Impact Assessment (EIA) before the start of project.

There is no law/regulation relevant to solar energy generation on national level. But on international level; many laws/regulations prevail within their territorial boundaries. The relevant international laws are also discussed within this section.

In Pakistan Environment Protection Agency (Pak-EPA), there is no regulation mentioned in schedule I or schedule II (PEPA Regulations 2000) relevant to solar power generation. After the implementation of the 18th amendment that was passed in National Assembly in 2010, Pak-EPA was developed in provincial subjects hence Punjab-EPA is undergoing a process of amendments in PEPA Act 2000, in which solar and wind power will soon be added.

2.1 National Policies, Plans, Acts and Legislation

2.1.1 National Policy and Administration Framework

The Pakistan National Conservation Strategy (NCS), approved by the Federal Cabinet in March 1992, is the principal policy document on environmental issues. The NCS outlined the country's primary approach towards encouraging sustainable development, conserving natural resources, and improving efficiency in the use and management of resources. The NCS has specific programs in core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment. The core areas that are relevant in the context of the proposed project are pollution prevention and abatement, conserving biodiversity, supporting forestry and plantations.

The Government of Pakistan promulgated "Pakistan Environmental Protection Act (PEPA) in 1997. Two organizations, the Pakistan Environmental Protection Council (PEPC) and the Pak-EPA (now developed), are primarily responsible for administering the provisions of the Act at the federal level. The PEPC oversees the functioning of the Pak-EPA. Its members include representative of the government industry, non-governmental organization and the private sector. The Pak-EPA is required to ensure compliance of the

National Environmental Quality Standards (NEQS) and establish monitoring and evaluation systems. The Pak-EPA was authorized to delegate powers to its provincial counterparts, the provincial EPAs or EPD (Environmental Protection Department in Punjab), but the provinces are now conferred full authority after development. One of the functions delegated by the Pak-EPA to provincial EPAs/EPD is the review and approval of environmental assessment reports of projects undertaken in their respective jurisdictions.

2.1.2 Pakistan Environmental Protection Act, 1997

The Pakistan's Environmental Protection Act, 1997, empowers the Pak-EPA to:

- Delegate powers including those of environmental examination/ assessment to the provincial EPAs/ EPD
- Develop environmental emission standards for parameters such as air, water and noise pollutants
- Develop procedures for conducting IEE and procedures for the review and approval of the same
- Identify categories of the projects to which the environmental examination/ impact assessment provisions will apply
- To Develop plans for conducting IEE and procedures for the review and approval of the same
- Delegate powers including those of environmental examination/ assessment to the provincial EPAs/ EPD
- Implement the provisions of the Act through environmental protection orders and environmental tribunals which are headed by magistrates with wide-ranging powers, including the right to fine violators of the Act.
- Under the provisions of the 1997 Act, the Pak-EPA has authorized five provincial EPAs/ EPD (including AJK) for managing the environmental concerns of their respective provinces. The provincial EPAs/ EPD can frame environmental regulations tailored to the requirements of their province, provided these regulations meet or exceed the minimum standards set by the Pakistan EPA. They are also essential to review and approve IEEs/ EIAs of all the development projects.

2.1.3 National Environmental Quality Standards, (NEQS) 2000

The NEQS 2000 specify the following standards:

- Maximum allowable concentration of pollutants (32 parameters) in municipal

and liquid industrial effluents discharged to land waters, sewage treatment facilities, and the sea (three separate sets of numbers).

- Allowable noise levels from vehicles

2.2 Provincial Departments

It is the main responsibility of the provincial departments to affirm that the project complies with the laws and regulations controlling the environmental impacts at pre-construction conditions, operation and construction stages of the project.

2.2.1 Provincial Departments of Forest and Wildlife

When there is vegetation and trees on the proposed project area, the project contractor will be responsible to obtain the "No Objection certificate" (NOC) from provincial forest department. Application for NOC will need to be authorized by the Proponent.

As the construction is to be carried out in close proximity of protected forests and wildlife areas, the Proponent is required to coordinate with other departments to ensure that the impacts on flora and fauna species are minimized. Solution De Energy is the Proponent of the project and is responsible for receiving an approval for the environmental clearance from the Punjab-EPA.

2.2.2 Provincial Revenue Departments

Under the National laws, the matters relating to land acquisition and ownership are provincial subjects, and the Revenue Department of the concerned province is empowered to carry out the acquisition of private land and built-up property for public purposes, including on behalf of another Provincial or Federal Agencies. For those purposes, the lead department must lodge an application with the concerned provincial government to depute a Land Acquisition Collector (LAC) and revenue staff, which will be responsible for handling matters relating to land in case of any issue arise.

2.2.3 Punjab Environmental Protection Department

The Proponent will be responsible for providing the complete documentation required by the Punjab Environmental Protection Department and will remain committed to the approved project design. No deviation is permitted during the project implementation without the prior and explicit permission of the Punjab EPA/ EPD.

2.2.4 Agriculture and Horticulture Department

It also requires a liaison with the provincial departments of agriculture, horticulture and forestry in case of issues associated with these departments. The concerns could be relating to the affected vegetation resources, such as trees and crops. In case of some public buildings/ infrastructure is involved, Proponent will approach the building department for relocation/ assessment of compensation.

2.2.5 Coordination with District Government

The Project Proponent will coordinate with all concerned Government Departments and ensure that the project meets the criteria of District Government / Authorities as related to the establishment of construction camps and plants and the safe disposal of waste, solid waste and toxic material. Proponent will also ensure periodic monitoring of the EMP during both construction and operation period through deployment of an Environment Specialist.

2.3 Other Relevant Acts

2.3.1 Local Government Act 2001 and Amended in 2003

These ordinances, issued following the devolution process, establish regulations for land use, the conservation of natural vegetation, air, water, and land pollution, the disposal of solid waste and wastewater effluents, as well as matters related to public health and safety.

2.3.2 Punjab Wildlife Protection Act, 1974

The Punjab Wildlife Protection Act, 1974 was approved by the provincial assembly of Punjab in 1974. This Act is applicable to the whole of the Punjab province for protection, conservation, preservation and management of Wildlife. This Act also addresses designated areas of sanctuaries and protection of rare and endangered species.

2.3.3 Protection of Trees and Brushwood Act, 1979

This Act forbids cutting or lopping of trees and brushwood without permission of the concerned Forest Department and demands a NOC from Forest Department before cutting of trees.

2.3.4 Clean Air Act, (1990)

This law sets the release of pollutants into the air. It sets standards for air quality and to enforce regulations to protect the environment from airborne pollutants, which are known to be dangerous to human health.

2.3.5 Migratory Bird Treaty Act (MBTA)

The Migratory Bird Treaty Act of 1918 (MBTA), is a United States federal law, which was first enacted in 1916. The act makes it unlawful without a waiver to pursue, hunt, take, capture, kill or sell birds as listed therein ("migratory birds"). The statute does not discriminate between live or dead birds and also grants full protection to any bird parts including feathers, eggs and nests.

2.3.6 Land Acquisition Act, 1894

The land acquisition act was established in 1984 which is implemented to fulfil the needs of government and companies for land required by them for their projects, and to determine pay and compensation to those private persons or bodies whose land is to be acquired. The Land Acquisition Act is limited to a cash compensation policy for the land acquisition and built-up property, and damage to other assets such as crops, trees and infrastructure. The LAA does not take into account the rehabilitation and settlement of displaced population and restoration of their livelihoods. In addition to that LAA only allows comparative to legal titleholders of the land and does not speak about the squatters illegal occupants. Presently, the requisite land for the proposed project is already owned by the project Proponent, as such no additional private or government land will need to be acquired for the project.

2.4 Applicable World Bank Policies

The World Bank's environmental and social safeguard policies (ten of them) are a cornerstone of its support to sustainable poverty reduction. The objective of these policies is to prevent and mitigate undue harm to people and the environment in the development process. These policies provide guidelines for the identification, preparation, and implementation of programs and projects.

2.4.1 Procedure for Environmental Approval

This section describes the procedures required for obtaining NOCs for IEE from concerned authorities. The following general stages have to be followed in the application

and approval process for obtaining an "Environmental Approval" for the 50MW Solar Power Project, Siddique Sons Rawalpindi.

a) Classification of the Project
b) Submission of IEE; and
c) Issuance of NOC

Detailed process for obtaining NOC according to PEPA-1997 is as follows;

a. Classification of the Project

The proposed project requires an IEE in accordance with Schedule-I of PEPA-1997. According to the TOR / Scope of Work of the 100MW Solar Power Project, Block A Chishtian Pakistan. Consultants are required to prepare the IEE and to assist in obtaining NOC from EPD Punjab.

b. Submission of IEE

Under Section 12 of the PEPA 1997, a project falling under any category specified in Schedule-I, requires the proponent to file an IEE with the Federal EPA or provincial agency for obtaining the NOC. After preparation of IEE report, eight hard copies and two electronic copies are needed to be submitted to the concerned agencies along with completed Schedule IV form and a non-refundable review fee. In case of the proposed Project, EPD Punjab based in Lahore will be the main government agency responsible for the issuance of an NOC.

c. Issuance of NOC

Within ten working days of the filling of the IEE; the concerned agencies will confirm that the document submitted is complete for the purpose of review. During this time, should the concerned agency require the proponent to submit any additional information, it will return the IEE to the proponent for revision, clearly listing those aspects that need further discussion. Subsequently, the concerned agency should make every effort to complete an IEE review within 45 days of filing and finally decision on IEE shall be communicated to the proponent in the form prescribed in Schedule V. In case of approval, conditional NOC having validity of three years will be issued. The NOC process for IEE is given below in Table 2.2:

Table 2.2: IEE Approval Process

Category	Description
Project Phase	Detailed Design
Approving Authority	Environment Protection Department Punjab
Applicable Legislation	Pakistan Environmental Protection Act, 1997
Application File Prepared by	Solution De Energy assisted by IVY Engineering Services (Pvt.) Limited
Project Title	Construction of 100 MW Solar Power Project, Chishtian
Timeframe	Approx. 10 months
Pertinent Regulatory Steps	
Submission of IEE	• Review fee as per rates in Schedule III • Filled Application form (Schedule IV) • IEE Report (08 hard copies and 02 electronic copies)
Decision on IEE	• Decision communicated to proponent in form prescribed in Schedule V • In case of approval, Issuance of NOC

3. APPROACH AND METHODOLOGY

Environmental impact study is a formal procedure for investigating, analysing and presenting the environmental implication of a proposed development and identifying mitigation measures required to trim down the adverse of environmental impacts by taking it to acceptable levels. In so much that Initial Environmental Examination (IEE) shall have to be carried out to ensure issues associated with the project foreseen and potential benefits brought to light prior to implementation in an objective way, considering regional development issues, as well as legislative and institutional aspects.

The consultant is required conducting IEE study based upon approved Terms of Reference, objectives and guidelines for preparing IEE Report are mentioned in the succeeding sub-sections.

The IEE methodology follows the conventional methods that meet the minimum Punjab EPA requirements in particular, as well as fulfils the IFC's guidelines in general, on social and environmental sustainability standards and policies.

3.1 Adopted Procedure

The IEE approach, methodology and procedure were generally followed according to the provisions of the EPA, 1997. Data collection process was completed from 13th to 14 September, 2015 by the consultant team.

- Desk Analysis
- Collection and review of secondary sources of information
- Preparation of Project Specific Checklist
- Field Survey
- Public Consultation
- Compiling and collection of Existing Information and Impact Identification
- Monitoring Plan and Mitigation Measures
- Collection of Laboratory Samples
- Conclusion and Recommendations

3.2 Survey of the Proposed Project Area

A multi-disciplinary team visited the project area for updating/verification of the baseline information on physical, biological, socio-economic and cultural environment of the

proposed Project, to evaluate the anticipated environmental impacts and propose the practical mitigation measures.

Following team of professionals were responsible for data collection, field study, analysis and report writing:

1. Malik Muhammad Qasim, Chief of Environment Section, supervised the field team in Cholistan desert and guided them to use correct methodology of data collection process.

2. Engr. Rebab Maria Mehmood, Environmental Engineer, recorded ground truths through structured questionnaires and also helped out other team members in record keeping.

3. Bushra Siddique, Environmental Specialist, conducted detailed field surveys; she explained the environmental monitoring results of the laboratory and discussed accordingly.

4. **Ziaur Rehman, Environmentalist** completed the environmental checklists of the Project Area and prepared 'ecological environment, part of IEE report.

5. Ms. Shazia Ehsan, Senior Sociologist provided the details of the land acquisition record as prepared by the design team of the Consultant. Major emphasizes was on the status of the affected families for their resettlement options.

6. Rozeena Latif Khan, Integrated Communication Specialist, participated in field work, received and discussed the existing drawings to build a census among the team members, also helped out other team members in record keeping and photo-banking.

7. Muhammad Arshad, Sociologist, designed socio-economic questionnaires and conducted focus group discussions and social survey which included identification of proposed sites and study area.

8. Hafiz Muhamad Farhan, Enumerator, supported report formatting and also helped out other team members in record keeping, recording of coordinates of different physical inventory and keeping records for photo-banking.

3.3 Public Consultation and Information Disclosure

In order to ensure the public involvement, the following procedures were followed during IEE report preparation:

- IEE team interacted with local communities and related stakeholders during field surveys to collect the public concerns and suggestions.
- Information about the proposed project was disseminated through person to person contacts, interviews and group discussions as a part of mandatory public disclosure. The approved IEE report by the Punjab-EPA will be accessible to interested parties and general public from the following quarters:
    1. MdeCC Head Office, Islamabad
    2. IVY Engineering Services (Pvt.) Limited, Lahore
    3. Punjab Environment Protection Agency (Punjab-EPA), Lahore

3.4 Mitigation Measures and Monitoring Plan

Based upon the identified impacts their nature, extent and magnitude, the mitigation and monitoring prescriptions were developed. A realistic approach was applied for the application of the mitigation measures in the local context. Environmental monitoring plan was developed to assess the effectiveness of the mitigation measures and implementation status.

3.5 The Final Report

The IEE report was prepared by untiring efforts of above mentioned study team. After reviewing the final IEE report according to TOR, it was submitted to Environment Protection Department through client for approval.

4. Project Description

This Chapter provides an overview of the proposed Project, its associated components, design considerations, construction procedures, and operation and maintenance activities. The Project alternatives are also discussed within this chapter.

4.1 Project Clarification

Pakistan's existing resources are not enough to fulfill the needs of rapidly growing population and therefore have the negative impact on economic condition of the country. The requirement of sufficient and reliable energy source to carry out the domestic and socio-economic activities is inevitable. For this purpose, the installation of Quaid-e-Azam Solar Park Project will fulfill those electricity requirements; yet it is the best energy solution for this electricity deficient country.

4.2 Important Nominal Characteristics of the Project

The proposed "100MW Solar PV Plant at Block A" Project which will cover the area about 500 acre. This planned Project would be completely equipped with all the obligatory things including solar energy producing apparatus, a switching place, a specialist care and repairs facility, a Project substation and all arrangements including barrier and access road expansion, after that the powerhouse divisions will be established at ground level. This solar park would be the combination of several PV components which will be fixed at steel type supportive constructions often known as tables. In which the topography will play the important role because it will change the distance from ground level to PV unit's tables. The PV modules would be electrically associated by electric wiring harnesses running alongside the lowermost side of each table to combiner boxes that receive power from various rows of segments. By means of underground cables DC command would be given to the combiner boxes from the units to the local grid.

A number of the important characteristics of suggested Project to be installed at Cholistan desert are given in Table 4.1.

Table 4.1: Important Characteristics of the Project

Parameter	Feature
Nature of region	Desert
Project range	100 MWp
Solar energy producing zone New services establishment Overall terrestrial site for suggested project area	400 acres 100 acres 500 acres
Form of technology	Photovoltaic (PV)
Project finishing point	Around 10 months
Transportation arrangement	Chishtian Grid Station
Kind of apparatus to be used	Fixed installation type X-Si solar cells

4.3 Cost and Magnitude of Operation

Cost of the proposed project is 18 billion and it will take 1 year duration for its initial stages to end production stage. World's largest ten countries that produce electricity from sun with their solar energy production capacity are given below.

Table 4.2 Top Solar Energy Producing Countries

Country Name	Capacity (GW)
Germany	38.2
China	18.3
Italy	17.6
Japan	13.6
United State	12
Spain	5.6
France	4.6
Australia	3.3
Belgium	3.0
United Kingdom	2.9

Worldwide growth of photovoltaic is extremely dynamic and varies strongly by country. By the end of 2014, cumulative photovoltaic capacity increased by more than 40 Giga Watt (GW) and reached at least 178 GW, sufficient to supply 1 percent of the world's total electricity consumption of currently 18,400 TWh. As in the year before, the top installers of 2014 were China, followed by Japan and the United States, while the United Kingdom emerged as new European leader ahead of Germany and France. Germany remains for one more year the world's largest producer of solar power with an overall installed capacity of 38.2 GW. The newcomers of the year were Chile and South Africa, which entered straight into the world's

Top 10 ranking of added capacity. There are now 20 countries around the world with a cumulative PV capacity of more than one Giga-Watt. Thailand, the Netherlands, and Switzerland, all crossed the one Giga-Watt-mark in 2014. The available solar PV capacity in Italy, Germany and Greece is now sufficient to supply between 7% and 8% of their respective domestic electricity consumption.

4.4 Schedule of Implementation

Table 4.3 Timeline for Construction of Project

S#	Activity	Month											
		2W	1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M
1	Detailed Designing												
2	Mobilization of Contractors												
3	Plant Construction Period												
4	Peak Construction Period												
5	Restoration of Site												
6	Commissioning												*

4.5 Appropriate Information of PV Solar Energy Technology

During the daylight various PV units receive 80% of sunlight from the sun round and PV technology converts this solar radiation into DC electricity. The absorbed sunlight energy is transferred to electrons in the atoms of the PV cell. With their fresh originated energy; these electrons outflow from their ordinary sites in the atoms of the semiconductor PV material becomes the part of the electrical flow, or current, in an electrical route. Figure 4.1 shows the flowchart of Photo Voltaic electric power generation. This gives a true image of the current Project that how it would produce electrical energy and distribute it to the national grid.

4.6 Inquiry of Substitutes

This segment represents the idea of substitute's inquiry for the proposed solar power Project. The following scenarios have been considered:

- Substitute Approaches of power production;
- No project Development;
- Alternative Site for the proposed project.

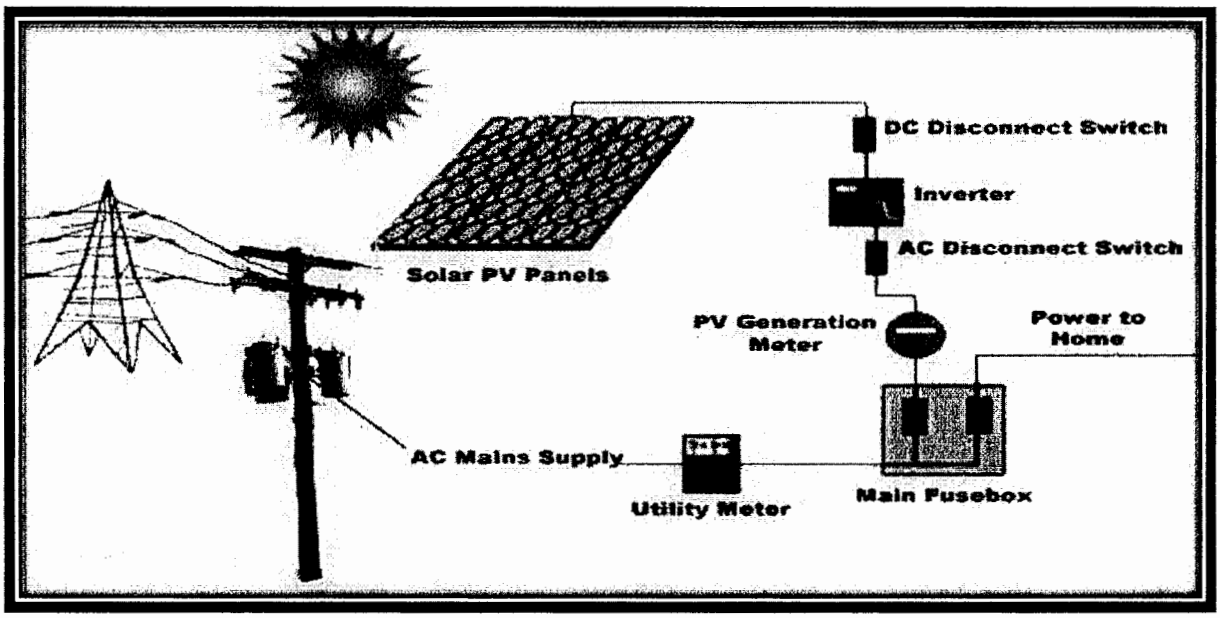


Figure 4.1: PV Technology Schematic Diagram

4.6.1 Substitute Approaches of Power Generation

Solar energy:

It is nonpolluting and most plentiful source of energy production; introduced from last 15-30 years.

Merits:

- This method of energy production is considered first extraordinary investment reliant on sunny weather condition.
- No gaseous or liquid emissions are generated.

Demerits:

Solar energy production needs extra energy to operate in less sunny areas.

b. Wind energy:

This energy source is renewable energy source, affordable, having relatively high output and little impacts on ecosystem.

Merits and Demerits:

- Output is proportional to wind speed.
- This method is not feasible for all geographic locations.
- High initial investment and on-going maintenance costs as well. This method requires extensive land use.
- No gaseous or liquid emissions are generated.

c. Hydro-Power:

This energy source is also renewable source of energy production.

Merits:

- It is Reliable, capable of generating large amounts of power.
- Output from this source can be regulated to meet the demand.
- No gaseous or liquid emissions are generated.

Demerits:

- It produces Environmental impacts by changing the environment in the dam areas.
- Hydroelectric dams are expensive to build.
- Dams may be affected by drought Potential for floods.

d. Natural Gas:

Currently, natural gas is widely being used as a source of energy production in our country.

Merits:

- Cleanest-burning fossil fuel.
- Often used in combination with other fuels to decrease pollution in electricity generation.
- Made safe by adding artificial odor so that people can easily smell the gas in case of a leakage.

Demerits:

- Transportation costs are high.
- Lack of infrastructure makes gas resources unavailable from some areas.
- Burns cleanly, but still has emissions.
- Pipelines spread for transportation can impact on ecosystems.

e. Petroleum:

It is efficient transportation fuel for the entire world.

Merits:

- Basis of many products, from prescription drugs to plastics.
- Economical to produce and easy to transport.

Demerits:

- High CO^2 emissions production.
- Found in limited areas.
- Supply may be exhausted before natural gas/coal resources.
- Possible environmental impact from drilling and transportation.

f. Biomass:

It is readily available energy producing source because of abundant supply.

Merits:

- Fewer emissions than fossil fuel sources.
- It can be used in diesel engines.
- Auto engines can be easily converted to run on biomass fuel.

Demerits:

- It emits some pollution as gas/liquid waste.
- It can increases emissions of nitrogen oxides which is an air pollutant and can deteriorate air quality.
- It is little bit costly, regarding, uses of some fossil fuels in conversion purposes.

g. Coal:

One of the abundant sources of energy production.

Merits:

- Currently inexpensive to extract.
- It is Reliable and capable of generating large amounts of power.

Demerits:

- It emits major greenhouse gases/acid rain.
- High environmental impact from mining and burning, although cleaner coal-burning technology is being developed.
- Mining can be dangerous for miners.

h. Uranium:

Merits:

- This process does not lead to greenhouse gases or CO_2 emissions.
- Efficient at transforming energy into electricity.
- Uranium reserves are abundant.
- Refueled on yearly basis (unlike coal plants that need trainloads of coal every day)

Demerits:

- Higher capital costs due to safety, emergency, containment, radioactive waste, and storage systems.
- Problem of long-term storage of radioactive waste.
- Heated waste water from nuclear plants harms aquatic life.
- Potential nuclear proliferation issues.

i. Geothermal

Merits:

- It produces minimum environmental impacts.
- Power plants have low emissions.
- Low cost after the initial investment.

Demerits:

- Geothermal fields found in few areas around the world.

- Expensive start-up costs.
- Wells could eventually be depleted.

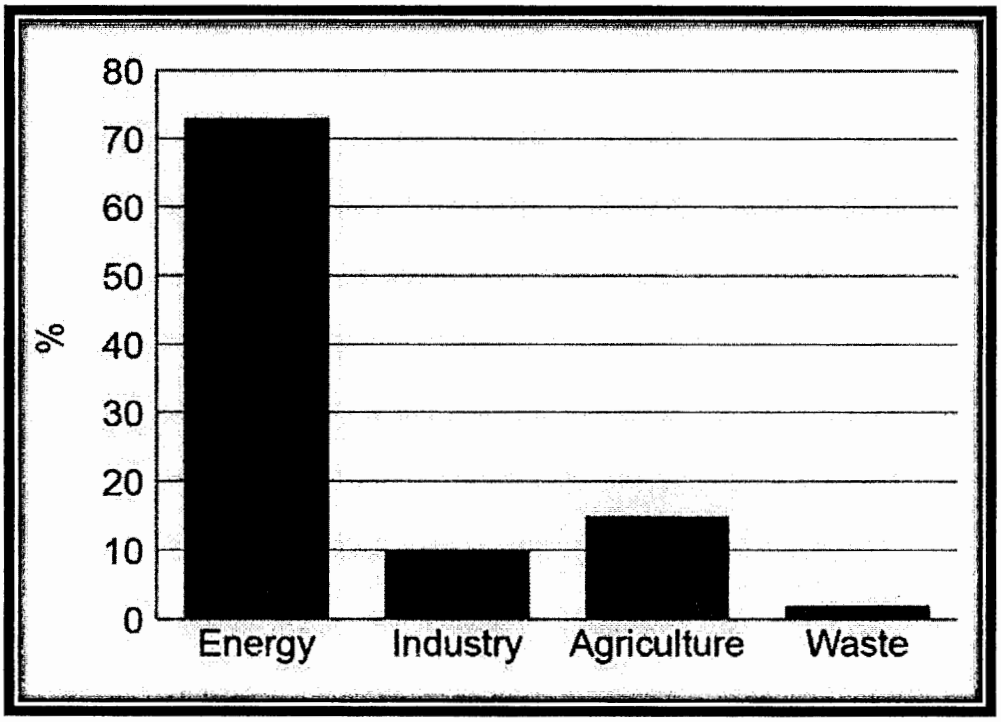


Figure 4.4: Comparison of GHG emission from different sources

4.6.2 No Project Option

Pakistan is situated in the equatorial sun belt of the earth, thus getting plentiful solar energy. In Pakistan, solar radiation and daily sun light duration is observed through Meteorological Department of Pakistan. Being a part of good climatic zone, our country is facing about 250 to 300 days a year. Pakistan receives 16-21 MJ/m2 per day of solar radiation as an annual mean value, with 19 MJ/m2 per day over most areas of the country.

The annual average values of sunlight interval fall between 8 to 10 hours per day around the country, excluding northern areas. The present power source scenario clearly reflects the obvious shortfall in supply. So, there is need for new method to solve this demand and supply issue. For this purpose we need to increase renewable/ non- conventional sources of power over conventional sources. That's why the current Project is related to the non-conventional sources to overcome the shortfall in the country.

Government of Pakistan is trying hard to tackle the power shortages and is consuming all existing energy producing means. Therefore, many other projects including nuclear, thermal,

coal and renewable energy producing projects are in running phase to fulfill the country's demand. Keeping in view this condition, the "No Project Option" will further deplore the power crisis of the country. Therefore, No "Project Option: is not considered.

4.6.3 Alternative Site of the Proposed Project

Solar power projects are supposed to environment friendly, energy generation projects that are totally dependent upon the accessibility of adequate solar energy. In Pakistan, the most areas especially the Southern Punjab receive maximum solar radiation due to extremely hot and dry weather conditions. The Project promoter has passed out evaluation studies in order to recognize the power generation capacity of different locations. The following supplementary criteria have been measured for site selection:

- The sites should be situated away from main settlements.
- The sites do not fall under any reserved or protected forests;
- The land, acquired for the locations, contains income property which was not used by the communal for any purpose;
- No environmental profound types such as water bodies, forests, and archaeological sites are found in the close site environs.

4.6.4 Alternate Technology for Project

Many types of solar sections are used for producing solar energy but planned project intends to use Thin Film PV technology due to multiple reasons. The Large scale production of thin film solar panels are less complicated than crystalline based PV cells. They are cheaper as compared to other mono crystalline PV / Solar panels. The uniform appearance of thin film solar panels are more attractive and can be used for beautification purpose as well. It has high temperature tolerance, i.e. high temperature and shading have less impact on thin film solar panels. Therefore Thin Film Technology is preferred over other alternates.

4.7 Construction Features

4.7.1 Contractor's Conveniences

It will be contractor's responsibility to provide all the facilities for machinery, labor and vehicle etc. It is predicted that here is huge area found for the contractor nearby the planned site without alarming any native, ecosystem or the substructure.

4.7.2 Work Force

It is estimated that the skillful control will be involved in manufacturing and fixing things during construction phases of the project. The analysis of the staff power during normal and highest construction points is estimated as 300 and 600, respectively.

4.7.3 Edifice Material and Conveyance

All the solar panels will be established on steel bars that are stable in the ground. Likewise, other building material will also be used to form associated arrangements like office, supply room, entertainment site, switchyard, etc. using mounted building technology. The mounted configuration will consist of reinforced cement concrete (RCC) by means of mostly steel, cement, sand, cumulative for construction purposes.

The movement of construction machinery/vehicles in the Project area is difficult due to unpaved earthen tracks. The pathways cannot bear the load of heavy machinery/vehicles; therefore, movement will be restricted in rainy days.

4.8 Restoration and Rehabilitation Plan

After completion of the construction work all the disturbed sites will be changed into conditions as they were prior to the commencement of the project or better than that. The area will be planted with indigenous vegetation and all the access roads will be broken in the strategic places so that it can no longer be used. All the concrete will be broken and disposed of according to the waste disposal plan. The fences will be removed, the borrow areas leveled and top soil restored separately after the construction.

4.9 Site Waste Management Plan

All construction projects must have a site waste management plan (SWMP) which explains how construction waste is handled by following the law on managing waste. The project Contractor should not start construction work until they have an approved SWMP in place. It must contain a response to the following questions:

- What kind of waste will be produced by the site
- How to ensure the waste disposal, e.g. reuse, recycle, landfill, etc.
- How many waste carriers are required and the supply
- The address and environmental permission of the site, where the waste is being sent

4.10 Government approvals

Approvals from all the concerned departments like PBDB, Revenue, CAA, Forest, Agriculture, livestock and Irrigation will be provided by the client. NOC from Environment Department has been issued already for this project on another site. For details please refer to Annex I

4.11 Road Access Plan

Kindly refer to Road Access Plan in Annex F

5. ENVIRONMENTAL & SOCIAL BASELINE CONDITIONS

This chapter gives an overview of the prevailing environmental and social baseline conditions of the proposed Project. The information has been compiled from primary and secondary resources.

Cholistan desert spreads over an area of 26000 km^2 in the southern part of Punjab province and includes the districts of Bahawalpur, Rahim-Yar-Khan and Bahawalnagar. It is located at an elevation of 89 meters above sea level. Its coordinates are 28°15'0" N and 70°45'0" E in DMS (Degrees Minutes Seconds) or 28.25 and 70.75 (in decimal degrees). Towards the Eastern flanks, Cholistan extends into the Indian states of Rajhistan and Punjab and joins the greater Thar Desert.

5.1 Study Area

An area within around the project can be considered as influence zone and hence it has been taken as study area to collect the primary data related to physical, biological and socio-economic environment.

5.2 Data Source

Prior to the detailed site investigations (survey findings), it was important to overview the relevant previous studies. The previous reports/studies that have been reviewed to ascertain their applicability in the prevailing conditions of Project area are:

- Topographical map of Survey General of Pakistan,

5.3 Geology

One of the important geological features of the Cholistan is the old Hakra River, which is dried out about 600 years ago. The Hakra riverbed forms the dividing line between the two eco-regions of the desert. The Lesser part forms the Northern portion of the desert margin and includes areas North of the Hakra along the bank of the Sutluj River, while the Greater part is found to the South of the riverbed. The Greater Cholistan extends from the most recent course of the extinct Hakra River to the border with India. As such there is no major geology features. Topography, soil type and texture, and vegetation structure divide this desert into two distinct regions: the Northern region (Lesser Cholistan) covers about 7,770 km2 and the Southern region (Greater Cholistan) about 18,130 km2.

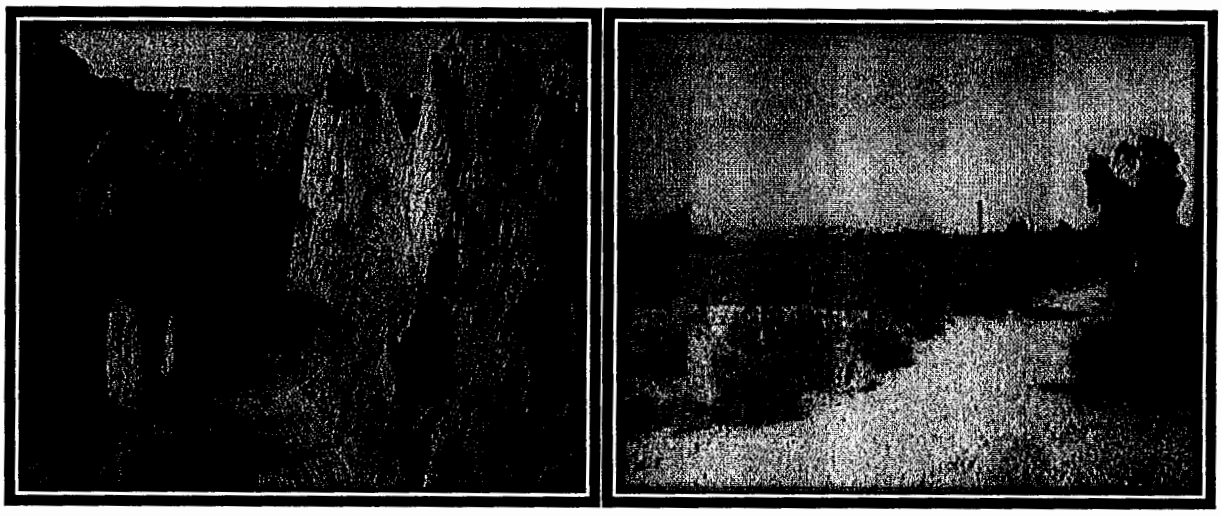


Figure 5.1 Geology of Cholistan

5.4 Water

The population of the area is 0.155 million and there is 1.5 million livestock. Ground water is mostly brackish and main source of drinking water is rain water that is stored in Tubas and kinds. Since 2005, four water supply pipelines were laid. The standard of drinkable water is gradually on decline in Bahawalnagar and its outskirts and citizens are facing threat of harmful diseases. To this effect, the Punjab government has been initiating efforts to supply potable water to Bahawalnagar City and Chishtian through pipeline. The IUB is also ready to cooperate with public and private sector organizations in all aspects.

Rainwater is harvested in low-lying areas or dug-out ponds (Tobas) are used by the human and their livestock. Underground water is mostly brackish containing salts (9000 - 24000 mg/l). Unpredictable rainfalls support only leafless and spiny scrub jungle with stunted and half nibbled shrubs with a few trees. These plant species, though very slow growing, respond very well to the favorable climatic conditions and provide ample biomass for consumption by livestock and wildlife. The average annual rainfall in the desert ranges from 100 to 200 mm. Consequently, freshwater availability is very limited. There are no perennial or ephemeral streams, and most of the groundwater is saline with a medium to high range of dissolved solids that make it generally unfit for drinking. To make the best use of this potential, the herders have found ponds known locally as tubas. These store runoff water for use during the dry periods. Harvested rainwater is also stored for household use in large circular or

rectangular tanks called kinds.

Samples of Drinking water were taken from the proposed project area. Chemical analysis of the samples is being done by GEL laboratory and the detailed result in Annex-D. Groundwater is potable and quality of surface water is good. Owner of surface water body and its existing use is government. No herbicides/chemicals are present in water pollution sources, and no grey water reuse. Storm water drains are available, good quality of water is not available. There is no impervious area and no permits are required for maintenance works etc. Aquatic ecosystem is canal system and wheat and cotton is mainly cultivated.

5.5 Soil

The soils of Cholistan desert are generally poor, lacking organic matter, saline alkaline, gypsiferous and often duned. The dune reaches up to an average height of 100-150 m. Soil analysis was conducted in the Analytical chemistry laboratory of the Department of Chemistry, the Islamia University of Bahawalpur, Pakistan. Soil pH, electrical conductivity, total nitrogen, organic matter, sulphur, phosphorus, carbonates, bicarbonates and exchangeable cautions, i.e., sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) contents were determined by using standard procedures (Anon., 1984). Each analysis was done in triplicate to verify the results and averages were used for further steps. The topography and levels of area with its surroundings are sandy clay. There are no wetland/marshes

5.6 Land Use

The proposed Project area is Government wasteland. There are few shrub thickets near the Project site. There are few settlements near Project site. There is a defense line in this project area which will be relocated to somewhere else. The area of Cholistan Desert is 2.6 million. The desert measures 480 km in length and between 32 and 192 km in breadth. Human and livestock population in the desert is 0.1 and 2.0 million, respectively. There is no river or canal flowing through the desert area. The main profession in the area is livestock rearing. Agricultural farming is not practiced due to unavailability of irrigation water and low rainfall. More than 81% of the desert is under small and big sand dunes, while 19% consists of alluvial flats and sand hummocks. The soil is sandy which is porous comprising of more of gravel and less silt and clay content. There are some sand dunes in small area. Overall the

area is plain with gentle slope. The Cholistan Desert comprises maximum wasteland which is essentially desert area in the country as well as highest solar radiation. Vicinity of project area is almost sandy & barren .The area is affected by severe to very severe desertification due to poor vegetation cover, severe wind, erosion and very severe soil salinity. After desertification, the area is now under forest trees, orchard of grafted zizyphus and date palm, fodder crops and grassland grown with collected rainwater and saline groundwater. Now the area is fully secured from desertification and its micro-climate has been transformed into pleasant and friendly environment.

Climate

It is a hot and sandy desert with a mean annual rainfall of 100 to 250 mm usually during the monsoon season (July through September) and winter and spring (January through March). The mean temperature of the winter is 6.6oC (December and January) and the mean of the summer is 46.5oC, soaring up to 51oC. Aridity is the most striking feature of this desert with wet and dry years occurring in clusters. Wind and storms are uncommon during the summer. The surface of this desert consists of a succession of sand dunes, rising in places to a height of 150 meters. It is covered with the vegetation peculiar to the sandy tracts

5.7 Air Quality

Ambient air of the Project area is clean and there is no noise pollution at present because of no anthropogenic, industrial or other source of air pollution existing in the Project area. Windblown dust can be observed during strong winds. Project area falls under silence zone i.e. noise level is around 47 dB (A) while NEQS level is 65dB.

The GHG are not detected within the Project area. Moreover the wind velocity is moderate so the particulate Matter PM10 in the proposed Project area is very low. Results are attached as Annex-D.

5.8 Wind Speed

Analysis of hourly wind speed shows that the winds are generally light to moderate in this area. The annual mean wind speed varies from 1.30 to 1.9 m/s.

5.9 Water Bodies

The main source of irrigation in the project area is Fortwah Canal. The major crops grown are

cotton, wheat and sugarcane. New sweet water sources have been developed after necessary reconnaissance and technical sweep of the area. The dominant crops are cotton in kharif and wheat during rabi. Water tables vary a great deal in the area, from 2 to 10m depth.

5.10 Terrestrial Ecology

Cholistan desert, being a very unique eco-zone of Pakistan, enjoys a very special status of its own kind. Its biological resources are confronted with multiple stresses of long droughts, increased salinity, high temperature, a very low rainfalls ratio and enhanced grazing pressure. Therefore, the plant species have developed very typical xeric genetic adaptation to cope with these highly stressed environmental conditions. After sufficient rains, this desert flourishes into a good grazing ground and becomes an incredibly good supply line of animals and their by-products reaching to all major cities of the country, as well as neighboring states. To alleviate the sufferings of poor inhabitants of Cholistan desert, the Islamia University of Bahawalpur has established the Cholistan Institute of Desert Studies (CIDS) in 1982-83.

The major object of this institute is to undertake useful scientific planning and research, to restore and rehabilitate the dwindling biological resources and to minimize the sufferings of the peoples of desert area. The institute comprises of a Biological Division, Physical Sciences Division and Socio-economic Division. The Institute initiated a number of useful projects pertaining to the exploration and utilization of desert's inherent genetic resources as no credible benchmark of this type was already available.

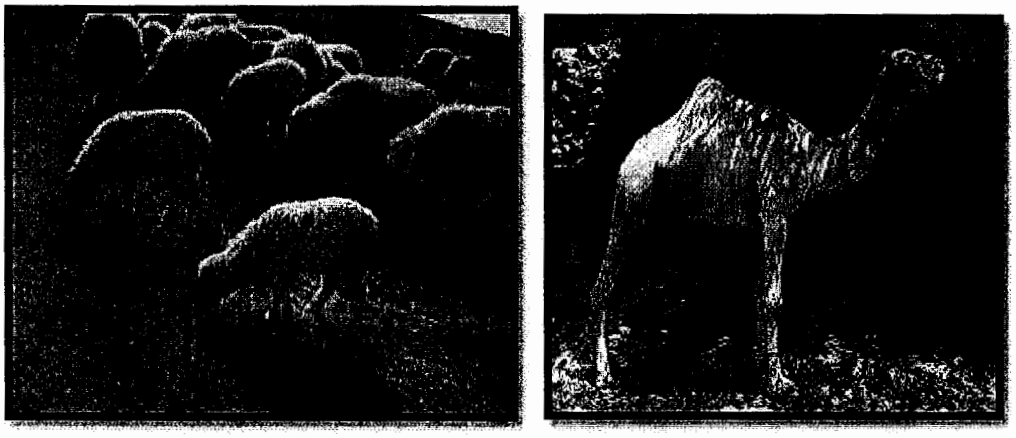


Figure 5.2: Livestock of Project Area

5.10.1 Flora

A floristic survey of Cholistan desert was carried out during 2009-2011 and total of 38 families, 106 genera and 154 species were documented from the area. Among families, 33 families belong to Dicotyledons of 79 genera and 115 species, while the 38 species of 26 genera belong to 4 families of Monocotyledons and 1 family of gymnosperms with 1 genus and 1 species. The largest family was Poaceae with 34 species followed by Papilionaceae and Zygophyllaceae with 10 species while Asteraceae with 9 species respectively. The life form of plant species was determined by following the Raunkier's method. Therophytes comprised of 74 species (48%), Chamaephyte 40 species (26%), Hemicryptophyte 18 species (12%), Phanerophyte 19 species (12%) and Cryptophyte 3 species (2%) of the flora of the area.

Table 5.1: Most Important Medicinal Plants of Cholistan Desert[1]

Family	Plant species
Cyperaceae	Cyperusrotundus
Poaceae	Cymbopogonjawarancusa,Panicumantidutale
Amaranthaceae	Aervapersica
Asclepiadaceae	Calotropisprocera,Leptadeniapyrotechnica
Capparidaceae	Capparisdecidua,Cleomeviscosa
Chenopodiaceae	Haloxyonerecurvum,Sasolabaryosma,suaedafruticosa
Convolvulaceae	Convolvulusmicrophyllus,Ovassacretica
Cuscutaceae	Cuscutareflexa
Malvaceae	Abutilonmutidum
Menispermaceae	Coculuspendulus
Mimosaceae	Acacianilotica,Prosopischenaria
Neuradaceae	Neuradaprocumbens
Papilionaceae	Alhagimaurorum,Crotalariaburhia
Polygonaceae	Calligonumpolygonoides.
Rhamnaceae	Zizyphusmauritiana
Salvadoraceae	Savadoraoleoides
Solanaceae	Solanumsurattense
Tamariceae	Tamarixaphylla.
Tiliaceae	Corchorusdepressus
Zygophyllaceae	Fagoniacretica,phagonumharmala,Tribulus longepetalus,Tribulusterrestris.

a. Grasses and Hedges

2. *Aeluropuslagopoides*(Linn) Trin .ex.Thw
3. *Aristidaadscensionis L.*
4. *AristidafuniculataTrin.* &Rupr.
5. *Aristidahystricula*(Edgew)
6. *AristidamutabilisTrin. &Rupr.*
7. *Cenchrusbiflorus*(Roxb)
8. *Cenchrusciliaris* (linn.)
9. *Cenchrusprieurii* (Kunth.) A Marie
10. *CenchrussetigerousVahl.*
11. *Cymbopogonjwarancusa* (Jones.) schult
12. *Cynodondactylon* (L.) Pers.
13. *EnneapogondesvauxiiP.Beauv.*
14. *EragrostisbarrelieriDav.*
15. *Eragrostisciliaris (Linn.) R. Br*
16. *Eragrostis japonica (Thumb.) Trin.*

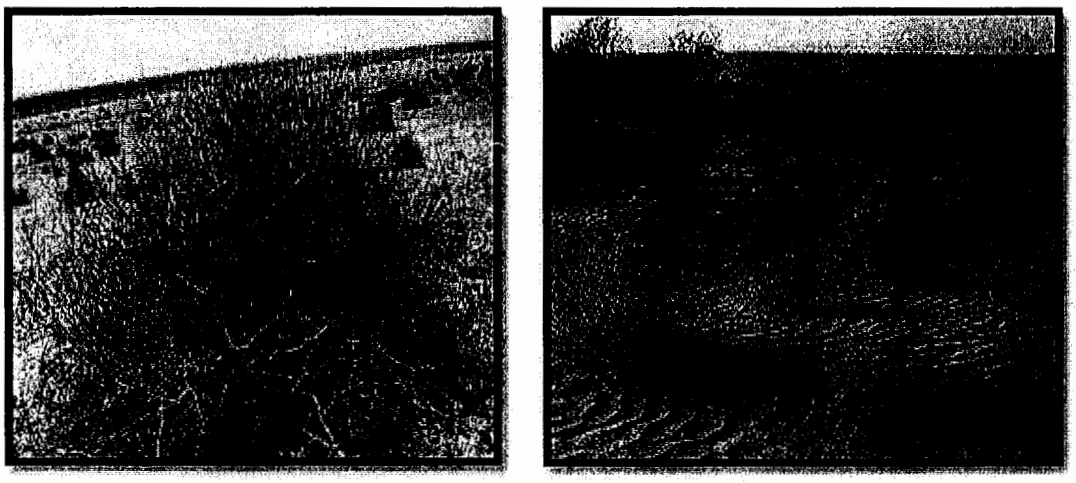


Figure 5.3: Grasses and Hedges of Cholistan Desert

5.10.2 Fauna

The study on terrestrial fauna in the study area is based upon the field investigation, reports of Forest Department, Documents of Islamia University Bahawalpur. Due to scanty vegetation

growth in this region, not much of varied animal life is found in this State. Despite this, still a large variety of animals are found in this area. The different variety of faunal life can be categorized as,

- Primates
- Carnivores
- Angulate
- Rodents
- Lagomorpha
- Insectivore
- Crustivore

Corresponding to its variegated topography and climate, the state has a wealth of animal life. Mostly domestic animal like cow, sheep, buffalo and goat are reported in the study area.

5.10.3 National Parks and Wildlife Sanctuaries

There is a National Park named Lal Sohanra national park near the of Project area. Distance of desert national park from site is at distance of 60km.

Table 5.2: The Notable Wildlife Species of Cholistan Desert

Mammals		
S.No.	English name	Scientific name
1	Indian Caracal	Felis caracal
2	Jungle Cat	Felischaus
3	Indian Mongoose	Herpestesedwardsi
4	Desert cat	Felislibyca
5	Jakal	Canis aureus
6	Fox	Vulpesvulpes
7	Hedgehog	Hemiechnusauritus
8	Chinkara	Gazellabennetti
9	Nilgai	Boselaphostragocamelus
10	Honey Badger	Mellivoracapensis
11	Porcupine	Hystrixidica
12	Hare	Lepus nigricolis
13	Wolf	Canis lupus
14	Wild boar	Susscrofacristatus

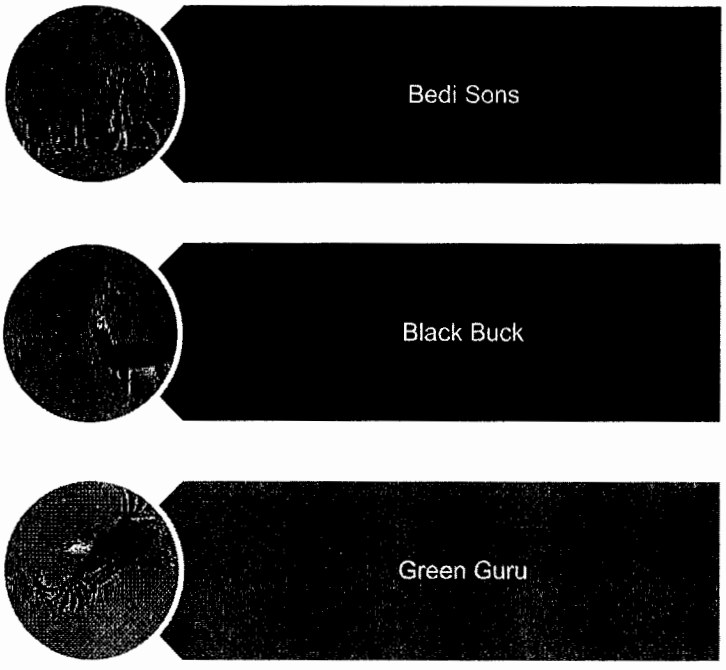


Figure 5:4: The Notable Wildlife Species of Cholistan Desert

Table 5.3: Birds of Cholistan Desert

Birds		
S.No.	English name	Scientific name
1	Grey partridge	Francolinuspondicerianus
2	Indian Desert Finch – Lark	Ammomanesdesertiphoenicuroides
3	Common Indian Starling	Sturnus vulgaris
4	Houbara bustard	Chiamydotisundulata
5	Great Indian bustard	Choriotisnigriceps
6	Imperial sand grouse	Pteroclesorientalis
7	Indian grey shrike	Laniusexcubita
8	Spotted owl	Athenebrama
9	Lagar falcon	Falco biarmicusjugger
10	Saker falcon	Falco biarmicuscherrug
11	Desert buzzard	Buteobuteovulpinus
12	Indian sparrow hawk	Accipiter nisus melaschistos
13	Tawny eagle	Aquila rapoxvondhiana
14	Harrier	Circus macrourus
15	Indian ring dove	Streptopeliadecaocto
16	Little egret	Egrettagarzetta
17	Pond heron	Aredeolagrayii
18	Golden backed wood pecker	Dinopiumbenghaleuse
19	Warblers	Sylvia nana nana

Table 5.4: Amphibians and Reptiles of Cholistan Desert

Amphibians and Reptiles

S.No.	English name	Scientific name
1	Tiger bull frog	Rana tigrina
2	Spiny tailed lizard	Uromastrixhardwicki
3	Spotted Indian house geko	Hemilacytylusbrooki
4	Indian monitor lizard	Varanusbengalensis
5	Black cobra	Najanaja
6	Common crate	Bungaruscaereleus
7	Saw scaled viper	Echiscarinatus
8	Sand boa	Eryxconicus
9	Brahminy blind snake	Typholopsbraminus

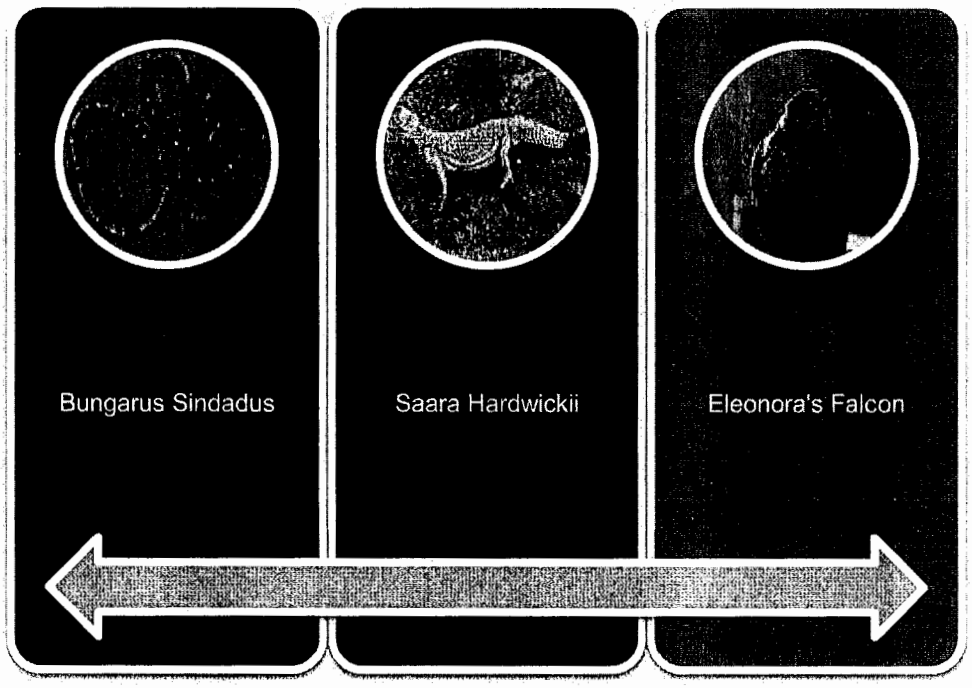


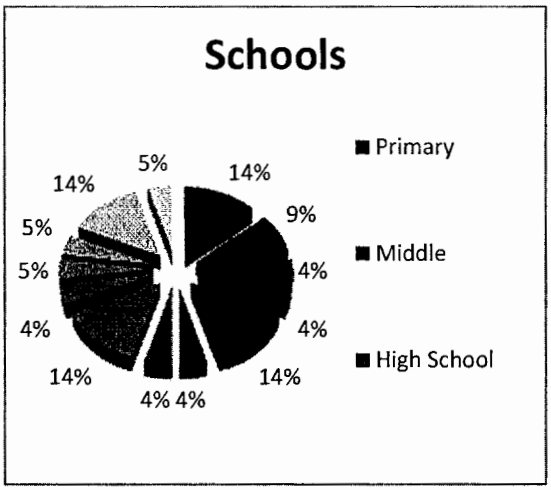
Figure 5.5: Amphibians and Reptiles of Cholistan Desert

5.11 Baseline Socio-Economic Status

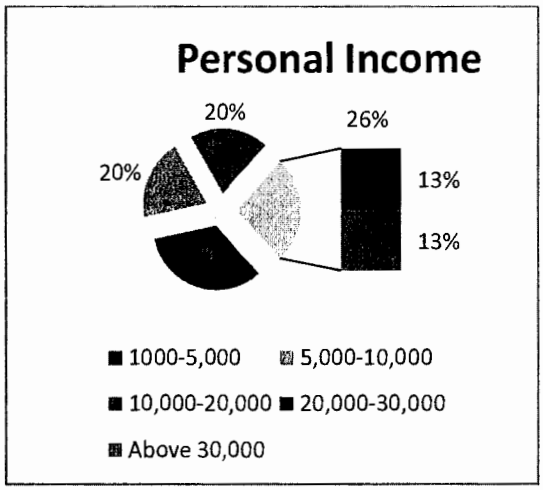
There is no permanent settlement present in the Project Area, thus no socio-economic accounts is given in this respect.

There are no institutional facilities in the village like hospital, dispensary, basic health unit, post

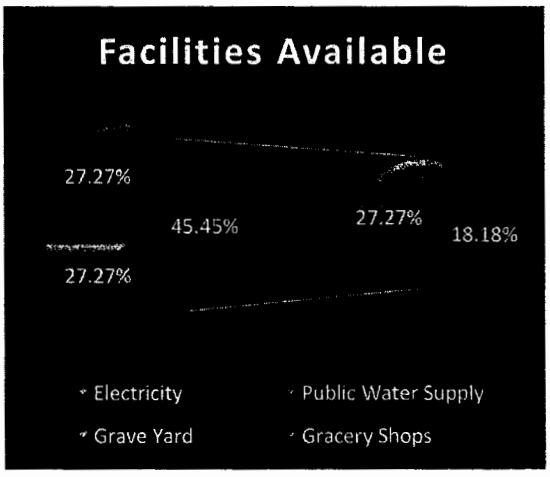
office, banks and other facilities except mosque is present. There are some civil facilities are present like grocery shops, graveyards, electricity, and public water supply but lined drainage system, street lights, recreational works are not present. Primary schools of government, of boys and government middle school of girls, are present. These graphical representations are showing percentages of the respective socio economic condition of the proposed area.



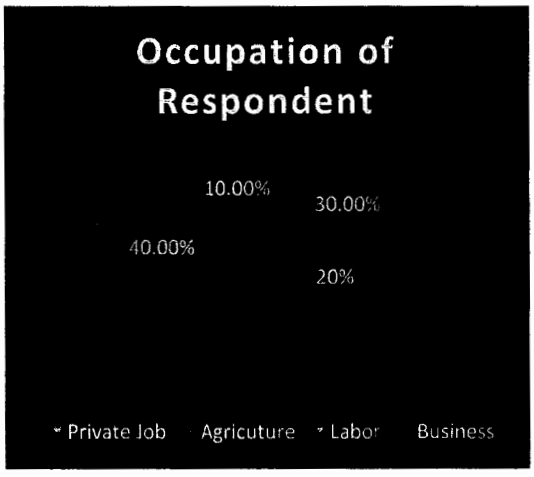
Graphical representation of schools



Graphical representation of personal income



Graphical representation of facilities available



Graphical representation of occupation of respondent

6. Environmental Impacts and Mitigation Strategies

The progress of any task surely carries variation in native environment with respect to biological, physical, socio-economic facets. The influences created in these phases should leave a positive or negative effect. To consider as a whole progress events, due to the variation in biological, physical and socio-culture, this Project will surely lead to the production of various environmental influences. This Chapter thus identifies the potential impacts due to the implementation of 100 MW Solar PV Project Block A on the physical, biological and social environment of Project area. The chapter also identifies measures that will help mitigate the Project's adverse environmental effects and enhances positive impacts.

During manufacturing and subsequent operational stages, every single environmental finding (possible effects) has been assessed with respect to their present situation. That's why these impacts have been identified in terms of their interval, extent, magnitude. The reason is that this recommended Project is the use of solar radiation for power generation which will be known as renewable energy project. These projects are well known to be cleaner as compared to fossil fuel based energy plans

6.1 Impact Prediction Methodologies

However, to resolve or identify the main impacts, various practices can be used, but, their choices should be in such a way, to meet the suitability of circumstances.

These can be based upon:

- Professional judgment with adequate reasoning and supporting data. This technique requires high professional experience
- Experiments or tests. These can be expensive
- Past experience
- Numerical calculations & mathematical models. These can require a lot of data and competency in mathematical modeling without which hidden errors can arise
- Physical or visual analysis and detailed description is needed to present the impact
- Geographical information systems
- Risk assessment, and
- Economic valuation of environmental impacts

6.2 Impact and Mitigation Management

Purpose of mitigation is to evade, reduce or balance the expected antagonistic effects in suitable way, to integrate these into environmental managing strategy or plan. At every stage of the project, mitigation plan for all the adverse impacts should be predictable and coasted to find out the best alternative.

The objectives of mitigation are to:

- Invention of best substitution and means of better alternatives and ways of doing things
- To improve the environmental and societal payback of the project.
- To prevaricate, remedying or reduce, provocative impacts.
- To certify that remaining negative influences are kept within permissible limits

In this part of the report, a number of complications including cleanliness, environmental health and safety, societal and environmental managing and inspection, industrial vulnerability, tools and apparatuses, and during construction stages the, influx of people, procurement of land have been deeply elaborated.

Table 6.1: Design of Mitigation Measures

Approach	Examples
Avoid	Change of route or site details, to avoid important ecological or archaeological features
Replace	Regenerate similar habitat of equivalent ecological value in different location
Reduce	Filters, precipitators, noise barriers, dust, enclosures, visual screening, wildlife corridors, and changed time of activities
Restore	Site restoration after construction
Compensate	Relocation of displaced communities, facilities for the affected communities, financial compensation for the affected individuals etc.

So, these are concisely computed under with having swift inspection of circumstances. The possible impacts (positive and negative) from the proposed project during construction and operation are presented in the following sub-sections.

6.3 Project Benefits

One of the major benefits is that the proposed Project can be applied for Clean Development Management (CDM), which detailed below:

6.3.1 Clean Development Mechanism (CDM)

The clean development mechanism (CDM) was initiated under the Kyoto Protocol of the united nation Framework Convention on climate change (UNFCCC) in order to explore cost-effective options to mitigate the impacts of climate change. It is one of the instruments that help the developing countries in achieving sustainable development while at the same time; it contributes to the ultimate objective of the UNFCCC. CDM assists the developing countries to implement project activities that reduce GHG emission in return for generating Carbon Credits/Certified emission Reduce (CeR).

Pakistan deposited its instrument of accession to the Kyoto Protocol on 11th January 2005, and thus became eligible to benefit from CDM. For this purpose the Ministry of Climate Change has been declared as the Designated National Authority (DNA). A CDM Cell has been established in August 2005 for providing technical and policy support to, including implementation of CDM Strategy, conduct awareness raising, enhancement of capacity for CDM project development, review of CDM projects for grant of approval by the DNA and to advise the Government in technical matters related to CDM in Pakistan.

Pakistan National Operational Strategy for CDM provides policy guidance for implementation of CDM in Pakistan in line with national sustainable development goals. It is an incentive based Strategy which ensures efficiency and transparency. The Strategy defines institutional arrangement for implementation of CDM in Pakistan, tax and credit sharing policy and the Criteria grant of Host Country Approval to CDM projects.

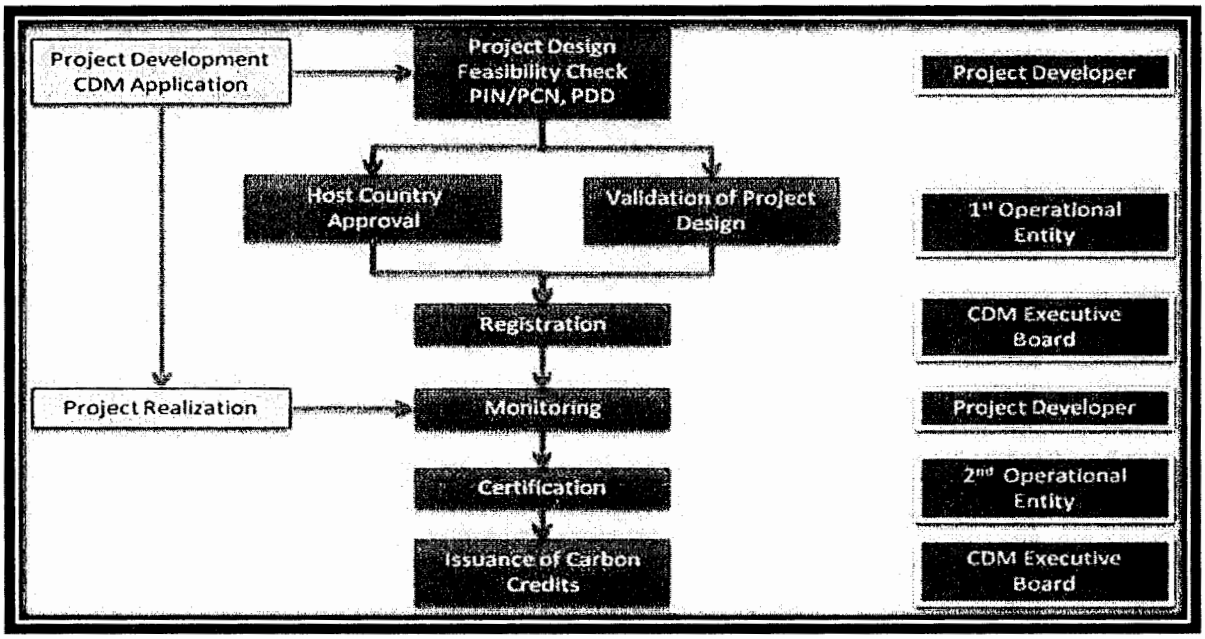


Figure 6.1: CDM Flow Chart

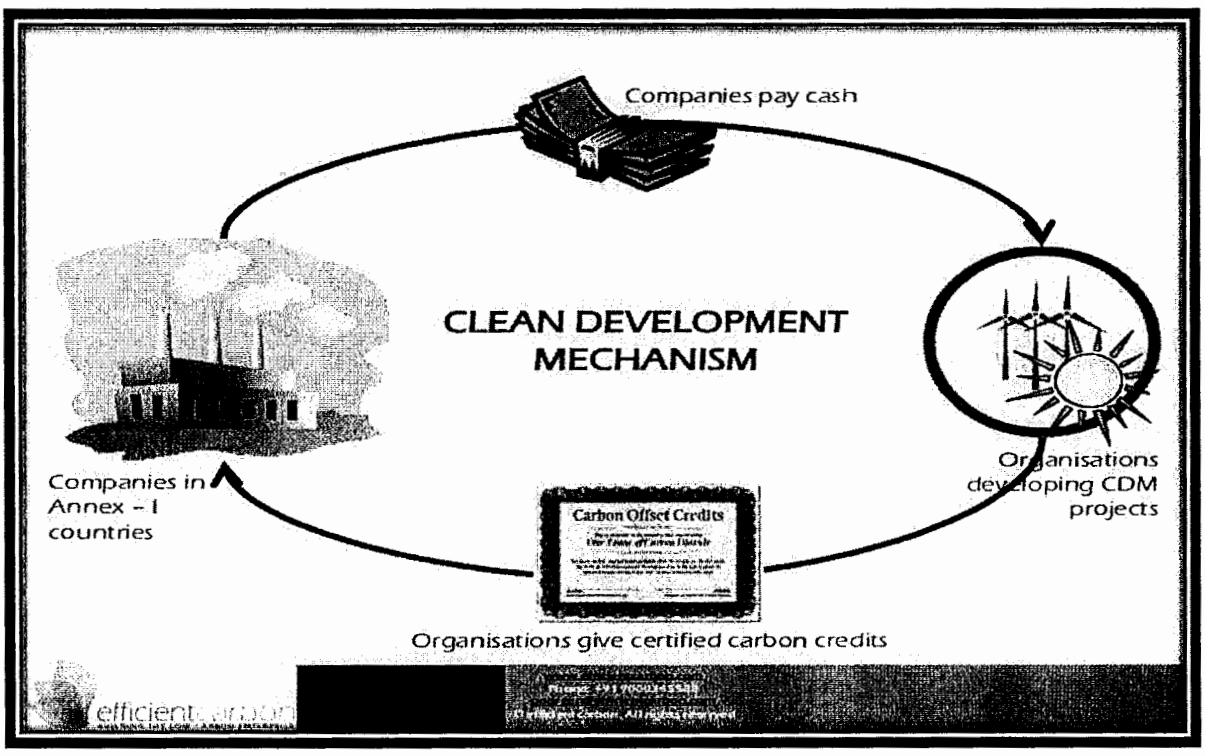


Figure 6.2: CDM Mechanism

6.3.2 Types of CDM Projects

Pakistan shall allow unilateral, bilateral and multilateral CDM projects preferably in the following areas:

- Livestock and agricultural practices
- Waste Management (e.g., solid waste management, recycling, landfills, animal/livestock wastes)
- Transportation (e.g. mass transit systems alternative fuel vehicles, cleaner engines, Compressed Natural Gas (CNG) and Industrial processes
- Different sorts of Energy including energy efficiency, renewable energy, energy conservation and fossil-fueled cogeneration
- Land use and its change and Forestry

To be qualified for national approval under CDM, the project in the above listed areas must meet the National Sustainable Development Criteria.

6.4 Construction stage

6.4.1 Beneficial Impacts

As matter of fact during construction and development of perspective project, dozens of beneficial impacts can be considered in particular for dwellers, which are given below.

a. Employment Opportunity to Local People

This new project will affect local community for longer run as providing them supplementary new sort of additional jobs for even shorter period of time and some for longer period of time as well. The poor slum residents and villagers depend on local livestock for their livelihood, generation of edible and medicinal plants and sometimes being a guide for tourists. This impact will lead to a significant effect on earnings of local community and thus is considered as positive.

b. Impact on Local Economy Due to Increased Economic Activities

Extra earning sources of concerned dwellers during construction were at peak which will be diminished, as the construction phase culminates. On the other hand in operational phase sale of everyday life commodity increases including higher grocery shops, cookies shops and

restaurants. All these sorts of activities uplift the local market and business which will reduce poverty directly and indirectly.

6.4.2 Adverse Impacts

Apart from the positive impacts of Project; some adverse impacts are also envisaged. Presence of labor from outside at Project site may pose several temporary adverse impacts on Project area including hazard of communicable diseases, etc. This impact is considered negative of moderate magnitude.

6.5 Adverse Impacts on Physical Environment

6.5.1 Disturbance and Change in Landscape, Land-Use

The proposed PV Solar power project includes variety of construction activities such as earth work excavation, spoil disposal, quarrying and burrowing in concerned land area. Site clearness removes tiny plants and grass which will disturb earth slope stability and enhance the exposed earth surface. Excavation and uncontrolled activities and generated waste can affect the quality of water. Erosion will be increased which will boost the water runoff and slope overloading. Rare floral life will be at stack of distinction due ill-managed activities.

Nature of Impact

The impact will be direct, low, site specific, short term and hence insignificant.

Mitigation

Proper pre well managed plan for all possible movements and clearness should be designed to reduce unrequired clearness. Try best as you can to follow existing pathways and transportation for both men and material. Reduce unrequired movement of workers and to be kept within footprint of the area required. Cover all lighter material which is likely to carry with wind.

Tree cutting or any other type of flora and fauna damage should be reduced by asking the workers and planner not to cut those trees which are not directly affecting the solar panels. Noise pollution can be reduced by lesser use of horns and by maintenance of vehicles.

6.5.2 Air and Noise Quality Degradation

Drilling, vibrators, dozers, loaders, rollers, cranes, generators, and pumps will produce high noise more than prescribed standards. Smoke of equipment and vehicle will affect air quality in huge. This negative congener not only effects the calm environment but local peoples will suffer for shorter period of time also.

Nature of Impact

The impact will be direct, medium, local, short term and hence significant.

Mitigation

Providing cover to the loose material ad lighter material at construction site is way to reduce the dust pollution at proposed site. Proper maintenance and monitoring of vehicles will reduce the smoke pollution under control. Sprinkling of water on bare and unpaved pathways reduce dust generation. Tarpaulin sheets usage in offsite transportation cover the materials. Greasing and oiling the noisy equipment can improve the situation. Moreover maintenance and checking is very important practical step to follow and to make clean and noise free surroundings. Provision of rubber paddings/noise isolators at equipment /machinery used for construction. Construction vehicles are to be well maintained and switch off, while not in use. Noise prone activities will be restricted to the extent possible during night time to reduce the noise impact.

6.5.3 Solid Waste Generation

Domestic and construction waste is produced during construction activities. Firstly Domestic waste quantity depends upon the project duration, nature and engaged workers. The more number of workers and visitors leads to higher production of domestic waste in located area. Secondly, Construction waste is based upon heavy and light machinery. Uncontrolled and improper management brings unpleasant odors, deterioration of water quality, visual impacts and public health hazards.

Nature of Impact

The impact will be direct, medium, site specific, short term and hence insignificant.

Mitigation

A workable and proper waste management plan should be formulated by the site engineers while planning for construction.

6.5.4 Groundwater Degradation

Possible leakages and haphazard spoil of various hazardous materials such as paints, emulsion, bitumen; batteries affect the water quality if lesser care is involved. Meanwhile higher demand of water and suction of greater quantity of water from earth lower the water table.

Mitigation

Sensible usage of water at working should be managed to run all processes smoothly. Tanker water suppliers can help to use lesser ground water. Moreover, avoid chemicals entering into water bodies.

6.6 Adverse Impacts on Cultural, Religious and Archeological Sites

The survey team did not find any cultural or religious sites that might be affected by the project. Since there will be no impact regarding cultural, religious and archeological sites.

6.7 Impacts on Biological Environment

6.7.1 Disturbance and Threat to Wildlife

Deforestation of rare vegetation and other manufacturing activities may lead to the destruction of native habitat of all wildlife animals in this area. But the potential of these impacts onto whole native flora and fauna will be negligible.. So, there will be negligible disruption to wildlife due to rush of conveyance and free movement of people. Actually, up to some extent, the disturbing factor in this proposed project area for wildlife will be noted by hunting and poaching wildlife or necessary project noisy and vibration producing activities. These hunting and catching activities for flora and fauna through labor force will be increased but it will remain the limited and short term impacts on wildlife.

Nature of Impact

The impact will be direct, low, local, short term and hence insignificant.

6.8 Operational stage

6.8.1 Impacts on Social and Economic Environment

It is admitted fact that increased economic social activity will be the main reason to change the behavior of people socially.

6.8.2 Impact on Road Traffic

The is a possibility that the traffic on Fort Abbas road can be affected by solar panels' reflection as the drivers may get visionless for short time.

Nature of Impact

The impact will be direct, low, local, medium term and hence insignificant.

Mitigation

There is a very slight chance of occurrence of this impact. Anti-reflective coating and proper fitting of panels might be used as mitigation to avoid reflection.

6.8.3 Impact on Water Resources and Water Sharing

Solar energy power plant is considered to be an environmental friendly technique without producing any water and air pollution problems or GHG emissions but indirect influence will be kept in mind because of using various harmful materials, many organic solvents, and alcohol in the manufacturing process of photovoltaic cells (PV), which convert sunlight into electricity.

Nature of Impact

The impact will be direct, low, local, long term and hence insignificant.

Mitigation

Management of water bodies for current project will be solved through project manager & native people. There are chances of arguments on equally used or shared water for domestic purpose.

6.8.4 Impact on Cultural and Religious Activities if any

Due to having their different traditional and religious deeds, during manufacturing and working stages, the impacts would be minimum.

Nature of Impact

The impact will be indirect, low, local, long term and hence insignificant.

6.9 Decommissioning Stage

It is an extremely difficult task to select a best suited method for the interchanging of PV panels. It requires more information to characterize their behavior and impact in the environment. Up to now, it's a serious issue to care the discharging of PV panels. That's why it has become a major environmental and social problem. Therefore, to keep the environment clean and public friendly, the PV panel supplier has been suggested to replace useable PV panels to new panels, however, their excessive use after due date and improper management have more toxic effects to threaten the health of human being and living environment with potentially influence the growth of wildlife with the release of silicon. Because their shelf life is about 25 year, after that they require to be changed to new ones. So, too much use of these panels after their expiry date to carry on various project works would be hazardous to minimize their efficiency about 80 percent. To understand the entire situation, it will be the project responsibility to take over the old panels to the REC (Renewable Energy Corporation). REC is a full member of PV cycle association industry alliance that is pooling resources to collect and recycle solar modules from customers of member companies when project reaches at the end of its useful life, thus there is minimal impact from decommissioning practices of the project. Realizing this concern, the Project has contacted REC, the supplier of PV panels, to take all the PV panels after expiring to its recycling facilities. REC (Renewable Energy Corporation ASA) is a full member of PV Cycle Association, a solar industry alliance that is pooling resources to collect and recycle solar modules from customers of member companies when the products reach the end of their useful life, Thus, there is minimal impact from decommissioning practice of the Project.

6.9.1 Impacts on Biological Environment

a. Disruption to Wildlife Movement/Corridor

It is necessary to protect natural wildlife; they are rare species in this area and therefore are of great environmental significance. Some human being activities during the project running like, use of lights, sounds produced and heavy traffic may ultimately intrude the native wildlife population. But their movement along the projected area will be low due to the fencing and anthropological intervention around the vicinity of particular area of the project. After this, the desert ecosystem would likely to be affected through improper solar power management. Appropriate handling and disposal of potentially harmful fluids that are being used to operate the Solar Power System should be compulsory.

Nature of Impact

The impact will be indirect, medium, local, long term and hence significant.

6.9.2 Impacts on Social Environment

a. Possible Impact on Existing Facility and Resources Such As Health, Education, Water Resources

Project area has fewer facilities and inadequate services by the government. Health centers, veterinary services, post office, agriculture centers and secondary schools exist within the area but with miserable conditions. Even these facilities are not enough to meet the local needs. Development of new infrastructure brings huge influx of unemployed peoples in the regarded area which will consequently lead towards extra burden on local facilities. This trend will worsen the existing situation. Disputes and conflicts might be major issues due to these insufficient and limited amenities provided by the government.

Nature of impact

The impact will be indirect, low, local, short term and hence insignificant.

Mitigation

The only and best possible method to combat this situation is only by government or any non-profitable agency which is likely to enhance the existing services not only for locals but for aliens too.

6.9.3 Impacts on Occupational Health and Safety

Risks related to occupational health and safety (drinking water contamination, fire hazards, chemical spillages, falls, communicable diseases etc.) for construction workers may arise due to different construction activities and require adequate Personal Protective Equipment (PPEs) and emergency procedures. This impact is considered negative of moderate magnitude.

Mitigation

Following must be ensured during Project implementation;

- Providing basic medical training to specified work staff and basic medical service and supplies to workers;

- Work safety measures and good workmanship practices are to be followed by the contractor to ensure no health risks for laborers;
- Protection devices (ear muffs) will be provided to the workers operating in the vicinity of high noise generating machines;
- Provision of adequate sanitation, washing, cooking and dormitory facilities including lighting up to satisfaction;
- Provision of protective clothing for laborers handling hazardous materials, e.g. helmet, adequate footwear, protective goggles, gloves etc.;
- Ensure strict use of wearing these protective clothing during work activities;
- Availability of safe drinking water for the workers;
- Elaboration of a contingency planning in case of major accidents;
- Close consultation with local communities to identify optimal solutions for diversions to maintain community integrity & social links;
- Provision of proper safety signage at sensitive/ accident-prone spots; and
- Setting up speed limits in close consultation with the local stakeholders.

6.9.4 Preservation and Development of Communal Services

After the completion of project, numerous communal services will also be renovated and improved in very close site around the subjected area.

Nature of Impact

The impact will be indirect, low, local, long term and hence insignificant.

6.10 Enhancement Measures

As panels are raised above the ground on posts, greater than 95% of a field utilized for solar farm development is still accessible for plant growth and potentially, for wildlife enhancements. Furthermore, solar sites are secure sites with little disturbance from humans and machinery once construction is complete. Most sites have a lifespan of at least 20 years which is sufficient time for appropriate land management to yield real wildlife benefits.

- Biodiversity gains are possible where intensively cultivated arable or grassland is converted to extensive grassland and/or wildflower meadows between and/or

beneath solar panels and in field margins. The best results are likely to come from sites that contain wild flower.

- Planting wild bird seed or nectar mixes, or other cover crops could benefit birds and other wildlife. For example, pollen and nectar strips provide food for pollinating insects through the summer period, and wild bird seed mixes provide food for wild birds through the winter
- Bare cultivated strips for rare arable plants, and rough grassland margins could also be beneficial. For instance, small areas of bare ground may benefit ground active invertebrates
- It may be possible for panels to be at a sufficient height for regular cutting or grazing to be unnecessary. Rough pasture could then be developed, potentially providing nesting sites for birds
- Boundary features such as hedgerows, ditches, stone walls, field margins and scrub can provide nesting and foraging areas, as well as means for wildlife to move between habitats
- Biodiversity enhancements should be selected to fit the physical attributes of the site and should tie in with existing habitats and species of value on and around the site.

7. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

7.1 Environment Management Plan (EMP)

The Environmental Management Plan (EMP) is a set of recommendations that manages the impacts of the proposed 100 MW Solar PV Project and also delineate the responsibility of various participants involved in construction and operational phases of the Project.

The mechanism to ensure the implementation of proposed mitigation measures during construction and operation of proposed Project is discussed in this EMP. Also, the EMP includes a set of institutional measures for construction and operational stages of the Project.

7.2 Objectives of EMMP

The main objectives of the EMMP, for proposed Project, are to:

- Define roles and responsibilities for the Project proponent, Contractors, Construction Supervision Consultants for implementation.
- Provide mechanism for unanticipated environmental situation; and
- Identify training requirements at various levels (if any)

The activities proposed under Environmental Management Plan should be an obligatory part of bidding document and contract agreement with the contractor.

7.3 Environmental Monitoring Plan

Mitigations for physical, biological and socio-economic parameters will be measured to determine compliance with standards established in Environmental Management Plan.

In general, the objectives of the monitoring will be, to:

- Record the inputs provided by various participants in the environmental and social management process (i.e. Client (Executing Agency), Consultants, Contractors, etc.)
- Check whether the prescribed national and provincial guidelines and plans are being followed
- Ensure that the required mitigation measures and activities are being accomplished in time
- To identify problems or potential problems

- To identify solutions to rectify such problems.

7.4 Recommended Environmental Monitoring Protocol Pre Construction Phase

7.4.1 Ambient Air Quality

Quality of air (NOX, SO_2, CO, HC) prior to drilling should be monitored twice or thrice in a weak at project location site.

7.4.2 Surface water Quality

Parameters like pH, conductivity, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS), Heavy metals, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) of Surface water present within the 1km radius of project area prior to drilling should be monitored and at least three samples should be collected to frequently reporting.

7.4.3 Ground Water Quality

Ground water quality parameters prior to drilling like physical-chemical parameters, heavy metals and toxic organic compounds within 1km of project site should be monitored carefully. Monitoring should be done at minimum four locations and at least three samples should be collected from each location.

7.4.4 Noise Level Quality

Noise level should be monitored by using Noise meters on daily basis at project site which is prior to drilling.

7.5 Recommended Environmental Monitoring Protocol during Site Preparation

- During site preparation, below given physical infrastructure at the project site should be monitored/planned/constructed.
- Mud and work associated system should be separated from rain/storm drainage system.
- Construction of Separate run off routes for non-contaminated and contaminated water. Treatment facilities for the contaminated water should be planned during or before site preparation.
- Septic tank & soak pits of adequate size and presence of bunds around the pits

should be constructed.

- During site preparation, Inventory of trees likely to be cut and number of trees to be planted should be equal at the project location because it is the part of Compensatory Tree Plantation program.

7.6 Recommended Environmental Monitoring Protocol during Construction Phase

- Natural resources like quality and quantity of material used including water consumption; fuel used for power generation and transportation from/to rig location/base should be monitored daily at project site.
- Ambient Air Quality parameters like NOx, SO2, CO, and HC should be monitored twice a week for 24 hours at project location.
- Water bodies within the radius of 1km of project site that will be utilized during construction phases, should be monitored regarding pH, conductivity, TSS, TDS, heavy metals, BOD and COD etc. on every fortnight. Monitoring should be done at the site which was already used for?.
- Solid waste production at project site should be monitored on daily basis according to waste segregation and disposal as per waste management plan.
- Monitor soil variations especially soil erosion with your vision daily during routine monitoring at project site and report it on a weekly basis to project environment officer.
- Skills of local people recruited for manual job should be monitored during drilling operations.

7.7 Recommended Environmental Monitoring Protocol during Post Construction

- Drilling waste like drill cuttings, its quantity, transportation and safe disposal at project site should be monitored at the end of drilling operations.
- Surface water quality parameters like pH, conductivity, TSS, TDS, BOD and COD should also be monitored once a week after drilling is complete. Samples should be taken from the site which is already used for sampling of pre and during drilling phase.
- Groundwater Quality parameters like Physical-chemical properties, heavy metals and toxic organic compounds should be monitored at the end of project. Monitoring

should be done for once in pre and post monsoon season for three years. Samples should be taken from the same site as it was taken for pre-construction phase.

- Soil erosion and habitat disturbance at drilling site and within the project site boundary respectively, should be monitored at the end of the project. Soil variation is monitored visually at the end of project by contractor and reported to PEO of the project. Habitat disturbance is also monitored visually.
- Number of trees present around the project area should be monitored on the basis of survival rate of tree saplings. Monitoring should be done once in a year. This repetition should be done for three years.

Summary of impacts along with their mitigation measures is given in the portion of executive summary of this report.

7.8 Institutional Arrangements and EMMP

Environmental management is basically the institutional arrangement which delegates some specific assigned responsibilities and those responsibilities are to be monitored properly. For this purpose a good and functional institute must be present in order to reduce adverse socio-environmental effects of the proposed project. This process requires proper monitoring in order to report any performance of any mitigation measurement of adverse impact generated by proposed project. The Solution de Energy is the proponent of a solar power plant. So all the mitigation measures will also be proposed by them and so the monitoring will be their responsibility too. The proponent will ensure the proper implementation of mitigation measures for the concerned operation and maintenance phase through adequate monitoring.

7.9 Training Schedules

To enhance the capacity of the Proponent/EA as well as the Contractor, training will be imparted related to the environmental and social issues of the project implementation of mitigation measures and the monitoring protocols and reporting mechanism.

Project will ensure in-house training for the project staff, Contractor, and the Supervisory staff of the Proponent/EA and the Consultants through the provision of one day basic training and one day advanced training, covering environmental and social aspects of the development projects in general, and implementation requirements will emphasize on the development projects in general, and implementation requirements with emphasis on the roles and

responsibilities of the Proponent/EA and the Contractor staff while executing the environmental monitoring plan in particular. The training protocols will include the following aspects:

- Procedures for monitoring the air quality parameters and measures to be adopted for avoiding or minimizing air pollution, particularly from the concrete batching plant, haul-trucks, etc.
- Procedures for monitoring water quality parameters and measures to be adopted for avoiding or minimizing water pollution, particularly from the wastewater effluent generated from the workshops, machinery washing yards, and other obnoxious chemicals;
- Safe waste disposal practices;
- Safe noise levels from the construction machinery etc.
- Safety measures against hazards for workforce and the local communities arising from the construction activities; and
- Use of safety gadgets by the workforce.

7.10 Institutional Capacity

Institutional capacity of the proposed project is given below in the Table:

Table 7.1: Environmental Management Structure and Responsibility

Project Stage	Responsible Organization	Responsibilities
Detailed Design	Environment Management Committee	• Incorporation of mitigation measures into engineering design and technical specification. • Review and approve environmental mitigation and management measures
Construction	Environmental Protection Agency Punjab	• Ensure compliance with Government legal requirements (EMMP) during construction. • Review complicated issues that arise from the Project.
	Contractor	• Implementation of required environmental measures
	Design and Field Team Site Engineer and Field Team Consultant	• Supervise contractor's implementation of environmental measures on a daily basis. • Enforce contractual requirements
Operation	Executing Agency and HSE officer	• Review monitoring reports • Implement the environmental management and monitoring plan

7.11 Environmental Budget

Please refer to the following Table for a detail of environmental cost:

Table 7.2: Environmental Budget

S#	EMP Parameters	Unit Cost	Before Construction		During Construction		After Construction		[illegible]
			Times	Cost	Times	Cost	Times	Cost	
1	Environmental testing (water, air, etc.)	0.4	1	0.4	1	0.4	1	0.4	**1.2**
2	Internal Environment Auditing	0.3	0	0	1	0.3	1	0.3	**0.6**
3	Environmental Training	0.2	1	0.2	1	0.2	0	0	**0.4**
4	Social cost (meeting, visit, tour, etc.)	0.6	2	1.2	6	3.6	4	2.4	**7.2**
5	Area development Projects***	12	0	0	2	24	4	48	**72**
6	Environmental reporting & review	0.4	0	0	3	1.2	3	1.2	**2.4**
	Total								**83.8**
7	Operation & Maintenance (5%)								**4.19**
	Contingencies (10%)								**8.38**
	[illegible] Total								**96.37**

Legend: EMM= Environment Management & Monitoring; [illegible] plantation [illegible] solid waste [illegible] hospital, park, etc. Cost of roads [illegible] calculated [illegible] Punjab [illegible] Department [illegible] that

7.12 Equipment maintenance details

a. Different Steps of PV Maintenance Procedures

- Perform Visual Inspection
- Verify System Operation
- Perform Corrective Actions
- Verify Effectiveness of Corrective Actions

b. Perform Visual Inspection

It includes:

- Array Maintenance Shade
- Control Electrical
- Equipment Maintenance

c. Array Maintenance

General tasks

- Module inspection
- Shade control / soiling
- Debris removal
- Array mount inspections

d. Shade Control

General Activities

- Perform regular shading analysis of array(s)
- Inform customer about impact of shading and recommend regular tree trimming where necessary if they are causing shading on the panels.

e. Electrical Equipment Maintenance

General Activities

- Visual inspection of inverters, transformers, and other electrical equipment.
- Inspect all wiring, conductors, terminators, conduit, and junction boxes
- Disconnects, fuses, and circuit breakers checked for proper operation
- Exposed conductors checked for insulation damage, clean and secure terminals, adequate strain relief, and properly connected and supported conduits

Table below is showing maintenance frequency:

Table 7.3: Maintenance Plan

Task	As Required	Monthly	Semi-annually
Inspect modules for damage			✓
Address shading issues	✓		
Remove debris	✓		
Inspect mounting system			✓
Check inverter		✓	
Inspect/clean electrical equip.			✓
Monitor system volts & amps		✓	

8. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

Public participation and consultation are vital components for the success of any development project, to ensure two way communications between the project sponsor and relevant stakeholders, accountability and transparency in the development process.

Public consultations for the "100MWp Solar Power Plant Block A" were undertaken from 13 to 14 September, 2015 during the preparation of the IEE.

A consultation process was initiated at the commencement of the project. The overall objective was to ensure that stakeholders were kept informed about project proposals and developments, and that they were afforded the opportunity to contribute their views to project planning and the decision making processes.

To involve the local community in the planning stage, the Participatory Rapid Assessment (PRA) technique was used to gather information from key stakeholders of the study area during baseline survey. The PRA covers the following indicators:

- Major occupations of the affected people
- Monthly income amounts of poor, middle and large income group of current uses of water resources
- Opinion about technology options
- Opinion about atmospheric emissions and water quality
- Problems encountered such as conflict in the use, protection and conservation and management of fisheries resources
- Participation and conflict resolution mechanism
- Perception of the community towards proposed development
- Suggestions on how Government may assist the community with program of development

In September 2015, only stakeholder's consultation was used.

8.1 Stakeholder Identification

The stakeholders for the Project were prioritized by identifying the direct and indirect stakeholders. Consultations were conducted with the various stakeholders by a professional team of TR Consultants.

8.2 Information Disclosure

On behalf of Solution de Energy, the Consultants for the IEE study arranged several consultation meetings with local stakeholders for information dissemination and community participation. Such meetings were with the concerned NGOs, and other relevant persons. The consultant and their team investigated all the relevant matters regarding the project by arranging meetings, and group discussions for people's awareness.

The consultant worked with Focus Group Meeting in the community. In these meetings all classes of public including businessmen, farmers, school teachers, and religious leaders were present.

The project was explained and those present were informed that the project will be constructed in the existing land. No acquisition of land is needed for the proposed project. No permanent acquisition of land and consequent resettlement will be required for the project. Some noise, air pollution may occur, but it will be minimized using proper methods. The consultant has carefully studied all types of impacts in the locality likely to be caused by the proposed plant and informed the meetings of the impacts.

The Initial Environmental Examination process under the Pakistan Environmental Protection Act 2000 only requires the disclosure to the public after the statutory IEE / EIA has been accepted by the relevant EPA to be in strict adherence to the rules. The locations of consultation and people consulted are listed in the full table of public consultation presented in Table 8.1 and Table 8.2.

During the IEE studies, well informed persons related to the Project Area were interviewed and all necessary information pertaining to the Project Area was recorded during data collection process. This process also supported the understanding of the Consultants as a lot of information was exchanged during interviews. Please refer to Table 8.1.

8.3 Monitoring and Evaluation

Most IEE Projects usually have no monitoring systems of PCs built into their structure. Monitoring and Evaluation (M&E) assess the quality of public consultations in the IEE process. Techniques for monitoring and evaluating PCs include confirmation that participants understood the consultation content (correct language, level of technicality), and assessment of stakeholders" opinions of PC effectiveness and PC impact on Project design and implementation. Through appropriate use of M&E, public consultation strategies can be adjusted during the Project cycle to improve stakeholder participation,

information dissemination strategies, and mechanisms for integrating participant feedback into Project design and implementation.

8.4 Methodology Adopted

a. Stakeholders Analysis

Stakeholder analysis is a tool to identify all parties that have direct and indirect interests in the project and its potential impacts on them. Failure to identify the stakeholders and consult with them could impair transparency in decision-making and which, in turn, could lead to conflicts, delaying the project process. Therefore, it is important to identify the stakeholders, the potential project impacts on them, and also to evaluate their concerns and needs, and their ability to understand and influence the decision-making at the project preparation stage.

There are few categories of stakeholders:

- Local communities
- Civil society
- Government and local government bodies
- Private sector bodies
- Participants from local NGO's (not mandatory)
- Other institutions

8.5 Techniques and Tools used for Public Consultation

There are techniques for getting information to the public:

The techniques used for public consultation in the Project area include;

- Questionnaire Survey
- Meetings
- Focus Group Discussions
- Survey
- Exchanging information

In this regard, the rounds of public consultation and social assessment survey were held with selected persons including Government/ Non-Government Officials, village notables and general community of Project area. Environmental team of IVY Engineering Services (Pvt.) Limited, Team leader introduced everyone about the aim of the meeting and briefed about the Project. The purpose of this survey was to highlight the main issues in the

implementation of the proposed Project and finally propose mitigation measures. Open and close ended questionnaires were used to collect the views concerning the assessment survey. Scoping sessions and informal group discussions were also carried out with local residents and local government representatives regarding the proposed Project. The outcome of whole consultation process was very encouraging. The following issues were discussed during Informal Meetings with local representatives:

i. Brief Description of the Project
ii. Reservations about the Environmental impacts of the Proposed Project and their suggested mitigation measures
iii. Perceptions about the proposed Project

8.6 Responsible Authority

8.6.1 Meeting with District Officer, Environment

It is a good project and people are happy this project is coming to Chishtian. We also visited the site and this is a good site for the project. We also conveyed this message to the DO Lahore.

8.6.2 Meeting with Additional Deputy Commissioner

We gave the briefing to the ADC, he is aware of the project and he assured all the help and support regarding the project.

8.7 Other Stakeholders

The detail is given in Table 8.1.

Table 8.1: Public Consultation

Records of Meeting				
Job Title	Initial Environmental Examination for the QASP 100MWp Solar Power Project (Block-A)			
Meeting Title	Public Consultation			
Venue	Chishtian			
Attendance				
S#	Name	Village Name	CNIC No	Contact No
1	M. Tariq Javed	Chak 175 M Tehsil Chishtian	31602-4412098-7	0300-6677175
2	M. Shahbaz	Chak 176 Tehsil Chishtian	31102-6029851-[illegible]	0301-[illegible]
3	Abdul Jabbar	Chak 177 M	31602-8267154-5	0300-6987780
4	Shabir Ahmad	Chak 177 M, Tehsil Chishtian District Bahawalnagar	31102-0572593-[illegible]	0345-[illegible]
5	Shokat Iqbal	Chak 183M Dakhana Khas Hasilpur	31203-9781774-1	0341-8298783
6	M. Yaseen	Chak 199 Tehsil Chishtian	31102-1168966-5	0344-[illegible]
7	Asfaq Hussain	Chak 199 M Chishtian	31102-0571373-1	0345-7039566
8	M. Pervaiz	Chak 199 Tehsil Chishtian		0305-[illegible]
9	Maqsood Ahmad	Gali/Mahala Garbi, Dak Khana Chak 200	31102-0588030-1	0345-2552199
10	M. Siddique	Chak No 204 Chastian	31102-4776061-1	0308-[illegible]

11	Mehmood Amjad	-	31102-6448400-7	0302-7921554
12	Ghulam Yaseen		31102-[illegible]	0302-[illegible]
13	Altaf Hussain	Chak No 204-Ezafi Basti Tehsil Chishtian	31102-1980378-3	0300-3940205
14	Talib Hussain	204 Murad	31102-[illegible]	0302-[illegible]
15	Safdar Hussain	Chak No. 204 M. Shariqe	31102-0584717-3	0305-9858620
16	Khadam Husssain	Mairgah	31102-[illegible]	0306-[illegible]
17	Muhammad Ashraf	Chak No. 204 M. Shariqe	31102-9958020-1	0333-0657556
18	Maqbool Ahmad	Chak 199 M Christian	31102-[illegible]	0345-[illegible]

Figure 8.1 Public Consultation Session being conducted at Chak No 209 Murad and Chak No. 177 Murad

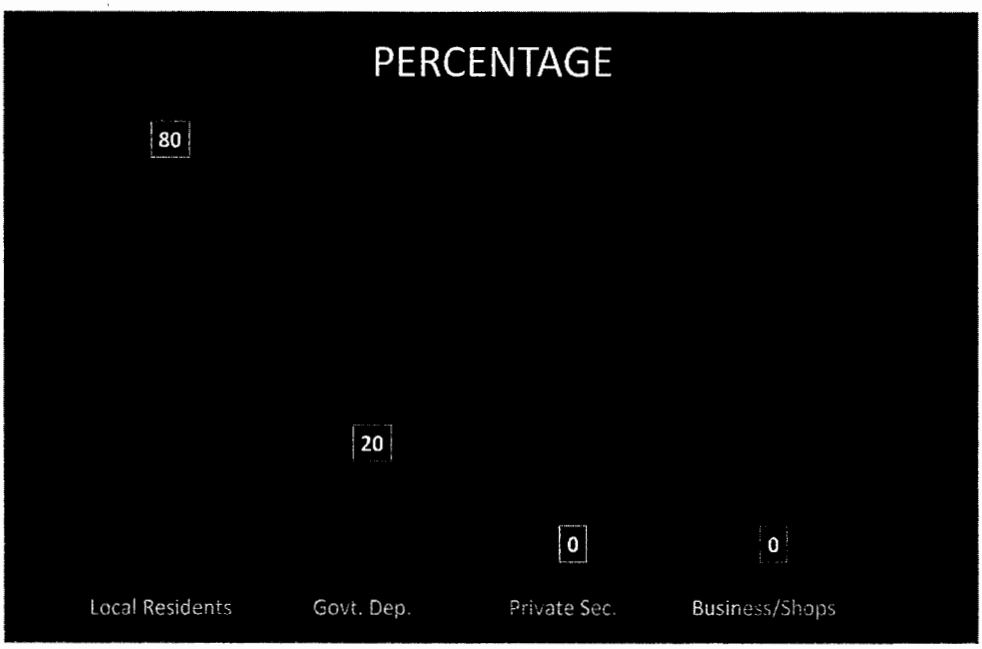


Figure 8.1: Stakeholder Consultation Shown in Graph

8.9 Summary of Key Informant Interview

- ➔ To take care of the public safety as well as to provide security in critical locations. In order to remove any fear of explosion, the authority should exercise adequate care in construction & maintenance work.
- ➔ Works should be completed as quickly as possible in order to reduce construction impacts.
- ➔ The electricity should be made available to the people at the earliest possible opportunity.
- ➔ To ensure quality of material & best workmanship for a safe and durable power plant and to provide uninterrupted supply to the consumers.
- ➔ The executing agency should follow all rules, regulations and standards in the construction of the project.
- ➔ Care should be taken for ensuring the least possible damage to local infrastructure viz. roads & structures during construction of the project.
- ➔ Contingency plan should be taken to meet any eventual accident.
- ➔ No fossil fuels will be used for energy production. Moreover, its benefits as to the carbon emission reduction where also discussed. He was satisfied and of the view that Project will go a long way toward electricity production and sustainability.
- ➔ Significantly strong winds blow in the area which can wash out local structures (huts) causing nuisance and inconvenience.
- ➔ A briefing session was also conducted to inform the stakeholders about the Project and its benefits. They were convinced and optimistic over the matter.

8.10 Suggestions from the Local People

- ➔ Local people urged to be involved in all sorts of employment opportunity both temporary and permanent.
- ➔ Ensure stable electricity connection for the local area
- ➔ Noise pollution should be avoided.

Figure 8.2: Public Consultation Session Being Held At Chak 199 Murad

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusion

Pakistan located in the sunny belt, is lucky to have long sunshine hours and is ideally located to take advantage of solar energy technologies. Based upon the environmental and social impacts assessment of the proposed Project, it is concluded that Project will have short term and reversible adverse impacts with moderate to minor magnitude, thus it can be rated as an environment-friendly project. Socioeconomic impacts on micro and macro level will be insignificant. On macro-scale, the impact is highly positive as the Project would meet and reduce the deficit in energy sector which in turn will boost the economy of the region. Additionally it will substantially reduce environmental GHG emissions.

Specific social and environmental benefits have been mentioned in this report which depends on the strict compliance of the mitigation measures suggested in EMMP and best engineering practices.

The IEE Report of QASP 100MW Solar Power Project for Block A concludes that the Project is acceptable from an environmental perspective. Mitigation measures are taken into consideration and enhanced in an Environmental Management Plan (EMP) to make final design, construction and operation of the Solar Power Plant.

9.2 Beneficial Effects

The solar power generation is a renewable energy source and utilizes/produces clean energy thus can win the favor of Clean Development Mechanism. Its concept is in line with the national energy development policy. The solar plant will grant efficient wheels to local economic development and meanwhile solar plant will become the local scenic spot for scientific education and tourism. In addition, it will promote the wildlife and vegetative cover.

9.3 Adverse Effects

There is no adverse impact of the construction of solar plant on the environment nor does it cause any pollution to the environment. The adverse impacts to the environment appear temporary because they are limited to the construction period and can be minimized by taking effective engineering measures.

9.4 Recommendations

Following issues are recommended:

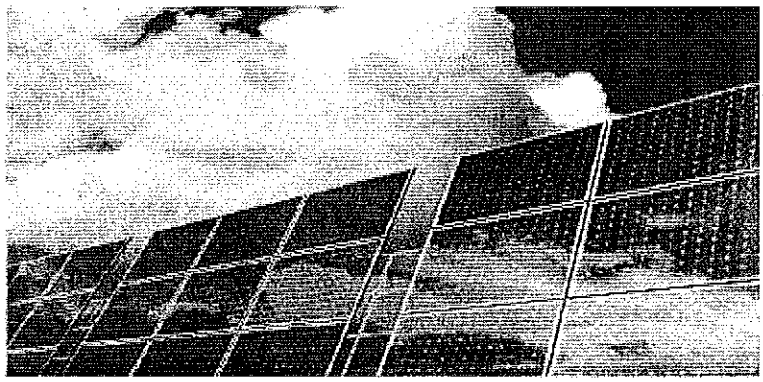
- Since there will be side by side multiple construction activities by various Proponents, thus it is recommended that they should adopt an integrated construction and environmental approach.
- NOC will be issued by the rangers for the defence line dislocation.
- The Proponent should obtain an environmental approval (no objection certificate) from the Punjab-EPA before proceeding further into the construction activities.

Report No. PPI-172.1-Draft/15

INTERCONNECTION STUDY

For

100 MW Solar Power Project by M/s Solution De Energy (Pvt) Limited



Draft Report
(October 2015)

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Executive Summary

- The study objective, approach and methodology have been described and the plant's data received from the client Solution De Energy Solar PP has been validated.
- The expected COD of the project is the third quarter of 2016. Therefore, the month of September 2016 have been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load forecast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-380/26231-32 dated 25-06-2015.
- The nearest substation of MEPCO is Chishtian-New 132 kV. The following scheme of interconnection of Solar Power Plant by Solution De Energy Solar to evacuate maximum power of 100 MW is envisaged and studied in detail:
    - Two loops with two 100 MW solar power plants each have been proposed to be connected to Chishtian-New.
    - The first loop comprises of Solution De Energy and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
    - The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 kV grid station.
- Detailed load flow studies have been carried out for the peak load conditions of September 2016 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 100 MW of the plant under normal and contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Solution De Energy Solar Power Plant at 132 kV, and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from the Solution De Energy Solar Power Plant.

- The maximum short circuit level of 132 kV bus bar of Solution De Energy Solar Power Plant is 5.71 kA and 4.53 kA for 3-phase and 1-phase faults respectively and the maximum short circuit level of 33 kV bus bar of Solution De Energy Solar Power Plant is 14.99 kA and 12.83 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for September 2016. The stability check for the worst case of three phase fault on the 132 kV bus bar of the Solution De Energy Solar power plant substation followed by the final trip of 132 kV circuit connected to this substation has been performed for fault clearing of 9 cycles (180 ms) as understood to be the maximum fault clearing time of 132 kV protection system. The system is found to retain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Chishtian - New 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

Report Contents

1. Introduction

1.1 Background

Solution De Energy Solar (Private) Limited is setting up a 100 MW solar power plant at Quaid-e-Azam Solar Power Park near Chishtian - New, Punjab. The site of the proposed project is located in the concession area of Multan Electric Power Company Limited (MEPCO). The peak AC net output planned to be generated from the project is about 85 MW which will start commercial operations by the third quarter of 2016. The electricity generated from this project will be supplied locally to the Chishtian - New Grid Station and to the MEPCO network through the 132 kV grid located in the vicinity of this project.

1.2 Objectives

The overall objective of the Study is to develop an interconnection scheme between Solution De Energy Solar Power Project and MEPCO network, for stable and reliable evacuation of 85 MW of electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives are:

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

1.3 Planning Criteria

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

Steady State:

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

Dynamic/Transient:

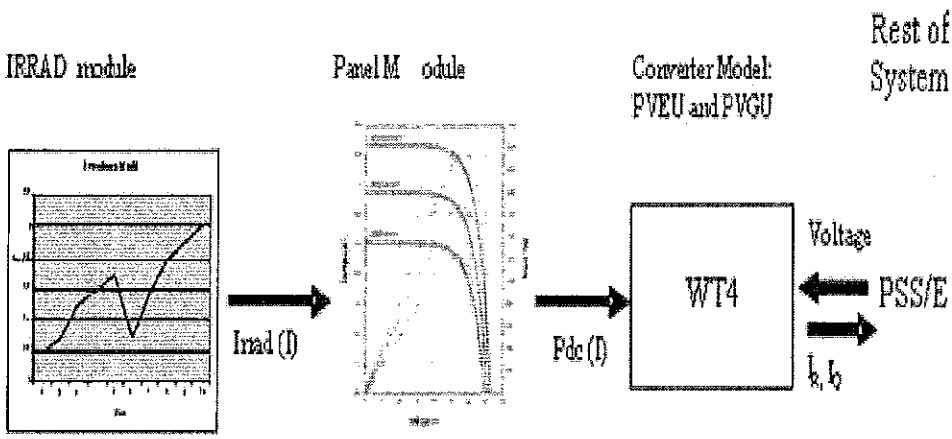
- The system should revert back to normal condition after the transients have died down without losing synchronism with good damping. For 11 kV the total maximum fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 180 ms (9 cycles).
- For the systems of 132 kV and above the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles).
- For the systems of 132 kV and above, in case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles).

2. Assumptions of Data

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

2.1 Solar Power Plant data

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



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

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

Steady State data:

2 x 20 MVAR SVCs will be used to provide reactive compensation for Solution De Energy Solar-PP

Dynamic Data:

Converter time constant for IQcmd seconds = 0.02 s

Converter time constant for IQcmd seconds = 0.02 s

Voltage sensor for LVACR time constants = 0.02 s

Voltage sensor time constant = 1.1 s

2.2 Network data

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

The latest generation, transmission plan and load forcast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-380/26231-32 dated 25-06-2015.

3. Study Approach and Methodology

3.1 Understanding of the Problem

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

The existing nearest grid station available for interconnection is Chishtian - New 132 kV Substation. The addition of this source of power generation embedded in local distribution network of this area shall provide relief to Chishtian - New 132 kV substation feeding the local network. The 132 kV network surrounding Chishtian - New has significant load demand, therefore most of the power from the Solution De Energy Solar Power Plant will be utilized locally in meeting this load demand.
The adequacy of MEPCO network of 132 kV in and around the proposed site of Solution De Energy Solar Plant has been analysed in this study for absorbing and transmitting this power, fulfilling the reliability criteria.

3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for September 2016 considering maximum AC out of 85 MW for the solar plant by Solution De Energy Solar (Pvt.) Limited, comprising all 500 kV, 220 kV and 132 kV system and envisaging the load forecast, the generation additions and transmission expansions for that year particularly in MEPCO.
- The project is expected to be completed by the third quarter of 2016. Therefore the month of September 2016 has been selected to carry out the study as it will allow the maximum impact of the project to be judged.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, has been developed.
- Performed technical system studies for peak load conditions to confirm technical feasibility of the interconnections. The scheme has been subjected to

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

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

4. Development of Scheme of Interconnection

4.1 The Existing Network

The nearest existing MEPCO interconnection facilities at the time of commissioning of Solution De Energy Solar Power Project would be Chishtian-New 132 kV Substation.

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

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

Given the physical proximity of Chishtian - New to Solution De Energy Solar power plant and the fact that the other facilities are at a considerable distance from the plant, the most feasible interconnection of the Solution De Energy Solar Power Plant will be with Chishtian – New 132 kV substation.

4.2 The Scheme of Interconnection of Solar Power Plant

Keeping in view the above mentioned 132 kV network available in the vicinity of the site of the Solution De Energy Solar Power Plant, the interconnection scheme has been developed as shown in Sketch-2 in Appendix B. The following scheme of interconnection is proposed and studied in detail:

- Two loops, with two 100 MW solar power plants each, have been proposed to be connected to Chishtian-New.
- The first loop comprises of Solution De Energy and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
- The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 kV grid station.

4.3 Proposed additions at 132 kV in Chishtian – New 132 kV Substation

Three breaker/panels of 132 kV along with respective protection equipment would be required to be added in 132 kV switchgear hall of Chishtian - New 132 kV substation to provide connection to direct 132 kV circuits forming the proposed loops.

5. Detailed Load Flow Studies

5.1 Load Flow without Solution De Energy Solar Power Plant, September 2016

A base case has been developed for the peak load case of September 2016, using the network data of Solution De Energy Solar-PP and MEPCO network.

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

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

For N-1 contingency conditions we have performed the following cases

Exhibit 0.1	Solar-PP-1 to Chishtian-New 132kV Single Circuit Out
Exhibit 0.2	Solar-PP-2 to Chishtian-New 132kV Single Circuit Out
Exhibit 0.3	Solar-PP-2 to Solar-PP-3 132kV Single Circuit Out
Exhibit 0.4	Solar-PP-3 to Dharanwala 132kV Single Circuit Out
Exhibit 0.5	Dharanwala to Chishtian-New 132kV Single Circuit Out
Exhibit 0.6	Chishtian-New to Bahawalnagar 132kV Single Circuit Out
Exhibit 0.7	Chishtian-New to Chsihtian-Old 132kV Single Circuit Out

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

5.2 Reactive Power Requirements

Solution De Energy Solar Power Plant power factor is 0.90 lagging (capacitive/generating) and 0.90 leading (inductive/absorbing). Part of this reactive power will be consumed by the step-up transformers and the rest may be consumed in

the MV collector cables of the solar plant. However some reactive power might reach the MV bus bar of solar plant substation. That means each inverter is self sufficient to meet VAR absorption requirement of its step-up transformer with some contribution of VARs to the Solar Plant MV network.

The Grid Code Addendum No.2 requires to meet the criteria of ± 0.95 power factor at the point of interconnection with the NTDC/MEPCO grid at 132 kV (point of common coupling). Therefore Solution De Energy Solar Power Plant with its maximum output of 85 MW generating capacity is required to pump MVAR to the grid at maximum AC power output of 85 MW. The VAR generating capability of the inverters will not be able to fully meet this VAR demand of the system because of VAR loss in step-up transformers, collector cables and the HV/MV transformers at the Solar Plant substation. In order to meet the Grid Code criteria, we have proposed the installation of two SVCs of -5/+20 MVAR each at the Solar Plant substation capable of generating 40 MVAR and delivering at 132 kV bus about

27.88 MVAR after VAR loss across transformers

5.3 Load Flow with Solution De Energy Solar Power Plant, September 2016

The following scheme of interconnection is proposed and studied in detail:

- Two loops, with two 100 MW solar power plants each, have been proposed to be connected to Chishtian-New.
- The first loop comprises of Solution De Energy and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
- The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 kV grid station.

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

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

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

Exhibit 1.1	Solution-De-Energy 132/33kV Single Transformer Out
Exhibit 1.2	Solution-De-Energy to Chishtian-New 132kV Single Circuit Out
Exhibit 1.3	Solution-De-Energy to Solar-PP-1 132kV Single Circuit Out
Exhibit 1.4	Solar-PP-1 to Chishtian-New 132kV Single Circuit Out
Exhibit 1.5	Solar-PP-2 to Chishtian-New 132kV Single Circuit Out
Exhibit 1.6	Solar-PP-2 to Solar-PP-3 132kV Single Circuit Out
Exhibit 1.7	Solar-PP-3 to Dharanwala 132kV Single Circuit Out
Exhibit 1.8	Dharanwala to Chishtian-New 132kV Single Circuit Out
Exhibit 1.9	Chishtian-New to Bahawalnagar 132kV Single Circuit Out
Exhibit 1.10	Chishtian-New to Chishtian-Old 132kV Single Circuit Out

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

5.4 Conclusion of Load Flow Analysis

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

6. Short Circuit Analysis

6.1 Methodology and Assumptions

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

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

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

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2016 i.e. all the generating units have been assumed on-bar in fault calculation simulations.

6.2 Fault Current Calculations without Solution De Energy Solar Power Plant, September 2016

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

The results are attached in Appendix – D.

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

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

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

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

Table - 6.1
Maximum Short Circuit Levels without Solution De Energy Solar PP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Chishtian-New 132 kV	**9.63**	**10.36**
Solar PP-1 132 kV	**5.66**	**4.52**
Solar PP-2 132 kV	**4.65**	**3.83**
Solar PP-3 132 kV	**4.65**	**4.34**
Dharanwala 132 kV	**4.89**	**4.84**
Bhawalnagar 132 kV	**7.90**	**8.60**
Chishtian-Old 132 kV	**8.57**	**9.47**

6.3 Fault Current Calculations with Solution De Energy Solar Power Plant, September 2016

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

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

Comparison of Tables 6.1 and 6.2 shows slight increase in short circuit levels for three-phase and single-phase faults due to connection of Solar Power Plant on the 132 kV bus bars in its vicinity. This increase is limited considering the fact that the Solar Power Plant is a voltage source convertor. We find that even after some increase, these fault levels are much below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of 132 kV bus bar of Solution De Energy Solar Power Plant is 5.71 kA and 4.53 kA for 3-phase and 1-phase faults respectively and the maximum short circuit level of 33 kV bus bar of Solution De Energy Solar Power Plant is 14.99 kA and 12.83 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.

Table-6.2
Maximum Short Circuit Levels with Solution De Energy Solar PP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Solution De Energy 33 kV	**14.99**	**12.83**
Solution De Energy 132 kV	**5.71**	**4.53**
Chishtian-New 132 kV	**9.8**	**10.54**
Solar PP-1 132 kV	**5.71**	**4.53**

Solar PP-2 132 kV	**4.73**	**3.9**
Solar PP-3 132 kV	**4.73**	**4.42**
Dharanwala 132 kV	**4.97**	**4.92**
Bhawalnagar 132 kV	**8.01**	**8.73**
Chishtian-Old 132 kV	**8.72**	**9.63**

6.5 Conclusion of Short Circuit Analysis

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

The maximum short circuit level of 132 kV bus bar of Solution De Energy Solar Power Plant is 5.71 kA and 4.53 kA for 3-phase and 1-phase faults respectively and the maximum short circuit level of 33 kV bus bar of Solution De Energy Solar Power Plant is 14.99 kA and 12.83 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.

7. Transient Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Stability Models

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

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

Generator	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1

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

7.1.2 System Conditions

We have used the system conditions of September 2016 given the COD of the subject Solar Power Plant in the third quarter of the year 2016.

The following scheme of interconnection is proposed and studied in detail:

- Two loops, with two 100 MW solar power plants each, have been proposed to be connected to Chishtian-New.
- The first loop comprises of Solution De Energy and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
- The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 grid station.

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

7.1.3 Presentation of Results

The plotted results of the simulations are placed in Appendix - E. Each simulation has been run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish that the pre fault/disturbance conditions of

the network under study were smooth and steady. Post fault recovery has been monitored for ten seconds. Usually all the transients due to non-linearity die down within 2-3 seconds after disturbance is cleared in the system.

7.1.4 Worst Fault Cases

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

7.2 Transient Stability Simulation Results, September 2016

7.2.1 Fault at 132 kV Solution De Energy

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

Fig. 1.1 Bus Voltages

The bus voltages of 132 kV bus bars of Solution De Energy, Solar-PP-1, Chishtian-New, Dharanwala, Solar-PP-2 and 33 kV bus bar of Solution De Energy are plotted. The results show quick recovery of the voltages after clearing of fault

Fig. 1.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solution De Energy Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 1.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 1.5 MW /MVAR flow from Solar-PP-1 to Chishtian-New 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the Chishtian-New and Solution De Energy causes the entire output of Solution De Energy to flow through the intact 132 kV circuit between Chishtian-New to Solar-PP-1. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 MW/MVAR Output of Solar-PP-1

The pre-fault output of Solar-PP-1 was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 1.7 Rotor Angles

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

7.2.2 Fault at 132 kV Solution De Energy (Stuck Breaker Case)

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

Fig. 2.1 Bus Voltages

The bus voltages of 132 kV bus bars of Solution De Energy, Solar-PP-1, Chishtian-New, Dharanwala, Solar-PP-2 and 33 kV bus bar of Solution De Energy are plotted. The results show quick recovery of the voltages after clearing of fault

Fig. 2.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solution De Energy Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 2.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 2.5 MW /MVAR flow from Chishtian-New to Solar-PP-1 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the Chishtian-New and Solution De Energy causes the entire output of Solution De Energy to flow through the intact 132 kV circuit between Chishtian-New to Solar-PP-1. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 MW/MVAR Output of Solar-PP-1

The pre-fault output of Solar-PP-1 was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 2.7 Rotor Angles

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

7.2.3. Fault at 33 kV Solution De Energy

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

Fig. 3.1 Bus Voltages

The bus voltages of 132 kV bus bars of Solution De Energy, Solar-PP-1, Chishtian-New, Dharanwala, Solar-PP-2 and 33 kV bus bar of Solution De Energy are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 3.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solution De Energy Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 3.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 3.5 MW /MVAR flow on Solution De Energy 132/33 kV Transformer

Followed by clearing of fault, the trip of one Solution De Energy 132/33 kV Transformer causes the entire output of Solution De Energy to flow through the intact Solution De Energy 132/33 kV Transformer. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains steady state level with power swings damping down fast.

Fig. 3.6 MW/MVAR Output of Solar-PP-1

The pre-fault output of Solar-PP-1 was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 3.7 Rotor Angles

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

7.2.4 Fault at 132kV Chishtian-New (Stuck Breaker Case)

We applied three-phase fault on the Chishtian-New 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 132 kV circuit between the Solar-PP-1 and Chishtian-New. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows

Fig. 4.1 Bus Voltages

The bus voltages of 132 kV bus bars of Solution De Energy, Solar-PP-1, Chishtian-New, Bhawalnagar, 220 kV bus bar of Chishtian and 33 kV bus bar of Solution De

Energy are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 4.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 4.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solution De Energy Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 4.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 4.5 MW /MVAR flow from Solution De Energy to Chishtian-New 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the Chishtian-New and Solar-PP-1 causes the entire output of Solution De Energy to flow through the intact 132 kV circuit between Chishtian-New to Solution De Energy. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 4.6 MW/MVAR Output of Solar-PP-1

The pre-fault output of Solar-PP-1 was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 4.7 Rotor Angles

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

7.4 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed scheme for the severest possible faults of 132 kV systems near and far away from the Solar Power Plant of Solution De Energy Solar. Therefore there are no issues of dynamic stability for interconnection of this Solar Power Plant; it fulfils all

the criteria of transient stability. The reactive support from the inverter also helps the system stability.

8. Conclusions

- The study objective, approach and methodology have been described and the plant's data received from the client Solution De Energy Solar PP has been validated.
- The expected COD of the project is the third quarter of 2016. Therefore, the month of September 2016 have been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load forecast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-380/26231-32 dated 25-06-2015.
- The nearest substation of MEPCO is Chishtian-New 132 kV. The following scheme of interconnection of Solar Power Plant by Solution De Energy Solar to evacuate maximum power of 100 MW is envisaged and studied in detail:
- Two loops with two 100 MW solar power plants each have been proposed to be connected to Chishtian-New.
- The first loop comprises of Solution De Energy and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
- The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 kV grid station.
- Detailed load flow studies have been carried out for the peak load conditions of September 2016 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 100 MW of the plant under normal and contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Solution De Energy Solar Power Plant at 132 kV, and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from the Solution De Energy Solar Power Plant.

- The maximum short circuit level of 132 kV bus bar of Solution De Energy Solar Power Plant is 5.71 kA and 4.53 kA for 3-phase and 1-phase faults respectively and the maximum short circuit level of 33 kV bus bar of Solution De Energy Solar Power Plant is 14.99 kA and 12.83 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for September 2016. The stability check for the worst case of three phase fault on the 132 kV bus bar of the Solution De Energy Solar power plant substation followed by the final trip of 132 kV circuit connected to this substation has been performed for fault clearing of 9 cycles (180 ms) as understood to be the maximum fault clearing time of 132 kV protection system. The system is found to retain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Chishtian - New 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.