ASIA ENERGY (PRIVATE) LIMITED

November 28, 2018

The Registrar
National Electric Power Regulatory Authority
NEPRA Tower, Attaturk Avenue (East)
G-5/1, Islamabad

Subject: APPLICATION FOR GENERATION LICENCE

I, Mir Shahzad Khan Talpur, the Chief Executive Officer, being the duly authorised representative of Asia Energy (Private) Limited, by virtue of Board Resolution dated September 29, 2018, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation Licence to Asia Energy (Private) Limited for their 30 MWp Solar Power Project, 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.

A bank draft in the sum of Rupees 300,170, being the non-refundable licence application fee calculated in accordance with Schedule II of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Best Regards,

Asia Energy (Private) Limited
A.E.L.
Karachi

Mir Shahzad Khan Talpur
Chief Executive Officer

Address: D – 52, Block – 4, Clifton, Karachi, Pakistan
Phone: +92-21 35294034-37 UAN: +92-21 111-275-111

ASIA ENERGY (PRIVATE) LIMITED

EXTRACTS FROM RESOLUTION PASSED BY THE BOARD OF DIRECTORS OF ASIA ENERGY (PRIVATE) LIMITED DATED SEPTEMBER 29, 2018

RESOLVED that Asia Energy (Private) Limited (the "**Company**") shall apply for a generation license in respect of the Company's 30 MW Solar Power Project in Noorsar, Bahawalnagar, Punjab, Pakistan (the "**Project**"), and in relation thereto, sign all requisite documentation, pay all applicable fees and undertake all other necessary and ancillary acts and deeds.

RESOLVED FURTHER THAT an application for a generation license be made to the National Electric Power Regulatory Authority ("**NEPRA**") with regards to the Project (the "**License Application**").

RESOLVED FURTHER THAT Mir Shahzad Khan Talpur, bearing CNIC No. 42301-3408346-9, the Chief Executive Officer of the Company be and is hereby authorized to sign the License Application and any documentation ancillary thereto, represent before and provide any information required by the NEPRA in relation to the License Application, do all lawful acts and deeds necessary and ancillary for the processing, completion and finalization of the License Application, and authorize legal advisors to represent the Company before NEPRA in respect of the License Application.

FURTHER RESOLVED THAT the Company shall apply for determination of tariff in respect of the Project, and in relation thereto, sign all requisite documentation, pay all applicable fees and undertake all other necessary and ancillary acts and deeds.

FURTHER RESOLVED THAT an application for the determination of tariff be made to NEPRA with regards to the Project (the "**Tariff Application**").

FURTHER RESOLVED THAT Mir Shahzad Khan Talpur, bearing CNIC No. 42301-3408346-9, the Chief Executive Officer of the Company be and is hereby authorized to sign the Tariff Application and any documentation ancillary thereto, represent before and provide any information required by NEPRA in relation to the Tariff Application, do all lawful acts and deeds necessary and ancillary for the processing, completion and finalization of the Tariff Application, and authorize legal advisors to represent the Company before NEPRA in respect of the Tariff Application.

CERTIFIED TO BE TRUE COPY

Fawad Aftab
Director
Asia Energy (Private) Limited

Asia Energy (Private) Limited A.E.L. Karachi

CERTIFICATION

CERTIFIED, that, the above resolution was duly passed by the Board of Directors of Asia Energy (Private) Limited in their meeting held on September 29, 2018, for which the quorum of directors was present.

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

Fawad Aftab
Director
Asia Energy (Private) Limited

Asia Energy (Private) Limited A.E.L. Karachi

Address: D – 52, Block – 4, Clifton, Karachi, Pakistan.
Phone: +92-21 35294034-37 UAN: +92-21 111-275-111

ASIA ENERGY (PRIVATE) LIMITED

VAKALATNAMA

I, **Mir Shahzad Khan Talpur**, bearing CNIC No. 42301-3408346-9, the Chief Executive Officer of the Asia Energy (Private) Limited (the "**Company**"), hereby appoint and constitute M/s **Mr. NADIR ALTAF** of **RIAA BARKER GILLETTE,** Advocates and Corporate Counsellors, to appear and act for us as our advocates in connection with the processing, presentation of the Company's Application for the Generation License (the "Application"), in connection with the Application for the Company in respect of the Company's 30 MW Solar Power Project in Noorsar, Bahawalnagar, Punjab, Pakistan (the "Project").

I also authorize the said Advocates or any one of them to do all acts and things necessary for the processing, completion and finalization of the Application with NEPRA.

ACCEPTED

Mir Shahzad Khan Talpur

Asia Energy (Private) Limited

Asia Energy (Private) Limited A.E.L. Karachi

RIAA Barker Gillette

RIAA Barker Gillette Chambers
3rd Floor, 65-W, Executive Heights,
Block-H, Fazl-ul-Haq Road,
Blue Area, Islamabad,
Pakistan

T +92 51 111 LAWYER

www.riaabarkergillette.com

A011283

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. 0096049

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

Given under my hand at Karachi this Sixth day of November, Two Thousand and Fifteen.

Incorporation fee Rs. 1,000/= only

(Sidney Custodio Pereira)
Joint Registrar of Companies
Karachi

Asia Energy (Private) Limited
A.E.L.
Karachi

THE COMPANIES ORDINANCE, 1984

(PRIVATE COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

OF

ASIA ENERGY (PRIVATE) LIMITED

I. The name of the Company (the "Company") is "**ASIA ENERGY (PRIVATE) LIMITED**".

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

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

1. To carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying (in bulk or retail), exporting and dealing in electricity and all other forms of energy and products or services associated therewith, promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply.

2. To locate, establish, construct, equip, operate, use, manage and maintain any power generation plant whether based on any fuel or any renewable source, power grid station, transforming, switching, conversion, and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, turbines, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops, workshops, warehouses and other storage facilities.

A.E.L

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

4. To import, purchase or otherwise buy any raw material to use the same as energy resource or power generation resource or to sell such raw material to its customers;

5. To purchase, buy, import or otherwise deal in all articles, parts, spares, mill stores, accessories, all sort of plant and machinery, implements, foundry products, engineering stores and works, lubricants, chemicals and all commodities, articles, goods and things required by the Company;

6. For purposes incidental to the above clauses, to acquire, by purchase, exchange, lease, hire, assignment or otherwise, lands, tenements, buildings, easements, rights, advantages, moveable and immoveable property of any kind whatsoever, machinery, trade-marks, patents or inventions, licences to use patents, or other properties, plants and stock-in-trade and to employ, resell, sell, exchange, mortgage, let on lease, licence to use or otherwise deal in the same and to pay for the properties, rights or privileges acquired by the Company;

7. To cause procuring of tariff for bulk or retail supply that will secure recovery of operating costs, interest charges and depreciation of assets, redemption at due time of loans other than those covered by depreciation, expansion projects, payment of taxes, and reasonable return on investment, to quote the tariff to bulk purchasers / users of electrical power, and to prefer petition to the

A.E.L.

appropriate authority for approval of the schedule of tariff and of adjustments or increases in tariff as may be deemed expedient by the Company.

8. To enter into, make and perform contracts and arrangements of every kind and description that may be conducive to the Company's object or objects and for any lawful purpose with any government, authority, public, quasi-public, supreme, municipal, local, railway or any other authority and with any firm, person or company without any limit as to amount and obtain from any government, authority, firm or persons, any rights, privileges, contracts concessions, grants, which the Company may think desirable to obtain and to carry out, exercise and comply with any such arrangement, rights, privileges, contracts and concessions and dispose of or turn to account the same;

9. To enter into any arrangement with any government or authorities (federal, provincial, municipal, local or otherwise), or any corporations, companies, firms 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, decrees, rights, privileges and concessions which the Company may think desirable, and to carry out, exercise and comply with any such charters, contracts, decrees, rights, privileges and concessions;

10. To open accounts with scheduled banks or financial institutions and to draw, make, accept, endorse, discount, execute and issue promissory notes, bills of exchange, cheques, bills of lading, warrants, debentures and other negotiable or transferable instruments, concerning the business of the Company;

11. To borrow or procure on interest, profit or return in any form, money or finances, in local or any foreign currency from any bank or financial institution and to receive money on interest by issuing debentures and on security of any such money so borrowed or received to mortgage, pledge, charge or hypothecate the whole or any part of the property, assets or revenue of the Company, (both present and future) by special assignment or otherwise to transfer or convey the same conditionally, absolutely or in trust and to give,

A.E.L. Karachi

tender power to, sell such other powers as may seem expedient, and to purchase or redeem such securities and pay for such borrowings and loans;

12. To procure or arrange finances from scheduled banks and financial institutions under any mode of Islamic financing scheme like, redeemable capital including Modaraba, Musharaka, Ijara-wa-iktine and Qarze-Hasna and to procure or to secure the money in such manner as the Company may deem fit and particularly by mortgage of its property in full or in part on both the present and future assets in accordance with the Islamic Laws and/or by the issuance of shares, bonds, debentures, participation term certificates, term finance certificates, or redeemable capital or any other securities charged or based upon the undertaking of the Company, on any part of its property, both present or future and generally to borrow money for the purposes of the business of the Company in such manner as the Company shall deem fit;

13. To pay commission or otherwise remunerate any company or firm or firms or person or persons (whether an officer of the Company or not) for services rendered in placing or assisting to place any of the shares of the Company's capital or any debentures or other securities of the Company, or for negotiating any of the purchases or sales by the Company, or for rendering any services of any kind whatsoever to the Company;

14. To get insured against losses, damages, risks, accidents and liabilities of all kinds which may affect the Company whether in respect of its contracts, agreements, advances or securities or in respect of servants or employees of the Company, or in respect of property belonging to or leased to or hired by the company, either by setting apart funds of the Company or by effecting such insurances, and in latter the case to pay the premium there on, but not to act as an insurance company;

15. To guarantee the performance of contracts, agreements, obligations or discharge of any debt of the Company or on behalf of any company or person in relation to the payment of any financial facility including but not limited to loans, advances, letters of credit or other obligations through creation of any or all types of mortgages, charges, pledges, hypothecations, on execution of the

A.E.L

usual banking documents or instruments or otherwise encumbrance on any or all of the movable and immovable properties of the Company, either present or future or both and issuance of any other securities or sureties by any other means in favour of banks, Non-Banking Finance Companies (NBFCs) or any financial institutions and to borrow money for purpose of the Company on such terms and conditions as may be considered proper, but not to act as a banking company.

16. To invest moneys of the Company not immediately required in and subscribe for, take, acquire, hold and dispose of shares, debentures and securities of any other company or corporation whatsoever, and to invest moneys of the Company in any other manner, including investment in mutual funds and the purchase of any book or any other debts without doing the business of an investment company within the meaning of the law, but not to act as an investment company;

17. To apply for, purchase or by any other means acquire and protect, prolong and renew any patents, patent rights, trade-marks, formulae, licences, protections and concessions which may appear likely to be advantageous or useful to the Company and to use and turn to account and to manufacture under or grant licenses or privileges in respect of the same, and to spend money in experimenting upon and testing and improving or seeking to improve any patent, inventions or rights which the Company may acquire or propose to acquire:

18. To sell or dispose of the undertaking of the Company or any part thereof for such consideration as the Company may think fit and in particular for shares, debentures or securities of any other company having objects altogether or is part similar to those of this Company;

19. To create any depreciation fund, provident fund, reserve fund, sinking fund, insurance fund, or any other special fund conducive to the interest of the Company;

20. To capitalise such portion of the profits of the Company as are not distributed amongst members of the Company in the form of dividend and as the

A.E.L

Company may think fit, and to issue bonus shares as fully paid-up in favour of the members of the Company;

21. To issue any shares of the Company as fully paid-up and at par or at a premium or at a discount as provided by law;

22. To sell, improve, manage, develop, mortgage, dispose of, turn to account, or otherwise deal with all or any part of the property and rights of the Company;

23. To procure the registration or other recognition of the Company in any country, state or place and to establish and regulate agencies and open branches in any part of the world for the purposes of the Company's business;

24. To transfer the registered office of the Company from one province to another if deemed beneficial for the Company;

25. To pay the costs, charges and expenses preliminary and incidental to the formation, establishment and registration of the Company, and to remunerate any person or company for services rendered or to be rendered in placing or assisting to place, or guaranteeing the placing of any of the shares in the Company's capital or any debentures or other securities of the Company. or in or about the conduct of its business.;

26. To distribute any of the property of the Company amongst the members in specie or kind and in particular any shares. debentures or securities of other companies belonging to the Company, or of which the Company may have the power of disposing;

27. To appoint such persons or firms as may seem expedient to be general managers, officers, secretaries, managers, branch managers or district representatives of the Company upon such terms as the Company may determine;

28. To remunerate directors, officials and servants of the Company or any other person or firm or company rendering services to the Company, out of, or in proportion to the returns or profits of the Company or otherwise as the Company may think proper, either by cash payment or by the allotment to him

A.E.L

or them of shares or securities of the Company credited as paid-up in full as may be thought expedient;

29. To grant pensions, allowances, gratuity, and bonuses to officers, ex-officers, employees or ex-employees of the Company or its predecessors in business or the dependents or connections of such persons and establish and support or aid in the establishment and support of associations, institutions, funds, trusts and conveniences calculated to benefit employees and ex-employees and officers and ex-officers (including directors and ex-directors) of the Company, or the dependents or connections of such persons, and to pay gratuities or grant pensions and allowance and to make payments towards insurances, and to subscribe or guarantee money or charitable or benevolent objects, or for any exhibition, or for any public, general or useful objects;

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

31. To establish and maintain branches, receiving offices and distributing centres and to enter into contracts or agency agreements (other than a managing agency) with any other persons or firms or companies as distributing centres of the efficient carrying on of the business of the Company;

32. To adopt such means of making known and advertising the products and services of the Company as may seems expedient;

33. To take interest in, promote and undertake the formation and establishment of such institutions, businesses or companies as may be considered to be conducive to the profit and interest of the Company; and to carry on any other business which may seem to the Company capable of being conveniently carried on in connection with any of these objects or otherwise calculated, directly or indirectly, to render any of Company's property or rights for the time being profitable; and also to acquire promote, aid, foster, subsidies, or acquire an interest in any industry or undertaking in any country or countries;

A.E.L

34. To purchase or otherwise acquire and undertake the whole or any part of the business, property rights and liabilities of any persons, firm or company carrying on any business which the Company is authorised to carry on;

35. To undertake and execute any trusts which the Company may think fit and expedient;

36. To amalgamate, either in whole or in part with any company or companies or enter into any partnership with or acquire interest in the business of any other Company, person or firm carrying on or engaged in, or about to carry on or engage in any business or transaction included in the objects of the Company, or enter into any arrangement for sharing profits, or for co-operation or for mutual assistance with any such person, firm or company, or to acquire, carry on any other business auxiliary to the business of the Company or connected therewith or which may seem to the Company capable of being conveniently carried on in connection with the above or calculated directly or indirectly to enhance the value or render more profitable any of the Company's property, and to give or accept by way of consideration for any of the acts or things aforesaid or property acquired, any money, shares, debentures, debenture-stock, loan stock or securities that may be agreed upon and to hold and retain, or sell, mortgage and deal with any shares, debentures, debenture-stock or securities so received but not to engage in the business of investment companies.

37. To act in conjunction with, unite or amalgamate with, create or constitute or assist in creating or constituting any other company or association of a kind similar, wholly or partially, of the Company or for any other purpose which may seem directly or indirectly calculated to benefit this Company, and to build up or absorb all or any part of the business or property of any such company or association, and to acquire and secure membership, seat or privilege in and of any association, market or institution in Pakistan or any part of the world.

38. To do all or any of the above things in any part of the world, and either as principals, agents, contractors, trustees or otherwise, and by or through

A.E.L

trustees, agents or otherwise, either alone or in conjunction with other corporate bodies, firms or individuals, to do all such other things as are incidental or conducive to the attainment of the above objects or any of them in all parts of Pakistan as well as in all foreign countries that the Company may deem fit, but in any case not to act as managing agent; and

39. To carry on any other business which in the opinion of the Company, is capable of being conveniently and advantageously carried on by the Company in connection with and as ancillary to the objects specified above profitably with any of the Company's property or rights and generally to do an to perform all such other things or/and acts as may appear to be incidental or conducive to the attainment of the above objects or any of them, provided the same are not inconsistent with the laws of Pakistan.

It is hereby declared that the objects specified in each of the above paragraphs shall, except where otherwise expressed in any such paragraph, be regarded as independent objects, and accordingly shall in no way be restricted by reference to or inference from the objects indicated in any other paragraphs or the name of the Company, but may be carried out in as full and ample manner as if each paragraph defines the objects of a separate, distinct and independent Company.

Notwithstanding anything contained hereinabove, it is hereby declared and undertaken that the Company shall not engage in banking business or business of forex or illegal brokerage or the business of an investment or finance company or a non-banking finance company or leasing business or insurance business or business of managing agency, or engage in any unlawful business and that nothing in this Objects Clause shall be construed to entitle the Company to engage in any such business directly or indirectly and the Company shall not launch multilevel marketing (MLM), pyramid and ponzi-schemes.

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

A.E.L

IV. The liability of the members is limited.

V. The authorised capital of the Company is Rs. 5,000,000/- (Rupees five million (Five hundred thousand ordinary shares) only) divided into 500,000 ordinary shares of Rs. 10 each with power to enhance, (Rupees ten) reduce or consolidate the share capital and to divide the shares of the Company into different classes and kinds subject to the provisions of the Companies Ordinance, 1984.

A.E.L

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

No.	Name and Surname (present & former) in full (In Block Letters) with CNIC / Passport Number	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
1	ASIA PETROLEUM LIMITED (THROUGH ITS REPRESENTATIVE MR. YACOOB SUTTAR)	Incorporation No. 0032985	Pakistani	Business	14th Floor, The Harbour Front, HC-3, Dolmen City, Block 4, Scheme-5, Clifton, Karachi, 75600, Pakistan	498,000 (Four hundred ninety eight thousand)	
2	SHEIKH IMRANUL HAQUE 42301-0819482-1	Sheikh Nisarul Haque	Pakistani	Business Executive	House # 112/B, 25th Street, Khayaban-e-Bukhari, Phase VI, DHA, Karachi, Pakistan	500 (Five hundred)	
3	SYED NADIR SHAH 42301-1049967-7	Syed Nizam Shah	Pakistani	Business Executive	House # 4, Bath Island, Mary Road, Karachi, Pakistan	500 (Five hundred)	
4	YACOOB SUTTAR 42301-3267856-5	Ibrahim Suttar	Pakistani	Business Executive	House # 87/2, 18th Street, Khayaban-e-Rahat, Phase VI, DHA, Karachi, Pakistan	500 (Five hundred)	
5	GULZAR KHOJA 42301-0823044-4	Ghulam Ali Khoja	Pakistani	Business Executive	House # F/64, Block 7, Clifton, Karachi, Pakistan	500 (Five hundred)	
					Total number of shares:	500,000 (Five hundred thousand)	

Dated the 27th day of October, 2015

Witness to above signatures

Full name:	Kamran Anwar	Signature:	
Father's name:	Muhammad Anwar Tahir	CNIC#	42101-1473444-5
Full Address:	House # R-106, Gul Houses, Block-7, Gulistan-e-Jauhar, Karachi	Nationality	Pakistani
Occupation:	Business Executive		

22/6/16

A.E.L

THE COMPANIES ORDINANCE 1984

(PRIVATE COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION
O F
ASIA ENERGY (PRIVATE) LIMITED

PRELIMINARY

TABLE 'A' NOT TO APPLY

1. The regulations contained in Table "A" in the First Schedule to the Companies Ordinance 1984 shall not apply to the Company except in so far as they are repeated or contained in these Articles.

INTERPRETATION / DEFINITIONS:

2. The chapter headings shall not affect the construction hereof, and in these Articles, unless there is something in the subject or context inconsistent therewith: -

"Articles" means these Articles of Association, as originally framed or as altered from time to time by Special Resolution.

"Board" shall mean the Directors from time to time of the Company acting at a meeting or pursuant to written consent.

"Chairman" means the Chairman of the Board appointed from time to time pursuant to the Articles.

"Chief Executive" means an individual who subject to the control and directions of the directors, is entrusted with the whole, or substantially the whole, of the powers of management of the affairs of the company and includes a director or any other

Asia Energy (Private) Limited A.E.L. Karachi

"Register" means the register of members to be kept pursuant to Section 147 of the Ordinance.

"Seal" means the common seal of the Company.

"Section" means a section of the Ordinance.

"Special Resolution" has the meanings assigned thereto by clause (36) of sub-section (1) of Section 2 of the Ordinance.

"In writing" and "Written" includes printing, lithography and other modes of representing or reproducing words in a visible form.

"Words" importing the singular number include the plural number and vice versa.

"Words" importing the masculine gender only include the feminine gender and words or expressions contained in the Articles but not defined herein, shall bear the same meaning as in the Ordinance.

"Words" importing persons include bodies corporate.

PRIVATE COMPANY:

3. The Company is a private company within the meaning of clause (28) of sub-section 1 of Section 2 of Ordinance, and accordingly:

(a) the right to transfer the shares in the Company is restricted in the manner given hereunder;

(b) the number of members in the Company is restricted to fifty excluding the persons who are in the employment of the Company; Provided that where two or more persons hold one or more shares in the Company jointly they shall be treated as a single member; and

Asia Energy (Private) Limited A.E.L. Karachi

(c) no invitation shall be issued to the public to subscribe for the shares, debentures or debenture stock of the Company.

CAPITAL:

4. The Authorised capital of the Company is the amount set out in Clause V of the Memorandum divided into the number of ordinary shares of Rs. 10 (Rupees ten) each set out in that Clause.

ISSUE OF SHARES:

5. Subject to the provisions of the Ordinance and Article 7 below, the shares shall be under the control of the Board who may allot or otherwise dispose of the same or any of them to such persons, on such terms and conditions, and at such time as the Board thinks fit, and at a premium or at par or (subject to the provisions of the Ordinance) at a discount, and for such consideration as the Board thinks fit.

6. The Board shall, as regards any allotment of shares, duly comply with such provisions of Sections 68 to 73 as may be applicable.

7. Subject to Section 86, where at any time the Board decides to increase the issued capital of the Company by issuing any further shares, such shares shall be offered to the members in proportion to the existing shares held by each member, and such offer shall be made by notice specifying the number of shares to which the member is entitled, and limiting a time within which the offer, if not accepted, will be deemed to be declined and after the expiration of such time, or on receipt of information from the member to whom such notice is given that he declines to accept the shares offered, the Board may dispose of the same in such manner as it may consider most beneficial to the Company.

FRACTIONAL SHARES:

8. If and whenever as a result of an issue of new shares or any consolidation or sub-division of shares any member becomes entitled to hold shares in fractions, the

Asia Energy (Private) Limited A.E.L. Karachi

Board shall not be required to offer or issue such fractional shares and shall be entitled to sell whole shares at a reasonable price and pay and distribute to and amongst the members entitled to such fractional shares in due proportion the net proceeds of the sale thereof. For the purpose of giving effect to any such sale the Board may authorise any person to transfer the shares sold to the purchaser thereof, and the purchaser shall be registered as the holder of the shares comprised in such transfer but he shall not be entitled to see the application of the purchase money nor shall his title to the shares be affected by any irregularity or invalidity in the proceedings in reference to the sale.

SHARES IN PAYMENT FOR PROPERTY:

9. Subject to the provisions of the Ordinance and the Articles, the Board may allot and issue shares in the capital of the Company as payment or part payment for any property sold or transferred, goods or machinery supplied, or for services rendered to the Company in the conduct of the business or affairs, and any shares which may be so allotted shall be issued as fully paid up shares, and if so issued, shall be deemed to be fully paid up shares.

EVIDENCE OF MEMBERSHIP:

10. Any application for subscription signed by or on behalf of an applicant or subscriber for shares in the Company, followed by an allotment of any shares therein, shall, be an acceptance of shares within the meaning of the Articles, and every person who thus or otherwise accepts any shares and whose name is entered on the Register shall for the purpose of the Articles be a member.

TRUST NOT RECOGNISED:

11. Save as herein otherwise provided, the Company shall be entitled to treat the person whose name appears on the Register as the holder of any shares as the absolute owner thereof, and accordingly shall not (except as ordered by a Court of competent jurisdiction or as by law required) be bound to recognise any trust or equity or

Asia Energy (Private) Limited A.E.L. Karachi

benami, equitable, contingent or other claim to or interest in such shares, on the part of any other person whether or not it shall have express or implied notice thereof.

CERTIFICATES

MEMBER'S RIGHT TO CERTIFICATE:

12. Every member shall be entitled without payment to one Certificate for all the shares registered in his name, or upon paying such fee as the Board may from time to time determine, to several Certificates, each for one or more shares. Every certificate of shares shall specify the number and denote the number of shares in respect of which it is issued, and the amount paid thereon. such certificate shall be issued under Seal, and shall bear the signature of one Director and shall be counter-signed by the Secretary or by a second Director, or by some other person appointed for that purpose by the Board. The Directors, may by resolution determine, either generally or in any particular case, that the signature of any Director(s) may be affixed by some mechanical means in the mode and manner specified in such resolution. 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.

ISSUE OF NEW CERTIFICATE IN PLACE OF DEFACED LOST OR DESTROYED CERTIFICATE:

13. If any Certificate is worn-out, defaced or rendered useless, then upon production thereof to the Board, it may order the same to be cancelled and may issue a new Certificate in lieu thereof, and if any certificate is lost or destroyed, then on proof thereof, to the satisfaction of the Board and on such indemnity as the Board deems adequate being given, a new Certificate in lieu thereof shall be given to the party entitled to such lost or destroyed Certificate. The new certificate may be issued on such terms and fee as may be prescribed by the Board including payment of expenses incurred by the Company in investigating title.

Asia Energy (Private) Limited A.E.L. Karachi

TRANSFER AND TRANSMISSION

EXECUTION OF TRANSFER:

14. 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 of members in respect thereof. The Company shall keep a book to be called the "Register of Transfers" and therein shall be fairly and distinctly entered the particulars of every transfer or transmission of any share.

TRANSFER

15. The instrument of transfer of any share shall be in writing in the usual common form or in the form appearing in the next article 16 or as near thereto as circumstances will admit.

FORM OF TRANSFER:

16. **Asia Energy (Private) Limited**

"I/We,_____, son/daughter/wife of _____, and of _____ being a _____ national, called the "Transferors" in consideration of the sum of (_____) paid to me/us by _____, son/daughter/wife of _____, of _____ national(s) of _____ (hereinafter called "The Transferee(s)") do hereby transfer to the Transferee(s) _____ share(s) numbered _____ in the undertaking called **Asia Energy (Private) Limited** to hold the same unto the said Transferee(s), his (or her or their) executors, administrators and assigns subject to the several conditions on which I/we held

Asia Energy (Private) Limited A.E.L. Karachi

the same immediately before the execution hereof, and I/we, the Transferee(s), do hereby agree to take the said share(s) subject to the conditions aforesaid.

AS WITNESS my/our hands this _____ day of _____, _____

Witness

Signature ..... dated.....
[Name,
CNIC Number
And Full Address]

Witness

Signature ..... ated.....
[Name,
CNIC Number
And Full Address]

Signature.....
Transferor

Signature.....
[CNIC Number (in case of
Witness Foreigner, Passport Number)]
Transferee
Full Name, Father's /
Husband's Name
Nationality
Occupation and Address of
transferee

The Board may from time to time alter or vary the transfer form.

WHEN REGISTER MAY BE CLOSED:

17. The Board shall have power on due notice (given in the manner prescribed in the Ordinance) to close the Register of Transfers for such period(s) of time not exceeding thirty days at a time or fortyfive days in any year.

TRANSMISSION OF SHARES OF DECEASED MEMBER:

18. In the case of the death of a shareholder, the survivor, where the deceased was a joint holder, and (subject as herein- after provided), where the deceased was a sole or only surviving holder, the executors or administrators of the deceased holding a Grant or Probate or Letters of Administration or the nominees of the deceased appointed under Section 80, or any person or persons mentioned in any Succession Certificate effective in Pakistan shall be the only persons recognised by the Company as having any title to the shares, but nothing herein contained shall release the estate of a deceased holder (whether sole or joint) from any liability, (whether sole or joint), in respect of any share solely or jointly held by him. In any case in which such a Grant of Probate or Letters of Administration or Succession Certificate to the estate of a deceased sole or only surviving holder has not been obtained or a nomination was

Asia Energy (Private) Limited A.E.L. Karachi

not made by the deceased as above mentioned, the Board may, but shall not be bound to, recognise the title of any person claiming to be entitled to the deceased holder's share on production by such claimant of any other evidence of title as the Board may deem sufficient, and upon the claimant furnishing such indemnity, if any as the Board may require.

RESTRICTION ON TRANSFER:

19. The Board may decline to register any transfer of shares to a person of whom they do not approve, and may also decline to register any transfer of shares on which the Company has a lien. If the Board refuses to register a transfer of any shares it shall within thirty days after the date on which the transfer was lodged with the Company send to the transferee and the transferor notice of the refusal.

RIGHT OF THE SURVIVOR TO BE REGISTERED AS A MEMBER OR TO TRANSFER SHARES:

20. Any person becoming entitled to a share in consequence of the death or insolvency of a member shall, upon such evidence being produced as may from time to time be required by the Board, 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 Board shall, in either case, have the same right to decline or suspend registration as they would have had in the case of a transfer of the share by the deceased or insolvent person before the death or insolvency.

RIGHT OF SURVIVOR TO RECEIVE DIVIDENDS AND OTHER ADVANTAGES:

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

Asia Energy (Private) Limited A.E.L. Karachi

COMPANY NOT TO BE LIABLE:

22. The Company shall incur no liability or responsibility whatever in consequence of its registering or giving effect to any transfer of shares made or purporting to be made by any apparent legal owner thereof (as shown or appearing in the Register) to the persons having or claiming any equitable right, title or interest to or in the same shares, notwithstanding that the Company may have had notice of such equitable right, title or interest or notice prohibiting registration of such transfer, and the Company shall not be bound or required to regard or attend or give effect to any notice which may be given to it of any equitable right, title or interest, or be under any liability whatsoever for refusing or neglecting so to do, but the Company shall nevertheless be at liberty to regard and attend to any such notice and give effect thereto, if the Board shall so think fit.

ALTERATION OF CAPITAL

POWER TO INCREASE AUTHORISED CAPITAL:

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

24. Except and so far as otherwise provided by the conditions of issue or by the Articles, any capital raised by the creation of new shares shall be considered part of the authorised capital and shall be subject to the provisions herein contained with reference to transfer and transmission, voting and otherwise.

POWER TO REDUCE SHARE CAPITAL:

25. The Company may by Special Resolution reduce its share capital in any manner and with and subject to any incident authorisation and consent required by law.

POWER TO SUB-DIVIDE OR CONSOLIDATE SHARES:

26. Subject to Section 92, the Company may in General Meeting by ordinary resolution alter the conditions of its Memorandum as follows:

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

(b) sub-divide shares or any of them into shares of smaller amounts than originally fixed by the Memorandum, subject nevertheless to the provisions of the Ordinance in that behalf;

POWER TO CANCEL SHARES NOT TAKEN:

(c) cancel shares which at the date of such General Meeting have not been taken or agreed to be taken by any person and diminish the amount of its share capital by the amount of the shares so cancelled.

POWER TO BORROW:

POWER OF THE BOARD:

27. The Board may from time to time borrow any moneys for the purposes of the Company from the members or from any other persons, firms, companies, corporations, Government Agencies, institutions or banks, or the Directors may themselves lend moneys or provide finance to the Company.

GIVING OF SECURITIES:

28. The Board may borrow moneys and secure payment thereof in such manner and upon such terms and conditions in all respects as it may think fit, and in particular by the issue of bonds, debentures, or by mortgage or charge or other security on the whole or any part of the property, assets and rights of the Company, (both present and future), including its undertaking.

Asia Energy (Private) Limited A.E.L. Karachi

CONDITIONS OF BONDS, ETC:

29. Any bonds, debentures or other securities issued or to be issued by the Company shall be under the control of the Board which may issue them upon such terms and conditions and in such manner and for such consideration as shall be considered by the Board to be for the benefit of the Company.

ISSUE AT DISCOUNT:

30. Any bonds, debentures or other securities may be issued at a discount or premium or otherwise and with any special privileges as to redemption, surrender, drawings, convertibility into shares, attending and voting at General Meetings of the Company, appointment of Directors, and otherwise subject, however, to the approval of the Members in a General Meeting of the Company.

INDEMNITY TO DIRECTORS:

31. If the Directors or any of them or any employee of the Company shall become personally liable for the payment of any sum primarily due from the Company, the Board may execute or cause to be executed any mortgage, charge or security over or affecting the whole or any part of the assets of the Company by way of indemnity to secure the Directors or such employees so becoming liable as aforesaid from any loss in respect of such liability.

GENERAL MEETINGS

GENERAL MEETING WHEN TO BE HELD:

32. A General Meeting, to be called Annual General Meeting, shall be held, in accordance with the provisions of Section 158, within eighteen months from the date of incorporation of the Company and thereafter once at least in every calendar year within a period of four months following the close of its financial year and not

A.E.L.

more than fifteen months after the holding of its last preceding Annual General Meeting as may be determined by the Board.

EXTRAORDINARY GENERAL MEETING:

33. All general meetings of the Company other than an Annual General Meeting shall be called Extraordinary General Meetings.

WHO MAY CALL EXTRAORDINARY GENERAL MEETINGS:

34. The Chief Executive or, in his absence, any two Directors, may call an Extraordinary General Meeting, and Extraordinary General Meetings shall also be called on such requisition, or in default, may be called by such requisitionists, as is provided by Section 159.

NOTICE OF MEETINGS:

35 Twenty one days' notice at the least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given) specifying the place, the day and the hour of General Meeting and, in case of special business, all material facts concerning such business, shall be given in a manner provided by the Ordinance for the General Meetings to such persons as are, under the Ordinance or the Articles, entitled to receive such notices from the Company.

SPECIAL BUSINESS:

36. All business shall be deemed special that is transacted at an Extraordinary General Meeting, and also all that is transacted at an Annual General Meeting with the exception of declaring a dividend, the consideration of the accounts, balance sheet and the reports of Directors and Auditors, the election of Directors, the appointment of, and the fixing of the remuneration of the Auditors. Where it is proposed to pass a Special Resolution at a General Meeting, notice of the Meeting shall specify the intention to propose the Resolution as a Special Resolution.

Asia Energy (Private) Limited A.E.L. Karachi

OMISSION TO GIVE NOTICE:

37. In a case in which notice of any Meeting is given to the shareholders individually, the accidental omission to give notice to any of the shareholders or the accidental non-receipt thereof shall not invalidate the proceedings at any such Meeting.

PROCEEDINGS AT GENERAL MEETING

QUORUM

38. Provided that at least two members are present in person, members representing not less than twenty five (25%) per cent of the total voting power in the Company either on their own account or as proxies shall be a quorum for a General Meeting. No business shall be transacted at any General Meeting unless the quorum requisite is present at the time when the Meeting proceeds to business.

WHO TO PRESIDE IN GENERAL MEETING:

39. The Chairman shall be entitled to take the chair at every General Meeting. If there is no Chairman or if at any Meeting he shall not be present within fifteen minutes after the time appointed for holding such Meeting or is unwilling to act, the Directors present may elect a Director as Chairman and if none of the Directors is present or being present is unwilling to act as Chairman, the members present shall choose one of the members to be the Chairman.

ADJOURNMENT OF MEETING FOR LACK OF QUORUM:

40. If within half an hour after the time appointed for the holding of a General Meeting a quorum is not present, the Meeting if convened on the requisition of the members, shall be dissolved, and in every other case shall stand adjourned to the same day in the week following at the same time and place. If at the adjourned meeting a quorum is not present the member or members present personally or by proxy shall be the quorum and may transact the business for which the meeting was called.

ADJOURNMENT BY CHAIRMAN:

41. The Chairman with the consent of a General Meeting may adjourn any Meeting from time to time and from place to place, but no business shall be transacted at any adjourned Meeting other than business left unfinished at the Meeting from which the adjournment took place.

VOTING ON RESOLUTIONS BY SHOW OF HANDS AND WHEN POLL DEMANDED:

42. At any General Meeting a Resolution put to the vote of the Meeting shall be decided on a show of hands, unless a poll is (before or on the declaration of the results of the show of hands) demanded by at least one member present in person or by proxy if not less than seven members are personally present or by two members present in person or by proxy if more than seven members are personally present or by the Chairman of the Meeting, or by any member or members present in person or by proxy and having not less than one-tenth of the total voting power in respect of the resolution or by any member or members present in person or by proxy and holding shares in the Company conferring a right to vote on the resolution being shares on which an aggregate sum has been paid up which is not less than one-tenth of the total sum paid up on all the shares conferring that right, and unless a poll is so demanded, a declaration by the Chairman that a resolution has been carried or carried unanimously or by a particular majority or lost, and an entry to that effect in the books of the proceedings of the Company shall be conclusive evidence of the fact without further proof of the number or proportion of the votes recorded in favour of or against such Resolution.

POLL:

43. If a poll is demanded as aforesaid it shall be taken in such manner and at such time and place as the Chairman of the Meeting directs, and either at once or after an interval or adjournment of not more than fourteen days from the day on which the poll is demanded and the results of the poll shall be the resolution passed at the

Atlas Energy (Private) Limited A.E.L. Karachi

Meeting at which the poll was held. The demand for a poll may be withdrawn at any time by the person or persons who made the demand.

POLL ON ELECTION OF CHAIRMAN AND ADJOURNMENT:

44. Any poll demanded on the election of a Chairman of a Meeting or on any question of adjournment shall be taken at the Meeting and without adjournment.

EFFECT OF POLL:

45. The demand for a poll shall not prevent the continuation of a Meeting for the transaction of any business, other than the question on which the poll was demanded.

MINUTES:

46. Minutes shall be made in books provided for the purpose of all resolutions and proceedings at General Meetings, and any such Minutes if signed by any person purporting to have been the Chairman of the Meeting or next following Meeting shall be receivable as evidence of the facts therein stated without further proof.

MINUTE BOOKS:

47. The Books containing Minutes of proceedings of General Meetings of the Company shall be kept at the Office and shall during business hours (subject to reasonable restrictions as the Board may from time to time impose but so that no less than two hours each day is allowed for inspection) be open to the inspection of any member without charge.

VOTES OF MEMBERS

VOTE OF MEMBERS:

48. Except as provided in Article 64 hereof, upon a show of hands every member entitled to vote and present in person or by proxy shall have one vote, and upon a

poll every member entitled to vote and present in person or by proxy shall have one vote for every share held by him.

RIGHT TO VOTE OF JOINT HOLDERS:

49. 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.

REPRESENTATIVES OF CORPORATE MEMBERS:

50. A company or other body corporate which is a member of the Company may, by resolution of its Directors, or proxy signed by authorised officers, authorise any of its official or any other persons to act as its representative at any meeting of the Company and the person so authorised shall be entitled to exercise the same powers on behalf of the company which he represents as if he were an individual shareholder of the Company.

VOTING BY MEMBER OF UNSOUND MIND:

51. 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 on show of hands or on a poll, by his committee or other legal guardian, and any such committee or guardian may, on a poll, vote by proxy.

POLL BY PROXY:

52. On a poll votes may be given either personally or by proxy.

PROXY:

53. Every proxy shall be appointed in writing under the hand of the appointer or by an agent duly authorised under a Power of Attorney or if such appointer is a company or corporation under the Common Seal of the company or corporation or the hand of its Attorney who may be the appointer. A proxy need not be a member. A proxy

shall have such right as respects speaking and voting at a Meeting as are available to a member personally present at the Meeting. A member shall not be entitled to appoint more than one proxy to attend any one Meeting. If any member appoints more than one proxy for any one Meeting and more than one instruments of proxy are deposited with the Company, all such instruments shall be rendered invalid.

IRREVOCABLE PROXY:

54. Any proxy declared expressly on its face to be irrevocable shall not be revoked or be deemed revoked by the member giving such proxy without the consent of the proxy-holder, whether by attendance at any General Meeting held during the period of such proxy or by any other action on his part whatsoever or otherwise during the term of such proxy if such proxy is furnished to and filed with the records of the Company, and the Company shall be bound to recognise and give effect to such proxy in accordance with the terms thereof.

PROXY TO BE DEPOSITED AT THE OFFICE:

55. No person shall act as proxy unless the instrument of his appointment and the Power of Attorney, if any, under which it is signed, shall be deposited at the Office at least forty eight hours before the time for holding the Meeting at which he proposed to vote.

FORM OF PROXY:

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

"I/We _____ of _____ in the district of _____ being a member of **Asia Energy (Private) Limited** hereby appoint _____ of _____ as my proxy to vote for me/us and on my/our behalf at the (annual, extraordinary, as the case may be) general meeting of the Company to be held on the _____ day of _____ and at any adjournment thereof."

Signed this _____ day of _____

Asia Energy (Private) Limited A.E.L. Karachi

VALIDITY OF PROXY:

57. A vote given in accordance with the terms of an instrument of proxy shall be valid notwithstanding the previous death of principal or revocation of the proxy or of any power of attorney under which such proxy was signed, provided that no intimation in writing of the death or revocation shall have been received at the Office of the Company before the Meeting or the adjourned Meeting at which proxy is used.

VALIDITY OF VOTE:

58. No objection shall be made to the validity of any vote except at the Meeting or at the poll at which such vote shall be tendered, and every vote whether given personally or by proxy not disallowed at such Meeting or poll shall be deemed valid for all purposes of such Meeting or poll.

CHAIRMAN TO DECIDE:

59. If any question is raised, the Chairman of the Meeting shall decide on the validity of every vote tendered at such Meeting in accordance with these Articles.

DIRECTORS

60. The number of Directors of the Company shall not be less than two elected Directors (including the first Directors appointed under Article 61). The Board shall fix the number of elected Directors of the Company not later than thirty five days before the convening of the General Meeting at which Directors are to be elected, and the number so fixed shall not be changed except with the prior approval of the General Meeting of the Company.

FIRST DIRECTORS:

61. The number and names of the first Directors shall be determined by the subscribers to the Memorandum.

TERM OF OFFICE, REMOVAL AND CASUAL VACANCIES

FIRST DIRECTORS TO RETIRE:

62. The first Directors of the Company shall stand retired from office at the first Annual General Meeting of the Company, unless a Director resigns earlier or becomes disqualified as a Director or otherwise to hold office.

NOTICE FOR ELECTION AS A DIRECTOR

63. Any person who seeks to contest an election to the office of Director shall, whether he is a retiring Director or otherwise, file with the Company, not later than fourteen days before the date of meeting at which elections are to be held, a notice of his intention to offer himself for election as a Director, provided that any such person may, at any time, before the holding of elections withdraw such notice.

ELECTION OF DIRECTORS

64. (i) After the first appointment of Directors, the number of elected Directors fixed by the Board under Article 60 shall be elected to office by the members in General Meeting in the following manner, namely:

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

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

- the candidate who gets the highest number of votes shall be declared elected as Director and then the candidate who gets the next highest number of votes shall be so declared, and so on until the total number of Directors to be elected has been so elected.

(ii) Where the number of candidates is equal to or less than the number of Directors to be elected it will not be necessary to hold an election as laid down in clause (i) of

this Article and all the candidates shall be deemed to have been elected under this Article.

In addition to the Directors elected or deemed to have been elected by the shareholders, a Company may have, subject to the provisions of the Ordinance, Directors nominated by the Company's creditors or other special interests by virtue of contractual arrangements.

TERM OF OFFICE:

65. A Director elected under Article 64 shall hold office for a period of three years, unless he earlier resigns, becomes disqualified from becoming a Director or otherwise ceases to hold office. A retiring Director shall be eligible for re-election. An election of Directors in the manner prescribed by the preceding Article shall be held once in every three years.

REMOVAL:

66. The Company may by resolution in General Meeting remove a Director appointed under Article 61 or 68 or elected or deemed to have been elected under Article 64:

Provided that a resolution for removing a Director shall not be deemed to have been passed if the number of votes cast against the resolution is equal to or exceeds:

(i) the minimum number of votes that were cast for the election of a Director at the immediately preceding election of Directors, if the resolution relates to removal of a Director elected in the manner provided in or under Article 64; or

(ii) the total number of votes for the time being computed in the manner laid down in Article 64 divided by the number of Directors for the time being, if the resolution relates to removal of a Director appointed under Article 61 or 68.

CONTINUING DIRECTORS TO ACT:

67. The continuing Directors may act notwithstanding any vacancy in their body, but if

the minimum falls below the number fixed by Article 61 hereof, the Directors shall not, except for the purpose of filling a vacancy in their number or of convening a General Meeting, act so long as the number remains below the minimum.

FILLING CASUAL VACANCY:

68. The Directors may at any time appoint any person to be a Director to fill a casual vacancy in the Board. Any Director so appointed shall hold office for the remainder of the term of the Director in whose place he is appointed.

REMUNERATION OF DIRECTORS:

69. Every Director (including an alternate Director) shall be entitled to be paid as remuneration for his services for attending Meetings of the Board or of Committees of Directors, a fee in such amount as may be fixed from time to time by the Board and unless otherwise determined shall not exceed Rs 500/- (Rupee Five hundred) per meeting at which the Directors shall be present from the commencement till the end of the business transaction. Each Director (including each alternate Director), shall be paid such travelling, boarding, lodging and shall be entitled to be reimbursed his reasonable expenses incurred in consequence of his attendance at meetings of the Directors, or of Committees of Directors.

EXTRA REMUNERATION MAY BE PAID TO A DIRECTOR:

70. Any Director who devotes special attention to the business of the Company, (including holding the office of the Chairman) or who otherwise performs services which, in the opinion of the Board, are outside the scope of the statutory duties of a Director may be paid such extra remuneration as may be determined by the Board, provided that a Director shall not, without the sanction of the Company in General Meeting, accept or hold an office of profit under the Company other than that of chief executive or a legal or a technical adviser or a banker.

SHARE QUALIFICATION

SHARE QUALIFICATION FOR DIRECTORS.

71. The qualification of a Director shall be that he must be a Member, unless he represents the Government or an institution or an authority which is a Member on

A.E.L.

the Board, or is a whole time working Director who is an employee of the Company, or a Chief Executive or a person representing a creditor on the Board.

GENERAL POWERS OF COMPANY VESTED IN DIRECTORS:

72. The control of the Company shall be vested in the Board and the business of the Company shall be managed by the Board, which may pay all expenses incurred in forming and registering the Company, and may exercise all such powers of the Company as are not by the Ordinance or by these Articles required or by a Special Resolution required to be exercised by the Company in General Meeting.

POWER TO OBTAIN FINANCES AND GIVING OF SECURITIES:

73. The Board may exercise all the powers of the Company to borrow and mortgage or charge its undertaking, property and assets, (both present and future), and to issue debentures and other securities. whether outright or as collateral security for any debt, liability or obligation of the Company, or of any third party.

MINUTE BOOKS

74. (i) The Board shall cause Minutes to be made in books provided for the purpose:

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

(b) of the names of Directors present at each meeting of the Board and of any Committee of Directors;

(c) of all resolutions and proceedings at all meetings of the Company, and of the Board, and of Committee of Directors;

and every Director (including Alternate Director) present at any meeting of Board shall sign his name in a Book to be kept for the purpose.

(ii) Any such minutes of any Meeting of the Board or of a Committee of Directors or of the Company, if signed or purporting to be signed by the Chairman of such Meeting, or of the next succeeding Meeting, shall be receivable as evidence of the matters stated in such minutes.

(iii) A copy of the minutes of the meetings of the Board shall be furnished to every Director within fourteen days of the date of the meeting.

POWERS TO PAY PENSIONS, ETC.

75. The Board may pay and agree to pay pensions or other retirement, superannuation, death or disability benefits or allowances to any person in respect of any Director or former Director who may hold or may have held any executive office or employment under the Company, or any subsidiary company of the Company, or its holding company, (if any), and for the purpose of providing any such pensions or other benefits or allowances, may contribute to any scheme or fund and may make payments towards insurances or trusts in respect of such persons.

DIRECTORS TO COMPLY WITH THE ORDINANCE:

76. The Directors shall duly comply with the provisions of the Ordinance or any statutory modification thereof for the time being in force, and in particular with the provisions in regard to the registration of the particulars of mortgage and charges affecting the property of the Company or created by it, to the keeping of a register of the Directors, and to the sending to the Registrar of an annual list of members, and a summary of particulars relating thereto and notice of any consolidation or increase of share capital, or sub-division of shares, and copies of special resolutions and a copy of the register of Directors and notification of any changes therein.

POWER TO APPOINT ATTORNEYS

77. The Directors may from time to time and at any time by power of attorney appoint any company, firm or person or body of persons, whether nominated

directly or indirectly by the Directors, to be the attorney or attorneys of the Company for such purposes and with such powers authorities and discretions (not exceeding those vested) and such period and subject to such conditions if any as they may think fit, and any such powers of attorney may contain such provisions for the protection and convenience of persons dealing with any such attorney to delegate all or any of the powers, authorities and discretions vested in him.

DIRECTOR MAY HOLD OFFICE OF PROFIT

78. A Director of the Company or a firm of which such Director is a partner, or a private company of which such Director is a Director, may with the consent of the Company in general meeting hold any office of profit in the Company.

DIRECTORS MAY MAKE CONTRACTS WITH THE COMPANY

79. Subject to the provisions of the Ordinance, a Director shall not be disqualified from contracting with the Company either as a vendor, purchaser, or otherwise, nor shall any such contract or agreement entered into by or on behalf of the Company with any company or partnership of or in which any Director of the Company shall be a member or otherwise interested be avoided nor shall any such Director so contracting or being such member or so interested be liable to account to the Company for any profit realised by any such contract or arrangement by reason of such Director holding that office or of the fiduciary relation thereby established, but the nature of his interest must be disclosed by him at the meeting of the Directors at which the contract or arrangement is determined on, if the interest then exists, or in any other case at the first meeting of the Directors after the acquisition of the interest. A general notice that any Director of the Company is a Director or a member of any other company or is a member of any named firm and is to be regarded as interested in any subsequent transaction with such company or firm shall as regards any such transaction be sufficient disclosure under this Article and subject to the provisions of Section 214 of the Ordinance, after any such general notice it shall not be necessary to give any special notice relating to any particular transaction with such firm or company. In the case of a contract for the appointment of a manager of the

company, the provisions of Section 218 of the Ordinance shall be observed and performed.

REGISTER OF CONTRACTS WITH DIRECTORS

80. In accordance with the provisions of Section 219 of the Ordinance a register shall be kept by the Directors in which shall be entered particulars of all contracts or arrangements to which Article 79 applies and which shall be open to inspection by any Member at the Office during business hours.

MANNER OF SIGNING CERTAIN DOCUMENTS

81. All cheques, promissory notes, drafts, bills of exchange and other negotiable instruments, and all receipts for moneys paid to the Company, shall be signed, drawn, accepted, endorsed or otherwise executed, as the case may be, in such manner as the Directors shall from time to time by resolution determine.

PROCEEDINGS OF DIRECTORS

MEETINGS OF DIRECTORS:

82. The Directors may meet together for the despatch of business, adjourn, and otherwise regulate meetings of the Board as they think fit. A Resolution moved at any meeting of Directors shall be passed by a simple majority vote. In the case of an equality of votes, the Chairman shall have a casting or second vote. A Director may at any time summon a meeting of the Board. Unless otherwise decided by the Board, at least seven clear days notice must be given to all Directors to summon a meeting of the Board, and such meeting shall set forth the purpose or purposes for which such meeting is summoned. With the consent of all the Directors entitled to receive notice of a meeting, or to attend or vote at any such meeting, a meeting of the Board may be convened by shorter notice than specified in this Article. Any Director may waive notice of the time, place and purpose of any meeting of Directors either before, at or after such meeting.

QUORUM OF DIRECTORS' MEETINGS AND POWERS:

83. A meeting of the Board for the time being at which a quorum is present shall be competent to exercise all or any of the authorities, powers and discretion by or under the Articles vested in or exercisable by the Board generally. Two Directors personally present shall constitute a quorum.

MATTERS REQUIRING SPECIFIC APPROVAL OF BOARD

84. No resolution, concerning any matter listed below when put to vote, shall be deemed to be carried except when voted in favour of such resolution by a majority of Directors, for the time being, of the Company;

i. The issue or allotment of any existing or new shares in the capital of the Company.

ii. The exercise of borrowing power and the issue of guarantees and indemnities on behalf of the Company.

iii. The issue of securities and redeemable capital for and on behalf of the Company.

iv. Investment in any business competing with the business of the Company.

v. Investment of the Company's funds in any asset property or security.

vi. Unilateral repudiation of agreements for the supply of products of the Company.

vii. Capital expenditure exceeding such limit as may be fixed by a resolution of the Directors from time to time in respect of any unit of an asset owned or to be acquired by the Company.

viii. Sale or disposal of the undertaking of the Company or any substantial part thereof or any unit of an asset of the Company of such monetary limit as may be fixed by a resolution of the Directors from time to time.

A.E.L.

ix. Granting of loans to or guaranteeing the indebtedness of any person excluding those in the permanent employment of the Company and paid Directors.

All other questions arising at any meeting of Directors shall be decided by a simple majority of votes. In the case of equality of votes, the Chairman of the meeting shall have a second or casting vote.

AS TO PRESIDING AT DIRECTORS MEETING:

85. The Chairman shall, whenever present, preside as Chairman at each meeting of the Board, but if at any meeting the Chairman is present and not willing to act or is absent beyond ten minutes after the time fixed for holding the same, the Directors present shall within fifteen minutes of the time fixed for the meeting choose one of their members to be Chairman of such meeting.

WHEN ACTS OF MEETINGS OF THE BOARD OR COMMITTEE VALID NOTWITHSTANDING DEFECTIVE APPOINTMENT ETC.

86. All acts done by any meeting of the Board or of a Committee of Directors, or by any person acting as a Director or alternate Director shall, notwithstanding that it be afterwards discovered that there was some defect in the appointment of any such Directors or persons acting as aforesaid, or that they or any of them were disqualified, be as valid as if every such Director or person had been duly appointed and was qualified to act. Provided that as soon as any such defect has come to notice, the Director or other person concerned shall not exercise the right of his office till the defect has been rectified.

RESOLUTION BY CIRCULATION:

87. A resolution in writing signed by a majority of the Directors (including any alternate Director) shall be effective as if such resolution had been passed at a meeting of the Directors, provided that the resolution has been circulated to all Directors.

A.E.L

ALTERNATE DIRECTOR

POWER TO APPOINT ALTERNATE DIRECTOR:

88. Any Director not permanently resident in Pakistan or any Director so resident but intending to be absent from Pakistan for a period of not less than three months may appoint any person acceptable to the Board to be an Alternate Director of the Company to act for him. Every such appointment shall be in writing under the hand of the Director making the appointment. An Alternate Director so appointed shall not be entitled to appoint another Director, but shall otherwise be subject to the provisions of the Articles with regard to Directors, except that he need not be a member nor shall he require any share qualification. An Alternate Director shall be entitled to receive notices of all meetings of the Board, and to attend and vote as a Director at any such meeting at which the Director appointing him is not personally present, and generally to perform all the functions of his appointer as Director in the absence of such appointer. An Alternate Director shall ipso facto cease to be an Alternate Director if his appointer for any reason ceases to be a Director or if and when his appointer comes or returns to Pakistan, or if the appointee is removed from office by notice in writing under the hand of the appointer.

COMMITTEES OF DIRECTORS

COMMITTEES OF DIRECTORS:

89. The Board may from time to time delegate all, or any of their powers not required to be exercised at a meeting of the Board to a committee or committees consisting of two or more Directors as the Board thinks fit. Any committee so formed shall conform to any regulations that may be imposed upon it by the Board and shall be governed, in the exercise of the powers so delegated, by the provisions herein contained for regulating meetings and proceedings applicable to the Directors.

CHAIRMAN AND CHIEF EXECUTIVE

APPOINTMENT OF CHAIRMAN:

90. Upon the first appointment, and thereafter upon each election of Directors or

A.E.L

whenever the office of the Chairman becomes vacant for whatsoever reason, the Directors shall (i) appoint a Director as the Chairman of the Board and (ii) determine the period for which he is to hold office.

APPOINTMENT OF CHIEF EXECUTIVE:

91. (i) The Board shall within fourteen days of the incorporation of the Company appoint an individual (including a Director) as the chief executive of the Company designated as the Chief Executive. The first Chief Executive shall hold office until the first Annual General Meeting of the Company (unless he earlier resigns or otherwise ceases to hold office) or until the expiry of a shorter period if the Board had fixed a shorter period for this appointment. If the Chief Executive ceases to hold office before the first Annual General Meeting, the Board shall fill the vacancy within fourteen days, but the person appointed to fill the vacancy shall hold office only till the first Annual General Meeting.

(ii) Within fourteen days from the date of an election of Directors under Article 63 or within fourteen days from the date on which office of a Chief Executive falls vacant for whatsoever reason, the Board shall appoint any person (including an elected Director) to be the chief executive of the Company designated as Chief Executive, but such appointment shall not be for a period exceeding three years from the date of appointment.

(iii) Upon the expiry of his term of appointment under clauses (i) and (ii) above a Chief Executive shall be eligible for re-appointment.

(iv) The Chief Executive shall, if he is not already a Director of the Company, be deemed to be its Director and be entitled to all the rights and privileges, and subject to all the liabilities of the office of Director of the Company.

(v) The Directors of the Company may by a resolution passed by not less than three-fourths of the total number of Directors for the time being, or the Company may by a special resolution, remove a Chief Executive before the

expiration of his term of office notwithstanding any thing contained (if any) in these Articles or in any agreement between the Company and the Chief Executive.

(vi) The terms and conditions of appointment of the Chief Executive shall be determined by the Board.

POWERS OF CHIEF EXECUTIVE:

92. The Chief Executive shall have overall authority over and responsibility for the management of the affairs of the Company and the conduct, and the custody and maintenance of its properties, assets, records and accounts in accordance with the policies and guidelines established by the Board. In addition, the Board may entrust to and confer upon a Chief Executive any of the powers exercisable by the Board (other than the powers which are required to be compulsorily exercised under the Ordinance by the Board at its meeting) upon such terms and conditions and with such restrictions as it may think fit, and may from time to time revoke, withdraw, alter or vary all or any of such powers.

DISQUALIFICATION OF DIRECTORS

VACATION OF OFFICE OF DIRECTORS:

93. The office of a Director shall ipso facto be vacated if:

(a) he becomes ineligible to be appointed a Director on any one or more of the grounds enumerated as follows, that is to say, he:

(i) is a minor;

(ii) is of unsound mind;

(iii) has applied to be adjudicated as an insolvent and his application is pending;

(iv) is an undischarged insolvent;

(v) has been convicted by a court of law for an offence involving moral turpitude;

(vi) has been debarred from holding such office under any provision of the Ordinance;

(vii) has displayed lack of fiduciary behaviour and a declaration to this effect has been made by the Court under Section 217 at any time during the preceding five years;

(viii) is not a member:

Provided that this clause (viii) shall not apply in the case of:

(i) a person representing the Government or an institution (including a multi-national company or authority which is a member;

(ii) a whole-time Director who is an employee of the Company;

(iii) a chief executive; or

(iv) a person representing a creditor;

(b) he absents himself from three consecutive meetings of the Directors or from all the meetings of the Directors for a continuous period of three months, whichever is the longer, without leave of absence from the Directors; the appointment of an alternate Director will constitute leave of absence from the Board to the Director for whom such alternate is appointed during such Director's absence;

A.E.L

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

(i) without the sanction of the Company in General Meeting accepts or holds any office of profit under the Company other than that of the Chief Executive or a legal or technical adviser or a banker; or

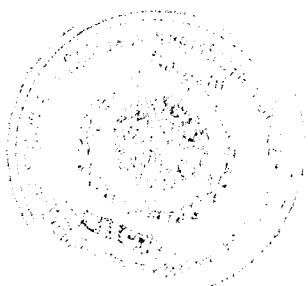
(ii) accepts a loan or guarantee from the Company in contravention of Section 195 (if applicable in terms of that section);

(d) he resigns his office by notice in writing to the Company;

(e) he, being a Director who is an employee of the Company, ceases to be an employee of the Company for whatsoever reason;

(f) he, being an employee of an affiliate of the Company, ceases to be an employee of the Company's affiliate; or

(g) he does not hold or ceases to hold the share qualification, if any, necessary for his appointment.



THE SEAL

CUSTODY OF SEAL:

94. The Board shall provide a Seal for the purposes of the Company and for the safe custody of the Seal, and the Seal shall never be used except by the authority of the Board or a Committee of Directors previously given, and one Director at least shall sign (in the same manner as provided for in Article 12) every instrument to which the Seal is affixed. The Board shall also have power to destroy the Seal and substitute a new Seal therefor, if necessary.

DIVIDENDS AND RESERVES

DECLARATION OF DIVIDENDS AND RESTRICTIONS ON AMOUNT THEREOF:

95. The Company in General Meeting may declare dividends, but no dividends shall exceed the amount recommended by the Board.

INTERIM DIVIDEND:

96. The Board may from time to time pay to the Members such interim dividends as appear to be justified by the profits of the Company.

DIVIDEND OUT OF PROFITS ONLY:

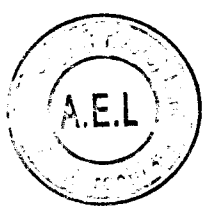
97. No dividends shall be paid otherwise than out of profits of the year, or any other undistributed profits from prior years.

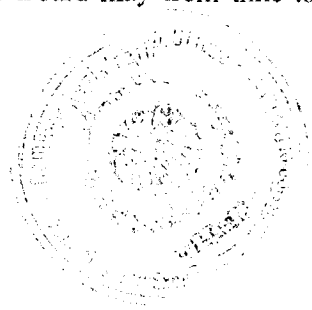
DISTRIBUTION OF DIVIDENDS:

98. The profits distributed as dividends shall be distributed among the shareholders and all dividends shall be declared and paid according to the amounts paid on the shares.

POWER OF BOARD TO CREATE RESERVE:

99. The Board may before recommending any dividend, set aside out of the profits of the Company such sum as it thinks proper as a reserve or reserves, which shall, at the discretion of the Board, be applicable for meeting contingencies, or for equalising dividends, or for any other purpose to which the profits of the Company may be properly applied, and pending such application may, in the like discretion, either be employed in the business of the Company or be invested in such investments, (other than shares of the Company), as the Board may from time to time think fit.





RECEIPTS FOR DIVIDENDS BY JOINT HOLDERS:

100. If several persons are registered as joint holders of any share, any one of them may give effectual receipts for any dividends payable on the share.

NO INTEREST ON DIVIDENDS:

101. No dividend shall bear interest against the Company. The Dividend shall be paid within the period laid down in the Ordinance.

PAYMENT BY POST:

102. (a) Any dividend may be paid by cheque or warrant sent through the post to the registered address of the member or person entitled thereto, or in the case of joint holders to any one of such joint holders at his registered address, or to such person and at such address as the member or person entitled or such joint holders, as the case may be, may direct. Every such cheque or warrant shall be made payable to the order of the person to whom it is sent, or to the order of such other person as the member or person entitled or such joint holders, as the case may be, may direct.

(b) Unclaimed dividends may be invested or otherwise used by Board for the benefit of the Company until claimed.

CARRYING FORWARD OF PROFITS:

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

CAPITALISATION

CAPITALISATION OF RESERVES:

104. Any General Meeting may, upon recommendation of the Board, by ordinary resolution resolve that any undistributed profits of the Company including profits

carried and standing to the credit of any reserve or reserves or other special accounts or representing premiums received on the issue of shares and standing to the credit of the share premium account and other free reserves be capitalised. Such capitalised undistributed profits and reserves shall be distributed amongst such of the shareholders as would be entitled to receive the same if distributed by way of dividend, and in the same proportions, on the footing that they become entitled thereto as capital. All or any part of such capitalised fund may be applied on behalf of such shareholders for payment in full or in part either at par or at such premium as the resolution may provide, for any unissued shares or debentures of the Company which shall be distributed accordingly, and such distribution or payment shall be accepted by such shareholders in full satisfaction of their interest in the said capitalised sum.

ACCOUNTS

BOOKS OF ACCOUNT TO BE KEPT:

105. The Board shall cause to be kept proper books of account as required under the Ordinance.

WHERE TO BE KEPT:

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

INSPECTION BY MEMBERS

107. The Board shall from time to time determine whether and to what extent and at what time and places and under what conditions or regulations the accounts and books or papers of the Company or any of them shall be open to inspection of members, and no members (not being a Director) shall have any right of inspecting any account and books or papers of the Company except as conferred by law or authorised by the Board or by the members by Special Resolution.

PROFIT AND LOSS ACCOUNT AND BALANCE SHEET:

108. Within eighteen months of the incorporation of the Company, and subsequently once at least in every calendar year, the Directors shall cause to be prepared and laid before the Company in General Meeting a balance sheet and profit and loss account, both made up in accordance with the Ordinance and to a date not more than four months before the date of the Meeting for the period, in the case of first balance sheet and profit and loss account, since the incorporation of the Company, and in case of any subsequent balance sheet and profit and loss account, since the preceding account. Every such balance sheet shall be accompanied by an Auditor's report and the Directors' report in accordance with the provisions of the Ordinance in that behalf.

COMPLIANCE WITH ORDINANCE

109. The Directors shall in all respects comply with Sections 230 to 237 in regard to accounts of the Company.

COPIES OF DIRECTORS' REPORT AND BALANCE SHEET TO BE SENT TO MEMBERS:

110. A copy of the Balance Sheet and Profit and Loss Account together with a copy of the Auditors' report and Directors' report shall be sent to all members along with the notice convening the Annual General Meeting before which the same are required to be laid at least twenty one days preceding the Meeting.

AUDIT

APPOINTMENT OF AUDITORS AND THEIR DUTIES:

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

A.E.L

NOTICES

HOW NOTICE TO BE SERVED ON MEMBERS

112. (1) A notice may be given by the Company to any member or Director either personally or by sending it by post to him at his registered address or, (if he has no registered address in Pakistan), to the address, if any, within or outside Pakistan supplied by him to the Company for the giving of notices to him. A notice may be given by telex or facsimile transmission.

SERVICE BY POST:

(2) Where a notice is sent by post, service of the notice shall be deemed to be effected by properly addressing, prepaying and posting a letter containing the notice, and, unless the contrary is proved, to have been effected at the time at which the letter would be delivered in the ordinary course of post.

NOTICE TO MEMBERS ABROAD BY ADVERTISING IN NEWSPAPERS:

113. If a member or Director has no registered address in Pakistan and has not supplied to the Company an address within or outside Pakistan for the giving of notices to him, a notice addressed to him or to the shareholders or Directors generally and advertised in a newspaper circulating in the District in which the Office is situated shall be deemed to be duly given to him on the day on which the advertisement appears.

NOTICE TO JOINT HOLDER:

114. A notice may be given by the Company to the joint holder of a share by giving the notice to the Joint holder named first in the Register in respect of the share.

NOTICE TO PERSONS ENTITLED BY TRANSMISSION:

115. A notice may be given by the Company to the persons entitled to a share in

consequence of the death or insolvency of a member by sending it through the post in a prepaid letter addressed to them by name, or by the title of representatives of the deceased, or assignee of the insolvent, or by any like description, at the address, (if any) in Pakistan supplied for the purpose by the persons claiming to be so entitled, or (until such an address has been so supplied) by giving the notice in any manner in which the same might have been given if the death or insolvency had not occurred.

NOTICE OF GENERAL MEETING:

116. Notice of every General Meeting shall be given in some manner hereinbefore authorised to (a) every member of the Company except those members who, having no registered address within Pakistan, have not supplied to the Company an address within or outside Pakistan for the giving of notices to them and also to (b) every person entitled to a share in consequence of the death or insolvency of a member, who but for his death or insolvency would be entitled to receive notice of the meeting, and (c) to the auditors of the Company for the time being.

NO SHAREHOLDERS TO ENTER THE PREMISES OF THE COMPANY WITHOUT PERMISSION:

117. No member or other person (not being a Director) shall be entitled to enter the property of the Company, or to inspect or examine the Company's premises or properties of the Company, without permission of the Board or the Chairman, or Chief Executive, and to require disclosure of any information respecting any detail of the Company's trading, or any matter which is or may be in the nature of a trade secret, mystery of trade or secret to/of the conduct of the business of the Company and which in the opinion of the Board or the Chief Executive will be inexpedient in the interest of the members to communicate.

SECRECY

118. Every Director, Chief Executive, Chairman, Manager, Auditor, Trustee, member of committee, officer, servant, agent, accountant or other person employed in the business of the Company shall, if so required by the Board before entering upon his duties, sign a declaration in the form approved by the Board pledging himself to

A.E.L

observe strict secrecy representing all transactions of the Company with the customers and the state of accounts with individuals and in matters relating thereto, and shall by declaration pledge himself not to reveal any of the matters which may come to his knowledge in the discharge of his duties except when required so to do by the Board, or by any General Meeting, or by a court of law, or by a competent authority and except so far as may be necessary in order to comply with any provisions in these presents contained.

WINDING UP

SERVICE OF NOTICE IN WINDING UP

119. In the event of a winding up of the Company, every Member of the Company, who is not for the time being in Pakistan, shall be bound, within eight weeks after the passing of an effective resolution to wind up the Company, to serve the notice in writing on the Company appointing some house-holder residing in the neighbourhood of the Office upon whom all summons, notices, process, orders and judgement in relation to or under the winding up of the Company may be served, and in default of such nomination, the liquidator of the Company shall be at liberty on behalf of such Member to appoint some such persons, and service upon any such appointee, whether appointed by the Member or the liquidator shall be deemed to be good personal service on such Member for all purposes, and where the liquidator makes any such appointment he shall with all convenient speed give notice thereof to such member by advertisement in some daily newspapers circulating in the neighbourhood of the Office or by a registered letter sent through the post and addressed to such member at his address as mentioned in the register and such notice shall be deemed to be served on the day following that on which the advertisement appears or the letter is posted. The provisions of this Article shall not prejudice the right of the liquidator of the Company to serve any notice or other documents in any other manner prescribed by the Articles of the Company.

DISTRIBUTIONS OF ASSETS ON WINDING UP:

120. (i) If the Company shall be wound up, (whether voluntarily or otherwise) the liquidators may, with the sanction of a Special Resolution and any other

A.E.L

loss or damage arising from the bankruptcy, insolvency or tortuous act of any person with whom any money, securities or effects shall be deposited, or for any loss occasioned by any error of judgment or oversight on his part, or for any other loss, damage or misfortune whatever which shall happen in the execution of duties of his office or in relation thereto, unless the same happens through his own willful act, neglect, default or dishonesty.

123. In the event that a dispute, claim or controversy arises between the Company, its management or its shareholders, or between the shareholders inter-se, or the directors inter-se, all steps shall be undertaken to settle the dispute and resolve the issue through mediation by an accredited mediator before taking recourse to formal dispute resolution such as arbitration or litigation.

A.E.L

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

No.	Name and Surname (present & former) in full (In Block Letters) with CNIC / Passport Number	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
1	ASIA PETROLEUM LIMITED (THROUGH ITS REPRESENTATIVE MR. YACOOB SUTTAR)	Incorporation No. 0032985	Pakistani	Business	14th Floor, The Harbour Front, HC-3, Dolmen City, Block 4, Scheme-5, Clifton, Karachi, 75600, Pakistan	498,000 (Four hundred ninety eight thousand)	
2	SHEIKH IMRANUL HAQUE 42301-0819482-1	Sheikh Nisarul Haque	Pakistani	Business Executive	House # 112/B, 25th Street, Khayaban-e-Bukhari, Phase VI, DHA, Karachi, Pakistan	500 (Five hundred)	
3	SYED NADIR SHAH 42301-1049967-7	Syed Nizam Shah	Pakistani	Business Executive	House # 4, Bath Island, Mary Road, Karachi, Pakistan	500 (Five hundred)	
4	YACOOB SUTTAR 42301-3267856-5	Ibrahim Suttar	Pakistani	Business Executive	House # 87/2, 18th Street, Khayaban-e-Rahat, Phase VI, DHA, Karachi, Pakistan	500 (Five hundred)	
5	GULZAR KHOJA 42301-0823044-4	Ghulam Ali Khoja	Pakistani	Business Executive	House # F/64, Block 7, Clifton, Karachi, Pakistan	500 (Five hundred)	

Total number of shares: 500,000 (Five hundred thousand)

Dated the 27th day of October, 2015

Witness to above signatures

Full name: Kamran Anwar
Father's name: Muhammad Anwar Tahir
Full Address: House # R-106, Gul Houses, Block-7, Gulistan-e-Jauhar, Karachi
Occupation: Business Executive

Signature:
CNIC# 42101-1473444-5
Nationality Pakistani

A.E.L

PROFILE OF THE SPONSOR

Asia Petroleum Limited (APL) is an energy infrastructure company, headquartered in Karachi, Pakistan. It owns and operates an oil terminal and a pipeline system to transport Residual Fuel Oil (RFO) from Pipri, Karachi to Hub Power Company Limited(HUBCO), a 1292 MW Independent Power Plant located in Baluchistan province of Pakistan.

APL with its multi-disciplinary and highly experienced team of professionals is committed to excellence in customer service and fulfillment of corporate responsibility. Since its commissioning in 1996, it is adding value to Pakistan's energy sector through provision of high quality environment-friendly and cost-effective fuel transportation services, while ensuring full compliance with standards of health, safety and quality assurance. APL was formed with support of the World Bank and the Government of Pakistan as a joint venture between following reputable national and international investors:

Pakistan State Oil Company Limited (PSO), Pakistan

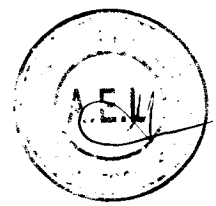
PSO is a leading oil marketing company of Pakistan, having largest market share. It owns and operates 74% of fuel storage infrastructure in the country and is engaged in import, storage, distribution and marketing of various petroleum products including lubricants.

Infraavest Limited, Hong Kong

It is an investment company with stakes in oil and gas infrastructure in the Middle East, and offshore marine interest. Besides their investment in APL, their other investments in Pakistan include Fauji Oil Terminal and Distribution Company Ltd (FOTCO) and Fauji Infraavest Foods Ltd. Infraavest is represented by Mr. Brian Chang and Mr. Malcolm Chang on APL's Board of Directors. Mr. Brian Chang was initial shareholder of HUBCO and the sponsor of APL and FOTCO. Pakistan Power Limited represented by Mr. Brian Chang was one of the promoting shareholders in HUBCO with 10% shareholding Mr. Brian Chang remained Director of HUBCO from October 10, 1994 to February 6, 2003.

Independent Petroleum Group (IPG), Kuwait

It is a group of companies headquartered in Kuwait with worldwide operations in the trading and marketing of crude oil, petroleum products, LPG, petrochemicals and fertilizers. In addition to this core activity, IPG has interests in terminals, pipelines and shipping business.



VECO International Incorporation, USA

VECO International is a management and investment company with operations in the energy sector. VECO International is incorporated in Texas and operates its domestic and international business out of Alaska, USA.

PROFILE OF THE APPLICANT'S DIRECTORS

Asia Energy (Private) Limited (the Applicant) was incorporated by the sponsors for the project. The Board of Directors' of the Applicant include experienced personnel.

Syed Jehangir Ali Shah

Syed Jehangir Ali Shah is a seasoned veteran of the Energy Sector. He has been appointed as Acting Managing Director of PSO on September 06, 2018. This position was also held by him previously in 2011. He joined PSO in 1984 and had worked in various management positions. His forte however, remained sales and marketing as he has led almost all marketing departments in PSO. Prior to his current elevation to the position of Acting Managing Director, he was serving as Deputy Managing Director – Operations and was responsible for managing critical supply chain function and extensive infrastructure network of the flagship oil entity of Pakistan. Mr. Jehangir Ali Shah holds master's degrees from the University of Jamshoro as well as from the McGill University, Canada.

Mir Shahzad Khan Talpur - CEO

Mir Shahzad Khan Talpur is highly accomplished professional lawyer with over 24 years of diversified experience comprising of energy sector, civil service, agriculture and politics. He commenced his career in Civil Service in 1993-1994. Mr. Talpur joined PSO in 1995 and served in various roles in different departments till 1997. In 1998 Mr. Talpur established his career with Barrister Aziz-ul-Shaikh Law Firm where he work till 2001 after which he spent few years with organizations including Shahadat Law Firm and Mir & Mir Law Associates. He was also elected for Nazim Mayor of Local Bodies in 2005.

He rejoined PSO in February 2009 and have worked in various capacities and departments including Company Secretary, Legal, Chemical, Supply, Operations, Corporate Planning & Strategy and New Business Development. He also served in various committees of PSO including CSR and Grievances Committee which he chaired. Mr. Talpur joined Asia Petroleum Limited in March 2018.

Syed Nadir Shah

A business developer with 25 years' experience of capital markets, commodity trading, and infrastructure projects with an emphasis on agriculture & logistics management. He is working as a Director on the Boards of various companies including Fauji Akbar Portia Marine Terminals Limited, TPL Direct Insurance Limited, Asia Petroleum Limited and Princely Jets (Pvt.) Limited. Besides, he is also providing advisory services to his local and international cliental.

Fawad Aftab

Mr. Aftab is a member of the Institute of Chartered Accountants of Pakistan and he is also a member of the Institute of Cost and Management Accountants of Pakistan. After completing his mandatory audit training from A.F. Ferguson & Co. in 1999, he held various positions in the field of financial planning, operational controls, risk management, compliance, taxation, treasury & HR management with globally leading and well reputed MNCs operating in the areas of container terminal operations, logistics, storage & distribution, commodity trading and supply chain management. Prior to joining APL, he was Country Controller Cargill Group of Companies in Pakistan which were subsidiaries of Cargill Inc. USA.

He started his professional career with Karachi International Container Terminal Ltd, a subsidiary of Hutchison Port Holdings which is a global leader in port management and operations. Besides his professional qualifications he has also obtained leadership training from IVEY Business School, High Performance Managers Training from Cargill Leadership Academy, and Directors Training from Institute of Chartered Accountants of Pakistan.

ANNEXURE 11

PROJECT DESCRIPTION

Asia Energy (Private) Limited (**the Applicant**), established in 2015, is a subsidiary of Asia Petroleum Limited (APL). Established in 1996, APL is an oil transportation company, headquartered in Karachi, Pakistan. It owns and operates an oil terminal and a pipeline system to transport Residual Fuel Oil (RFO) from Pipri, Karachi to Hub Power Company. APL is a joint venture between Pakistan State Oil Company Limited (PSO) (49%), Pakistan, Infraavest Limited (26%), Hong Kong, Independent Petroleum Group (IPG) (12.5%), Kuwait and VECO International Incorporation (12.5%), USA.

Subsequent to the issuance of the LOI, the Applicant engaged experienced technical consultants 8.2 Ingenieurpartnerschaft Obst & Zichmann (8p2) for conducting the feasibility study of the Project and Power Planners International for the Grid Interconnections Study (GIS). The Feasibility Study was submitted by the Applicant to the panel of experts of Alternate Energy Development Board (AEDB) which was duly approved by AEDB. GIS was submitted to Central Power Purchase Agency (Guarantee) Limited (CPPA) which was forwarded to National Transmission and Despatch Company Limited (NTDC) and Multan Electric Power Company (MEPCO) and was duly approved by both NTDC and MEPCO. Brief information about the project and the technology selected is mentioned below.

Project Site

The Project site is located in the southern region of the Punjab province about 12 km south of Madrassah in the vicinity of Noorsar town, District Bahawalnagar. The Project site is located around 35 kilometers away from Bahawalnagar city. The total area of the Project site is around 205 Acres. The land is arid with little to no vegetation. The proposed site located at latitude of 29.833° N and longitude of 73.075° E.

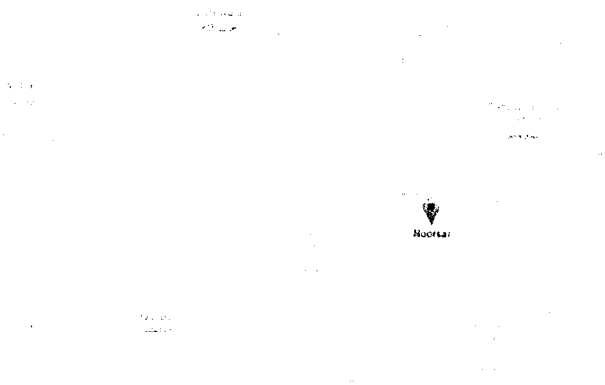


Figure 1: Geographical Location of the Project

Topographical and Geological Conditions at Project Site:

Land considered for the Project mostly uncultivated arid regions and desert-like area which is surrounded by patches of agricultural land. The soil in this desert like region is mostly sandy to dusty. The ground is mostly dry and there is little to no vegetation on site. The terrain for the solar plant area is mostly even. The site has only little water resources from rain (less than 200 mm/a) and some ground water (likely fresh water) from seepage next to some channels but outside of the site. A canal runs along the boundary of the plant.

Site Accessibility:

The site is right next to the Madrassah – Noorsar road. The nearest airport is located at a distance of 160 km in Bahawalpur city and the nearest railway station is at a distance 32 km in Chishtian.

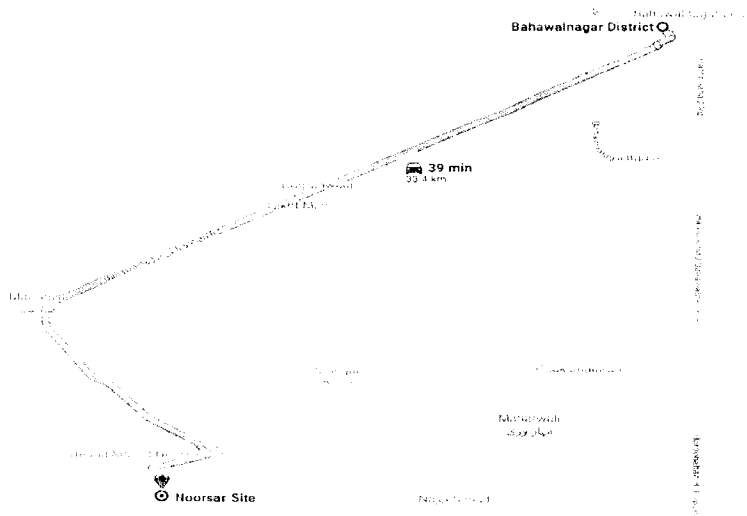


Figure 2: Bahawalnagar city to Project Site

Telecommunication at Project site

Landline service not available but mobile phone service is available at village levels only.

Availability of Semi-Skilled and Skilled Labor

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

Project Site Security:

The Applicant has plans to use the infrastructure at Noorsar Site in the most efficient manner to provide seamless security at admin offices, accommodations and the plant site.

Grid Connectivity:

Currently there is no high voltage grid access directly on site, but the site is proposed to be connected to the Noorsar grid station. The Project is planned to be connected with the existing 132kV Noorsar grid station in accordance with the requirements of the Grid Code.

Annual Energy production:

Based on the available performance and data, the annual energy production of the Project will be 58.372 GWh.

EPC Bidding Process:

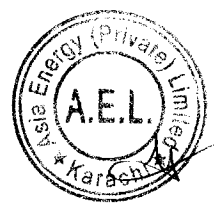
A transparent bidding procedure was carried out in accordance with NEPRA (selection of Engineering, Procurement and Construction contractor by independent Power Producers) Guidelines 2017. The project was advertised through two international and four local newspapers as well as on four international tender websites. Subsequently, 21 contractors applied for Pre-Qualification out of which 17 were prequalified. A detailed Request for Proposal including the draft Agreements were prepared with the assistance of technical and legal consultants and proposals were invited from the prequalified EPC contractors.

The Applicant received proposals from 6 international EPC contractors. Subsequent to the detailed deliberation and negotiations, the Applicant selected the consortium of CSUN Solar International Limited and China Construction Installation Engineering Company Limited as the EPC contractor for the project.

Project Information

Project Name:	30 MWp Solar Power Project at Noorsar
Project Owner:	Asia Energy (Private) Limited
Project Location:	Noorsar, District Bahawalnagar, Punjab, Pakistan. Latitude 29.825N Longitude 73.080E
Capacity:	30 MWp DC
Term of License:	25 years from commercial operations
Plant Factor:	22.21%
Modules:	Polycrystalline 330Wp, CSUN 330-72P
No. of Modules:	90915
No. of Strings:	4785
Mounting Method:	Single-axis plane tracking system
Inverter:	1250 kW Centralized Inverter: SG 1250
Step-up transformer:	1450 kVA Step-up Transformer
Transmission Lines:	132 kV
Switch Substation:	132 kV Step-up substation with 2*Main MV/HV Transformers
Construction Duration:	10 months
Estimated COD Date:	December 2019

SOLAR PANEL TECHNOLOGY



Solar Panel Technology:

The Solar PV Module selected for the scope of this project is **Si-Poly CSUN330-72P**, 330 W. Brief specifications of the Solar Module is given in table below:

Solar Panel Characteristics	
Manufacturer	CSUN
Module Type	CSUN330-72P
Cell Type	Si-Poly
Module Efficiency	17.04%
Dimensions (L*W*H)	1956 x 992 x 40 mm
Maximum Power - Pmpp (W)	330
Open Circuit Voltage - Voc (V)	45.3
Short Circuit Current - Isc (A)	9.31
Maximum Power Voltage - Vmpp (V)	36.4
Maximum Power Current - Impp (A)	9.08

DATASHEET OF SOLAR PANEL

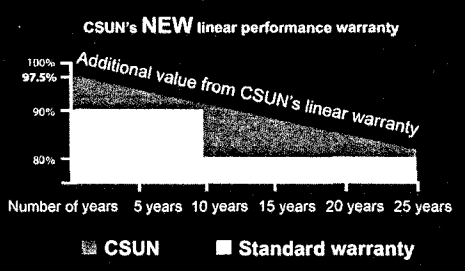
Asia Energy (Private) Limited
A.E.L.
Karachi

Poly

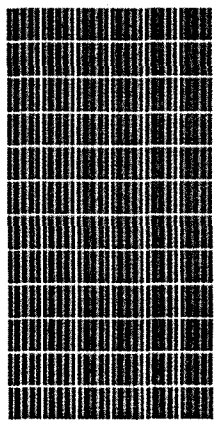
PowerGuard
SPECIALTY INSURANCE SERVICES

Powerguard Insurance Global Coverage

The power output shall not be less than 97.5% of the minimum power output stated in the product data sheet in the first year of the product's life cycle. The loss of power output shall not exceed 0.7% per year thereafter, ending with 80.7% in the 25th year.



energy for today



CSUN330-72P

The Large Scale Project Solution

Module Fire Performance: Type 1(UL 1703)
Fire Resistance Rating: Class C(IEC 61730)

CSUN330-72P CSUN325-72P
CSUN320-72P CSUN315-72P
CSUN310-72P

17.04%
Module efficiency

330 W
Highest power output

10 Years
Material & Workmanship warranty

25 Years
Linear power output warranty

- PID free
- Industry leading conversion efficiency
- Positive tolerance offer
- Passed salt mist & ammonia corrosion, blowing sand and hail testing
- Certificated to withstand wind (2400 Pa) and snow load (5400 Pa)
- Excellent performance under weak light condition
- Good temperature coefficient enables better output in hot climates

- China Sunergy (Nanjing) Co., Ltd. designs, manufactures and delivers high efficiency solar cells and modules to the world from its production centers based in China,Turkey, South Korea and Vietnam.
- Founded in 2004, China Sunergy is well known for its advanced solar cell technology, reliable product quality, and excellent customer service.
- As one of leading PV enterprises, China Sunergy has delivered more than 4.0GW of solar products to residential, commercial, utility and off-grid projects all around the world.

Note:
All specifications, warranties, certifications about module of "CSUN" series also apply to that of "SST".

All information and data are subjects to change without notice.

Electrical Characteristics at Standard Test Conditions (STC)

Module Type	CSUN 330-72P	CSUN 325-72P	CSUN 320-72pP	CSUN 315-72P	CSUN 310-72P
Maximum Power - Pmpp (W)	330	325	320	315	310
Positive Power Tolerance	0~3%	0~3%	0~3%	0~3%	0~3%
Open Circuit Voltage - Voc (V)	45.3	45.1	45	44.9	44.8
Short Circuit Current - Isc (A)	9.31	9.24	9.17	9.11	9.03
Maximum Power Voltage - Vmpp (V)	36.4	36.3	36.2	36.1	36
Maximum Power Current - Impp (A)	9.08	8.96	8.84	8.73	8.61
Module Efficiency	17.04%	16.78%	16.52%	16.27%	16.01%

Standard test conditions (STC): irradiance 1000W/m²; AM 1.5G; cell temperature 25°C. Measuring uncertainty of power is within ±3%.
Certified in accordance with IEC 61215, IEC 61730-1/2 and UL 1703.

Electrical Characteristics at Nominal Operating Cell Temperature (NOCT)

Module Type	CSUN 330-72P	CSUN 325-72P	CSUN 320-72P	CSUN 315-72P	CSUN 310-72P
Maximum Power - Pmpp (W)	243	239	235	232	228
Maximum Power Voltage - Vmpp (V)	34.3	34.2	34.1	33.8	33.5
Maximum Power Current - Impp (A)	7.07	6.99	6.89	6.86	6.80
Open Circuit Voltage - Voc (V)	41.9	41.7	41.6	41.5	41.4
Short Circuit Current - Isc (A)	7.49	7.45	7.40	7.34	7.30

Nominal operating cell temperature (NOCT) : irradiance 800W/m², wind speed 1 m/s, module temperature 45°C; ambient temperature 20°C.
Measuring uncertainty of power is within ±3%. Certified in accordance with IEC 61215, IEC 61730-1/2 and UL 1703

Temperature Characteristics

Voltage Temperature Coefficient	-0.292%/K
Current Temperature Coefficient	+0.045%/K
Power Temperature Coefficient	-0.408%/K

Maximum Ratings

Maximum System Voltage (V)	1500
Series Fuse Rating (A)	20
Reverse Current Overload (A)	27

Mechanical Characteristics

Dimensions (L*W*H)	1956 x 992 x 40 mm
Weight	22.1 kg
Frame	Anodized aluminum profile
Front Glass	Toughened low iron glass, 3.2 mm
Cell Encapsulation	EVA (Ethylene-Vinyl-Acetate)
Back Sheet	Composite film
Cells	6*12 pieces polycrystalline solar cells series strings (156*156mm)
Junction Box	Rated current ≥ 12A, IP ≥ 65, TUV & UL
Cable	Length 900 mm, 1x4 mm²
Connector	Compatible with MC 4

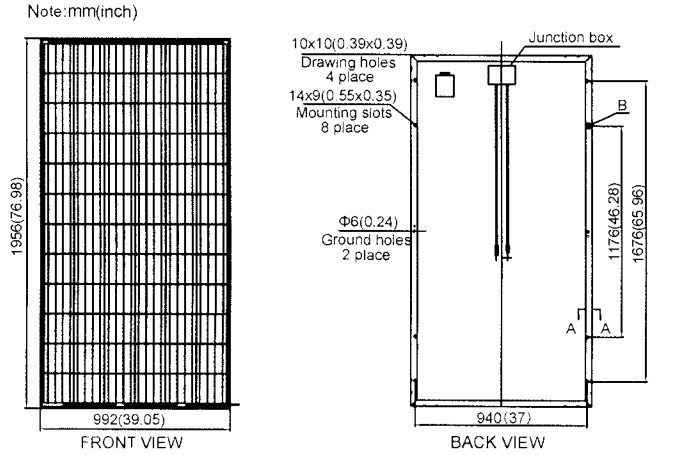
Packaging

Dimensions (L*W*H)	2015 x 1170 x 1137 mm
Container 20'	260 pcs
Container 40'HC	672 pcs

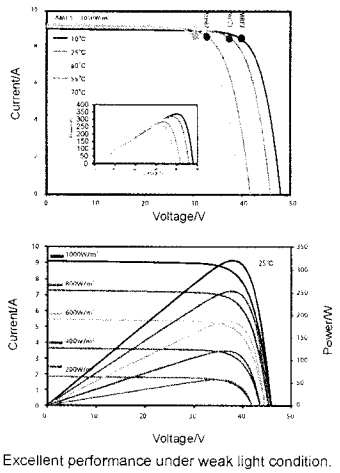
System Design

Temp. Range	-40°C to + 85°C
Hail	Max. diameter of 25mm with impact speed of 23m/s
Max. Capacity	Snow 5400 Pa, wind 2400 Pa
Application Class	A
Safety Class	II

Dimensions



IV-Curves



Excellent performance under weak light condition.

INVERTER TECHNOLOGY

Inverter Technology:

The Inverter selected for the scope of this project is **Sungrow SG1250**.
A brief detail of the inverter is given in table below:

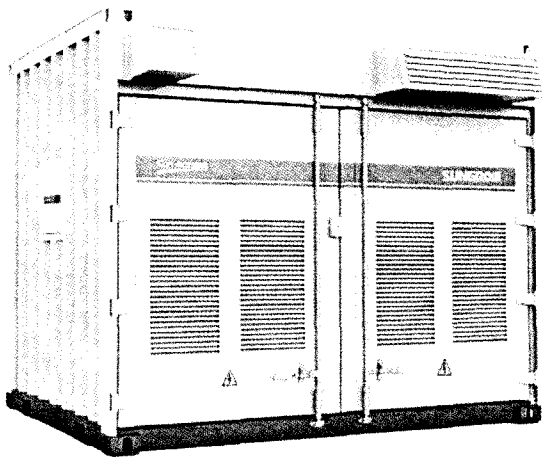
Inverter Characteristics	
Manufacturer	Sungrow
Inverter Type	SG 1250 – 10
Max Efficiency / Euro. Efficiency	99.0 % / 98.7%
Dimensions (W*H*D)	2991*2591*2438 mm
Maximum PV Input Voltage (V)	1000
Minimum PV Input Voltage (V)	520 – 540
Number of DC Inputs	8 – 16
Nominal AC Power (kW)	1260
Nominal AC Voltage (V)	288 – 414
Degree of protection	IP54

DATASHEET OF INVERTER

SUNGROW

SG1000/SG1250

Turnkey Station



High Yield

- Efficient three-level topology, max. system efficiency up to 99 %
- 1 or 2 MPPT, wide MPP voltage range
- Full power operation without derating at 50 °C
- One inverter unit fails, the other unit continues operation

Easy O&M

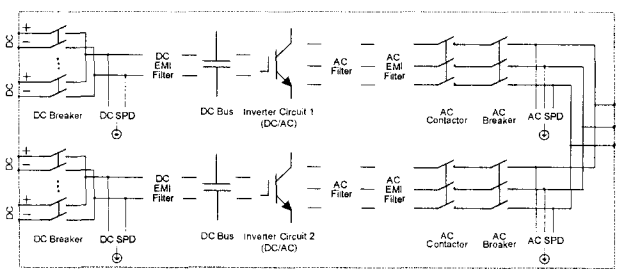
- Integrated zone current monitoring function for fast trouble shooting
- Module design and front service, easy for maintenance
- DC circuit breaker design for convenient maintenance

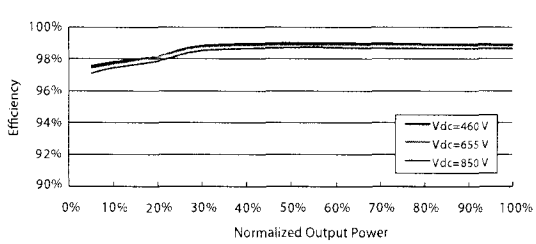
Saved Investment

- 10-foot container design, no need to build extra inverter house
- Integrated LV auxiliary power supply

Grid Support

- Compliance with local standards: CE, IEC 61727, IEC 62116
- Low/High voltage ride through (L/HVRT)
- Active & reactive power control and power ramp rate control





GROW

SG1000/SG1250

Max. PV input voltage	1000 V	
Min. PV input voltage / Startup input voltage	460 V / 500 V	520 V / 540 V
MPP voltage range for nominal power	460 - 850 V	520 - 850 V
No. of independent MPP inputs	1 or 2	
No. of DC inputs	8 - 16	
Max. PV input current	2440 A	2712 A
Max. DC short-circuit current	2920 A	3390 A
Nominal AC power (at 50 °C)	1000 kW	1260 kW
Max. AC output at PF=1 (at 45 °C)	1100 kW	1386 kW
Max. AC apparent power (at 45 °C)	1100 kVA	1386 kVA
Max. AC output current	2016 A	2222 A
Nominal AC voltage	315 V	360 V
AC voltage range	252 - 362 V	288 - 414 V
Nominal grid frequency / Grid frequency range	50 Hz / 45 - 55 Hz, 60 Hz / 55 - 65 Hz	
THD	< 3 % (at nominal power)	
DC current injection	< 0.5 % In	
Power factor at nominal power / Adjustable power factor	> 0.99 / 0.8 leading - 0.8 lagging	
Feed-in phases / Connection phases	3 / 3	
Max. efficiency / Euro. efficiency	99.0 % / 98.7 %	
DC input protection	Circuit breaker	
AC output protection	Circuit breaker	
Overvoltage protection	DC Type II / AC Type II	
Grid monitoring / Ground fault monitoring	Yes / Yes	
Insulation monitoring	Yes	
Overheat protection	Yes	
Anti-PID function	Optional	
Dimensions (W*H*D)	2991*2591*2438 mm	
Weight	4.3 T	
Isolation method	Transformerless	
Degree of protection	IP54	
Auxiliary power supply	220 Vac, 2 kVA / Optional: 380 Vac, up to 15 kVA	
Operating ambient temperature range	-35 to 60 °C (> 50 °C derating)	
Allowable relative humidity range (non-condensing)	0 - 95 %	
Cooling method	Temperature controlled forced air cooling	
Max. operating altitude	5000 m (> 3000 m derating)	
Display	Touch screen	
Communication	Standard: RS485, Ethernet; Optional: optical fiber	
Compliance	CEA, IEC 62109, IEC 61727, IEC 62116, IEC 60068, IEC 61683, CE	
Grid Support	LVRT, HVRT, active & reactive power control and power ramp rate control	
Type designation	SG1000-10	SG1250-10

III. Project Cost, Sources and amounts of Equity and Debt

The total project cost is USD 22.8 million out of which USD 19.7 million will be the EPC Cost. The project is to be financed with a combination of debt and equity. Based on initial discussions with the financial institutions, the Applicant is likely to finance the project on the basis of a Debt:Equity ratio of 75:25. The debt amount is expected to be funded through SBP Financing Scheme for Renewable Energy with quarterly instalments. The term of the loan is expected to be 10 years plus grace period for construction.

IV. Project Schedule with Milestones

The project is currently in an advanced stage of development prior to financial close. The following milestones have been achieved to date:

- Incorporation of Project Company
- Issuance of Letter of Intent by the Alternative Energy Development Board (AEDB)
- Arranging project land
- Topographic and soil investigation surveys
- Rigorous solar resource assessment and basic plant design
- Approval of grid interconnection study by MEPCO and NTDC
- Submission and approval of environment study
- Commercial and technical negotiations with shortlisted EPC contractors
- Drafting EPC agreements

The following activities will be pursued on a fast track basis:

- Finalization of project capital structure
- Procurement of various other regulatory approvals and consents

Commercial operations date is expected to be achieved within ten months of financial close. The timelines shall be firmed up and divided into more detailed milestones in consultation with the EPC contractor, project lenders and other stakeholders.

V. Safety and emergency plans

The Applicant is committed to ensuring the highest standard when it comes to the health and safety of people and protection of the environment. This applies to all locations of the office space as well as the construction site. Applicant is committed to continuously improve HSE at the workplace, and requires contractors to follow its example. HSE requirements have been included in EPC contract. Relevant extracts are reproduced below:

Project Health, Safety and Environmental Management Plan

The purpose of this Project Health, Safety and Environmental Management Plan, (PHSEMP), is to provide health, safety and environmental direction and guidance for project personnel and all contractors involved in the execution of the project and provide a framework for monitoring and overseeing compliance. This PHSEMP defines the HSE requirements during the project execution.

Application

This PHSEMP is for the use of all project stakeholders. It encompasses the standards, working behaviors and safe work practices that are expected of all project team members

Asia Energy (Private) Limited A.E.L Karachi

including management, workers, client representatives, vendors, contractors, sub-contractors and visitors. It applies to all activities and phases of the project, construction related or otherwise.

Applicable Legislation

As a minimum the project will be executed in compliance with the following:

- OHSAS 18001:2007: Occupational Health and Safety Management Systems Requirements;
- ISO 14001: 2004: Environment Management System;
- ISO 31000:2009: Risk Management;
- Local standards and regulations.

Policy, Leadership, Objectives and Targets

EPC Contractor is committed to minimize the environmental impact of construction and influence its employees, subcontractors and other relevant to reduce the risk of health and safety to a minimum. Management and employees of EPC contractor will constantly strive to improve the HSE management. The goal of EPC contractor will be to fulfill international HSE standards with responsible attitude, create healthy and safe working environment. Through the promotion and implementation of the HSE standards, the EPC contractor should strive to eliminate the risk to the health, safety and environment. EPC contractor will provide professional HSE training for staff to achieve these goals.

It is EPC contractor's ultimate responsibility of ensuring effective operation of HSE management system at all levels. A reasonable clear linear management responsibility system will be used to make all staff to comply with HSE guidelines, principles and policies to fulfill their duties. This plan mandates that all the project activities strive towards achieving '**Zero Harm**' to people, the environment and the community.

Leadership and Commitment

While it is recognized that safety is everyone's responsibility, managers at all levels have an important leadership role in promoting and monitoring a safe and healthy working environment. The Project Leadership Team, typically comprising the Project Manager, Construction Manager, Project Engineering Managers, are obligated and held personally accountable for exercising due diligence in meeting local legal obligations.

To facilitate a '*one team*' approach ensuring that a safety culture and harm free working environment is aligned amongst project stakeholders, a safety leadership matrix has been developed for the project that identifies the projects key stakeholders, defines their roles in relation to the project and sets out the safety leadership responsibilities on the project. In the case of any conflict between this matrix and relevant project contracts, the project contractual requirements will take precedence.

Asia Energy (Private) Limited A.E.L. Karachi

VI. Plant Characteristics: Generation Voltage, Frequency, Power Factor, Automatic Generation Control, Ramping Rate

Plant characteristics to the extent relevant to the plant are as follows:

Solar Panels PV Modules			
1.	Model of module	CSUN 330-72P	
2.	Manufacturer	CSUN	
3.	Type of cell	Polycrystalline	
4.	Dimension of each module	1956 x 992 x 40 mm	
5.	No. of panel /modules	90915	
6.	No. of strings	4785	
7.	Modules in string	19	
8.	Weight of one module	22.1 kg	
9.	Module frame	Anodized aluminum profile	
10.	No. of solar cells in each module	6*12 pieces polycrystalline solar cells	
11.	Efficiency of module	17.04%	
12.	Maximum Power (P_{max})	330 W	
13.	Voltage @ P_{max}	36.4 V	
14.	Current @ P_{max}	9.08 A	
15.	Open circuit voltage (V_{oc})	45.3 V	
16.	Short circuit current (I_{sc})	9.31 A	
17.	Maximum system Voc	860.7 V	
Inverters			
1.	Model of inverter	SG1250	
2.	Manufacturer	Sungrow	
3.	Inverter dimensions	2991 x 2591 x 2438 mm	
4.	No. of inverters	21	
5.	Maximum / Euro Efficiency	99.0% / 98.7%	
6.	Maximum allowable input voltage	1000 V	
7.	Maximum allowable input current	2712 A	
8.	MPP tracking range	520~850V	
9.	Output electrical power	1260 kW	
10.	Rated output voltage	360 V	
11.	Power factor (adjustable)	0.8 leading - 0.8 lagging	
12.	Power control	MPP tracker	
13.	Rated frequency	50 Hz	
14.	Ramping rate	~ 0.3MW/minute(23.8%/minute) at normal startup or shutdown of Inverter	
15.	Degree of protection	IP54	
16.	Environmental enclosures	Relative Humidity	0 - 95%
		Operating Elevation	Max 5000 m, derating when higher than 3000 m
		Operating temperature	-35 C to 60 C

Asia Energy (Private) Limited A.E.L. Karachi

17.	Grid operating protection	DC circuit breaker
		AC circuit breaker
		DC overload protection
		Lighting protection
		Grid monitoring
		Insulation monitoring
		Anti-Islanding
		LVRT, HVRT
		Active and reactive power control
		Power ramp rate control
Junction Boxes		
1.	No. of junction box units	309
2.	Input circuits in each box	16
3.	Max. input current for each circuit	15A
4.	Protection level	IP65
5.	Overcurrent protection	Fuse /MCCB
6.	Surge protection	Yes
Data Collection System		
1.	Weather data	Pyranometers and Thermometer
2.	System data	DC input voltage and current of each inverter/junction box
		Total DC power generated by PV array
		AC output voltage and current of each inverter/junction box
		AC output power and energy of each inverter
		Frequency
		Power factor
Transformer		
1.	Rating	30 MVA (2 sets)
2.	Type of transformer	Oil-immersed
3.	Purpose of transformer	Step-up voltage
4.	Output Voltage	132 kV

VII. Control, metering, instrumentation and protection

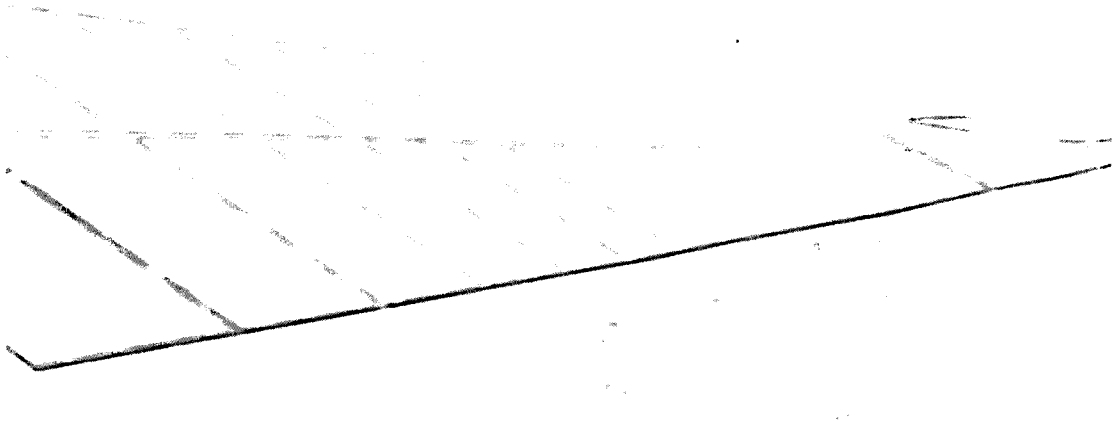
Please refer the plant characteristics in VI above

VIII. Information regarding training and development

The Applicant has ensured through contractual requirements that the EPC contractor will be providing training to applicant's personnel on site during construction and commissioning, and will ensure that such personnel shall be able to operate and maintain the plant with reasonable professional competence.

Asia Energy (Private) Limited A.E.L. Karachi

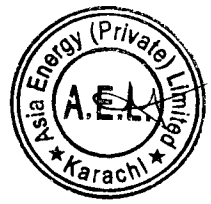
8.2



Feasibility Study

Type of Report:	Feasibility Study
Project:	30 MW Asia Petroleum
Client:	Asia Petroleum Ltd.
Purpose:	Assessment of the technical and economic viability of a 30 MWp Solar PV Project at Noorsar, Pakistan
Site location, Country:	Noorsar, Pakistan
Report number:	14K5193-PV-Asia-Petroleum-R01-FS-ASC_UM-2016
Date of Inspection:	-

8.2 Obst & Ziehmann International GmbH.
Ing. Alexander Schleiffer
Brandstwiete 4
20457 Hamburg
Germany
Tel: +49 (0)40 / 18 12 604-29
Fax: +49 (0)40 / 18 12 604-99
E-Mail: alexander.schleiffer@8p2.de



General Data

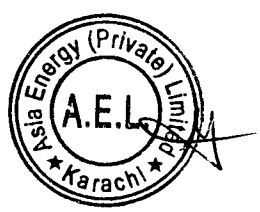
The company Asia Petroleum Limited intends to build a photovoltaic power plant at a site Noorsar, situated 7 km south of Madressa located on Bahawalpur-Bahawalnagar Road ishtian region.

Assignment

Task:	Technical Site Assessment to evaluate the suitability and potential of the site.
Client:	Asia Petrolatum Limited D-52, Block-4, Scheme 5 Clifton 75600 Karachi, Pakistan
Order Date:	26.10.2016
Authors:	Ing. Alexander Schleiffer Umar Mustafa, R.E
Project Number:	14K5193

Basic Data: Plant Location and PV System

Client:	Asia Petroleum Limited	
Site:	Noorsar, Punjab	
	Latitude	29.825° N
	Longitude	73.080° E
	Altitude above sea level	155 m



Revisions

Version	Modifications
R00	First Draft for Client
R01	First version for Submission

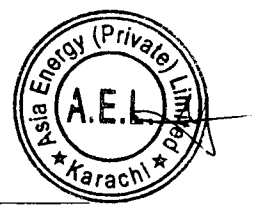


Table of Contents

1 EXECUTIVE SUMMARY 6

2 PROJECT INFORMATION AND OUTSTANDING ITEMS 7

2.1 TECHNICAL PROJECT DESCRIPTION 7

2.2 PROJECT STATUS 7

3 LIST OF ABBREVIATIONS: 8

4 OVERVIEW OF PHOTOVOLTAIC TECHNOLOGY 9

4.1 BASIC PRINCIPLES OF SOLAR PHOTOVOLTAIC PLANTS 9

4.2 BASIC PRINCIPLES OF PHOTOVOLTAIC MODULES 9

4.3 MOUNTING STRUCTURES AND TRACKING SYSTEMS 11

4.4 INVERTER TECHNOLOGY 11

4.5 CONTROL SYSTEM 12

5 SITE DESCRIPTION AND ASSESSMENT 13

5.1 GEOGRAPHIC PARAMETERS 13

5.2 CLIMATE CONDITIONS 15

5.3 ENVIRONMENTAL ASPECTS 16

5.4 TOPOGRAPHY AND GROUNDING 17

5.5 METEOROLOGY INCLUDING SOLAR RESOURCE 18

5.6 TRANSPORT ACCESS 21

5.7 WATER ACCESS 22

5.8 GRID ACCESS 23

5.9 FACILITY ACCESS 24

6 GRID INTERCONNECTION 26

6.1 POSSIBLE ELECTRICAL FAULTS AND THEIR IMPACT ON THE GRID 26

6.2 IMPACT ON THE EVACUATION NETWORK 26

6.3 BALANCING POWER 26

6.4 GRID CONTROL STRATEGIES 26

6.5 TECHNICAL SPECIFICATIONS 27

6.6 APPROVALS 27

7 PLANT LAYOUT AND DESCRIPTION OF TECHNICAL EQUIPMENT 28

7.1 POWER SUPPLY INFRASTRUCTURE 28

7.2 POWER PLANT TECHNOLOGY CONFIGURATIONS 28

7.3 SYSTEM DESIGN 28

7.3.1 PRELIMINARY LAYOUT 28

7.3.2 MODULES 29

7.3.3 STRUCTURE 29

7.3.4 CABLES 30

7.3.5 INVERTERS 30

7.3.6 HV STATION 30

7.3.7 MONITORING 30

7.3.8 SECURITY 30

8 ENERGY YIELD ASSESSMENT 31
8.1 SOLAR IRRADIATION DATA 31
8.2 UNCERTAINTY ANALYSIS OF IRRADIATION DATA 32
8.3 PERFORMANCE RATIO 32
8.4 SHADING ANALYSIS 33
8.5 EXPECTED LOSSES 33
8.6 ENERGY YIELD SIMULATION FOR MOST SUITABLE TECHNICAL DESIGN 38

9 ANNEXURES 39

Asia Energy (Private) Limited
A.E.L
Karachi

1 Executive Summary

This study assesses the feasibility for the 30 MWp solar power plant at a site in Noorsar. The assumptions, results and conclusions of this study have been refined during multiple site visits.

Analysis of data obtained from various sources lets us conclude that the site allocated for PV plant is feasible. Components, currently available in the market, are suitable for the environmental conditions of the region. However, a risk management strategy for development, construction and operation is highly recommended.

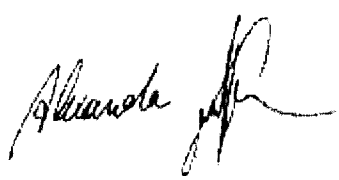
Solar parks of this size are standard and it is possible to develop highly efficient parks irrespective of their size. The experiences of these large scale solar parks around the world together with the lessons learnt can be disseminated and implemented in Pakistan by knowledge transfer.

Concerning the technology and mounting options we recommend fixed type installation as it has least capital and operational risks. For the economic viability of a tracking device versus a fixed installed system, accurate irradiation data would be required on ground level which is not yet available. In addition, tracking devices require more maintenance due to their moving parts.

The client is opting for upfront tariff to be issued by NEPRA by mid-January 2017 along with corresponding parameters quoted therein. The total cost of project is expected to approximately 34.4 million USD. A project timeline of 12 months from financial close is a reasonable assumption for a project of this size.

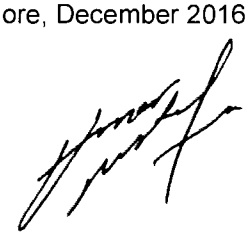
The Asia petroleum Plant in this region will be very beneficial to the people of Pakistan receiving more and more power through one of the cleanest sources of energy.

Hamburg, December 2016

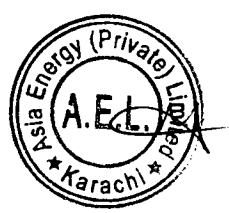


Ing. Alexander Schleiffer

Lahore, December 2016



Umar Mustafa, R.E



2 Project information and outstanding items

This feasibility study summarizes and assesses the given information and includes additional results from extensive site visits.

2.1 Technical Project Description

The PV solar plant will be developed and will be located to the south of Madrassah, a small town situated in tehsil Chistian of district Bahawalpur. The site can be accessed through Bahawalpur – Bahawalnagar Road. The plant will be connected to the upgraded 132 kV Noorsar Grid station. The plant will use polycrystalline module technology and central inverters. However, design and make and model of equipment will only be finalized after the final EPC is selected.

2.2 Project Status

The Project is currently in the feasibility stage. It is recommended that a master plan should be developed and within the master plan, an overview of available information, the first steps of investigation into resources, and the rights and general information should be given. The land settlements should also be finalized as soon as possible so any change in the proposed plant layout can be carried out. As of writing of this report, the following land is available for installation of the Solar Plant.

Pic. 1: Land available to Asia Petroleum for 30MW plant

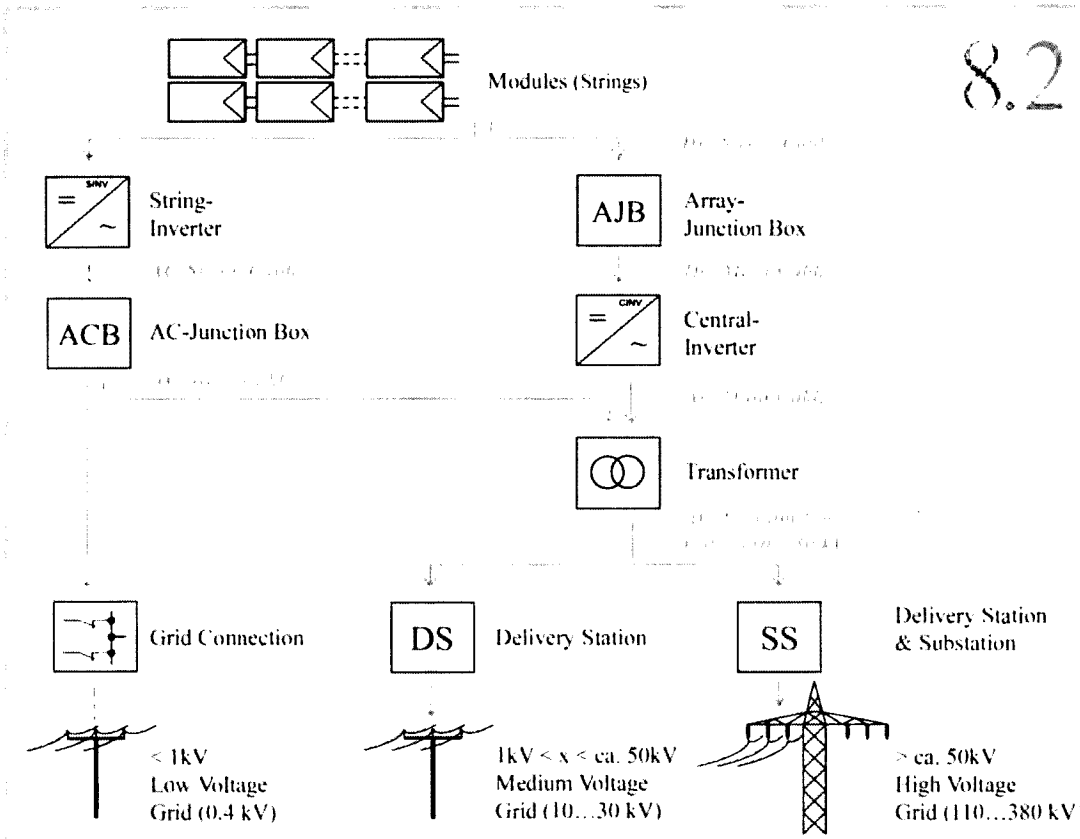
3 List of Abbreviations:

a	Year
A	Ampere
AC	Alternating Current
BOS	Balance of System
CE	Conformité Européenne
DC	Direct Current
DIN	Deutsches Institut für Normung (German Institute for Standardisation)
EN	European Standard
EPC	Engineering, Procurement and Construction
h	Hour
HTA	High Tension between 1 kV and 50 kV AC
HTB	High Tension exceeding 50 kV AC
HV	High Voltage
I	Electric Current
IEC	International Electro-technical Commission
ISO	International Organization for Standardization
kV	Kilovolt (1,000V)
kVA / MVA	Kilovolt-ampere / Megavolt-ampere
kW	Kilowatt (1,000W)
kWh	Kilowatt hour
kWp	Kilowatt peak (PV module rated DC power)
MV	Medium Voltage
MV/HV	Medium Voltage to High Voltage (transformer)
MWp	Megawatt peak
NEPRA	Energy Regulator in Pakistan
NEPRA-PTD	NEPRA Procedure for Tariff Determination
O&M	Operations and Maintenance
PR	Performance Ratio
PV	Photovoltaic
RFP	Request for Proposal
TA	Technical Advisor
TC	Technical Consultant
U	Electric Voltage
V	Volt

4 Overview of Photovoltaic Technology

4.1 Basic Principles of Solar Photovoltaic Plants

Solar photovoltaic plants use the global irradiation (GI), which is converted into electric energy. Adequate Project locations should offer at least 1200 kWh/m^2 per year.



Pic. 2: Single Line Diagram Photovoltaic System

4.2 Basic Principles of Photovoltaic Modules

Photovoltaic technologies differ primarily by the type of the manufacturing process, which leads to different price ranges, manufacturing cost and performance for the different technologies. Photovoltaic technology is based on the photoelectric effect, in which the photons emitted by the sun impact a semiconductor surface and are absorbed. The semiconductor is typically made of silicon.

These absorbed photons hit the atoms and thus are releasing electrons, which causes a chain reaction that multiplies the effect of electrons released. The electrons move from lower potential to higher. This increase of potential results in the generation of current through potential difference (voltage). The reactions and the release of electrons are continuous.

The purity level of the conductor material is important and that there are no gaps at the molecular and atomic level of the semiconductor material. Higher the purity of the used material, the greater is the likelihood that it achieves the maximum potential of a photoelectric cell.

The efficiency of a solar cell (η) is the percentage of power from solar energy, incident on the panel, converted to electrical energy. This term is calculated using the ratio of the maximum power point of the cell, Pm, divided by the light power that reaches the cell, the global irradiance (E, in W/m²) under standard conditions (STC, 1000 W/m², 25°C, AM 1,5), and the surface area of the solar cell (A_c in m²).

$$\eta = \frac{Pm}{E \; x \; Ac}$$

A solar cell can operate in a wide range of voltages and currents. This can be achieved by varying the load resistance in the electric circuit on the one hand, and on the other, by varying the impedance of the cell from the value zero (short circuit) to very high (open circuit). The theoretical maximum power point can be determined this way, i.e. the point in which the product of voltage V and current I are maximized in time. In other words, the load for which the cell can deliver the maximum electric power for a given level of radiation.
Another important variable is the Normal Operating Cell Temperature (NOCT) of the module. This is a characteristic cell value defined as the temperature of the cells, which they reach at an irradiance of 800 W/m², an ambient temperature of 20°C and a wind speed of 1 m/s.

Three main cell categories can be defined:
- Monocrystalline
- Polycrystalline
- Thin Film

Monocrystalline Technology
The manufacturing process of monocrystalline cells requires more effort in comparison to other technologies; however, these cells offer higher efficiency – typically within 15-20 %.

Advantages:
- The loss of efficiency due to the higher temperature is lower than for other types of crystalline module technologies.
- Mature and commercially proven technology.
- Long lifetime of panels.
- Low degradation of maximum 0.1 % - 0.5 % per year (manufacturer guarantee is 0.7 % degradation per year; however reality proves to be less).
- Lower installation costs.
- More environmentally friendly than other technologies, for example, some thin film technologies use cadmium. Monocrystalline cells are not harmful to the environment.

Disadvantages:
- The initial investment costs are higher.
- Higher risk of damages during transport or during operation at sites with high wind speeds.

Polycrystalline Technology
This technology exists since 1981. The manufacturing process is simpler when compared with monocrystalline technology.

Advantages:
- Lower production costs.

Disadvantages:
- Lower efficiency, due to lower purity of the cell material: 13-16 % (module size).

Because of the lower efficiency, slightly more ground surface area is required to reach the same capacity (as for monocrystalline).

Thin Film Technology

This technology is called Thin Film because only a couple nanometers of the semiconductor material are placed on a substrate material. Hence, a very low amount of material is needed. The main semiconductor materials in use are:

- Amorphous Silicon (a-Si)
- Cadmium Telluride (CdTe)
- Copper Iridium Gallium Selenium (CIS / CIGS)
- Organic photovoltaic cells

Thin Film technologies have a low market share, except of the CdTe material. Depending on the technology, standard thin film module efficiencies have reached 7-14 %. Prototypes of these technologies reach 16 % and more which is expected to be transformed to standard products in the future.

Advantages:

- Easier to manufacture, thus lower costs.
- Homogenous appearance.
- Flexible, hence for use at different applications and surfaces.
- Less affected by high temperatures and shadowing.

Disadvantages:

- Faster degradation rate of up to 0.7 % per year.
- Lower efficiency leads to greater surface area requirements, for the same capacity.

4.3 Mounting structures and tracking systems

The photovoltaic panels may be installed on fixed structures or on structures that are tracking the sun. Trackers can be equipped with either a single axis or dual axis tracking system.
Fixed structures are usually just tilted to face south (north in southern hemisphere), or may have south as their main angle and a slight inclination to the east and west as secondary angle (for example 10°). This roof-shape inclination would offer lower peak capacity, however the generation curve would be less spiked and will allow an energy generation distribution to be more equal over the day.
Alternatively, for tracker solutions, the aim is to follow the sun and maintain the panels perpendicular to the axis of incidence of the sun. Thus a greater efficiency in converting solar energy can be achieved. The dual axis tracking can follow the sun both in azimuth and angle - this means that the sun can be tracked over the course of the day - from east to west and the tilt angle can also be adjusted to compensate for the changing angle the sun has over the year.
The decision to choose any of the three types of mounting structure is based on a technical and economic evaluation. When choosing a tracking system, the extra energy generation in combination with the energy price must be compared to the additional investment and maintenance costs required for tracking systems.

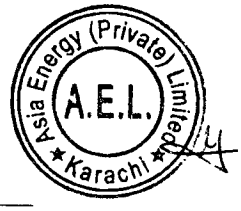
4.4 Inverter Technology

Because photovoltaic panels generate DC electricity, it must be converted to alternating current before it can be fed into the grid. This is achieved by an electronic device called inverter that performs this function.

State of the art inverters offer a broad range of operational stages, which generally fulfil all the requirements of the international grid codes in terms of fault-ride-through and reactive power provision. Inverter stations provide a protective shell in which PV-strings can be connected to inverters. Centralized inverters typically have a capacity from 500 kWp to 1500 kWp of DC PV-Power, depending on the size of inverter.
From the inverter stations the AC power is stepped-up by a MV or HV-Transformer, and then connected to a medium or high voltage grid (for instance 132 kV as in Pakistan).

4.5 Control System

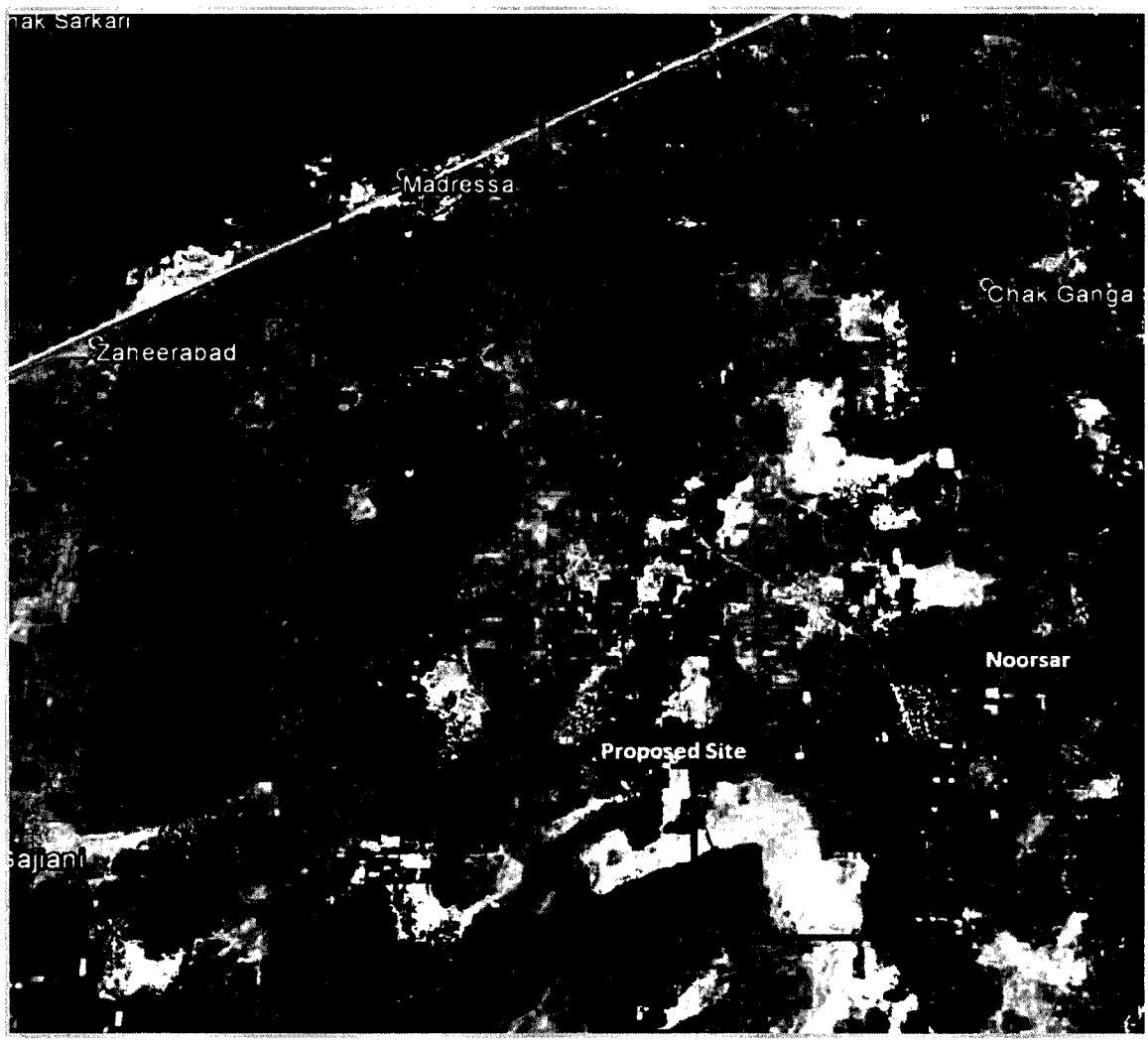
A PV plant typically is controlled by a SCADA System (Supervisory Control and Data Acquisition) and can remotely be managed and supervised. However, for preventive, planned and corrective maintenance, adequate staff and qualified contractors must be identified for the Operations & Maintenance (O&M) of the PV plant.



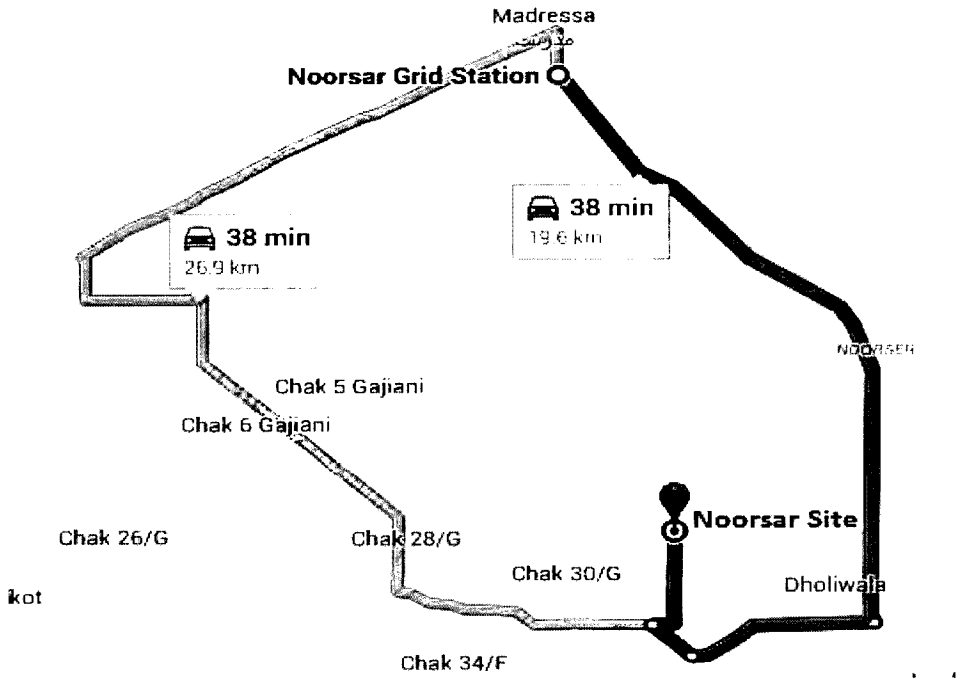
5 Site Description and Assessment

5.1 Geographic Parameters

The site is located in the southern region of the Punjab province (geographic coordinates: 29.825 N; 73.080 E) about 12 KM south of Madrassah in the vicinity of Noorsar town. The overall site includes slightly different conditions and the land considered for use almost entirely consists of uncultivated arid regions and desert like area surrounded by patches of agricultural land.



Pic. 3.1: Overview of location / region in Pakistan



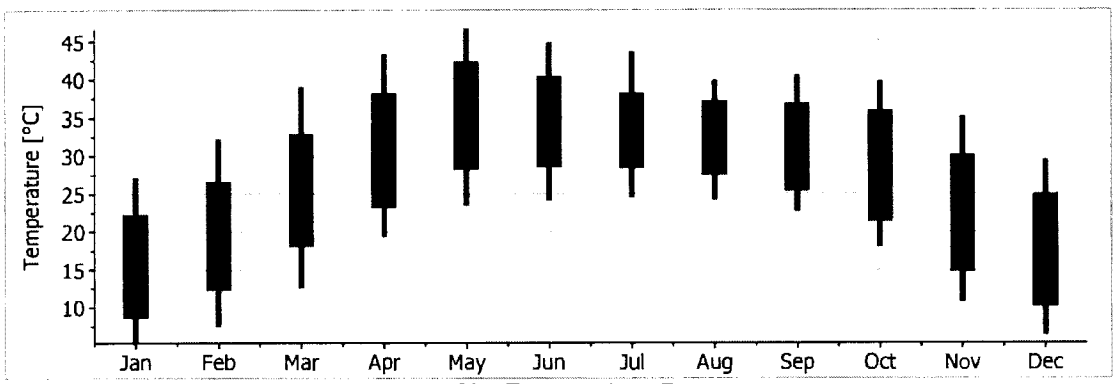
Pic. 3.2: Overview of location / Road Access

Pic. 3.3: Demarcation of Site

Geographic parameters	The area of 202.5 acres is sufficient for placement of 30MW of Plant. The land is arid with little to no vegetation and would not require significant levelling.	**Land is already procured and no significant relocation of vegation / people will be required.**

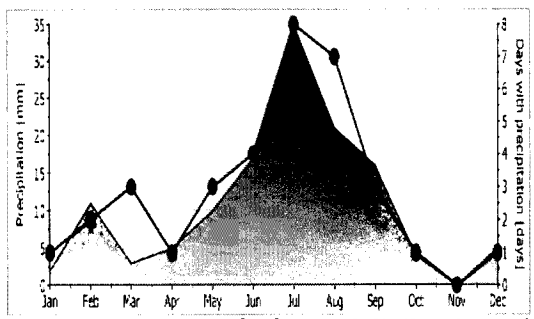
5.2 Climate conditions

Climate conditions have influence on the construction and foundation layout as well as energy production. There are seasonal variations from cold winters to hot summers with up to 40 or even 50°C.



Pic. 4: Site Temperature Range

The monsoon season lasts from May through September with a peak in July and August. 60-70 % of the yearly rainfall occurs in these months. The average rain fall per year is about 120-170 mm.

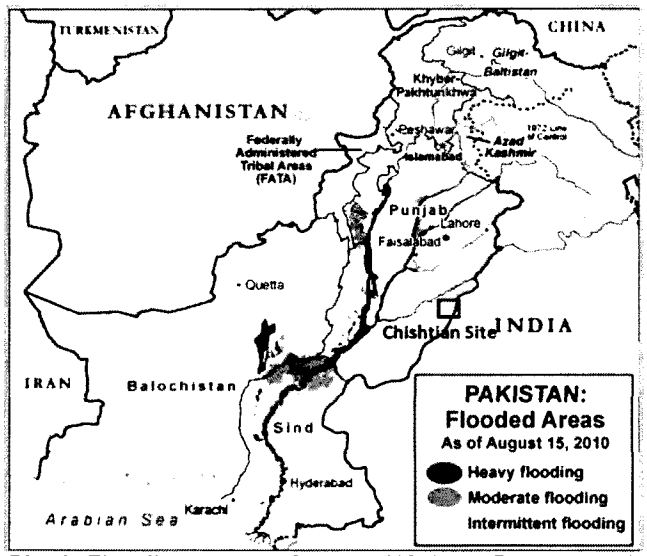


Pic. 5: Monthly rain day's precipitation (mean)

Drainage from the site seems not to be an issue. No puddles were found and seepage into the ground seems to be quite effective. There is an average of 8 to 9 hours of clear sky per day throughout the year and 2900 h – 3300 h sun hours annually.

The region is a moderate low wind area. With the monsoon season the wind speeds up especially at daylight. Storm statistics from the nearest meteorological station will have be considered during detail design.

Micro climate effects can cause dusty and windy conditions which should be evaluated more deeply. Seasonal flooding is possible; however, recent events of flooding have had no impact in this specific region.



Pic. 6: Flooding events (Source: US State Department)

Impact on the Project:

Electrical equipment such as the inverters which will be used on the site should be designed for high ambient temperatures and all of the Inverters, transformers etc. should be installed on elevated terrain. Dusty conditions shall be considered for the design of filters for all electric equipment and buildings. The position of the modules and other structures should be chosen so that an intelligent drainage and seepage network can be incorporated into the Solar Plant.

Climate conditions	Hot and dry desert-like climate requires robust components. Amongst other criteria effective cooling, dust/sand filters and abrasive resistant materials shall be utilized.	not critical – to be considered in detailed design

5.3 Environmental Aspects

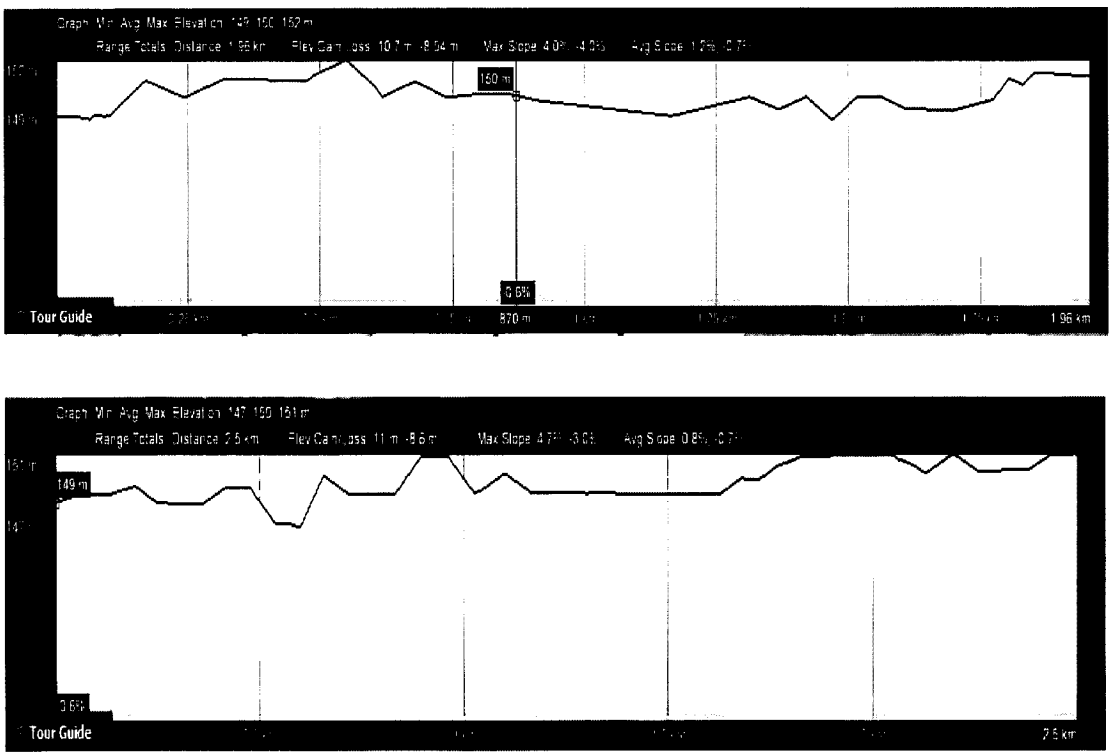
The area at present is free of pollution. No industrial activities are present. There are few agriculture activities around the Site. Pakistan Environment Protection Agency (PEPA) has no regulations or requirements for solar power generation (PEPA Regulations 2000). Low rainfall and some wind cause slight erosion of soil. No protected wild plants or animals are reported for that Site. The ecosystem is described as fragile. The acoustic environment is good with low noise from some local traffic on dirt roads. Complete Environmental are discussed in initial environmental Examination report (IEE) Report.

Impact on the Project:
No critical aspects can be detected as long as all obligatory safety rules are respected e.g. for oil pollution from facilities and transformers. Details can be found in the Initial Environmental Examination Report that has been carried out for the site.
Protection against rodents and other animals would have to be considered. They are known to eat plastics and cables.

Environmental Aspects	Precautions against browsing of rodents shall be adopted to protect cabling effectively. Environmental impact study has been carried out to find the exact environmental impact on the project.	not critical – to be considered in detailed design

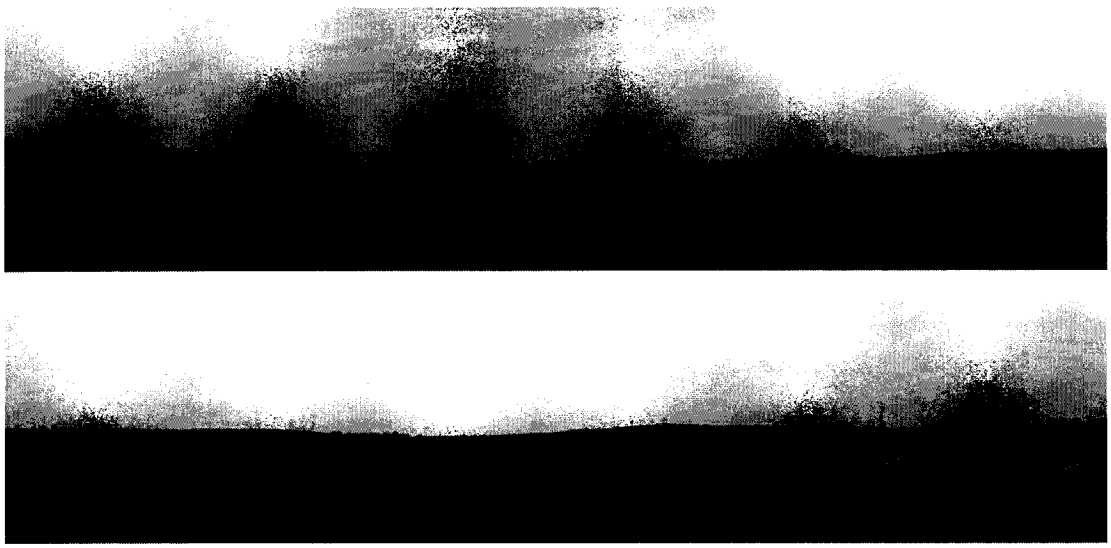
5.4 Topography and grounding

The soil in this desert like region is mostly sandy to dusty. The ground was mostly dry and there is little to no vegetation on site. The terrain for the solar plant area is mostly even. For the planning of the Solar plant a closer look at the data and a small scale on site viewing is required. Below are given panoramic views of the site. Required area has no high-rise buildings which can cast shadow. Ground profile from North to South and East to West is more or less flat and variations are shown below:



Pic. 7: Ground Profile (N-S), (E-W)

The soil has to be prepared for heavy transport traffic. The natural state layer is not suitable as a foundation bearing layer. A topographical survey and geotechnical investigation has been conducted. The reports have been annexed as part of this feasibility.



Pic. 8: Site Panoramic view

The ground looks ideal for screw piles. More details will have to be considered according to the geotechnical investigations at the site.

Even though the site is located in a low seismic activity region, potential risk of earthquakes should be considered during detailed design. Overall the region is of stable structure. More information is required for specific design of substructures and foundations. The ground conditions can be summarized as intermediately complicated.

Water table depth will have to be considered for any issues that might arise during electrical grounding.

Topography and grounding	Screw pile mounted sub construction seems to be the best foundation for PV-generator.	**Topographic survey and geotechnical investigation has been carried out . To be considered in detail design.**

5.5 Meteorology including Solar Resource

Pakistan is exposed to strong solar radiation, long hours of sunshine, and abundant solar energy resources. The annual sunshine hours range between 2900h - 3300h, with a daily average of 8 – 9 sunshine hours.

Chishtian District is located in the south of Punjab Province. Metrological Data from the nearest weather station should be obtained for better understanding of the metrological conditions of the site.

The region of is hot and dry, as shown in the following table:

	Sun hours / day	T Amb	Wind
	h	°C	m/s
January	7.2	14.8	3.1
February	7.8	19.1	3.5
March	8.1	25.1	3.9
April	9.0	30.9	4.2
May	8.8	35.2	4.6
June	7.3	34.9	5.0
July	7.2	33.2	4.4
August	8.3	32.2	3.7
September	9.3	31.3	3.4
October	9.2	28.3	2.9
November	8.8	22.2	2.8
December	7.2	16.8	2.9
Annual average	Total: 3000	27.0	3.7

Sun hours: Sunshine duration per day (Meteonorm 7)
T Amb: Average ambient temperature (Meteonorm 7)
Wind: NASA at 50m

Table 1: Climate data of the region (extract)

For this Technical Site Assessment we calculated the solar irradiance resource from the Meteonorm database because this source was used by NEPRA for determining the actual Tariff. For determining the best data for the solar irradiation predictions we also analyzed data sources from NASA and SolarGIS. Generally, the different sources refer to the same satellite and ground measured data. In the following paragraphs we will describe the differences and define the preferred meteorological dataset for the yield assessment.
The high level of global horizontal irradiation with the typical shape of seasonal variation through the monthly values shows a difference of only 5 % on yearly basis between different sources.

SolarGIS provides irradiation data based on calculations from satellite images. The database represents the long-term global data (1994 to 2013). The spatial resolution is 250 m. SolarGIS typically has an uncertainty of 3.5 % based on experiences in other countries of the MENA region and Middle East. For Pakistan and the region of Cholistan we calculate an uncertainty of 5 % due to the missing reliable reference of meteorological stations with measurement for irradiance values. Further details can be provided in a separate copious report.

Meteonorm uses several sources like different satellites and ground stations for mean values. The main time period is 1986 – 2005 (total 1942 stations). The most important source of radiation data is the Global Energy Balance Archive (GEBA, https://protos.ethz.ch/geba/). This database is also used to extract uncertainty, variability and trend information (770 stations are used for this). Additionally the global radiation values of the stations of NREL's TMY3 database (http://rredc.nrel.gov/solar/ old_data/nsrdb/1991-2005/tmy3/) with the highest quality level (NSRDB class I) have been included in the Meteonorm database. Interpolation of global radiation data is based on a mixture of ground measurements and satellite data. The calculation of the uncertainty values of global radiation is based on (1) uncertainty of ground measurement based on the long term variability of local climate, (2) uncertainty of interpolation

of ground measurement and uncertainty of satellite based data and (3) on uncertainty of splitting into diffuse and direct radiation and inclined planes. Four parameters have been classified: (1) duration of measurement period, (2) standard deviation, (3) decadal trend and (4) end of measurement period. Interpolation of ground stations is modelled with help to the nearest station. For the designated site the nearest meteorological stations are Bikaner (176 KM) and Hissar (283 KM).

High latitudes and high "albedo" would increase the uncertainty additionally which is not the case for the site. The uncertainty of satellite data is given by Meteonorm with 4-8 %. The annual uncertainty calculated internally by the Meteonorm software comes out at 10 % based on the available 20 years long term data set for this region for global horizontal irradiation (Ghi).

The **NASA** source also uses satellite images with its own calculations for irradiance data. For Pakistan we can recommend an uncertainty of not better than 15 % due to our experience with ground measured data in India.
For the first energy yield calculations in the region of Chishtian, based on best estimation of basic system design, the irradiance and weather data were generated from the Meteonorm database (see also 8.1).

For a more exhaustive overview the different sources of irradiance data are shown below.

Irradiation Sources Bahawalpur Average monthly sum	Meteonorm 7 1986-2005 GlobHor	Solar GIS 1999-2012 GlobHor	NASA 1981-2011 GlobHor
	kWh/m².mth	kWh/m².mth	kWh/m².mth
January	106.1	101.6	108.8
February	120.9	122.7	119.3
March	164.0	178.7	154.1
April	184.1	196.8	171.9
May	202.1	205.4	191.9
June	192.5	182.4	190.8
July	187.8	174.9	177.3
August	181.1	181.2	169.6
September	170.7	172.1	154.5
October	146.6	155.4	142.9
November	119.4	114.1	114.9
December	100.3	102.6	101.1
Annual sum kWh/m²*a	1875.7	1887.9	1797

Table 2: Results from different sources for irradiance data

For further energy yield analyses the Meteonorm data will be used. A comparison between actual ground data of the last 6 months and meteonorm data should be performed to reduce the uncertainty in irradiation before financial close.

Irradiation Data	The uncertainty of the satellite irradiance data for this area is given by Meteonorm with 10 %	**Comparison between actual Ground measurements of at least for some 6 months should be done before financial close to reduce the uncertainty**

5.6 Transport Access

The site is right next to the Madrassah- Noorsar road. In Bahawalnagar, the nearest airport is located at a distance of 78 km and the nearest railway station is at a distance 32 km in Chishtian.

A solid road able to carry heavy traffic will have to be developed. The current road that accesses the site might not be able to bear the heavy traffic load.

Pic. 8: Access Road

Road Traffic Planning

The main roads of the overall Solar Plant should be planned. Any roads near HV transmission lines should be at a minimum distance of 30 m for safety reasons.

Besides accommodating the roads, the corridors will also be used for the overhead power lines, buried water pipelines, telecommunication lines and other utilities. The main roads passing through the corridors should have a total width of 12.7 meters with a carriageway of 7.3 meters, and have a 50 mm thick asphalt wearing course over water bound macadam base, treated shoulders 1.2 m wide and earthen berms 1.5 m wide. Cross slope of the road will be 1.5 % for easy surface drainage. Right of way for the roads is recommended as 40 m. Further details are available in the transportation Study attached under Annexures

Design of Road Works

The roads will turn orthogonally at 90° as much as possible. Precautionary lights are recommended along the roads. Considering the small population and light traffic, the road turnings are planned to be rounded off only at the roadway edge. No public transportation will be permitted to enter the Solar Plant. Solar farm sponsors will arrange vehicles according to their own needs for travelling in and out of the farm along with parking lots within their farm boundaries.

Road Vertical Design

As the land within the solar plant is undulating, the range of longitudinal gradient of roads is recommended to be 0.3 %. In specific cases like escarpments, the gradient limitation may be

relaxed according to the site conditions. In order to ensure smooth longitudinal curve of the road, cut and fill balance method should be used. Factors such as comfort, smooth ride, engineering parameters and proper visibility are to be considered in vertical design, especially at road turnings whereas the longitudinal slopes of roads on both sides of the turning should remain the same.

Road bed / Subgrade

The road bed is required to be strong, stable and economical and should be prepared according to the local conditions including geology, hydrology and available material as well as other construction requirements. Accordingly, the subgrade is proposed to have a minimum thickness of 300 mm having CBR values 8 %. Compaction of fill material in the subgrade should be 95 % of AASHTO T-180 (MDD). Borrow pits and spoil heaps should be properly dressed to avoid any hazards.

Pavement

It is expected that during construction of the solar farms, there will be considerable vehicle movement on the roads; however during the operation stage the traffic will be quite light. The road pavement has been accordingly designed on the basis of one million ESAL traffic load and subgrade CBR requirement of 8 %. The road surface needs to be stable and strong enough to meet the requirements of being smooth, anti-sliding and having a good drain system. Accordingly, the consultants have proposed a sub-base thickness of 150 mm, overlain with 175 mm thick water bound macadam meeting the standard AASHTO specification. The asphalt wearing course is designed to have a thickness of 50 mm. The shoulders have a double surface treatment over the 150 mm thick water bound macadam. Thickness of sub-base and subgrade is the same as that for the main carriageway.

The roads are proposed to be constructed phase-wise based on traffic needs. The first road is built and ready for use from the end of access road being constructed by C&W up to the phase-I area.

Traffic Access	The accessibility to the complete PV development area including the section of this 30 MWp plant should be realized via a solid access road.	IPP will be responsible for construction roads within the plant area.

5.7 Water Access

Water will be required for dust prevention during the construction phase and for cleaning of modules in the operation phase.

Water demand

The majority of the water will be needed for regularly cleaning the modules. Further small amounts of water will be needed for domestic consumption (e.g. living), landscaping and dust prevention on roads/tracks. Cleaning of the modules is supposed to take place once per month. The total demand of fresh water is estimated to approx. 3025 m^3 / year including the amount for domestic, landscaping and dust prevention consumption. The daily water demand equals to approx. 0.30 m^3 / day per MW PV plant. In case of realizing shorter wet-cleaning intervals (e.g. twice per month) for prevention of greater soiling losses, the water demand could rise up to approx. 0.50 m^3 / day per MW PV plant.

Water supply

The desert like region has only little water resources from rain (less than 200 mm/a) and some groundwater (likely fresh water) from seepage next to some channels but outside of the Site. A canal runs along the boundary of the plant however a detailed study for water sources will have to be carried out.

Water re-use / treatment / disposal

The water utilized for cleaning the modules will not be reused or treated after the module cleaning procedure. The water will be let to seep away into the ground, as catching the water before dropping off the modules is a very complex process. As only environmental pollutants, e.g. dust, sand, and bird droppings, are mixed within the used cleaning water, those naturally occurring elements are not regarded to give any negative influence to the PV plant's soil. However, in the long term of operating the solar plant it can be efficient to apply some type of water recycling to reduce fresh water consumption for module cleaning process.
Water used for domestic supply is supposed to be collected in underground waste water storage tanks. A procedure to recycle grey water, e.g. for lavatory, is currently not scheduled but recommended to be applied for efficient reduction of fresh water consumption.
A waste water treatment plant is currently not intended, but recommended to be adopted in due course. Waste water from domestic use shall not be dissipated into the ground without treatment.

Water related environmental impact analysis

The water related environmental impact analysis will have to be considered.

Water management plan

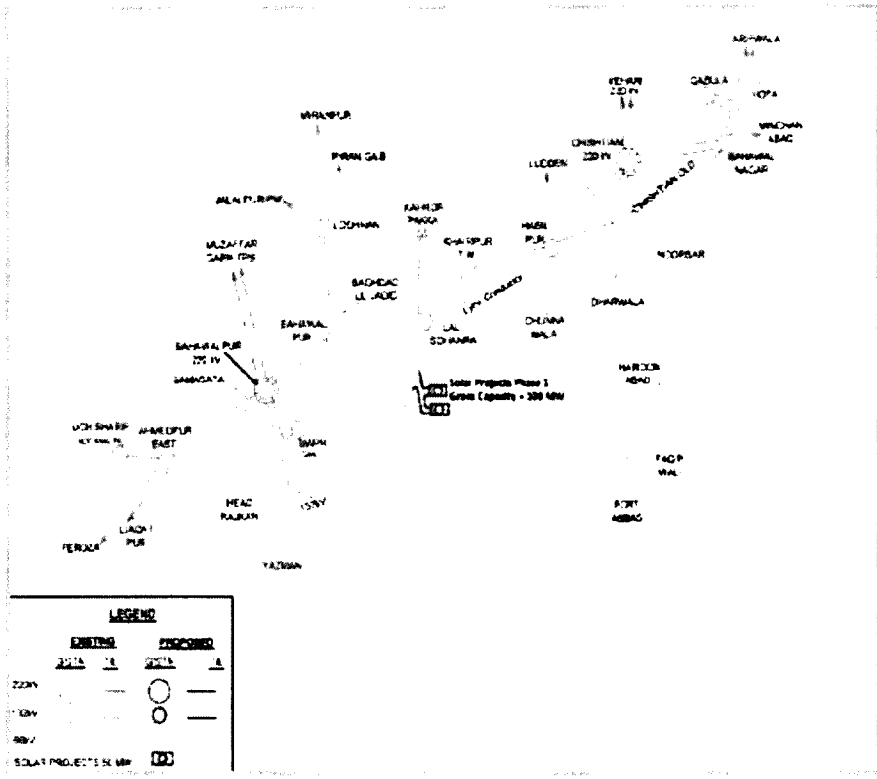
We recommend to carry out a water management plan for construction and operation of the solar power plant, specifying clearly in context of the O&M strategy. In particular:

- Water demand of the plant (e.g. for construction and cleaning of the modules).
- Water supply to the plant (based on the hydrological situation in the area).
- Water reuse/recycling schemes (e.g. waste treatment, storage ponds...).
- Waste water discharge (e.g. quality and amount of waste water, run-off systems, etc.).
- Water-related (hydrological) environmental impact analysis.

Water Access	A water management plan for construction and operation of the plant, as specified above shall to be carried out.	**not critical - to be done during detailed design**

5.8 Grid Access

Currently there is no high voltage grid access directly on Site, but the site is proposed to be connected to the Noorsar grid station. A grid interconnection study has been carried out to find out the evacuation capabilities this grid station, however it is yet to be approved by NTDC. The existing 66kV Noorsar grid station has already been upgraded to 132 kV. This will enable the plant to be grid connected as per NTDC and solar grid code.



Pic. 9: E-Grid overview / power lines

An 11 kV medium voltage grid is available, from which arrangements of auxiliary supply for the project area during construction phase will have to be made.

Grid Access	The medium voltage (11 kV) grid accessibility for the construction phase is available. However, load shedding might occur so a backup facility will be needed.	Not critical - to be considered during project planning

5.9 Facility Access

The PV development site is about 13 km away from Madrassah, where facilities such as a fire department, police station and hospital are available.
It will have to be checked if the fire station can meet the fire protection requirements of the Solar Plant. The water for fire-fighting is pro-posed to be supplied through the main water supply pipe running between the eastern and western corridors.
According to the features of the Solar Plant, and on the basis of the relevant specifications of Code of Design on Building Fire Protection and Prevention (GB50016-2006), fire hydrants will be provided in the general services area and the step-up stations. The outdoor fire hydrant shall be erected along the roadside, and the arranged distance between the hydrants shall be no more than 120 m. The fire devices shall be designed according to the secondary load power supply standard, using double circuit power supply and switching automatically at the end. The fire devices shall use fire protection or fire-resistant cables. The fire protection and firefighting system of each plot in the Park is part of safety requirement and shall be designed and provided by the EPC Contractor

The distance to the hospital is acceptable. An emergency kit has to be provided in each station on Site, along with an emergency guideline, the emergency number and a description of the travel route to enable a rapid aid.
The distance to the police station is also acceptable, but it is recommended that the Site has its own full time security staff located near or on the Site.

Facility Access	Access to public facilities (fire / police station, hospital) is well available nearby. T/he access road enables quick rescue services in case of an emergency. Fire hydrants have to be established along the roadside at a distance of max. 120 m.	**To be taken care of during detailed design**

6 Grid interconnection

In developed countries, many years of experience with grid connected renewable energy power plants have shown that it is possible to integrate these power plants into the grid under consideration of clearly defined technical aspects. PV plants, especially, are also able to offer reactive power 24/7 and can thereby help to stabilize the grid.

6.1 Possible electrical faults and their impact on the grid

In general, measures have to be taken in order to assure that all types of electrical faults as well as, all other states of the PV plant are managed in accordance with the relevant national grid code (Grid Code June-2005) and the existing "Technical Conditions for Grid Connection" of the corresponding grid operator. The requirements can be fulfilled by selecting the right safety equipment and a safety concept which includes all components from inverter up to the grid connection point.

6.2 Impact on the evacuation network

With respect to the transmission grid at high voltage level the conditions for a safe grid integration of 25 MVA nominal AC power needs to be formally assessed and signed off. The corresponding key indicators for this assessment are the short circuit power and the impedance angle of the grid at the grid connection point.

6.3 Balancing power

Due to their very nature, PV plants as such are not suitable for providing balancing power. According to the installed inverters the PV plant has to be operated far below nominal power at certain times of the day to ensure the requested reactive power. Usually inverters react slowly to the request to change the share of reactive power. Due to the slow reaction of the inverters and the need for fast power balancing, a compensation system has to be implemented. The PV plant needs to be formally assessed, so that adequate measures to provide the required balancing power can be implemented and an overall monitoring and control system installed.

6.4 Grid control strategies

Basically grid control strategies can only be set up with a somewhat clear understanding of the potential energy mix of a specific region in the future. Once this mix is known at least on "target basis", it is feasible to exploit the potential of modern inverters to the full extent, for instance their capabilities of providing reactive power on demand in more or less real time or in case of low voltage. Accordingly, to the aims of the Master plan the requirements of the grid code have to be broken down into requirements for the PV plants. Therewith the PV plant can be designed to support a proper control of the grid.

6.5 Technical Specifications

Technical specifications for grid interconnection and the equipment have to be in compliance with international and national standards (voltage and frequency range, power factor, voltage drop, current rating, switching capability, safety features, control and monitoring etc.)
Prior to setting up technical specifications for the grid connection a comprehensive analysis of the existing grid codes, relevant guidelines and national regulations, has to be carried out with the target to establish the exact conditions for a safe, technically and economically viable grid connection of the PV plant. Following this analysis, detailed technical requirement specifications concerning the behaviour of the grid connected PV plant can be set up in order to make sure that faults and deviations from the established set of conditions result in predefined actions. Key issues in this respect are:

- Decoupling of the PV plant in case of short circuit and voltage or frequency deviation above or below defined thresholds
- Dynamic grid support in case of short term voltage drops
- Provision of reactive power and control of effective power as required

6.6 Approvals

A grid connection study considering evacuation of the complete park was carried out. Only 30 MW DC are being constructed right now and there shall be no limit for this project in evacuation capacity. There has been a grid integration and connection study to confirm the conditions of integration of this 30 MWp PV solar plant, however it is yet to be approved. Within the connection conditions of the Energy Purchasing Agreement and its Annexes the details of the quality of power and measurements have to be fixed. In particular:

- Potentials and limitations for the integration of the power product of the different scales of SPV plants into the daily and yearly load curves.
- Quantitative and qualitative needs and already available grid-inherent potentials to provide balancing power.
- Quantitative and qualitative needs for additional balancing power.
- Further risks and necessary risk mitigation measures for ensuring grid stability.
- Required power quality output parameters of the plant.
- Technical requirements of inverters, transformer, switching devices, circuit breakers etc.
- Control parameters and control interfaces to the grid operators control schemes.
- Further risks and necessary risk mitigation measures avoiding and handling electric failures of the plant.

Comments on the grid study have been received from MEPCO and are being responded by M/S Power Planners International.

Grid connection	The specific requirements and approval for grid connection need to be confirmed by NEPRA / NTDC	not critical - Under process

7 Plant Layout and Description of Technical Equipment

7.1 Power supply infrastructure

An 11 kV overhead power cable line will have to be made available for auxiliary loads.

This power line will be large enough for supplying the auxiliary power, but not large enough to evacuate the produced electricity of the park.
The grid connection for this 30 MWp PV power plant can be realized by connecting the Park to the nearest 132 kV power line access to which will have to be established.

7.2 Power plant technology configurations

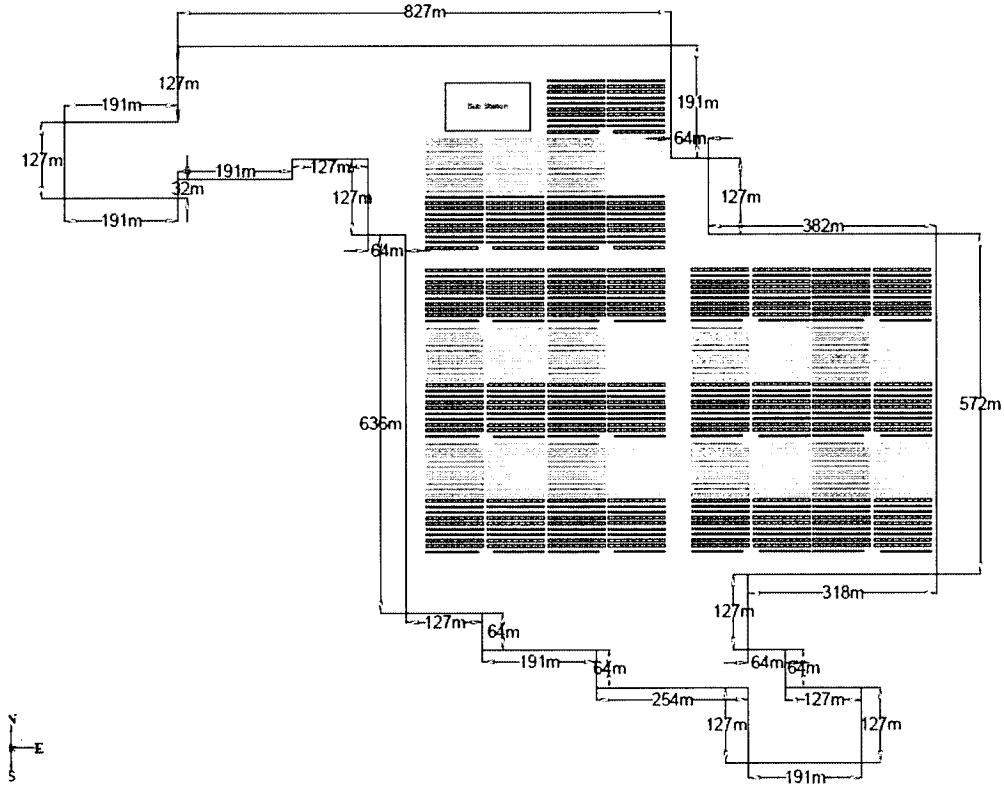
In general several technology configurations can be realized.
Easiest and cheapest technology configuration is fixed mounted module installation with a 25-30° tilt to the south with central inverters. The density of installed PV power to ground space is highest and the specific energy output by installed PV power is lowest.
Alternatively, a dual axis tracking system represents the complete opposite: it is more expensive, it has the lowest density of installed PV power to ground space and the highest specific energy output of installed PV Power.
A compromise of these two technologies lays in a single axis tracking system. This option offers a good cost to power ratio. Due to this insight, several versions of single axis tracking systems (with horizontal North-South axis) may be compared.
A fixed tilt installation is being considered for the plant due its lowest risk profile.

Pile rammed sub-structures are the best recommended foundations for PV racks, according to geotechnical investigations, but the best foundation for this specific site will be decided by the executing company.

7.3 System Design

7.3.1 Preliminary Layout

The final layout will be defined once the final choice of modules, structures and inverters has been made. Based on the current land layout provided, the following design has been proposed.



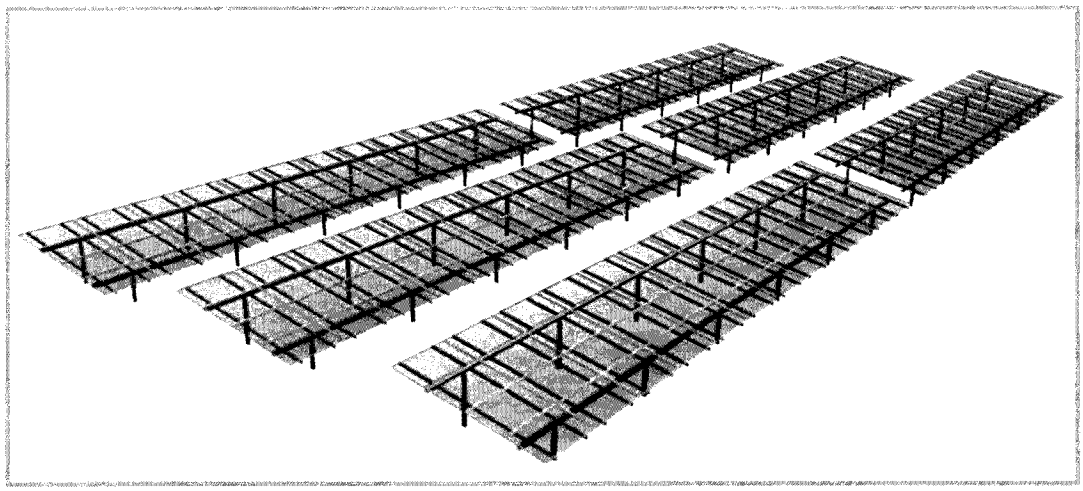
Pic. 4: Proposed layout based on the available land

7.3.2 Modules

Standard crystalline PV modules, sorted according to a positive tolerance, were selected for the system design. This type of module is currently state of the art. Such modules are readily available in cost-efficient and sufficient amounts to realize a 30 MWp Solar Park Project.
Quality of the modules will be assured by a pre-construction factory-audit of the manufacturer, laboratory testing of recently produced modules and on-site testing of modules delivered to construction site.

7.3.3 Structure

For mounting the PV modules on Site a standard fixed tilt metal mounting structure will be proposed. Using ramming piles or earth-screws as the structure's foundation is a common and cost efficient method. The method has proven its reliability in several PV projects throughout the world.
The modules are mounted to the structure in a tilt- angle of 25°-28° to the ground to enable sun exposure and high energy yield.



Pic. 5: Schematic diagram of PV mounting structure, Source S-Flex GmbH

7.3.4 Cables

The electrical interconnection between PV modules and inverters is designed to be made of minimum 4 mm² copper cable. This is a standard approach according to the international best practice and suitable for the Project.

7.3.5 Inverters

For this Technical Site Assessment, centralized type AEG inverters were selected. This type of inverter is a typical and high quality state of the art product suitable for the Project. Inverter quality shall be secured by a factory-audit of the manufacturer before production and delivering stage.

7.3.6 HV Station

The substation is considered as a critical part for the Project concerning the time line for its construction. Availability and delivery time of the chosen components and design criteria acceptable to NTDC have to be considered.
A standard substation consisting of a Medium Voltage part including HV transformer, HV portion of the PV plant, double bus bar single breaker scheme designed for HV portion is recommended for utilization in this Project.

7.3.7 Monitoring

A SCADA system of high temporal resolution (minimum should be 15 Minute average values) is recommended to be adopted. It is also recommended to measure the fine resolution of PV plant components, e.g. in one channel combination of two module strings only.
To achieve an optimum energy yield it is recommended to keep the staff operating on Site for monitoring the performance of the PV plant continuously.

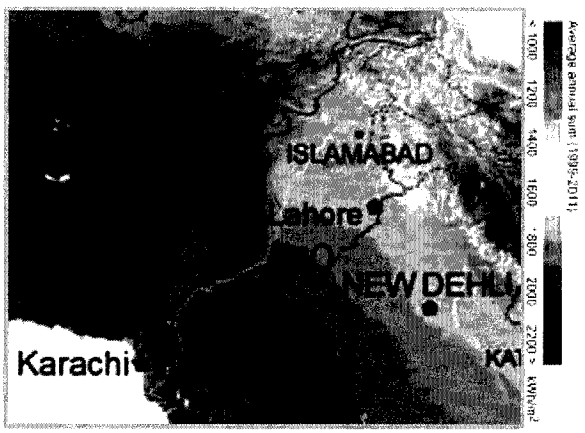
7.3.8 Security

For securing the Site against theft and vandalism as well as for protection of personnel, a fence of minimum 2 m height plus barbed wire should be erected. As an alternative, a solid concrete wall should be erected. In addition, a video surveillance system connected to a maintenance office is recommended to be installed to remotely supervise activities on Site.

8 Energy Yield Assessment

8.1 Solar irradiation data

The given sunshine hours can only indicate the volatility through the years which is around 20 %. Besides these sun hour data there are also other sources for irradiation data available e.g. satellite. Dimension shall be kWh/m² instead of sun hours to calculate energy values. For initial energy yield analysis the annual horizontal global irradiation was evaluated as 1862 kWh/m² (Meteonorm data base, see also 5.5).



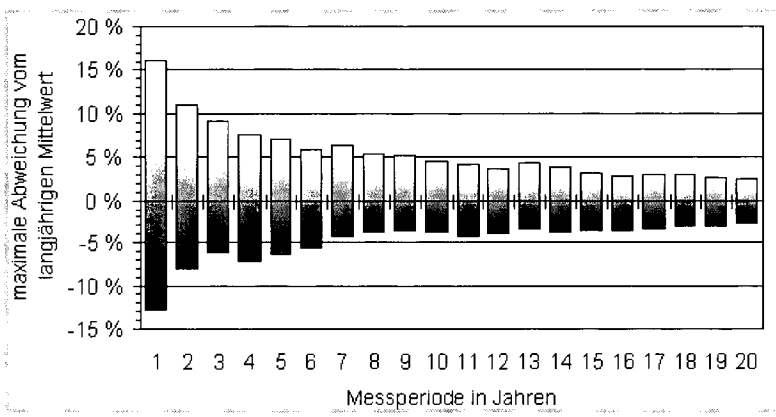
Pic. 6 : Global horizontal irradiation (GHI) for Pakistan, source: SolarGIS 2012

Month	GlobHor (Ghi)	T Amb (Ta)
	kWh/m² * a	°C
January	97.2	13.4
February	119.6	17.5
March	176.8	23.5
April	195.9	29.1
May	207.1	33.8
June	180.6	33.3
July	171.7	32.3
August	178.9	31.3
September	173.6	29.6
October	154	26.8
November	112.1	20.2
December	99.2	15.3
Year	1866.7	25.55

Table 3: Global horizontal irradiance (Ghi) and ambient temperature (Ta) by Meteonorm / monthly means

8.2 Uncertainty Analysis of Irradiation Data

The deviation of single years from the long-term average can amount up to 15 % and can show the same trend over several years. To minimize deviations for yield calculations it is necessary to take into account a long term average of irradiation. The figure below demonstrates the decrease of deviation from the long term average according to the number of measurement years. In fact, there will always be deviations in irradiance between each year of operation. Regarding the long term of operation these deviations will lead to an average irradiance very close to that number given in the yield analysis. The actual uncertainty figures for the fixed as well as single axis tracked system will be incorporated in the financial and economic model and compared with the NEPRA model for up-front tariff of July 2016.



Pic. 7 : Deviation of solar irradiation from the long-term average

Source: Volker Quaschning „Unstete Planungsgröße"; Maximum deviation of measuring periods of different duration from the long-term average in the years 1937-1999 at the Potsdam/Germany site.

The uncertainty of annual irradiance data is 10 % (source: Meteonorm software, Version 7.1.1.122). This value is high because the nearest ground measurement station for comparative values is at quite a large distance.

8.3 Performance Ratio

A solar cell is the smallest semi-conductor element within a PV module to perform the immediate conversion of sunlight into electrical energy by the photovoltaic effect. Depending on the employed technology, the degree of efficiency amounts up to 18 %. This value seems to be quite low but the free supply of primary energy (solar radiation) and the corresponding absence of power dissipation in the conventional sense should be taken into consideration. By using appropriate technology, the direct current generated by the solar modules is converted into alternating current that can be fed into the public power supply.
The conversion into alternating current implicates losses depending on the PV system configuration, the choice of components and, to a minor degree, on the local Site conditions.
If these losses are identified and evaluated, the system operation quality – the performance ratio (PR) – can be ascertained.
The PR is stated as percent and describes the relationship between the actual and theoretical energy outputs of the PV plant considering module efficiency.
PR = energy yield / (un-shaded annual irradiation on array surface * module efficiency according to STC)

$$PR = 100 \times \left[\frac{E_{AC}}{E_{Irradiation} \times A_{Array} \times \eta_{STC}} \right]$$

E_{AC} = energy coming from the inverter or measured at the energy meter in kWh
$E_{Irradiation}$ = un-shaded irradiation at module level in kWh
A_{Array} = total surface of all solar modules in m²
η_{STC} = module efficiency at STC

The module efficiency (contrary to the cell efficiency) considers the gross module surface and can be calculated as following:

$$\eta_{STC} = \left[\frac{P_{Module}}{A_{Module} \times 1.000}\right]$$

8.4 Shading analysis

From multiple site visits we can safely assume that vegetation and terrain causes no relevant shading. No relevant objects can be seen so far. Few trees and small bushes existing at site have been proposed to be cut. This eliminates all chances of external shading.

8.5 Expected losses

System Operation Quality / Performance Ratio

A fundamental step in understanding this important quality criterion is the explanation of the typical loss factors affecting the energy yield with different weights. In every simulation step, all described aspects have an hourly impact on the overall result.

- *Irradiation gain by inclination of modules*

In non-equatorial zones, the degree of irradiation at module level can be improved by the inclination of modules southwards (northern hemisphere) or northwards (southern hemisphere) against the horizontal. When reaching a normal module inclination angle of 25-30 degrees, the irradiation gain can amount up to 10-15 % in temperate zones. It is expressed by the surface-factor F (A) ~ 1.10 – 1.15. The inclination angle causes an additional irradiation because the ground reflects the light to the modules. This reflection on different soil types is expressed by the Albedo Factor. There are empirical values for different soil surfaces. For example, the solar reflectance of grassland and cropland is about 20 %. The effect on the energy yield is scarcely weighty but even so, it is considered in the yield simulations. The product of irradiated amount of energy at module level and module efficiency (not cell efficiency, which is higher) is the basis for the initial value for the PR calculation and is defined to be 100 %.

Description of types of technical losses

Technical losses are calculated in the energy yield analysis depending on system design, chosen components and operation conditions.

- *Technical losses because of shading*

If there are objects in the immediate vicinity of the planned solar plant causing shading of the solar generator, these shadings can be considered and simulated by shading analysis. A distinction is made between "horizon shading" and "nearby shading".
"Horizon shading" causes a shading effect which has a permanent impact on the entire generator field. The simulation considers this effect by adjusting the horizon line. Objects that are in a large distance to the modules, e.g. mountain ranges, are typical horizon shadings. Such shadings always affect a larger module field, i.e. an array.

"Nearby shading", on the contrary, has a temporary and impact only on some parts of the generator field. Other parts of the plant remain absolutely unaffected. Objects at close distance to the modules act as cast shadows, e.g. power poles, trees but also row shading in large rack-mounted solar fields.
Greater distances between the mounting rows will lead to less nearby shading, as the effect of shading at low sun-angle will reduce.
Depending on the site conditions, these aspects are considered in the yield simulation.
Best in class shading losses would be represented by values in the range of up to 1 %. Acceptable values would range between 1 % up to 5 % always depending on the required use of ground and intended energy yield of the PV plant. Shading above 5 % would be un-acceptable.

- *Technical losses because of soiling*

Dirt on the modules also causes shading effects which can change over time and season. This shading impact on the energy yield depends, for example, on the surrounding landscape, cultivation and precipitation. The impact can only be estimated and is based on experience. Consequently, the uncertainty is high. It is recommended to clean the modules at least once per month.
Best in class soiling losses would be represented by values in the range of up to 1 %. Acceptable values would range between 1 % up to 4 %. Soiling above 4 % would be un-acceptable.

- *Technical losses because of temperature fluctuation*

Ambient temperature and degree of irradiation have an influence on the cell temperature and so affect the energy conversion process. According to the defined STC value of 25° C the electrical power output decreases with higher module cell temperature and increases with lower cell temperature. The module model shows this characteristic by means of temperature co-efficient for current and voltage.
Best in class losses due to temperature fluctuation would be represented by values in the range of up to 10 % under the site conditions. Acceptable values would range between 9 % up to 13 %. Temperature fluctuation losses above 13 % would be un-acceptable.

- *Technical losses because of reflection*

In particular inclined irradiation causes reflection of sunlight at the glass and cell surface. For "solar glass" it is considered by an empirically determined factor: IAM (Incidence Angle Modifier) = 0.05.
Best in class losses due to reflection would be represented by values in the range of up to 1 %. Acceptable values would range between 1 % up to 4 %. Reflection losses above 4 % would be un-acceptable.

- *Technical losses because of low irradiance level*

Due to production processes the relative power of the Modules might differ under different light levels.
Best in class losses due to this effect would be 0.2%. Acceptable values would range between 0.2 % up to 0.8 %.

- *Technical losses because of fluctuations in module quality*

Due to measurement errors or contractually allowed tolerances, the module output power under standard test conditions might deviate.
Best in class losses due to module quality are negative if only positive tolerances would be allowed. Acceptable values would range between 0 % up to 1.5 %.

- *Technical losses because of fluctuations in module arrays*

Due to production reasons, the module performances are subject to fluctuations:

Because of the different manufacturing technologies the module wiring to module strings causes the so-called mismatch effect.
Best in class losses due to mismatch would be represented by values in the range of up to 0.5 %. Acceptable values would range between 0.5 % up to 1.5 %. Mismatching losses above 1.5 % would be un-acceptable.

- *Technical cable losses*

The whole wiring of the solar park is subjected to cable losses due to the natural resistance of conductors - the Ohmic resistance. Due to small-scale plant design and cable dimensioning for maximum performance, losses normally amount to 1-2 %.
Best in class ohmic losses would be represented by values in the range of up to 1 %. Acceptable values would range between 1 % up to 2.5 %. Ohmic losses above 2.5 % would be non-acceptable.

- *Technical losses because of DC/AC inversion*

The conversion of direct current into grid compatible alternating current entails inevitable losses. The manufacturer's data of the inverters relating to the European standard efficiency regard typical European operating conditions. The temporal distribution of the performance quantity is evaluated here.
Best in class losses due to DC/AC inversion would be represented by values in the range of up to 1.8 %. Acceptable values would range between 1.8 % up to 3 %. DC/AC inversion losses above 3 % would be un-acceptable.

- *Technical losses because of transformation (transformer losses)*

Transformer losses depend simultaneously on several parameters. Basic technical parameters like ohmic and magnetic resistance can be taken into calculation. Depending on technology the losses are around 1-2%. For step-up transformers (MV/HV) this value is typically <1%.
Best in class losses due to voltage transformation would be represented by values in the range of up to 0.6 %. Acceptable values would range between 0.6 % up to 1.2 %. Transformation losses above 1.2 % would be un-acceptable.

- *Technical losses because of plant-availability*

The technical availability of a PV plant crucially determines the energy yield. Outages due to failure of fuses, disconnected strings or broken inverters are likely to occur and therefore must be considered in the expected energy yield.
Best in class technical availability losses would be represented by values in the range of up to 0.3 %. Acceptable values would range between 0.3 % up to 0.8 %. Availability losses above 0.8 % would be un-acceptable.

- *Technical losses because of weathering and degradation*

Changes in the energy yield because of weathering need to be considered in the expected long term energy yield. As degradation of the modules is a continuous process, depending on time, performance will decrease with the time of operation. Performance guarantees of the manufacturer and different practical results diverge a lot. Former long-term study findings cannot be applied easily to modules produced with today's manufacturing processes and product features. But it is assumed that today's processes and technologies lead to a higher module quality. The consideration of an annual correction value for weathering / degradation is recommended for the overall result.

Best in class degradation losses would be represented by values in the range of up to 0.3 %. Acceptable values would range between 0.3 % up to 0.8 %. Degradation losses above 0.8 % would be un-acceptable.

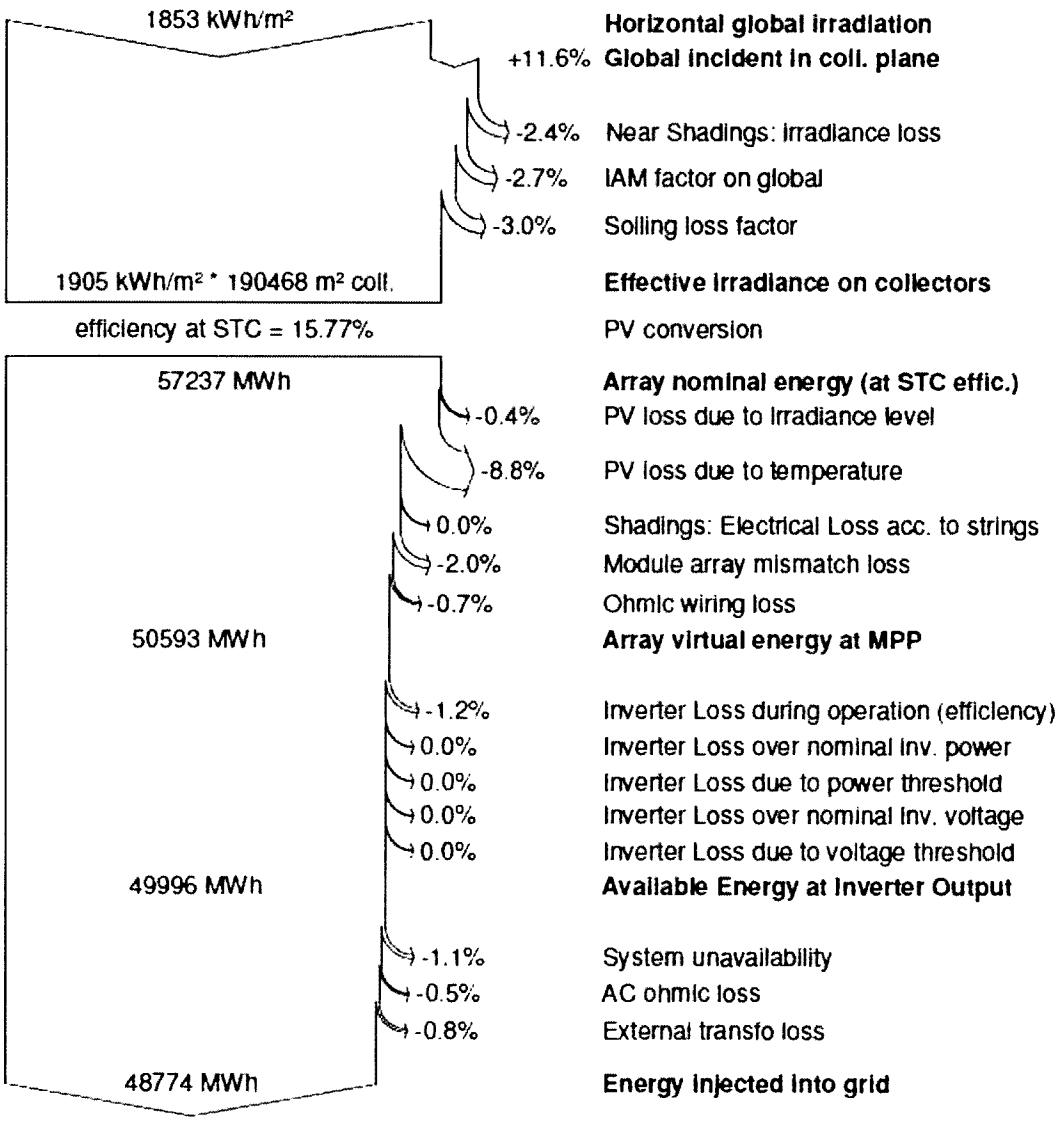
Up to now, the technical design has not yet been decided. We have made conservative assumptions by also using state of the art components.

Loss factor	quality classification		
	best in class	our assumption	non-acceptable
	%	%	%
Shading	< 1.0	2.5	> 5.0
Soiling	< 1.0	3.0	> 4.0
Temperature fluctuation	< 9.0	9.2	> 13.0
Reflection	< 1.0	1.3	> 4.0
Module low light performance	< 0.0	0.0	> 0.8
Module quality performance	< -0.2	0.0	> 1.5
Module mismatch losses	< 0.5	2.0	> 2.5
Cable losses	< 1.0	1.2	> 2.5
DC/AC conversion	< 1.8	1.2	> 3.0
Voltage transformation	< 0.6	0.8	> 1.2
Availability	< 0.3	1.0	> 0.8
Degradation on average	< 0.3	0.5	> 0.8

Table 4: Overview to loss factors and quality classification

Shown below are the results for fixed mounted structure with a fixed tilted array with 28° tilt angle of the modules.
General explanation to the waterfall diagram: (1) Starting with the Horizontal Global Irradiance the tilted installation increases the irradiance on tilted module plane – in the shown example – by 11.1 %. Near shadings and glass reflections reduce that gain. (2) Once the irradiance reaches the active cell it is converted to electric power by the efficiency of the cell ("PV conversion"). (3) The electrical system then causes more losses which depend on the characteristic behavior of the components cabling design and operation.
The PR is calculated between "Energy injected to grid" and "Array nominal energy (at STC efficiency)".

Loss diagram over the whole year



Pic. 8 : Waterfall diagram of losses (50 Case- simulation for 30MW cluster with fixed tilt 28° to south)

8.6 Energy yield simulation for most suitable technical design

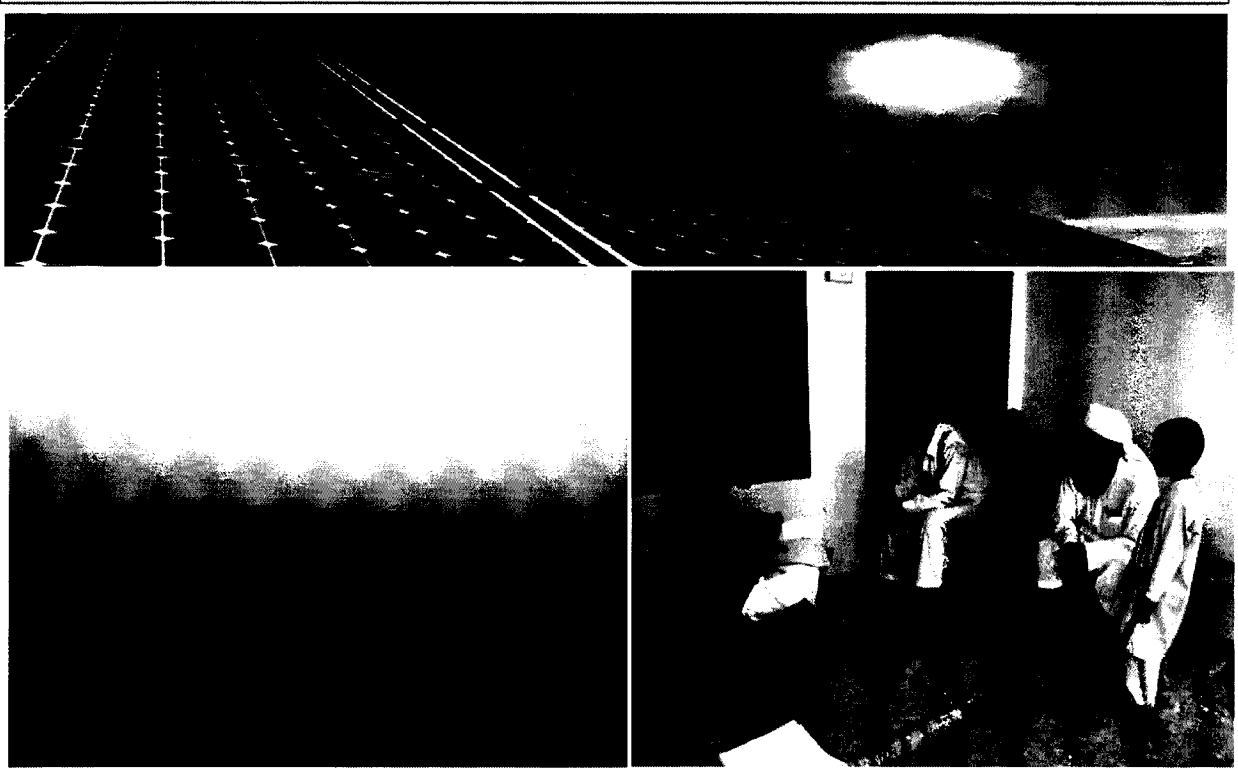
Different pre-assessments have been calculated with the simulation software PVSyst.
PVSyst takes as an input the meteorological data as well as a given system design and a component selection. Then it simulates a whole operational year in two-minutes-steps through a whole year.
The options for technical design are fixed mounted at different tilt-angles. The yield assessments show following annual outputs to the grid. The results are calculated for the point of interconnection with the HV grid and include transformer losses and cable losses to the point of interconnection to the HV Power line.

	Fixed mounted
	28° to south
Irradiation in module plane kWh/(m²*a)	2068
Performance Ratio (PR) %	78.61
Specific output kWh/kWp	1626
Total output for 30 MWp kWh/a	48,620,000

Table 5: (Summary of Simulation results)

Asia Petroleum Limited

IEE of 30MW Solar Power PV Project Noorsar, Chishtian, Bahawalnagar



January 2017

Initial Environmental Examination (IEE) Report

INTIAL ENVIRONMENTAL EXAMINATION OF 30MW SOLAR POWER PV PLANT NOORSAR, CHISHTIAN, BAHAWALNAGAR

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1 INTRODUCTION 1

1.1 Background 1
1.2 Project Location, Nature and size 1
1.3 Scope of the IEE Study 2
1.4 Key Features of Project 3
1.5 Environmental Sensitivity of the Project 4
1.6 Limitations of Study 4
1.7 Purpose of the Report 4
1.8 Details of Proponent 4
1.9 Details of Consultant 5

2 LEGAL / REGULATORY FRAMEWORK 6

2.1 National Policies, Plans, Acts and Legislation 6
2.1.1 Province Revenue Departments 6
2.1.2 Pakistan Environmental Protection Act, 1997 7
2.1.3 National Environmental Quality Standards, (NEQS) 2000 8
2.2 Provincial Departments 8
8
2.2.1 Provincial Revenue Departments 8
2.2.3 Punjab Environmental Protection Department 8
2.2.4 Agriculture and Horticulture Department 9
2.2.5 Coordination with District Government 9
2.3 Other Relevant Acts 9
2.3.1 Local Government Act 2001 and Amended in 2003 9
2.3.2 Punjab Wildlife Protection Act, 1974 9
2.3.3 Protection of Trees and Brushwood Act, 1979 9
2.3.4 Clean Air Act, (1990) 9
2.4 Procedure for Environmental Approval 10
a Classification of the Project 10
b Submission of IEE 10
c Issuance of NOC 10

3 PROJECT DESCRIPTION 12

3.1 Purpose and General Description of Project Activity 12
3.2 Location and Site Layout of the Project 12
3.3 Category of the Project 12
3.4 Project Objectives 12
3.5 Important Nominal Characteristics of the Project 13
3.6 Schedule of Implementation 14
3.6.1 Other Power Generation Options 14
3.6.2 No Project Option 16
3.6.3 Alternative Site of the Proposed Project 17
3.6.4 Alternate Technology for Project 17
3.7 Construction Aspects 18
3.7.1 Contractor's Facilities 18
3.7.2 Work Force 18
3.7.3 Construction Material and Transportation 18
3.7.4 Import of Solar System Material 18

3.8 Restoration and Rehabilitation Plan 19
3.9 Site Waste Management Plan (SWMP) 19
3.10 Government Approvals 19
3.11 Road Access Plan 19

4 APPROACH AND METHODOLOGY 20

4.1 Adopted Procedure 21
4.2 Survey of the Proposed Project Area 21
4.3 Public Consultation and Information Disclosure 22
4.4 Mitigation Measures and Monitoring Plan 22
4.5 The Final Report 23

5 ENVIRONMENTAL & SOCIAL BASELINE CONDITIONS 24

5.1 Study Area 24
5.2 Data Source 24
5.3 Geology 24
5.4 Water 25
5.5 Soil 26
5.6 Land Use 26
5.7 Climate 26
5.8 Water Bodies 28
5.9 Terrestrial Ecology 28
5.9.1 Flora 29
5.9.2 Fauna 31
5.9.3 National Parks and Wildlife Sanctuaries 32
5.10 Baseline Socio-Economic Status 33
5.11 Demographic Information of Main Project Site 33
5.12 Physical Structures 34
5.12.1 Structures 34
5.12.2 Religious Structures 34
5.12.3 Protected Structures 34
5.13 Social and Public Amenities Available to Proposed Area 34
5.14 Social Inventory of the Surveyed Area 35
a Occupation of Population 37
b Personal Income 37
c School in the Area 37
d Facilities Available 38
e Satisfied with educational facilities in the area 38
f Favor of the Proposed Project 38

6 PUBLIC CONSULTATION AND INFORMATION DISCLOSURE 39

6.1 Objectives of Stakeholder's Consultation 39
6.2 Stakeholder Identification 40
6.3 Information Disclosure 40
6.4 Monitoring and Evaluation 41
6.5 Methodology Adopted 41
6.5.1 Stakeholders Analysis 41
6.6 Classification of Stakeholders 42
6.7 Interested and Affected Parties Consulted 43

6.8 Consultation with Local Stakeholders 44

7 ENVIRONMENTAL IMPACTS AND MITIGATION STRATEGIES 46

7.1 Impact Prediction Methodologies 46
7.2 Impact and Mitigation Management 46
7.3 Project Benefits 48
7.3.1 Clean Development Mechanism (CDM) 48
7.3.2 Types of CDM Projects 49
7.4 Beneficial Impacts 50
7.4.1 Employment Opportunity to Local People 50
7.4.2 Increased Economic Activities 50
7.5 Adverse Impacts 50
7.5.1 Construction Stage 50
a Adverse Impacts on Physical Environment 50
b Impacts on Biological Environment 53
c Impacts on Social & Economic Environment 53
7.5.2 Operational Phase 54
a Impacts on Social and Economic Environment 54
b Impact on Water Resources and Water Sharing 54
7.5.3 Decommissioning Stage 55
7.6 Enhancement Measures 55

8 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN 56

8.1 Environment Management Plan (EMP) 56
8.2 Objectives of EMMP 56
8.3 Environmental Monitoring Plan (EMP) 56
8.4 Recommended Environmental Monitoring Protocol Pre Construction Phase 57
8.4.1 Ambient Air Quality 57
8.4.2 Surface Water Quality 57
8.4.3 Ground Water Quality 57
8.4.4 Noise Level Quality 57
8.5 Recommended Environmental Monitoring Protocol during Site Preparation 57
8.6 Recommended Environmental Monitoring Protocol during Construction Phase 58
8.7 Recommended Environmental Monitoring Protocols after Construction 58
8.8 Institutional Arrangements and EMMP 59
8.9 Training Schedules 59
8.10 Institutional Capacity 60
8.11 Environmental Budget 61
8.12 Equipment Maintenance Details 61
a Different Steps of PV Maintenance Procedures 61
b Perform Visual Inspection 61
c Array Maintenance 61
d Shade Control 62
e Electrical Equipment Maintenance 62

9 CONCLUSIONS AND RECOMMENDATIONS 63

9.1 Conclusions 63
9.2 Recommendations 64

LIST OF TABLES

Table #	Description	Page #
Table 1.1	Coordinates of different Locations of Project Area	2
Table 2.1	IEE Approval Process	11
Table 3.1	Important Characteristics of the Project	13
Table 3.2	Timeline for Construction of Project	14
Table 3.3	Energy Source Comparison	15
Table 5.1	Most Important Medicinal Plants	28
Table 5.2	Grasses and Hedges	29
Table 5.3	The Notable Wildlife Species (Mammals)	31
Table 5.4	Birds of Study Area	32
Table 5.5	Amphibians and Reptiles	33
Table 5.6	Social Inventory of the Surveyed Area (Moza Khazan Singh)	35
Table 6.1	Public Consultation	44
Table 7.1	Design of Mitigation Measures	47
Table 8.1	Environmental Management Structure and Responsibility	60
Table 8.2	Environmental Budget	61
Table 8.3	Maintenance Plans	62

LIST OF FIGURES

Figure #	Description	Page #
Figure 1.1	Proposed Project Area	2
Figure 5.1	Geology of Study Area	25
Figure 5.2	Annual Rainfall	26
Figure 5.3	Annual Temperature	27
Figure 5.4	Flora of Project Area	28
Figure 5.5	Grasses and Hedges of the Study Area	30
Figure 6.1	Public Consultation Session conducted at Moza Khazan Sigh	44
Figure 6.2	Public Consultation Session Conducted at Village Noorsar	45
Figure 7.1	CDM Flow Chart	48
Figure 7.2	CDM Mechanism	49

LIST OF ANNEXES

Annex-A Socio-Environment Team

Annex-B Reference Documents

- Annex-B1 TOR
- Annex-B2 PEPA 2000
- Annex-B3 NEQS 2000

Annex-C Survey Tools

- Annex-C1 Maps
- Annex-C2 Environmental Checklist
- Annex-C3 Village Profile
- Annex-C4 Socio-Economic Questionnaire

Annex-D Photo Gallery

Annex-E End Notes

- Annex-E1 References
- Annex-E2 Glossary

ACRONYMS

AJK	Arif Junaid Karim Engineering Private Limited
AJK	Azad Jammu Kashmir
BOD	Biological Oxygen Demand
CDM	Clean Development Management
CER	Credits/Certified Emission Reduce
COD	Chemical Oxygen Demand
DNA	Designated National Authority
ECCS	ECOCARE Consultancy Services Private Limited
EMP	Environment Management Plan
EPA	Environment Protection Agency
EPD	Environmental Protection Department
GHG	Greenhouse Gases
IEE	Initial Environment Examination
M&E	Monitoring and Evaluation
NCS	National Conservation Strategy
NEQS	National Environmental Quality Standards
NGO	Non-Governmental Organization
PEPA	Pakistan Environment Protection Act, 2000 (Amended 2012)
PEPC	Pakistan Environmental Protection Council
PPDB	Punjab Power Development Board
PPE	Personal Protective Equipment
PV	Photo Voltaic
SA	Study Area
SWMP	Solid Waste Management Plan
UNFCCC	United Nation Framework Convention on Climate Change

EXECUTIVE SUMMARY

Name of the Project:	**Construction of 30 MW Solar Power Plant at Noorsar Village Chishtian, Bahawalnagar**
Proponent:	**Asia Petroleum Private Limited**
Consultant:	**ECOCARE Consultancy Services (ECCS) Private Limited**

1. Introduction

Pakistan is ideally located in the sun-belt. Solar is served as energy source and it is widely distributed in the country. The development and adaptation of solar energy technology is to use both light and heat energy to produce electricity which can help to reduce the shortfall and to meet the demands of electricity. Thus, the country has begun diversifying its energy producing capacity by investing in wind and solar power plants that have ability to offset energy shortage.

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

ECOCARE Consultancy Services (ECCS) Private Limited is the consultant firm which has conducted environmental study and prepared this final IEE Report on behalf of the ECCS-AJK JV for the Project Proponent in accordance with the EPA-Punjab guidelines.

2. Legal/Regulatory Framework

The national guidelines and legislations related to environment are considered for the proposed Project including National Conservation Strategy (1992), National Environment Policy (2005), Pakistan Labor Policy (2010), Punjab Environmental Protection Act (PEPA 1997), amended PEPA (2000), National Environmental Quality Standards (NEQS), Punjab Wildlife Act (1974), Punjab Plantation and Maintenance of Trees Act (1974) and Antiquities Act (1975).

Current national environmental policy as well as administrative and legal framework of PEPA 2000, has been reviewed comprehensively which provides an overview of the national policies, laws, guidelines and regulations related to the IEE study. Initial Environmental Examination (IEE) Report is mandatory to obtain Non-Objection Certificate (NOC) according to Pakistan Environmental Protection Act (PEPA-1997). Section 12(1) of PEPA-1997 stipulates that no project involving construction or any change in the physical environment can be undertaken unless an IEE or EIA is conducted and NOC is received from the relevant provincial environmental agency. This IEE Report has been prepared with due consideration of PEPA, 1997, Punjab Environmental Protection (Amendments) Act, 2012 and all other legal requirements of Pakistan and Punjab Government.

3. Project Description

A brief description of the Project parameters is given below;

Parameter	Feature
Nature of Area	Desert
Project	30 MW Solar Power Generation
Total Area (involve Installation of Solar Panels, Buildings for Control Room and Offices)	205 acres
Form of Technology	Photovoltaic (PV)
Project Finishing Point	Around 10 Months
Transmission Line Arrangements	Noorsar Grid Station
Kind of Apparatus to be Used	Fixed Installation (Type X-Si) Solar Cells

4. Approach and Methodology

The IEE document is presented for the purpose of enabling decision makers to assess the anticipated impacts on the social, biological and physical environment arising from 30MW Solar Power PV Plant at Noorsar, Chishtian, Bahawalnagar. A conventional approach was followed to conduct IEE to meet the requirements of Punjab-EPA for social and environmental sustainability standards and policies. The IEE process, however, has undergone the following steps mandatory for any environmental assessment:

- Consultation with experienced environmental experts to discuss and examine the potential environmental impacts. They could also predict the potential environmental impacts caused by the Project upon special study and simulation incorporating experts' opinion
- Secondary information was collected by studying Project designing, drawings and other related studies
- To collect baseline information and to identify the present environmental conditions in the Study Area; field investigation, predication and monitoring techniques was used
- To understand public experience of the related projects public consultation and project disclosure to the affected community
- A solid liaison with the public-sector departments/agencies to involve them in administrative and responsibility hierarchy
- Evaluate the environmental impacts envisaged to be caused by the Project according to relevant laws, regulations, standards and results were predicted
- Relevant policies and environmental guidelines were used to access the doable remedial measures, to assess the residual impacts and for evaluation whether they meet the Devise Environmental Management and Monitoring Plan (EMMP) to evaluate the actual environmental impacts and the implementation of the remedial measures/mitigations

5. Environmental and Social Baseline Conditions

The semi-desert area comprises maximum wasteland which receives maximum solar radiation. The vicinity of Project Area is almost sandy and barren. A floristic survey of area was carried out during 2009-2011, total of 38 families, 106 genera and 154 species were documented in the area. Among plant 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 a lack of almost all social amenities in the settlements nearby, like hospital, school, post office, grocery shops, graveyards, electricity, gas and public water supply.

6. Public Consultation and Information Disclosure

A series of consultation was carried out with stakeholders and general public in proposed Project Area. In this regard, the rounds of public consultation and social assessment survey were held during October 2016 with selected persons including government officials, notables and general community of Project Area.

The community took keen interest in the objectives and interventions of the Project and gave their comments accordingly. Residents of the nearby settlement were very much supportive to the Proposed Project. The local poor people predominantly requested for un-skilled and semi-skilled jobs during implementation of the Project. They also demanded better educational and health facilities. On the basis of the consultations so far, it appears that the Project will have no insurmountable environmental and social impacts. The community generally supported the proposed 30MW Solar Power Project.

7. Environmental Impacts and Mitigation Strategies

The impacts, their nature and degree is given below;

S	[illegible]	Before	During	After
	Atmospheric Environment	0	0	0
	Flora & Fauna	0	0	0
	Land Use	0	+1t	+1p
	Solid Waste Generation	0	-1t	-1t
	Impacts on Public and Occupational Safety	0	-2t	0
	Social Environment	0	0	+1t

Legends: 1= Low; 2= Medium; 3= High; 4= Extremely High; NA= Not Applicable; t= Temporary; p= Permanent; app= Applicable; 0= Negligible

8. Environmental Management and Monitoring Plan

This Report contains a comprehensive EMMP in order to facilitate the implementation of mitigation measures suggested during the present study. This plan includes various components, for instance, institutional arrangements for the implementation of EMMP which covers the roles and responsibilities of the Client, Consultant and the Contractors during the construction and operational phases and up to some extent after decommissioning stage. This section will end up with an estimation of environmental cost to meet the expenses of all aforementioned plans which is **4.56 million.**

9. Conclusions and Recommendations

Based on the environmental and social impacts assessment of the proposed 30 MW Solar Power Project, it is concluded that Project will have short term and reversible adverse impacts with moderate to minor magnitude. Implementation of the proposed Project will alleviate/offset the power crisis as anticipated by Asia Petroleum with the arrangement of cheaper and uninterrupted energy supply which will provide electricity to their newly built manufacturing plant. Although comprehensive mitigation measures have been proposed in the report to minimize, to offset the adverse impacts and to enhance the positive impacts, however, major recommended measures are summarized as under:

- The contractor should plant at least 100 trees as a part of environment enhancement measures
- Contractor's camp size should be developed at least 500m away from both the villages to avoid/minimize the construction impacts and should be facilitated with proper drainage facilities
- Solid Waste Management and high noise levels should be controlled with the use of good engineering practices
- The Contractor will have to adopt suitable timing (9pm-8am) for the construction activities so as to cause the least disturbance to the local community particularly women considering their peak movement hours.
- Contractor should take due care of the local community and its sensitivity towards local customs and traditions
- Locals should be preferred for the job opportunities during construction and operation of the Project
- EMMP proposed in Chapter 7 should be implemented in its true spirits
- Strengthening of road network, education facility and health improvement system may be enhanced as Area Development Plan
- The Proponent must apply for Environmental Approval (NOC) to EPA-Punjab before proceeding further into the Project implementation

1. INTRODUCTION

1.1 Background

Pakistan is ideally located in the sun-belt. Solar is served as energy source and it is widely distributed in the country. The development and adaptation of solar energy technology is to use both light and heat energy of sun to produce electricity which can help to reduce the shortfall and to meet the demands of electricity. Thus, the country has begun diversifying its energy producing capacity by investing in wind and solar power plants that have ability to offset energy shortage.

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

ECOCARE Consultancy Services (ECCS) Private Limited is the consultant firm which has conducted environmental study and prepared this final IEE report on behalf of the ECCS-AJK JV for the Project Proponent in accordance with the EPA-Punjab guidelines.

1.2 Project Location, Nature and Size

The proposed site for the construction of 30MW solar power PV plant is located 11.5 km away from local Madrassa, 4.5 km away from Noorsar village and 37 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 Asia Petroleum Limited in view of availability of abundant land with adequate solar index. Asia Petroleum Limited has purchased 205 acres of private land for the proposed Project. Location coordinates of the proposed Project are given in Table 1.1:

Table 1.1: Coordinates of different Locations of Project Area

Direction	North	East
Tibba Khazan Singh	29^0 49' 25.4"	073^0 04' 56.3"
Noorsar Town	29^0 50' 50.8"	073^0 05' 23.3"
Madrasa	29^0 54' 03.7"	073^0 02' 12.7"
Village Chutalla	29^0 48' 38.7"	073^0 04' 07.1"
Noorsar Grid Station	29^0 53' 38.98"	073^0 02' 13.30"

The map showing Project Area is given below as Figure 1.1. It is also shown as google map under Annex-C1. Project Area demarcation can be seen in Photo gallery (Annex-D).

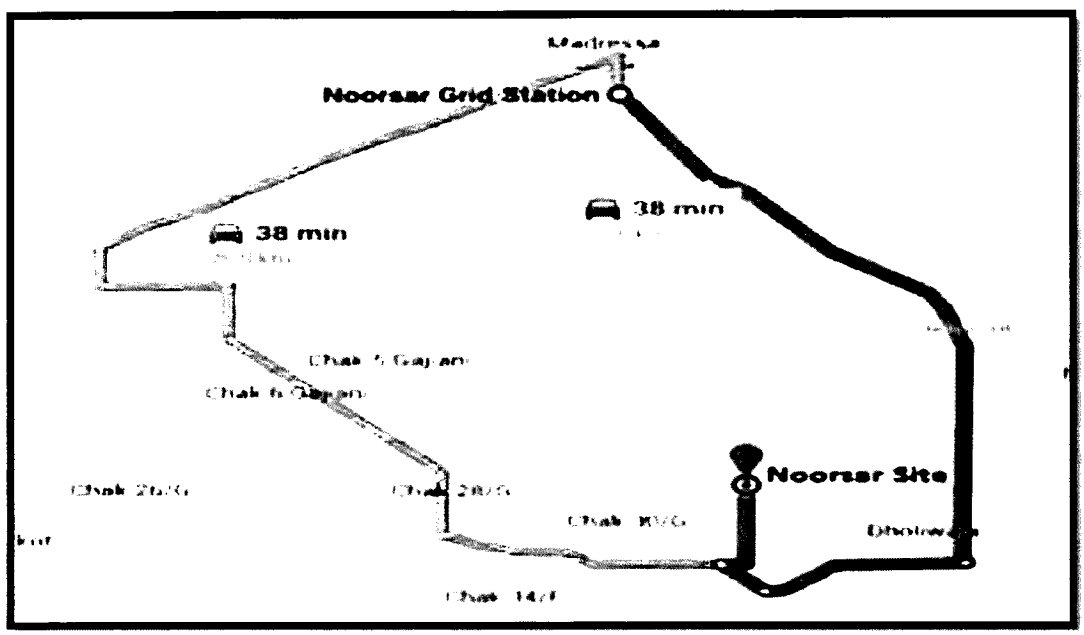


Figure 1.1: Proposed Project Area

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. 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 their views/concerns.

The ultimate objective of this study is to assess 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 follow:

- To collect the baseline data regarding physical, biological and socio-environmental within the Project's 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 potential adverse environmental and social impacts
- To know the views of general public consultation was carried out
- 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 Project:

- Total 205 acres of land is available for proposed Project to generate 30 MW of electricity
- Physical infrastructure will be constructed by Client such as; access roads, boundary wall, transmission line, auxiliary power as well as security will be provided
- The proposed Project location is one of the "hot and dry" places of Pakistan and comprises extreme weather conditions of hot desert
- According to requirements of Solar 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 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

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 off, they can contaminate the environment.

According to the PAK-EPA Regulations 2000 this Project falls under Schedule-I (Regulation 3) Projects and according to ADB Regulations proposed Project falls under Category C; which reflects that this Project has no long term significant adverse impacts. There may be some short term or temporary adverse impacts that 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 was used in this report being the closer ones. The Pakistan Environment Protection Act (PEPA 2000) states that installation of 205 MW Projects requires IEE study to apply for NOC to EPA-Punjab. The Client requested the Consultants to carry out an IEE study of "30MW Solar Power PV Project at Noorsar, Chishtian".

1.7 Purpose of the Report

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

1.8 Details of Proponent

Asia Petroleum Limited is the Proponent for the proposed Project 30MW Solar Power Photovoltaic Project, Noorsar, Chishtian, district Bahawalnagar. The contact detail for the Proponent is given below:

Mr. Fawad Aftab
Director
M/S Asia Energy Limited
D-52, Block-4, Scheme 5,
Clifton, Karachi, Pakistan
Phone: +92 21 35294034-7
Email: fawad.aftab@asiapetroleum.com
Fax: +92 21 35294040

1.9 Details of Consultant

ECOCARE Consultancy Services (ECCS) Private Limited is the consultant firm which has conducted environmental study and prepared this final IEE Report on behalf of the Project Proponent in accordance with the Punjab-EPA guidelines. The contact details of the consultant are given as under:

Syed Amir Raza Ali
Managing Director
M/S ECOCARE Consultancy Services (ECCS) Private Limited
M-128 Jeff Heights, Main Boulevard, Gulberg III, Lahore
Phone: +92 42 35782191
Email: info@ecocare.pk

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 Pakistan Environmental Protection Act 1997 (Amended 2012), it is mandatory to carry out an Initial Environmental Examination (IEE) or Environment Impact Assessment (EIA) before starting a project.

There is no law/regulation present, relevant to solar energy generation, on national level. But on international level many laws/regulations are found within their territorial boundaries. The relevant international laws are also discussed in 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 EPA- Punjab 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 2012. 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, NGOs and 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 EPAs, 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 (Amended 2012)

The Pakistan's Environmental Protection Act, 2012, 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 be applied
- 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 2012 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, construction and operation phases of the project.

2.2.1 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 who will be responsible for handling matters relating to land in case of any issue arise.

2.2.2 Punjab Environmental Protection Department

The Proponent will be responsible for providing the complete documentation required by the EPD-Punjab 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.

2.2.3 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.

2.2.4 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 constructional and operational periods 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 an NOC 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.

2.4. 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 by the application and approval process for obtaining an "Environmental Approval" for the 30MW Solar Power Project, Asia Petroleum Limited, Noorsar, Chishtian.

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

Detailed process for obtaining NOC according to PEPA-2012 is as follows:

a. Classification of the Project

The proposed project requires an IEE in accordance with Schedule-I of PEPA-2012. According to the TOR / Scope of Work of the 30MW Solar Power Photovoltaic Project, Noorsar, Chishtian, district Bahawalnagar, Pakistan, consultants are required to prepare the IEE and to assist in obtaining NOC from EPA-Punjab.

b. Submission of IEE

Under Section 12 of the PEPA 1997 (amended 2012), a project falling under any category specified in Schedule-I, requires the proponent to file an IEE with the Federal EPA or provincial agency to obtain the Environmental Approval (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, EPA-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 filing of the IEE the concerned agencies will confirm that the document submitted is complete for the purpose to review. During this time the concerned agency may require the proponent to submit any additional information returning 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 2.1:

Table 2.1: IEE Approval Process

Category	Description
Project Phase	Detailed Design
Approving Authority	Environment Protection Agency (EPA) Punjab
Applicable Legislation	Pakistan Environmental Protection Act, 1997 (amended 2012)
Application File Prepared by	ECOCARE Consultancy Services (ECCS) Private Limited
Project Title	Construction of 30 MW Solar Power Plant at Noorsar Village Chishtian, Bahawalnagar
Construction Period	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. PROJECT DESCRIPTION

3.1 Purpose and General Description of Project Activity

The proposed Project is solar powered 30MW electricity generation plant designed to produce electricity by Asia Petroleum Limited at Noorsar, Chishtian district Bahawalnagar in the province of Punjab, Pakistan. It works with Solar Photovoltaic (PV) technology that converts solar energy directly into electricity, while producing zero Greenhouse Gases (GHG). The Project follows the government policy that promotes development of renewable energy technology and contributes to lowering dependence on electricity generation by fossil fuels and good source of clean energy.

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 in this chapter.

3.2 Location and Site Layout of the Project

The site of proposed 30MW Solar Power Project is located 4.5 km away from village Noorsar, Chishtian, Bahawalnagar. The total area of proposed Project site is 205 acres. The Project will involve installation of solar panels and associated structures including buildings for control room and offices.

3.3 Category of the Project

According to the PAK-EPA (review of IEE and EIA) Regulations 2000, this Project falls under Schedule-I (Regulation 3) which requires an IEE and according to ADB Regulation proposed Project falls under Category C.

3.4 Project Objectives

The objectives, of proposed 30MW Solar Power Project, are;

- To analyze and reconcile power requirements for Private Plant and other needs keeping in view the future expansion of Client

- To have a clear idea, strategy and complete program for construction of Solar Power Plant keeping in view the technical and procedural aspects
- To propose cost effective, reliable and quality assured plant

3.5 Important Nominal Characteristics of the Project

The proposed Project covers the area of 205 acres. This planned Project will be completely equipped with all the required things including solar energy producing apparatus, switch-yard, repair facility and sub-station with all arrangements including barriers and access road expansion, after all this the power-house components will be established at ground level. This solar plant 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 will electrically be connected 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 are given in Table 3.1.

Table 3.1: Important Characteristics of the Project

Parameter	Feature
Nature of region	Desert
Project Capacity	30 MW
Total Area (involve installation of Solar Panels, buildings for control room and offices)	205 acres
Form of technology	Photovoltaic (PV)
Project Construction Period	Around 10 months
Grid arrangement	Noorsar Grid Station
Kind of apparatus to be used	Fixed installation type X-Si solar cells

3.6 Schedule of Implementation

Table 3.2: Timeline for Construction of Project

Sr. #	Activities	2.5 Months			2.5 Months			2.5 Months			2.5 Months		
		2W	4W	4W	2W	4W	4W	2W	4W	4W	2W	4W	4W
1	Detailed Designing	■	■	■									
2	Mobilization of Contractors				■								
3	Lean Construction Period					■	■						
4	Peak Construction Period							■	■	■	■	■	
5	Restoration of Site												■
6	Commissioning												*

3.6.1 Other Power Generation Options

After hydropower generation, two major potential power generation options available in Pakistan are still untapped, viz. solar and wind. The growth of nuclear power stations has not been a very feasible option from the point of view of providing quick and reliable relief. Unfortunately, hydropower generation issues are also politicized since many decades. It is, therefore, apprehended that no big hydropower generation unit will be completed in Pakistan in many years to come. Thus, planners are forced to opt for other power generation avenues, particularly renewable avenues, amongst them solar power generation appears the best option.

Solar power generation option remained under hot discussion for bridging the gap between demand and supply because solar is not only a renewable power generation source and environment friendly but also suitable for Pakistan due to having vast wastelands which are more workable for solar power generation like Cholistan, Thar and Thal. Though no feasibility study on solar power is available in the country except our company's especially on economic and technical aspects but some successful precedents are present in the neighboring countries.

Table 3.3: Energy Source Comparison[1]

Energy Source		Merits	Demerits
Solar Energy	It is nonpolluting and most plentiful source of energy production; introduced since last 15-30 years.	• This method of energy production is considered first extraordinary investment reliant on sunny weather condition. • No gaseous or liquid emissions are generated.	• High initial investment is dependent on sunny weather • Supplemental energy may be needed in low sunlight areas • Requires large physical space for PV Cell Panels Limited availability of polysilicon for panels.
Wind Energy	This energy source is renewable energy source, affordable, having relatively high output and little impacts on ecosystem.	• No emissions Affordable • Little disruption of ecosystems Relatively high output	• 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.
Hydro-Power	This energy source is also renewable source of energy production.	• 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.	• 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 environmental impacts by changing the environment in the dam area • Hydroelectric dams are expensive to build and may be affected by drought.
Natural Gas	Currently, natural gas is widely being used as a source of energy production in our country.	• 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.	• 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.

[1] www.energy4me.org/energy-facts/environmental-protection/environmental-impact-by-source/

Petroleum	It is efficient transportation fuel for the entire world	• Basis of many products, from prescription drugs to plastics • Economical to produce and easy to transport	• High CO2 emissions production • Found in limited areas • Supply may be exhausted before natural gas/coal resources • Possible environmental impact from drilling and transportation
Biomass	It is readily available energy producing source because of abundant supply	• It emits fewer emissions than fossil fuel • It can be used in diesel engines • Auto engines can be easily converted to run on biomass fuel	• It emits some pollution as gas/liquid waste • It can increase emission 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
Coal	Coal is one of the abundant sources of energy production	• Currently inexpensive extraction • It is reliable energy source • It is capable of generating large amounts of power	• It emits major greenhouse gases and can be one of the reasons of acidic rain • High environmental impact from mining and burning, although cleaner coal-burning technology is being developed • Mining can be dangerous if proper health and safety measures will not followed
Uranium		• This process does not lead to greenhouse gases or CO2 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)	• 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.

3.6.2 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/m^2 per day of solar radiation as an annual mean value, with 19 MJ/m^2 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 of Pakistan. 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 shortage 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 electricity 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.

3.6.3 Alternative Site of the Proposed Project

Solar power projects are environment friendly, energy generation projects that are totally dependent on 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 should not fall under any reserved or protected forests
- The land, acquired for the locations, contains purchased property which was not used by the public/locals for any purpose
- No environmental profound types such as water bodies, forests and archaeological sites are found in the close proximity of proposed Project.

3.6.4 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 is 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 is more attractive and can be used for beautification purposes 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.

3.7 Construction Aspects

3.7.1 Contractor's Facilities

Contractor will have to construct facilities for labor, machinery and vehicles, etc. There is a lot of space available for this purpose without disturbing any resident, ecology or the infrastructure.

3.7.2 Work Force

It is expected that the skilled staff will be engaged in the construction and installation work during the construction stage of the Project. The breakdown of the staff strength during the average and peak construction stages is expected as 100 and 205 respectively.

3.7.3 Construction Material and Transportation

Solar panels will be erected on steel rods fixed in the ground. Similarly, other construction material will also be used to build allied structures such as office, store room, parking area, switchyard, etc. using framed construction technology. The framed structure will consist of Reinforced Cement Concrete (RCC) using mainly steel, cement and sand aggregate for construction purposes. Transport of construction materials to the construction site will not be a big issue.

3.7.4 Import of Solar System Material

Solar panels, inverters and batteries (if required) are not available in Pakistan, so they have to be imported from China or other countries. This is important issue but positive aspect is

that the representatives of many commercial companies of manufacturing countries are present in Pakistan and ensuring to supply everything in time before construction of the proposed power plant.

3.8 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. 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.

3.9 Site Waste Management Plan (SWMP)

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 till they have an approved SWMP in place.

3.10 Government Approvals

Approvals from all the concerned departments like Punjab Power Development Board (PPDB), Revenue, Forest, Agriculture, livestock and Irrigation will be provided by the client.

3.11 Road Access Plan

Kindly refer to Road Access Plan "Annex C1".

4. APPROACH AND METHODOLOGY

Initial Environmental Examination (IEE) is a formal procedure for investigating, analysing and presenting the environmental implications of a proposed development plan and identifying mitigation measures required to trim down the adverse environmental impacts by taking it to acceptable levels. Initial Environmental Examination will be carried out to ensure issues associated with the project's, foreseen and potential, benefits in a neutral way; considering regional development, legislative and institutional aspects as well.

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

The approach and methodology applied for the execution of the impact assessment study is as provided:

- The relevant project document and detailed project report were reviewed to understand the project requirements
- Regulatory review was undertaken to understand the applicable, local and national legislation and regulatory frameworks.

A detailed social and environmental assessment of site and surrounding area was undertaken through:

- Assessment of impacts based on understanding of the project activities and existing baseline status;
- Reconnaissance surveys to understand site specific issues
- Discussions with the local community and identification of key issues

Collection of secondary information on social aspects of the site, supplemented by consultations with the local communities to understand community perception with regard to the project and its activities included:

- Stakeholder mapping and Identification;
- Focused group consultations with selected land losers and other impacted groups
- Field surveys and data compilation

- Preparation of Environment and Social Management Plan (ESMP)

4.1 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 8 to 9 October, 2016 by the consultant team where the following tasks were conducted:

- 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

4.2 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. **Athar Aslam, Health and Safety Expert,** supervised the field team 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. **Ms. Lina Maqbool, Environment Specialist**, conducted detailed field surveys and wrote related chapters such as Baseline, Impact and Mitigation and Environmental Management and Mitigation Plan.

4. **Muhammad Arshad, Senior Sociologist** provided the details of the land acquisition record as prepared by the design team of the Consultant.

5. **Rozeena Khan, Sociologist,** designed socio-economic questionnaires and conducted focus group discussions and social survey which included identification of proposed sites and Study Area.

6. **Hamayun Khan, 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.

4.3 Public Consultation and Information Disclosure

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

- Survey 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. Asia Petroleum (Pvt.) Limited
2. ECOCARE Consultancy Services (ECCS) Pvt. Limited, Lahore
3. Punjab Environment Protection Agency (Punjab-EPA), Lahore

4.4 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.

4.5 The Final Report

The IEE Report was prepared by untiring efforts of above mentioned team. After reviewing the final IEE Report according to TOR, it was submitted to EPA through client for approval.

5. ENVIRONMENTAL AND 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. Chishtian, Bahawalnagar, spreads over an area of 1500 km^2 in the southern parts of Punjab province. It is located at an elevation of 89 meters above sea level. Its coordinates were 28°15'0" N and 70°45'0" E or 28.25 and 70.75 (in decimal degrees).

5.1 Study Area

An area around the project can be considered as influence zone and hence it has been taken as Study Area (SA) 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 like "Topographical map of Survey General of Pakistan" to ascertain the applicability in the prevailing conditions of Project Area.

5.3 Geology

One of the important geological features of the Cholistan is the old Hakra River, dried out about 600 years ago. The Greater Cholistan desert extends from the most recent course of the extinct Hakra River to the borders of India. As such there are no major geological features. Topography, soil type and texture; and vegetation structure divides this desert into two distinct regions:

- The Northern region (Lesser Cholistan) covers about 7,770 km^2 and
- The Southern region (Greater Cholistan) about 18,130 km^2

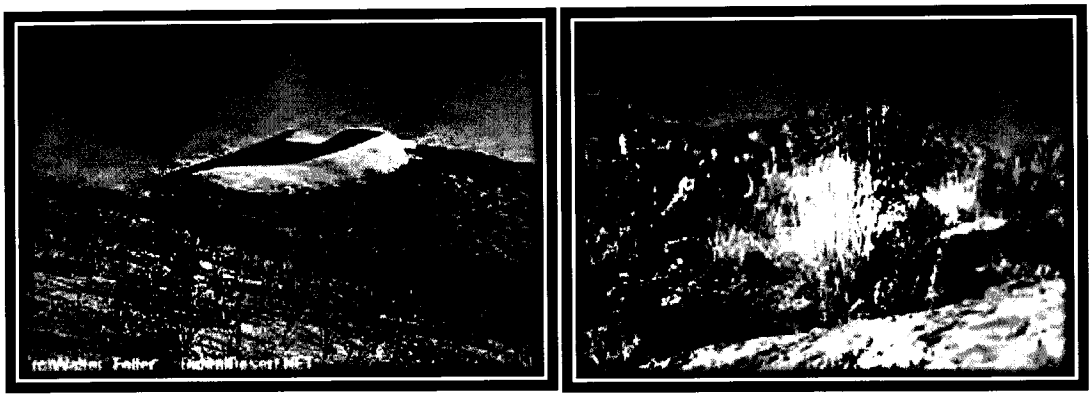


Figure 5.1: Geology of Study Area

5.4 Water

The population of Chishtian is around 0.1 million and there are 1.2 million livestock. Ground water is mostly brackish and main source of drinking water is rain water that is stored in Tobas and kinds. Since 2000, four water supply pipelines were laid down. The standard of drinkable water is gradually on decline in Chishtian, Bahawalnagar and its outskirts and citizens are facing threat of harmful diseases. To this effect, the Punjab government has initiated efforts to supply potable water to Bahawalnagar City and Chishtian through pipeline.

Rainwater is harvested in low-lying areas or dug-out ponds called Tobas and used by the human and their livestock as well. Underground water is mostly brackish containing salts (3000 - 3500 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 of Cholistan near Bahawalnagar ranges from 20 to 75 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.

Owner of surface water body and its existing use is government. No herbicides/chemicals are present in water pollution sources. Storm water drains are available but good quality of water is not available. There is no impervious area and no permits are required for maintenance works. Irrigation system is canal water. Wheat and cotton are mainly cultivated.

5.5 Soil

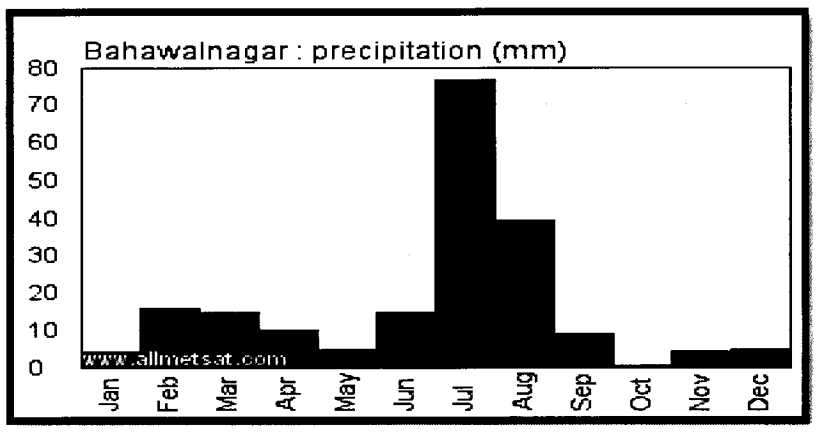
The soil of Chishtian, Bahawalnagar is generally poor, lacking organic matter; saline alkaline, gypsiferous and dunes are appeared. The dune reaches up to an average height of 1-5 m.

5.6 Land Use

There are few shrub thickets near the Project site. There are few settlements near. The main profession in the area is livestock rearing. Agricultural 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, less silt and clay content. Overall the area is plain with gentle slope. Vicinity of Project Area is almost sandy and barren.

5.7 Climate

It is a hot and sandy desert with annual rainfall of 20 to 75 mm usually during the monsoon season (July to September) and 5 to 18 in winter and spring (January to March).



[2]

Figure 5.2: Annual Rainfall

[2] http://www.eldoradocountyweather.com/climate/pakistan/Bahawalnagar.html

The mean temperature of the winter is 6.6°C (December and January) and the mean of the summer is 46.5°C, soaring up to 51°C.

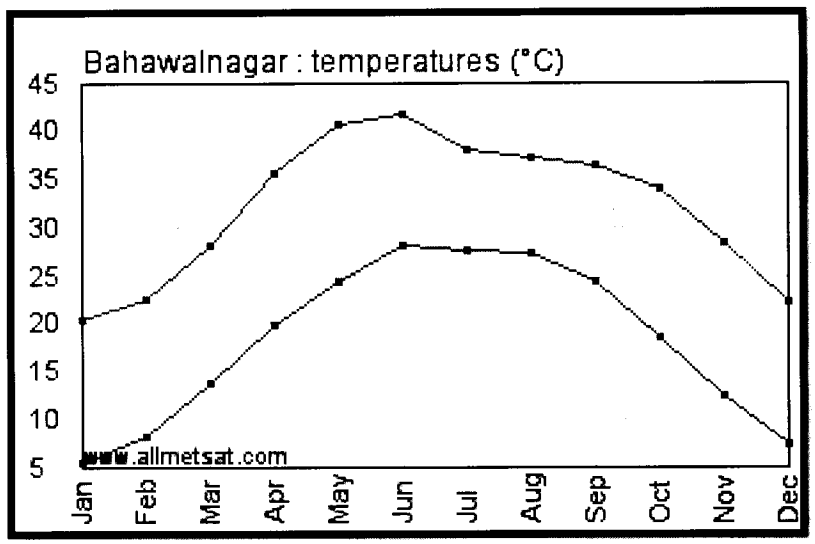


Figure 5.3: Annual Temperature

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.

5.8 Water Bodies

The main source of irrigation in the Project Area is Fordwah 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 vastly in the area, from 2 to 10m depth.

5.9 Terrestrial Ecology

Chishtian 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.

5.9.1 Flora

A floristic survey of Chishtian was carried out during the month of October 2016 and total of 38 families, 106 genera and 154 species were documented from the area. Among families, 33 families belong to Di-cotyledons of 79 genera and 115 species, while the 38 species of 26 genera belong to 4 families of Mono-cotyledons 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.

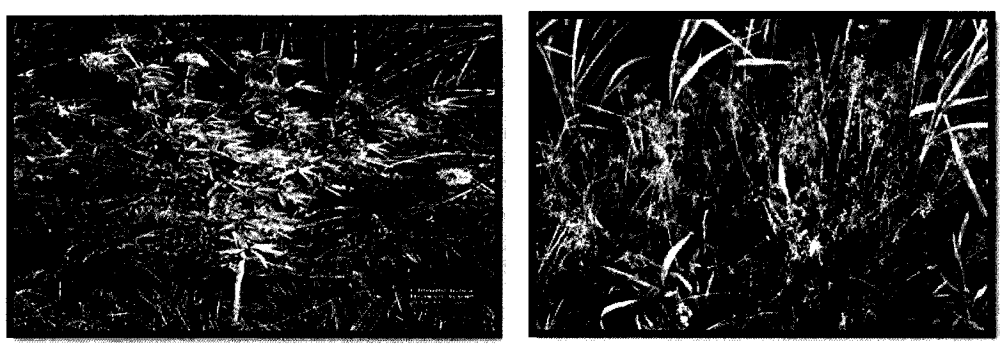


Figure 5.4: Flora of Study Area

Table 5.1: Most Important Medicinal Plants

Sr.	Family	Plant Species
1	Cyperaceae	Cyperusrotundus
2	Poaceae	Cymbopogonjawarancusa, Panicumantidutale
3	Amaranthaceae	Aervapersica
4	Asclepiadaceae	Calotropisprocera, Leptadeniapyrotechnica

5	Capparaceae	Capparisdecidua, Capparisspinosa.
6	Chenopodiaceae	Haloxyonerecurvum, Sasolabaryosma, Suaedafruticosa
7	Convolovulaceae	Convolvulusmicrophyllus, Creassacretica
8	Cuscutaceae	Cuscutareflexa
9	Malvaceae	Abutilonmuticum
10	Menispermaceae	Coculuspendulus
11	Mimosaceae	Acacianilotica, Prosopiscineraria
12	Neuradaceae	Neuradaprocumbens
13	Paplionaceae	Alhagimaurorum, Crotalariaburhia
14	Polygonaceae	Calligonumpolygonoides.
15	Rhamnaceae	Zizyphusmauritiana
16	Salvadoraceae	Savadoraoleoides
17	Solanaceae	Solanumsuranttensa
18	Tamariceae	Tamarixaphylla
19	Tiliaceae	Corchorusdepressus
20	Zygophyllaceae	Fagoniacretica, phagonumharmala, Tribuluslongepetalus, Tribilusterrestris

a. Grasses and Hedges

Table 5.2: Grasses and Hedges

Sr.	Name
1	Aeluropuslagopoides(Linn) Trin .ex.Thw
2	Aristidaadscensionis L.
3	AristidafuniculataTrin. & Rupr.
4	Aristidahystricula(Edgew)

5	AristidamutabilisTrin. & Rupr.
6	Cenchrusbiflorus (Roxb)
7	Cenchrusciliaris (linn.)
8	Cenchrusprieurii (Kunth.) A Marie
9	Cenchrussetigerous Vahl.
10	Cymbopogonjwarancusa (Jones.) schult
11	Cynodondactylon (L.) Pers.
12	EnneapogondesvauxiiP. Beauv.
13	Eragrostisbarrelieri Dav.
14	Eragrostisciliaris (Linn.) R. Br
15	Eragrostis japonica (Thumb.) Trin.

Figure 5.5: Grasses and Hedges of the Study Area

5.9.2 Fauna

The study on terrestrial fauna in the Study Area is based upon the field investigation and reports of Forest Department. 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. Different varieties of faunal life can be categorized as:

- Primates
- Carnivores
- Angulate
- Rodents
- Lagomorphs
- Insectivore
- Crustivore

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

5.9.3 National Parks and Wildlife Sanctuaries

There was not any National Park near the of Project area within of 50 km around.

Table 5.3: The Notable Wildlife Species (Mammals)

Sr.	English name	Scientific name
1	Dog	Canis Lopus
2	Wild Buffalo	Bison
3	Indian Caracal	Felis caracal
4	Jungle Cat	Felischaus
5	Indian Mongoose	Herpestesedwardsi
6	Desert cat	Felislibyca
7	Jackal	Canis aureus

8	Fox	Vulpesvulpes
9	Porcupine	Hystrixidica
10	Hare	Lepus nigricolis
11	Wild boar	Susscrofacristatus

Table 5.4: Birds of Study Area

Sr.	English name	Scientific name
1	Crow	Corvus
2	Desert buzzard	Buteobuteovulpinus
3	Golden backed wood pecker	Dinopiumbenghaleuse
4	Great Indian bustard	Choriotisnigriceps
5	Grey partridge	Francolinuspondicerianus
6	Harrier	Circus macrourus
7	Hobara bustard	Chiamydotisundulata
8	Imperial sand grouse	Pteroclesorientalis
9	Indian Desert Finch – Lark	Ammomanes Desertiphoenicuroides
10	Indian gray shrike	Laniusexcubita
11	Indian ring dove	Streptopeliadecaocto
12	Indian sparrow hawk	Accipiter nisus melaschistos
13	Lagar falcon	Falco biarmicusjugger
14	Little egret	Egrettagarzetta
15	Pond heron	Aredeolagrayii
16	Quail	Coturnix
17	Saker falcon	Falco biarmicuscherrug
18	Sparrow	Passeridae
19	Spotted owl	Athenebrama
20	Tawny eagle	Aquila rapoxvondhiana
21	Warblers	Sylvia nana nana
22	Wood Pecker	Picidae

Table 5.5: Amphibians and Reptiles

Sr.	English name	Scientific name
1	Black cobra	Najanaja
2	Brahminy blind snake	Typholopsbraminus
3	Common crate	Bungaruscaereleus
4	Indian monitor lizard	Varanusbengalensis
5	Sand boa	Eryxconicus
6	Saw scaled viper	Echiscarinatus
7	Spiny tailed lizard	Uromastrixhardwicki
8	Spotted Indian house geko	Hemilacytylusbrooki
9	Tiger bull frog	Rana tigrina

5.10 Baseline Socio-Economic Status

This topic covers the socio-economic profile of the main Project Area by focusing on demographic features including the information on population, occupation, income, common diseases and other social amenities etc. where it can be constructed.

5.11 Demographic Information of Main Project Site

There is settlement adjacent to the project area naming "Tibba Khazan Singh" which was surveyed by the professional consultants of ECCS on 9 and 10 October, 2016. According to the information collected from the consultation, the area is populated and under the practices of agriculture. Major cash crops are cultivated in this area. An un-metaled road having length of half a kilometer leads to the main Project Site. Desert type area has surrounded the whole way. Main project site is baron and consists of sandy area. The village, Basti Khazan Singh, was surveyed that comprises a population of 1500 persons approximately (this data is collected from the two villages of the area). Punjabi and Urdu languages are spoken there. No dislocation is being faced by the population of villages because these are situated away from the main Project Site. As the Project Area is located in the South Punjab so almost all major

castes of Punjab are found there, including Malik, Bhatti, Awan, Araeen and Chohaan etc.

Major occupation of the people residing in these area is service (private employment, government employment), labor (skilled and unskilled), Agricultural, Business and others. The results of socio-economic baseline survey have revealed that on overall basis, 80 % of the sample population is job holder, 10 % belongs to labor class and remaining is attached with Agriculture and Animal Husbandry.

Overall general health of the population of the surveyed area indicate serious health problems and suffer from diseases like Fever, Diarrhea, Typhoid, Hepatitis and Malaria.

5.12 Physical Structures

This topic elaborates the overall physical geography of proposed Project Area.

5.12.1 Structures

According to information collected through survey, a number of structures are present like houses, shops, primary schools, dispensary and other structures.

5.12.2 Religious Structures

In the surveyed areas, mosques and graveyard are present. However, there will be no significant, even minor impact of the project construction on any religious structure.

5.12.3 Protected Structures

There is no protected site, present in the Project Area.

5.13 Social and Public Amenities Available to Proposed Area

The social and public amenities present in the area show that there is a strong network of road facilities. The major road which connects the area is Noorsar, Chishtian road. Roads play an important role for establishing the development pattern and growth of the Project Area. Main Project Area is connected with its surrounding cities and urban and rural settlements by a network of roads.

5.14 Social Inventory of the Surveyed Area

This topic covers the baseline structure of the Project Area. Survey team of ECCS paid a detailed survey in different villages nearby in October, 2016 and collected the desired information. Refer to Table 5.6 for social inventory of surveyed area. Socio-economic questionnaire method was used by the survey team to collect this information which is in Table 5.6. The details of this survey are given below:

Table 5.6 Social Inventory of the Surveyed Area (Moza Khazan Singh)

1	**Gender**		
	Male	10	85
	Female	2	15
2	**Education Level**		
	Illiterate	3	25
	Primary	2	17
	Middle	2	17
	Secondary	2	17
	Higher Secondary	2	17
	Graduate	1	8
	Post Graduate	0	0
	Religious Studies	0	0
3	**Employment Status**		
	Unemployed	0	0
	Employed	9	72
	House Wife	2	15
	Student	1	8
	Disabled	0	0
4	**Types of Employment**		
	Govt. Employee	2	16
	Private Employee	1	8
	Agriculture	7	56
	Business	0	0
	Daily Wages	0	0
	Any Other	0	0
5	**Personal Income (Monthly Average)**		
	Rs. 1,000 - 5,000	0	0

	Rs. 5,000 - 10,000	2	16
	Rs. 10,001 - 20,000	4	32
	Rs. 20,001 - 30,000	2	16
	Rs. 30,001 +	4	32
6	**Family System**		
	Joint	11	90
	Independent	1	10
7	**Nature of House Construction**		
	Concrete	10	33
	Bricked	0	0
	Mud	20	67
	Hut or temporary settlements	0	
8	**Facilities available**		
	Electricity	Yes	
	Water Supply	Yes	
	Gas	No	
	Telephone	Yes	
	Sewerage	Yes	
	Transport	Yes	
	Other		
9	**Satisfied with the Educational Institutions**		
	Yes	7	60
	No	5	40
10	**Favor of the Proposed Project**		
	Yes	12	100
	No	0	0
11	**Type of Benefits Acquired from the Project**		
	Employment	Yes	
	Development	Yes	
	Travelling Facilities	Yes	
	All of the above	Yes	
	Any Other		
12	**Problems faced**		
	Education	Yes	
	Job Opportunities	Yes	
	Transport	Yes	
	Recreation Places	Yes	
	Health Services	Yes	
	Any Other		
	None of the above		

13	**Solution of the Particular Issue**		
	Yes	12	100
	No	0	0
14	**Common Diseases**		
	Asthma	Yes	
	Flu	Yes	
	Throat Infection	Yes	
	Blood Pressure	Yes	
	Hepatitis	Yes	
	Stomach Problem	Yes	
	Malaria	Yes	
	Eyes Infection	Yes	
	Jaundice	Yes	
	Anemia	Yes	
	Gastro	Yes	
15	**Recommendations**		
Educational Facilities, Electricity & Hospital, Road infrastructure, Gas, Public Transport and Recreational Facilities			

a. Occupation of the Population

Most of the people of the area were linked with private or public jobs. Approximately 40% population was recorded as Government employees and 20% as private employee. 20% people were linked with Agriculture and 20% were attached with other occupations.

b. Personal Income

According to survey, 40% people of Basti Khazan Sigh, Noorsar, Nehalka and Dholiwala villages were recorded in area having average monthly income ranging 5,000-10,000. Approximately 60% persons were recorded to earn a monthly income of 10,001-20,000.

c. School in the Area

According to the survey, one Government primary school for boys and one for girls are available for the both villages.

d. Facilities Available

According to survey, majority of the area is entertained with the basic facilities like water supply, telephone, transport and others. Electricity is available to 100% of the population entertaining minor and other basic facilities.

e. Satisfied with educational facilities in the area

According to the information collected through survey, 40% people disagree/not satisfied with the educational facilities in the area.

f. Favor of the Proposed Project

All of the surveyed area's residents (100%) agreed with the proposed project.

6. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

Public involvement and consultation are vital components for the attainment of any development project, to ensure two-way communication between the project sponsor and relevant stakeholders, accountability and transparency in the development process.

Public consultation, conducted for the proposed project was commenced from 8 to 9 October, 2016 during the preparation of IEE. A consultation procedure was originated at the beginning of project. Overall objective was to ensure that stakeholders were kept cognizant about project proposals, developments and may gain opportunity to contribute their views to project planning and decision making processes.

6.1 Objectives of Stakeholder's Consultation

The overall objectives of the consultation with stakeholders are to get help, for the verification of environmental and social issues, besides technical ones that have been supposed to arise and to identify those which are not known or unique to the Project. In fact, discourse with many who have carefully observed the site conditions in the pre-development phase, goes a long way in updating the knowledge and understanding the scenario.

The aims and objectives of public involvement and consultation include:

- To provide information related to proposed Project activities to stakeholders
- Allowing the public to express their views on the scope and content of an IEE (and the proposed development action)
- Obtaining local and traditional knowledge (corrective and creative) before decision-making
- To seek for the participation of all concerned parties and to identify stakeholders' interests and issues
- To enhance the Project by learning from the expertise of individuals, professionals, communities and organizations to encourage transparency and inculcate trust among various stakeholders to promote support and partnership with the communities and local leadership

- Ensuring that important impacts are not ignored and benefits are maximized
- Reducing conflict through the early identification of contentious issues
- Influencing project design in a positive manner (thereby creating a sense of ownership of the proposal)
- Improving transparency and accountability of decision-making and increasing public confidence in the IEE process

6.2 Stakeholder Identification

Stakeholders for the Project were prioritized by identifying as direct and indirect stakeholders. Consultations were conducted with various stakeholders by a professional team of the consultants.

6.3 Information Disclosure

On behalf of Asia Petroleum Limited, the consultants arranged several meetings, for IEE study, with local stakeholders for information dissemination and community participation. Such meetings were with concerned NGOs and other related persons. The consultant and his team inspected all relevant matters regarding project by arranging meetings and group debates for people's awareness. The consultant worked with Focus Group Meeting in community. In these meetings, all classes of public including businessmen, farmers, school teachers and religious leaders were present.

Project was explained and the people present there were informed that the project will be constructed in existing land. No acquisition of land is needed for the Proposed Project. No permanent acquisition of land and consequent resettlement will be required as well. Some noise or air pollution may occur but it will be minimized using proper methods. The consultant has sensibly studied all types of impacts in area likely to be caused by proposed plant.

Initial Environmental Examination (IEE) process under the Pakistan Environmental Protection Act (PEPA) 2000 only requires disclosure to public after 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 full table of public consultation presented in Table 6.1.

During IEE studies, well informed persons related to Project Area were interviewed and all necessary information pertaining to Project Area was recorded during data assembly process. This process also supported the understanding of consultants as a lot of information was exchanged during interviews. Please refer to Table 6.1 for further information.

6.4 Monitoring and Evaluation

Mostly IEE Projects have no monitoring systems of public consultation built in to their structure. Monitoring and Evaluation (M&E) assess the quality of public consultations in IEE process. Techniques for monitoring and evaluating Public Consultations include:

- Confirmation that participants understood consultation content (correct language, level of technicality)
- Assessment of stakeholders' opinions about effectiveness of Public Consultation impact on project design and implementation.
- Through appropriate use of M&E, public consultation strategies can be adjusted during Project Cycle to improve stakeholder participation, information distribution strategies and mechanisms for integrating participant feedback into project design and implementation.

6.5 Methodology Adopted

6.5.1 Stakeholders Analysis

The stakeholders, for the Project, were selected by identifying the direct and indirect stakeholders. Consultations were conducted with various stakeholders by a professional team of ECCS. The Public Consultation process has been started in the initial feasibility stages (prior to construction) in order to disclose the project information to the stakeholders and record feedback regarding proposed project and preferences. Prior to the implementation of the consultation, feedback was taken to support this IEE study.

The disclosure of the enhancement project, in advance and subsequent consultation with stakeholders, has advantages in the environmental assessment and mitigation of impacts. Public Consultation can also provide a channel for improvement of the project implementation

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

6.6 Classification of Stakeholders

In IEE study, it is not possible to consult everybody that might be considered to constitute the public. Current practice refers to identifying stakeholders who collectively can be taken as representatives of the public. When stakeholders are being identified, certain broad categories are defined and individual stakeholders are assigned to one of the categories. One of the most common divisions is between primary and secondary stakeholders. The former consists of those whose interests can be affected directly by a decision on a proposed initiative (examples are local communities living in the Project Area). Secondary stakeholders consist of those who are not directly affected but may be indirectly affected and/or have an ability to influence the decision (examples might be international conservation NGOs or local/national media). Another classification divides stakeholders into internal and external groups. The former is those who are involved in decision-making and later are those having interests that may be directly or indirectly affected. This "internal / external" distinction is not in common use and is perhaps more relevant to IEE. Relevant categories are as follows:

- Local people (individuals) and communities are likely to be affected by a project. Traditional leaders or representatives of community level bodies can be consulted to obtain a community viewpoint
- Non-resident social groups who may use local resources, either regularly or intermittently, for example pastoralists
- Selected social categories, for example women; the elderly and poor (a current concern of international financial institutions and bilateral donors), religious leaders, politicians, NGOs, labor unions and cooperatives.
- Private sector bodies such as professional societies, trade associations, chambers of commerce, media (newspapers, radio, television), national and local government ministries; departments and statutory agencies whose remit and responsibilities include areas and sectors likely to be affected (such as health, natural resources and land use).

Such individuals, groups or organizations probably represent the minimum "search category" for the planning of public involvement and consultation in an IEE study. All the people may not be involved in every study. Often, IEE study provides an opportunity for others to be involved. There may be other stakeholders that needs to be included in certain circumstances, for example, the project, program or plan beneficiaries (may or may not be local) and perhaps the interested "public" in the country of any external financing agency/agencies. With reference to NGOs, it can be difficult to decide which NGOs are stakeholders as many are international in focus and may have no local or even national existence.

6.7 Interested and Affected Parties Consulted

The following list outlines the parties that will be affected or have interest in the Proposed Project, to be undertaken by the proponent (see full list of the people/Stakeholders consulted in Table 6.1).

- Government institution/ officials
- NGOs
- Ordinary citizens

- Local community representatives (Community leaders and community members)

6.8 Consultation with Local Stakeholders

Communities were consulted during informal and formal meetings held in Study Area. The socio-economic team, assisted by sociologists, initiated the sessions of consultation, keeping in view the importance of stakeholders' participation proposed in the said project.

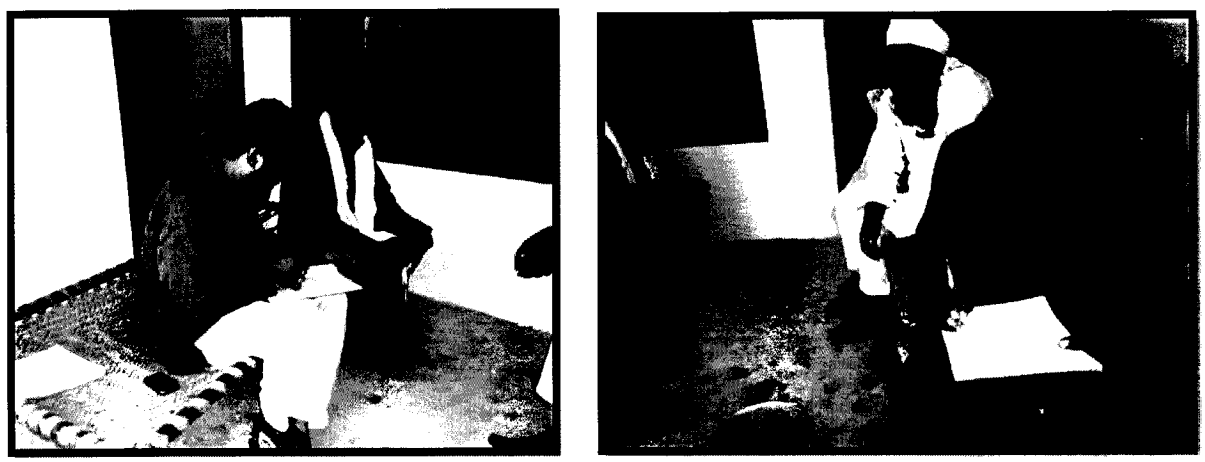


Figure 6.1: Public Consultation Session conducted at Moza Khazan Sigh

The consultants participated in a series of meetings with public/private organizations/institutions and disclosed the project information to them for their opinions or views about it that was followed by an open discussion, allowing participants to express their concerns and opinions. The feedback and immediate needs were also identified and documented during the consultation. Detail is given in Table 6.1.

Table 6.1: Public Consultation

Records of Meeting				
Job Title	Initial Environmental Examination of 30 MW Solar PV Plant at Chak Noorsar, Chishtian, Bahawalnagar			
Meeting Title	Public Consultation			
Venue	**Chishtian, Bahawalnagar**			
S#	**Name**	**Village Name**	**CNIC No**	**Contact No**
1	M. Faisal Sadiq	Chak Noorsar	31101-4119612-5	0344-8686427

2	Naeem Imran	Moza Khazan Singh	31101-4801829-7	0300-4766224
3	Muhammad Khan	Moza Khazan Singh	31101-4420110-1	0300-6938447
4	Dr. Muhammad Imran	Chak Noorsar	31101-1253755-1	0308-4991602
5	Muhammad Imran	Moza Dholiwala	31101-8968590-9	0307-4990784
6	Naheed Akhtar	Moza Khazan Singh	--	0304-4801256
7	Muhammad Nadeem	Moza Khazan Singh	--	0307-8721282
8	Naveed Akhtar	Moza Khazan Singh		0302-3540581
9	Muhammad Shareef	Moza Khazan Singh	31101-2406029-9	0345-7036987
10	Muhammad Shehzad	Moza Khazan Singh	--	0300-8134792

Figure 6.2: Public Consultation Session Conducted at Village Noorsar

7. ENVIRONMENTAL IMPACTS AND MITIGATION STRATEGIES

The progress of any task surely carries variation in native environment with respect to biological, physical and socio-economic facets. The influences created in these phases leave a positive or negative effect. This Chapter identifies the potential impacts due to the implementation of 30 MW Solar Power Project Noorsar, Chishtian 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 and magnitude. The reason is that this recommended Project uses of solar radiation for power generation which is known as renewable energy project. These projects are well known to be cleaner as compared to fossil fuel based energy plans.

7.1 Impact Prediction Methodologies

To identify or resolve the main impacts, various practices was used. These can be based on:

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

7.2 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 alternatives. The objectives of mitigation are to:

- Invent best substitution, means of better alternatives and ways of doing things
- Improve the environmental and societal payback of the project
- Prevaricate, remedying or reduce, provocative impacts
- 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, environmental managing, inspection, industrial vulnerability, tools and apparatuses. During construction stages the influx of people and procurement of land have been deeply elaborated.

Table 7.1: Design of Mitigation Measures

Approach	Examples
Avoid	Change of route or site details, to avoid important ecological or archaeological features
Replace	Restore similar habitat of equivalent ecological value
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.

The possible impacts (positive and negative) from the proposed project during construction and operation are presented in the following sections.

7.3 Project Benefits

One of the major benefits is that the proposed Project can be regarded as Clean Development Mechanism (CDM), which is detailed below:

7.3.1 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. It also 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 presented its consent to the Kyoto Protocol on 11th January 2000, and thus became eligible for 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 2000 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.

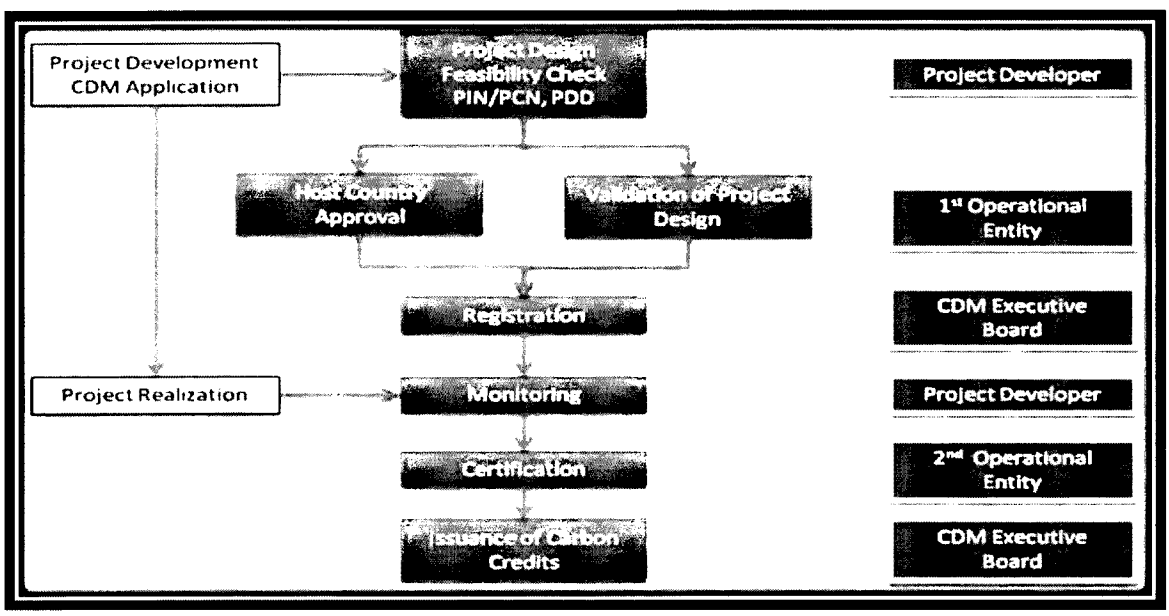


Figure 7.1: CDM Flow Chart

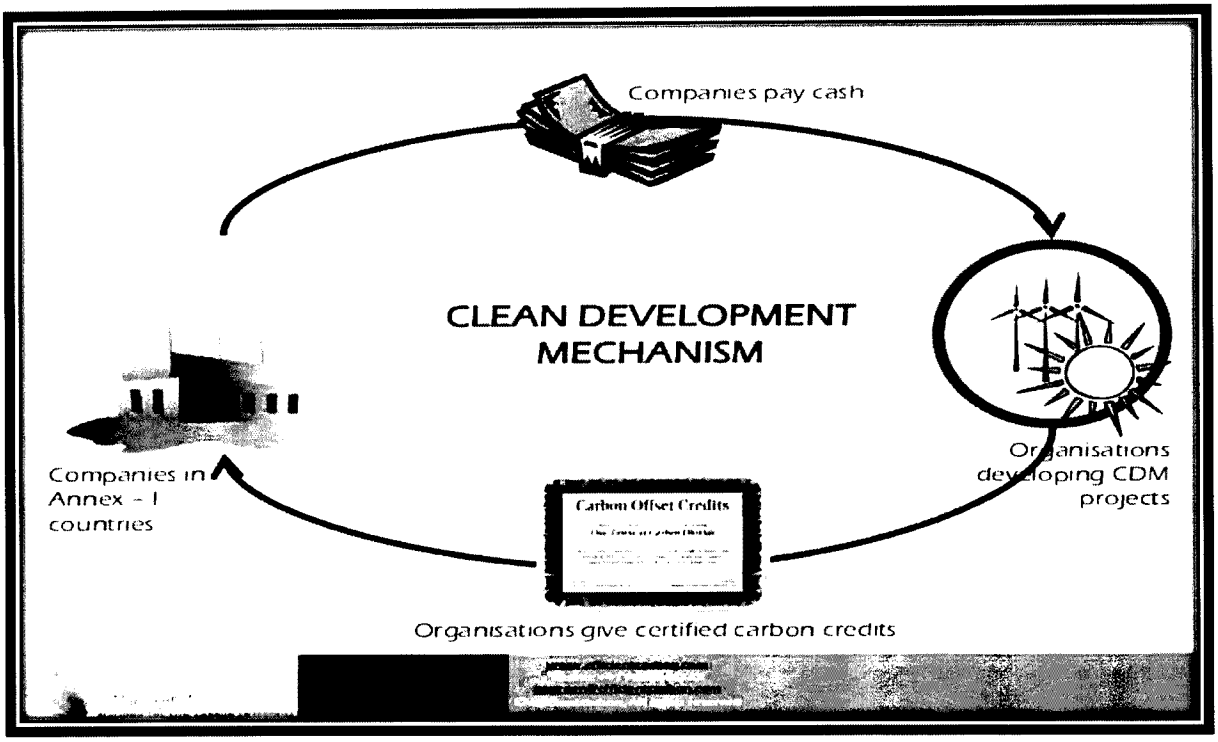


Figure 7.2: CDM Mechanism

7.3.2 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 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.

7.4 Beneficial Impacts

As a matter of fact, dozens of beneficial impacts can be considered during construction and development of perspective project, particularly for dwellers, which are given below:

7.4.1 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 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. This impact will lead to a significant effect on earnings of local community and thus is considered as positive.

7.4.2 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 commodities increases including grocery shops and restaurants. All these sorts of activities uplift the local market and business which reduces poverty directly and indirectly.

7.5 Adverse Impacts

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

7.5.1 Construction Stage

a. Adverse Impacts on Physical Environment

<u>Disturbance and Change in Landscape and Land-Use</u>

The proposed PV Solar Power Project includes variety of construction activities such as; earth work excavation, spoil disposal, quarrying and borrowing in concerned land area. Site

clearness removes tiny plants and grass which will disturb earth slope stability and enhance the exposed earth surface. Excavation, uncontrolled activities and generated waste can affect the quality of water. Increased erosion will boost the water runoff and slope over-loading. Rare floral species will be at verge of extinction due ill-managed activities.

Nature of Impact

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

Mitigation

A well-managed plan for all possible movements and clearness should be designed to reduce unrequired clearness.

Impact of transportation can be reduced by using existing pathways for transportation.

Noise pollution can be reduced by lesser use of horns and by regular maintenance of vehicles.

Air and Noise Quality Degradation

Drilling, vibrators, loaders, rollers, cranes, generators and pumps will produce high noise more than prescribed NEQS. Smoke from equipment and vehicles will affect air quality. This negative congener not only effect the air quality but also impact the calm environment and local people will suffer for short period of time.

Nature of Impact

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

Mitigation

Providing cover to the loose and lighter material at construction site is way to reduce the dust pollution at proposed site. Proper maintenance and monitoring of vehicles will keep the smoke pollution under control.

Sprinkling water on bare and unpaved pathways reduces dust generation. Tarpaulin sheets usage in off-site transportation cover the materials.

Greasing and oiling the noisy equipment can improve the situation.

Provision of rubber paddings/noise isolators at equipment/machinery used for construction will reduce the vibration.

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.

Solid Waste Generation

Kitchen waste and construction waste is produced during construction activities. 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. In addition to this, construction waste is based on 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 and disposal plan should be formulated by the site engineers while planning for construction.

Adverse Impacts on Culture

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

b. Impacts on Biological Environment

Disturbance and Threat to Wildlife

Deforestation of rare vegetation and other manufacturing activities may lead to the destruction of native habitats. The nature of these impacts on native flora and fauna will be negligible. 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 native animals will be affected by hunting and poaching. Necessary noisy and vibration producing activities may have negative impact. These hunting and catching activities for flora and fauna through labor force will be increased but it will remain limited and short term impacts on wildlife.

Nature of Impact

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

c. Impacts on Social & Economic Environment

Impacts on Occupational Health and Safety

Risks related to health and safety (fire hazards, chemical spillages, communicable diseases, etc.) for construction workers may arise due to different construction activities. This impact is considered negative and of moderate magnitude.

Mitigation

Following mitigations must be ensured during Project implementation;

- Providing basic medical training to specified work staff, basic medical service and supplies to workers
- PPEs such as; protective clothing, helmet, adequate footwear, protective goggles, gloves, etc. should be provided to the workers
- Ensure strict use of wearing these protective clothing during work activities
- Unfortunate accidents can be avoided by adequate occupational health and safety trainings and by following emergency response plan
- Provision of adequate sanitation, washing, cooking and dormitory facilities including lighting up to satisfaction level are required to ensure health of the workers
- 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 and social links
- Provision of proper safety signage at sensitive/accident-prone spots

- Setting up speed limits in close consultation with the local stakeholders

7.5.3 Operational Phase

a. 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.

b. Impact on Water Resources and Water Sharing

Solar energy power plant is considered to be an environment friendly technique but water will be used for plant washing and by labor that may put stress on scarce groundwater resources in the vicinity of Noorsar village. There are chances of arguments on equally used or shared water for domestic purpose.

Nature of Impact

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

Mitigation

Efficient management and utilization of groundwater resources may solve the problem.

The generated wastewater will be disposed off directly by using septic tanks and the groundwater resources will be replenished.

7.5.4 Decommissioning Stage

It is an extremely difficult task to select a best suited method for the interchanging of PV panels. It requires detail information to characterize their behavior and impact in the environment. Up to now, is 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 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 on humans and environment with potentially influence on the growth of wildlife with the release of silicon because their shelf life is about 25 years, after that they require to be changed. 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%. To

understand the entire situation, it will be the project manager responsibility to take over the old panels to the Renewable Energy Corporation (REC). 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 to its recycling facilities after expiring. REC (Renewable Energy Corporation) 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.

7.6 Enhancement Measures

As panels are raised above the ground on posts, more than 95% of a field utilized for solar farm development is still accessible for plant growth and potentially, for wildlife enhancements. Furthermore, sites are secure 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 local flower meadows between and/or beneath solar panels and in field margins. The best results are likely to come from sites that contain local flower.
- 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 and can served as a potentially available 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

8. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

8.1 Environment Management Plan (EMP)

The Environmental Management Plan (EMP) is a set of recommendations that manages the impacts of the proposed 30 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 are discussed in this EMP. Also, the EMP includes a set of institutional measures for construction and operational stages of the Project.

8.2 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
- Identify training requirements at various levels (if any)

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

8.3 Environmental Monitoring Plan (EMP)

Mitigations for physical, biological and socio-economic parameters will be measured to determine compliance with standards established in EMP. 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 are being followed
- Ensure that the required mitigation measures are being accomplished in time
- Identify problems or to identify solutions to rectify such problems.

8.4 Recommended Environmental Monitoring Protocol Pre-Construction Phase

8.4.1 Ambient Air Quality

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

8.4.2 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 1km radius of Project Area prior to drilling should be monitored and at least three samples should be collected for frequent monitoring/reporting.

8.4.3 Ground Water Quality

Ground water quality parameters prior to drilling like physio-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.

8.4.4 Noise Level Quality

Noise level should be monitored by using noise meters on daily basis at Project Site.

8.5 Recommended Environmental Monitoring Protocol during Site Preparation

During site preparation, below given physical infrastructure at the project site should be monitored. Following recommendations should be adopted;

- 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 or 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.

8.6 Recommended Environmental Monitoring Protocols 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, SO_2, CO, and HC should be monitored twice a week for 24 hours at Project Site.
- Water bodies within the radius of 1km of Project Site 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.
- 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.

8.7 Recommended Environmental Monitoring Protocols After 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.
- Groundwater quality parameters like physical-chemical properties, heavy metals and toxic organic compounds should be monitored at the end of the project. Monitoring should be done for once in pre-and post-monsoon season for three years.
- 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 Project Director. 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 a year this should be repeated for three years consecutively.

8.8 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 Asia Petroleum 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.

8.9 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's staff while executing the Environmental Monitoring Plan in particular. The training protocols will include the following aspects:

- 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 8.3: 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		✓	

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

Based on the environmental and social impacts assessment of the proposed 30 MW Solar Power Project, it is concluded that Project will have short term and reversible adverse impacts with moderate to minor magnitude. Implementation of the proposed Project will alleviate/offset the power crisis anticipated by Asia Petroleum with the arrangement of cheaper and uninterrupted energy supply which will provide electricity to their newly built manufacturing plant. The major impacts of the Project are summarized as under:

- The construction activities of proposed Project will not involve cutting/ removal of any trees and negligible clearance.
- All the other impacts like soil erosion, soil contamination, solid waste generation, high noise level, etc. will be of temporary nature and can be controlled and mitigated through good engineering practices.
- No protected forest area or wildlife sanctuary or any other environmentally sensitive site exists within the Project Area of influence and around it.
- No indigenous people have been identified in Project Area.
- A comprehensive EMP has been developed identifying the impacts, mitigation measures, agencies responsible for implementation and monitoring of the proposed measures. EMP also describes the environmental and social monitoring responsibilities.
- The total estimated cost for the environmental and social management comes to about **PKR. 4.56 million**.

In the light of above discussion, it may be concluded that most of the above-mentioned impacts are of temporary nature rather manageable through proper planning/execution and good engineering, furthermore, none of these are irreversible, therefore proposed Project is environment friendly and will have the least adverse impacts on the area in terms of social and environmental settings.

8.2 Recommendations

Although comprehensive mitigation measures have been proposed in the report to minimize offset the adverse impacts and enhance the positive impacts of the Project, however, major recommended measures are summarized as under:

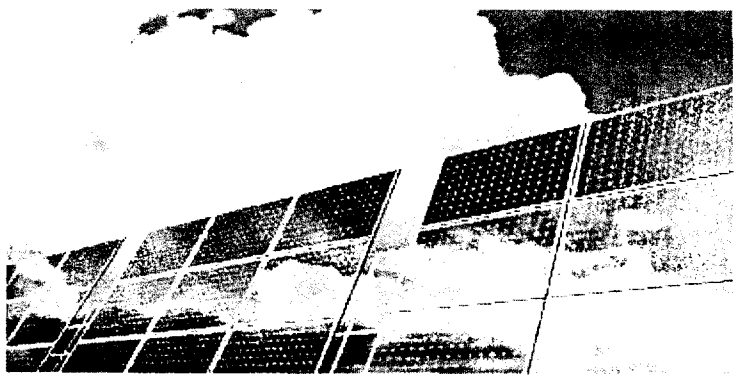
- The contractor should plant at least 100 trees as part of environment enhancement measures.
- Contractor's camp size should be developed at least 500m away from both villages to avoid/minimize the construction impacts and should be facilitated with proper drainage facilities.
- Solid waste management and high noise levels should be controlled with the use of good engineering practices.
- The contractor will have to adopt suitable timing (9pm-8am) for the construction activities so as to cause the least disturbance to the local community particularly women considering their peak movement hours.
- Contractor should take due care of the local community and its sensitivity towards local customs and traditions.
- Locals should be preferred for the job opportunities during construction/operation of the Project.
- EMP proposed in Chapter 7 should be implemented in its true spirits.
- Strengthening of road network, education facility and health improvement system may be enhanced as Area Development Plan.
- The Proponent must apply for Environmental Approval (NOC) to EPA, Punjab before proceeding further into the Project implementation.

Report No. PPI-180.4-Final/17

INTERCONNECTION STUDY

For

30 MW Solar Power Project by M/s Asia Petroleum Limited



Final Report
(August 2017)

POWER PLANNERS INTERNATIONAL LTD.

Registered in England & Wales No. 6363482

UK Office:
3-Sylvester Road,
Sudbury Town, Middlesex,
HA0 3AQ, UK
Phone & Fax:+44-(0)208-9223219

Pakistan Office:
64-F/1, Wapda Town,
Lahore 54770, Pakistan
Phone: +92-42-35182835;
Fax: + 92-42-35183166

Email: info@powerplannersint.com
www.powerplannersint.com

AEL

Executive Summary

- The data received from the client is validated and the study objective, approach and methodology have been described. The nominal net AC output power of the plant would be 23.3 MW.
- The system data provided to PPI as per NTDC Letter No. GMPP/CEMP/ TRP-380/solar common/5131-32 dated 09-12-2015. This has been attached in Appendix-A.
- The expected COD of Asia Petroleum Solar Power Plant is June 2018. The nearest substations of MEPCO are Noorsar 132 kV, Bahawalnagar 132 kV and Chishtian-New 132 kV.
- Given the location of Asia Petroleum Solar power plant, the most feasible interconnection scheme would be laying a double circuit of 12 km from Noorsar 132 kV Grid station. The conductor used would be Lynx Conductor. The complete circuit is shown in Appendix – B. The above proposed interconnection scheme has been tested for steady state, short circuit and transient stability conditions through detailed technical studies for the load conditions of June 2018 and Future scenario.
- Detailed load flow studies have been carried out for the peak load conditions of June 2018 and year June 2021 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate 23.3 MW maximum AC output of the plant under normal and contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Asia Petroleum Solar Power Plant 11 kV, and the substations of 132 kV in its vicinity. We find out 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 rating due to contribution of fault current from Asia Petroleum Power Plant.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability check for the worst case of three phase fault right on the 132 kV bus bar of the Asia Petroleum plant substation followed by the final trip of

132 kV circuit emanating from this substation has been performed for fault clearing of 9 cycles (180 ms). The system is found out to be strong enough and recovered with fast damping. 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, dynamic/transient conditions and is therefore recommended to be adopted.

Report Contents

1. **Introduction**
   1.1. Background
   1.2. Objectives
   1.3. Planning Criteria
2. **Assumptions of Data**
   2.1 Solar Power Plant Data
   2.2 Network Data
3. **Study Approach & Methodology**
   3.1 Understanding of the Problem
   3.2 Approach to the Problem
4. **Development of Scheme of Interconnection**
   4.1 The Proposed Network for Asia Petroleum Solar Power Plant
   4.2 The Scheme of Interconnection of Asia Petroleum Solar Power Plant
5 **Detailed Load Flow Studies**
   5.1 Modeling of Solar Power Plant in Load Flow
   5.2 Reactive Power Requirement
   5.3 Base Case Peak June 2018, Without Asia Petroleum Solar Power Plant
   5.4 Base Case Peak June 2018, With Asia Petroleum Solar Power Plant
   5.5 Base Case Off-Peak June 2018, With Asia Petroleum Solar Power Plant
   5.6 Base Case Peak June 2018, With Asia Petroleum Solar Power Plant (Scenario-I: Without 3 x 100 MW Power Plants at Chistian-New)
   5.7 Base Case Peak June 2021, With Asia Petroleum Solar Power Plant
   5.8 Conclusion of Load Flow Analysis
6. **Short Circuit Analysis**
   6.1 Methodology and Assumptions
   6.2 Fault current calculations without Asia Petroleum Solar Power Plant
   6.3 Fault current calculations with Asia Petroleum Solar Power Plant Interconnected for Year 2018
   6.4 Fault current calculations with Asia Petroleum Solar Power Plant Interconnected for Year 2021

6.4 Conclusion of short circuit analysis

7. Transient Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Stability Models

7.1.2 System Conditions

7.1.3 Presentation of Results

7.1.4 Worst Fault Cases

7.2 Transient Stability Simulations' Results

7.2.1 Fault at 132 kV Asia Petroleum

7.2.2 Fault at 132 kV Asia Petroleum (Stuck Breaker Case)

7.2.3 Fault at 132 kV Noorsar

7.3 Transient Stability Simulations' Results (Scenario-I)

7.3.1 Fault at 132 kV Asia Petroleum

7.3.2 Fault at 132 kV Asia Petroleum (Stuck Breaker Case)

7.3.3 Fault at 132 kV Noorsar

7.3 Conclusion of Dynamic Stability Analysis

8. Conclusions

Appendices

Appendix –A: Generation, Transmission Schedule and Load Forecast

Appendix – B: Sketches

Appendix –C: Plotted Results of Load Flow for Chapter 5

Appendix –D: Results of Short Circuit Calculations for Chapter 6

Appendix –E: Plotted Results of Stability Analysis for Chapter 7

Appendix –F: Dynamic Data for Stability

1. Introduction

1.1 Background

Asia Petroleum Solar is a 30 MW Solar Power Project. The site of proposed project is located in Punjab in the concession area of Multan Electric Power Company (MEPCO). The nominal net AC output power of the plant would be 23.3 MW. The project will start commercial operation by June 2018. The electricity generated from this project would be supplied to the MEPCO network through the network developed for evacuation of power.

1.2 Objectives

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

- To develop scheme of interconnections at 132 kV for which right of way (ROW) and space at the terminal substations would be available.
- To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
- To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 132 kV voltage levels to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at the Asia Petroleum Solar Power Plant.
- 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
	49.4 - 50.5 Hz, Short Time
Power Factor	± 0.95 (as per Grid Code Addendum No. 2 for Solar Power Plants)

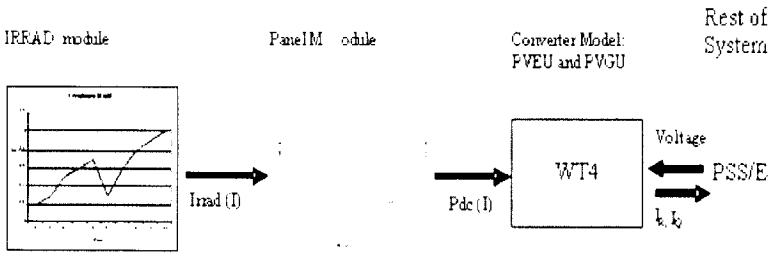
Dynamic/Transient:

- The system should revert to normal condition after dying out of transients without losing synchronism with good damping. For the systems of 132 kV and above, total time taken for normal fault clearing 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).
- In case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles) for 132 kV and higher voltage levels

2. Assumptions of Data

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.

2.2 Network data

The 132 kV networks available for interconnection to Asia Petroleum Solar Power Plant are as shown in Sketches in Appendix-B. The lengths of the circuits are also mentioned in the sketches.

The input data of MEPCO/NTDC has been used in this study. The latest load forecast and the generation expansion plan of NTDC provided vide this letter has been used as shown in Appendix A.

3. Study Approach and Methodology

3.1 Understanding of the Problem

The 30 MW Solar Power Plant by Asia Petroleum is going to be embedded in the 132 kV distribution network of MEPCO. It would run almost all the months of the year though with some variation in its output due to variation in the strength of light in winter and in rainy season.

The existing nearest MEPCO grid stations are Noorsar 132 kV, Bahawalnagar 132 kV and Chishtian-New 132 kV Substations. The addition of this source of power generation combined with the power from other solar power plant in its vicinity shall provide relief to the sources feeding this area from further away. The 132 kV network of MEPCO in the electrical vicinity of Asia Petroleum Solar has significant load demand; therefore a considerable portion of the power from Asia Petroleum Solar Power Plant will be utilized in meeting this load demand on substations.

The adequacy of MEPCO network of 132 kV in and around the proposed site of Asia Petroleum Solar Power Plant would be investigated 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 the peak load case of June 2018, comprising all 500 kV, 220 kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year particularly in MEPCO.
- The expected COD of the project is June 2018. In view of planned COD of Asia Petroleum Solar Power Plant, the above proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for June 2018 and future scenario of year 2021.
- 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, short circuit and transient stability study to

check the strength of the plant and the proposed interconnection scheme under disturbed conditions.

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

4. Development of Scheme of Interconnection

4.1 The Proposed Network for Asia Petroleum Solar Power Plant

The nearest existing MEPCO interconnection facilities at the time of commissioning of Asia Petroleum Solar Power Project are Noorsar, Bahawalnagar and Chishtian-New 132 kV Substations.

Given the location of Asia Petroleum Solar power plant, the most feasible interconnection scheme would be laying a double circuit of 12 km from Noorsar 132 kV Grid station. The conductor used would be Lynx Conductor. The complete circuit is shown in Appendix – B.

Under these conditions, the existing 132 kV network around these 132 kV grid stations is shown in Sketch-1 in Appendix-B.

4.2 The Scheme of Interconnection of Asia Petroleum Solar Power Plant

Given the location of Asia Petroleum Solar power plant, the most feasible interconnection scheme would be laying a double circuit of 12 km from Noorsar 132 kV Grid station. The conductor used would be Lynx Conductor. The complete circuit is shown in Appendix – B.

4.3 Solar Plant Substation 132/11 kV

A substation would be built at the Solar Power Plant to collect all the power from the collector groups, spread out in the solar park, at medium voltage (MV) level of 11 kV and step-up this power to high voltage (HV) level of 132 kV so that the Farm's output may be evacuated to the main grid of MEPCO/NTDC. The single line diagram of the substation, as a conceptual design, is shown in SLD-1 in Appendix-B for 11 kV and 132 kV.

5. Detailed Load Flow Studies

5.1 Modeling of Solar Power Plant in the Load Flow

Representation of all the individual inverters in a large Solar Power Plant is inappropriate in most grid impact studies. There is a provision in the model structure of PSS/E to allow single equivalent collector model to represent multiple collectors. For grid system impact studies, simulations are typically performed with the irradiance sufficient to produce the rated output on all the inverters. Though simulations of bulk system dynamics using a single inverter equivalent are adequate for most planning studies, we have adopted a rather more detailed level of modeling by using an equivalent collector to represent the collector system in each of the bus sections of the solar plant.

5.2 Reactive Power Requirements

Asia Petroleum Solar power factor is 0.95 lagging (capacitive/generating) and 0.95 leading (inductive/absorbing). Part of this reactive power will be consumed by the step-up transformers and the rest may be consumed in collector cables of the solar plant. However some reactive power might reach the 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 Asia Petroleum Solar with its maximum output is required to pump 7.65 MVAR to the grid at maximum AC power output of 23.3 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 transformers at the Solar Plant substation. In order to meet the Grid Code criteria, the reactive power compensation equipment will be provided and we have proposed the installation of one SVC of -5/+12 MVAR at 11 kV bus of the Solar Plant substation of sufficient size capable of delivering approx. 7.6 MVAR at 132 kV bus after VAR loss across 132/11 kV transformers.

5.3 Base Case Peak June 2018, Without Asia Petroleum Solar Power Plant

A base case has been developed for the peak load of June 2018, using the network data of MEPCO and NTDC.

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit shows 132 kV network in the vicinity of Asia Petroleum Solar.

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	Noorsar to Bahawalnagar 132 KV Single Circuit Out
Exhibit 0.2	Chistian-New to Chistian-Old 132 KV Single Circuit Out
Exhibit 0.3	Chistian-New to Noorsar 132 KV Single Circuit Out
Exhibit 0.4	100 MW Solar to Chistian-New 132 KV Single Circuit Out
Exhibit 0.5	100 MW Solar to Chistian-New 132 KV Single Circuit Out

We see that the power flows on all circuits remain within their ratings. Thus we find that there are no capacity constraints in terms of MW or MVA flow in the 132 kV network available in the vicinity of Asia Petroleum Solar Power Plant for its connectivity under normal conditions and the N-1 contingency conditions considered.

5.4 Base Case Peak June 2018, With Asia Petroleum Solar Power Plant

We have considered the scenario of peak load June 2018 so that we can judge the maximum impact of the project on the system when the loading on the lines would be at its maximum.

Opening of T-off line Qabula from Noorsar to Bwl.Nagar would be required for June 18 to avoid over-loadings of Noorsar Qabula T off under N-1 contingency conditions.

The results of load flow with Asia Petroleum Solar Power Plant interconnected as per proposed scheme are shown in Appendix - C. The power flows on the circuits under

normal conditions are seen well within the rated capacities. Also the voltages on the bus bars are within the permissible operating range of ± 5 % off the nominal. We find no capacity constraints on the 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 – C as follows:

Exhibit 1.1	Asia Petroleum 132/11 KV Single Transformer Out
Exhibit 1.2	Asia Petroleum to Noorsar 132 KV Single Circuit Out
Exhibit 1.3	Noorsar to Bahawalnagar 132 KV Single Circuit Out
Exhibit 1.4	Chistian-New to Chistian-Old 132 KV Single Circuit Out
Exhibit 1.5	Chistian-New to Noorsar 132 KV Single Circuit Out
Exhibit 1.6	100 MW Solar to Chistian-New 132 KV Single Circuit Out
Exhibit 1.7	50 MW Solar to Chistian-New 132 KV Single Circuit Out

In all the above contingency cases, we find that in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the rated limits in all the contingency events. Thus there are no constraints in this scheme in the contingency conditions mentioned above.

5.5 Off-Peak Case June 2018, With Asia Petroleum Solar Power Plant

Load Flow analysis has been carried out for the off- Peak conditions, so that we can judge the steady state impact of the reduced loads and generations, as higher loading is expected during off-peak conditions.

Base case of June 2018 has been selected to carry out load flow analysis of system in off-peak condition. Loads are reduced to 80 percent. The results of load flow with Asia Petroleum Solar Power Plant interconnected as per proposed scheme are shown in Appendix - C. The power flows on the circuits under normal conditions are seen well within the rated capacities. Also the voltages on the bus bars are within the permissible operating range of ± 5 % off the nominal. We find no capacity constraints on the 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 – C as follows:

Exhibit 2.1 Asia Petroleum 132/11 KV Single Transformer Out

Exhibit 2.2 Asia Petroleum to Noorsar 132 KV Single Circuit Out

Exhibit 2.3 Noorsar to Bahawalnagar 132 KV Single Circuit Out

Exhibit 2.4 Chistian-New to Chistian-Old 132 KV Single Circuit Out

Exhibit 2.5 Chistian-New to Noorsar 132 KV Single Circuit Out

Exhibit 2.6 100 MW Solar to Chistian-New 132 KV Single Circuit Out

Exhibit 2.7 50 MW Solar to Chistian-New 132 KV Single Circuit Out

In all the above contingency cases, we find that in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the rated limits in all the contingency events. Thus there are no constraints in this scheme in the contingency conditions mentioned above.

5.6 Senerio-1: Base Case Peak June 2018 without 3X100 MW Solar Power Plants, With Asia Petroleum Solar Power Plant

The scenario of peak load June 2018 without 3 x 100 MW Solar Power at Chistian-new and Dharanwla is simulated in order to analyze the impact of the project on the system, when 3 x 100 MW is decreased from the system.

The load flow results are shown in Appendix - C. The power flows on the circuits under normal conditions are seen well within the rated capacities. Also the voltages on the bus bars are within the permissible operating range of ± 5 % off the nominal. We find no capacity constraints on the 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 – C as follows:

Exhibit 3.1 Asia Petroleum 132/11 KV Single Transformer Out

Exhibit 3.2 Asia Petroleum to Noorsar 132 KV Single Circuit Out

Exhibit 3.3 Noorsar to Bahawalnagar 132 KV Single Circuit Out

Exhibit 3.4 Chistian-New to Chistian-Old 132 KV Single Circuit Out

Exhibit 3.5 Chistian-New to Noorsar 132 KV Single Circuit Out

Exhibit 3.6 Evening scenario

Exhibit showing evening peak scenario when solar of whole Mepco is zero has been attached and it shows no overloading for N-1 Contingency.

In all the above contingency cases, we find that in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the rated limits in all the contingency events. Thus there are no constraints in this scheme in the contingency conditions mentioned above.

5.7 Load Flow with Asia Petroleum Solar Power Peak Load Case 2021

Detailed load flow studies have also been carried out for an extended term spot year of 2021. The objective is to have a comprehensive total view of Solar power potential expected to be commissioned by 2021 and the adequacy of respective transmission plans to evacuate overall power from the Solar Power Plants sources going to be added in the area by that time.

Load flow studies have been carried out with all the additional power generation and the associated additional transmission schemes. Complete scheme is shown in Appendix-C.

The results of load flow with Asia Petroleum Solar Power Plant interconnected as per proposed scheme are shown for each case. The power flows on the circuits under normal conditions, with the above mentioned line openings, are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

To fulfill N-1 criteria of Grid Code, one-line-out contingency studies have also been carried out. Their results are shown plotted in Appendix-C as follows:

Exhibit 4.1 Asia Petroleum 132/11 KV Single Transformer Out

Exhibit 4.2 Asia Petroleum to Noorsar 132 KV Single Circuit Out

Exhibit 4.3 Noorsar to Bahawalnagar 132 KV Single Circuit Out

Exhibit 4.4 Chistian-New to Chistian-Old 132 KV Single Circuit Out

Exhibit 4.5 Chistian-New to Noorsar 132 KV Single Circuit Out

Exhibit 4.6 100 MW Solar to Chistian-New 132 KV Single Circuit Out

Exhibit 4.7 50 MW Solar to Chistian-New 132 KV Single Circuit Out

The results indicate that under all contingent conditions, the power flowing on the intact circuits are within the rated limits and the bus voltages are also within the allowable limits.

5.8 Conclusion of Load Flow Analysis

From the analysis discussed above, we conclude that the proposed interconnection scheme ensures reliability under all events of contingencies i.e. planned or forced outages studied in this report.

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analysis 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 2018 and 2021 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

6.2 Fault Current Calculations without Asia Petroleum Solar Power Plant

6.2.1 Maximum short circuit levels- Case Year 2018

In order to assess the short circuit strength of the network of 132 kV without the Asia Petroleum Solar Power Plant for the grid of MEPCO in the vicinity of the site of the Plant at Asia Petroleum Solar, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will not only give us the idea of the fault levels without Asia Petroleum 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 also we get a feel of 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 11 kV and 132 kV which are shown in the Exhibit 5.0 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 11 kV and 132 kV bus bars of our interest i.e. 132 kV circuits lying close to Asia Petroleum Solar. The tabular output is the detailed output showing the contribution to the fault current from the adjoining sources i.e. the lines and transformers connected to that bus. The phase currents, the sequence currents and the sequence impedances are shown in detail for each faulted bus bar.

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

Table - 6.1
Maximum Short Circuit Levels without Asia Petroleum Solar PP

Substations	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Bhawal-Nagar 132kV	6.42	4.11
Bhawal-Nagar-II 132kV	5.20	3.29
Noorsar 132kV	7.72	5.06
Mnchnabad 132kV	2.79	1.75
Chishtian 220kV	9.35	5.74
Chishtian-New 132kV	11.03	7.72
100 MW Solar(R) 132kV	7.61	5.03
MCLD GNJ 132kV	2.18	1.36
50 MW Solar (R) 132kV	7.60	5.03
Harronabad 132kV	7.61	5.11
Bhawal-Nagar 132kV	6.42	4.11
Bhawal-Nagar-II 132kV	5.20	3.29
Noorsar 132kV	7.72	5.06

6.3 Fault Current Calculations with Asia Petroleum Solar Power Plant interconnected

6.3.1 Maximum short circuit levels for Case Year 2018

Fault currents have been calculated for the proposed scheme of interconnection. Three phase and single-phase faults have been applied at the 11 kV and 132 kV bus bars of Asia Petroleum Solar Power and other bus bars of the 132 kV substations in the electrical vicinity of Asia Petroleum Solar. The graphic results are indicated in Exhibit 5.1

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

We find that even after the interconnection of Asia Petroleum Solar Power Plant these fault levels are much below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of 11 kV bus bar of Asia Petroleum Solar Power Plant is 26.73 kA and 30.22 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA is proposed at 11 kV switchyard of Asia Petroleum Solar as per NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

The maximum short circuit level of 132 kV bus bar of Asia Petroleum Solar Power Plant is 6.39 kA and 5.12 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 132 kV switchyard of Asia Petroleum Solar as per NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

Table-6.2
Maximum Short Circuit Levels with Asia Petroleum Solar PP – 2018

Substations	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Asia PP 11 KV	26.73	30.22
Asia PP 132 KV	6.39	5.12
Bhawal-Nagar 132kV	6.46	4.55
Bhawal-Nagar-II 132kV	5.24	3.67
Noorsar 132kV	7.77	6.01
Mnchnabad 132kV	2.81	1.83
Chishtian 220kV	9.37	6.11
Chishtian-New 132kV	11.08	8.34
100 MW Solar(R) 132kV	7.64	5.29
MCLD GNJ 132kV	2.19	1.41
50 MW Solar (R) 132kV	7.65	5.29
Harronabad 132kV	7.64	5.38
Asia PP 11 KV	26.73	30.22
Asia PP 132 KV	6.39	5.12
Bhawal-Nagar 132kV	6.46	4.55

6.3.2 Maximum short circuit levels for Case 2021

Fault currents have been calculated for the year 2021. Three phase and single-phase faults have been applied at the 11 kV and 132 kV bus bars of Asia Petroleum Solar Power and other bus bars of the 132 kV substations in the electrical vicinity of Asia Petroleum Solar. The graphic results are indicated in Exhibit 5.2.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV bars of the network in the electrical vicinity of Asia Petroleum Solar Power Plant are placed in Appendix-D. Brief summary of fault currents at significant bus bars of 11 kV and 132 kV are tabulated in Table 6.3.

We find that even after the interconnection of Asia Petroleum Solar Power Plant 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 Asia Petroleum Solar Power Plant is 7.82 kA and 6.04 kA for 3-phase and 1-phase faults respectively for the year 2021. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 132 kV switchyard of Asia

Petroleum-Solar-PP as per NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

Similarly the maximum short circuit level of 11 kV bus bar of Asia Petroleum Solar Power Plant is 28.05 kA and 30.96 kA for 3-phase and 1-phase faults respectively for the year 2021. Therefore industry standard switchgear of the short circuit rating of 40 kA is proposed to be installed at 11 kV switchyard of Asia Petroleum Solar-PP as per NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity

Table-6.3

Maximum Short Circuit Levels with Asia Petroleum Solar PP – 2021

Substations	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Asia PP 11 KV	28.05	30.96
Asia PP 132 KV	7.82	6.04
Bhawal-Nagar 132kV	8.98	6.31
Bhawal-Nagar-II 132kV	6.12	4.16
Noorsar 132kV	10.09	7.62
Mnchnabad 132kV	3.13	2.01
Chishtian 220kV	12.57	8.36
Chishtian-New 132kV	14.74	11.43
100 MW Solar(R) 132kV	10.02	7.61
MCLD GNJ 132kV	2.36	1.51
50 MW Solar (R) 132kV	9.99	7.57
Harronabad 132kV	9.49	6.56
Asia PP 11 KV	28.05	30.96
Asia PP 132 KV	7.82	6.04
Bhawal-Nagar 132kV	8.98	6.31

6.4 Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of Asia Petroleum Solar Power Plant there are no 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, either three-phase faults or single phase faults.

The maximum short circuit level of 11 kV bus bar of Asia Petroleum Solar Power Plant is 26.73 kA and 30.22 kA, and 28.05 kA and 30.96 kA for 3-phase and 1-phase faults respectively for the year 2018 and year 2021. Therefore industry standard switchgear of the short circuit rating of 40 kA is proposed to be installed at 11 kV switchyard of Asia Petroleum Solar as per NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

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 Solar power generator, its electrical model and the panel as follows;

Generator	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1.

7.1.2 System Conditions

We have used the system conditions of Peak June 2018 because this will allow the maximum impact of Asia Petroleum Solar Power Plant to be judged.

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 runs are placed in Appendix - E. Each simulation is 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 nine seconds. Usually all the transients due to non-linearity die out within 2-3 seconds after disturbance is cleared in the system.

7.1.4 Worst Fault Cases

Three phase faults are considered as the worst disturbance in the system. We have considered 3-phase fault in the closest 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. 180ms, followed by permanent trip of one 132 kV transmission line emanating from this substation.

.

7.2 Transient Stability Simulations' Results

7.2.1 Fault at 132 kV Asia Petroleum

We applied three-phase fault on the Asia Petroleum 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132 kV circuit between Noorsar and Asia Petroleum. 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 11 kV and 132 kV bus bars of Asia Petroleum, Noorsar, Bahawalnagar Chishtian-New and Haroonabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

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

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Asia Petroleum Solar Power Plant was 30 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 1.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 1.5 MW /MVAR flow on Asia Petroleum to Noorsar 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between Noorsar and Asia Petroleum causes the entire output of Asia Petroleum to flow through the intact circuit between Noorsar and Asia Petroleum. We plotted the flows of MW and MVAR on

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

Fig. 1.6 MW/MVAR output of of 100 MW Solar PP

The pre-fault output of Solar-PP 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 Foundation-P 132 kV, Engro Energy 220 kV, Liberty 132 kV, Eithad 132 kV and Hamza 132 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 Asia Petroleum (Stuck Breaker Case)

We applied three-phase fault on the Asia Petroleum 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 132 kV circuit between Noorsar and Asia Petroleum. 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 11 kV and 132 kV bus bars of Asia Petroleum, Noorsar, Bahawalnagar Chishtian-New and Haroonabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

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

Fig. 2.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Asia Petroleum Solar Power Plant was 30 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 2.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 2.5 MW /MVAR flow on Asia Petroleum to Noorsar 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between Noorsar and Asia Petroleum causes the entire output of Asia Petroleum to flow through the intact circuit between Noorsar and Asia Petroleum. We plotted the flows of MW and MVAR on this transformer and see that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 2.6 MW/MVAR Output of 100MW Solar PP

The pre-fault output of Solar-PP 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 Foundation-P 132 kV, Engro Energy 220 kV, Liberty 132 kV, Eithad 132 kV and Hamza 132 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 132 kV Noorsar

We applied three-phase fault on the Noorsar 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132 kV circuit between Noorsar and Asia Petroleum. 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 11 kV and 132 kV bus bars of Asia Petroleum, Noorsar, Bahawalnagar Chishtian-New and Haroonabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

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

Fig. 3.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Asia Petroleum Solar Power Plant was 30 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 3.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 3.5 MW /MVAR flow on Noorsar 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between Noorsar to Asia Petroleum causes the entire power to flow through the intact circuit between Noorsar to Asia Petroleum. We have plotted the flows of MW and MVAR on this transformer and see that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 3.6 MW/MVAR Output of 100MW Solar PP

The pre-fault output of Solar-PP 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 Foundation-P 132 kV, Engro Energy 220 kV, Liberty 132 kV, Eithad 132 kV and Hamza 132 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.

7.3 Transient Stability Simulations' Results (Scenario-I)

7.3.1 Fault at 132 kV Asia Petroleum

We applied three-phase fault on the Asia Petroleum 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132 kV circuit between Noorsar and Asia Petroleum. 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 11kV and 132 kV bus bars of Asia Petroleum, Noorsar, Bahawalnagar Chishtian-New and Haroonabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

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

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Asia Petroleum Solar Power Plant was 30 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 1.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 1.5 MW /MVAR flow on Asia Petroleum to Noorsar 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between Noorsar and Asia Petroleum causes the entire output of Asia Petroleum to flow through the intact circuit between Noorsar and Asia Petroleum. We plotted the flows of MW and MVAR on this transformer and see that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Foundation-P 132 kV, Engro Energy 220 kV, Liberty 132 kV, Eithad 132 kV and Hamza 132 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.

7.3.2 Fault at 132 kV Asia Petroleum (Stuck Breaker Case)

We applied three-phase fault on the Asia Petroleum 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 132 kV circuit between Noorsar and Asia Petroleum. 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 11 kV and 132 kV bus bars of Asia Petroleum, Noorsar, Bahawalnagar Chishtian-New and Haroonabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

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

Fig. 2.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Asia Petroleum Solar Power Plant was 30 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 2.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 2.5 MW /MVAR flow on Asia Petroleum to Noorsar 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between Noorsar and Asia Petroleum causes the entire output of Asia Petroleum to flow through the intact circuit between Noorsar and Asia Petroleum. We plotted the flows of MW and MVAR on this transformer and see that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Foundation-P 132 kV, Engro Energy 220 kV, Liberty 132 kV, Eithad 132 kV and Hamza 132 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.

7.3.3 Fault at 132 kV Noorsar

We applied three-phase fault on the Noorsar 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132 kV circuit between Noorsar and Asia Petroleum. 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 11 kV and 132 kV bus bars of Asia Petroleum, Noorsar, Bahawalnagar Chishtian-New and Haroonabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

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

Fig. 3.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Asia Petroleum Solar Power Plant was 30 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at the same value.

Fig. 3.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 3.5 MW /MVAR flow on Noorsar 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between Noorsar to Asia Petroleum causes the entire power to flow through the intact circuit between Noorsar to Asia Petroleum. We have plotted the flows of MW and MVAR on this transformer and see that the power flows on this circuit attain steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of Foundation-P 132 kV, Engro Energy 220 kV, Liberty 132 kV, Eithad 132 kV and Hamza 132 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 to and far of the Solar Power Plant of Asia Petroleum Solar. Therefore there is no problem 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 expected COD of Asia Petroleum Solar Power Plant is June 2018. The nearest substations of MEPCO are Noorsar 132 kV Chishtian-New 132 kV and Bahawalnagar 132 kV.
- Given the location of Asia Petroleum Solar power plant, the most feasible interconnection scheme would be laying a double circuit of 12 km from Noorsar 132 kV Grid station. The conductor used would be Lynx Conductor. The complete circuit is shown in Appendix – B. The above proposed interconnection scheme has been tested for steady state, short circuit and transient stability conditions through detailed technical studies for the load conditions of June 2018 and Future scenario.
- Detailed load flow studies have been carried out for the peak load conditions of June 2018 and year 2021 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate 23.3 MW maximum AC output of the plant under normal and contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Asia Petroleum Solar Power Plant 11 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 rating due to contribution of fault current from Asia Petroleum Power Plant.
- The maximum short circuit level of 11 kV bus bar of Asia Petroleum Solar Power Plant is 26.73 kA and 30.22 kA and 28.05 kA and 30.96 kA for 3-phase and 1-phase faults respectively and for 132 kV bus bar of Asia Petroleum Solar Power Plant is 6.39 kA and 5.12 kA and 7.82 kA and 6.04 kA for 3-phase and 1-phase faults respectively for the year 2018 and year 2021. Therefore industry standard switchgear of the short circuit rating of 40 kA is proposed to be installed at 11 kV and at 132 kV switchyard of Asia Petroleum Solar as per NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

- The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability check for the worst case of three phase fault right on the 132 kV bus bar of the Asia Petroleum plant substation followed by the final trip of 132 kV circuit emanating from this substation has been performed for fault clearing of 9 cycles (180 ms). The system is found strong enough to stay stable and recovered with fast damping. 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, dynamic/transient conditions and is therefore recommended to be adopted.