ENERGY FOR A BETTER TOMORROW

SIACHEN ENERGY LIMITED

GENERATION LICENSE APPLICATION

100 MW_P SOLAR POWER PROJECT

SIACHEN ENERGY LIMITED

ENERGY FOR A BETTER TOMORROW

ANNEX-1

SEL/CEO/NEPRA/16-0007

June 06, 2016

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

Dear Sir,

Subject: <u>Application for a Generation License -100 MW_P Solar PV Power Generation Project</u>

I, Muhammed Sohail Shamsi, Chief Executive Officer, being the duly authorized representative of Siachen Energy Limited ("the Company"), by virtue of the Board Resolution of the Company dated June 03, 2016, hereby apply to National Electric Power Regulatory Authority ("NEPRA"), for the grant of a Generation License to the Company, pursuant to Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support, attached with this application, are prepared and submitted in conformity with the provisions of 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 Demand Drafts, bearing number 00084590 dated June 06, 2016, amounting to Rs. 352,400/- (Rupees Three Hundred and Fifty Two Thousand and Four Hundred Only) being the non-refundable license application fee, calculated in accordance with Schedule II to National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also being attached herewith.

Muhammed Sohail Shamsi
Chief Executive Officer

4TH FLOOR, PLOT 36-C, LANE # 13, BUKHARI COMMERCIAL AREA, PHASE VI, DHA, KARACHI 75500, PAKISTAN
T: +92 21 3515 6172-3 | F: +92 21 3515 6174 | E: info@sel.com.pk | W: www.sel.com.pk; www.siachenenergy.com

SIACHEN ENERGY LIMITED

ENERGY FOR A BETTER TOMORROW

ANNEX-II

RESOLUTION PASSED BY THE BOARD OF DIRECTORS OF SIACHEN ENERGY LIMITED

DATED: June 03, 2016

"**RESOLVED** that Siachen Energy Limited ("the Company") may file an application for the grant of a Generation License for its 100 MW_P solar based power generation plant to be located at Mirpur Sakro, Thatta, Sindh ("the Project") with the National Electric Power Regulatory Authority ("NEPRA").

FURTHER RESOLVED that Mr. Muhammed Sohail Shamsi, Chief Executive Officer of the Company, be and is hereby authorized representative of the Company, to file application(s) for generation license to NEPRA in respect of the Project, and in relation thereto, enter into and execute all required documents, including application(s) for generation license, make all filings and pay all applicable fees, in each case, of any nature whatsoever as required, appear before NEPRA and provide any information required by NEPRA in respect of the Project, and to do all acts and things necessary, for processing, completion and finalization of the aforementioned application.

AND FURTHER RESOLVED that Mr. Muhammed Sohail Shamsi, Chief Executive Officer of the Company, be and is hereby, also authorized to delegate all or any of the above powers, in respect of the foregoing, to any other official(s) of the Company as deemed appropriate."

Moreover, the specimen signature of Mr. Muhammed Sohail Shamsi, Chief Executive Officer of the Company appears below:

For and on behalf of Siachen Energy Limited,

Zeeshan Mirza
Company Secretary &
Chief Financial Officer

Siachen Energy Limited

A010164

SECP

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. **0093721**

I hereby certify that **SIACHEN ENERGY 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 **First day** of **June,** Two **Thousand** and **Fifteen**.

Incorporation fee Rs. **172,000/=** only

(Sidney Custodio Pereira)
Joint Registrar of Companies
Karachi

Certified to be True Copy
Joint Registrar of Companies

(The Companies Ordinance, 1984)

MEMORANDUM

AND

ARTICLES OF ASSOCIATION

OF

Company Registration Office
Karachi
Securities & Exchange Commission of Pakistan

SIACHEN ENERGY LIMITED

Siachen Energy Limited

THE COMPANIES ORDINANCE, 1984

(PUBLIC COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

OF

SIACHEN ENERGY LIMITED

I. The name of the Company is "SIACHEN ENERGY LIMITED".

II. The Registered Office of the Company shall be situated in the Province of Sindh, Pakistan.

III. The objects for which the Company is established are all or any of the following and in the construing the following sub-clauses, the object set forth in any sub-clause shall not, except when the context expressly so requires, in any way limit or restrict by reference to or inference from the terms of any such sub-clause.

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

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

3. To carry on all or any of the businesses of wholesalers, retailers, traders, importers, exporters, suppliers, distributors, designers, developers, manufacturers, installer, filters, testers, repairers, maintainers, contractors, constructors, operators, users, inspectors, reconditioners, improvers, alterers, protectors, removers, hirers, replacers, importers and exporters of and dealers in, electrical appliances, systems, products and services used for energy conservation, equipments, machinery, materials and installations, including but not limited to 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.

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

5. To carry on the business of establishing a refinery for refining crude oil and to produce petroleum products of all kinds.

6. To establish, erect, run, own, manage and operate refinery and to carry on the business of drilling, manufacturing, blending, refining and processing of crude oil and to produce petroleum and petroleum products like premium motor gasoline, high diesel, kerosene oil, furnace oil, aviation fuels, paving asphalt, cutback asphalt, polymer modified bitumen, mineral turpentine, light diesel oil, naphtha, liquefied petroleum gas, Jute batching oil, lube oil and solvent oil.

7. To purchase or otherwise acquire, import, export, transport (by rail, road and sea), market, distribute, supply, sell, and otherwise dispose off and generally trade in any and all kinds of lubricants, greases, petroleum, petroleum products and other related products having applications for use in auto vehicles, industrial units, power houses and other industrial consumption and to market these products through company owned resources or its subsidiary, dealers, stockiest and organizations all over the country and to own, purchase or otherwise acquire or hire services for the introduction and promotion of lubricants and other products either under specific brand names or otherwise and to carry on any other business which may seem to company capable of being conveniently carried on exclusively for operating the objective as stated above.

8. To carry on the business as petroleum engineers, providing consultancy services, preparation of feasibilities for all sorts of petroleum related industries and to manufacture, buy, sell, import, export and to deal in all sorts of oil field equipments.

9. To refine, process, formulate, produce, buy, sell, export, import, indent or otherwise deal in all types of chemicals, petro-chemicals and petroleum industry or any material used or capable of being used in the petro-chemicals industry, industrial chemicals or any mixtures, derivatives and compounds thereof.

10. To carry on the business of purchase or otherwise acquire, sale, store, transport, market, distribute, supply, sell, import, export, and otherwise dispose of and generally trade in any and all kinds of petroleum and petroleum products, oil, gas, hydrocarbons, petrochemicals, asphalt, bituminous substances and to undertake all such activities as are connected herewith or ancillary thereto and to take over the running or likely to be running business of alike nature with or without assets, liabilities, rights, privileges, registration, trade mark, import and export registration or any other facility.

11. To import, export, transport, market, and distribute CNG, LNG Liquefied Petroleum Gas (LPG) and to facilitate production of CNG, LNG, LPG by third parties.

12. To carry on the business of exporting and importing of product of refinery and other merchandise, machinery, equipment, articles manufactured or otherwise, spare parts, produce of all kinds of or from any country or transport or carry or convey the same from one part of the country to an other part thereof, act as manufacturers, representative producers representative, auctioneers, commission agent, commercial marketing agent. To secure orders for supply of any articles or things and to carry out and comply with the said orders.

13. To carry on the business of transporting crude oil or other products of the refinery by rail, road and sea within Pakistan as well as abroad and to market the same.

14. To carry on the business of manufacturing which may to the Directors of the Company seem capable of being conveniently carried on in connection with the above, calculated directly or indirectly to enhance the value of or to render profitable any of the Company's property or rights.

15. To establish branch/branches in foreign countries after obtaining necessary permission of respective Government department and to carry on all or any of the objects of the Company, subject to the laws of the land in which the branch/branches are established.

16. To produce, purchase and market the finished/ unfinished, refined products of the refinery through company owned or subsidiary owned or through contract, gas stations to market the products.

17. To engage in the commercial sale and marketing of the refined petro chemical products through legally established patrol/gas service stations both in Pakistan and abroad.

18. To purchase, acquire, on lease or by way of license or other possessory mortgage or exchange or as a donee or in any other lawful manner whatsoever, lands, building, structure, open place, surface rights or other premises for the purpose of the Company.

19. To build, erect, construct, furnish or refurnish, equip, maintain or improve any building, structure, edifice, hall enclosure, studio for the use of the Company, its employees or other persons connected with the affairs of the Company or business subsidiary to the objects of the Company.

20. To take on lease, purchase or acquire in any manner whatsoever, apartments, offices, houses, flats, rooms, huts or other accommodation for staff and to let or dispose of same by outright sales, whether by private treaty or by auction, or in any other mode of disposition, all or any integral part thereof.

21. To carry on the research work in connection with the business of the Company and for such purpose to subsidize, install, open, maintain institutions for experimental work, to construct, equip, acquire, maintain or lease laboratories, scientific museums, whether inside or outside the country and to make or cause experiments to be made, whether on land sea, air or underground, in connection with or for the improvement of the business of the Company.

22. To acquire and undertake, manage or maintain, the whole or any part of the business, property and liabilities of any persons or Company carrying on any business which the Company is authorized to carry on or be possessor of property suitable for the purposes of the Company.

23. To purchase or otherwise acquire and to sell, change, surrender, lease mortgage, charge, convert, turn to account, dispose of and to deal with property and rights of all kinds and in particular, mortgages, charges hypothecations, debentures, concessions option, contracts, patents licenses, shares, bonds, policies, book debts, business concerns an undertakings and actions of all kinds.

24. To amalgamate, enter into partnership or into any arrangement for sharing profits, union of interest, co-operation, joint venture, reciprocal concession or otherwise with any person, firm or Company carrying or engaged in, or about to carry on or engage in, any business or transaction capable of being conducted so as directly or indirectly to benefit this Company.

25. To take or acquire and hold shares in any other Company having objects altogether or in part similar to those of this Company or carrying on any business capable of being conducted so as directly or indirectly to benefit this Company.

26. To sell or dispose of the undertaking of the Company or any part thereof for such consideration as the Company may deem fit.

27. To invest and deal with the surplus moneys of the Company not immediately required in such manner as may from time to time be determined.

28. To assist, promote, aid, or subscribe to the establishment and maintenance of any institutions, association, fund or charity for the benefit and use of the employees and ex-employees of the Company and to grant gratuity, bonus, pension, privileges, relief and other emoluments to them and their dependents and to provide for their welfare, convenience, entertainment, education, development and assurance of the said employees and their dependents or those who may have any moral claim on such employees or ex-employees. To provide or assist all those who may have suffered or may be suffering or expected to suffer in connection with the affairs of the said Company or in the environment, vicinity or neighborhood of the said Company. To encourage, donate or otherwise aid benevolent society, institution and association for the uplift of the employees or ex-employees and their family members and their associates or relations.

29. To pay or enter into bond or agreement or other arrangement for payment of all costs, charities, expenses and liabilities or obligations incurred or sustained in, or in respect of, the promotion, floatation, registration and establishment of the Company or in connection with the inauguration of the offices and branch offices or agencies of the Company and in performing the opening or other inaugural ceremony to pay or adjust the underwriting commission, brokerage, printing, development or such other expenditure as the Directors of the Company may consider as preliminary expenses.

30. To borrow loans whether on promissory note, bond, bill of exchange or other security for the purposes of the Company or to advance to any other person or Company as may be considered necessary, whether directly or indirectly, to carry on or advance the business of the Company. To issue debentures or debenture stock on the assets of other undertakings of the Company or on the security of the Company as may be found necessary or expedient in the interest of the Company.

31. To advance money to such person or persons of another Company whether on security or otherwise, as may be conducive to the interest of the Company.

32. To draw, accept, discount, bills of exchange, cheques and to make, execute or issue promissory notes or cheques or other negotiable instruments or to accept, endorse, any bill of lading, warrants or issue debentures or other transferable instruments concerning this Company.

33. To obtain or make arrangement for the obtaining of or passing of any Act or Ordinance of the legislature or other law making body which may be necessary or advantageous for the carrying on of the business of the Company and enter into such obligations or take such proceedings as may be calculated to advance the said objects of the Company.

34. To distribute in specie, if so considered fit among the members of the Company, any assets or properties of the Company including its shares, debentures, debenture stocks or other securities formed to take over the whole or any part of the assets, properties or liabilities, in the event of winding up of this Company.

35. To sell or sub-let or otherwise dispose of any licences, privilege concession or contract entered into by the Company or to enter into any agreement with any other Company in connection with undertaking and business of the Company with any other Company having objects similar to the objects of this Company.

36. To enter into any agreement or arrangement with any authority Government, local body, or other institution, anywhere in Pakistan which may be considered beneficial for or conducive to the objects of the Company or any of them and to obtain from such authority or authorities any concession, privileges, licenses and to subject or dispose of the same or exercise any right relating thereto as may be beneficial or conducive to the objects of the Company.

37. To remunerate any person or company in cash or otherwise or to pay any brokerage or commission or bonus to any person who may have undertaken to serve or render services to the Company in the matter of selling or disposing of the shares or debentures or debenture stocks or other stocks or assets of the Company or who may guarantee placing the shares or debentures in the market.

38. To undertake and execute any trusts or to do any other such act as may seem desirable or beneficial whether with or without consideration.

39. To do such other things as may be considered incidental or conducive for the fulfillment of the objects of the Company or any of them.

40. To employ experts to investigate and examine the condition, prospect value, character and circumstances of any business concerns undertakings and generally of any assets, property or right.

41. To adopt such means of making known the products or services of the Company as may seem expedient, and in particular by advertising in the press, by circular, by purchase and exhibition of works of art or interest, by publication of books and periodicals, and by granting prizes, rewards and donations.

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

43. 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 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.

44. The company shall not engage in banking business, business of an investment company, Non-Banking Finance Corporation, leasing company and insurance company, business of managing agency or any unlawful business and nothing in object clause shall be construed to entitle company to engage in such business, directly or indirectly. The company shall not launch multilevel marketing, pyramid and ponzi schemes.

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

IV. The liability of the members is limited.

V. The authorised capital of the Company is Rs. 50,000,000/- (Rupees Fifty Million only) divided into 5,000,000/- (Five million) Ordinary shares of Rs.10/- (Rupees ten) each with powers to increase or reduce the share capital and consolidate and divide the shares into higher and lower denomination.

We the undersigned several person, whose names, addresses and description are subscribed are desirous of being formed into a Company, in pursuance of these Memorandum of Association and we respectively agree to take the number of shares in the Capital of the Company set opposite to our respective names:-

Name & Surname (Present & former) in full (In Block Letters	Father's / Husband's Name in full	Nationality with any other Former Nationality	Occupation	Residential Address in full	Number of shares taken by each Subscriber	Signature
MUHAMMAD SOHAIL SHAMSI	ABDUL SAMAD SHAMSI	Pakistani	Business	74, J Street Off. Khayaban-e-Muhafiz, Phase VI, DHA, Karachi	95,000 (Ninety Five Thousand)	
MRS. UROSA SOHAIL SHAMSI	MUHAMMAD SOHAIL SHAMSI	Pakistani	Business	74, J Street Off. Khayaban-e-Muhafiz, Phase VI, DHA, Karachi	4,000 (Four Thousand)	
MRS. ALYZA PURI	MOHAMMAD IQBAL PURI	Pakistani	Lawyer	23, M Street, Phase VI, DHA Karachi	1,000 (One Thousand)	
				Total	***100,000 (One Hundred Thousand)***	

Witness to the above : **NIFT (Pvt) Limited**

Full Address : **5th Floor, AWT Plaza, I.I. Chundrigar Road, Karachi 74200, Pakistan.**

16 NOV 2015

(THE COMPANIES ORDINANCE, 1984)

(PUBLIC COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

SIACHEN ENERGY LIMITED

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1. The marginal notes hereto shall not affect the construction hereof and in these presents unless there be something in the subject or context inconsistent herewith:

"The Board" means the Board of Directors for the time being.

"The Ordinance" means the Companies Ordinance, 1984. (All reference to Sections and sub sections herein is to section of the Ordinance).

"Special Resolution" and "Extraordinary Resolution" have the meaning assigned thereto respectively by the Ordinance, (Section 159)

"The Company" means SIACHEN ENERGY LIMITED

"The Chairman" means the Chairman of the Board appointed form time to time.

"The Directors" means the Directors for the time being of the Company

"The Chief Executive/Managing Director" means the Chief Executive/Managing Director for the time being.

"The Office" means the Registered office for the time being of Company.

"The Register" means the Register of Members to be kept pursuant Section 147 of the Ordinance.

"The Deputy Registrar" means the Deputy Registrar of Company Karachi.

"Dividend" include bonus.

"Month" means calendar month. "Year" means calendar year.

"Proxy" includes attorney duly constituted under Power of Attorney

"In Writing" and "Written" include printing, lithography and other mode of representing or reproducing words in a visible form.

Words importing the singular number also include the plural number, and vice versa.

Words importing the masculine gender also include the feminine gender and vice versa.

Words importing persons include Corporations.

2. Save as reproduced herein, the regulations contained in Table 'A' in first schedule to the Ordinance shall not apply to the Company.

SHARES

3. The authorised capital of the Company is Rs. 50,000,000/- (Rupees FiftyMillion only) divided into 5,000,000 (Five million) Ordinary shares of Rs.10/- (Rupees ten each) with powers to increase or reduce the share capital and consol and divide the shares into higher and lower denomination.

4. No shares shall be offered to public for subscription except upon the term that amount payable on application shall be the full amount of the nominal amount of shares.

5. Subject to the provisions of the Ordinance and these Articles the share in the capital of the Company for the time being shall be under the control of the Directors who may allot or otherwise dispose of the same or any of them to such persons and on such terms and conditions as the Company in general meeting or the Board may think fit and either at premium or at par or (subject to compliance with Section 84 of the Ordinance) at discount as the company in general meeting or the board may from time to time think fit and proper and with full power to give to any person the option to call for or be allotted shares of any class of the Company either at par or at premium or subject as aforesaid at a discount such option being exercisable at such times and for such consideration as the Directors think fit.

6. The shares in the capital shall be numbered progressively according to their denominations and, except in the manner hereinbefore mentioned, no share shall be sub-divided.

7. If the Company shall offer any of its shares to the public for subscription:

   (a) No allotment thereof shall be made, unless the amount stated in the prospectus as the minimum amount, which in the opinion of the Board must be raised by the issue of shares capital in order to provide the same, or if any part thereof is to be defrayed in any other manner, the balance of the sum required to be provided in respect of the matter specified in Section 68 of the Ordinance has been subscribed, and the sum has been paid to or received by the Company and the Board shall otherwise comply with the requirements of that section; but this provision shall no longer apply after the first allotment of shares offered to the public for subscription.

   (b) The amount payable on application on each share shall be the full amount of the nominal amount of the shares.

   And if the Company shall propose to commence business on the footing of a statement in lieu of prospectus, the Board shall not make any allotment of shares payable in cash unless a minimum subscription of Rs. 500,000/- of the shares proposed to be issued shall have been subscribed for on a cash footing.

8. An application signed by or on behalf of an applicant for shares in the Company followed by an allotment of any shares therein, shall be an acceptance of shares within the meaning of these Articles, and every person who thus or otherwise accepts any shares and whose name is on the Register, shall for the purpose of these Articles, be a shareholder.

9. Save as herein otherwise provided, the Company shall be entitled to treat the registered holder of any shares as the absolute Owner thereof, accordingly shall not, except as ordered by a Court of Competent jurisdiction, or as by statute required, be bound to recognize any benami, equitable, contingent or partial interest in or any other right in respect of such shares on the part of any other person.

PAID UP CAPITAL & ITS INVESTMENT

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

11. As regards all allotments from time to time made, the Directors shall duly comply with Section 73 of the Ordinance.

12. If the Company shall offer any of its shares to the public for subscription:

    a) No allotment thereof shall be made, unless the amount stated in the prospectus as the minimum amount, which in the opinion of the Board must be raised by the issue of shares capital in order to provide the same, or if any part thereof is to be defrayed in any other manner, the balance of the sum required to be provided In respect of the matter specified in Section 68 of the Ordinance has been subscribed, and the sum has been paid to or received by the Company and the Board shall otherwise comply with the requirements of that Section; but this provision shall no longer apply after the first allotment of shares offered to the public for subscription.

    b) The amount payable on application on each share shall be the full amount of the nominal amount of the shares.

    AND if the Company shall propose to commence business on the footing of a statement in lieu of prospectus, the Board shall not make any allotment of shares payable in cash unless a minimum subscription of Rs.500,000/- of the shares proposed to be issued shall have been subscribed for on a cash footing.

13. The Company may at any time pay a commission to any person for subscribing or agreeing to subscribe (whether absolutely or conditionally) for any shares, debentures or debenture-stock in, the Company or procuring or agreeing to procure subscriptions (whether absolutely or conditionally) for any shares, debentures or debenture-stock in the Company, but so that if the commission in respect of the shares shall be paid or payable out of capital the statutory conditions and requirements shall be observed and complied with, and the amount or rate of commission shall not exceed the rate, if any, fixed under section 82 of the Ordinance. The commission may be paid or satisfied in cash or (subject to the provisions of the Ordinance and these Articles) in shares, debentures or debenture stock of the Company.

14. The Company may at also on issue of shares pay such brokerage as may be lawful.

CERTIFICATES

15. The certificate of title to shares and duplicate thereof shall be issued under the Seal of the Company and signed by two Directors of the Company or by one such Director and an Officer of the Company authorized in this behalf provided such signatures may if necessary be printed, lithographed or stamped subject to approval of Directors.

16. Every member shall be entitled to one certificate for all shares of each class registered in his name, or if the Board so approves to several certificates each for one or more of such shares, but in respect of each additional certificate, the Board shall be entitled to charge a fee of Rs.10/- or such sum as they may determine. Every certificate of shares shall specify the number and denoting numbers of the shares In respect of which it is issued and the amount paid up thereon.

17. If any certificate be worn out or defaced, then upon production thereof to the Board they may order the same to be cancelled and may issue a new certificate in lieu thereof, and if any certificate be lost or destroyed then, upon proof thereof to the satisfaction of the Board and on such indemnity as the Board deem adequate being given, a new certificate in lieu thereof shall be given to the registered holder of the shares to which such lost or destroyed certificate shall relate.

18. For every certificate issued under the last preceding Article there shall be paid to the Company the sum of Rs.10/- or such sums as the Directors may determine.

19. The Certificate of shares registered in the names of two or more persons shall be delivered to the person first named on the Register.

TRANSFER AND TRANSMISSION

20. The Company shall keep a book to be called "the Register of Transfers" and therein shall fairly and distinctly enter the particulars of every transfer or transmission of any share.

21. The instrument of transfer on any share or shares shall be in writing in the usual common form or any such form as may be approved by the Directors and every such instrument of transfer shall be signed by the Transferor and by the Transferee and the Transferor shall be deemed to remain the holder of such shares until the name of Transferee in the Register in respect thereof.

22. The Directors shall not refuse to transfer any fully paid shares or debentures of the Company, unless the transfer deed is for any reason defective or invalid, provided the Company shall within thirty days from the date on which the instrument of transfer was lodged with it, notify the defect or invalidity to the transferee who shall, after the removal of defect thereof be entitled to re-lodge the transfer deed with the Company. Upon such re-lodgement, the Company shall, within thirty days thereof register such transfer in favor of the transferee, is satisfied about removal of such defect or invalidity. Provided that no share shall be sold/transferred by the original founder/subscriber of the company without the unanimous approval/ consent of all the directors for a period of two years from the date of incorporation of the company.

23. Subject. to the provisions of Section 76 of the Companies Ordinance, 1984 no transfer of shares shall be registered unless a proper instrument of transfer duly stamped and executed by the transferor and the transferee has been delivered to the Company together with the certificate or certificates of the shares. The instrument of transfer of any shares shall be signed both by the transferor and transferee, and shall contain the name and address both of the transferor and transferee, and the transferor shall be deemed to remain the holder of such shares until the name of the transferee is entered in the register in respect thereof. Each signature to such transfer shall be duly attested by the signature of one credible witness who shall add his address and occupation.

24. All Instruments of Transfer which shall be registered shall be retained by the Company, but any Instrument of Transfer which the Directors may decline to register shall on demand be returned to the person depositing the same.

25. No transfer shall be made to a minor or a person of unsound mind.

26. Every instrument of transfer shall be left at the office for registration accompanied by the certificate of the shares to be transferred and such other evidence as the Board may require to prove the title of the transferor or his right to transfer the shares, and upon payment of the proper fee the transferee shall, (subject to the Board's right to decline to register as hereinbefore mentioned) be registered as member in respect of such shares. The Board may waive the production of any certificate upon evidence satisfactory to them of its loss or destruction.

27. The Company shall incur no liability or responsibility whatsoever in consequence of their registering or giving effect to any transfer of shares made or purported to be made by an apparent legal owner thereof (as shown or appearing in the Register) to the prejudice of persons having or claiming any equitable right, title or interest or notice prohibiting registration of such transfer and may have entered such notice or referred therein in any book of the company, 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, or interest or be under any liability whatsoever for refusing or neglecting so to do though it may have been entered or referred to in some book of the company. The company shall, nevertheless, be at liberty to have regard and attend to such notice, and give effect thereto, if the Board shall think fit.

28. All instruments of transfer which shall be registered, shall be retained by the Company but any instrument of transfer which the Board may decline to register shall be returned to the person depositing the same. Any instrument of transfer, retained may be destroyed after three years.

29. The transfer books and the register of members may be closed during, such time as the Board thinks fit, not exceeding in the whole forty-five days in each year, and not exceeding thirty days at a time No fee will be charged for transfer of shares.

TRANSMISSION OF SHARES

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

31. 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 o insolvent person before the death or insolvency.

32. A person becoming entitled to a share by reason of 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 registered as a member in respect of the share instead of being registered as a member in respect of the share or, be entitled in respect of it to exercise any rights conferred by membership in relation to meetings of the Company.

33. Any committee or guardian of lunatic or infant member or any person becoming entitled to or to transfer shares in consequence of the death or bankruptcy or insolvency of any member upon producing such evidence that he sustains the character in respect of which he proposed to act under this Article, or of his title as the Board thinks sufficient, may with the consent of the Board (which they shall not be under any obligation to give) be registered as a member in respect of such share or may subject to the regulations as to transfer hereinbefore contained transfer such shares. This article is hereinafter referred to as the transmission clause.

34. All instrument of transmission which shall be registered shall remain in the custody of the Company for such period as the Board may determine but any instrument of transmission which the Board may decline to register or act upon shall be returned to the person depositing the same.

SURRENDER OF SHARES

35. The Board may accept the surrender of any shares subject to the provisions of Sections 95 to 106 of the Ordinance.

INCREASE AND REDUCTION OF CAPITAL

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

37. Subject to any special rights and privileges for the time being attached to any issued shares, the new shares shall be issued upon such terms and conditions and with such rights and privileges annexed thereto as, consistent with the provisions of the Ordinance, the resolution creating the same shall direct, and if no direction be given as the Board shall determine, and in particular, such shares may be issued with a preferential or qualified right to dividends, and in the distribution of the assets of the Company, and with any special right or without any right of voting.

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

39. The Company may by ordinary resolution:

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

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

(c) Cancel any shares and or re-distribute amongst the existing members which, at the date of the passing of the resolution have not been taken or agreed to be taken by any person.

40. The Company may, by special resolution, reduce its share capital in any manner and with, and subject to any incident authorised and consent required by law.

41. if at any time the capital by reason of the issue of preference shares or otherwise, is divided into different classes of shares, all or any of the rights and privileges attached to any such class may be modified, abrogated or dealt with, subject to the provisions of the Ordinance by agreement between the Company and person purporting to contract on behalf of that class, provided such agreement is (a) ratified in writing by the holders of at least three fourths of the issued shares of that class, or (b) confirmed by special resolution passed at a separate general meeting of the holders of shares of that class, and all the provisions hereinafter contained as to general meetings shall apply to every such meeting, except that the quorum thereof shall be members holding or representing by proxy one-fifth of the nominal amount of the issued shares of that class.

VARIATION OF SHAREHOLDERS RIGHTS

42. The rights and privileges attached to each class of shares, may be modified, commuted, affected or abrogated in the manner provided in Section 108 of the Ordinance.

BORROWING POWERS

43. The Board may from time to time borrow any moneys for the purposes of the Company from the members or from any other person, firms companies, corporations, institutions, or banks, or the Directors, members themselves be called upon by the Board to lend any money to the Company or to make capital contribution.

44. The Board may secure the payment or re-payment of any sum or sums in such manner and upon such terms and conditions in all respects as they think fit, and in particular by the creation of any mortgage or charge on the undertaking or the whole or any part of the property of the Company (both present or future) including its uncalled capital or by the issue of bonds, perpetual or redeemable, debentures or debenture-stock of the Company, charged upon all or any part of the property of the Company (both present or future) including its uncalled capital for the time being.

45. Debentures, debenture-stock, bonds and other securities may be made assignable free from any equities between the Company and the person to whom the same may be issued.

46. Any debentures, debenture-stock, bonds, or other securities may be issued at a discount, premium or otherwise and with any special privileges as to redemption, surrender, drawings or allotment of shares.

47. The Board shall cause a proper book to be kept in accordance with Section 125 of the Ordinance, of all mortgages, and charges specifically affecting the property of the Company, and shall duly comply with the requirements of Sections 121 and 122 of the Ordinance, in regard to the registration of mortgages and charges, therein specified and otherwise and shall to keeping of copy of every instrument creating any mortgage or charge by the Company at the office, and the requirement of Section 132 of the Ordinance, as to giving intimation of the payment or satisfaction of any charge or mortgage created by the Company.

48. Every register of holders of debentures of the Company may be closed for any period not exceeding thirty days in any year. Subject as aforesaid, every such register shall be open to the inspection of the registered holders of any such debentures and of any members, but the Company may in general meeting impose any reasonable restrictions so that at least two hours in each day, when such register is open, are appointed for inspection.

49. Subject to the provisions of Section 76(1) of the Ordinance, no transfer of registered debentures shall be registered unless a proper instrument of transfer duly stamped and executed by the transferor and the transferee has been delivered to the Company together with the certificate of the debentures.

50. If the Board refuses to register the transfer of any debenture, the Chief Executive / Managing Director shall, within two months from the date on which the instrument of transfer was lodged with the Company, send to the transferee and the transferor notice of the refusal.

51. The Company shall comply with the provisions of Section 136 of the Ordinance as to allowing inspection of copies kept at the office in pursuance of Section 130 of the Ordinance, and as to allowing inspection of the register of mortgages to be kept at the office in pursuance of Section 150 of the Ordinance.

52. The Company shall comply with the provisions of Section 150 of the Ordinance as to supplying copies of any register of holders of debentures or of any trust deed for securing any Issue of debentures.

53. Holders of preference shares and debentures shall have the same right to receive and inspect the balance sheets and profit and loss accounts of the Company and the reports of the Auditors and Directors' reports as is possessed by the holders of ordinary shares in the Company

54. If any uncalled capital of the Company be included in or charged by any mortgage or other security, the Board may, by instrument under the Company's seal, authorise the person in whose favor such mortgage or security is executed, or any other person in trust for him, to make calls on the members in respect of such uncalled capital, and the provisions hereinbefore contained in regard to the calls shall, mutatis mutandis apply to calls made under such authority, and such authority may be made exercisable either conditionally or unconditionally and either presently or contingently and either to the exclusion of the Directors powers or otherwise, and shall be assignable if expressed so to do.

RESERVE AND DEPRECIATION FUNDS

55. The Board may, from time to time before recommending any dividend set apart any and such portion of the profits of the Company as it think fit as a Reserve or depreciation fund to meet contingencies or for the liquidation of any debentures, debts, or liabilities of the Company, for equalization of dividends, or for repairing, improving, rebuilding restoring, replacing, altering or maintaining any of the property of the Company as the Board in its absolute discretion thinks conducive to the interest of the Company and may invest the several sums so set aside upon (other than shares of this Company) as they may think fit, and from time to time deal with and vary such investment and dispose of any part thereof for the benefit of the Company and may divide the reserve fund into such special funds as it thinks fit, with full power to employ the Reserve funds or any part thereof in the business of the Company, and that without being bound to keep the same separate from the other assets.

56. All moneys carried to the Reserve fund and the Depreciation fund respectively shall nevertheless remain and be profit of the Company, applicable subject to due provision being made for actual loss or depreciations, for the payment of dividend, and such money and all other moneys of the Company not immediately required for the purposes of the Company may be invested by, the Board in or upon such investments or securities as it may select or may be used as working capital or may be kept at any bank on deposit or otherwise as the Board may from time to time think proper.

GENERAL MEETING

57. The Statutory Meeting of the Company shall be held within the period required by Section 157.

58. 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 more than fifteen months after the holding of its last preceding annual general meeting as may be determined by the Directors.

59. All general meetings of the Company, other than an annual general meeting mentioned In Section 158 and the statutory meeting mentioned in Section, 157, shall be called Extraordinary General Meetings.

60. The Board may, whenever they think fit, call an extraordinary general meeting and extraordinary general meeting shall also be called on such requisition or in default, may be called by such requisition, as is provided by Section 159. If at any time there are not within Pakistan sufficient Directors capable of acting to form a quorum, any Director of the Company may call an extraordinary general meeting in the same manner as nearly as possible as that in which the meeting may be called by the Board.

NOTICE AND PROCEEDINGS OF GENERAL MEETING

61. Twenty one day's notice at least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given specifying the place, the day and the hour of meeting and, in case of special business, the general nature of that business, shall be given in the manner provided by the Ordinance, for the general meeting, to such persons as are, under the Ordinance, or regulations of the Company, entitled to receive such notice from the Company, but the accidental omission to give notice to, or the non- receipt of notice by any member shall not invalidate the proceedings at any general meeting.

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

63. No business shall be transacted at any general meeting unless a quorum of members is present at that time when the meeting proceeds to business; save as herein otherwise provided, not less than three members having fifty-one percent of the total voting power present in person or through proxy; shall be a quorum.

64. If within half an hour from the time appointed for the meeting there is no quorum, the meeting, if called upon the requisition of members, shall be dissolved; in any other case, it shall stand adjourned to the same day in the next week at the same time and place, and, if at the adjourned meeting a quorum is not present within half an hour, from the time appointed for the meeting, the members present, being not less than two, having not less than fifty-one percent of the total voting power shall be a quorum.

65. The Chairman of the Board, if any, shall preside as Chairman at every general meeting of the Company, but if there is no such Chairman, or at any meeting he is not present within fifteen minutes after the time appointed for the meeting, or is unwilling to act as Chairman, any one of the Directors present may be elected to be Chairman and if none the Directors, is present, or willing to act as Chairman, the members present shall choose one of their members to be Chairman.

66. The Chairman may, with the consent of any meeting at which a quorum is present (and shall if so directed by the meeting), adjourn the meeting from time to time but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place; When a meeting is adjourned for ten days or more, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid, it shall not be necessary to give any notice of an adjournment or of the business to be transacted at an adjourned meeting.

67. At any general meeting a resolution put to the vote of the meeting shall be decided on a show of hands unless a poll is (before or on the declaration of the result of the show of hands) is demanded. Unless a poll is so demanded, a declaration by the Chairman, that resolution has, been carried, or carried unanimously or by a particular majority on a show of hands, 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 proof of the number or proportion of the votes recorded in favor of, or against, that resolution.

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

69. If a poll is duly demanded, it shall be taken in accordance with the manner laid down in Section 168 and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded.

70. A poll demanded on the election of Chairman or on a question of adjournment shall be taken at once.

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

VOTES OF MEMBERS

72. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands, every member present in person shall have one vote. However, in case of election of Directors the provisions of Section 178 shall apply. On a poll every member shall have voting rights as laid down in Section 160.

73. 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 of members.

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

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

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

77. The instrument appointing proxy and the power of attorney or other authority shall be deposited at the registered office of the company not less than forty eight hours before the time for holding the meeting and which the person named in the instrument proposed to vote and in default the instrument of proxy shall not be treated as valid.

78. The instrument appointing a proxy and may be in the following form, or form as near thereto as may be;

SIACHEN ENERGY LIMITED

I, ... of .... in the district, being a member of the Siachen Energy Limited hereby appoint .... as my proxy to vote for me and on my 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.

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

DIRECTORS

80. The number of Directors shall not be less than three and more than fifteen.

81. The following shall be the, first Directors of the Company.

    1 MR. MUHAMMED SOHAIL SHAMSI

    2 MRS. UROSA SOHAIL SHAMSI

    3 MRS. ALYZA PURI

82. The qualification of a Director shall be the holding in his own name, whether beneficially or as a trustee for any Company or person or otherwise, of ordinary shares in the Company to the nominal value of Rs.10/- provided that a Director representing interest holding shares of the requisite value shall require no qualification.

83. A Director, who is required to hold a qualification may act as a Director before acquiring his qualification but shall in any case acquire the same within two months from his appointment.

84. A Director may retire from his office upon giving one month's notice in writing to the Company of his intention to do so and such resignation shall take effect upon the expiration of such notice or its earlier acceptance.

85. Unless otherwise determined by the Company in general meeting, the remuneration of each Director shall be Rs.500/- for each meeting he attends plus the actual traveling expenses incurred by him. Provide that any change in the fee of a Director shall be subject to the prior approval of the Controller of Capital Issues.

86. A Director may continue to act notwithstanding any vacancy in the corporate body that he represents but only if the vacancy does not deplete the voting strength of the respective corporate body.

87. Every Director of the Company shall be entitled to carry on and continue to carry on his personal business as at the date of incorporation of this Company or which may be undertaken by him hereafter in connection with this aforesaid business or any of them and shall not in any way be liable to account to the Company for any benefits or profits or gains recovered or receivable by him in respect of any such business.

88. A Director of this Company may become a Director of any other company, whether promoted by this Company or not, or in which he may be interested as vendor, shareholder or otherwise.

89. The Company at the meeting at which the Directors retire in the manner aforesaid, may fill the vacated offices by electing thereto the member who qualify to be the Directors and offer themselves as candidates failing this, retiring Directors shall, if they offer themselves for re-election, be deemed to have been re-elected

90. The remuneration of the Director for performing extra services, including the holding of the office of Chairman, shall be determined by the Directors of the Company in general meeting.

91. The Company at the general meeting at which a Director retires in the manner aforesaid may fill up the vacated office by electing a person thereto.

92. A Company may by resolution in general meeting remove a Director appointed under Section 176 or Section 180 or elected in the manner provided for in Section 178.

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

a) 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 sub-section (5) of Section 178: or

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

94. The Company shall keep at its registered office a register of its Directors and officers, including the Chief Executive, Managing Agents, Secretary, Chief Accountant, Auditors and Legal Advisors containing with respect of each of them particulars as required by Section 205 (1-a) and (b).

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

96. A Director who may be prevented from attending Board meetings for not less than three months may, with the approval of the Directors, appoint any person to be an Alternate Director during such absence, and such appointment shall have effect and such appointee, whilst he holds office as an Alternate Director, shall be entitled to notice of meetings of Directors and to attend and vote there at accordingly, but he shall not require any qualification and shall ipso facto vacate office if and when the appointer returns to the district in which meetings of the Directors are ordinarily held or vacates office as a Director or removes the appointee from office and any appointment and removal under this Article shall be effected by notice in writing under the hand of the Director making the same.

97. An Alternate Director shall, in the absence of a direction to the contrary in the instrument appointing him, be entitled to receive notice of and to vote at general meetings of the Company on behalf of his appointer and generally to represent his appointer in the same manner as if he had been appointed as a General Proxy under the provisions of these Articles. Director's remuneration shall continue to be paid to the appointer during his absence and not to the Alternate Director.

PROCEEDINGS OF DIRECTORS

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

99. Every Board should be chaired by the Chairman of the Company nominated by the company in its first board meeting. If at any meeting the Chairman is not present within fifteen minutes after the time appointed for holding the same or is unwilling to act as Chairman, the Directors present may choose one of their members to be Chairman of the meeting.

100. The Board may delegate any of their powers not required to be exercised in their meeting to committees consisting of such member or member of their body as they think fit; any committee so formed shall, in exercise Of the powers so delegated, conform to any restrictions that may be imposed on them by the Board.

101. A meeting of the Directors for the time being at which a quorum be present shall be competent to exercise all or any of the authorities powers and discretions by or under the articles of the Company for the time being vested in or exercisable by the Directors generally. Four Directors personally present or one third of the total number of directors whichever is greater, shall form the quorum.

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

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

104. The meeting and proceedings of any such committee consisting of two or more members shall be governed by the provisions herein contained for regulating the meeting and proceedings of the Directors so far as the same are applicable thereto, and are not superseded by any regulations made by the Directors under the last preceding Article.

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

106. A resolution in writing signed by all the Directors for the time being entitled to receive notice of a meeting of the Directors shall be as valid and effectual as if it had been passed at a meeting of the directors duly convened and held.

FILLING OF VACANCIES

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

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

109. The Directors shall comply with the provisions of Sections 174 to 178 and Sections 180 and 184 relating to the election of Directors and matters ancillary thereto.

110. Subject to the provisions of the Ordinance, the Company may from time to time in annual general meeting increase or decrease the number of Directors.

111. Any casual vacancy occurring on the Board may be filled up by the Directors, but the person so chosen shall be subject to retirement at the same time as, if he had become a Director on the day on which the Director in whose place he is chosen was last elected as Director.

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

GENERAL POWER OF COMPANY VESTED IN DIRECTORS

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

114. The Board shall not, except with the consent of the general meeting either specifically or by way of an authorisation, do any of the following things, namely:

(a) sell, lease or otherwise dispose of the undertaking or a sizable part thereof, unless the main business of the Company comprises, of such selling or leasing; and

(b) remit, give any relief or give extension of time for the repayment of any debt outstanding against any person specified in sub-section (1) of Section 195.

115. The Board shall appoint a Chief Executive in accordance with the provisions of Sections 198 and 199 of the Ordinance.

116. The amount for the time being remaining undischarged of moneys borrowed or raised by the Board for the purposes of the Company (otherwise than by the issue of share capital) shall not at any time, without the sanction of the Company in general meeting, exceed the issued share capital of the Company.

117. The Board shall duly comply with the provisions of the Ordinance or any statutory modification thereof for the time being in force, and in particular, with the provisions in regard to the registration of the particulars of mortgages and charges affecting the property of the Company or created by it, to the keeping of a register of 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.

118. The Board shall cause minutes to be made in books provided for the purpose: -

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

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

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

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

CHIEF EXECUTIVE

119. The Board as from a date not later than the fifteenth day after the date of its incorporation, appoint any individual with the requisite professional qualification to be the Chief Executive of the Company.

120. The Chief Executive appointed as aforesaid shall, unless he earlier resigns or otherwise ceases to hold office, hold office upto the first annual general meeting of the Company or, if a shorter period is fixed by the Board at the time of his appointment, for such period .

121. Within fourteen days from the date of the election of Directors under Section 178 or the office of the Chief Executive falling vacant, as the case may be, the Board shall appoint any person, including an elected Director, to be the Chief Executive, but such appointment shall not be for a period exceeding three years from the date of appointment.

122. On the expiry of his term of office under sub-section (1) of Section 198 a Chief Executive shall be eligible for re-appointment.

123. The Chief Executive retiring under Section 198 shall continue to perform his functions until his successor is appointed unless non-appointment of his successor is due to any fault on his part or his office is expressly terminated.

124. The terms and conditions of appointment of a Chief Executive shall be determined by the Board.

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

126. No person who is ineligible to become a Director of under Section 187 shall be appointed or continue as the Chief Executive of any Company.

127. The board by a resolution passed by not then two-third of the total number of Directors for the time being, or the Company by a special resolution, may remove a Chief Executive before the expiration of his term of office, notwithstanding any thing contained in the articles or in any agreement between the Company and such Chief Executive.

LOCAL MANAGEMENT

128. The following provisions shall have effect: -

(a) The Board may from time to time provide for management of the affairs of the Company outside Pakistan or in any special locality in Pakistan in such manner as they shall think fit and the provisions contained in the four next following paragraphs shall be without prejudice to the general powers conferred by this paragraph.

(b) The Board, from time to time and at any time, may establish any local board or agencies for managing any of the affairs of the Company outside Pakistan or in any specified locality in Pakistan and may appoint any persons to be agents and fix their remuneration.

(c) The Board, from time to time and at any time, may (subject to the provisions of the Ordinance) delegate to any person so appointed any of the powers, authorities and discretions for the time being vested in the Board other than the powers of borrowing, making, calls and issuing debentures, and may authorise the members for the time being of any such Local board or any of them to fill up any vacancies therein and to act notwithstanding vacancies and any such appointment or delegation may be made on such terms and subject to such conditions as the Board may think fit, and the Board may at any time remove any person so appointed and may annul or vary any such delegation.

(d) The Board may at any time, and from time to time by Power of Attorney under the Company's seal, appoint any person or persons to be the attorneys of the Company for such purposes and with such powers, authorities and discretions (not exceeding those vested in or exercisable by the Board under these presents) and for such period and subject to such conditions as the Board may from time time to time think fit, and any such appointment may, if the Board thinks, be made in favor, of the members of any local board, established as aforesaid or in favor of any Company or of the directors, nominees, or managers of any Company or firm, or in favor of any fluctuating body of persons whether nominated directly or indirectly by the Board, and any such Power of Attorney may contain such provisions for the protection or convenience of persons dealing with such Attorney or Attorneys as the Board may think fit.

(e) Any such delegates or attorneys as aforesaid may, be authorised by the Board to sub-delegate all or any of the powers, authorities and discretions for the time being vested in them.

GENERAL MANAGER

129. The Board may from time to time appoint any person other than Director to be the General Manager of the Company either for a fixed term or without any limitation as to the period for which he is to hold office and may from time, to time remove or dismiss him from office an appoint another in his place.

130. The remuneration of the General Manager shall be fixed by the Board

131. The General Manager shall have such powers, authorities and discretion as shall be conferred upon him by the Board.

SECRETARY

132. The Board may from time to time appoint any person other than Director to be a Secretary on such terms and conditions as they may deem fit. The Secretary so appointed can be removed by the board. The remuneration of the Secretary shall be fixed by the Board.

DISQUALIFICATION OF DIRECTORS

133. No person shall become the Director of a Company if he suffers from any of the disabilities or disqualifications laid down in Article 135 of the Articles of Association and, if already a Director, shall cease to hold such office from the date he so become disqualified or disabled.

134. No person shall be appointed as a Director of a Company if he: -

(a) is a minor ;

(b) is of unsound mind;

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

(d) is an undischarged insolvent;

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

(f) has been debarred from holding such office under any provision of the Ordinance.

(g) has betrayed lack of fiduciary behaviour and a declaration to this effect has been made by the Court under Section 217 at anytime during the preceding five years.

(h) is not a member :-

Provided that clause (h) shall not apply in the case of:-

i) a person representing the Government or an institution or authority or a corporate body 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 or a lender.

135. The office of a Director shall be vacated if: -

a) he becomes ineligible to be appointed a director on anyone or more of the grounds enumerated in clause (a) to (h) of Articles 135;

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

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 a general meeting, accepts or holds any office of profit under the Company; other than that of Chief Executive or a legal or technical! advisor or a banker; or

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

136. No Director shall vacate his office by reason only of his being a member of any other Company which has entered into contracts with, or done any work for the Company of which he is Director, but such Director shall not vote in respect of any such contract or work, and if he does so vote, his vote shall not be counted.

THE SEAL

137. The Directors shall provide for the safe custody of the seal and the seal shall not be affixed to any instrument except by the authority of a resolution of the Board or by a committee of Directors authorised in that behalf by the Board and in the presence of at least two Directors and the Secretary or such other person as the Board may appoint for the purpose; and those two Directors and Secretary or other person as aforesaid shall sign every instrument to which the seal of the Company is so affixed in their presence.

DIVIDENDS AND RESERVE

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

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

140. No dividends shall be paid otherwise than out of profits of the year or any other undistributed profits and dividends shall not carry interest as against the Company.

141. Subject to the rights of persons (if any) entitled to shares with special rights as to dividends, all dividends shall be declared and paid according tothe amounts paid on the shares, but if and so long as nothing is paid upon any of the shares in the Company, dividends may be declared and paid according to the amounts of the shares. No amount paid on a share in advance of calls shall be treated for the purposes of this regulation as paid on the share.

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

143. Any general meeting declaring a dividend may specifically resolve that such dividend be paid wholly or in part by the distribution of specific assets, and in particular paid up shares, debentures or debenture-stock either of the Company or of any other Company or in anyone or more such ways.

144. Any general meeting may resolve that any moneys, investments or other assets forming part of the undivided profits of the Company standing to the credit of the Reserve fund or Depreciation fund or in the hands of the Company and available for dividend or representing premium received on the issue of shares and standing to the credit of the share premium account, be capitalised and 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 and that all or any part of such capitalised funds be applied on behalf of such shareholders in paying up in full either at par or such premium as the resolutions may provide, any unissued shares, debentures or debenture-stock of the Company which shall be distributed accordingly or in or towards payment of the uncalled liability on any issued shares or debentures or debentures-stock and that such distribution or payment shall be accepted by such shareholders in full satisfaction of their interest in the said capitalised sum.

145. For the purpose of giving effect to any resolution under the two last preceding Articles, the Board may settle any difficulty which may arise in regard to the distribution as they think expedient; and in particular, may issue fractional certificates and may fix the value of distribution of any specific assets and may determine that cash payment shall be made to any member upon the footing of the value so fixed in order to adjust the rights of all parties and may vest any such cash or specific assets in trustees upon such trusts for the persons entitled to the dividend or capitalised funds as may seem expedient to the Board. Where requisite a proper contract shall be filed in accordance with the Ordinance, and the Board may appoint any person to sign such contract on behalf of the persons entitled to the dividend or capitalised fund and such appointment shall be effective.

146. A transfer of shares shall not pass the right to any dividend declared thereon before the registration of the transfer.

147. The Board may retain the dividends payable upon shares in respect of which any person is, under the 'Transmission Clause' entitled to become a member or which any person under that clause is entitled to transfer, until such persons shall become a member in respect thereof or shall duly transfer the same.

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

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

150. Unless otherwise directed, 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 the registered address of that one whose name stands first on the Register in respect of the joint-holding or to such person and such address as the member or person entitled or such joint-holders, as the case may be, may direct and every cheque or warrant so sent shall be made payable to the order of such other person entitled or such joint-holder, as the case may be, may direct. Several executors or administrators of a deceased member in whose sole name any shares shall stand shall, for the purposes of this clause, be deemed to be join-holders thereof.

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

152. The dividends shall be paid within the period laid down in the Ordinance.

153. All dividends unclaimed for one year after having been declared may be invested or otherwise made use of by the Board for the benefit of the Company until claimed.

ACCOUNTS

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

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

156. The Board shall from time to time determine whether and to what extend 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 the inspection of members not being Directors, and no member (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 Company in general meeting.

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

158. Balance sheets, profit and loss accounts and other reports referred to in the above articles shall be made out in every year and laid before the Company in the annual general meeting, made up to a date not more than six months before such meeting. The balance sheets and profit and loss accounts or income and expenditure accounts shall be accompanied by a report of the Directors.

159. Every such Balance sheet shall be accompanied by a report of the Directors as to the state and condition of the Company and as to the amount (if any) which they propose to carry to the reserve fund and the depreciation fund. The profit and loss accounts, the balance sheets and the Directors' reports shall be signed by two Directors.

160. A copy of the balance sheet and profit & loss account and report of the Directors and Auditors shall, at least twenty one days preceding the meeting, be sent to the persons entitled to receive notices of general meetings in the manner in which notices are to be given.

161. After the balance sheet and profit & loss accounts have been laid before the Company at the general meeting, five copies thereof signed by the Chief Executive and a Director of the Company, shall be filed with the Registrar, at the same time as the copy of the annual list of members and summary is prepared, in accordance with the requirements of Section 242 of the Ordinance.

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

AUDIT

163. Auditors shall be appointed and their duties regulated in accordance with Sections 252 to 255 of the Ordinance.

NOTICES

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

165. 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.

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

167. A notice may be given by the Company to the joint holder named first in the register in respect of the share.

168. A notice may be given by the Company to the person entitled to a share in consequence of the death or insolvency of a member by sending it through the post in a prepaid letter addressed to them by name, or by the title of representatives of the deceased, or assignee of the insolvent or by any like description at the address (if any) in Pakistan, supplied for the purposes by the person 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.

169. 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 Pakistan for the giving of notice to them, and also to

(b) every person entitled to a share in consequence of the death or insolvency of a member who, but for his death or insolvency, would be entitled to receive notice of the meeting and

(c) to the auditors of the Company for the time being.

170. Any notice required to be given by the Company to the members or any of them, and not expressly forbidden by these presents, shall be sufficiently given if given by advertisement.

171. Any notice required to be or which may be given by advertisement shall be advertised once in one English and one Urdu daily newspaper in Pakistan.

172. Any notice given by advertisement shall be deemed to have been given on the day on which the advertisement shall first appear.

173. Every person who, by operation of law, transfer or other means whatsoever, shall become entitled to any share shall by every notice in respect of such share which previous to his name and address being entered on the Register shall be duly given to the person from whom he derives his title to such share.

174. Any notice or document delivered or sent by post to, or left at the registered address of any member in pursuance of, these presents shall, notwithstanding that such member be then deceased and whether or not the Company has notice of his demise be deemed to have been duly served in respect of any registered shares, whether held solely or jointly with other persons by such members, until some other person be registered in his stead as the holder or joint-holder thereof, and such services shall for all purposes of these presents, be deemed a sufficient , service of such notice or document on his or her heirs, executors or administrators and all persons, if any, jointly interested with him in any such share.

175. The signature to any notice to be given by the Company may be written or printed.

WINDING UP

176. If the Company is wound up, the Liquidator may, with the sanction of a special resolution of the Company and any other sanction required by the Ordinance, subject to the claim of lenders, if any, divide amongst the members, in specie or in kind, the whole or any part of the assets of the Company, whether they consist of property of the same kind or not.

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

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

INDEMNITY

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

Certified to be True Copy
Joint Registrar of Companies
17/3/16

We the undersigned several person, whose names, addresses and description are subscribed aredesirous of being formed into a Company, in pursuance of these Articles of Association and we respectively agree to take the number of shares in the Capital of the Company set opposite toour respective names:-

Name& Surname (Present & former) in full (In Block Letters	**Father's / Husband's Name in full**	**Nationality with any other Former Nationality**	**Occupation**	**Residential Address in full**	**Number of shares taken by each Subscriber**	**Signature**
MUHAMMAD SOHAIL SHAMSI	ABDUL SAMAD SHAMSI	Pakistani	Business	74, J Street Off. Khayaban-e-Muhafiz,Phase VI, DHA, Karachi	95,000 (Ninety Five Thousand)	
MRS. UROSA SOHAIL SHAMSI	MUHAMMAD SOHAIL SHAMSI	Pakistani	Business	74, J Street Off. Khayaban-e-Muhafiz,Phase VI, DHA, Karachi	4,000 (Four Thousand)	
MRS. ALYZA PURI	MOHAMMAD IQBAL PURI	Pakistani	Lawyer	23, M Street, Phase VI, DHA Karachi	1,000 (One Thousand)	
				Total	***100,000 (One Hundred Thousand)***	

Witness to the above : **NIFT (Pvt) Limited**

Full Address : **5th Floor, AWT Plaza, I.I. Chundrigar Road, Karachi 74200, Pakistan.**

THIRD SCHEDULE
(Se section 156)

FORM A - ANNUAL RETURN OF COMPANY HAVING SHARE CAPITAL

1. Registration No.	0093721
2. Name of the Company	SIACHEN ENERGY LIMITED
3. Form A made upto (Day/Month/Year)	30/10/2015
4 Date of AGM (Day/Month/Year)	30/10/2015

PART - A

5 Registered Office Address	74, J Street, Off Khayaban-a-Muhafiz Phase VI, DHA, KARACHI Sindh 75500
6. Email Address	info@sel.com.pk
7. Office Tel. No.	021-35156172
8. Office Fax No.	021-35156174
9. Nature of Business	-POWER GENERATION - ALLIED (OTHER)

10. Authorized Share Capital

Type of Shares	No. of Shares	Amount	Face Value
Ordinary Shares		50,000,000.00	

11. Paid up Share Capital

Type of Shares	No. of Shares	Amount	Issue Price
Ordinary Shares		1,500,000.00	

12. Amount of indebtedness on the date upto which form A is made in respect of all Mortgages/Charges: 0.00

13. Particulars of the holding company

Name			
Registration No.		% Shares Held	

14. Chief Executive

Name	Mohammad Sohail Shamsi	NIC	4230170529573
Address	74, J Street, Off Khayaban e Muhaffiz, Phase VI DHA Karachi		

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19/1/16

IQBAL, Stamp Vendor
16 NOV 2015

IQBAL, Stamp Vendor
16

15. Chief Accountant

Name	Zeeshan Mirza	NIC	4220181762039
Address	A-29, Naseerabad, Shah Faisal Colony, Karachi		

16. Secretary

Name	Zeeshan Mirza	NIC	42201-8176203-9
Address	A-49, Naseerabad, Shah Faisal Colony, Karachi		

17. Legal Advisor

Name	Mansoor Ali Ghanghro
Address	D-21, Block 4, Off Abdullah Shah Ghazi Road, Clifton, Karachi

18. Auditors

Name	A. F. Ferguson and Co.
Address	State Life Building No. 1-C, Off II Chundrigar Road, Karachi

19. List of Directors on the date of Form-A

Name of Director	Address	Nationality	NIC (Passport No. if Foreigner)
Uroosa Shamsi	74, J Street, Off Khayaban e Muhaffiz,	Pakistan	4230181289488
Alyza Puri	23, M Street, Phase IV, DHA Karachi	Pakistan	4230130966048
Mohammad Sohail Shamsi	74, J Street, Off Khayaban e Muhaffiz,	Pakistan	4230170529573
Muhammad Kashif Shamsi	B-7, Circular Street, Phase II, DHA, Ka	Pakistan	4230124989821

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19. List of Directors on the date of Form-A

Name of Director	Address	Nationality	NIC (Passport No. if Foreigner)

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21. Transfer of shares (debentures) since last Form A was made

No.	Name of Transferor (Members)	Name of Transferee	Number of Shares Transferred	Date of Registration of
1	Mohammad Sohail Shamsi	Muhammad Kashif Shamsi	500	05/10/2015
2	Alyza Puri	Muhammad Sohail Shamsi	500	05/10/2015
3	Uroosa Shamsi	Muhammad Sohail Shamsi	2000	05/10/2015

22. I certify that this return and the accompanying statements state the facts correctly and completely as on the date upto which this Form-A is made

Date (DD/MM/YYYY) 12/01/2016

Signature Muhammad Sohail Shamsi

Designation

☑ Chief Executive

☐ Secretary

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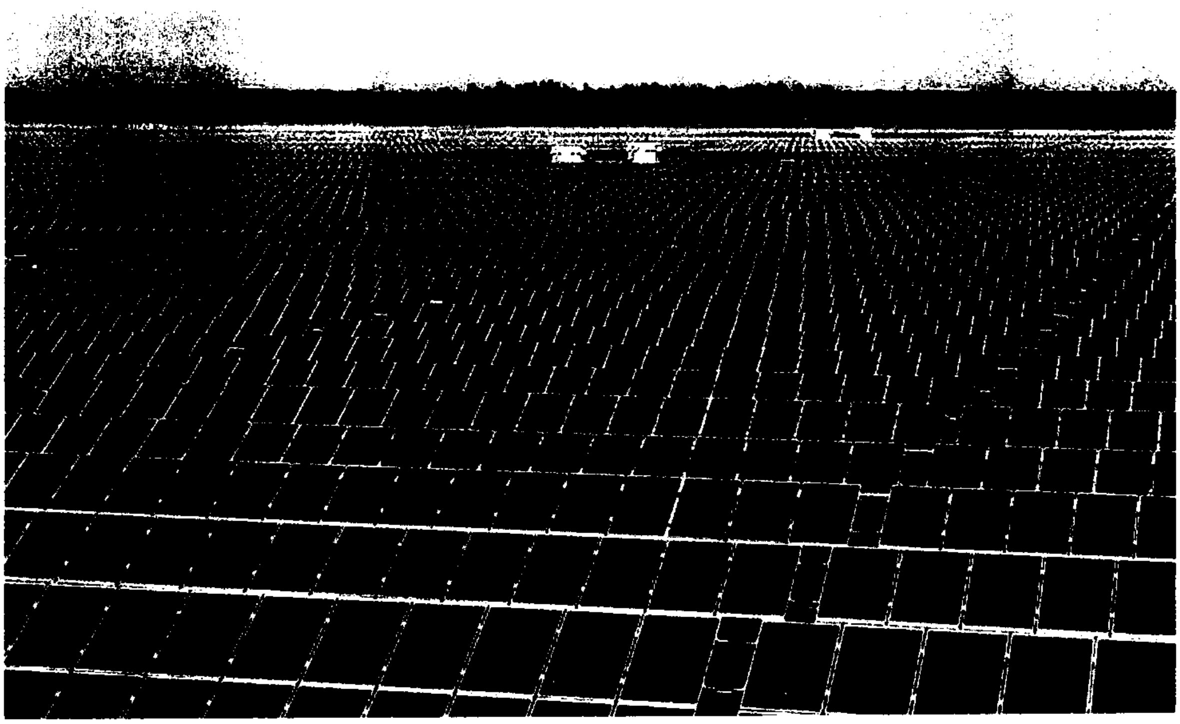
Siach Enterprises Limited

Prospectus

Siachen Energy Limited

100 MWp Solar PV Power Plant

Mirpur Sakro, District Thatta, Sindh



June 2016

The Company

Siachen Energy Limited ("the Company") has been incorporated as an unquoted public limited company, under the Companies Ordinance, 1984, with the main objective of carrying on the business of generating and dealing in electricity. Mr. Muhammed Sohail Shamsi ("Mr. Shamsi") is the Chief Executive Officer and major shareholder of the Company since incorporation. The Company envisages to set up 200 MWp solar photovoltaic power generation plants. In the first phase, the Company plans to set up a 100 MWp solar photovoltaic power generation plant ("the Project") for which a generation license application in being filed with National Electric Power Regulatory Authority ("NEPRA").

The Project

Pursuant to proposal of the Company dated March 15, 2015, the Company has been awarded LOI No. DAE/Solar/81/2015 dated August 28, 2015 by the Directorate of Alternative Energy, Energy Department, Government of Sindh, for setting up the Project. Copy of the same is being enclosed for reference. The Project is presently at an advanced stage of development prior to financial close.

The Project Sponsors

The Project is being developed by an experienced businessman Mr. Muhammed Sohail Shamsi ("Mr. Shamsi") who is also the Chairman and Chief Executive Officer of Indus Refinery Limited. Mr. Shamsi, holds a Bachelor's degree in Business Administration from the University of Texas, Arlington, USA. He brings with him over 35 years of management and consulting experience. He is ably supported by a team of experienced professionals and consultants.

Mr. Shamsi possesses deep understanding and knowledge of the power sector. His latest venture in the power sector has been the development of a captive power plant (thermal) of about 28 MW installed capacity for Indus Refinery Limited. Mr. Shamsi is ably supported by an experienced team of professionals and advisers to the Company. Advisors of the Company include Going Green (Pvt.) Ltd., Sinew Associates (Pvt.) Ltd. (financial advisors), OST Energy Pty Ltd. and Integrators (Pvt.) Ltd. (technical advisors) and Mr. Mansoor Ali Ghanghro (Legal Advisor).

The Project Site

The Project will be located at Ghulam Ullah Road, Taluka Mirpur Sakro, District Thatta, Sindh. The proposed site is situated at a distance of about 75 KMs from Karachi and about 9 KMs from Mirpur Sakro the nearest town. The Project site is easily accessible from Mirpur Sakro Ghulam Ullah Road and Mirpur Sakro Abdullah Kundan Goth Road, both of which are passing right along the border of the proposed site.

The Project is expected to occupy approximately 760.12 acres of land, which is at present owned by the sponsors. The land will be sold / leased for 25 years to the Company under a 25 year agreement, by the land owners at the prevailing market rates.

Siachen En

The coordinates of land identified for the Project are as follows:

Land Coordinates: 24°34'29.7" N 67°42'33.6" E

Interconnection Study

An interconnection study for the project has been completed by Power Planners International and submitted to CPPA vide letter no. SEL/GM/PPI/2015-0048 dated December 22, 2015. The interconnection study proposes a 132 kV double circuit of 18 km from the Company to Gharo-New 132kV grid station to evacuate the power from the Company to National Grid. The interconnection study includes all the necessary information required for considering the feasibility of interconnection with the main grid and includes load flow analysis, short circuit analysis, dynamic and transient stability analysis. The study has concluded that there are no technical constraints whatsoever in the way of bringing in the power from the Company at the proposed site and scheduled time of commissioning, in any respect of steady state (load flow) or short circuit or dynamic performance (stability) or power quality issues related to this plant.

Applicable Policy Framework

The Project has been awarded LOI by the Directorate of Alternative Energy, Energy Department, Government of Sindh and the Project is being set up pursuant to the Policy for Development of Renewable Energy for Power Generation 2006.

Under the said policy, AEDB is offering Federal Government Guarantee to projects initiated under provincial LOIs, provided they obtain a tripartite LOS (AEDB, Provincial Govt. and IPP). Required amendment in the Policy for Development of Renewable Energy for Power Generation 2006 has been approved by the ECC on May 21, 2015. Standard templates of tripartite LOS, PG, Facilitation Agreement and Coordination Agreement have also been approved by the ECC.

The Company intends to obtain a tripartite LOS according to the amendment in the Policy for Development of Renewable Energy for Power Generation 2006 as detailed above and to get its tariff approved by NEPRA.

Power Purchaser

The Company intends to sell all energy generated from the Project to the Central Power Purchasing Agency under a 25 year Energy Purchase Agreement pursuant to NEPRA (sale of electric power by Renewable Energy Companies) Guidelines, 2015.

Tariff

The Company will charge such tariff as is approved by NEPRA on an application / petition filed by the Company.

Energy Purchase Agreement

A standardized EPA for solar PV projects has been prepared by AEDB and approved by the Government of Pakistan. The EPA will be executed between the Company and the power purchaser for sale and purchase of power, generation and dispatch methodology, operating procedures and practices, and commercial terms including billing and payments. The EPA shall become effective in its entirety upon the date of financial close and delivery of a standby letter of credit by the Company backstopping its obligation to achieve Commercial Operation Date ("COD") on or before a stipulated time. The term of the EPA shall extend until the 25th anniversary of the COD.

The 25 year tariff to be approved by NEPRA shall form the basis of the EPA and allow the necessary revenue predictability and consistency that is the key to any investment. The compensation will be based on energy payments divided into O&M, insurance, return on equity and the debt (principal and mark-up) components.

Implementation Agreement

As in the case with the EPA, a standardized Implementation Agreement ("IA") for solar PV projects has been approved. The IA will be negotiated and signed between the Company and the Government of Pakistan. The term of the IA shall commence from the execution of the EPA and continue for the rest of its term. The IA defines the Government of Pakistan's ("the GOP") obligations with respect to the GOP guarantee for payment of amount due by the power purchaser, compensation payments in case of termination due to seller / power purchaser event of default or Force Majeure, provision of additional security, provision of consents, etc. The IA also includes provisions related to protection against any discriminatory action by the GOP or public entity which materially and adversely affects the project or its ownership.

EPC Contract

The Company is in the advanced stage of finalization of EPC contract for the Project. The Company intends to finalize the EPC contract with a reputable EPC contractor who will take the responsibility of delivering the plant as per specifications and time schedule. The Company has developed a standard request for proposal and is actively pursuing number of leading European and Chinese EPC contractors, including Dan Solar, Denmark, who have confirmed their interest to act as EPC contractor for the Project, for submission of their proposals.

The EPC contractor will be responsible for delivering the goods to the site, their installation as well as testing and commissioning. The scope will be comprehensive and the contractor shall be responsible for engineering and procuring from outside Pakistan; supply of equipment, material and services required for the Project; and contracts with other local or international vendors.

The EPC contract shall have a typical payment stream starting with an advance payment secured by advance payment guarantee. The EPC contractor shall be required to provide warranties and securities to design, construct, commission, tests and deliver the plant within the stipulated period and as per the agreed design parameters to avoid losses to the Company. These commitments shall be secured by bank / performance guarantees which are typical for project finance of this size and nature. The EPC contractor is expected to also provide performance guarantees for post COD period of 12 months. The structure of the EPC contract and accompanying securities are expected to be such which are acceptable to financiers and are in line with project finance precedents.

The Project Cost

The total Project cost is expected to be in the range of USD 119.394 million with Engineering, Procurement & Construction Cost of USD 107.143 million. The Project will be financed on a non-recourse project finance basis under the budgeted debt equity ratio of 75:25. The cost is budgetary at this stage and shall be firmed up in due course after conclusion of EPC contract, negotiations and finalization of financing arrangements. The break-up of the Project cost is summarized as follows:

THE PROJECT COST	**USD IN MILLIONS**
EPC Cost	107.143
Other Costs:	
Land Cost	2.381
Project Development Cost	3.666
Insurance during Construction	1.071
CAPEX	**114.261**
Finance Cost:	
Financing Fees & Charges	2.999
Interest during Construction	2.133
Sub total	5.132
Total project cost	**119.394**

Technology & Conceptual Design

The plant will consist of a number of poly-crystalline photovoltaic modules installed in arrays in a number of strings. The number of modules will add up to a capacity of 100 MWp. The output of modules will be fed into inverters through combiner boxes.

The number of inverters and their capacities will be in accordance with the expected AC output after losses, which will be simulated, based on satellite irradiation data. The AC output from inverters will be stepped up through step up transformers to 132 KV. For this purpose, a complete 132 KV substation will be established at the plant site as per the power purchaser's specifications for interconnection of the grid system.

The plant will have an internal monitoring system to monitor the operation of the plant. In addition to this, equipment will be installed for connection of irradiation and temperature data at regular intervals. The SCADA system will be available for the control of the plant as a part of 132 KV network. The protections at plant and other equipment will match the utility standards.

Construction Period

The estimated construction period for the Project by the EPC contractor including detailed design and procurement/delivery of all materials is one year.

Other Studies

As part of the development of the project and its feasibility, the sponsors have conducted a number of essential studies such as Initial Environment Examination, Geotechnical study and topographic survey.

PROJECT TECHNICAL, FINANCIAL AND OTHER INFORMATION

a) General Information

i.	Name of Licensee	Siachen Energy Limited
ii.	Registered Office	74 J Street, Off Khayaban-e-Muhafiz, Phase VI, DHA, Karachi, Pakistan
iii.	Plant Location	Ghulam Ullah Road, Taluka Mirpur Sakro, District Thatta, Sindh
iv.	Type of generation facility	Solar Photovoltaic (PV)

b) Solar power generation Technology & Capacity

i.	Type of Technology	Photovoltaic (PV) cell
ii.	System Type	Grid connected
iii.	Installed Capacity	100 MWp

c) Technical Details of Equipment (typical parameters)

	Solar Panels – PV Modules		
i.	Type of Module	Polycrystalline PV Module 250 Watt	
ii.	Type of Cell	Polycrystalline	
iii.	Dimension of each Module	1650 mm x 992 mm x 35 mm	
iv.	No. of Panel/Modules	400,000	
v.	Total Module Area	445 Acres	
vi.	Panel's Frame	Anodized Aluminum alloy	
vii.	Weight of one Module	18.6 Kg.	
viii.	Module Output Warranty	For first year	For 2nd to 25 year
		Not more than 2.5% output reduction	Not more than 0.5% annual degradation
ix.	Number of solar cells in each module	60 cells	
x.	Efficiency of Module	15.30%	
xi.	Environment protection system	Encapsulation and sealing arrangements for protection from environment	
xii.	Nominal Maximum Power (P_{max}) at STC	250 W	

xiii.	Power Tolerance at STC	0 / +3W	
xiv.	Optimum Operating Voltage at STC	30.30V	
xv.	Optimum Operating Current at STC	8.27A	
xvi.	Open circuit voltage (V_{oc}) at STC	38.0 V	
xvii.	Short circuit current (I_{SC}) at STC	8.79A	
xviii.	Maximum system Voltage at STC	1000 V DC (IEC)	
	PV Array		
i.	No. of PV modules	400,000	
ii.	Modules in a string	20	
iii.	Total number of strings	20,000	
	PV Capacity		
iv.	Total	100 MWP	
	Junction boxes	IP 65 or IP 67 rated	
	Inverters (Central)		
i.	Inverter Model	1000CP XT	
	Input (DC)		
ii.	Max. input voltage	1000 V	
iii.	MPP voltage range [@ 25°C/@ 40°C/@ 50°C]	688 to 850V/ 625 to 850 V/ 596 to 850V	
iv.	Rated input voltage	688V	
v.	Maximum input current	1,635 A	
vi.	Max. DC short-circuit current	2,500 A	
	Output (AC)		
vii.	AC power [@ 25°C/@ 40°C/@ 50°C]	1,100 kVA/ 1,000 kVA / 900 kVA	
viii.	AC power frequency/ range	50 Hz,60 Hz /47...63Hz	
ix.	Rated power frequency/rated grid voltage	50 Hz / 405 V	
Xiii.	Power factor at rated power/ Displacement power factor, adjustable	1 / 0.9 leading to 0.9 lagging	
xiv.	Feed-in phases/ connection phases	3/3	
	Efficiency		
	Max. efficiency/ European efficiency/ CEC efficiency	98.7% / 98.4% / 98.5%	
	Protective Devices	a) Input-side disconnection device b) Output-side disconnection device c) DC overvoltage protection d) Stand-alone grid detection active/passive e) Grid monitoring f) Ground fault monitoring g) Insulation monitoring h) Surge arrester for auxiliary power supply	
	Environmental Enclosures	Operating temperature range	-25° C to +62° C/-13° .....144°F

		Maximum permissible value for relative humidity (non-condensing)	15... 95 %
		Noise emission	68 dB(A)
	Data Collection System		
i.	Weather Data	a)	Pyranometer – Sets (Incline to record irradiation level) [Yes]
		b)	Thermometer – Sets (to record ambient temp) [Yes]
ii.	System Data	i.	DC input voltage (V) & current (A) of each inverter (phase, line) [Yes]
		ii.	Total DC power (kw) generated by PV array [Yes]
		iii.	AC output voltage (V) and current (A) of each Inverter (Phase, Total) [Yes]
		iv.	AC output power (kW) and energy (kwh) of each inverter [Yes]
		v.	Frequency (Hz) [Yes]
		vi.	Power Factor (PF) [Yes]
		vii.	Temperature inside inverter station [Yes]
	Isolating Transformer		
i.	Model	MV-Power Station-1600-SC-IT (or of similar specification)	
	Medium-Voltage side		
ii.	Rated power (@25°C/40°C /50°C)	1796 kW	
iii.	Nominal AC power (@25°C/40°C /50°C)	1760kVA/1664 kVA/1660kVA	
iv.	Rated grid voltage	20 kV	
v.	Nominal AC voltage range	6.6 kV ... 35 kV	
vi.	**Low-Voltage side**		
vii.	Nominal input voltage	641 V	
	Outdoor Cubicle Control Room		
i.	Data record	Continuous logging with data logging software	

		[Yes]
ii.	Control room system	Computerized data acquisition system [Yes]
iii.	Control room system detail	Interfacing hardware & software, Industrial type PC, which will be robust & rugged suitable to operate in the control room environment [Yes]
	Mounting Structure	
i.	Application	Ground Mounted
	Model	Sigma I XL
ii.	Module Layout	Multi-variation, maximum table length 20 m
iii.	Module inclination	25°
	Quantity	400,000
	Structure Profile/s	Steel Zinc -flake-coated Stainless Steel Extruded aluminium
	Foundation structure	Reinforced concrete pile or Spiral steel piles

O & M Management

The O & M will consist of routine operational checks via remote and local monitoring; check calibration and maintenance of electrical equipment, module cleaning and general groundwork and repairs. The majority of maintenance shall be planned but a strategy, along with the ability to respond effectively, will be in place to quickly turn around forced outages.

Health & Safety

The plant and all systems forming part of it, shall be constructed and operated with safety as a prime consideration. The health and safety of all personnel, whether constructors, operators, maintenance workers or other, shall be of foremost consideration at all stages of the development, construction and operations and the contractor and operators shall ensure that the safety of all is guaranteed during development, construction and operations.

Social and Environmental Benefits

The energy sector of Pakistan is relying heavily on imported fossil fuels for generation of electricity. The development of solar power generation projects could reduce dependence on fossil fuels for thermal power generation and increase diversity in Pakistan's electricity generation mix thereby reducing greenhouse gas (GHG) emissions. The electricity generated shall directly offset greenhouse gas emissions from the combustion of fossil fuels and displace significant CO_2 emissions. There are no endangered flora or fauna species occupying the land, therefore the environmental impact of the proposed solar power plant shall be minimal and will be greatly outweighed by the environmental benefits of generating much-needed renewable and pollution free electricity. An Initial Environmental Examination has been conducted for the project and Environmental Protection Agency, Government of Sindh vide its letter reference IEE/92/2015/12/15 dated January 13, 2016 has accorded its approval to the project..

The Project will also generate direct and indirect employment opportunities for the local population. The Project will improve the basic infrastructure, which can be used by people of nearby villages. The Project will give priority to skilled, semi-skilled and unskilled labor of nearby villages. Overall, it is anticipated that there will be marginal impacts on the socio-economic conditions of the locality and the impact will be positive.

Training & Development

Training & development is the part of scope of work to be conducted under the Engineering, Procurement & Construction ("EPC") Contract. The EPC Contractor shall also carry out the training of employer's personnel in the operation & maintenance of the Complex.

Key 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 the Company
- Issuance of Letter of Intent by the Directorate of Alternative Energy, Energy Department, Government of Sindh
- Arranging of the Project land
- Completion of environment study
- Approval of environmental study by Environmental Protection Agency, Government of Sindh
- Completion of Interconnection Study
- Preparation of initial technical feasibility

The following activities are currently being pursued on a fast track basis:

- Shortlisting of EPC contractors
- Finalization of project capital structure
- Drafting EPC, land and other project agreements for sharing with lenders
- Procurement of various other regulatory approvals and consents

Financial close for the Project is targeted by June 2017, while COD is expected to be achieved by June 2018. However, the timelines shall be firmed up and divided into more detailed milestones in consultation with the EPC contractors, project lenders and other stakeholders.

GOVERNMENT OF SINDH
Directorate of Alternative Energy
ENERGY DEPARTMENT

Ph: 021-99206449

Karachi, dated: 28th August, 2015

Mr. Muhammad Sohail Shamsi,
Chairman & CEO,
Siachen Energy Ltd.,
74, J Street, Kyaban e Muhafiz,
Phase VI, DHA, Karachi.

Subject: **LETTER OF INTENT (LOI) FOR 100 MW SOLAR PV POWER PROJECT IN SINDH (PROJECT – I)**

Reference: Your Proposal dated 15th March, 2015.

In pursuance of the Policy for Development of Renewable Energy for Power Generation 2006 ("Policy"), implemented by Govt. of Sindh under clause 32 of Schedule II, Sindh Govt. Rules of Business 1986, the Directorate of Alternative Energy, Energy Department Govt. of Sindh, (DAE, GoS) hereby confirms its interest in your proposal for establishing an approximately 100 MW Solar PV Power Generation Project in Gharo District Thatta Sindh.The Sponsor(s) has proposed to developed the project on its own land.The sponsor(s) may approach the Land Utilization (LU) Department, through Energy Department Government of Sindh for acquisition of land. DAE GoS shall facilitate the Sponsor(s) for acquisition of land for project development. DAE GoS acknowledges receipt of Bank Guarantee vide No. **150031PER00014**, dated: 30th July, 2015 in the sum of USD 50,000/- (US Dollar fifty thousand only) for 100 MW Solar PV Power Project received from Bank Alfalah Limited, Clifton Branch, Karachi and verified vide letter No. CGD/A014 dated 4th August, 2015 for the issuance of Letter of Intent ("LOI") **NO. DAE/Solar/2015/81/36**

2. The Sponsor(s) is required to complete the feasibility study and achieve the milestones listed at the **Annex-I** to this LOI ("LOI Milestones") for the subject project, at no risk and at no cost to, and without any obligation on the part of the DAE Energy Department, Government of Sindh or any other Provincial (Sindh) Agency, within a period of Eighteen (18) Months from the date of issuance of this LOI.

3. The Sponsor(s) is required to carry out and complete the feasibility study in accordance with internationally acceptable standards and in accordance with the terms and conditions stipulated in the Policy and this LOI. The feasibility study must include, *inter alia*, Solar PV Power Plant equipment siting details, detailed power production estimates based on solar irradiance data of project site, soil tests reports, technical details pertaining to solar PV panels and other allied equipment to be used in the Solar PV Plant, grid tied solar PV project, electrical studies (including but not limited to short-circuit study, power quality study, load flow study and stability study), environmental study, project costing, financing plan, carbon credits, financing terms, tariff calculations and assumptions for financial calculations including economic/financial analysis. The Sponsor is also advised to liaise with Panel of Expert (POE), constituted by DAE,GoS while determining

the site, project layout, sub-station design and layout, the transmission line, interconnection arrangements and other related matters.

4. The validity of this LOI is Eighteen (18) calendar months from the date of its issue, where after it will automatically lapse immediately (unless extended pursuant to clause 5 or 6, being the **27th February, 2017** (the "**Expiry Date**"). Issuance of this LOI or the lapsing of its validity, or your conducting a feasibility study there under, cannot form the basis of any claim for compensation or damages by the Sponsor(s) or the project company or any party claiming through or under them against the Government of Sindh or any of its allied department, employees or consultants on any grounds whatsoever, during or after the expiry of the validity of the LOI.

5. The Sponsor(s) is therefore required to complete the feasibility study and achieve the LOI Milestones for the subject project within the validity of this LOI. The Sponsor(s) is also required to submit quarterly progress reports to be reviewed by Panel of Experts (POE). Provided the Sponsor(s) meets the LOI Milestones on the stated dates, the expiry date of this LOI shall be extended on a day-to-day basis for the number of days of delay by which the approval or review by the relevant public sector entity listed in the LOI Milestones is delayed beyond the corresponding period stated in the LOI Milestones. In case there is a delay in completion of the feasibility study within the validity of this LOI for reasons not attributable to a public sector entity, a one-time extension may be granted up to a maximum period of one hundred and eighty (180) days, provided that DAE GoS is satisfied that the feasibility study is being conducted in a satisfactory manner and is likely to be completed shortly, and provided the Sponsor(s) enhance the amount of the bank guarantee to twice its original amount and extend its validity for a period six (6) months beyond the extended expiry date of the LOI. Furthermore, if the said feasibility study is technically approved by the Panel of Experts and later the tariff awarded by NEPRA is not agreed by the Sponsor(s) (such decision to be made within thirty (30) days of the award of the tariff, and in any event within the validity of the LOI), the Bank Guarantee less 10% deduction for administrative and ancillary charges, would be returned to the Sponsor(s).

6. The Sponsor(s) shall apply to NEPRA for award of tariff within the period of validity of this LOI. Upon tariff being given, the Sponsor(s) shall forthwith submit a new Performance Guarantee in the sum of **USD 250,000/-** (US Dollars two hundred and fifty thousand only) (subject to revision from time to time) and obtain the Letter of Support (Tripartite i.e. AEDB for GoP, Energy Department for GoS and Project Company) from DAE GoS within the validity period of this LOI, provided, if the award of the tariff is delayed beyond the initial validity of the LOI, the Sponsor(s) shall extend the bank guarantee for a further period of six (6) months (or such period as may be determined by DAE GoS in the circumstances) and the validity of this LOI shall be extended *ipso facto* for a further period of six (6) months, and the Sponsor(s) shall obtain the Letter of Support (LOS) and submit the Performance Guarantee within the extended period afore-said. For avoidance of doubt, the afore-said extension process may be repeated if the tariff is not announced (including any review petition filed by the Sponsor(s), such review (if any) to be filed within the period prescribed in the NEPRA (Tariff Procedures and Standards Rules) up to fifteen (15) days before the then prevailing Expiry Date.

7. In case the Sponsor(s) fails to meet the LOI Milestones or perform any other obligations set forth in the Policy and this LOI, including the extension of the date of expiry

of bank guarantee as provided herein, DAE GoS will terminate this LOI and encash the bank guarantee.

8. (A) Pending the nomination of the Main Sponsor per sub-clause (B), the **M/S SMA Solar Technology AG.** *(being the individual or group holding at least 20% equity or participatory interest in the IPP project)* is liable for all obligations and liabilities of and on behalf of all other shareholders/ Sponsor(s) (without relieving the other shareholders/Sponsor(s) of their obligations and liabilities under this LOI). It is emphasized that the financial and other relevant credentials of **M/S SMA Solar Technology AG.** were a fundamental consideration for exercise of its shareholding (or other participatory interest, if the project company is not formed by the date of issue of the LOI) in the project or the project company without the prior written approval of DAE, GoS, which approval may be declined by DAE, GoS in its discretion if the proposed transferee's financial and other relevant credentials are found unsatisfactory.

(B) The Sponsor(s) is advised to nominate the Main Sponsor (being the individual or group holding at least 20% equity or participatory interest in the IPP project) no later than the Expiry Date of the LOI. In default of nomination as previously mentioned, the **M/S SMA Solar Technology AG.** will be deemed the Main Sponsor for all intents and purposes. The Main Sponsor together with other initial project shareholders/Sponsor(s) (which shall, subject in each case to sub-clause (A) above, by firmly settled and announced to DAE GoS by the Expiry Date of the LOI), must hold 51% of the project equity for a period up to the project's Commercial Operations Date (COD).

(C) Any actual or purported transfer or assignment of the shares or other participatory interests by the Sponsor(s) / shareholders in contravention of the foregoing restrictions without prior written consent of the DAE GoS shall render this LOI void and the bank guarantee will be encashed in such case by DAE GoS.

9. This LOI is not assignable and non-transferable. This LOI shall be void upon any actual or purported assignment or transfer hereof without the prior written consent of DAE GoS.

10. This LOI is issued in duplicate on the date hereof, and it shall come into effect when one copy is received by DAE, GoS. After being duly countersigned by you. Nevertheless, this LOI shall lapse if the countersigned copy is not received at DAE within 15 days of its issuance.

Agreed & Accepted for and on behalf
M/S Siachen Energy Ltd,.

Name: Muhammad Sohail Sheikh
Designation: Chief Executive

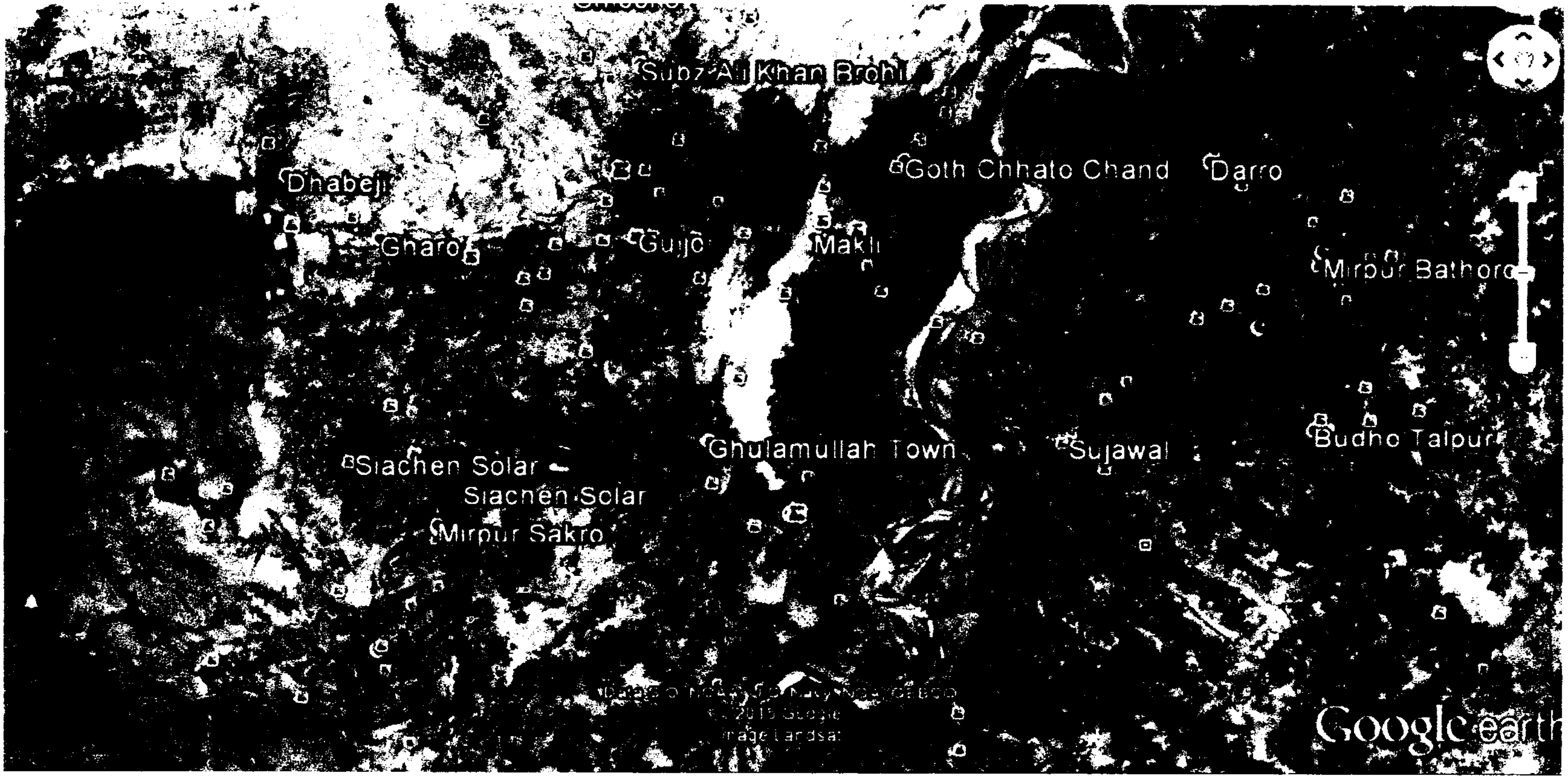
28-08-2015
(ENGR. MEHFOOZ AHMED QAZI)
Director Alternative Energy
DAE, Energy Department
Govt. of Sindh, Karachi

Siachen ... Limited

Annex-I

Milestones for the Letter of Intent (LOI)

Sr. No.	Milestones	Time Frame (in Months)
1.	Issuance of Letter of Intent (LOI)	T0
2.	Completion of Feasibility Study i) Technical study along with project description ii) Solar Resource assessment, plant and equipment details, iii) Project layout and production details.	No later than 120 days prior to the expiry date of the LOI
3.	Approval of IEE/EIA from SEPA	No later than completion of the feasibility study
4.	Approval of Electrical and Grid Studies by NTDC	No later than completion of the feasibility study
5.	Verification fee	To be submitted within seven (7) days of written request by DAE, GoS after preliminary approval (If required)
6.	Vetting and approval of Feasibility study by Panel of Experts	Within thirty (30) days after preliminary approval, provided any requisite modifications are timely made by the Sponsor(s) and the modified feasibility study is resubmitted within 15 days of a letter by DAE, GoS requiring modifications
7.	Submission of application to NEPRA for tariff determination and Generation License	Within fifteen (15) days of final approval of the feasibility study by DAE, GoS
8.	Award of Tariff and Generation License by NEPRA	Within validity of the Lol (as may be extended under clause 6)
9.	Posting of Performance Guarantee for Issuance of Letter of Support (LoS)	At least fifteen (15) days before expiry of LOI
10.	Issuance of Letter of Support (LoS)	At least seven (7) days before expiry of LOI
	TOTAL MAXIMUM TIME FRAME OF LOI	**18 Months**


Subz Ali Khan Brohi
Dhabeji
Gharo
Gujjo
Makli
Goth Chhato Chand
Darro
Mirpur Bathoro
Siachen Solar
Siachen Solar
Mirpur Sakro
Ghulamullah Town
Sujawal
Budho Talpur
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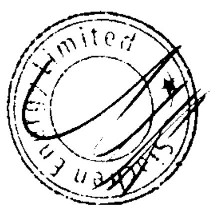


Reference No: EPA/ IEE/ 92/ 2015/ 12/ 15

ENVIRONMENTAL PROTECTION AGENCY

GOVERNMENT OF SINDH

Plot # ST-2/1, Sector 23, KIA, Karachi-74900
Ph: 5065950, 5065598, 5065637
5065532, 5065946, 5065621
epasindh@cyber.net.pk
Facsimile: 5065940

Date: 13-1-2016

SUBJECT:-**DECISION ON INITIAL ENVIRONMENTAL EXAMINATION (IEE).**

1. **Name & Address of Proponent:** Mr. Muhammad Aasim General Manager
M/s. Siachen Energy Limited

   Plot No. 36-C, Lane-13, 4th Floor Bukhari Commercial Area, Phase IV, DHA Karachi, Pakistan

2. **Description of Project:** Construction & Operation of Solar Power Project of 100 MW

3. **Location of Project:** Mirpur Sakro District Thatta Sindh Pakistan

4. **Date of Filing of IEE:** 03-12-2015

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

   a. The mitigation measures suggested in the IEE report and Environment Management Plan (EMP) should be strictly adhered to minimize any negative impacts on physical and biological environment of project & its nearby surrounding areas.

   b. The proponent shall depute staff for developing implementing and compliance of the all plans (camp management, Waste management, Traffic Management, Tree Plantation, Environmental Health Safety & Emergency Plan) including EMP. However, for this cost of EMP will separate be allocated and included in the tender document.

   c. Monitoring shall be carried out during the entire period of the project activities.
   Monitoring reports of the whole activities should be submitted to Sindh EPA on quarterly basis.

   d. A complete code of Health, Safety and Environment (HSE) shall be developed, which should include efficient parameters at specific work place. For this purpose HSE setup established and supervised by a designated HSE officer at the senior level with sufficient administrative and technical authority to perform the designated functions. Proponent will make sure that the operating instructions and emergency actions are made available to every worker/labor/visitors at the site.

   e. The proponent shall ensure that no unfortunate incident(s) are caused due to construction and operation of project. The cost of damage to the environment, property and life of the people/workers shall lie on the proponent.

   f. The proponent will take care critical terrestrial and aquatic habitat surrounding by project area by means of modifying/ avoiding the constriction activities during breeding or other sensitive seasons of the fauna.

g. The Project Proponent shall minimize the removal of native plant species and in case of removal the marking of vegetation to be removed is being done and ensure to replanting of same native species as per World Bank Standard 1 ratio 5 (plantation of five plants with respect to removal of one plant)

h. At the end of the project, the solar modules/panel shall be disposed as per international practices as already done in developed countries and inform to this office accordingly.

i. The proponent will prevent work force for disturbing the flora: fauna including hunting of animals and awareness program regarding conservation of flora & fauna be given to project staff including divers: operators and other workers.

j. To prevent soil erosion adequate/ appropriate measures such as plantation activities would be taken in order to minimize its impacts

k. Construction activity shall be restricted to day time as far as possible to avoid disturbance to surrounding areas.

l. Main sources of gaseous emissions SO_2, NOx, and particulate matters released during construction phase shall conform/meet to Provincial Environmental Quality Standards (NEQS/SEQS) all the time; at no time, the discharge/emission levels shall go higher than stipulated standards.

m. The well maintained machinery will be used for construction or other project activities that meet the Sindh Environmental Quality Standards (SEQS)

n. All noise generating equipment used during construction shall be provided with noise control devices and properly maintained. In addition noise barriers & personal protective equipment such as ear plugs, earmuffs etc shall also be provided in high noise areas.

o. Construction facilities should be place at least 1000 m away from water bodies; natural flow path ; important ecological habitats and residential areas

p. Proponent will continue all the activities include construction & operation by following the national & international guidelines to minimize the impacts on Soil, Water & Air quality parameters.

q. The construction materials should be stored in covered areas to ensure protection from dust emission and such materials should be bundled in environmental friendly and nuisance free manner.

r. Hazardous materials stored at the construction site like acetylene. cylinders, petroleum. diesels ,spirits, lubricant, oil, paints as per international guidelines and under Sindh Environment Act 2014 & its Rules and Regulation made its under.

s. The natural drain will be protected from diversions and to avoid disturbance to the surface water bodies and water consumption will be minimized by effective water management (reuse).

t. The project proponent makes ensure to disposed wastewater under international guidelines (IFC) and sanitary waste will be disposed off through septic tank. However, discharged should be planned away from environmental sensitive areas with special attention to high water tables vulnerable aquifers and wetlands community receptors including water wells, water intakes and high agriculture land.

u. To avoid storage of constriction materials beside the road around water bodies residential or public sensitive location

v. The project proponent will ensure to install; firefighting equipment to be located close to transformers; power generation. And substation will be designed with modern fire control system.

w. Security fences around the substation and establishment of warning signs to avoid death injury to workers and public from electric shock

x. For all engineering designs, NFPA (National Fire Protection Authority) codes will be followed. Standard fire and smoke detection and protection devices such as alarms, sprinklers, fire hoses and hydrants will be provided at all critical locations.

y. Proponent will use of well trained and experienced machinery operators to reduce accidental damages

z. First aid training programs should also be conducted for all employees with the help of qualified medical & Para-medical staff. The programme should include basic first-aid techniques and should be repeated periodically to refresh knowledge.

aa. Compensation should be provided to inhabitants in case of loss of agricultural land property etc in accordance with rates that are agreed upon. All the conflicting issue regarding compensation etc should be settled amicably before or during the project activities.,

bb. Proponent will identify CSR initiatives in line with local requirements and community development plans shall be developed & implanted to improve the quality of life of local villages.

cc. The proponent will keep a record book of all grievances concerning the environment. health: safety: labor & working conditions, land compensation etc.

dd. The project area shall be restored at its original landscape after completion of the project

ee. Proponent shall facilitate EPA Officer(s)/Official(s) as and when required for inspection of compliance status against the provisions of Sindh Environmental Protection Act. 2014, rules and regulations framed there under and the conditions laid down in this approval.

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

7. ***In case of any dispute of land and resettlement of the local community in the project area, this approval will be withdrawn and restore subject to conditions that proponent will provide sufficient evidence and record that compensation of land and resettlement issues are resolved. Proponent will provide report to this office through local administration i.e Deputy Commissioner/Assistant Commissioner Revenue department/Mukhtairkar that land and resettlement issues are resolved.***

8. This office reserve to rights to withdraw of this approval at any stage in case of location of this project fall in any protected area notified by Wildlife Department Government of Sindh

9. The proponent shall be liable for compliance of EIA/IEE Regulation. which direct for conditions for approval. confirmation of compliance, entry, inspection and monitoring.

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

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

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

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

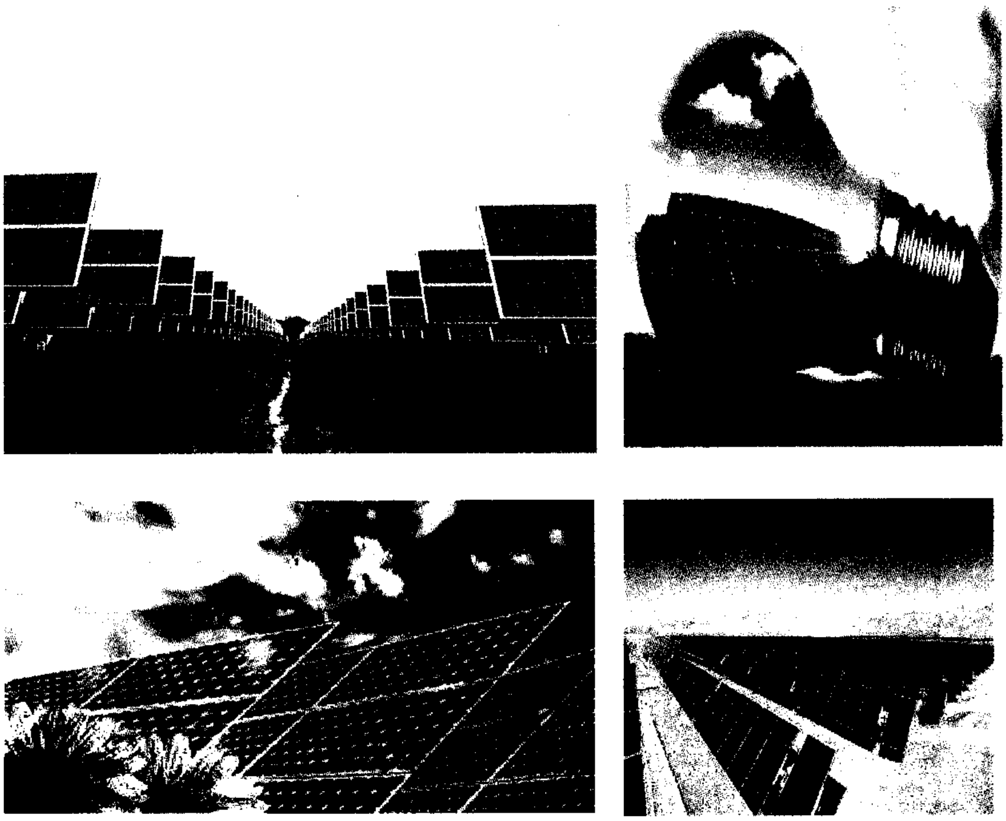
14. Proponent is bound to provide jobs to the local community as per their skill.

15. Proponent will arrange tree plantation of about 1000 indigenous trees in and around the project area.

16. This approval is not valid for the construction/operation of solar power at the agriculture land.

Waris Ali Gabol
Deputy Director (Tech-I)

INITIAL ENVIRONMENTAL EXAMINATION AND SOCIAL ACCEPTANCE OF 100 MW SOLAR PARK NEAR MIRPUR SAKRO, DISTRICT THATTA



November - 2015

By

Siachen Energy Pvt. Ltd

4th FLOOR PLOT 36-C, Lane 13, Bukhari Commercial Area, Phase IV, DHA, Karachi

Table of Content

List of Annexure

List of Acronyms

WAPDA	Water and Power Development Authority
KESC	Karachi Electric Supply Corporation
MW	Mega Watt
GW	Giga Watt
KWH	Kilo Watt Hour
SEPA	Sindh Environment Protection Act
MECPAK	Marina Environmental Consultants Pakistan
SECP	Securities & Exchange Commission of Pakistan
NEPRA	National Electric Power Regulatory Authority
EA	Environmental Assessment
EIA	Environment Impact Assessment
IEE	Initial Environmental Examination
EMP	Environmental Management Plan
ESMP	Environmental and Social Management Plan
CDM	Clean Development Mechanism
DC	Direct current
IFC	International Finance Corporation
PV	Photo Voltaic
AC	Alternative current
GOP	Government of Pakistan
NEQS	National Environmental Quality Standards

PC	public consultation
SEPA	Sindh Environmental Protection Agency
PEPAct	Pakistan Environment Protection Act 1997 (as regulated and amended)
EPA	Environment Protection Agency
NOC	No Objection Certificate
NPO	No Project Option
DOE	District Officer Environment
BE	Baseline Emission
CER	Carbon Emission Reduction
TSS	Total Suspended Solid
GHG	Green House Gases
EPD	Environment Protection Department
TL	Transmission Line
Cfs	Cubic Feet per Second
dB	Desi Bell
HSE	Health Safety and Environment

EXECUTIVE SUMMARY

INTRODUCTION

Siachen Energy Limited is a registered company in security exchange Commission n of Pakistan (SECP). The company is planning to set up a Solar PV Power Project of the capacity of 100 MW), on the land of Sukhpur , Bhalki and ~~Murjhar~~ village Tehsil Mirpur Sakro, District of Thatta, Sindh on the area of ~~850 acre~~ 760.12

Project Description

Siachen Energy limited has proposed the production of 100 MW solar PV on the land of Sukhpur, Bhalki and Murjhar village tehsil Mirpur Sakro district Thatta. The project is a solar farm which will utilized solar radiation to generate electricity using solar PV panels at the area of ~~850~~ 760.12 acres.

Sr. No	Particular	Description
1	Type of the area	Barren land
2	Project site	Sukhpur, Bhalki and Murjhar
3	Tehsil	Mirpur Sakro
4	District name	Thatta
5	Name of the Province	Sindh
6	Latitude:	24^0 34' 29.7" N
7	Longitude:	67^0 42' 33.64" E
8	Road Accessibility:	Mirpur Sakro- Ghulamulla town road
9	Nearest Town:	Mirpur Sakro
10	Total Land for proposed project area	~~850~~ acres 760.12 acres
11	Water Requirement:	133500 m^3/ year

12	Daily Global Solar Irradiance	5.65 kWh/m^2
13	Annual Global Solar Irradiance	2063 kWh/m^2
14	Type of System	Fixed tilt (25 degree)
5	Type of Technology	Photovoltaic (PV)
16	Type and made of PV modules	Fixed installation type Polycrystalline -Si solar cells
17	Proposed capacity	100 MW
18	Width of Utility Corridor	170 m
19	Nearest TL interconnection	Overhead
20	Traffic planning	Parallel to existing 132 KV TL
21	Type of equipment to be used	Fixed installation type Polycrystalline -Si solar cells
22	Project components	Grid station, switchyard, TL
23	Project Completion time	Approximately 24 months

Area Break up Details

Particulars	Area in acre
PV module area (Direct Area)	~~730~~ 445
Balance of plant	49.42

Open area	~~74~~ 265.1
Total	~~850~~ **acre** 760.12 acre

Reference (NREL, US Department of Energy)

BASELINE ENVIRONMENT

The proposed Solar PV project is proposed near Saman village Tehsil Mirpur Sakro in district of Thatta. It is in western part of Sindh which falls under 'Hot and Humid' Climatic Zone of the country. An area within 2 km around the project can be considered as influence zone and hence it has been taken as study area to understand even setting in the vicinity of the proposed project.

The area lies in the Indus basin and soil is saline and water logged having least agricultural value where mini natural drains flowing towards the river and sea.one such drain is passing by the proposed plant area. The area has no forest only wild herbs and shrubs of no importance are seen growing .All the shrubs found there are of xerophytic and halophytic in nature (Detailed in chapter no.4) .There is no any wildlife observed except cranes near the natural ponds and drains of project area. There is no national park or biological reserve near proposed project site.

LEGAL POLICIES & INSTITUTIONAL FRAMEWORK

The project is covered under schedule 1 under IEE/EIA regulation 2014 notified by government of Sindh, which requires IEE .The IEE is reviewed by Sindh Environment Protection Agency under section 17 of Act 2014 adopted by Sindh government in year 2014.The proponent is subject to file an application on the format of schedule V, undertaking under schedule VIII 10 copies of IEE and two soft copies of the report. The proponent is also bound to submit a pay order of one hundred thousand rupees in the name of director general EPA Sindh as IEE review fee. The provincial agency is bound to decide the case within maximum 45 days. Moreover national environment quality standards notified under section 11 of PEPA 1997 are also binding for the proponent. The excessive emissions to the NEQS limits is prohibited and liable to be punished under section 11 of SEPA 2014.It is also in line with the policy of federal as well as provincial governments.

WASTE WATER TREATMENT AND DISPOSAL SYSTEM

Siachen energy Limited has planned to use the wiping method for cleaning PV modules instead of sprinkle system. This will not only substantially reduce the water requirement of the Project, but also the water discharge from the project. Since the water is used for PV module cleaning purpose, the drain water collected after cleaning the solar modules would be passed through a sump with a baffle wall to arrest the suspended solids if any. Water runoff / discharge from the panels will be collected into the ponds to be discharged into the drain passing adjacent to the site after due permission from the irrigation department. The discharge water does not include any chemical or hazardous material and hence no treatment is required. The municipal waste water from the plant will be treated in septic tank before final disposal into the drain.

The proposed Solar PV project is proposed near Saman village Tehsil Mirpur Sakro in district of Thatta. It is in western part of Sindh which falls under 'Hot and Humid' Climatic Zone of the country. An area within 2 km around the project can be considered as influence zone and hence it has been taken as study area to understand even setting in the vicinity of the proposed project.

Mitigation of Adverse Environmental Impacts

Solar project has minimum environmental issues which are limited to construction phase. The adverse environmental impacts during construction and operational phases will be minimized by strictly complying with the measures suggested in ESMP. There will be proper solid waste disposal system at the site, and appropriate sewage system will be provided to the labor and engineers at site. Mitigation measures will be taken to reduce noise and nuisance as well as health and safety issues of the labor.

ENVIRONMENTAL & SOCIAL IMPACT & MANAGEMENT PLAN

The ESMP has been designed within the framework of requirement under Pakistan Environmental legislation and IFC Performance Standards on environmental and socio-economic aspects for construction and operation phases of the proposed project. The ESMP as described in the report summarizes project impacts and describes proposed mitigation measures and also identifies the authorities responsible for implementing those mitigation measures.

Conclusions and Recommendations

The overall findings of this IEE show that the proposed work has been undergone through exhaustive environmental screening process, which involved site visits, consultations with project stakeholders, review of documents, etc. It is believed that the process was sufficient to identify and examine all possible interactions between the project and the environmental and social conditions at the site. Several factors preclude any significant adverse environmental and social impact associated with the project. It is anticipated that no significant, long lasting and irreversible environmental and social adverse impacts will emerge due to project interventions. Despite the environmental friendly nature of the project it is recommended that the proponent should obtain an environmental approval (no objection certificate) from the Sindh EPA before proceeding further into the construction activities as per regulatory requirements. The project is in line with the policy of federal and provincial governments. It is also environment friendly project which will reduce the CO2 emission at national level. Therefore, it is recommended for environmental approval.

CHAPTER-1
INTRODUCTION

1.1 BACKGROUND

Electricity in Pakistan is generated, transmitted, distributed, and retail supplied by two vertically integrated public sector utilities: Water and Power Development Authority (WAPDA) for all of Pakistan (except Karachi), and the Karachi Electric Supply Corporation (KESC) for the city of Karachi and its surrounding areas. There are around 20 independent power producers that contribute significantly in electricity generation in Pakistan.

For years, the matter of balancing Pakistan's supply against the demand for electricity has remained a largely unanswered matter. Pakistan faces a significant challenge in revamping its network responsible for the supply of electricity. Pakistan's electricity producers are now seeking a parity in returns for both domestic and foreign investors which indicates it to be one of the key unresolved issues in overseeing a surge in electricity generation when the country faces growing shortages.

As of 2013 massive long-standing electricity shortages continued with long-standing failure to provide reliable service and rampant line losses, unauthorized connections, and refusal by consumers to pay for intermittent service. Electricity generation in Pakistan has shrunk by up to 50% in recent years due to an over-reliance on fossil fuels. In 2008, availability of power in Pakistan falls short of the population's needs by 15% Pakistan was hit by its worst power crisis in 2007 when production fell by 6000 Megawatts and massive blackouts followed suit. Load Shedding and power blackouts have become severe in Pakistan in recent years.

Total installed capacity is **21,103 MW** (2013) which is distributed by source as under:

- Fossil fuel – 13,637 MW – 65% of total
- Hydro – 6,654 MW – 31% of total
- Nuclear – 812 MW – 4% of total

The consumption of electricity in Pakistan is about 500 KWH per capita. The vast gap in production capacity and the consumption is becoming vast resulting in intermittent load shedding.

To save the country from negative impacts of the load shedding and ensure the sustainability of Pakistan's economic growth, government has floated the policy of replacement of fuel for power generation sector. Energy prices are increasing rapidly that is why world is finding the cheaper sources of electricity. It's a great cause of concern that in Pakistan with presence of cheaper sources of energy, we are using expensive energy options. During the last year 35% of total electricity was produced on oil. The solar PV project is renewable source of energy which is best available cost effective and environment friendly alternative in Pakistan as compared to Coal, Furnace oil and Hydro sources. It will decrease the coal and furnace oil import which is costly with respect to the economic point of view of the country. The solar power project is pollution free source of energy.

Pakistan's power generation capacity is at the lowest during these months due to water and gas shortages. Additional power generation through a local renewable biomass fuel will not only help the country reduce its chronic power shortages during this critical period but also save precious foreign exchange spent on import of furnace oil. Furthermore, efficient use of a renewable sources like solar PV is environmentally friendly and would help to mitigate greenhouse gas emissions from the country's power sector. Usage of solar panel in Pakistan was limited for household, but now its installation has significant importance for industrial sector to meet power demand. While neighboring country India is producing 2.3 GW electricity production from solar PV panel also been moving forward strongly on clean energy. It has a goal to reach 20 GW by 2020 as well. China currently electricity production is 18.3 GW from Solar PV panels.

The environmental degradation as already is translated to socio-economic problems and these problems would pay economic dividends, strengthen the growth potential and productivity of natural assets and lowering the incident of lowering diseases. Where cost of electricity will reduce the cost of environmental degradation will increase at the same time. The Constitution of the Islamic Republic of Pakistan provides that provinces may construct power houses and grid-stations and lay transmission-lines for use within the province, and also that they may, in such instances, determine the tariff for distribution of electricity within the Province. The desire of governments to support renewables is based on a number of issues. First and foremost, Pakistan is blessed with enormous resources of solar energy, wind energy, hydel energy and by virtue of being an agricultural country biomass. Currently, Pakistan's renewable energy policy is developed from a triad of concerns: security of energy supply, competitive energy costs and prices, and the environmentally benign use of energy. Additionally, renewable energy ensures that nations reduce their exposure to impending inflation in the price of traditional energy generating resources. Finally, the clean process from which Renewable energy based power is produced has proved increasingly attractive to political power wielders as global warming has featured more prominently on the political agenda. In the context of Pakistan, it is imperative for the government to diversify its sources of energy and reduce the reliance on depleting indigenous natural gas and imported oil. Furthermore, development of the renewable energy sector will result in several other benefits such as creation of employment and infrastructure development in remote areas of Pakistan.

100 MW Solar PV project by Siachen Energy Limited is situated on the land of Sukhpur, Bhalki and Murjhar villages near Mirpur Sakro- Ghulamulla town road Tehsil Mirpur Sakro, District Thatta.

1.2 PURPOSE OF THE STUDY

The purpose of the this study is to identify the possible beneficial and adverse environmental impacts of the project as presently envisaged and propose the applicable mitigation measures to be implemented during construction and operational stages of the project to minimize the negative impacts to fulfill the legal requirement of the project under section 11 SEPA, 2014.

To fulfill the social and legal binding upon Siachen Energy Private for compliance of National Environmental Quality Standards (NEQS) for industrial waste, industrial emissions, ambient air, motor vehicles and noise (**Annex-I**) in letter and spirit.

Environment Assessment (EA) is interdisciplinary and multistep procedure to ensure that environmental considerations are included in decisions regarding the project which may affect the environment. In other word environmental assessment helps identify the possible impacts of proposed activity and how these impacts can be mitigated.

The following rules and regulations are applicable on environmental assessment:

a) Sindh Environmental Protection Act (SEPA), 2014;

b) Sindh Environmental Protection Agency IEE/EIA Regulations, 2014.

c) Sectoral Guidelines issued by Pakistan Environment Protection agency for power plants.

d) Policy and Procedure for filing, review and approval of environmental assessments

e) Guidelines for public consultation

Section 17of The Sindh Environment Protection Act of 2014 **(Annexure-II)** binds the developer (proponent) to submit an IEE report to a Provincial EPAs and get approval for construction and operation phase of the project in a manner prescribed in IEE/EIA Regulations notified by Sindh EPA (**Annex-III**) and sectoral guidelines for preparation of IEE. The project is covered under schedule 1 under IEE/EIA regulation notified by government of Sindh where solar power project requires an IEE .The IEE is reviewed by Sindh Environment Protection Agency under section 17 of Act 2014 adopted by Sindh government in year 2014. To fulfill the legal obligations the project has been analyzed for possible positive and negative, social and environmental impacts and their abatement, for submission to Sindh-EPA Karachi for issuance of Environmental approval under above said regulation.

1.2.1 Justification

The growing Pakistani economy has been brought to a virtual stand-still due to the Country's acute power shortage in the recent years. Many industries (including the very significant textile industry) have been forced to shut down entirely or slow down their industrial production; and households in cities and villages alike are facing load-shedding of 8-12 hours per day in summer months. The power shortage that was between 1,000 and 2,000 megawatt (MW) in 2007, 6,000 MW in 2013 (HBP, 2013); and on a peak of 5500 megawatts (MW) in June 2015 - more than 40% of national demand (NBR, 2013). There are multiple reasons for the current energy problems in the country. There are many reasons of this crisis but process of fuel was also one of the factor which increase the circular debt in billions of rupees. To come out of this mess government has decided to tap the renewable energy resources in the country. And solar project is one of the important renewable energy source which requires to be harvested. The solar power project will decrease the burden on government in form of circular debt (PKR 872 Billion (IPRI, 2013) in form of reduction in fuel import. It is in line with policy of government of Pakistan and government of Sindh to encourage the generation of energy through Renewable sources and solar energy is one of them. The project is also justified with respect to the site of the project which minimize the expenditures of transmission line due to very closeness of to the national transmission line.

1.3 PROJECT PROPONENT

The project proponent is M/S **Siachen Energy Limited** for establishing a 100 MW Solar PV project in Sukhpur, Bhalki and Murjhar villages in Tehsil Mirpur Sakro dist. Thatta. The contact address of Siachen Energy Limited in this case is as follows:

The contact person will be:

Mr. Muhammad Aasim
General Manger
4th Floor Plot 36 -C Lane13
Bukhari Commercial Area Phase IV DHA, Karachi 75500, Pakistan
TEL: (PABX): 002131516172

002131516172
FAX: 02135156174
E-MAIL: m.aasim@sel.com.pk

1.4 Scoping session

The project is covered under schedule 1 under IEE/EIA regulation of Sindh EPA, which requires IEE. The regulations on IEE/EIA Sindh government, According to the guidelines of power plants, Policy and Procedure for filing, review and approval of environmental assessments and guidelines for public consultation were key documents which served basis for scoping of the IEE. The concerned departments were visited and had discussions to chalk out the scope of the report.

A meeting was held with Director (EIA) on the scope of the IEE report .he referred to the schedule I of IEE/EIA regulations of Sindh EPA in which solar power plants have been placed in the list of the projects which required IEE for Environmental approval.

The owners of the land and the people of the area were also contacted and interviewed to know the acceptability of the project. The categorically suggested that they want the elimination of load shedding and environment friendly project. Which will have zero emissions. They suggested that proper cost of land and assurance of effective pollution control measures are the basic steps for the acceptance of the project at that site.

After detailed discussion with stake holders it was decided that format of the IEE given in the "Policy and Procedure for filing, Review and Approval of Environmental Assessments" is the final and report will be prepared on its format mentioned in section 2.3 of above mentioned document.

1.5 Environmental Assessment Team

A team of experts comprising of experienced Environmental scientists, Ecologist along with Mr. Syed Momin Zaidi (Resident Engineer) of Siachen Energy Limited paid visits to the project site .Discussions were held on project components and detail design parameters. Meetings were also held with General Manager of Siachen

Energy Limited and his team for obtaining the basic information about site and aims and objectives of project. Siachen Energy Limited provided the baseline data and necessary technical, administrative, and environmental information of the project. The following team of Consultants remained engaged for preparation of the Initial Environmental Examination and Social Acceptance Report:

- Mr. Muhammad Farooq Alam, Senior Environmentalist and team leader
- Mrs. Fatima Khanum , Environmentalist
- Mr. Muhammad Shahbaz Environmental Engineer
- Mr. Siraj Ahmed (MECPAK)

1.6 NATURE, SIZE AND LOCATION OF THE PROJECT

1.6.1 Location

The proposed project is essentially a solar PV project based 100 MW Solar PV project to be installed on the land of Sukhpur , Bhalki and Murjhar villages in Mirpur Sakro-Ghulamulla town road Tehsil Mirpur Sakro, District Thatta .The proposed site for the Solar PV project land has been already procured at market rate from the owners of the land. The document of land is attached at **Annexure-IV.** The location of the site is given below. The success of a solar project lies in location where grid connections are available and least expenditure are incurred on transmission of generated power. The site is ideal as transmission line is passing through the proposed site area.

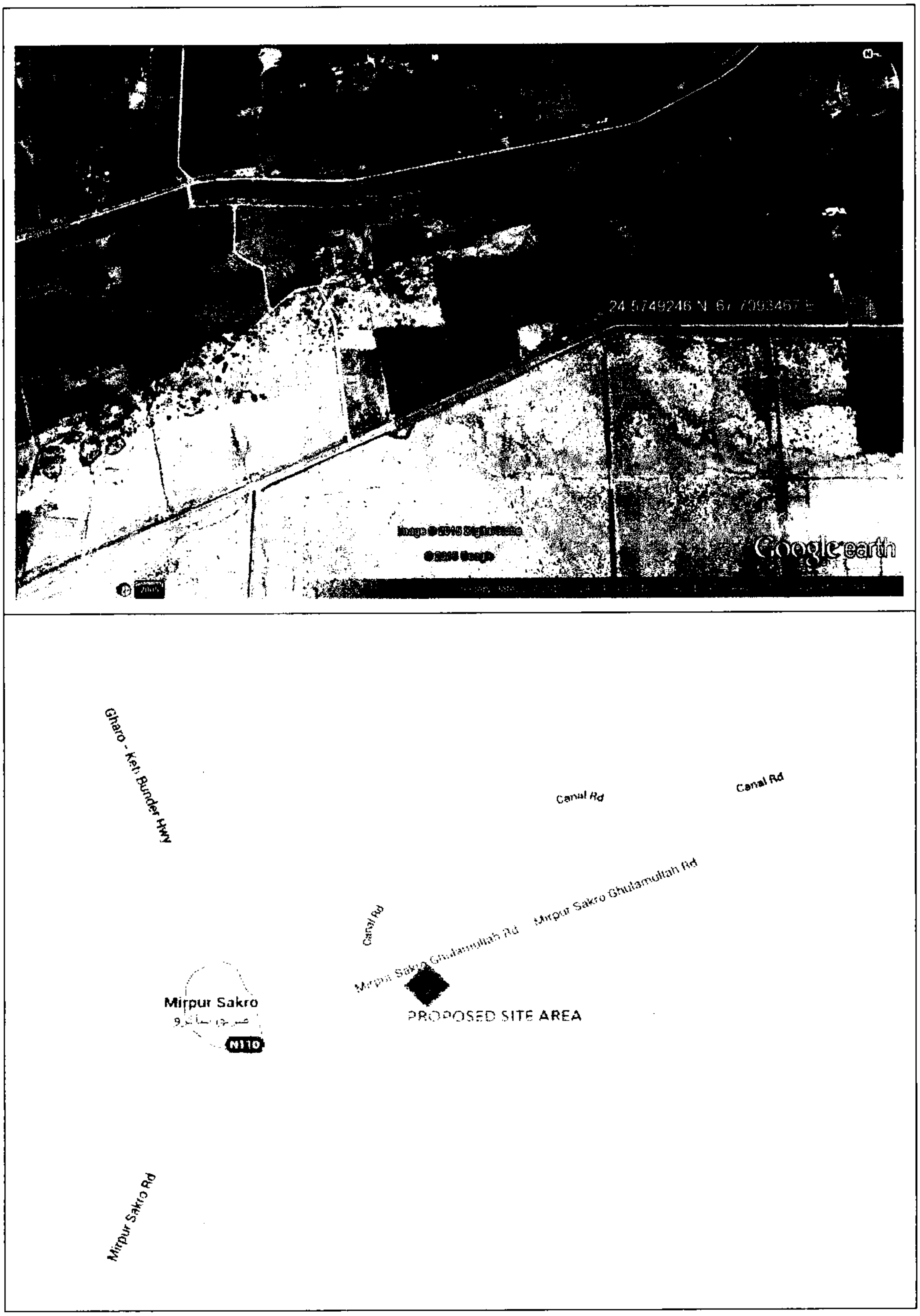
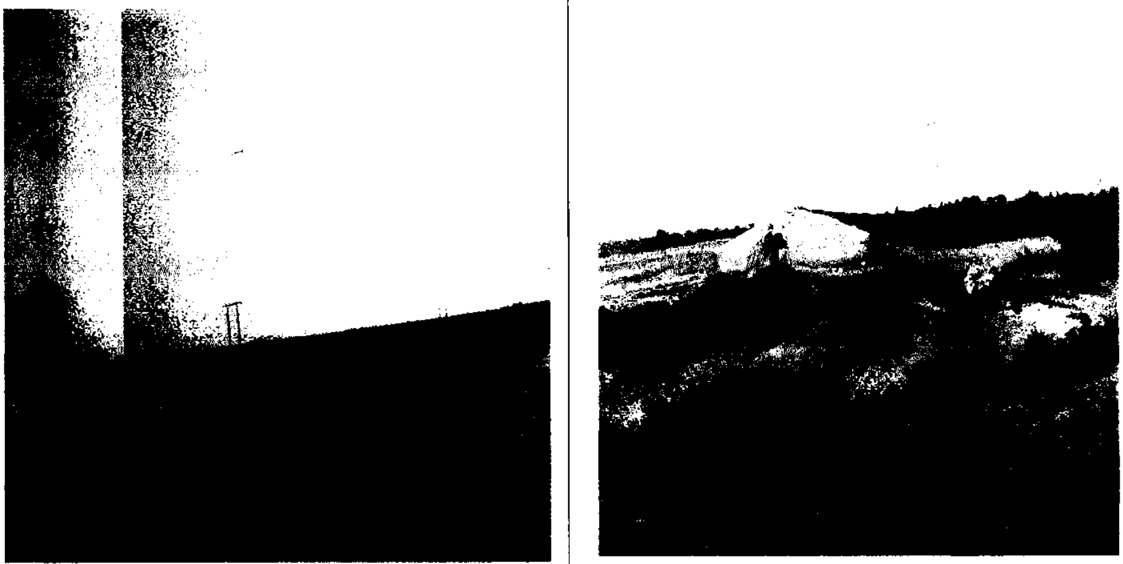


Figure 1.1 Location map of solar PV project site



PP 1.1:Existing Transmission Line passing near project area

Design of the plant

1.6.2 Nature and Size

A. Design:

Sr. No	Particular	Description
1	Type of the area	Barren land
2	Project site	Sukhpur, Bhalki and Murjhar
3	Tehsil	Mirpur Sakro
4	District name	Thatta
5	Name of the Province	Sindh
6	Latitude:	24^0 34' 29.7" N
7	Longitude:	67^0 42' 33.64" E

8	Road Accessibility:	Mirpur Sakro- Ghulamulla town road
9	Nearest Town:	Mirpur Sakro
10	Total Land for proposed project area	~~850~~ acres 760.12 acres
11	Water Requirement:	133500 m^3/ year
12	Daily Global Solar Irradiance	5.65 kWh/m^2 /day
13	Annual Global Solar Irradiance	2063 kWh/m^2
14	Tilt and Azimuth direction of Solar PV module	25^0 and 180^0 (RET screen PV syst, solar GIS) Or South Facing
15	Type of Technology	Photovoltaic (PV)
16	Type and made of PV modules	Poly – Crystalline Silicon
17	Total number of PV modules	400,000
18	Efficiency of Solar PV	15.9%
19	Proposed capacity	100 MW
20	Width of Utility Corridor	170 m
21	Nearest TL interconnection	Overhead
22	Traffic planning	Parallel to existing 132 KV TL
23	Project components	Grid station, switchyard, TL

Siachen Energy Limited

24	Project Completion time	Approximately 24 months
25	Project Cost	151.79 Million USD

The 100 MW solar PV project would be cogeneration facility. The electricity will be produced through conversion of solar radiation into electricity using solar PV panels. Solar panels vary in size and power capacity, with individual panels ranging from a watt to a couple of hundred watts. These individual panels can be connected together to for a solar PV array that can be up to a megawatt in capacity. It will supply electricity to the national grid. Electricity would be generated at 11KV and step up to 132 KV. The water requirement for the project is very less. The main consumption of the water is for solar module cleaning purpose. The discharge water does not include any chemical or hazardous material and hence no treatment is required. The municipal waste water from the plant will be treated in a septic tank before final disposal into the drain passing by project site.

B. Capacity:

The net capacity of the Solar PV Project is 100 megawatt of the electricity .The following components of the project:

- Type and made of PV modules = Poly crystalline silicon
- Azimuth of Solar PV module = 180^0 or South facing
- Total number of PV modules = 400,000
- Type of System = Fixed Tilt (25^0)
- Efficiency of solar PV = 15.9 %

The layout of the project is at **Annex-V**

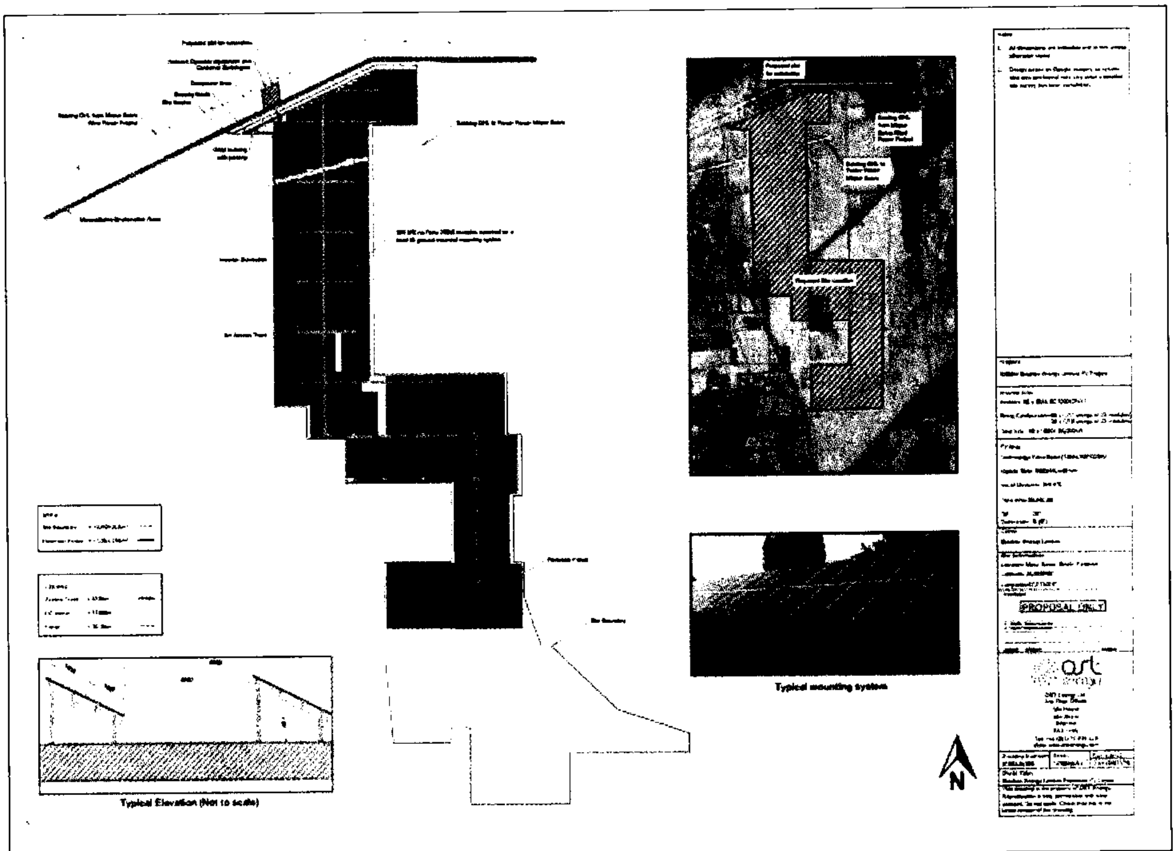


Fig 1.2: Layout of 100 MW Solar park in Mirpur Sakro, Sindh

1.7 CAPITAL COST ESTIMATES

The capital cost is yet to be calculated which include civil cost, mechanical, electrical, fabrication and erection cost.

1.8 STUDY AREA

For an environmental assessment Study, a clear delineation of the Study Area is important within which the impacts must be considered. In the light of this, impacts on the existing environment have been considered in a geographical area (Study Area) of the proposed Project. An area within 2 km around the project can be considered as influence zone and hence it has been taken as study area to understand even setting in the vicinity of the proposed project. As the area is purely barren land w with some herbs and shrubs. The following villages are located around the proposed plant.

- Gharo village is about 30km away from project site in west direction

- Mirpur Sakro is 10 km away from project area
- Qadir Bakish Shoro is about 4 km away from project area
- Saman village is adjacent to the project site

The irregular settlement is in forms of village Saman is the nearest village from the project site. It is group of some huts like houses situated at about 1 km of the project area. Population of the villages in the area depends upon agriculture, fishing, labor and business activities. Farmers, laborer and Fishers are the significant community in the project area.

The Ambient air monitoring at site shows the clear ambient air quality. The data of Meteorology Department, Government of Pakistan was also consulted for meteorological parameters.

1.9 STRUCTURE OF THE REPORT

The IEE report is structured in the light of guidelines for Review and filling of IEE and EIA and guidelines for thermal power plants issued by the government of Pakistan. It includes non-technical or executive summary and followed by eight (8) chapters with Chapter-1 provides introduction of the proposed project, Chapter 2 provides the country's environmental policy, legal and administrative framework applicable to the proposed project together with the guidelines. Chapter 3 is the description of the project including components, design parameters, detail of infrastructure facilities etc, Chapter 4 describes in detail the existing environmental baseline conditions of the Study Area considering the physical, ecological and social domains of environment. Chapter 5 describes the public consultation and information disclosure. Chapter 6 exhibits the anticipated environmental and social impacts at construction and operational stages of the proposed project along with their mitigation measure, Chapter 7 depicts Environmental and Social Management Plan (ESMP).Chapter 8 gives the conclusions and recommendations about the viability of the project.

CHAPTER - 2

ENVIRONMENTAL LEGISLATIVE REQUIREMENTS AND FRAMEWORK

2.1 GENERAL

This Chapter deals with the relevant policy, legal and administrative frameworks instituted by the Government of Pakistan and Sindh for the protection of environment. All the relevant provisions of these policy and legal frameworks have been duly considered in this IEE study. In addition to this, the roles and responsibilities of the Proponent and other key players such as EPA Sindh have also been discussed in this section. The legal set of documents which will applicable to this project is also discussed in this chapter.

2.2 LEGAL FRAMEWORK

The Government of Pakistan (GOP) has promulgate laws/acts, regulations and standards for the protection, conservation, rehabilitation and improvement of the environment. In addition to this, they have also developed environmental assessment procedures governing development projects. Following are the glimpse of these laws and procedures relevant to the proposed Project.

1. Pakistan Environmental Protection Act 1997

The Act was enacted on December 06, 1997 by repealing the Pakistan Environmental Protection Ordinance 1983. It provides the framework for implementation of the PNCS, 1992 establishment of provincial sustainable development funds, protection and conservation of species, conservation of renewable resources, and establishment of Environmental Tribunals, appointment of Environmental Magistrates, Initial Environmental Examination (IEE), and Environmental Impact Assessment (EIA).

Section 11 binds the proponents to emit the effluents and emissions within the prescribed limits as notified in NEQS. Section 17 of the Act stresses the need to carry out EIA/IEE study prior to construction or operation of a project. A committee under the chairman ship of Director General EPA reviews the report and gives its decision for approval or otherwise of any project. Environmental approval is issued for construction phase. After completion of the project construction approval for operational phase is also required to be obtained.

2. Pakistan Environmental Protection Act 1997 Amended 2012

After implementation of the 18th amendment government of Sindh, EPD adopted the federal act with minor modification which is now called the Sindh Environment Protection Act, 2014.All the rules and regulation made here under have been adopted by EPD.

The Sindh Environmental Protection Agency (Review of IEE/EIA) Regulations, 2014 these regulations provide criteria for projects requiring IEE and EIA. The project is covered under schedule 1 under IEE/EIA regulation 2014 notified by government of Sindh. Which requires IEE to be submitted for environmental approval before provincial or federal Environment protection agency. They also briefly describe the procedure for preparation and review of environmental reports in the department. (**Annex-Vi Review of IEE/EIA Regulations, 2014**)

Pak-EPA published a set of guidelines for conducting IEE/EIA and environmental management of different types of projects. The EIA/IEE process followed in Pakistan is provided in figure 2.1.

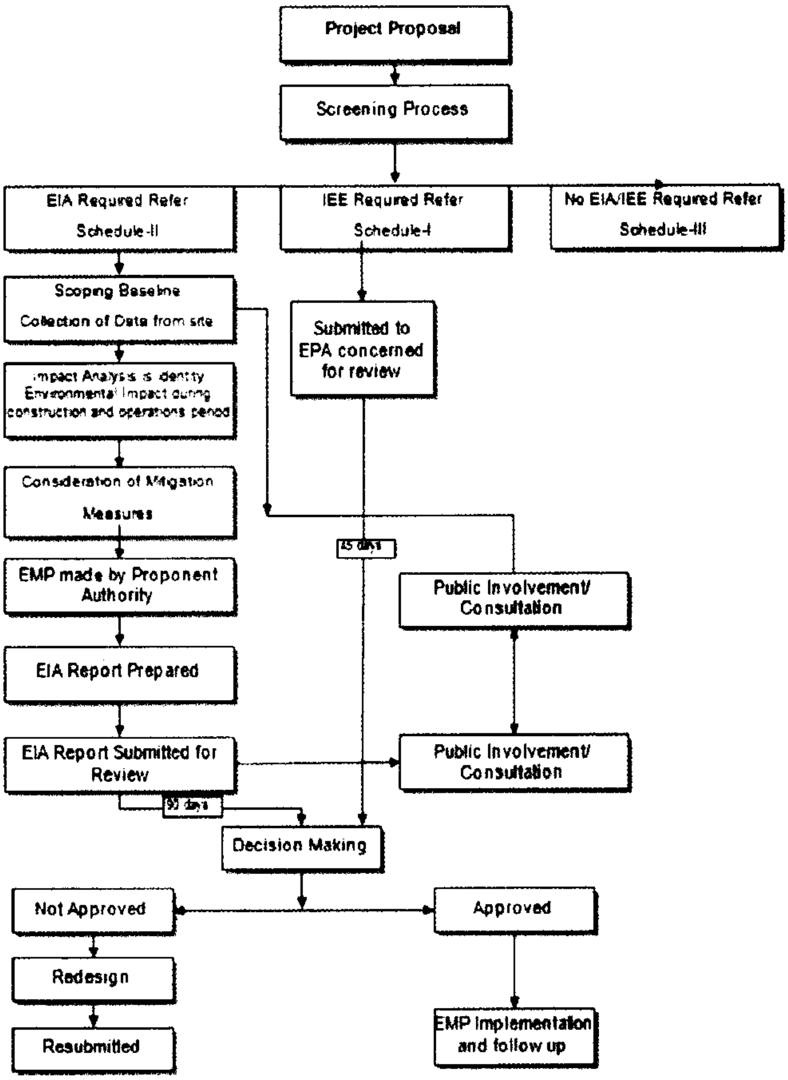


Figure 2.1 IEE/EIA Process in Pakistan

3 The Sindh Environment Protection council, 2014

The Government of Sindh shall, by notification in the official Gazette, establish a Council to be known as the Sindh Environmental Protection Council consisting of:

- Chief Minister or such other person as the Chief Minister may nominate in this behalf.
- Minister-in-charge of the Environment Protection Department. Vice Chairperson
- Additional Chief Secretary, Planning and Development Department,

Government of Sindh.

- Secretaries of the Environment, Finance, Public Health Engineering, Irrigation, Health, Agriculture, Local Government, Industries, Live Stock and Fisheries, Forest and Wildlife, Energy, Education, Departments of Government of Sindh and the divisional commissioners of Sindh.
- The Council shall co-ordinate and supervise the enforcement of the provisions of this Act and other laws relating to the environment in the Province.
- Approve comprehensive provincial environmental and sustainable development policies and ensure their implementation within the framework of a conservation strategy and sustainable development plan as may be approved by Government from time to time.
- Approve the Sindh Environmental Quality Standards
- It provide guidelines for the protection and conservation of species, habitats, and biodiversity in general, and for the conservation of renewable and non-renewable resources.
- Consider the annual Sindh Environment report and give appropriate Project:

2.3 Other Relevant Laws, 2014

2.3.1 PROHIBITIONS AND ENFORCEMENT

Section11 of the Act subject to the provisions of this Act and the rules and regulations, no person shall discharge or emit or allow the discharge or emission of any effluent, waste, pollutant, noise or any other matter that may cause or likely to cause pollution or adverse environmental effects, as defined in section 2 of this Act, in an amount, concentration or level which is in excess to that specified in Sindh Environmental Quality Standards;

All persons, in industrial or commercial or other operations, shall ensure compliance with the Environmental Quality Standards for ambient air, drinking water, noise or any other Standards established undersection 6(1)(g)(i); shall maintain monitoring records for such compliances; shall make available these records to the authorized person for inspection; and shall report or communicate the record to the Agency as required under any directions issued, notified or required under any rules and regulations.

2.3.2 Prohibition of Import of Hazardous waste

No person shall import hazardous waste into Sindh province or its coastal, internal, territorial or historical waters, except acquiring prior approval of the Agency.

2.3.3 Prohibition of Action Adversely Affecting Environment

According to the Sindh environment protection Act amended 2104,subject to the provisions of this Act and the rules and regulations, no person shall cause any act, deed or any activity, including:

(a) Recycling or reuse of hospital waste and infectious waste;

(b) Disposal of solid and hazardous wastes at unauthorized places as prescribed;

(c) Dumping of wastes or hazardous substances into coastal waters and in land water bodies;

(d) Release of emissions or discharges from industrial or commercial operations as prescribed;

(e) Recycling or reuse or recovery of hazardous wastes or Industrial by-products in an unauthorized or no prescribed manner or procedure; and

(f) Any activity which may cause adverse environmental affect due to Tran's boundary projects of Province of Sindh. Which lead to pollution or impairment of or damage to biodiversity, ecosystem, aesthetics or any damage to environment and natural resources as defined in section 2 (xxxvi) of this Act.
(2) No person shall generate, handle, transport, dispose of or handle the hospital waste and infections waste except in accordance with the Hospital Waste Management Rules and in such manner as may be prescribed.

2.3.4 Regulation of motor vehicles

According to the Sindh Environment protection Amended 2014, No person shall operate or manufacture a motor vehicle or class of vehicles from which air pollutants or noise are being emitted in an amount. Concentration or level which is in excess of the Sindh Environmental Quality Standards or, where applicable, the standards established under sub-clause (i) of clause (g) of sub-section (1) of section 6

2.3.5 Public Participation & Consultation

Public consultation and participation are mandatory for IEE/EIA procedure. Sectoral guide lines issued by Pakistan environmental agency are required to be consultant during the process of public consultation. IEE/EIA regulations 2014 also give guide line for public participation of schedule I projects. An advertisement is published in to leading newspaper for comments of the public on proposed project. Duration of thirty days is fixed for public comments. Finally a public hearing is conducted on any public place where each stakeholder is heard by the representative of Director General of EPA Sindh. Proper remedial measure/action is taken by IEE section on the reservation of stakeholders.

2.4 ENVIRONMENTAL QUALITY STANDARDS

2.4.1 National Environmental Quality Standards (NEQS), 2000

Compliance of NEQS is the requirement of approval of IEE/EIA. Ministry of Environment notified these standards in 1993. They were revised in 2000. They furnish information on the permissible limits for discharges of municipal and industrial effluent parameters and industrial gaseous emissions in order to control environmental pollution. A copy of these standards is attached as **(Annexure-INEQS AII).**

Table- 2.1 National Environmental Quality Standards for Municipal and Liquid Industrial Effluents (mg/l, Unless Otherwise Defined)

Sr. No.	Parameters	Revised Standards Into Inland Waters	Into Sewage Treatment(5)
1	Temperature or Temperature Increase	<3°C	<3°C
2	pH value (H^+).	6-9	6-9
3	Biochemical Oxygen Demand $(BOD)_5$ at 20°C(1)	80	250
4	Chemical Oxygen Demand (COD)(1)..	150	400
5	Total Suspended Solids (TSS)	200	400
6	Total Dissolved Solids(TDS)	3500	3500
7	Oil and Grease	10	10
8	Phenolic compounds(as phenol)	0.1	0.3
9	Chloride (as Cl^-)	1000	1000
10	Fluoride (as F^-)	10	10
11	Cyanide (as CN^-) total...	1.0	1.0
12	An-ionic detergents (as MBAS)(2)	20	20
13	Sulphate (SO_4^{2-})	600	1000
14	Ammonia (NH_3)	40	40
15	Pesticides	0.15	0.15
16	Cadmium(4)	0.1	0.1

Sr. No.	Parameters	Revised Standards Into Inland Waters	Into Sewage Treatment(5)
17	Chromium (trivalent and hexavalent (4)...	1.0	1.0
18	Cooper (4).....	1.0	1.0
19	Lead (4).....	0.5	0.5
20	Mercury (4).....	0.01	0.01
21	Selenium (4)	0.5	0.5
22	Nickel (4)....	1.0	1.0
23	Silver (4)	1.0	1.0
24	Total toxic metals....	2.0	2.0
25	Zinc....	5.0	5.0
26	Arsenic (4)...	1.0	1.0
27	Barium (4).....	1.5	1.5
28	Iron....	8.0	8.0
29	Manganese.....	1.5	1.5
30	Boron (4).....	6.0	6.0
31	Chlorine....	1.0	1.0

2.4.2 DRINKING WATER QUALITY STANDARDS

In pursuance of the statutory requirement under clause (e) of sub-section (1) of section (6) of the PEPA, 1997 the Pakistan Environmental Protection Agency, Ministry of Environment has notified drinking water quality standards. WHO drinking water quality guidelines have been used for bench marking purpose in the drinking water quality standards that are notified and given in **Table 2.2.**

Table- 2.2 National Standards Drinking Water Quality

Sr. No.	Parameters	Standard values for Pakistan (mg/l)	WHO (mg/l)
1	Aluminum (Al)	≤ 0.2	0.2
2	Ammonium (NH3)	-	1.5
3	Antimony (Sb)	≤ 0.005	0.02
4	Arsenic (As)	≤ 0.05	0.01
5	Barium (Ba)	0.7	0.7
6	Boron (B)	0.3	0.3
7	Cadmium (Cd)	0.01	0.003
8	Chloride (Cl)	< 250	250
9	Chromium (Cr)	≤ 0.05	0.05
10	Copper (Cu)	2	2
11	Cyanide (CN)	≤ 0.05	0.07
12	Fluoride (F)	≤ 1.5	1.5
13	Iron (Fe)	-	0.3
14	Lead (Pb)	≤ 0.05	0.01
15	Manganese (Mn)	≤ 0.5	0.5
16	Mercury (Hg)	≤ 0.001	0.001
17	Molybdenum (Mo)	-	0.07
18	Nickel (Ni)	≤ 0.02	0.02
19	Nitrate (NO_3)	≤ 50	50
20	Nitrite (NO_2)	≤ 3	3
21	Selenium (Se)	0.01	0.01
22	Silver (Ag)	-	NS
23	Sodium (Na)	-	200

Sr. No.	Parameters	Standard values for Pakistan (mg/l)	WHO (mg/l)
24	Sulphate (SO_3)	-	250
25	Residual Chlorine	0.2-0.5	-
26	Zinc (Zn)	5.0	3.0
27	Color	$\leq$ 15 TCU	$\leq$ 15 TCU
28	Taste	Non-Objectionable/ Acceptable	Non-Objectionable/ Acceptable
29	Odor	Non Objectionable/ Acceptable	Non Objectionable/ Acceptable
30	Turbidity	< 5 NTU	5 NTU
31	Total hardness	< 500 mg/l	-
32	TDS	< 1000	<1000
33	pH	6.5-8.5	6.5-8.5

2.5 ADMINISTRATIVE FRAMEWORK

2.5.1 Siachen Energy Limited

The implementing agency of the proposed Project is Siachen Energy Limited who will execute the proposed Project on the land of Sukhpur, Bhalki and Murjhar villages in Mirpur Sakro Ghulam mullah town road Tehsil Mirpur Sakro, District Thatta. The management of Siachen Energy Limited will ensure that all the proposed measures are effectively implemented at the design, construction and operational stages.

2.5.2 Environmental Protection Agency, Sindh

Pakistan Environmental Protection Council is the apex inter-ministerial and multi-stakeholders decision-making body, which is headed by Prime Minister. While Pakistan Environmental Protection Agency is meant for the enforcement of environmental laws in Pakistan, they have delegated powers to provincial environmental protection agencies for review, approval and monitoring of environmental examination/ assessment projects. After 18th Amendment EPD has all powers to enforcement of PEPA 1997 amended 2012. As regards the proposed Project, EPA Sindh will be responsible for reviewing the report, issuing No Objection Certificate (NOC) and overall/broad based monitoring of the proposed Project activities.

2.6 ENVIRONMENTAL GUIDELINES

Three sets of guidelines, the Pak-EPA's Environmental Guidelines, the World Bank Environmental Guidelines, and ADB Environmental Guidelines are reviewed here.

2.6.1 Environmental Protection Agency's Environmental Guidelines

The Federal EPA has prepared a set of guidelines for conducting environmental assessments. The guidelines derive from much of the existing work done by international donor agencies and NGOs. The package of regulations, of which the guidelines form a part, includes the PEPA 1997 and the NEQS. The guidelines themselves are listed below.

2 Guidelines for the Preparation and Review of Environmental Reports,

3 Guidelines for Public Consultation,

4 Guidelines for Sensitive and Critical Areas,

5 Sectoral Guidelines

It is stated that the Sindh Environmental Protection Agency Review of IEE and EIA Regulations, that the EIA or IEE must be prepared to the extent practicable, in accordance with the Pakistan Environmental Protection Agency Environmental Guidelines.

2.6.2 World Bank Environmental Guidelines

The principal World Bank publications that contain environmental guidelines are listed below.

1 Pollution Prevention Abatement Handbook 1998: Towards Cleaner Production, (WB/UNIDO/UNEP, 1999)

2 Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectoral Issues, (WB, 1991-a).

CHAPTER- 3
PROJECT DESCRIPTION

3.1 COMPONENTS OF THE SOLAR PV PROJECT

Siachen Energy limited has proposed the production of 100 MW solar PV on the land of Sukhpur, Bhalki and Murjhar village, tehsil Mirpur Sakro district Thatta. The project is a solar farm which will utilized solar radiation to generate electricity using solar PV panels at the area of ~~850~~ 760.12 acres. The power generated from the proposed solar power plant shall be evacuated through 132KV/11KV to the transmission line passing through the site of the project. The power generated from the proposed solar PV power plant at LT level shall be stepped up first to 11 kV level through suitably rated transformers & then to 132kV level through 11/132 kV step- up transformers. The power from the PV project shall be evacuated through proposed 132kV transmission line to near the sub substation. The water requirement for the project is very less. The main consumption of the water is for solar module cleaning purpose. Water would be drawn from tube wells.

The solar power project would have modern control system.

The following components of the plant will be installed:

- Type and made of PV modules = Poly crystalline Silicon
- Tilt angel - 25^0
- Azimuth/direction – 180^0
- Total number of PV modules = 400,000
- Efficiency of solar PV modules = 15.9 %
- DC-AC current Inverters and transformers
- Underground cabling/Overhead power lines
- PV module cleaning system
- Sewage and waste water system
- Auxiliary PV modules
- Facilities for Administration and Maintenance
- Power evacuation System

PV panels are typically up to 6 m^2 in size and the rows will be approximately 1 km in length, made up of approximately 100 m sections depending on the optimal final design and layout of the development. The panels will be mounted on metal frames with a maximum height of approximately 3m above the ground, supported by concrete foundations or pile foundations.

PP 3.1:Drilling and height of solar panel

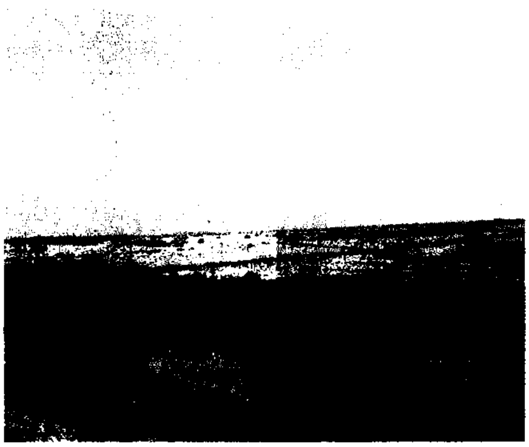
3.2 Recycling of Solar Panels

Over the past few decades, production of energy through the use of photovoltaic (PV) technology has increased. The past ten years have seen the largest growth in demand for PV modules, with a rate of 35% in 2010 and predicted rates of 20% or more through 2015.The majority of the PV market consists of silicon-based modules, most commonly constructed from crystalline silicon wafers. However, PV modules do not last forever; they have a life expectancy of about 30 years before they must be decommissioned. Failure of modules is often attributed to defects in the product, including "glass breakage, defect laminate, electrical defects, wrong designs, or process losses.

Currently, the end-of-life modules are treated as industrial waste in which the glass and metal components are recycled, but not the cells. As the quantity of solar-grade silicon decreases, simply throwing away old cells is an increasingly cost-inefficient process as well as hazardous. The majority of the discarded wafers are intact, and recycling methods have been developed by various research groups to refurbish old solar cells into new cells with similar efficiencies.

3.3 PLANT AREA AND WORKING ENVIRONMENT

The roads and parking area inside the site boundary line/ fence will be covered. Entrance gate will have a guard house which will consist of an office room and a sanitary area. The office room is ventilated and has well illuminations level. The following are the working conditions.



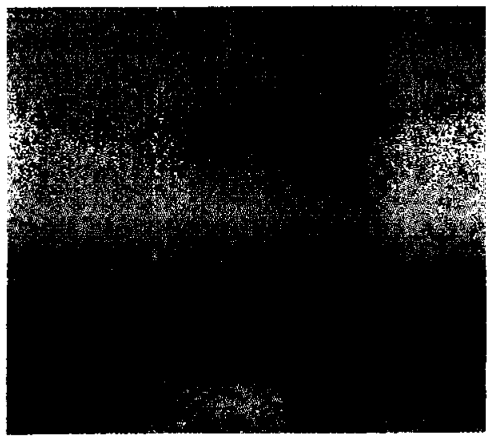


Photo plate 3.2: proposed site of solar PV power plant

- Altitude above mean sea level 9 m
- Minimum ambient air temperature 11.7 °C
- Maximum ambient air temperature 35.9 °C
- Earthquake design ground acceleration acc. g 15 to g 20 zone2A
- Air quality clean

3.4 CIVIL WORKS

The civil works include the construction of the following major components;

- Excavation, Leveling of the surface, compacting and paving
- Foundations
- Installation of PV modules
- Power evacuation
- Paving of plant area,
- Boundary wall and gates.
- Operator room and operator quarter.
- Admin office
- Waste water treatment plant for sewerage
- Ponds for water storage

3.5 Project Implementation schedule

An implementation schedule, outlining the sequence of major activities and the time required for engineering, construction, installation and commissioning of the 100MW solar PV power plant. The solar plant is expected to be commissioned and start exporting power to the grid before 2017.

Table 3.1: Project Implementation Schedule

Sr.No	Activity	Completion time
1	Award of EPC contract	2016
2	Site mobilization	2016
3	Basic Infrastructure building	2016
4	Detailed Engineering & Procurement	2016
5	Financial closure	2016
6	SPV module shipment	2016
7	Shipment of equipment	2016
8	Commencement of erection	2017
9	Construction of Evacuation system	2017
10	Commissioning, Trial run & testing	2017

11	Commercial Operation	2017

3.6 Analysis of Alternatives

Different alternatives were also considered by the design engineers for the proposed project which include No Project Option (NPO), other power generation options, site alternatives, and design & technology alternatives.

3.6.1 No Project Option (N.P.O)

The current power production in Pakistan is about 12-14 thousand MW against a demand of 16-17 thousand MW per day thus a demand-supply gap is around 3-4 thousand MW for the year 2012-13 resulting in load shedding of almost 6 to 8 hours a day in urban centers of Pakistan and even more in the rural areas. This gap is increasing annually and causing a great economic loss to the country apart from the human suffering due to regular power outages. In the light of the above situation, NPO is not acceptable under prevailing power shortage scenario.

3.6.2 Other Power Generation Options

Two major potential power generation options available in Pakistan are still untapped, viz. solar and wind.

Out of total installed generation capacity of about 20,215 MW in Pakistan, 6,463 MW belong to hydro, 6,590 MW thermal, 462 MW to nuclear and 6,414 MW to Independent Power Producers (IPPs). Around 286 MW was being produced by Rental Power stations (RPPs) which has turned into a total failure. 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 currently. 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 venues, particularly renewable avenues, amongst them solar power generation appears the best option.

3.6.3 Location Options

Solar parks usually need vast land therefore soil of less economic value is usually selected for this purpose .Quad-e-Azam solar park is selected in the area of Cholistan on the basis of land use .Keeping in the view this effect Siachen Energy Limited has selected the site in the area of Mirpur Sakro dist. Thatta which has less economic value in term of yield per acre and non-availability of irrigation water.

3.7 Plant Operation and Maintenance

The operation of solar power plant is relatively simple and restricted to daylight hours. With automated functions of inverter and switchyard controllers, the maintenance will be mostly oriented towards better upkeep and monitoring of overall performance of the system. The solar PV system requires the least maintenance among all power generation facility due to the absence of fuel, intense heat, rotating machinery, waste disposal, etc. However, keeping the PV panels in good condition, monitoring and correcting faults in the connected equipment and cabling are still required to get maximum energy from the plant.

3.8 CLEAN DEVELOPMENT MECHANISM (CDM)

Although CDM is going to be ended in 2016, yet it has the perspectives to be valuable till year 2020 but may be with different name.In1997, Kyoto Protocol (Protocol) linked to United Nations' Framework Convention on Climate Change resolved to reduce the greenhouse gases (GHGs) responsible for global warming. As an effort to minimize the global warming, Protocol sets binding targets for thirty seven industrialized countries, five percent below GHG emission levels prevailing in 1990, between 2008 and 2012. Protocol established three market based mechanisms allowing developed countries to meet the emission reduction targets.

Clean Development Mechanism (CDM) is one of the three project based mechanisms formulated under the Protocol. CDM establishes a win-win situation for both developed countries as well as developing countries. It allows developing countries to implement GHG emission reduction projects in a manner they assist developed countries meeting their GHG limitation targets in a cost-effective manner.

Efforts undertaken by the developers of such projects, in developing countries, is rewarded through issuance of salable Certified Emission Reductions / Carbon Credits stimulating economic growth in a sustainable manner.

Carbon dioxide (CO_2), one of the six GHGs covered under the Protocol. Since fossil fuels are one of the emission sources for electricity generation, any projects that reduce CO_2 emission may become CDM projects after going through scrutiny guidelines promulgated by CDM Executive Board (CDM-EB). Examples of such projects include higher efficiency electricity generation, lesser emission intensive fuels, renewable energy technologies and etc.

3.8.1 CDM Project cycle

CDM Project cycle comprises of two major phases, registration and operation, to generate Carbon credits. These include:

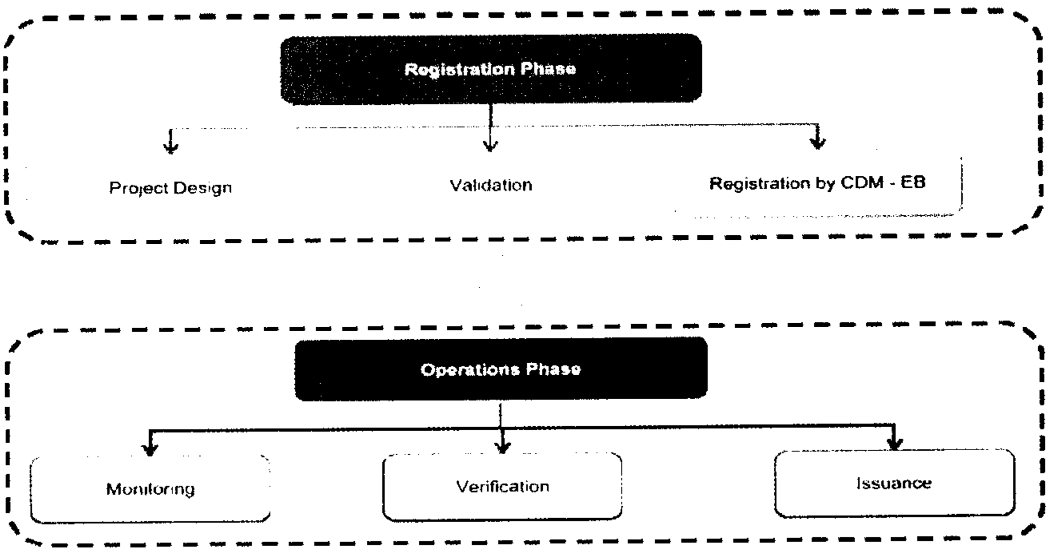


Figure 3.1 Project cycle of CDM

3.9 Technical Details of PV Technology

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of cells containing a photovoltaic material. Materials presently used for photovoltaic include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium selenide/sulfide Photovoltaic is the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are captured, an electric current result that can be used as electricity.

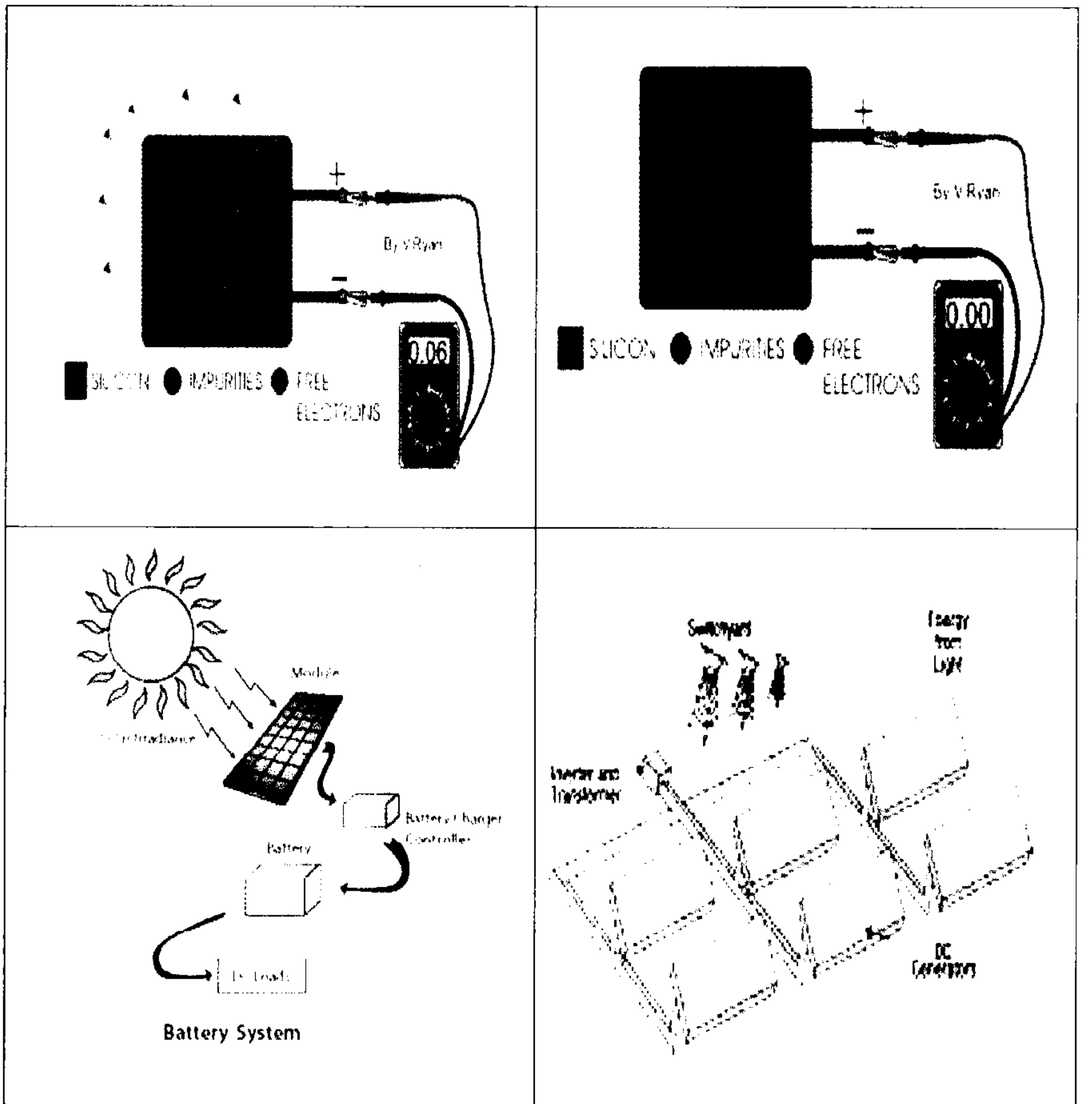


Figure 3.2: Power generation process of PV modules

3.9.1 Solar PV Array

Photovoltaic technology has been selected for the 100 MW Solar PV Power Project. It should perform satisfactorily in relative humidity up to 100% with temperatures between -10°C and +85°C and withstand gust up to 200 km/h from back side of the panel.

3.10 Baseline Emission (BE)

Project would generate approximately 419 MWh of electricity and displace equivalent amount of electricity from the NEPRA grid which otherwise would have generated by the fossil fuel based power plants. According to the methodology ACM0002, Baseline Emissions of the project is the CO_2 emissions avoided by the project considering the grid is emission intensive. An annual baseline emission for the project is outlined below:

Table 3.2: Annual base line emission of the project

Parameters	Units	Value
Net Electricity	MWh	419
CM	tCO2/MWh	0.9487
Baseline Emission	tCO2e	63360

3.10.1 Emission Reduction:

Eligible CERs is the difference between Baseline Emission, Project Emission and Leakage of the Project. Project Emissions and Leakages are attributed to the onsite emissions due to the construction and operation of the project. Since the project is a renewable energy project with no on site combustion of fossil fuel, project emissions and Leakage are considered Nil. Therefore, the annual emission reduction eligible for the project are equivalent to annual baseline emission computed above. The annual emission reductions for the entire crediting period of 10 years are noted as below 63,360.

3.10.2 Outlook

In Conference of Parties (CoP) 16 held, at Cancun, Mexico, in 2010, both the developed nations and developing nations adopted Cancun Adaptation Framework. Section 83 of the Cancun Adaptation Framework undertake to maintain and build upon the existing mechanism which means the CERs issued for the project activity would continue to meet compliance requirements for the next phase of the commitment period. Several Analyst reports suggest that the prices of the CERs would be higher than the prevailing CER prices.

Table 3.3: Comparison of Energy sources

Energy Sources	Pros	Cons
Solar Energy	• Nonpolluting • Most abundant energy source available • Systems last 15-30 years	• High initial investment • 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	• No emissions • Affordable • Little disruption of ecosystems • Relatively high output	• Output is proportional to wind speed • Not feasible for all geographic locations • High initial investment/ongoing maintenance costs • Extensive land use
Hydropower	• No emissions • Reliable • Capable of generating large amounts of power • Output can be regulated to meet demand	• Environmental impacts by changing the environment in the dam area • Hydroelectric dams are expensive to build • Dams may be affected by drought • Potential for floods

Natural Gas	• Widely available • 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 leak	• Transportation costs are high lack of infrastructure makes gas resources unavailable from some areas • Burns cleanly, but still has emissions • Pipelines impact ecosystems
Petroleum	• Efficient transportation fuel for the world • Basis of many products, from prescription drugs to plastics • Economical to produce • Easy to transport	• High CO2 emissions • Found in limited areas • Supply may be exhausted before natural gas/coal resources • Possible environmental impact from drilling/transporting
Biomass	• Abundant supply • Fewer emissions than fossil fuel sources • Can be used in diesel engines • Auto engines easily convert to run on biomass fuel	• Source must be near usage to cut transportation costs • Emits some pollution as gas/liquid waste • Increases emissions of nitrogen oxides, an air pollutant • Uses some fossil fuels in conversion
Coal	• Abundant supply • Currently inexpensive to extract	• Emits major greenhouse gases/acid rain

	• Reliable and capable of generating large amounts of power	• High environmental impact from mining and burning, although • cleaner coal-burning technology is being developed • Mining can be dangerous for miners
Uranium	• No greenhouse gases or CO2 emissions • Efficient at transforming energy into electricity • Uranium reserves are abundant • Refueled yearly (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 issue
Geothermal	• Minimal environmental impact • Efficient • Power plants have low emissions • Low cost after the initial investment	• Geothermal fields found in few areas around the world • Expensive start-up costs • Wells could eventually be depleted

3.11 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, sand, aggregate for construction purposes. Transport of construction materials to the construction site will not be a big issue till the vehicles run on metal roads but will face problem as soon as they turn on the earthen tracks. The bearing capacity of these jeep-able tracks is low for heavy machinery transportation. It is visualized that transportation may be suspended during wet season due to worsened condition of the tracks.

3.12 FIRE FIGHTING

Firefighting hazards affecting fire prevention services with solar panel use. Firefighters must distinguish between the types of solar power used to work efficiently in the event of a fire. Without knowledge the type of panel used, firefighters' safety may be at risk. Hazards apparent in both types include flame spread, slipping and structural collapse due to added weight.

Firefighters and other emergency response teams require special training to work safely around solar energy technology. The fire related hazards of photovoltaic conversion for emergency responders are burns, electric shock, inhalation of toxic smoke, battery leakage and explosion and roof related injuries.

- A PV system includes an electric shock hazard.
- Fires that involve solar power systems can be one of three basic types depending on the point of ignition:

  (1) An external exposure fire to a building equipped with a solar power system;
  (2) A fire originating within a structure from other than the solar power system; or
  (3) A fire originating in the solar power system as the point of ignition.

3.13 Cleaning of Solar PV Modules

Silicon Energy (SIE) cascade photovoltaic (PV) modules have been selected for this plant which don't require frequent cleaning however some quantity of water required is required for cleaning of debris ,dust , silt , bird droppings etc. This area is semi-arid in nature with no rainfall which require necessary cleaning.0.149 cusec (365 tons/day) of water required for cleaning of PV modules that will be drawn from a tube well. The drawing of 0149 cusec of water will not affect the ground water quantity and quality. During cleaning of panels PV modules will be closed. Soft brushes will be used for leaves and dust removal from PV modules with special care to avoid any breakage of PV Modules.

CHAPTER-4
DESCRIPTION OF THE ENVIRONMENT
(Baseline Conditions)

4.1 INTRODUCTION

This chapter describes the baseline conditions, which cover the existing physical, ecological, and socio-economic environment of the Study Area. Information on these aspects has been derived from the desk study of available data, field visits to the project area as well as information obtained through visits to the Government departments and other agencies namely Irrigation Department, Meteorological Department, EPD, Forest offices and prevailing environmental laws and environmental quality standards present on the website of EPD Sindh and etc.

4.2 DESK STUDIES

Plant design data was collected from Siachen Energy Limited and this data included the available documents, drawings, reports, etc. related to the proposed solar power plant. The experts conducted a detailed desk study of the above available data before the field visit. Salient features of the Project were thoroughly reviewed to assess the environmental implications. Performa for social and economic baseline condition was designed for field survey.

The documents which were consulted and departments visited are Irrigation Department, Archeology department, Meteorological Department, EPD, Forest offices and other related officials and literature on internet.

4.3 SITE VISITS

A team of experts of "Sustainable Environmental Solutions" along with Mr. Syed Momin Zaidi (Resident Engineer) visited the proposed site of Solar Power Plant and had discussion on the structure and design of the plant and options for disposal of the waste water.

The project area is situated on the land of Sukhpur, Bhalki and Murjhar villages near Mirpur Sakro Ghulam mullah Town road and surrounded by barren land, with some patches of agricultural fields where wheat, rice and vegetable are grown. Environmental data on physical, ecological and socioeconomic aspects were collected for carrying out environmental assessment. Secondary data were also collected from various sources mainly reports and literature. An introductory leaflet was prepared about the features of the proposed plant among the people of the area. After some days, social survey of the project area was carried out through a questionnaire under which people living around the proposed plant area were interviewed to have their views about the plant installation and the perceived impacts on the natural environment around the proposed plant. This included information on socioeconomic conditions, project information and its possible impacts. Photographs of the various environmental aspects both inside and outside the proposed plant area were also taken and are given as Photo logs.

4.4 PHYSICAL ENVIRONMENT

4.4.1 Topography

760.12

The project site comprises about ~~850~~ acres of land situated in Sukhpur, Bhalki and Murjhar villages in Tehsil Mirpur Sakro district Thatta. It is flat area of Indus delta which has become saline due to non-availability of irrigation water. The water logged condition of the soil has led to the formation of small drains which collect the water and carry to the sea. It is 29 Km from Gharo village. The site has a flat topography with terrain slope of about 18-20 cm / km. The area is covered with barren land where shrubs are seen along the water channels/drains .Small drain pass by the land. No tube well bore exist in the proposed site.

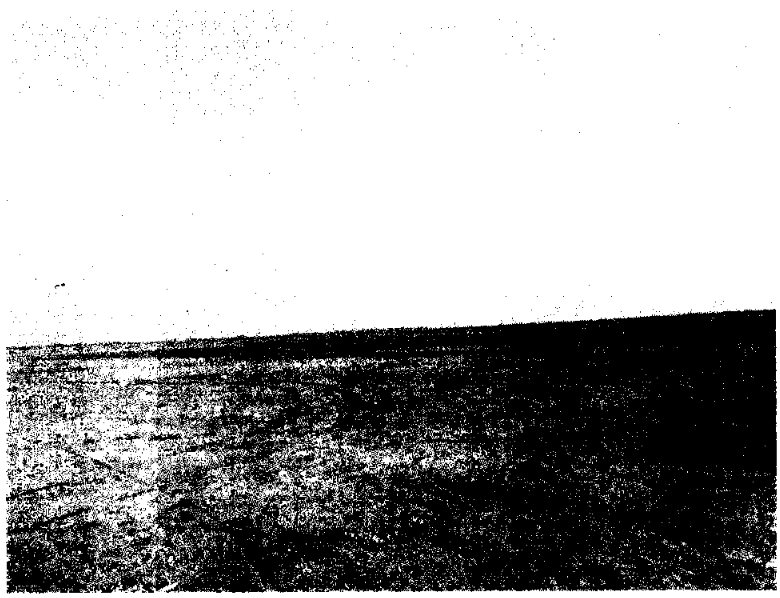
PP 4.1:Topography of site area

4.4.2 Soils

The soil of the district Thatta is of alluvial character of very recent origin formed by rivers and their changing courses and sand can be found a few feet below the surface. The course of the river Indus within Thatta area is winding and often subject to frequent alternations. In the rainy season, the currents are very strong. This leads to high floods in certain areas of district Thatta. Which do last for a number of days. According to the reports of District Disaster Management Authority and Trust for Conservation of Coastal Resources heavy rainfall occurred in 2010 which affected the 20 villages of Tehsil Mirpur Sakro having population about 10,000.The project area is not affected from flood. According to the past data of flood, the project is free from flood zone (page no.- 2 Trust for conservation of coastal resources).

Soil in the study area is dominated by light brown clay followed by silty and sandy clay. Arsenic content in the Ghulamullah soil is relatively higher (45-90: mean, 73µg/kg) than in Gujjo soil (44-78µg/kg, mean: 66 µg/kg) Similarly, Fe content in Ghulamullah soil (71-103 mean: 98 µg/kg) is also higher than in Gujjo soil (22-92, mean: 72µg/kg).In both union councils, clayey soil contains more arsenic (average, 79 µg/kg) than silty (average, 66 µg/kg) and sandy soil (44 µg/kg).

The Sakro canal has encouraged the water table levels in the project area. The geotechnical presence of the three distinct litho logical units is revealed in this area. First one is Lean Clay (CL) present in a firm to stiff state up to a depth of 3.0 to 4.0 m below NSL. Second is Silty fine Sand (SM) and poorly graded Sand with Silt (SP-SM) present in medium dense to very dense state following the top layer and extending up to maximum investigation depth of 30 m. Third layer is Lean Clay/Sandy Lean Clay (CL) of thickness ranging from 1.0 to 9.0 m is present at depths ranges from 14.0 to 23.0 m. The groundwater table was observed at a depth of 15 m below top of ground.



PP 4.2:Soil of site area

4.4.3 Seismology

Earthquakes are generated due to tectonic processes in the upper part of the earth called lithosphere, which is divided into several rigid parts called "Plates". Due to the movement of these plates, stress build up takes place and results in the deformation of the crustal mass in the form of folding and faulting. The energy produced due to movement along the faults is depicted in the form of earthquakes.

The Project site is located north of the collision zone between the Indian and Eurasian plates. This contact represented by the Himalayas has always been generating moderate to large earthquakes including Kashmir (2005), Kangra(1905),Nepal-Behar (1934) and Assam (1897 and 1950) that caused huge damage to life and property. Any major to large earthquake along Himalayan frontal faults can cause appreciable ground motion at site. The Sindh Plain, in which the Project is located, also shows low to moderate level of seismicity which is associated with the faulting in the Basement rocks covered by the alluvial deposits. A concentration of earthquakes has been observed west of the site between Shahkot and Sargodha which could be associated with faults in the Basement High. A minor to moderate earthquake originated from the Basement rocks in Sindh Plain could also produce appreciable ground shaking due to thick alluvial deposits. The project site lies in Zone III where ground acceleration of g/15 to g/20 is expected.

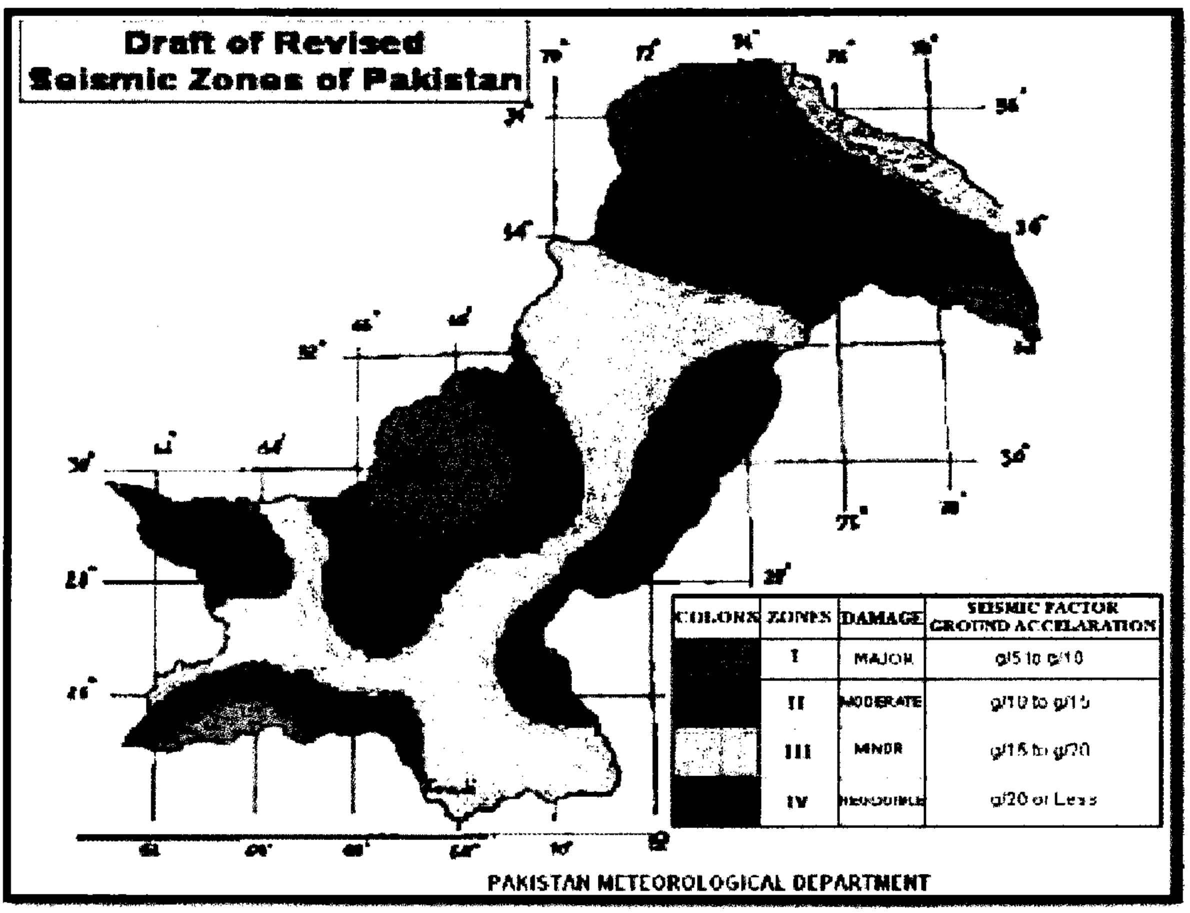
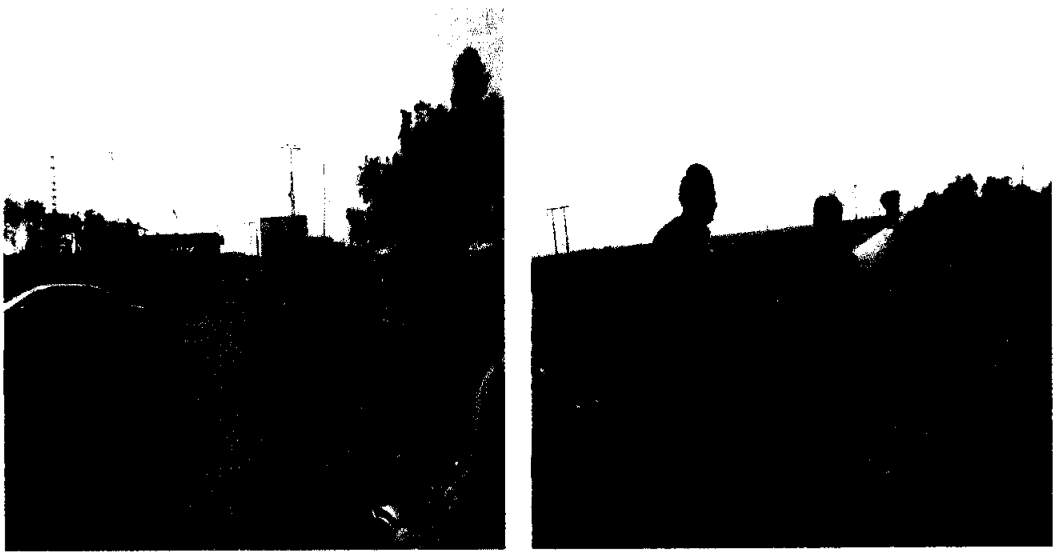


Fig 4.1 revised seismic Zones of Pakistan

According to Seismic Zoning Map of Pakistan included in the Pakistan Building Code Seismic Provisions (2007), district Thatta falls in Zone 2A, therefore project structures should be designed in accordance with the requirement of seismic designing Zone 2A after giving due consideration to the foundation material about 0.08 to 0.16 g.

4.4.4 Traffic

The site is adjacent to the Saman village near Mirpur Sakro Ghulamullah road which is 12 feet in width. The area is purely rural and very limited traffic is noted on Mirpur Sakro Ghulamullah road.



PP 4.3: Traffic movement near the site

Traffic density is very low. About 20 vehicles per hours were counted on and 31 October 2015. Motorcycles, tractors, rickshaw, car, bicycles, loader van, passenger van were among the motor vehicles. This traffic density has very limited contribution noise and air pollution generation. The railway track is far away from project area and therefore, air quality of the project site is almost clean.

4.4.5 Meteorology and Climatology

The project area lies in the plain lands of central Sindh. Summers are quite hot with moderate humidity, whilst winters are of extreme cold. Mean winter temperature (December/January) ranges between 19.8°C and 18.2°C. Mean summer temperature remains around 35 to 39°C with frequent spells crossing 40°C. The mean of the maximum temperature ranges between 36-40°C and mean of the minimum ranges from 10 to 15°C. Spring and autumn seasons are the most pleasant parts of the year and full of colorful activities. The season is divided into a dry period called "rabi" extending from October to March and a wet one called "kharif' with substantial precipitation (approx. 50% of annual total) occurring in July and August. Long-term climate trend data was obtained from the MET office, located at Karachi. The meteorological and climatic features of the project site are shown in **Table 4.1.**

Thatta has a hot semi-arid climate with rainy, long and extremely hot summers, dry and warm winters, a monsoon and dust storms. The weather of Thatta is extreme during the months of May, June and July, when the temperatures soar to 30–40 °C. From late June till August, the monsoon seasons starts, with heavy rainfall throughout the province. The highest average temperature recorded in summer is recorded in June that is 37.8 °C (100.4 °F) while the lowest was recorded in September that is 25.3 °C (77.54 °F).The lowest temperature recorded in Thatta is 10.9 °C (51.62 °F) recorded in month of January. The driest month is October, with 1 mm of rain. In July, the precipitation reaches its peak, with an average of 98 mm.

Table-4.1 Meteorological and Climatic features of the project site

Climatic features of the project area	
Classification of climate	Tropical (hot / humid)
Predominant wind direction	South west / West south
Wind intensity	Weak to moderate
Average annual precipitation	> 210mm
Rainy season	July to September

Dry season	October to June
Average annual temperature	18.2-26.8°C
Average summer temperature	35-40 °C
Average winter temperature	10.9-20 °C

The Project Area has extreme climate: it has hot and humid summer and cold winters. The summer starts from April and lasts till September. May, June, and July are the hottest months. The mean maximum and minimum temperature ranges from 37.8 °C and 25.9°C respectively for these months. The winter seasons last from November to March. December, January and February are the coldest months. The mean maximum and mean minimum temperature ranges from 18.2°C to 19.2°C in January. Few days earlier, temperature went down to 10 °C, ever minimum recorded in the history. Temperatures in the Project Area vary from 10 °C to 39 °C. The Project Area receives rains in all the seasons but monsoon rain is pronounced and constitutes a definite rainy season between the month of July and September. The average rainfall is about 210 millimeters per year. **Table-4.2** summarizes month-wise temperature, precipitation, and relative humidity. Based on climatic elements, five seasons are recognized in the Project Area:

Table 4.2: Average Monthly Temperature and Precipitation
Source: Meteorology Department

Month	**Mean Temperature**		**Precipitation (mm)**
	Maximum	**Minimum**	
January	25.5	10.9	5
February	28.3	13.4	8
March	32	18.5	5
April	36	**22.5**	3
May	37.8	**25.9**	3
June	36.8	**27.4**	17

July	34.8	[redacted]	98
August	33.3	[redacted]	50
September	33.8	[redacted]	15
October	35.2	22	1
November	32	17	2
December	27.2	12.4	3
Annual	**32.725**	**20.30**	**210**

4.4.5.1 Pre-monsoon Season

Pre-monsoon refers to the period from April to June prior to the setting of the monsoon. This is the hottest and the driest season, with persistent humid and hot winds. Day time temperature rises to 36 °C or even higher. The flows in the river begin to rise simultaneously due to melting of snow in the high mountains. The water table falls to the maximum depth.

4.4.5.2 Monsoon Season

Monsoon is the main rainy period, which starts at the beginning of July, reaches its climax in August and gradually, subsides in September. High intensity Rainfall causes soil erosion which is a function of erosivity and erodibility. The cool monsoon winds followed by heavy showers lower the temperature to great extent. The part of rain percolates into the soil and is conserved in the subsoil and part ads to the groundwater. It is one of the major source of ground water recharge. The conserved moisture in the soils is generally sufficient to rejuvenate the vegetation. All plants grow rapidly and mature towards the end of the season. With the start of monsoon season, the rivers flow at their peak level. The groundwater level is improved toward the end of the season in September and October.

4.4.5.3 Post-monsoon Season

Post monsoon season refers to autumn (October-November). The temperature starts falling but the extreme aridity prevents plants to flower early and set seed toward mid-seasons. Groundwater level rises as a result of infiltration from rainfall.

4.4.5.4 Winter Season

Winter refers to the period from December to January. Western Disturbance influence the winter season. The average lowest January temperature in the season of winter is 10.9°C (51.62F). While the average highest temperature in winter was recorded in the month of December which is of 27.2°C (80.96 °F). Heavy rains occur in winter which decreases the temperature further. Hailstorms also occur due to Western Disturbance. The highest monthly rainfall in winter occurs in February that is 8 millimeters. The plants become dormant and most of them dry out. Most of the trees shed their leaves and few remain green or partly green. Sometimes this season becomes severe due to cold Siberian winds. Groundwater level declines in this season due to low flows in the rivers and no or little rains which usually fall in light showers causing little soil erosion.

4.4.5.5 Spring Season

Spring refers to the period from February to April, when temperatures become pleasant. The highest average temperature of 36 °C (96.8 °F) in spring season was recorded in April while the lowest is recorded in March that is 18.5 °C (65.3°F). Rains are rare in the spring season. The highest average monthly rainfall was recorded in the month of Feb that is 8 mm. Some light showers of rain may also fall without generating run off. The vegetation sprouts again because of conserved moisture from winter and spring rains, if any. The water table starts falling.

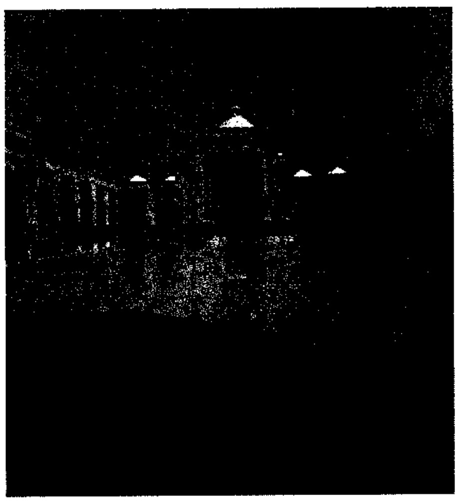
4.4.5.6 Rainfall

Towards end of June monsoon condition appears and during the following 2 and half months spell of season alternates with intervals of sultry weather. The winter rain falls during January, February and March ranging from 9 to 15 millimeters. Month wise mean precipitation recorded is given in **Table- 4.2**

4.5 Demography of the Area

4.5.1 Thatta

Thatta is a city and capital of district Thatta. It will be capital of the announced Banbhore Division. According to the 1998 census of Pakistan, it had a population of 1,113,194. It is a historic town of 220,000 inhabitants in the Sindh province of Pakistan, near Lake Keenjhar, the largest freshwater lake in the country. It has area of 17355 km^2. In August 2010 Thatta was one of the worst affected districts of Pakistan as a result of devastating floods. The sea was at high tide when flooded river water reached it, multiplying the damage. By August 28, 175,000 people had left their homes due to breached levees and were forced to camp on the main road under open sky Thatta's major monument, the necropolis at Makli Hill is listed among the World Heritage Sites. The Thatta is mentioned separately on the tentative list since 1993. Located 100 km (62 mile) east of the provincial capital of Sindh, Karachi, it makes for a practical escape for people from the city seeking to visit the attractive old town. Thatta is known to be the burial place of125, 000 (Sawa Lakh) saints; it also was a place of great learning where eminent scholars from Khorasan, Qandahar, Heart etc. had assembled. Thatta is also famous of being known as Door of Islam to subcontinent which symbolizes the famous entry of Mohammad Bin Qasim to the region.



PP 4.4 :View of Tomb Makli Hill and Shah Jahan mosque

4.5.2 Mirpur Sakro

Mirpur Sakro is a village located 45 km away from Thatta District while it's 68 km away from Karachi, Sindh. Mirpur Sakro is at an altitude height of 9 km. It's a small area having a population of 8371 settled in a scattered form and native language spoken here is Sindhi. The most prominent aspects of this village is, it's connectivity to Gharo-Keti Bunder highway and the Sakro Qabrustan (graveyard) which is around 2 km wide located in the middle of the village. As this village has a highway passing through it, transportation is not considered a hectic task for the natives. People of Sakro area usually work in fields and are farmers by profession or they are somehow linked agriculture to support their livelihood. Agriculture is usually carried through irrigation which possible in the area as Mirpur Sakro lies quite close to Sindh River. The landscape of the village comprises long cultivated field. Infrastructure of Sakro is not very advanced as there are usually cob houses while the roads are Kachi (unpaved). There are small health care centers or personal clinics here. Mirpur Sakro also have two government schools of matric level one for boys and one for girls and one private school Aga Khan School. The education of this area is not good. Only 0.5% students passed intermediate and 0.1% goes to universities for graduation. In inhabitants of Mirpur Sakro the Sindhi tribes and some Baloch tribes are settled here since 3 centuries.


PP 4.5: View of Mirpur Sakro

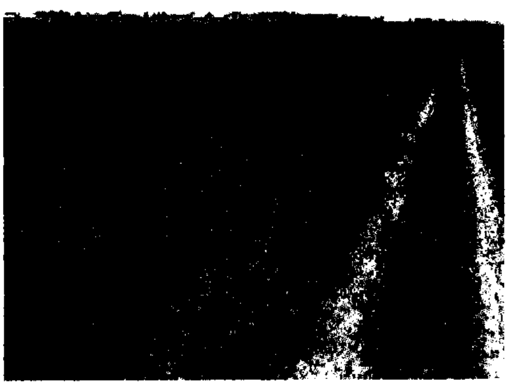
4.5.4 Education

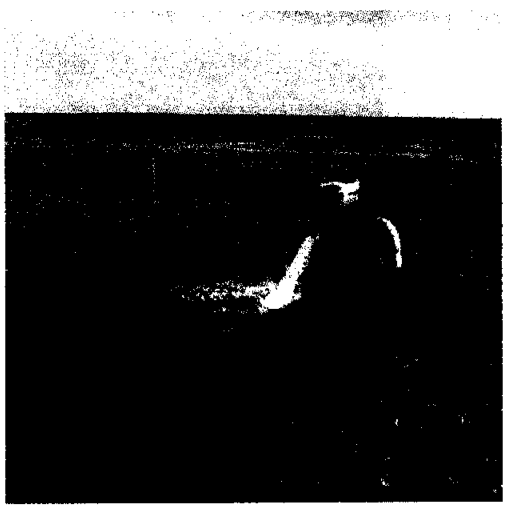
The education of this area is not good. Only 0.5% students passed intermediate and 0.1% goes to universities for graduation. The total literacy rate of the district Thatta is 22% (source, Socio economic baseline report of district Thatta by WWF).

- Government Higher Secondary school for boys and girls Mirpur Sakro
- Agha Khan School, Mirpur Sakro
- Government boys primary school Abdul Qadir Lashari
- Government primary school for boys and girls Gharo

4.5.5 Economy of Thatta

District Thatta is spread over 17,355 square kilometers with estimated population of 1,113,194 based on 1998 census. The density of population is 64 people/ square km which is the 2nd lowest in Province of Sindh after District Tharparkar. The figures shows that 80% of the population living below the poverty line in the district. District Thatta get the water from River Indus which flows from here till it meets to the great Arabian Sea in the south, District's economy based on Agriculture and Fishing is the 2nd largest source of income of the people, major portion of the population is related to these means of occupation. Main Crops are Rice, Sugarcane, wheat, Banana and Tomatoes.





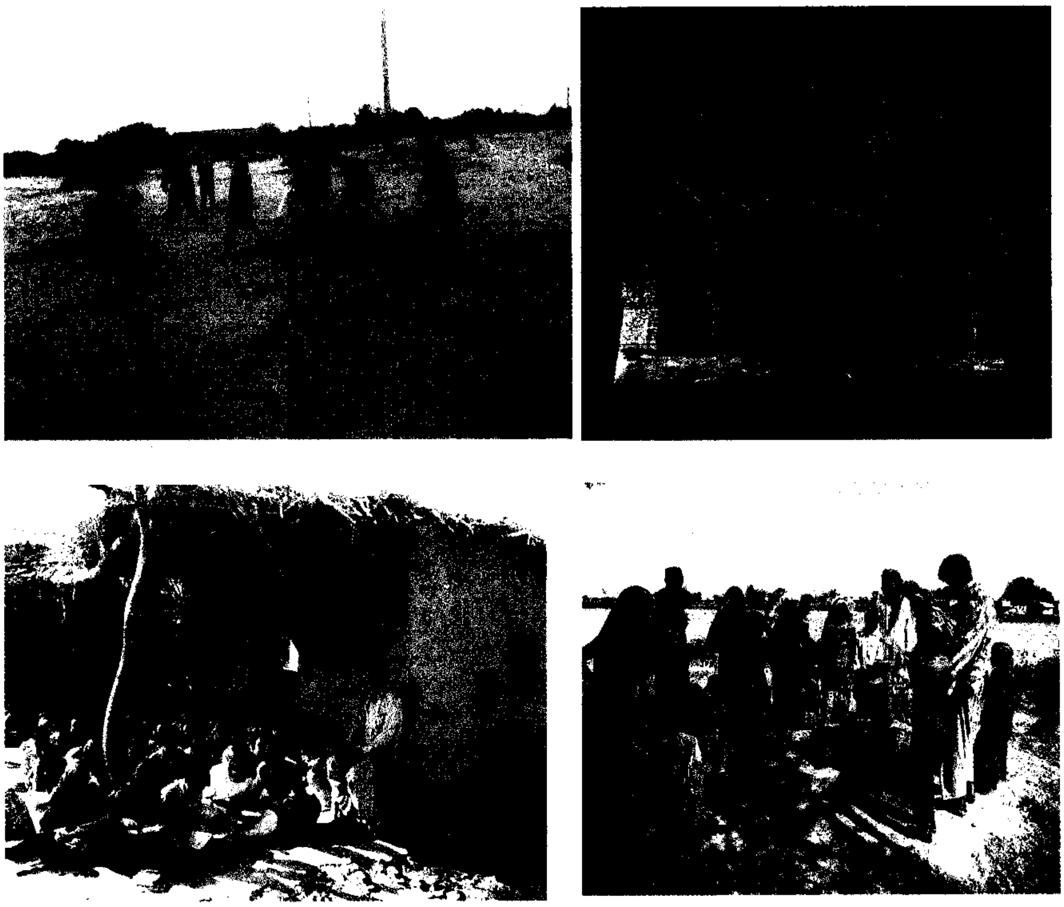

PP 4.6: View of Economic source in Thatta

4.5.6 Religion and ethnic groups

The majority religion in district Thatta is Islam, making up 96.0% of the city with small minorities of Christians (0.18%), Hindu (2.89%), and mainly Hindu and Ahmadis. The majority of Muslims belong to Sunni, Hanafi, and Barelvi schools of thought and Shiites are also present. The main ethnic groups in the district are, Sindhi, Lashari, Memon, Baloch, kodan , Khas Khaili, Hans, Johiya, Kathia, Syed, Brahui, Syal. But Lashari clan is dominant in project area.

4.6 Culture

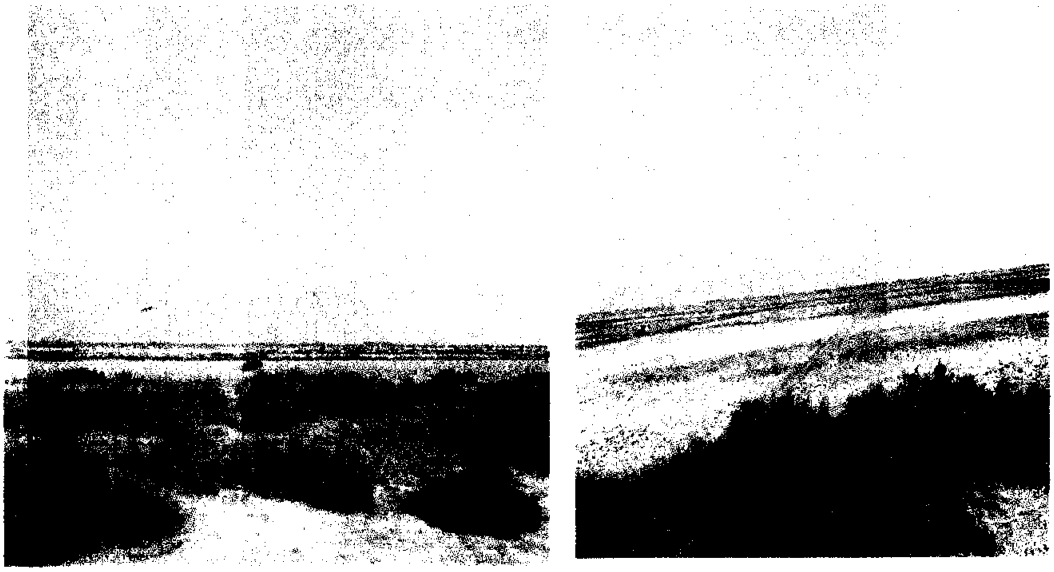
The city has been a focal point for many religions. Thatta's has probably largest number of monuments listed among the UNESCO's World Heritage Sites. It was the abode of the Alexander the great as well as a city favored and was inhabited by the scholar's poets and rulers. Shah Jehan the builder of Taj Mahal also built a mosque which is just as beautiful as Taj and stands in very good shape even today.



PP 4.7: cultural view of Thatta

4.7 Land use

The area is dominantly barren in nature. Wheat, rice and vegetable are main crops cultivated in some parts of the land here. Shrubs have been seen on edges of the water channels which add to the scenic beauty of the area. Pet animals and livestock are important source of income at the area. The area has no agricultural value.



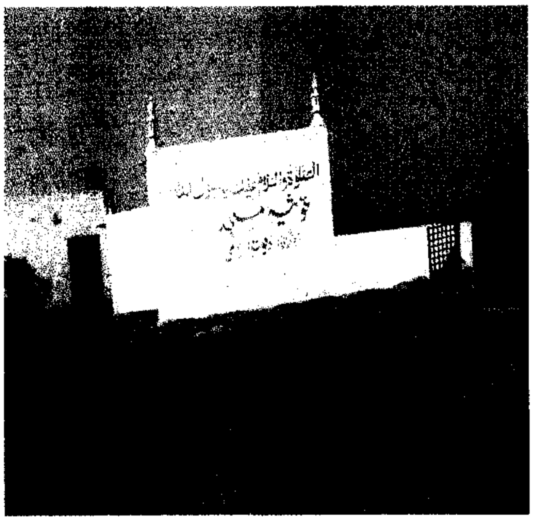
PP 4.8: Dominant barren land

4.8 Recreation and Tourism.

No recreational park or tourism site was found near the proposed site.

4.9 Infrastructure and Basic Facilities

The project area is under developed one. It is about 10 Km away from Tehsil Mirpur Sakro. The streets of the villages are semi-paved and unpaved. High schools of boys and girls are present in Mirpur Sakro, whereas Gharo has one basic health center in it where facility of doctor and medication are insufficient to cater of the requirement of the area. For surgery and better treatment and diagnostic they have to resolve to the city of Thatta .The village is lacking the facilities of gas, sewerage system, water supply system. The education level of the people is not good. Most of the people are illiterate to under matric. The new generation has the trend of achieving of the education. Government high school boys and girls are contributing significant role in increasing the literacy rate of the area.



PP4.9: Infrastructure near proposed project area

4.10 WATER RESOURCES

4.10.1 Rivers

The site is located in alluvial plain of Indus River which passes about 45 km on its Western side. The area is a flat, alluvial plain and saline not suitable for agriculture, with least agricultural value .It is located 45Km away from the river Indus which acts as the major recharge source of the subsoil water. Ground water is used as source of water for domestic and agriculture purpose. Therefore, there is no usage of river water in this project.

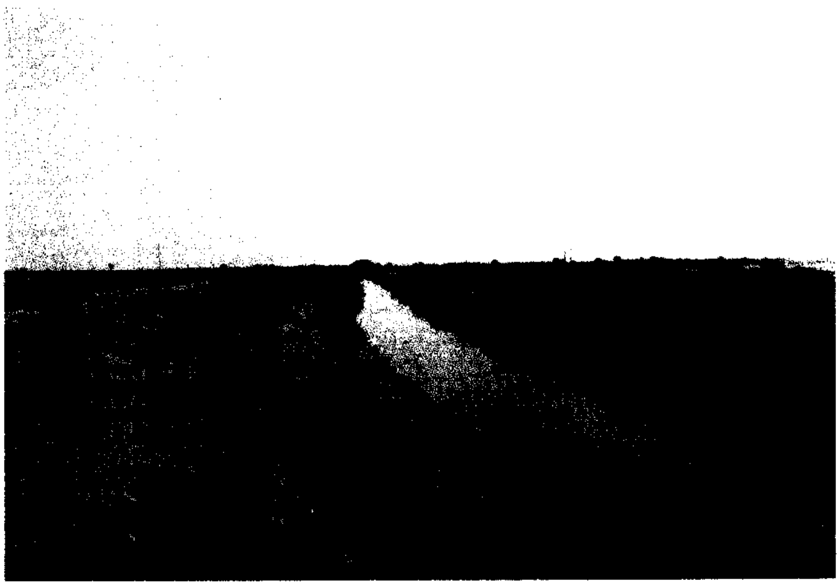
4.10.2 Canals

The important canal of the area is Sakro canal. Which passes about from 1km the proposed site the canal carries about 400 cusec of water. The proposed project will not take water for cleaning of PV modules from this canal. Results of canal water are attached at **Annex VII.**

PP 4.10: View of canal near project area

4.10.3 Drains

There is a drain passing by the proposed site area.



PP 4.11: View of drain passing by the project area

4.10.4 Groundwater

Groundwater in Thatta district is highly saline, due to semiarid climate, excessive evapotranspiration, connate water and recent seawater intrusion affecting soil and groundwater quality of this area. Depth of the wells in the area is very shallow, which led to the microbiological contamination of groundwater through unlined sanitation pit toilets and surface runoff. Elevated concentrations of arsenic in the soil and groundwater of the study area are mainly associated with abandoned courses of Indus River, and confined to Holocene fine grained, silty, clayey organic rich sediments. Biogenic reductive dissolution of Fe-ox hydroxides release arsenic from these sediments in the groundwater. Moreover, in Ghulamullah area, high concentration of arsenic as compared to Gujjo area is due to soil texture and mineralogy and prevalence of anoxic conditions in Holocene aquifers. The bacterial contamination of groundwater is causing heterogeneous local reducing conditions in the aquifers which may trigger the mobilization of arsenic in groundwater. Thus, both gelogenic and anthropogenic factors have contributed to the arsenic contamination of soil and groundwater in the study area. In Ghulamullah groundwater arsenic content ranges between 10-200 µg/Lin 10 out of total 14 shallow wells in the area, seven As contaminated wells were also found sewage impacted. While, in Gujjo groundwater, only three wells out of total 23 were found contaminated with As in the range of 10-20 µg/L. According to the report of Department of geology University of Karachi which published in Journal of Himalayan Earth Sciences Volume 47,(No. 2, 2014, pp. 175-183) describe the ground water quality of district Thatta The pH values of Ghulamullah groundwater are 6.7-8.1 (average, 7.5) and total dissolved solids concentrations are 267-1619 mg/L (average, 839 mg/L).The concentration of As is reported in water sample is 0.047 mg/L which is below the 0.05 mg/l National standard for drinking water quality.

PP 4.12: Sampling of existing underground water extraction sources

The analysis showed that the water is chemically fit with respect to NEQS for drinking water 2010. TDS concentration is below the NEQS standard but it is relatively higher side for industrial use. The chemical analysis of the groundwater is **summarized in Table 4.3.**The results of ground water are attached at **Annex VII**

Table 4.3: Analysis of Groundwater Samples

Sr. No	Parameter	Value
1	Colour	Colorless
2	pH	7.26
3	Conductivity	990 us/cm
4	Total Dissolved Solids (TDS)	490 mg/L
5	Total Hardness	62mg/L
6	Bicarbonate alkalinity	262mg/L
7	Arsenic	0.013 mg/L
8	Fluoride	0.18 mg/L
9	TSS	16.6 mg/L
10	Temperature	24 ^{0}C

4.10.5 Floods

In Pakistan, rainy season (monsoon) starts from June and lasts till September. The average rainfall in the district is 100 mm per year. In 2003 the rain started in the first week of June and lasted till August 2003. The total rainfall was more than 250mm and it created an emergency situation in the district, resulting in massive life loss and damage to crops, livestock and infrastructure. The rainfall below 100 mm is not alarming and is found to be manageable, but the rainfall exceeding the limit of 100mm will require immediate action. In August 2010 Thatta was one of the worst affected districts of Pakistan as a result of devastating floods. The sea was at high tide when flooded river water reached it, multiplying the damage. By August 28, 175,000 people had left their homes due to breached levees and were forced to camp on the main road under open sky. According to the reports of District Disaster Management Authority and Trust for Conservation of Coastal Resources heavy rainfall occurred in 2010 which affected the 20 villages of Tehsil Mirpur Sakro having population about 10,000.The project area is not affected from flood. According to the past data of flood, the project is free from flood zone.

4.10.6 Precipitation

In Pakistan, rainy season (monsoon) starts from June and lasts till September. The average rainfall in the district is 200 mm per year. In 2003 the rain started in the first week of June and lasted till August 2003. The total rainfall was more than 250mm and it created an emergency situation in the district, resulting in massive life loss and damage to crops, livestock and infrastructure.

4.11 Noise Levels

The major source of noise at the project Site is the vehicular traffic on the Mirpur Sakro Ghulamullah Road. The log equivalent of noise in the center of site was measured 45.67 dB (A). The noise at main road was measured 46-65 dB (A). When any motor vehicle presses horn the noise level goes up to 70 dB (A) which is not routine at this sight. Project area, however, fall under a sort of silence zone, i.e. noise level is around 45.15 dB (A).The result of ambient noise monitoring is attached at **Annex VI**

PP4.13:Measurement of noise levels

4.12 Air Quality

The air quality of the project area is clean, but there is no permanent environmental monitoring station in the whole Area. During the site visits it has been observed that ambient air is clean at present as no heavy industry or other source of air pollution exists in the project area. There is no air pollution source near proposed solar power plant. The results of environmental laboratory are attached at **Annex- VI.**

Table-4.4: Air quality Monitoring Data at Project Site

Sr. No.	Parameters & their Concentrations					
	CO (mg/m^3)	NO_2 ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	O3 ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
	1.06	3.61	8.81	7.36	82	20.31
NEQS for Ambient air	5	80	120	130	150	35

PP4.14:Measurement of air quality

4.13 BIOLOGY

The project area lies in purely barren land with some patches of agricultural land. Soil quality is saline and water logged having least agricultural value. The area has no forest only wild herbs and shrubs of no importance are seen growing .All the shrubs found there are of xerophytic and halophytic in nature. Wheat, rice, vegetables and various fodder crops like Bajra, Charri, Jantar ,barseem etc. are grown in agriculture area.

4.13.1 Fauna

In Thatta there are areas which can truly be classified as places of breeding, nesting and roosting for several bird species. The common animals at site are dog, cat, cow, goat, buffalo, sparrow, snake, turtle, oxen, sheep, squirell, crow, nightingale, and cuckoo. Some of them are reared as livestock while some of them are native to this area.

PP. 4.15:Fauna species of the project area

Only some of them were seen in the project area i.e sparrow, crow, crane, frog, duck, dove, and larks.

Not only the birds, but different other classes of the animal species also play an important role for the habitat of the area. The main animals which may be found in Sindh are as shown in **Table-4.5.**

Table-4.5: List of Different Classes of Animals

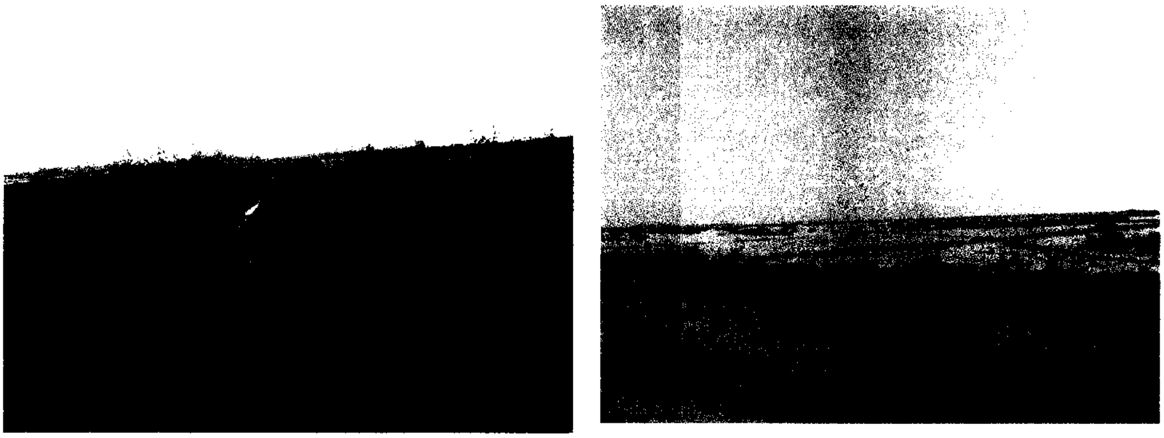
Mammals	Reptiles	Amphibians	Insects
Stray dogs	Monitor Lizard	Indus valley bullfrog	Dragonfly
Feral cats	Geckos	Common frogs	Damselfly
Donkeys	Snakes	Toads	Butterflies
Cows	-	-	Honey bees
Bats	-	-	Earthworms
Goats	-	-	Centipedes
Small Indian mongoose	-	-	-
Indian palm squirrel	-	-	-
Buffalo	-	-	-
Mole	-	-	-
Horse	-	-	-
Sheep	-	-	-

Source: WWF

However, site is barren in nature and therefore, it is the habitat of the animals like dove, squirrels, crow and two ducks which were swinging in the rain water accumulated at site. The pet animals of farmers were seen near the proposed site.

4.13.2 Flora

The present site topography shows that it barren land. The rice, vegetables and chara were present near the proposed site. About 200 small and large shrubs are present at site out of them 10 trees of Acacia and prosopis were found. No other species was noted at the proposed site.



PP4.16: Flora of the project area

4.13.3 Endangered Species

There was no endangered species found on project site.

4.13.4 Sensitive Habitat

No sensitive habitat has been seen or reported by any authority in or around the proposed site.

CHAPTER -5

PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

5.1 SOCIO-ECONOMIC SURVEY OF THE PROJECT AREA

Consultation with the stakeholders is a tool for managing two way communication between the project sponsors and the public. Its goal is to improve decision making and build understanding by actively involving individuals, groups and organizations which have a stake in the project. This involvement increase project's long term viability and enhances its benefits to locally affected people and other stake holders.

5.1.1 Methodology

5.1.1.1 Identification of stakeholders

Stake holders in this project were identified keeping in view the **Guidelines for Public consultation published by Sindh EPA, 2014**. The stake holders were identified from the following groups.

a) Local people
b) Proponents
c) Government Agencies
d) NGO
e) Influential people
f) Technical persons
g) Poor People

5.1.1.2 Techniques for Public Consultation

The following principals were kept to select the techniques or public consultation

- Provision of material / information in easy language
- Providing sufficient time to understand
- Providing discussion to understand the information in a friendly way
- Portraying the actual issues relating to the project

- Discussion at the place which has easily access to the people
- Selection the time when maximum people are available
- Selection of influential people of project area
- Including of poor people
- Selection of people who give true presentation of community make up
- School teachers of the area were included in public consultations
- Basic health centers and union council office of the area were consulted
- Concerned government departments were selected who had liaison with the execution of the project and environmental approval.

5.1.2 Dissemination of information

The IEE team reviewed the available information, held meetings with the proponent and designer. The pamphlet was distributed to the public in informal meetings group discussion and corner meetings at Public and work places of Mirpur Sakro villages and proposed site. An ample time of one week was given to the people to understand and discuss the issue with each other and make any opinion about the project. The image of the leaflet is given below:

PP5.1: Distribution of leaflet in Urdu to the people 31 October , 2015

5.1.3 Public Meetings and Group discussions

The area is barren and rural in nature therefore we decided to hold physical contact instead of using print or electronic media. The group discussion is the way of opinion making used in the Sindh since hundreds of years. It is reliable and unbiased way to get opinion of the people. The seminar or public gathering was avoided as the poor people cannot attend and unable to express his views without duress or influence of Chaudhry or wadera of the area or village.

5.1.4 Convenient Time and Place

The people in villages do not move away from village except in case of urgency. We went to them on their residences or work places. In this way no time and money of the people was spent and we got indiscriminate access to the concerned people. In this way the people who do not have money to travel to go to government departments got access to information and had opportunity to express his opinion in a liberal way.

5.2 Limitations of the Public Consultation

We tried our best to include all segments of life in to account according to education and professions as per local distribution of the social formation. They do not want to give any sign or photograph. Almost 20 people from different segment of society have been interviewed to know the public aware and response towards the implementation of this project in Tehsil Mirpur Sakro who were interviewed these were some educated who had clear and positive opinion about the solar power plant. They want prosperity of the area. They showed their interest for the installation of solar power plant.

5.3 Questionnaire

After review of the available information a questionnaire was developed containing all necessary information and question covering positive and negative aspects of solar power plant. The questionnaire comprised of two parts. First part has brief description of the project and part II was divided in the following parts:

- Socioeconomic background
- Positive impact of the solar Power plant

- Acceptance level of the Project.

5.4 Public Consultation

The following stake holders were identified and meetings were held with them to inform them about the project design and know their response

- Land owners of project site
- Numberdar of the villages
- Teachers of the schools of village Mirpur Sakro
- Dispenser posted at Mirpur Sakro health dispensary
- Shopkeepers of Mirpur Sakro
- Farmers
- Laborers
- Contractors of fish farm at site
- Management of the Siachen Energy Limited
- Residents of the area

After one week of the distribution of the leaflet on the project information, a socio-economic survey of the Project Area was carried out with the help of structured questionnaires to identify various stakeholders and to record their feedback regarding the proposed Project. The socio-economic information was gathered through different techniques and methodologies and is derived from primary and secondary sources. Primary data were collected through following data collection tools: (i) Village profiles; (ii) Socio economic survey; Village profiles were carried out for all villages/settlements falling in Project Area.

An introductory leaflet about basic information of the project was prepared in Urdu and distributed among the people at public places. This helped the people to understand about the project pros and cons. After one week the area was revisited by the team of experts and again asked the opinion of the people about the project in the form of well-designed social survey questionnaire. Public consultations were also conducted in the villages of Mirpur Sakro and Gharo.

Siachen Energy Limited

Table 5.1: People participated in Social survey

Sr. No	Name of village	Population	People participated in briefing	Questionnaire filled	Concerns
1	Hoti Khan Lashari	Approx. 500	6	1	Social work college
2	Qadir Bakish shoro	Approx. 200	4	1	Hospital Employment
3	Dah Supkhupur	1000-1500	10	2	Hospital Employment for the people of the area
4	Sukhpur	400	10	2	-
5	Abdul Qadir Lashari	500	15	3	-
6	Mirpur Sakro	10000	30	3	Employment for local people
7	Saman village	35-40 huts	15	3	Employment Teacher Staff for school

					should be provided
8	Gharo	500	10	5	Employment for village people

5.5 Issues Discussed

Following issues were discussed during the stakeholder consultation:

i) Personal information

ii) Education status

iii) Income level

iv) Residence status

v) Information about project

vi) Possible impacts on natural vegetation, land and properties;

vii) Beneficial factors and involvement

viii) Opportunities for the local people.

ix) Adverse effects of the project

x) Scope of the report

xi) Acceptance of the project by the people of the area

xii) Scope of the environmental assessment report

Different segments of the society were included to reflect the true and unbiased opinion. From numberdar to labor all segments of the project area were interviewed. Were also interviewed through a questionnaire which showed the following results:

Table 5.2: Socio Economic Survey

a) Gender:

Male	20
Female	0

b) Education level:

Primary	10	50%
Under matric	6	30%
Matric	1	5%
F.A	2	10 %
Graduation	1	5%
Post-graduation	0	0 %

c) Occupation:

Farmer	12	60 %
Labor	5	25%
Shopkeeper	2	10%
Government service	1	5%

d) Water pollution problem:

Concerned about water pollution	0	0%

Don't show any concern about water pollution.	20	100%

e) Employment chances Direct and indirect:

Yes	20	100%
No	0	0%

f) Reduction in Load shedding period:

Yes	20	100%
No		0%

g) Consent on project implementation:

Yes	20	100 %
No	0	0%

5.6 Apprehensions of the people of the area

- Low employment offer to local people during operation phase

5.7 Mitigation of the Peoples Apprehensions

i) No resettlement is involved

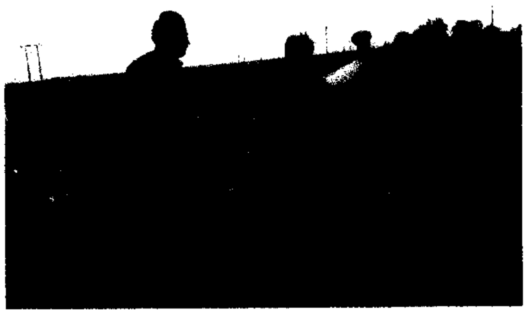
ii) More opportunities will be offered to local people of the area during construction phase and operation phase.

iii) There will be an increase in dust, noise and smoke emissions during construction which may be mitigated through compliance for NEQS for motor vehicles , dust suppression through sprinkling of water and controlled speed of motor vehicle during construction phase and paving of the access road within the plant

iv) Proper parking area should be provided in the design for the supply of construction machinery/material during the construction phase and during the operations.

v) It will enhance the life standards of the community.

vi) It will create employment opportunities.



PP5.2: Pictorial presentation of social and economic survey of the area

CHAPTER -6

ANTICIPATED ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

6.1 INTRODUCTION

The proposed project may have impact on the environment during construction & operation phases. During the construction phase, the impacts may be regarded as temporary or short term; while long term impacts may be observed during the operation stage. Spatially the impacts have been assessed over the study area of 2 km radius of the project site. The project has overall positive impacts by providing a compe293titive, cost-effective, pollution free reliable mode of Solar PV power. It will supply 95 MW electricity to the national grid which will certainly reduce the gap between demand and supply of power.

6.2 POTENTIAL ENVIRONMENTAL IMPACTS

Determining the significance of impacts identified is one of the main purposes of this IEE and it enables the identification of necessary mitigation and a determination of environmental and social costs associated with the project. Environmental and social impacts of any project are identified taking into account all phases of the project cycle, including planning, construction, operation and decommissioning. The environmental issues and impacts of a project depend on the nature of the project activities, and the types and extent of interventions involved. It is not easy to predict the future and assign a relative value or overall significance to an impact, since every impact has a different and multi-dimensional nature, and also because it involves personal and subjective judgment for many attributes. An environmental or social impact can be either beneficial or adverse and is assessed by comparing the quality of the existing environment with the predicted quality of the environment once the project is in place.

This IEE identifies the impacts likely to arise as a result of construction and operational activities and assesses the likely magnitude of the impact in order to provide some indication as to which impacts are likely to be most significant. A full determination of the significance of the identified impacts, based on an assessment of the magnitude in relation to the sensitivity of the receiving environment has been formed part of the IEE.

During the construction phase, the following activities may have impacts on environment:

- Site clearance
- Minor excavation and levelling
- Hauling of earth materials and wastes Cutting and drilling
- Erection of concrete and steel structures
- Road construction
- Painting and finishing
- Landscaping and afforestation

6.3 POSITIVE ENVIRONMENTAL IMPACTS

It is envisioned that the implementation of solar power unit in dist. Thatta will pose following positive impacts on the environment for which no mitigation is required:

- It will be a source of clean and renewable energy and its 10 to 20 years viability can grant a lot of economic and financial benefits to the country.
- On the basis of reduction in the GHG emission, this project may qualify for Clean Development Mechanism (CDM).
- Comparing solar with coal-fired power plant, it will reduce the discharging of various atmospheric pollutants and a large amount of ashes for each year to improve the environmental quality.
- It will become the local scenic spot of science, education and tourism, which will be beneficial to promote the development of the local tourism industry. Meanwhile, it will also develop local tertiary industry to improve quality of life of the settlements around. In addition to that better social and environmental benefits are visualized.

Some more significant positive impacts on the vegetative cover of desert surface can be assessed. For instance, large scale arrangement of solar cell panels may block direct sunshine up to some extent, large spaces between the lines of photovoltaic cell can still absorb solar energy at various times of the day which may reduce the evaporation capacity of the desert surface which otherwise very high under dry desert conditions. It will create the condition for a little longer water storage capacity of the surface to promote surface vegetation. Regular washing of solar cell panels will obviously soak the earth surface which will attain water supplement at regular intervals. Coupled with rainwater and sunshine, Vegetation will be increased easily on the confined area. On the same footprint, confined area under solar panels will provide favourable condition to the recovery of vegetation, as well as the fence will not allow grazing animals or people to enter so vegetation and small wild animals will be protected.

This phenomenon will therefore provide favourable conditions for the recovery of lost habitat of the flora and fauna. The dwarf grand flora (desert vegetation) having lower height than panels will be expected to grow significantly, also called forestation, because they will revive regular supply of water which is released after washing solar panels. This project will be a source of clean and renewable energy, despite the high initial cost but its 10 to 20 years viability can result in economic and financial benefits to the country.

6.4 ADVERSE ENVIRONMNETAL IMPACTS

Besides positive environmental impacts, a number of adverse environmental could also be assessed if proposed solar power generation project is implemented. Almost all adverse environmental impacts will be of temporary nature, thus short term mitigations are required. Following is a brief account of the impacts:

6.4.1 Environmental Impacts during Construction Phase

The environmental impact during construction phase is localized and of short term magnitude. Impact is primarily related to the civil works and some intensive impact due to erection of the equipment. The details of the activities and probable impacts are given below in table 6.1.

TABLE 6.1: ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION PLAN (CONSTRUCTION PHASE)

Construction	Environment	Probable Impacts	Mitigation Measures
Activities	**Attribute**		
Land Acquisition	Land	• No significant impact on land-use is expected.	No mitigation required
	Socio-economics	• No adverse Impact due to Rehabilitation & Resettlement • Issues is expected as local wasteland is being procured for the project.	Positive outcome is expected in implementation of the project in the form of job opportunities ,flow of money and reduction in load shedding
Site clearing and Leveling (cutting, stripping, excavation, earth movement, compaction	Air	• Fugitive Dust Emissions • Air Emissions from construction equipment and Machinery	• Water sprinkling for dust suppression , pavement of access roads, cleaning of the roads, low speed of trucks • NEQS for vehicular emission will

			be complied by the construction machinery and exhaust of the same will be monitored and reported to EPS Sindh.
	Noise	• Noise pollution	• The contractors should ensure the use of low noise and low vibration construction equipment. • Regular service for construction equipment should be ensured and some workers may be trained in machinery operation to hold charge of some machines

			according to operation specifications
	Water	• The site is plain therefore runoff limited level may happen	• The soil will be removed as soon as generated. The extra soil will be used to upgrade the low level area in the site.
	Land	• Loss of top soil at limited level	• Most of the PV panels are placed above the ground level and hence top soil will remain intact.
	Ecology	• Minimal loss of vegetation or habitat as the site is Barren land with almost no vegetation.	• Almost two time Plants and trees will be replanted after completion of the construction
Transportation and Storage of	Air	• Air Emissions from vehicles	• NEQS for vehicular

Construction Material or Equipment		• Fugitive Dust Emissions due to traffic movement	emission will be complied by the construction machinery and exhaust of the same will be monitored and reported to EPS Sindh • Speed of traffic will be kept slow to avoid any dust emission. pavement of access roads, cleaning of the roads and water sprinkling will be done on the loose soil, soil will be removed as soon as it is generated
	Water	• Runoff from Storage Areas of construction material	The rainy season in the area is limited to

			the moon soon period. The concrete batching plant should be set within the enclosed construction camp.
	Public Utilities	• Slightly Increased flow of traffic on Mirpur Sakro- Ghulamullha town road	• There is very few traffic on this road and addition of almost 5 trucks a day can be easily accommodate d.
Mech. and Elec. Erection Activities	Air	• Air Emissions from Machines or activities	• All the machinery employed during construction will be compliant of NEQS for vehicular emissions.
Influx of Labor and construction	Socio-economics	• Employment opportunities shall increase	• Camps will be maintained within the

of temporary houses		• Stress on infrastructure	plant premises • Local people will be employed during construction phase
	Land	• Change in land use pattern	• There will be positive impact of the project on land use
	Water	• Sanitary effluents from labor camps	• The sanitary waste water will be collected and treated in three stage aerated septic tank before its disposal.
Transportation and disposal of construction debris	Air	• Air Emissions from Transport Vehicles • Fugitive Dust Emissions due to Movement of traffic.	• Employment of trained staff • Speed of traffic will be kept slow to avoid any dust emission. pavement of access roads,

			cleaning of the roads and water sprinkling will be done
	Soil	• No Conversion of land into waste land as already barren land.	• There will be no impact on soil as minimum construction is involved in solar pv park and least debris will be produce during construction • The reusable items will be sold into the market whereas the inert debris will be disposed at the designated solid waste dumping site in Tehsil Mirpur Sakro

6.4.1.1 Impact on Land Use

The land required for the proposed solar PV project will be about ~~850~~ 760 acres. The construction activities attract a sizeable population and the influx of population is likely to be associated with construction of temporary hutments for construction work force, having an effect on land use pattern of the areas surrounding the project. The previous use of land was barren but after installation of 100 MW solar power project, it will convert into productive land giving the income about 15 times more than the existing output.

6.4.1.2 Impact on Soil cover

As the construction activities for the solar power project would be confined in the wasteland, the impact on soil will be minimal and confined. Only cutting and filling is required during construction. The construction activities result in not any significant loss of vegetation cover as the land is barren or hardly covered with the small shrubs and topsoil in the plant area. No adverse impact on soil in the surrounding area is anticipated. However, in order to minimize such impacts, appropriate soil erosion control measures would be undertaken by Siachen Energy Private Limited to conciliate the chances of soil erosion. Completion of excavation and foundation work in limited time schedule would also reduce or minimize the chances of soil erosion.

6.4.1.3 Impact due to Solid Waste

Solid waste during the construction phase consists primarily of scrapped building materials, excess concrete and cement, rejected components and materials, packing and shipping materials i.e. Pallets, crates, Styrofoam, plastics etc. and human waste. During the construction there will be generation of garbage, for which selected practices of solid waste disposal will be adopted. Recyclable or reusable material will be separated while other nonhazardous waste will be disposal on the designated solid waste disposal facility of TMA.

6.4.1.4 Impact on Air Quality

As the proposed project is Solar PV Project, the impact during construction of project is expected to be minimal as a barren land Project plant. Particulate matter in the form of dust would be the major pollutant affecting the air quality during the construction phase. Dust will be generated mainly during excavation, back filling and hauling operations along with transportation activities. However, a high boundary wall will prevent the dust generated due to construction activities going outside the project area. However, a high boundary wall will prevent the dust generated due to construction activities going outside the project area. The main source of gaseous emission during the construction phase is movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO_2, NO_X, and particulate matter. The impact is reversible, marginal and temporary in nature.

6.4.1.5 Impact of Noise

The major noise generating sources during the construction phase are vehicular traffic, construction equipment like dozer, scrapers, concrete mixers, cranes, generators, pumps, compressors, rock drills, pneumatic tools, vibrators etc. The operation of this equipment will generate noise ranging between 75 – 90 dB (A).

To minimize the impact on nearby communities, construction schedules have been optimized. Also the noise level is substantially lower near the plant boundary due to attenuation caused over the distance. Overall, the impact of generated noise on the environment during construction period is insignificant, reversible and localized in nature.

6.4.1.6 Impact on Water Quality

The construction personnel would be housed in temporary settlements. These settlements would discharge considerable amount of domestic wastewater. Stagnant pools of water would increase breeding of mosquitoes and generally create insanitary conditions. The municipal waste water from the plant will be treated in a waste water treatment plant before final disposal into the drain passing by the project area with permission of irrigation department.

6.4.1.7 Ecological Impact

The project site is mainly barren land and there are no settlements near the site. The impact of the construction activities would be primarily confined to the project site. Since, the entire land is barren land with some xerophytic plants and halophytic shrubs in nature. Thus, the site development works would not lead to any significant loss of important species.

6.4.1.8 Impact on Labor Health

The adverse impacts on worker's health will occur mainly during the construction period because the infrastructure building is relatively a crude operation. If the HSE management measures are unfavorable for dietetic hygiene, drinking water and environmental sanitation, they may increase the probability of spreading the infectious diseases.

Sufficient supply of potable water will be provided at camps and working sites. If the drinking water is obtained from the intermittent public water supply then storage tanks will be provided. All water supply storage may be at least 15m away from the toilets or drains. At every Camp first aid facility will be provided. Suitable transport will be provided to take injured or ill person to the nearest hospital.

6.5 Environmental Impact during operation phase

Various activities of operation and maintenance phase and their probable impacts on various sectors of environment are presented in table below.

Table 6.2: ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATION PLAN (O&M)

O&M Activities	Sector	Probable Impacts	Mitigation Measures
Land use		No adverse impact	No mitigation required
Transportation	Air	No regular transport of material is required so the impact will be negligible	No mitigation is required
Water Treatment for various Uses	Water	• Generation of Wastewater due to PV	• Since the water is used for PV module

		Cleaning Modules • Generation of sanitary waste water due to public utility	cleaning purpose. No treatment is required except passing of this water over a sump with baffle to separate the suspended solids • The sanitary waste water will be collected and treated in three stage aerated septic tank before its disposal.
Operation of Transformers	Water	Generation of effluents containing oil	This water will be collected

		separately for oil removal.
Air Emission	No emission during the operation phase	No mitigation measures required and project is environment friendly
Light Pollution	Adverse impact. May diverse it may disturb the drivers due to reflection of sunlight from panels	Setting of PV panels at angle of $45^0 - 60^0$ and they are installed at 3-4mm high
Pumping of Ground water for Cleaning Purpose	Small amount of water will not impact the subsoil water reserve	No Mitigation Measure required
CO2 Reduction	No CO2 emission. 0.948 tons per megawatt CO2 is reduced	Positive Impact
Electromagnetic radiation	No impact on telecommunication system	No mitigation measure required

6.5.1 Impact on land use

The proposed project will be set up on barren land. The site, after completion of its development, would consist of built structures, landscaped to give a pleasing outlook. Land released from the construction activities would be put to economic and aesthetic use to rush recovery from adverse impacts.

6.5.2 Impact on Soil Cover

Most impacts of Solar PV project on soil are restricted to the construction phase, which will get stabilized during operation phase.

The soil conditions of the project site would be allowed to stabilize during this period after the impacts of the construction phase. The topsoil in non-built up areas would be restored and such portions of the site would be subjected to plantations, which would help in bonding of the soil, thus increasing its strength. During operation of a project, no appreciable adverse changes in the soils are expected.

6.5.3 Air Impact

As the solar PV project is Eco-friendly, there will be no any gaseous emission by project.

6.5.4 Noise Impact

Protective instruments will be provided to the operators and workers working near the high noise generating machinery. As per Occupational Safety and Health Administration (OSHA) Standards, the maximum allowable noise level for the workers is 90 dB (A) for 8 hours exposure a day. Therefore, adequate protective measures in the form of ear mufflers/ear plugs to the workers working in high noise areas will be provided.

6.5.5 Impact on Ground Water

Silicon Energy (SIE) cascade photovoltaic (PV) modules have been selected for this plant which don't require frequent cleaning however some quantity of water required is required for cleaning of debris ,dust , silt , bird droppings etc. This area is semi-arid in nature with no rainfall which require necessary cleaning.0.149 cusec (365 tons/day) of water required for cleaning of PV modules that will be drawn from a tube well. The drawing of 0149 cusec of water will not affect the ground water quantity and quality.

6.5.6 Impact Due to Discharge of Waste Water

Since the water is used for PV module cleaning purpose, the drain water collected after cleaning the solar modules would be passed through a sump with a baffle wall to arrest the suspended solids if any. Water runoff / discharge from the panels will be collected into the ponds to be discharged into the drain passing adjacent to the site after due permission from the irrigation department. The discharge water does not include any chemical or hazardous material and hence no treatment is required. The municipal waste from the plant is mainly due to civic facilities for the workers and officials at site. It will be treated in a three stage septic waste water treatment plant before final disposal into the drain.

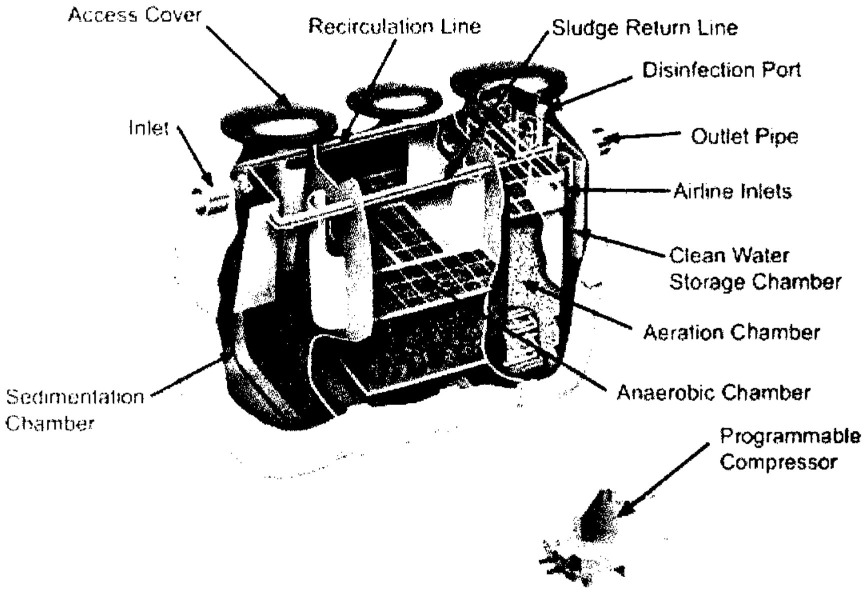


Figure 6.1: conceptual design of three stage septic tank

6.5.7 Change in Socio – Economic Condition of the Area

The project will generate employment opportunities for the local population of the area. Even indirect job opportunities will be created outside of the project area. The project will improve the basic infrastructure and the people of nearby villages can also use these facilities. Overall there will be marginal impact on the socio-economic condition of the locality and the impact will be highly positive.

6.5.8 Impacts due to Electromagnetic Radiation

The equipment used in the operation of photovoltaic power technology don't have electromagnetic impact on cross communications, thus it is envisaged that satellite signals will not be distorted anymore. It will not pose any adverse impact on the functioning of vital communication apparatuses like cell phones, radio or television.

6.6 MITIGATION MEASURES FOR ADVERSE IMPACTS

It is generally assessed that almost all adverse environmental impact s have temporary nature which will be faced during construction phase of the proposed project. Following are the suggested mitigation measures for corresponding major adverse environmental impacts:

6.6.1 Physical Environment

6.6.1.1 Prevention of Exhaust Gas and Dust

Since exhaust gases will generally be discharged during the construction and operation stages of the project, the number of construction vehicles should be controlled to minimize the impact on the environment. In order to reduce the impact of dust blowing during construction and operation following countermeasures should be taken into account:

- The construction workers should regularly sprinkle water at the construction site to prevent the generation of suspended dust. The volume and frequency of sprinkling should be increased when the wind is strong and weather is dry. Access roads should also be included in this operation.
- Vehicles should run at a slow or limited speed to reduce dust emission, which should be around 15 km/h.
- Covered trucks should be used to deliver the construction material
- The concrete batching plant should be set within the enclosed construction camp.
- Light-absorption system compatible with PV solar panels should be used just like the blue lights are used under foggy weather; because gales and wind storms will occur periodically in Thatta.
- Surface vegetation and some soil conservation techniques are protective measures against dust emission. They should be promoted so that secondary dust may not be spread during operation stage of the project.

6.6.2 Noise Pollution Mitigation Measure

Since noise can't be avoided during construction so the contractor should strictly follow the personal protection guidelines, i.e. OSHA guidelines (1970) in order to minimize the noise impacts. Following mitigations will also help:

- The contractors should ensure the use of low noise and low vibration construction equipment.
- Regular service for construction equipment should be ensured and some workers may be trained in machinery operation to hold charge of some machines according to operation specifications.

- Construction work should be carried out during day time if possible.
- OSHA Guidelines on "Noise Limits for Construction Site" should be followed

6.6.3 Sewage and Waste water Treatment Measure

The production of wastewater from the Project construction activities is mainly generated by washing the concrete truck mixers and other construction machinery, repairing equipment and maintaining vehicles, but the total amount of such waste water is small. The construction sites are relatively scattered, and the scope is also relatively wide, so the waste water can be used for spraying at the construction site.

During normal operation of the power plant, the waste water is mainly the domestic sewage. The domestic sewage should be collected and regularly treated in three stage septic tanks before disposal to the drain.

6.6.4 Solid Waste Disposal and Public Health Measure

The handling of earth excavated during construction: During excavation, the top-soil and bottom soil should be properly stock-piled separately at specified locations. After the construction, the exposed area should be covered with bottom soil first, and then with the top-soil;

- After the excavation and backfill, the left-over waste can be used as the filling material for the low-lying areas, if needed. After the backfill, these areas should be compacted and planted to avoid water and soil loss, vegetation growth and protect the environment;
- In addition, some of the construction waste excavation can be recycled the remaining can be transported together with the domestic waste to some nearby landfill.
- The power plant should be equipped with centralized solid waste collecting boxes which should be cleaned regularly. The solid wastes generated during the construction operation should be transported outside the plant to avoid spreading out due to wind blowing and effluent leakage from polluting the surrounding.

- During the normal operation of the power plant, the administrative staffs are mainly engaged in handling official business, monitoring and overhauling, and the solid wastes are mainly the office and domestic wastes. The living area should be provided with dust bins to collect the wastes, and the collected wastes should be transported to the nearby specified landfill site.
- Meanwhile, proper management of nutritional hygiene, domestic drinking water and environmental sanitation should be ensured to prevent the spread of infectious diseases and to protect the people health.
- The recyclable photovoltaic modules should be broken up and sent to relevant factories for recycling as required, while other parts that are hard to be recycled should be disposed of according to relevant regulations.

6.6.5 Ecological Environment

In order to preserve the ecological environment during construction, the construction operations should be arranged in accordance with the environment management system requirements to shorten the construction period, and reduce the environmental impacts on surrounding landforms. Following ecological protection measures should be adopted for the project:

- Preference should be given to environment-friendly equipment for construction, and construction operations should be planned to minimize dust and noise emissions, it should be guaranteed that any effluent discharges meet the environmental standards and guidelines.
- The top soil should be intensively piled and protected, and after the construction, the exposed land surface should be recovered with the original topsoil.
- The use of large machines should be minimized during the construction. After excavation, the foundation trenches should be concreted as soon as possible and backfilled in time. The surface layer of the trench should be improved to minimize the exposure time and reduce the dust emission. Blasting should be discouraged for excavation of foundation trenches so as to reduce the impact of dust and vibration on the surrounding environment.

- According to the environmental protection principles, four inch top soil of construction area may be excavated before construction and it will be relocated again below the panels to restore the site.

CHAPTER -7

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 INTRODUCTION

Environmental & Social Management Plan is an implementation plan to mitigate and balance the potential adverse environmental & social impacts of the project and enhance the positive impacts. Based on the environmental baseline conditions, planned project activities and impacts assessed earlier, this section counts the set of measures to be adopted to minimize the adverse impacts. Process of implementing mitigation and compensatory measures, execution, agencies responsible for their implementation and indicative cost is discussed in this chapter.

The project has overall highly positive impacts by providing a competitive, cost-effective, pollution free reliable mode of Solar PV power project. It will certainly meet the ever increasing demand of Power and will reduce the gap between demand and supply of power.

7.2 ENVIRONMENTAL & SOCIAL MANAGEMENT PROCESS

The ESMP has been designed within the framework of requirement under Pakistan legislation on environmental and IFC Performance Standards on environmental and socio-economic aspects for construction and operation phases of the proposed project.

The mitigation measures to be adopted for the implementation of the proposed project include the following:

- Environmental Management Plan
- Rainwater Harvesting +Ground water Extraction
- Clean Development Mechanism
- Occupational Health and Safety
- Labor Working Conditions
- Construction labor Management
- Environmental Action and Monitoring Plan
- Public Consultation and Information Disclosure Plan

7.3 OBJECTIVES OF THE ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) will help the management to address the future likely negative impacts of the proposed Project, enhance the Project's overall benefits and introduce standards of good environmental practice. The primary objectives of the EMP are to:

- Define the responsibilities of the Project Proponent and other key players during the design, construction and the operational phases;
- Facilitate the implementation of the mitigation measures by providing technical details of each project impact, and proposing an implementation schedule of the proposed mitigation measures;
- Develop a monitoring mechanism and identify monitoring parameters to ensure that all the proposed mitigation measures are completely and effectively implemented;
- Identify training requirements at various levels and provide a plan for the implementation of training sessions;
- Identify the resources required to implement the EMP and outline corresponding financing arrangements;
- Providing a cost estimate for all the proposed EMP actions.

The Project will develop and implement following management action plans under the ESMP:

7.4 Environment & Social Management Cell

Siachen Energy Limited will established an Environment & Social Management Cell (ESMC) at Corporate and Site level, headed by a Project Director of Chief Engineer rank to be responsible for day to day implementation of the Project. Siachen Energy is responsible for undertaking the transmission project in accordance with the Initial Environment Examination (IEE) and implementing the Environmental and Social Management Plan as per ADB's Safeguard Policy Statement (2009). The ESMC is responsible for coordinating and implementing all environmental and social activities.

During project implementation, the ESMC will be responsible for reflecting the occurrence of new and significant impacts resulting from project activities and integrating sound mitigation measures into the EMP. The ESMC includes a safeguard specialist and supporting staff, together forming the Environmental and Social Unit, appointed by Siachen Energy Limited to look at right of way, environmental, social and safety issues. The ESMC will be empowered to implement safeguards planning and monitor implementation.

The safeguards specialist gives guidance to the Project Manager and his staff to adopt the environmental good practice while implementing the project. The safeguard specialist is responsible for implementing safeguard issues associated with the project through a site team composed of Siachen Energy site staff and contractor's staff, to be assigned by the ESMC as necessary.

The duties of the Environmental and Social Unit of the ESMC at corporate level are to:

- Monitor the implementation of mitigation measures during construction and operation phases of the project.
- Prepare suitable environmental management reports at various sites.
- Advise and coordinating field units activity towards effective environment management.
- Prepare environment health and safety manual for the operation of transmission lines/substations.
- Advice during project planning/design cells on environmental and social issues while route selection of the alignment at the planning/design stage to avoid negative environmental impact.
- Provide training and awareness raising on environmental and social issues related to power transmission projects to the project/contract staff.

The duties of the Environmental and Social Unit at site level are to:

- Implement the environment policy guidelines and environmental good practices at the sites.
- Advise and coordinate the contractor activity towards effective environment management.

- Implement environment and safety manual.
- Carry out environmental and social survey in conjunction with project planning cell while route selection of the alignment at the planning stage to avoid negative environmental impact.
- Make the contractor staff aware of environmental and social issues so that EMP could be managed effectively.

The ESMC comprises of a team of qualified and experienced environmental engineers, analytical chemists, safety engineers and well trained personnel for environmental monitoring. The EMC also conducts regular training programs for the other personnel in the areas of environment, air quality and water quality aspects, energy and water conservation measures, safety and health aspects etc. The ESMC is supported by well-equipped testing laboratory and other facilities to facilitate effective working

Table 7.1: Key Responsibilities of Environmental & Social Management Cell

Sr.No.	Designation	Responsibility
1.	Project Director	Environmental and Social policy and directions
2.	Head-Operations	Overall in-charge of operation of environment & social management facilities: Ensuring legal compliance by properly undertaking activities as laid down by various regulatory agencies from time to time and interacting with the same.
3.	General Manager	Secondary responsibility for environment & social management and decision making for all environmental issues including Safety and Occupational Health.
4.	Site Engineers	Ensure environmental monitoring and social issues related to project as per appropriate procedures.

7.5 Corporate Social Responsibility Plan (Community Development Plan)

Corporate social responsibility is Siachen Energy self-regulation integrated into a business model. CSR policy functions is built in, self-regulating mechanism whereby business monitors and ensures its active compliance with the spirit of the law, ethical standards, and international norms. The goal of CSR is to embrace responsibility for the company's actions and encourage a positive impact through its activities on the environment, consumers, employees, communities, stakeholders and all other members of the public sphere. Identifying CSR initiatives in line with local requirements. Based on site visits of Environmental Experts along with Siachen Energy team and discussions with local people, following issues have been highlighted.

Table 7.2: Social Issues of local people

Sr.No.	Area	Community Need
1	Health	Establishment of Hospital for local population
2	Education	Facility of College
3	Employment	Employment opportunity for local people of the area

7.6 ESMP DURING CONSTRUCTION AND OPERATION

7.6.1 CONSTRUCTION PHASE

The environmental issues during construction stage generally involve safety and public health issue. The Contractor is required to comply with the laws with respect to environment protection, pollution prevention, safety and other applicable law. Environmental pollution during the construction phase will be less but control of pollution during this phase is of considerable importance. The EMP is an executable part of Project, and the activities are to be guided, controlled, monitored and managed as per the provision provided. Following activities require attention during construction phase.

7.6.1.1 Construction/labor Camp Management

The labor camp construction, upkeep and maintenance at the 100 MW Solar PV project site is under the scope of the contractor. 50 laborers are likely to cause influx in the project area. A proper Construction Camp Development Plan has to be formulated to control degradation of the surrounding landscape due to the location of the proposed construction camp.

Sufficient supply of potable water will be provided at camps and working sites. If the drinking water is obtained from the intermittent public water supply then storage tanks will be provided. All water supply storage may be at least 15m away from the toilets or drains. It is the responsibility of EPC contractor to fulfill the water requirement during construction period. Siachen Energy Limited will ensure that water will be supplied through water tanker from nearby area, where sufficient water is available. Adequate sanitation facility, Septic tank, will be provided.
At every Camp first aid facility will be provided. Suitable transport will be provided to take injured or ill person to the nearest hospital. Adequate supply of fuel in the form of kerosene or LPG will be provided to construction labors to avoid felling of trees for cooking and other household activities.

7.6.1.2 LABOUR AND WORKING CONDITIONS

Through a constructive employee-management relationship, and by treating the employees fairly and providing them with safe and healthy conditions, tangible benefits may be created, such as enhancement of the efficiency and productivity of their operations. The basic objectives is to ensure following.

- To establish, maintain and improve the employee-management relationship
- To promote fair treatment, non-discrimination and equal opportunity of employee, and compliance with national labor and employment laws
- To protect the employee by addressing child labor and forced labor
- To promote safe and healthy working conditions, and to protect and promote the health of workers by evolving safe working practices.

- To respect the worker's rights to freedom of association and the effective recognition of the right to collective bargaining, as per the relevant conventions of the International Labor Organization

The organization shall work to achieve these objectives, all relevant provisions of employee laws will be complied.

7.6.1.2.1 Child Labor

The company will not employ children in any manner i.e. economically exploitative or is likely to be hazardous or to interfere with the child education or to be harmful to the child's health or physical, mental, spiritual, moral or social development. Children below the age of 18 years will not be employed in dangerous work. The company in fact discourages child labor & encourages them to go to School by providing free education facilities & also providing education stipend for attending school.

CHAPTER -8

CONCLUSION AND RECOMMENDATION

The nature of a solar power plant is known to have minimal adverse impacts on the environment throughout its operation stage. Potential negative impacts can be expected during project construction phase of solar panel in the forms of noise and PM emissions, and discarding of expired PV panels, respectively. The Project has foreseen these concerns as it proposed a set of mitigation measures and a monitoring plan in the form of EMP for its contractors and staff to strictly follow. Consequently, it is expected that adverse impacts from the Project's life cycle will be minimal.

The people expected that the emergence of such project will not pose significant negative impacts on the environment. Instead, it would contribute to local employment and increased income, and the renewable energy generated would stabilize local energy supply in sustainable way. In addition, the provision of communication channels between the communities and the Project will form better understanding between the two parties. The local's expectation on the Project is in line with the Project's commitment on environmental and social responsibility.

Keeping in view the environment friendly nature of the project it is recommended along with mitigation measure mentioned in the report is recommended for environmental approval.

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SUPARCO

PAKISTAN SPACE & UPPER ATMOSPHERE RESEARCH COMMISSION (SUPARCO)

CHEMICAL ANALYSIS REPORT

[illegible] No: 10405-ES-[illegible] Date 24-11-15
[illegible]: M/s Manna Environmental Consultants Pakistan
[illegible]: Mirpur Sakro
[illegible]: Canal Water
[illegible]: 17-11-2014, 16:10 Hrs Grab/Composite: Grab
[illegible]: 17-11-2014, 21:00 Hrs
[illegible]: SUPARCO
[illegible] of analysis: 22-11-2015

S. No	Parameters	Unit	*NSDWQ	Result	Method	Remarks
[illegible]	[illegible]		6.5 - 8.5	[illegible]	US-EPA 150.2	Comply with limit
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[illegible]	[illegible]	mg/l	[illegible] 1000	44[illegible]	US EPA 160.1	Comply with limit
[illegible]	[illegible]	mg/l		13.8	US EPA 160.2	-
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[illegible]	Alkalinity	mg/l		[illegible]	AOAC # 973.43	-
[illegible]	[illegible]	mg/l	[illegible] 1.5	0.25	US-EPA 300.1 / HACH 8029	Comply with limit
[illegible]	[illegible]	mg/l	[illegible] 0.05	0.009	US EPA 200.8	Comply with limit

[illegible] National Standards for Drinking Water Quality

Sample analyzed by: Syed Asif Ali (Assistant Research Officer)
Reviewed by: Maqbool Ahmed (Assistant Manager)

Signature of incharge of environmental laboratory
Name: Dr. Muhammad Mansha
Designation: General Manager
Date: 24-11-2015

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Page 1 of 1

SUPARCO

PAKISTAN SPACE & UPPER ATMOSPHERE RESEARCH COMMISSION (SUPARCO)

CHEMICAL ANALYSIS REPORT

[illegible] No: 10405-ES-[illegible] Date 24-11-15
[illegible]: M/s Manna Environmental Consultants Pakistan
[illegible]: Mirpur Sakro
[illegible]: Hand Pump
[illegible]: 17-11-2014, 16:30 Hrs Grab/Composite: Grab
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[illegible]: SUPARCO
[illegible] of analysis: 22-11-2015

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[illegible]	[illegible]	mg/l	[illegible]	[illegible]	US EPA 160.1	Comply with limit
[illegible]	[illegible]	mg/l		[illegible]	US EPA 160.2	
[illegible]	Conductivity	µS/cm		[illegible]	US-EPA 120.1	
[illegible]	Alkalinity	mg/l		[illegible]	AOAC # 973.43	
[illegible]	[illegible]	mg/l	[illegible]	0.18	US-EPA 300.1 / HACH 8029	Comply with limit
[illegible]	[illegible]	mg/l	[illegible]	[illegible]	US-EPA 200.8	Comply with limit

[illegible] National Standards for Drinking Water Quality

Sample analyzed by: Syed Asif Ali (Assistant Research Officer)
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PAKISTAN SPACE & UPPER ATMOSPHERE RESEARCH COMMISSION

(SUPARCO ENVIRONMENTAL LABORATORY)

GSP

NOISE MONITORING REPORT

Report Reference Number:	10405-ES-1221	**Reporting Date:**	24-11-2015
Name of Client:	M/s Marina Environmental Consultants Pakistan	**Monitoring Date:**	17-11-2015
Address:	Office # 7-9, Asad & Awais Chamber, 2nd Floor, Shahrah-e- Faisal, Near Star Gate, Opp. PIA Club		
Telephone Number:	021-34590068	**Field Official:**	Muhammad Khalid
Monitoring Location/Site:	Mirpur Sakro	**Designation:**	Research Associate

S. No.	Sites Name	Unit	Method	NEQS* (Residential Area)	Results			
					L-1	L-2	L-3	Leq
1.	Point-1	dBA	40 CFR Part 201	55	50.10	48.20	46.40	48.49
2.	Point-2				45.50	47.30	46.40	46.46
3.	Point-3				48.20	44.60	44.60	46.15
4.	Point-4				46.40	43.70	46.40	45.67

*NEQS: National Environmental Quality Standard

Report Prepared By: Tooba Nazar
(Sub Engineer -II)

Report Reviewed By: Mr. Zaigham Farooq
(Assistant Manager)

Report Approved By: Dr. Muhammad Mansha
DH (Env. Monitoring & Modeling Div)

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P.O. Box 8402, SUPARCO Road, Gulzar-e-Hijri, Sector 28, Karachi
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PAKISTAN SPACE & UPPER ATMOSPHERE RESEARCH COMMISSION

(SUPARCO ENVIRONMENTAL LABORATORY)

GSP

AMBIENT AIR MONITORING REPORT

Report Reference Number	10405 ES 1815	**Reporting Date:**	20-11-2015
Name of Client:	M/s Marina Environmental Consultants Pakistan	**Starting Date & Time:**	17-11-2015 14.00 Hrs
Address	Office # 7-9, Asad & Awais Chamber, 2nd Floor, Shahrah-e-Faisal, Near Star Gate, Opp. PIA Club	**Completion Date & Time:** **Duration:**	17-11-2015 22:00 Hrs 8:00 Hrs
Telephone Number:	021-34590068	**Field Official:**	Muhammad Khalid
Monitoring Location/Site:	Mirpur Sakro	**Designation:**	Research Associate

S. No.	Parameters	Unit	NEQS*	Results			Method
				Min.	Max.	Avg.	
[illegible]	Nitrogen Oxide, NO	µg/m³	40	6.8	8.9	8.16	Gas Phase Chemiluminescence
[illegible]	Nitrogen Dioxide, NO_2	µg/m³	80	3.4	3.7	3.61	Gas Phase Chemiluminescence
[illegible]	Carbon Monoxide, (CO)	mg/m³	5	1.0	1.1	1.06	GFC Spectroscopy
[illegible]	Sulphur Dioxide (SO_2)	µg/m³	120	7.6	8.4	8.18	Fluorescence
[illegible]	Ozone, O_3	µg/m³	130	6.1	8.6	7.36	UV Spectroscopy
[illegible]	Particulate Matter ($PM_{2.5}$)	µg/m³	35	19.2	21.5	20.31	β Ray Absorption
[illegible]	Particulate Matter (PM_{10})	µg/m³	150		82		β Ray Absorption
[illegible]	Total Suspended Particulates (TSP)	µg/m³	500		176		Gravimetric analysis

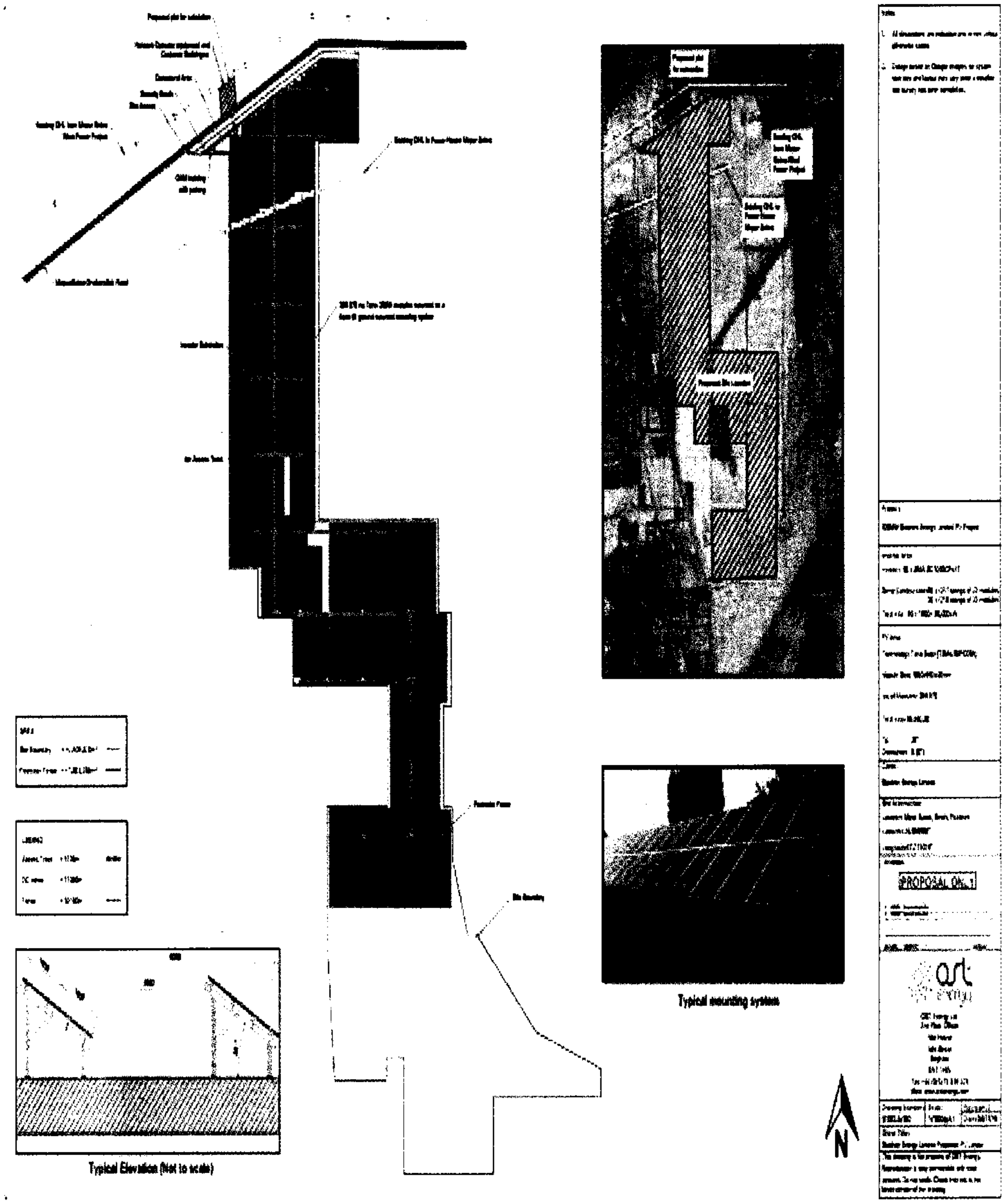
*NEQS: National Environmental Quality Standard

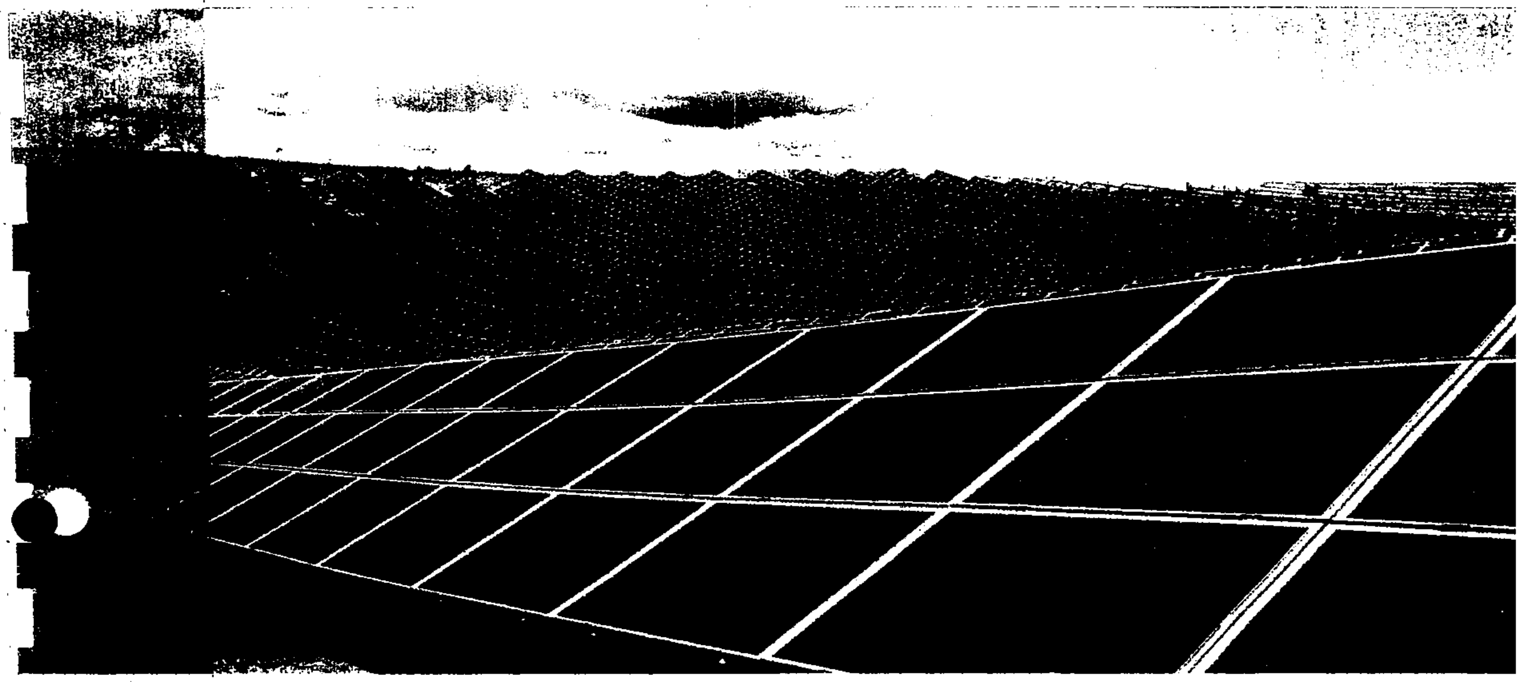
Report Prepared By: Tooba Nazar
(Sub Engineer -II)

Report Reviewed By: Mr. Zaigham Farooq
(Assistant Manager)

Report Approved By: Dr. Muhammad Mansha
DH (Env. Monitoring & Modeling Div)

Pakistan Space & Upper Atmosphere Research Commission (SUPARCO)
[illegible] SUPARCO Road, Gulzar-e-Hijri, Sector 28, Karachi
[illegible] Website: www.suparco.gov.pk


Typical mounting system
Typical Elevation (Not to scale)
N



Technical Feasibility Study

Mirpur Sakro 100 MWp Solar PV Plant

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1 Introduction

OST Energy Pty Ltd (OST) has been appointed by Siachen Energy Limited ('Siachen' or 'the Client') to assist with their development of a 100 MWp photovoltaic plant at Mirpur Sakro, Sindh, Pakistan (the 'Project' or the 'Plant').

This report has the objective to assess the feasibility of the Project and is structured as follows:

- Project overview
- Site assessment
- Permitting / Environmental Assessment
- Preliminary Grid Connection Study
- Conceptual Design
- Energy Yield Assessment
- Economic Analysis

This report is based on discussions held with the Client, a review of shared documentation, a site visit and specialist geotechnical, interconnection, and environmental reports.

At the time of writing, full geotechnical or grid connection studies have not been completed. This interim report is provided to advance the opportunity for review of work completed to date but is not yet complete or conclusive.

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2 Project overview

2.1 Site and Works overview

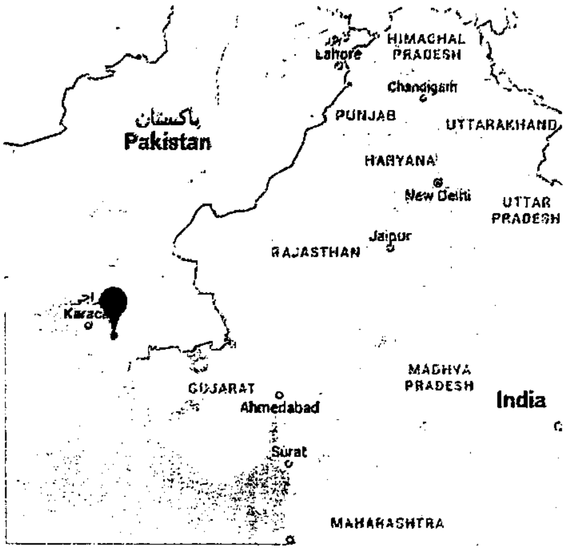
Key details for the project are shown in Table 3 and the location of the proposed site is indicated by the red marker as shown on map views in Figure 1 and Figure 2.

Table 3: Key details

Property	Value
Site coordinates	24.557 N, 67.711 E
Altitude (metres above sea level)	5
Site area (ha)	185
Proposed capacity (MW_{AC} / MW_{DC})	100_{DC}
Global Horizontal Irradiation ($kWh/m^2/year$)	1,874
Proposed layout concept	The proposed layout is for a ground mounted fixed system using Tier 1 polycrystalline modules and central inverters. A drawing of the proposed layout is shown in Appendix C

Figure 1: Local satellite view

Figure 2: National map view



An indicative timeline for the Project is shown in Figure 3 Contractors will be required to comply with a prearranged schedule of works and complete the construction and installation of equipment by the required deadline. We recommend that permits, equipment, infrastructure logistics and grid application be secured for the Project prior to commencement of works.

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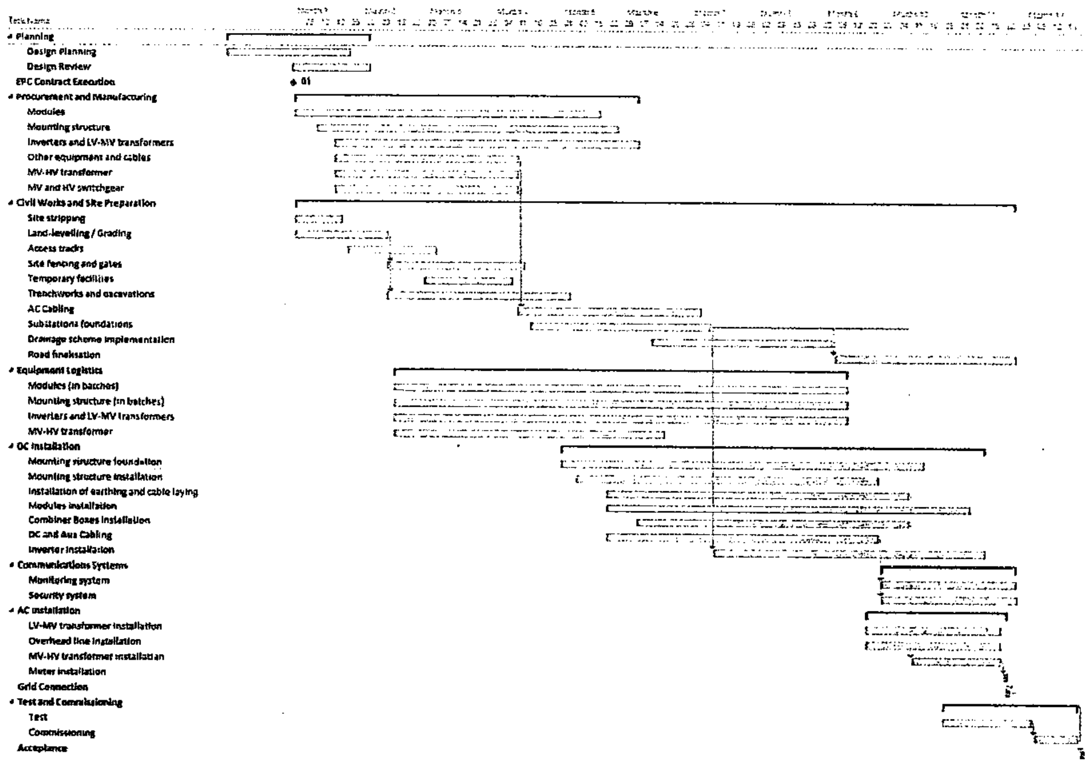
Figure 3: Planned timeline for works



2.2 Pakistan Power Market

2.2.1 Power Sector Structure Overview

The generation, transmission, distribution and retail supply of electricity in Pakistan is presently undertaken by a number of public and private sector entities comprising of one national transmission company; nine regional public sector-owned distribution companies; four public sector thermal generation companies; one public sector hydropower generation company and 41 independent power producers (IPPs). These entities enable the supply of power to the entire country except for Karachi. The metropolitan city of Karachi and some of its surrounding areas are supplied power by K-Electric, which is a vertically integrated utility owned by the private sector responsible for the generation, transmission and distribution of electricity in its region. Central Power Purchase Agency (CPPA), a public sector agency, has recently become active for the centralised purchase of power from all existing and upcoming private and public sector power producers. All public sector agencies/companies are administered/overseen by the Ministry of Water & Power, Government of Pakistan.

The National Electric Power Regulatory Authority (NEPRA) is an independent regulator setup for the regulation of Pakistan's power sector; in order to balance the interests of consumers and power sector companies. NEPRA develops the regulatory regime and future market design for the power sector. All generation, transmission, and distribution companies are now licensees of NEPRA and matters related to tariffs, licensing, safety, grid codes, consumer interest are regulated by NEPRA.

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2.2.2 Electricity Demand & Supply – a Deficit Power Market

The total installed generation capacity of Pakistan (excluding K-Electric area) is approximately 20,000 MW distributed as follows:

- Hydel: 7,121 MW (90 MW in private sector)
- Thermal (Public Sector): 3,678 MW
- Private Sector Producers: 9,282 MW

However due to a number of factors including seasonality of hydel & renewable resources, lack of maintenance/aging of public sector thermal units and consequent reduced capacity and technical issues with certain private sector producers the sector has been facing an average supply-demand gap of about 6,000 MW in the recent past. Despite an installed capacity of roughly 20,000 MW the sector had a maximum generation of approximately 15,500 MW in September 2015 at which time a demand-supply gap of approximately 4,600 MW still existed. This gap increases significantly during summer, low water or low gas supply months.

The present electricity demand supply gap, coupled with consistent growth in demand (6-7% per annum), indicates the fundamental need for enhancing the country's current power generation capability. It may also be noted that approximately 5,800 MW of existing private sector generation capacity and 3,700 MW of existing public sector generation capacity may be decommissioned on account of the plant life and fuel inefficiencies.

2.2.3 Pakistan Power Pakistan – Key Challenges

Pakistan's power sector is currently afflicted by a number of challenges:

- A supply-demand gap, where the demand for electricity outstrips the current generation capacity leading to a gap of up to 4,500 – 6,500 MW. The supply-demand gap has continuously grown over the past 5 years and has led to significant load-shedding across the country.
- Expensive electricity generation (approximately PKR 12/kWh) due to increased dependence on expensive thermal fuel sources including furnace oil and high speed diesel.
- Inefficient power transmission and distribution system that currently records losses of 23-25%. Government has estimated the true cost of delivering a unit of electricity to the end consumer at greater than PKR 15.60 after taking into account the collection losses and the real losses to the distribution companies.
- The aforementioned inefficiencies and high cost of generation are resulting in high levels of subsidies and circular debt.

2.2.4 Private Sector Participation in Pakistan's Power Sector

Private sector participation in the Pakistan power sector dates back to mid-1990s with investment by a number of international companies and renewed interest by Chinese companies in recent years. Presently, approximately 45% of the installed generation capacity of the country is in private sector, with another 5,000 MW of IPPs under construction. Successive governments in the country have reiterated the commitment to increase private sector participation.

Private Power & Infrastructure Board (PPIB) and the Alternate Energy Development Board (AEDB) have a track-record of attracting investment in the power sector for two decades or so and provide a one window facility for the processing of private power generation projects. PPIB

3 Site Assessment

OST has carried out an assessment of the site for the development of the 100 MWp PV plant to check that the selected area can accommodate the proposed development. The location and boundaries of the site have been provided by Siachen. We consider that the site is sufficiently sized and suitable to install the 100 MWp capacity.

This assessment was carried out via a desktop analysis of the site and information collected during a site visit undertaken by David Hawkins of OST during October 2015. The purpose of the assessment was to evaluate the suitability of the proposed site in terms of:

- Site setting
- Topography, terrain, and hydrology
- Near and onsite shading
- Site access, laydown area and security

These aspects are discussed in the following sections.

3.1 Site setting

It is important to consider the site setting in order to establish whether the local climate, weather, and landscape is suitable for a solar PV development. Local conditions can affect all aspects of the project including the equipment selection and the operations and maintenance activities. Sites which experience extremes in climate, weather, or landscape can affect project viability.

The site is located 8 km to the east of the town of Mirpur Sakro in the district of Thatta, Sindh Province, Pakistan, approximately 75 km south east of Karachi.

The site is within the Indus River Delta, with the open sea about 50 km to the west but inlets extending 20 km closer. The main Indus River flows to the south, about 25 km west of the site. The site assessed is predominantly flat.

According to the Köppen Climate Classification System (the most frequently used system to classify an area's climate) the climate in Thatta District is mainly arid, with hot and dry summers and mild and dry winters. Significant rainfall is expected at the site only during the wet season (June to September), as shown in Figure 4.

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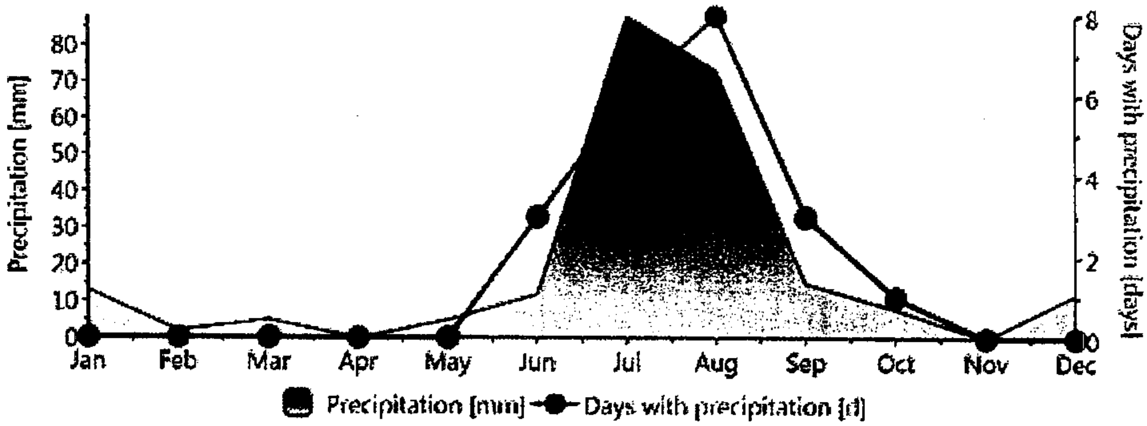
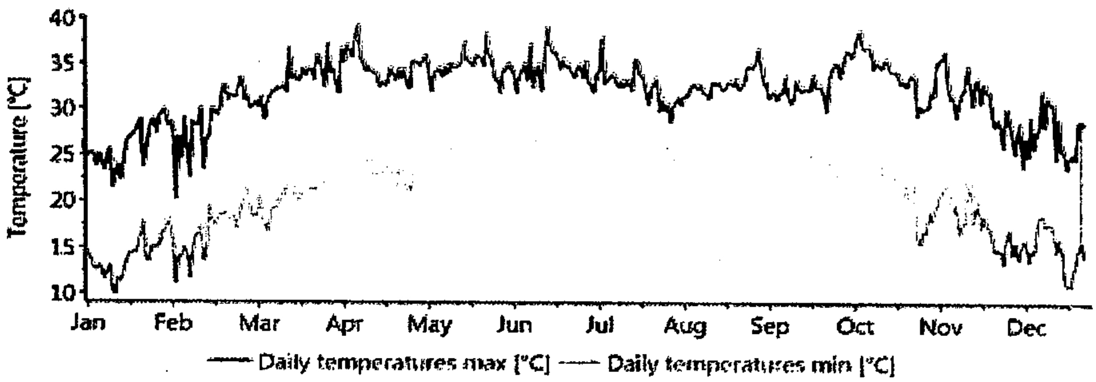
Figure 4: Average rainfall in the assessed site (rain days per month)[1]



The average wind speed is 3.5 m/s (12.6 km/h) with peaks around 5 m/s (18 km/h) between May and July. These values are not considered to represent an onerous load to solar PV structures.

Figure 5: Daily temperature at the assessed site[2]



Average maximum temperatures at the site can be seen in Figure 5 and range from 19 °C in January to 32 °C between May and June. The high temperature profile of the site will have an unfavourable effect on the expected PR of the system; nevertheless, it should be noted that wind has a cooling effect on PV cell temperatures that benefits the performance of the PV modules. All meteorological phenomena have been taken into account in OST's yield assessment.

The available site, an irregular shape comprising of consolidated field boundaries and elongated in the north south direction, aggregates to a total of approximately 290 hectares. It is comprised of privately owned land that is currently largely uncultivated or used for free-range livestock grazing, although the pattern of field boundaries suggests that it has been used for more intensive agriculture in the past. Some agricultural fields remain, particularly to the south where wheat, rice and vegetable are grown. Their area is estimated at less than 10% of the total site.

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[1] Source: Meteonorm 7.1

[2] Source: Meteonorm 7.1

Figure 6 shows the boundaries of the site and its immediate surroundings. The red line denotes the boundary of the available plot, the blue area shows installed solar field for 100 MW_{DC} capacity. Orange lines are overhead power lines.

Figure 6: Site and surroundings

The site is bounded to the north by the Mirpur Sakro to Ghulamullah Road, which is a single lane sealed road running from east to west. Approximately 75 m to the north of the road and parallel to it, runs a 132 kV overhead transmission line on steel lattice towers. It is proposed that a new 132 kV substation, dedicated to the solar power Plant, be constructed on a plot between the road and the transmission line, across from the solar power Plant site and connecting via a simple branch or spur connection. Between 800 and 400 m further north of the road and roughly parallel to it lies a canal. A local distribution line, estimated to be 33 kV runs across the site at a distance of between 350 and 500 metres south of the road.

Close to the western boundary of the site a drain (the 'Western Drain') runs south from the road and is intersected near the south west corner of the by another drain (the 'Southern Drain', see Figure 14) which bisects the southern end of the site in a north-east to south-west direction. Across the western side of the Western Drain, the land becomes more cultivated with dispersed homes. The satellite photographs indicate a small settlement approximately 350 m west of the south west corner of the site.

Land to the east of the site is generally similar to it and separated only by field boundaries. It is bisected by another drain (the 'Eastern Drain'), apparently unconnected to the others, which runs in a south westerly direction from the road to the eastern boundary of the proposed solar power Plant. This area is being considered by Siachen for another solar power plant.

Some of these features are shown in Figure 7, Figure 8, and Figure 9 which were taken from the Mirpur Sakro to Ghulamullah Road, at the northern end of the Western Drain and at the north western corner where the site entrance would be located.

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Figure 7: Looking east from site entrance towards Mirpur Sakro

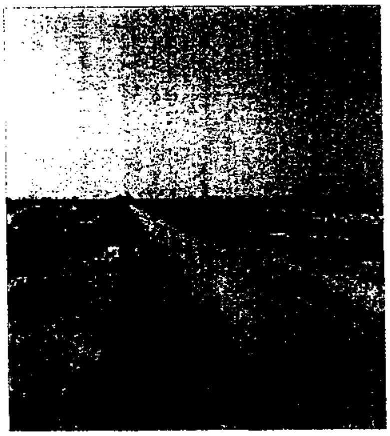

Figure 8: Looking north from site entrance to 132kV OHL

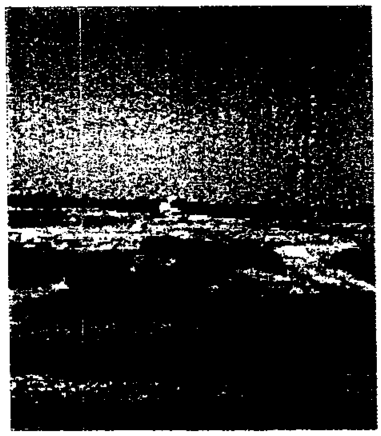

Figure 9: Looking south from site entrance

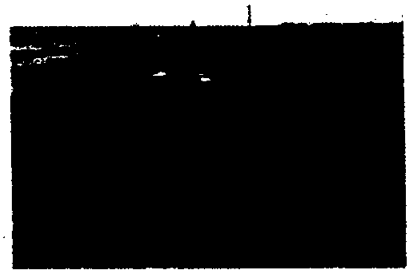

Table 4 provides a summary of the site settings.

Table 4: Summary of site setting

Item	Sultanabad Site
Current land use	Mostly barren land, some farmland
Neighbouring properties	Privately owned
Services (i.e. water, sewerage, electricity)	None
Distance from the town of Mirpur Sakro	30 km
Neighbouring settlements	Approximately 350 m west of the site boundary
Likely Environmental and Social Impacts of the Project	Some loss of low value agricultural land Traffic during construction

3.2 Topography, terrain and hydrology

Examinations of the topography, terrain, and hydrology are undertaken as further checks for the suitability of the site setting. Certain parameters of the site design, such as row spacing, can be heavily influenced by surface topography. The terrain must be surveyed for geological composition in order to check the suitability of components such as the mounting structure. Local hydrology must be considered in order to understand the risks of certain types of flooding.

The proposed site is predominantly flat. The soil is comprised of soft finely textured silt or sand and during our visit appeared moist below the dusty surface. Salt was evident on the surface in patches, possibly denoting a high and salty water table, which may also account for the land's apparent bareness where irrigation has not been carried out. Except where cultivated, the surface of the ground is generally bare, or sparsely vegetated with low lying bushes and grass.

The site is generally extremely flat and there was evidence of standing water, particularly further south on the site where large areas of cracked mud were encountered, see Figure 11. Whether this is due to local rainwater that failed to drain during the monsoon or was introduced as

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irrigation or flowed from elsewhere could not be determined. The soil pattern evident in satellite photographs suggests that the area has experienced surface water flows at some unknown time in the past and the area has a number of oxbow lakes and remnants of riparian flow typical of a delta area. However it was understood from local people that the site has not flooded in their memory and the IEE report suggests that the site was not affected by recent events that led to severe flooding elsewhere in the district.

Nevertheless we recommend that a specific Flood Risk Assessment (FRA) be undertaken to understand the particular characteristics of the site. It is also recommended that construction activities be avoided during and after the monsoon season to ensure that the site is trafficable for construction equipment and equipment deliveries. All electrical equipment, including inverter houses and junction boxes should be mounted on structures well clear of ground level. Module mounting height should be sufficiently elevated to ensure adequate clearance from surface water during high rainfall events. Access roads should be elevated to ensure all weather trafficability and particular attention paid to design of the site drainage system.

Figure 10: Looking south from road to Eastern Drain

Figure 11: Cracked mud at southern boundary

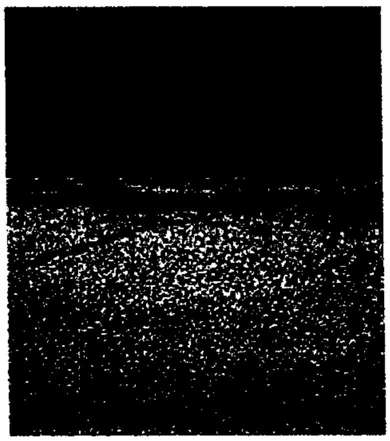

Figure 12: Ground conditions with mud and salt

The light, silty soil and barren soil, together with the open aspect of the site and its agricultural surrounds increases the potential for dust soiling on modules, which will have an impact on the annual yield of the solar Plant. We have accounted for these losses in the yield analysis described in Section 7.3.

At the time of writing, although a final geotechnical report has not been completed, a preliminary report has been made available for review. There are several types of soil across the site, which can be classified as light: loose to medium sandy silt or silty sand as well as very soft to soft silty clay or clayey silt. Underlying strata consist of medium dense to dense layers of silt and sand.

These soils are generally easy to excavate and may be suitable for ground screw anchors or other piling methods which can be quickly installed. Nonetheless, their low bearing capacity will require careful consideration of foundation design, especially to accommodate wind uplift forces. Other solutions, such as poured or pre-cast reinforced concrete footings may be considered.

Should laboratory tests be provided, a more extensive assessment could be provided; without conclusive results, the saturation and other physical properties of these soils remain unclear. Nevertheless, ground water level has been found at a depth of 1 m, which considering the thick alluvial soil and seismic zone, may result in liquefaction issues. We advise that several geotechnical solutions are considered in order to improve the ground properties prior to construction. Among them, rammed granular piles (RGB) are a cost-effective solution that leads to an increased bearing capacity, reduces settlement and improve ground stability.

In addition, due to the importance of the key equipment substations, the construction of gravel and / or rock drains around their foundations would be advisable to provide a rapid dissipation of earthquake shock-induced pore pressures. Moreover, it should be noted that the sulphate content in groundwater is found to be excessive. We therefore recommend the use of Sulphate Resisting Portland (SRP) cement for the key equipment foundations.

We recommend that costs for the ground preparation be included in the final economic analysis of the Project.

Table 5: Summary of topography, terrain and hydrology

Item	Characteristics
Topography	Slope-free and generally flat
Terrain	Barren silt and sand with some irrigated cultivation
Flood risk	No indication of flood risk noted. FRA required to confirm
Seismic Zone	2A, Seismic Provisions (2007) of Building Code of Pakistan Peak horizontal ground acceleration: 0.08 - 0.16 g
Climate	Arid with rainfall between June and September
Water access	Water available from canal to the north of the site. In addition, we understand from the Client that a water allotment application is being prepared to be submitted
Impacts	Surrounding land use, including ploughing, may result in module soiling Drainage system and elevated electrical equipment to avoid surface water Careful attention to foundation design required including pile pulling tests

Concerning the risk of earthquakes in the area, we have extracted data from Global Risk Data (GRID) platform to assess the earthquake occurred in the past, their frequency and intensity, as well as future hazards.

The earthquake data and visual maps have been made available by the United Nations Environment Programme (UNEP) and the GRID centre in Geneva, whose research has been based on the United States Geological Survey ShakeMap Atlas.

We note that no direct event has occurred in the site area and that the closest events are reported in the Badin district on 13th February 1970 (magnitude 5.2 and epicentre at 91 km of the site) and on 4th June 1976 (magnitude 5.2 and epicentre at 71 km of the site).

According to the GRID platform, the expected Peak Ground Acceleration (PGA) within the boundaries of the site is lower than 65 cm/sec^2 (0.065g) for a return period of 250 years and close to 125 cm/sec^2 (0.125g) for a return period of 1500 years. This peak acceleration measures the expected maximum force that a small mass located at the surface of the ground can experience during an earthquake and is a suitable index to assess the hazard for stiff structures such as the mounting structure and key equipment substations. We note that this PGA is

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classified as 2A in the Seismic Provisions (2007) of Building Code of Pakistan and recommend that this is taken into account in the design of the substation foundations and buildings.

3.2.1 Near and on-site shading

Shading on PV modules reduces the amount of electricity generated, consequently it is essential to consider the potential shading from both on-site and near-site objects. In addition to this, it is also important to consider the variation of size and shape of possible shading objects with time. These variations, in fact, may create shading issues where there were none previously.

The site is very flat and largely barren with only limited vegetation comprising mostly low lying bushes and grasses. The only shading anticipated on site would be caused by the local distribution overhead lines traversing the northern part of the site, 350-500 m from the road. These can be seen in the distance of Figure 9 and Figure 10. The preliminary solar field layout (see Appendix C) has been arranged to avoid the installation of modules under the overhead lines.

There are no buildings or tall structures around the site expected to cause shading on the arrays. Additionally, no hills or mountains were visible on the horizon.

3.3 Site access, laydown area and security

Construction of a solar PV plant requires safe and reliable access for large and heavy vehicles. It is important to consider the suitability of the current access, and highlight if any works will be required to enable satisfactory access pre-construction. The hardware and equipment used must be unloaded and stored somewhere before installation. This area is known as the laydown area and will normally also house site offices. Considering the build-up of equipment, personnel, and traffic, its location is critical. Security is very important in reducing the risk of theft and ensuring safe access for authorised personnel. Mitigation measures such as fencing and site management should be among the first things present and installed on site.

The site is accessed from the Mirpur Sakro to Ghulamullah Road, which is a single lane sealed road with broad unsealed shoulders to allow vehicles to pass each other. During our site visit traffic was light but included a few heavy vehicles. It is expected that most deliveries would be received via the town of Mirpur Sakro, 8 km to the west of the site. Mirpur Sakro has a crowded central market area and is on the more major Gaarho to Keti Bandar Highway, which is a sealed two lane road that connects the district to Karachi.

The road from Mirpur Sakro crosses several canals (see Figure 13). Whilst these bridges and culverts are relatively short and are currently accepting local agricultural vehicles, it is recommended that their suitability for the delivery of heavy components be confirmed, particularly transformers for the 132 kV substation.

We recommend that a community consultation process be carried out to prepare local residents for the additional heavy vehicle movements anticipated, particularly during equipment delivery. This consultation should include not only local residents and businesses, but also those in hamlets along the road from Mirpur Sakro and in the area of Mirpur Sakro market where there is a restricted and crowded intersection with the Gaarho to Keti Bandar Highway. A construction traffic management plan should be prepared prior to commencement of works. This plan should consider pre-staging for incoming deliveries and prevention of 2-way traffic along narrow sections of the access.

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Figure 13: Highway looking east, entrance to access road on left

Figure 14: Southern Drain, looking northeast

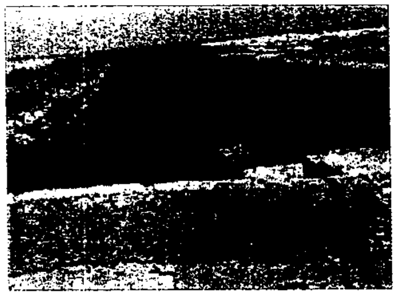

Figure 15: Southern boundary, looking east

The site will require a laydown areas where materials, machinery and equipment can be delivered and stored securely. The most logical location for the site entrance and laydown area is in the north-west corner of the site, adjacent to the road and Western Drain. This location offers not only easy access but will minimise disruption to construction activities within the solar field and is adjacent to the new proposed substation site. Fencing and security should be provided for the laydown area at the site from commencement.

It was noticed that all the current vehicle tracks at the site are raised (see Figure 15) and it is recommended that access roads within the solar field are also elevated to maintain their trafficability in wet weather, adequate culverts should be provided under the roads to release water. It may be possible to make a raised perimeter security track into a berm that will prevent water from neighbouring areas entering the site.

A detailed assessment of the security of the Project location and possible mitigation measures is outside the scope of this report. We recommend that security costs be considered in the final economic analysis of the Project, that preliminary discussions be held at an early stage with potential EPC contractors to ensure that they are able to operate in this location and that major vendors, including inverter suppliers, are confirmed as able to provide specialist staff for commissioning and ongoing service support.

The closest hospitals and police station are situated in the regional centre of Thatta, approximately 40 km north east of the site. There may be an opportunity to support local health care facilities to the benefit of both the Project and local community. In any case we recommend that the Project undertakes thorough emergency planning for both the construction and operational phases of the Project.

There is no municipal water supply or sewerage at the site and therefore water and ablution facilities will need to be provided for the construction of the plant as well as during operations and maintenance. Table 6 gives a summary of the access for the site.

Table 6: Summary of site access, laydown area and security

Item	Mirpur Sakro Site
Site access	Single lane sealed road with bridges
Access point	North western corner of boundary
Access road length from main road	Direct from Mirpur Sakro to Ghulamullah Road
Laydown area	North western corner of site recommended

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Item	Mirpur Sakro Site
Impacts	Increased traffic in residential/commercial area Security concerns could impact costs

3.4 Conclusion

OST considers the site setting satisfactory for the development of the Project. Local weather conditions are relatively hot and dry aside from the rain in monsoon season. The high temperatures experienced during the year as well as the dusty conditions of the site unfavourably affect the Plant performance. This has been accounted for in the yield assessment. The construction will likely cause higher volumes of local traffic however this can be safely managed.

At this stage of review, no significant issues have been identified with regard to the site topography, terrain, and hydrology although considering the site's location on a delta we recommend that a site specific FRA be conducted. OST recommends that construction should be avoided during monsoon rains and specific attention paid to site drainage and road construction. We await specific results from the geotechnical studies related to the possibility ofliquefaction.

No particular shading issues have been identified for the proposed site. The site layout has been configured to avoid installation of modules under existing overhead distribution lines in order to facilitate construction and minimise shading issues.

Unsealed roads should be adequately prepared to support large and heavy vehicles, and a survey should be conducted on bridges en-route in order to check safe loading capacity. OST highlights that security and welfare arrangements should be considered from the Project outset.

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4 Desktop Environmental and Social Impact Assessment

A project of this nature will be required to obtain the necessary environmental permit from the Sindh Environmental Protection Agency (SEPA). Environmental reporting for energy generation projects in Pakistan falls under the Pakistan Environmental Protection Agency Regulations 2000, which categorises development projects into two main schedules, Schedule I for lower impact and Schedule II for higher impact projects. No specific provision is made within these national regulations for solar projects, however the Government of Sindh Environmental Protection Agency IEE/EIA Regulations 2014 place solar projects under schedule I, for which only the IEE is required as part of the planning and approval process.

The IEE is required to demonstrate that the impact on the environment and local communities is acceptable and that the Project complies with national environmental laws and regulations. An IEE for the Project is currently under finalisation by a team of environmentalists and engineers from Saichen. Following submission and review of the IEE, SEPA will make a decision as to whether to approve the Project, and may impose conditions to be followed in its implementation. The Agency has a 60 day target following IEE submission to provide a decision.

If the Project depends at any stage on international financing it will be need to demonstrate compliance with the requirements of international financing institutions, such as development agencies and banks. This is generally achieved by following the International Finance Corporation's (IFC) performance standards on social and environmental sustainability, and Industry Sector Guidelines. The standards relate to various elements of social and environmental assessment and management, summarised as follows:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labour and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

The IFC Performance Standards are reinforced by the Equator Principles (EPs), a credit risk management framework for determining, assessing and managing environmental and social risk in Project finance transactions. As Lenders for this type of project are generally Equator Principles Financial Institutions (EPFIs), it is likely that adherence to these Principles will be required.

In order to identify where the IEE produced for the Project requires additional issues to be addressed in order to comply with IFC Standards and EPs, a full gap analysis would need to be prepared. This analysis will produce an Environmental and Social Action Plan (ESAP), listing actions required to meet the various standards. By systematically addressing the ESAP actions, risk to the Project will be reduced by safeguarding against any environmental and social uncertainties. It should be noted that this gap analysis is not within the scope of our report.

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The EPAP actions would form part of a Condition Precedent issued by the lender and can be addressed as financing proceeds. As a result, incorporating these standards is unlikely to result in delays to the Project or prohibitive costs.

The principal impacts of a solar development are discussed below.

4.1 Environment

The land required for the proposed PV Project is approximately 290 hectares. Although covering a large land area, once constructed, the solar projects will have very limited impacts on the surrounding environment. The panels are passive in nature, do not result in any emissions, do not generate waste during normal operation (aside from any required replacement of components) and require limited onsite activity during operation. The solar farm will not result in hazardous impacts, and it does not involve any unusually complex technologies. The risk of accidents is considered low, and restricted mainly to construction and maintenance activities.

In addition, the production of electricity from a renewable source will make a significant contribution to reductions in Greenhouse Gases (GHG) emissions over the lifetime of the Project. In particular, the Plant will contribute to a reduction of GHG emissions of approximately 0.54 tonCO_2/MWh,year[3] which corresponds to a total estimated reduction of 1.9 million tonCO_2 assuming 25 years Project lifetime. The numbers are based on our annual generation estimation, including the annual degradation.

The principal environmental and social aspects identified as part of our early observations are outlined below for the proposed project site, with a brief statement regarding possible mitigations that have been identified at this early stage.

4.1.1 Ecology

The site is described in the IEE report as barren land with some patches of agriculture and no significant populations of flora or fauna. There are a small number of shrubs and trees on the site, which may have the potential to provide habitat for various faunal species and it is recommended that an independent ecologist survey the site in order to confirm whether any protected species are present, and propose suitable mitigation if necessary.

4.1.2 Cultural Heritage

The city of Thatta, located approximately 45km from the Project site is noted in the IEE as featuring a number of world heritage sites, however no heritage or archaeological assets are reported on or nearby the site itself in the IEE. Confirmation should be obtained from the Sindh region Department of Antiquities that the site does not cover any areas of heritage or archaeological potential that may require further investigation or mitigation measures.

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3 Source: PROGRAMME DESIGN DOCUMENT FORM FOR CDM PROGRAMMES OF ACTIVITIES, 2012, available online at: https://cdm.unfccc.int/filestorage/s/4/37F2YI6MBTJ80EPC4AH9NVLK1GZWQD.pdf/7.pdf?t=cWp8bnZ5aDJyfDAtCwhmbuqWjHBAOlg3CanD

4.1.3 Landscape and Visual

The site and surrounding area are characterised by an overall flat topography, with no elevated areas in the vicinity to give significant views of the development. There are a number of small settlements in the vicinity of the site, the closest village being Saman, an irregular settlement adjacent to the site, and the villages of Qadir Bakish Shoro and Gharoa, three to four kilometres distant. Mirpur Sakro sits 10km to the west of the site. Due to the flat topography and the low height of the proposed development, views from any nearby residences are unlikely to be significant. Some existing areas of vegetation provide additional screening and it is recommended that measures to extend and infill this vegetation are investigated where any significant views of the site from residential areas may be identified.

The Project will be visible from the Mirpur Sakro Ghulamullah Road, which runs along the northern boundary of the site.

4.1.4 Agricultural Land Use

Although the site area is largely barren, some agricultural activity is noted in the IEE. Any users of the land need to be identified in order to assess the potential for economic displacement as a result of the Project.

Soil erosion control measures will be undertaken where necessary by the developers in order to maintain any agricultural potential of the land for possible cultivation after decommissioning of the Project.

Overall, there will be minimal loss of existing agricultural land and the installation of the solar farm will provide income from a previously unproductive area.

4.1.5 Hydrology and Water Use

The climate in the region is semi-arid, with hot and rainy summers and dry warm winters. The IEE describes mean temperatures in the central Sindh plains of between 35 and 39°C in summer and 18 to 20°C in the winter. The average annual precipitation in the region is approximately 210mm, with over 50% of this falling during the wet season in July and August. Groundwater levels peak in the post-monsoon season (October to November).

Water will be required for the cleaning of panels as part of the O&M activities. Dust from traffic movement along the Mirpur Sakro Ghulamullah Road to the north, the ploughing of surrounding agricultural fields and the site's proximity to surrounding desert areas are all likely to lead to windblown particulates soiling the panels, which will therefore need to be cleaned to reduce yield losses.

Water will also be required during construction for human consumption and washing facilities and for dust control purposes. In addition, should installation of panels by direct piling be considered inappropriate to ground conditions or the potential effects of seismic activity in the area, water for concrete foundations will also be required. The quantity of water required for the various site activities during the construction and operation of the Project should be assessed prior to those activities. Approximate values can be estimated using figures for water use requirements for similar solar projects:

- During construction, approximately 50 litres / person / day may be used for washing and consumption by site staff. Water required for dust control will depend on ground and weather conditions during construction. If considered necessary, concrete foundations would require a total of approximately 14,000 m^3 for the whole site, based on 0.6 m^3 concrete per pile and a single pile table design.

- During operation, the principal water use will be for the washing of panels, which may require up to 1,920,000 litres per wash, based on a standard figure of 3 litres per square metre of modules. The frequency of washing required will vary during the year, depending on levels of precipitation and other prevailing conditions. Staffing levels will be considerably less than during construction, and water use for human consumption will be proportionately reduced.

Water will be obtained via tube wells constructed on site. The IEE describes a groundwater analysis, which gave a TDD level of 830 mg/l, which is within the parameters considered suitable for panel washing. However, this figure is likely to vary considerably during the year as the rainfall / evaporation balance fluctuates, so periodic groundwater testing is recommended to ensure abstracted water is suitable for onsite use, and whether water treatment may be required. Effluent water from panel cleaning will be passed through a sump with a baffle wall to arrest any suspended solids and collected in ponds before being discharged into the drain which passes through the site. Permission for discharge will be obtained from the appropriate department. It is noted that no chemicals will be added to the water used for panel cleaning so no further treatment of the run-off will be required.

It is recognised that over-extraction of groundwater from boreholes could lead to negative impacts on nearby communities; further investigation will be required into water availability in the area and permitting requirements relating to water abstraction. Automated dry panel cleaning may also be considered as a less labour intensive alternative to manual cleaning of the panels.

High arsenic content is reported in water extracted from local wells, and sewage contamination in some wells is also reported. The IEE states that drinking water requirements for onsite workers will be met through storage of the local public supply in water tanks or through delivery by water tanker from nearby areas where adequate supply is available.

4.1.6 Dust Management

Dust generation on site will be reduced by paving the internal access roads. Although the site is largely barren, clearance of any vegetation during construction will result in additional risk of dust impacting on the Project and surrounding areas; further dust management measures should be applied where necessary to mitigate any impacts resulting from the clearance of onsite vegetation.

4.1.7 Waste Management

Accommodation for Project construction workers will be provided on site and a waste water treatment facility is proposed for sewage and kitchen waste produced.

Solid and hazardous waste quantities generated are expected to be minimal and not significant during both construction and operational phases of the Project and standard good waste management practices should be adequate to manage risks associated with the disposal and handling of this waste.

The most significant issue associated with waste management for the proposed solar PV Project is the disposal of the panels at the end of the lifetime of the Project. Opportunities for recycling of

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the panels should be investigated as a preferable option. If disposal of the panels is necessary, PV panels are classified as electronic waste and therefore must be disposed at a hazardous waste treatment facility. We consider that a decommissioning plan will be required to outline how responsible management of the panels at end of life will be ensured.

4.2 Social

The solar project should place emphasis on Corporate Social Responsibility. It is considered that a project of this scale will offer significant employment opportunities to the local population during the construction phase. It is recommended that commitments are made to providing jobs to local people where possible. We also recommend that a Labour and Employment Plan (LEP), based on International Labour Organisation (ILO) and IFC standards, is developed and implemented, covering hiring, training, worker rights etc.; the LEP should also cover accommodation for construction workforce and be based on IFC and EBRD guidance note on workers' accommodation. It is recommended that careful and appropriate management of local expectations with regard to job opportunities offered by the Project, particularly in the long term, as operational and maintenance employment opportunities are fairly limited in comparison to more traditional energy projects of this scale.

The IEE describes the local area as under-developed, with poor standards of education, inadequate medical facilities and lacking sewage, gas and water supply infrastructure. Large scale solar developments located in this type of social context often consider offering a community benefit fund for local people to spend on improving social conditions in the local area by targeting priority issues such as education or training projects. As well as providing potentially long-term benefit to a significant number of local people, this is likely to help foster good relations with the local community and reduce any risks associated with potential ill feeling towards the Project and unfulfilled expectations with regard to the employment and lifestyle opportunities offered.

4.3 Environmental and Social Management

4.3.1 Impact Assessment

The IEE provides a description of the environmental and social setting of the development, an assessment of potential impacts and recommendations for mitigation measures. The report, prepared by a team of environmentalists and engineers from Saichen Energy Ltd concluded that, "...it is expected that adverse impacts from the Project's life cycle will be minimal.".

4.3.2 Environmental Management Plan

A key requirement of the Project under PEPA regulations is the preparation of an Environmental Management Plan (EMP). The objectives of the EMP for the solar project are set out in Section 7 of the IEE, and include the implementation of mitigation measures and monitoring mechanisms for the development and the allocation of responsibilities for the environmental management of the Project.

Although the Project may be established using local financing, we recommend compliance with IFC Performance Standards is considered in the preparation of the EMP as this is industry best practice and demonstrates ongoing and responsive management of all potential social and environmental impacts throughout both construction and operational phases. Compliance with

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the IFC Standards will also be required should the Project require international financing at any stage. This compliance can effectively be demonstrated through a comprehensive and robust EMP, targeted to the IFC standards.

It is recommended that, once the EPC contractor has been appointed, the responsibilities with regards to fulfilling the requirements of the EMP and any other social, labour and employment commitments associated with the Project are clearly specified within the EPC.

4.3.3 Stakeholder Engagement Plan

Stakeholder engagement is an essential element of a robust environmental and social assessment and is a key lender requirement, eg. Principle 5: Stakeholder Engagement, of the Equator Principles, and IFC Good Practice Handbook for Stakeholder Engagement. The general stakeholder process is as follows:

- To identify people or communities that are or could be affected by the Project, as well as other interested parties.
- To ensure that such stakeholders are appropriately engaged on environmental and social issues that could potentially affect them through a process of information disclosure and meaningful consultation.
- To maintain a constructive relationship with stakeholders on an ongoing basis through meaningful engagement during Project implementation.
- To provide a grievance mechanism by which the general public and other stakeholders can raise concerns, which the Company will handle in a prompt and consistent manner.

The initial stages of public consultation for the Project has involved the distribution of an information pamphlet in the local area followed by briefings held in eight local villages. During the briefings, feedback on the proposals was gathered through a questionnaire, which was completed by a total of 20 people. The principal concern raised was in relation to local employment and comment(s) were also received regarding the provision of schoolteachers. All 20 of the respondents are reported to have consented to the implementation of the Project.

To follow up this initial consultation, it is recommended that a Stakeholder Engagement Plan (SEP) is developed that identifies how engagement with local communities will continue throughout the construction and operational phases of the Project. This should identify Project stakeholders and set out a stakeholder engagement programme and Action Plan, with particular focus on locally affected communities. It is noted that all of the 20 respondents to the initial consultation were male; notwithstanding cultural and religious norms, effective stakeholder engagement should make attempts to allow all people affected by the Project to have a voice in the consultation process. The document should also include a grievance mechanism for stakeholders to raise their concerns about the Project.

A project of this kind may give rise to expectations in the local population regarding short and long term economic and social benefits. It is important that public perceptions inform the management of the stakeholder engagement process and that any misconceptions are addressed at an early stage.

4.3.4 Labour and Employment Plan

Although it might be not essential, ~~it is~~ recommended that the project provides a Labour and Employment Plan (LEP) for implementation by the EPC, which takes into consideration relevant

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guidelines put forward by the International Labour Organisation (ILO), the IFC as well as national regulations. Should the Project seek refinancing at a later stage on the international market then there is a risk that EPs may apply in the future. As well as satisfying lenders requirements, a commitment to upholding standards relating to issues such as working conditions, health and safety, equal opportunities and remuneration, and discrimination will help foster goodwill within in the surrounding community and reduce any risks that may result from local dissatisfaction with the Project. At a minimum, a clear policy statement should be drafted that commits the Project to the relevant ILO and IFC standards on labour and employment, as well as emphasising local employment. If the developer has plans for more similar projects, it is advisable to have a LEP and policies that can then be easily applied to additional projects.

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5 Grid Connection

At the time of writing no grid interconnection study has been provided for review.

The aim of the grid interconnection study is to assess the reliability and stability of the Plant's connection under the following conditions:

- Steady state load flow
- Contingency load flows
- Short circuit currents
- Power quality and dynamic / transient conditions

We recommend that the grid interconnection study be carried out as soon as possible and related assessment report be provided for review.

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6 Conceptual Design

This section describes the conceptual design of the Plant, which follows conventional and well proven commercial practice. Detailed design will be undertaken by the EPC Contractor according the Technical Specification which will include specific Project's owner requirements, performance requirements and applicable standards including Pakistan Building Code and IEC standards. The Plant shall be designed for a minimum of 25 years life.

Appendix B provides preliminary details for each of the major components.

A preliminary layout for this Project is included as Appendix C.

6.1.1 Modules and mounting frames

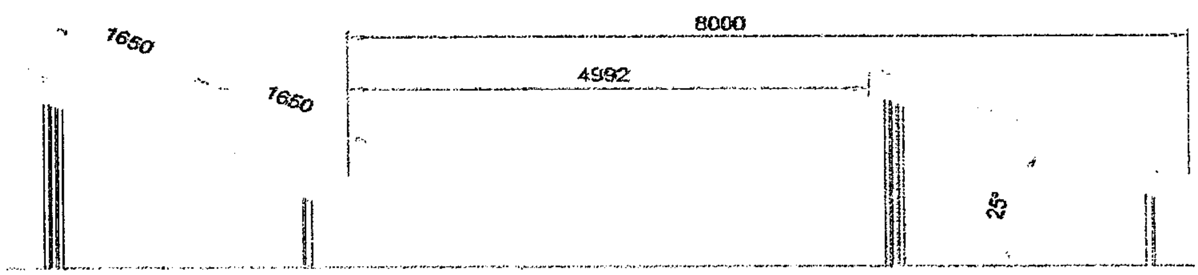
A module is an array of solar cells that converts the energy received from sunlight into electrical energy through use of the photovoltaic effect. Silicon solar cells are made from either mono-crystalline wafers which offer slightly higher efficiency at a higher cost, or poly-crystalline wafers which offer slightly lower efficiency but at a lower cost. Each individual photovoltaic module is approximately 1 m x 1.6 m and is of a glass construction, typically set in an outer metal framework. The front surface is generally treated with anti-reflective coatings. Poly-crystalline modules can offer more economic solutions for utility scale projects.

The modules are electrically connected by string cables which run through conduits placed behind the rows of modules. The string cables terminate at junction boxes which are generally found adjacent to module rows. Junction boxes then connect to inverters via larger diameter underground cables.

Modules are mounted on a static steel framework structure which securely holds the modules in the design-specified position, inclination, and orientation as shown in Figure 16.

The structure may be supported on a variety of different foundation designs including steel mini-piles driven directly into the ground or concrete foundations formed in place. The module support structure is arranged in rows, and follows the landform, generally rising no more than approximately 2.2 m above ground level at any point. The rows are separated from one another by an open space, which is determined by the site and project but generally between 3 m to 8 m.

Figure 16: Proposed module elevations



The framework mounting system can also employ tracker technology which varies the orientation of the modules to follow the sun's position through the day. The most common tracking solution in today's market is single axis tracking, which supports the modules in north-south rows and tracks the sun's position as it passes from east to west each day. The use of tracking system can improve the irradiation hitting the modules up to 20% with consequent increase of the yield. This can increase revenues in areas of high direct irradiation. However, tracker technology causes an increase in initial costs and maintenance costs, and due to the increase in system complexity, can reduce reliability and increase the risk of failure; trackers are best suited to large, unconstrained sites and have not been considered for Siachen solar power plant Project.

Generally less than 30% of the site area will be beneath solar arrays or taken up by ancillary buildings, leaving the majority as open space. The unoccupied ground between rows of modules and under the modules can be seeded to produce vegetation as desired. Once constructed, it is viable for farming activity to occur such as grazing of medium-sized animals like sheep.

Module manufacturers are classified by Bloomberg New Energy Finance into different tiers and are used to evaluate the bankability of the module provider. Tier 1 modules will generally be own-brand, own-manufacturer products, which have been financed by five different non-development banks in the past two years. OST notes that the Bloomberg Tiering system does not consider manufacturing quality, but only the "bankability" of the manufacturer; OST would be happy to offer a comprehensive technical review of modules if desired.

As an alternative to poly- or mono- crystalline silicone modules, thin film modules from a proven and bankable manufacturer may be employed. Such modules typically offer a lower capital cost for module purchase and potentially suffer reduced performance degradation at high ambient temperatures such as experienced at Mirpur Sakro. However against this must be weighed their generally lower efficiency which, in some cases, can minimise the price advantage. The Cd-Te technology employed by some thin film manufacturers would also make it imperative that firm provisions are made for removal and safe recycling of the modules at the end of the project life.

6.1.2 Inverters and transformers

Inverters are required to convert the direct current (DC) electricity generated by the PV modules into alternating current (AC) which is suitable for exporting to the grid. The inverters also manage and optimise specific electrical parameters in order to maximise energy production.

Inverters are most commonly available as either string inverters or central inverters. String inverters are smaller devices, each managing a small number of modules, typically mounted on the module support structures and with a capacity typically less than 50 kW. They are better able optimise electrical parameters and maximise energy production in conditions where orientation or shading vary, particularly rooftops. However, the large number required for a utility scale application often results in higher installation and maintenance costs, including replacement over the Plant lifetime.

Central inverters are larger devices with capacities up to 1,000 kW or more which manage greater sections of the Plant. They are generally able to optimise energy production more efficiently and are generally less resource intensive to maintain and can be more economical to purchase and install. Central inverters are generally housed within weatherproof skid-mounted enclosures with approximate dimensions 8.5 m long, 2.9 m wide and 3.2 m high. Alternatively they may be installed in a masonry building with adequate ventilation. Care should be taken to ensure adequate ventilation, particularly considering the high ambient temperatures at this site.

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OST considers that for a project of this scale, location, and landform, central inverters are likely to offer the best solution.

The transformers are required to step-up the relatively low AC voltage as generated by inverters (typically 300-400 V), into the high AC voltage grid, in this case 11 kV. The transformers may be installed integrally with the inverter enclosures or adjacent to them.

6.1.3 Switchgear

Switchgear is used to control the connection between the Plant and the electricity distribution network. There will be two sets; one belonging to the Distribution Network Operator (DNO), MEPCO in this case, and one belonging to the Plant, which are housed in separate cabins or switchrooms. The appearance and size of the cabins will be determined by the requirements of MEPCO and the Project, but it is likely they will be fabricated from brick or Glass-fibre Reinforced Plastic (GRP), with approximate dimensions of 5 to 7.5 m long, 2.75 to 4.75 m wide and 3 to 4 m high.

6.1.4 Monitoring and Control Room

Monitoring systems are required to provide feedback and information on the operational status of the Plant. Systems for monitoring the Plant such as the Supervisory Control and Data Acquisition (SCADA) operating system will be located in an air-conditioned cabin or office, which will also provide a working environment for the Plant operator or manager. The cabin dimensions would typically be 7 m long, 3 m wide and 3 m high and may be fabricated from GRP or masonry.

6.1.5 Security

From the beginning of construction, security measures are required to prevent unauthorised access into the solar farm, which is an energy generation system, and to protect the solar farm. Security arrangements typically consist of a high welded mesh security fence of at least 2.2 m, installed within the site boundary and pole mounted security cameras at approximately 3.25 m high positioned around the fence perimeter. The security cameras should employ infra-red technology and site lighting will not be required. Alternative security arrangements based on manned patrols may also be employed.

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Appendices

A. Irradiation Database Overviews

Table 27: Irradiation database details

Database Name	Description
Meteonorm 7.1	The latest version of Meteonorm blends ground and satellite data for the period 1991-2010 from a database of approximately 1,325 weather stations with global radiation and temperature data. Where no radiation measurement is available nearer than 200 km (Europe: 50 km) from the selected location, satellite information is used. If the nearest site is more than 30 km (Europe: 10 km) away, a mixture of ground and satellite information is used. In Europe the spatial resolution is between 2-3 km and 8 km for the rest of the world. The uncertainty of ground measurements ranges between 2-10%. The uncertainty in satellite data is a function of latitude and albedo.
SolarGIS	This dataset is calculated from satellite data from Meteosat, GOES and IODC satellite data, meteorological data and other geographical parameters, Meteosat data is based on satellite data obtained over thirty minute periods between 1994 and 2004 (Meteosat First Generation) and over fifteen minute periods between 2005 and 2010 (Meteosat Second Generation). For Asia, IODC region, irradiation data are available from 1999. The outputs include the modelled time-series GHI and DNI data and are resampled to 2 arc-minutes regular grid, The outputs are validated using ground measurements from worldwide met stations with a relative mean bias for GHI of 1.1% in Europe.
Photovoltaic Geographical Information System (PVGIS) Climate SAF	This dataset is based on calculations from satellite images performed by CM-SAF. The database represents a total of 13 years of data combining MFG first generation Meteosat satellite data (1998 to 2005) with MSG second generation Meteosat satellite data (2006 to 2011). The spatial resolution is 1.5 arc-minutes (around 2.5 km x 2.5 km).
NASA Surface Meteorology and Solar Energy (SSE)	This dataset uses long-term satellite-derived monthly averages from 22 years of data over the period 1983 to 2005. To acquire the results, the model accounts for over 200 satellite-derived meteorology and solar parameters and global solar energy data from 1,195 ground sites. Results are provided for 1° latitude by 1° longitude grid cells over the globe. The data is considered accurate for preliminary feasibility studies of renewable energy projects.
NREL CSR	NREL has developed 40-km resolution solar datasets of the period 1985-1991 for Central America/Cuba, the Caribbean, Asia/South Asia, Africa and South America. The data are based on gridded cloud cover data and aerosol optical depth data, which serve as inputs to NREL's Climatological Solar Radiation (CSR) model. The datasets have been developed for United Nations Environmental Program (UNEP)'s Solar and Wind Energy Resource (SWERA) project, which also included data

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Database Name	Description
	validation.
NREL SUNY (Pakistan Solar Resource Data)	Solar resource database of NREL using a satellite model developed at State University of New York at Albany (SUNY). Model estimates monthly average daily total irradiation, averaged from hourly estimates of direct normal irradiance over 3.5 years, April 2002- September 2005. The model inputs are imagery from Meteosat satellites and monthly average aerosol optical depth (AOD), precipitable water vapour and ozone sample at a 10 km resolution. The data are available via NREL's website.

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B. Requirements for Key Components

B.1. Photovoltaic Modules

B.1.1. Technical requirements

The EPC Contractor is allowed to make use of the following photovoltaic module technology:

- Polycrystalline silicon

Crystalline silicon modules are required to be IEC 61215 certified. Detailed specification sheets and certificates of compliance to these standards are to be provided.

In addition, the modules shall feature the following qualities:

- Normal Operating Cell Temperature (NOCT) is at maximum 46°C with a tolerance of ± 2°C
- The module operating temperature range is to be at least -10 to 85°C
- The temperature coefficients for power is to be at least -0.45%/°C (i.e. the magnitude of the power loss is less than 0.45%/°C)
- All modules are required to have a positive output tolerance
- Modules shall have anti-reflective coating

B.1.2. Flash Tests

A comprehensive IV flash test report for each PV module procured shall be provided to the Project Manager in Excel format prior to commencement of construction. The data must have the following information:

- Product name and number (external and internal)
- The test condition the measurement is carried out
- Serial number of the tested module, including which modules are in which shipping containers and pallets
- Power at maximum power point (Pmpp)
- Voltage at MPP (Vmpp)
- Current at MPP (Impp)
- Fill factor
- Open circuit voltage (Voc)
- Short circuit current (Isc)
- Module surface temperature (measured by temperature sensor, corrected and uncorrected if possible)

This information shall be provided by latest two (2) weeks prior to the arrival of PV modules on the Site.

B.1.3. Installation

The EPC Contractor is responsible for the installation of modules according to the manufacturer's specifications. The PV module installation manual must be provided as part of the as-built documentation. The manual shall contain all the necessary requirements and specifications for proper module installations such as (but not limited to):

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- Types of mounting structures including physical requirements for securing mechanisms (screws, clamps, dimensions, tightening force, locations) and useful information such as recommended mounting types, recommended spacing to guarantee sufficient air circulation, restrictions to certain environments etc.
- Mechanical and electrical configuration guidelines (landscape, portrait, string and array sizing, grounding etc.).
- Earthing requirements.

B.1.4. Guarantees and Warranties

Modules shall carry a defect warranty of at least 10 years and a 25 year linear performance guarantee with 80% of rated module power being guaranteed at year 25.

The warranties offered by the module manufacturer shall be transferrable to the Project's owner. Other terms and conditions for warranties transferability must be clearly defined.

The sales agreement with the module manufacturer shall clearly define the claiming procedure of defective modules, the required additional specific independent party involvement and any other conditions that might influence the honouring of the warranty and guarantee.

B.2. Inverters

B.2.1. Technical Requirements

The EPC Contractor may make use of Central inverters.

The Inverters shall comply with safety requirements according to IEC 62109 and feature anti-islanding according to IEC 62116.

The selection of inverters shall be based on the PV installation design and functional requirements, including the integration requirements into the PV system and the compatibility to the selected PV modules for the installations.

The inverter supplier has to approve the stringing chosen for the project. Inverters must be designed for PV application and include:

- At least one MPP tracker
- A display showing the faults and the performances
- An advanced system to allow power control and efficiency (maximum efficiency) must be at least 97% (excluding transformer)
- Remote monitoring and control capabilities
- Isolation fault detection
- Anti-islanding
- Ability to start and stop function automatically
- Variable power factor setting
- The ratio of the input DC power to output AC power must be between 80% and 120% at STC
- The MPP voltages of the strings are to be verified to lie in the MPP voltage range of the inverter for temperatures between 0°C and 70°C. The maximum inverter input voltage is not to be exceeded at temperatures of -10°C
- An IP protection class of at least 54 is required for outdoor mounting and an IP grade of at least 21 is required for indoor mounting of the inverters

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- If inverters are installed outdoors must have to be protected from direct sunlight
- The inverter requires an external DC switch

In cases where applicable, there may special grounding requirements for inverters. These are stipulated by the PV module manufacturer. In such cases, it is the EPC Contractor's responsibility to notify the Project Manager and implement these requirements.

B.2.2. Guarantees and Warranties

Inverters shall have a warranty of at least 10 years. The contract sales agreement with the inverter manufacturer shall clearly define the claiming procedure of defect inverters or parts. The required testing, independent verification requirements and any other conditions that might influence the honouring of the warranties.

Any extension and the full scope of that extension to the standard limited warranty that is included in the price should be indicated clearly.

Upon request by the Project Manager, the EPC Contractor must provide proof that the inverter manufacturers have sufficient financial backup that covers manufacturers in bankruptcy or insolvency procedures.

The conditions which void the warranties shall be clearly stated.

The warranties offered by the Inverter manufacturers shall be transferrable to the Project's owner. Other terms and conditions for warranties transferability must be clearly defined.

B.3. Mounting structure

Modules shall be mounted on a non-corrosive support structures. Structure and foundation or fixation arrangements should withstand the required dead and wind loads.

B.3.1. Fixed-inclination structure

Fixed-inclination structure, if selected, will be installed with modules facing due south at the required inclination to maximize annual energy output.

B.4. Balance of Plant

B.4.1. Transformers

The transformer shall comply with IEC 60076 and have a design life of at least 25 years. The transformer can be incorporated into a containerised solution (central) inverter, standalone or incorporated in a container with the Ring Main Unit. The internal ring voltage is 11kV. Transformers may be oil-immersed or dry type. The transformer shall have the appropriate IP class for the indoor or outdoor application in terms of IEC 60529.

B.4.2. Ring Main Unit

The Ring Main Unit (RMU) may be incorporated inside a cabinet together with the transformer or be a standalone unit within a cabinet. The RMU shall feature motorised contactors to allow remote operations. The RMU shall comply with IEC 62271-202/200/100.

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B.4.3. Protection and control devices

The protection and switching methodology shall be determined by the EPC Contractor's proposed design and technology but the degrees of protection shall comply with the applicable standards associated with PV and electrical works in general. Overcurrent and overvoltage devices shall be required on the DC and AC sides. Switchgear used in any switchboards shall comply with IEC 60947 and IEC 62271.

B.4.4. Lightning Protection and Earthing

The EPC Contractor is to conduct a risk mitigation study of lightning damage as per IEC 62305 and implement sufficient Lightning Protection System (LPS).

Earthing shall comply with IEC. A neutral earthing design is required

All structures, enclosures, PV modules and cabinets shall be earthed appropriately.

B.5. Cabling

B.5.1. General

All cabling shall be installed in accordance with manufacturers' requirements and to meet the design conditions used in the sizing calculations.

The combined cable DC and AC losses shall not exceed 3%.

B.5.2. DC cables

The DC cables of the PV installation must have the following characteristics as minimum:

- Cables used outside shall be UV resistant and ozone protected
- Cables should have Class II rating for insulation
- Cables must be rated for temperatures from -15°C to +90°C. This requirement is also applicable to all materials used in the installation (such as cable conduits)
- The cable shall be made of double insulated component and shall have a minimal life span of 25 years
- Cables shall comply with TÜV 2 Pfg 1169
- All DC solar cable shall be halogen free, flame resistant & fire retardant
- Cables shall be terminated with MC4 connectors
- The cable bending radius shall be at minimum four times the cable diameter or as specified by manufacturer, if different
- Cables have to be sized to allow a current up to 1.25 Isc and up to 1.2 Voc

Cables must be installed in conduits and hooded cable trays. The cable return path should follow the same way to avoid induction loops.

Cables must be dimensioned according to CEI 20-40 and CEI 20-67. Norm CEI 64-8 should be followed to prevent short-circuit-induced current. Norm CEI 82-25 should be followed regarding arrangement of cables and cables trays.

Combined DC cable losses are to be less than 2% at Standard Test Conditions

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B.5.3. AC cables

The AC cables of the PV installation must have the following characteristics as minimum:

- All AC cables may be XLPE or PILC with aluminium or copper stranded wire conductors
- All cable construction shall be according to IEC 60502
- All AC cables shall be suitable for direct buried (armoured) or ducted installation
- All joints and terminations be completed and tested in accordance with the manufacturer's recommendations
- AC cables are to be terminated in suitable lugs

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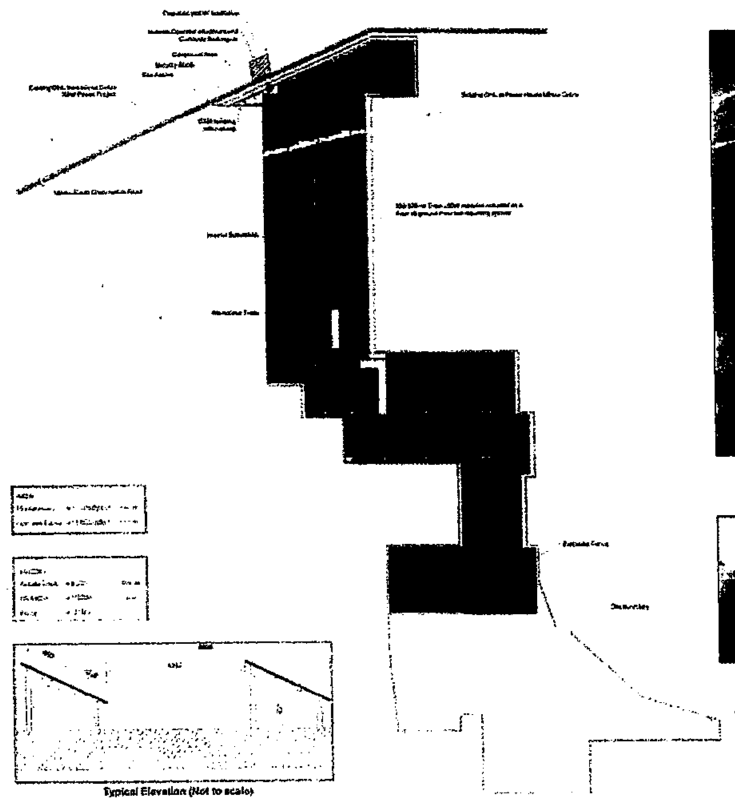
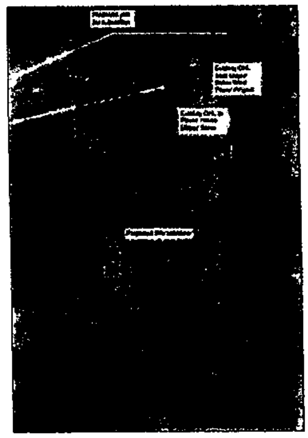
C. Proposed layout





Typical Elevation (Not to scale)

Typical mounding system

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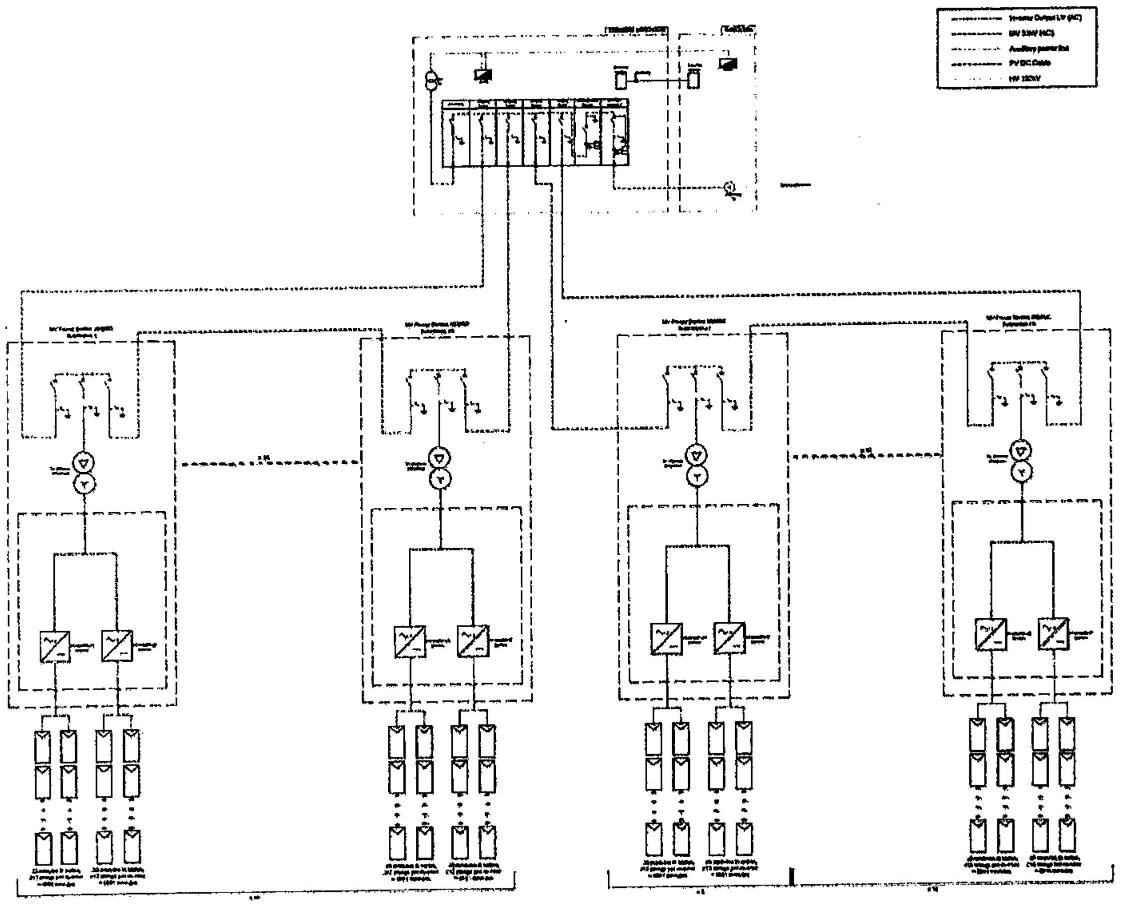
D. Plant Single Line Diagram (SLD)

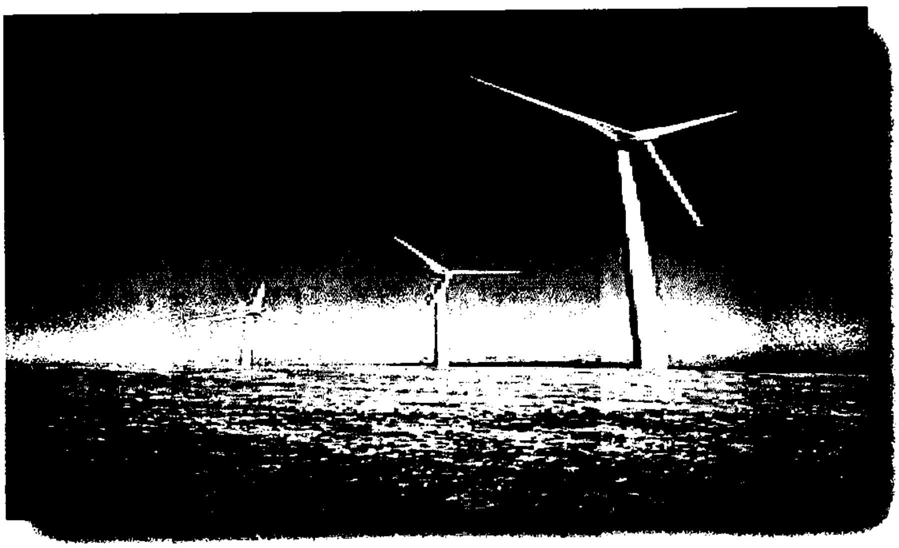


Report No. PPI-179.0/16

INTERCONNECTION STUDY

For

100 MW Solar Power Project by Siachen Energy Limited



Report
(January 2016)

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Executive Summary

- The study objective, approach and methodology have been described and the plant's data received from the client Siachen Energy Ltd. has been validated.
- The project by the name of Siachen Energy Power Plant is expected to start commercial operation by December 2017. Therefore, the month of June 2018 has been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load forecast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-380/ 5243-44 dated 14-12-2015.
- A 132 kV double circuit of 18 km has been proposed from Siachen Solar to Gharo-New 132kV grid station to evacuate the maximum of 100 MW power from Siachen Solar PP to National Grid. The Conductors used will be Greeley. As the 100 MW could not have been merged with any sub collector already proposed at Gharo-New 132kV.
- The scheme of interconnection of Siachen Solar PP presupposes the following reinforcement already in place in Jhimpir and Gharo clusters.
  - 220/132 kV Jhimpir-New substation at suitable location in Jhimpir cluster
  - 500/220 kV Matiari Collector Substation connected to Jhimpir 220/132 kV substation via 100 km long Greeley double circuit.
  - 70 km long double circuit from Jhimpir-New 220 kV Substation to the existing T.M. Khan Road 220 kV Substation.
  - A 132 kV double circuit of 82 km using Greeley conductor would be constructed to connect Jhimpir-New 220/132 kV Substation with T.M. Khan in HESCO network.
  - 220/132 kV Gharo-New substation at suitable location in Gharo cluster
  - 75 km long 220 kV double circuit from Gharo-New 220 kV Substation to Jhimpir-New 220 kV Substation

- Six sub-collectors groups will be connected to Jhimpir 220/132 kV collector substation through 132 kV double circuits using Greeley Conductor
- FFC and Zorlu looped in-out with Jhimpir-Nooriabad 132 kV circuit.
- Four WPPs in the collector system of Gharo 220/132 kV substation
- FWEL-I and FWEL-II through a 64 km long 132 kV D/C on Greeley conductor connected to Thatta
- Rehabilitation of the exiting 132 kV lines in the vicinity of WPP clusters, i.e. Jhimpir-Kotri, Jhimpir-Thatta, Thatta-Sujawal and Nooriabad-Jamshoro Old.

➢ The existing grid system of HESCO and NTDC in the vicinity of Siachen Solar PP has been studied in detail by performing load flow, short circuit and dynamic analysis for the conditions prior to commissioning of Siachen Solar PP and no bottlenecks or constraints have been found in the grid system.

➢ The medium voltage level of solar farm has been selected as 33 kV for unit step-up transformers, for collector circuits and step-up from MV to HV (132 kV) at Farm substation to connect to the HESCO/NTDC Grid.

➢ A conceptual design of scheme of 132/33 kV substation of Siachen Solar Farm has been laid down as follows

For 11 kV;

It comprises of

- Two single bus-sections of 33 kV with a bus sectionalizer
- Ten breaker bays to connect ten collector circuits
- Two breaker bays to connect two transformers of 132/33 kV
- One station auxiliary transformer 11/0.4 kV
- Two SVCs each of the size of -5/+20 MVAR
- Two breaker bays to connect two -5/+20 MVAR SVCs

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity = 31.5 kA

Normal continuous current = 1250 A for line breakers

= 2500A for Bus Sectionalizer and Power TF

For 132 kV;

- Double bus bars with a Bus Coupler
- Two breaker bays to connect two transformers 132/11 kV
- Two breaker bays to connect two circuits of 132 kV i.e. double circuit on single tower overhead line to connect to the grid system.

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity	= 40 kA
Normal continuous current	= 2000 A for line and TF breakers
	= 2500 A for Bus Coupler

The other equipment of the substation consists of:

- Two 132/33 kV, 67/100 MVA ONAN/ONAF OLTC transformers, $132\pm8\times1.25\%/33$kV, to fulfill N-1 criteria of Grid Code
- Energy meters would be installed on HV side (132 kV) of the 132/33kV transformers.

➢ Load flow analysis has been carried out for June 2018 considering the COD targeted by Siachen Solar PP, for the dispersal of load from Siachen Solar PP into HESCO Grid at 132 kV level using the latest load forecast, generation and transmission expansion plans of NTDC and HESCO. The above mentioned interconnection scheme has been evolved by performing the load flow studies testing the steady state performance for normal as well as N-1 contingency conditions fulfilling the Grid Code criteria of Power Plants. The reactive power requirement at point of common coupling to meet PF of ± 0.95, voltage and line loading criteria are fulfilled by these studies. The grid facilities of HESCO are found adequate to absorb output power of Siachen PP. The load flow results for these scenarios also establish that the proposed scheme of interconnection of Siachen Solar PP shows no bottlenecks or capacity constraints in the adjoining 500 kV, 220 kV and 132 kV network in terms of absorbing all the output of Siachen Solar PP under normal as well as the contingency conditions.

- Maximum and minimum short circuit levels for three-phase faults and single-phase faults have been evaluated. The maximum short circuit level has been evaluated for the year 2017-18 and the minimum short circuit level has been evaluated for 2017-2018 to evaluate the most stringent conditions, the fault levels of Siachen 132 kV are 6.65 kA and 4.75 kA for 3-phase and single phase faults respectively for 2017-18. This is much less than the switchgear rating of 40 kA recommended for Siachen Farm Substation as per NTDC requirements for 132 kV. The fault levels for Siachen 33 kV are 16.56 kA and 13.33 kA for 3-phase and single-phase faults respectively for year 2017-18. Therefore the short circuit rating for 11 kV switchgear is recommended as 25 kA. It has been found that the proposed scheme provides maximum SC strength for the evacuation of Siachen Solar PP power to the grid.

  The switchgear ratings for Siachen Solar substation are as follows:

  132 kV:

  Short circuit rating = 40 kA (3 sec.)

  Continuous rating = 2500 A

  33 kV:

  Short circuit rating = 25 kA (3 sec.)

  Continuous rating = 2500 A

- Transient Stability analysis has been carried out for Siachen Solar PP, with connectivity of proposed scheme. Different disturbances have been simulated to apply stresses from the system faults on the solar farm and vice versa and it was found that Siachen Solar unit's dynamic characteristics and the grid connectivity is strong enough to maintain stability under all disturbances. In turn, any disturbance from Siachen Solar PP side did not cause any stress on the main grid or the power plants in HESCO area viz. Kotri, Lakhra or Jamshoro such that the whole system remained stable under all events.
- 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 power quality; and is therefore recommended to be adopted.

- The issues of power quality like flicker, unbalance and harmonic resonance have been studied in detail. The results have indicated that the levels of flicker and unbalance are within the permissible limits of IEC and other International Standards.
- There are no technical constraints whatsoever in the way of bringing in the 100 MW of Siachen Solar Power Plant at the proposed site and scheduled time of commissioning, in any respect of steady state (load flow) or short circuit or dynamic performance (stability) or power quality issues related to this plant.

Report Contents

1. Introduction

1.1 Background

There exists a huge corridor in coastal Sindh, starting from Gharo-Ketti Bandar up to Jhimpir and upward, that has been identified by AEDB with an actual potential of about 50,000 MW. There are many entrepreneurs coming forward to tap this huge natural resource of power; fourteen of them in the Jhimpir cluster who have been allocated lands by AEDB to develop wind farms and set to achieve COD. Siachen Energy. Ltd. is one such pioneering entrepreneur who has come forward with a Solar Power Plant at Ghoro-New. Siachen Energy Limited is developing a 100 MW Photovoltaic (PV) based Solar Power Project.

The proposed Solar farm shall have the installed capacity of about 100 MW of electricity. The project is being developed in the private sector and the electricity generated from this project would be supplied to power grid of HESCO / NTDC. The services of Power Planners International have been engaged to perform the impact studies of penetration of this wind power in the national grid to evolve the most feasible interconnection scheme for this plant.

1.2 Objectives

The overall objectives of this study are:

1. Impact of Siachen Solar Power Plant on the System
2. Impact of the System on Siachen Solar Power Plant

These impacts are to be studied for different operating conditions of Plant as well as the System. The operating condition of the plant may vary from its 100 % output to 0 % i.e. no output at all. The system conditions would be peak load under two generation dispatch scenarios with high hydro power availability.

The impacts are required to be studied for steady state as well as the dynamic and disturbed conditions of the system. The specific objectives are:

1. To develop a feasible scheme of interconnections of Siachen Solar Power Plant with HESCO/NTDC network at 132 kV for which right of

way (ROW) and space at the terminal substations would be required to be made available.

2. To check the load-ability of lines and transformers to be within their rated limits satisfying the clauses OC 4.8, OC 4.9, and OC 4.10 of NEPRA Grid Code regarding the criteria of operation of frequency, voltage and stability under normal and contingency conditions for peak load conditions of grid as well as the plant.
3. To check the voltage profile of the bus bars of the neighboring interconnected network under different operating conditions
4. To check the reactive power limitations of the solar farm and the neighboring generators of the system; and evaluate the size of SVCs at Medium Voltage level of substation of invertor system of Siachen Solar Farm to regulate the voltage under steady state and contingency conditions to fulfill the Grid Code criteria of ± 0.95 Power Factor at the point of common coupling (interface point) interconnecting Solar Farm and the Grid.
5. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 220 kV and 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 Medium Voltage substation of collector system of Siachen Solar Farm and the NTDC/HESCO substations of 132 kV connecting with the Siachen Solar Farm.
6. To check the minimum short circuit strength of the system to handle large variation of generation of Solar Farm.
7. To check if the interconnection with the grid withstands transient stability criteria of post fault recovery with good damping satisfying the NEPRA Grid Code.

8. Transient stability to see the dynamic performance of Solar PP in response to Grid disturbances and vice versa the dynamic impact of disturbances in Siachen PP on the Grid.
9. Analysis of power quality issues such as flicker, voltage-unbalance, harmonics and resonance of the system.

1.3 Planning Criteria

The planning criteria required to be fulfilled by the proposed interconnection as enunciated in NEPRA Grid Code including Addendum No.1 for PPs are as follows:

Voltage	± 5 %, Normal Operating Condition
	± 10 %, Contingency Conditions
Frequency	50 Hz, Continuous, ± 1% variation steady state
	49.4 - 50.5 Hz, Under Contingency
Power Factor	± 0.95 (as per Grid Code Addendum No. 2 for Solar Power Plants)

Short Circuit:

132 kV Substation Equipment Rating 40kA

Dynamic/Transient:

- The system should revert back to normal condition after dying out of transients without losing synchronism with good damping. For the systems of 132 kV and above the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles).
- 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

Reactive Power and Power factor:

Reactive Power Control to maintain the power factor within the range of 0.95 lagging to 0.95 leading, over full range of plant operation, according to Dispatch Instructions/manual voltage adjustment requirements.

Power Quality Requirements:

As per IEC61400-21standards

1.4 Operating Criteria

The operating requirements to be fulfilled by the proposed solar PP as enunciated in NEPRA Grid Code for Power plants (Addendum No.1) are as follows:

Black Start and Islanded Operation:

Exempted

Active Power and Frequency Control:

Exempted from precise frequency control responsibility

Synchronization / De-Synchronization:

(i) The Power Plant will manage for

- (a) Smooth Synchronization
- (b) Smooth De-Synchronization

(ii) The above operations, achieved through appropriate equipment, will be without jerk(s), felt on the grid system

Power Generation Capability Forecasting Requirement:

(i) Power Generation Capability Forecasting, of average power on hourly basis, will be managed by the Solar Power Plant as required from conventional power plants, except provisions of clause (ii) & (iii) below.

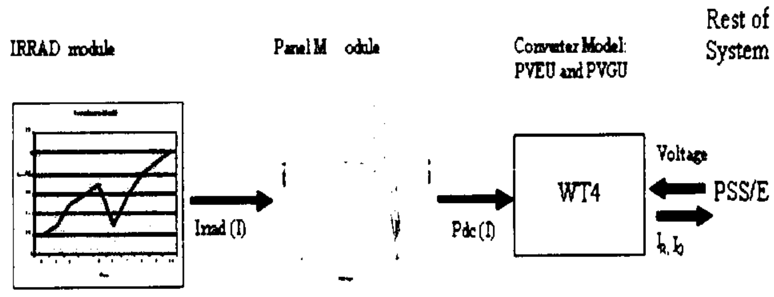
(ii) The forecasting, as required in (i), will be estimated by Solar Power Plant through

- (a) Expected availability of plant during the period of forecast.

1.5 Assumptions of Data

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.

Steady State data:

The data of the 132/33 kV Transformers is as follows:

MVA Rating of the Transformer = 100 MVA

Percentage Reactance of the Transformer at Own Base = 11%

Two -5/+20 MVAR SVCs will be used to provide reactive compensation for Flare-Solar-PP

Nominal Net Output of Solar PP = 80MW

Maximum Net Output of Solar PP = 88 MW

Dynamic Data:

Converter time constant for IQcmd seconds = 0.02 s

Converter time constant for IQcmd seconds = 0.02 s

Voltage sensor for LVACR time constants = 0.02 s

Voltage sensor time constant = 1.1 s

1.6 Input Data

The input data of HSECO / NTDC has been used in this study as per letter No. GMPP/CEMP/TRP-380/ 5243-44 dated 14-12-2015. In addition, NTDC via its letter No. MD/NTDCL/PS/4403-13, has intimated that the 132 kV collector substation at Jhimpir would be completed by June 2015 and the 220 kV Collector Substations at Jhimpir and Gharo would be completed by the end of 2016-2017. The load forecast and the generation expansion plan of NTDC provided vide this letter has been used as shown in Appendix A.

2. Description of Problem & Study Approach

2.1 Description of the Problem

In Pakistan, there is big power generation potential in the Southern parts of Sindh province, which is untapped as yet. However now with the establishment of Alternative Energy Development Board, this sector of power generation has taken an unprecedented stride and many entrepreneurs have come forward to build small and big Wind and Solar farms in this area.

The existing power plants nearest to the vast wind farm areas of Jhimpir in the existing power grid are Kotri and Jamshoro having installed capacity of 120 MW and 600 MW respectively. Next to them are Hub with 1200 MW, Lakhra with 70 MW. Apparently this amount of generation in Southern grid seems strong enough to absorb the penetration of solar power of 100 MW. But there are other variables that necessitate detailed studies like strengths of nodes of connectivity, loading capacity of the transmission lines to evacuate power from Solar Farm area and dynamic response of solar power plant and neighboring conventional synchronous generators.

The dynamic response of power plants in the neighborhood may not be uniform; as some of them are gas turbines and some are steam turbines i.e. Kotri has gas turbines whereas Jamshoro, Lakhra and Hub have steam turbines. Normally gas turbines are faster than the steam turbines to respond to changes in the system. The dynamic studies will determine how they respond to dynamic behavior of Siachen Solar PP.

There are other wind farms going to get developed soon in the neighborhood of Siachen solar farm. With the increase of penetration of more wind power in the same power grid, the impact studies would become even more involving from the point of view of dynamic stability.

2.2 Approach to the problem

We will apply the following approaches to the problem:

- The COD of Siachen Solar PP as provided by the Client Siachen Energy Limited and AEDB we have decided to perform our analysis for the scenario of 2017-18 to judge the maximum impact of the plant after the COD of the plant when the 220 kV Substation of Jhimpir is commissioned in 2016-2017.
- The base case for the year 2017-18 comprising all 500kV, 220kV and 132 kV, and 66kV system would be prepared envisaging the load forecast, the generation additions and transmission expansions for each year particularly in the Southern parts of the country. The case would include the Wind Power Plants which are developing on fast track basis and are expected to be commissioned by 2017-18 as per the latest schedule of AEDB.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, would be identified.
- Perform technical system studies for peak load conditions of high wind seasons' power dispatches, to confirm technical feasibility of the interconnections.
- The proposed interconnection scheme will be subjected to steady state analysis (load flow), short circuit and transient stability to test the robustness of the scheme under normal and contingency conditions by checking steady state and transient/dynamic behavior under all events.
- Determine the relevant equipment for the proposed technically feasible scheme of interconnection
- Perform sensitivity studies considering adjacent wind farms to check their impact on HESCO/NTDC Grid. This sensitivity check can be performed for the ultimate planned number of Power Plants in the neighborhood of Siachen Solar PP.

3. Analysis of Network Prior to Siachen Solar PP Interconnection

3.1 Description of the Network

The electrical grid, which is relevant for interconnection of Siachen Solar PP, is the 132 kV network that stretches through South of Hyderabad and Jamshoro up to coastal areas of Southern Sindh. This network, as it stands today is shown in Sketch-1 in Appendix-B. It comprises the following NTDC grid stations;

- Existing 500/220/132 kV grid station at Jamshoro connected through double circuits of 500 kV with Dadu in the North and Hub/New-Karachi in the South.
- Existing 220/132 kV Hala Road connected to Jamshoro 500/220/132 kV grid through a double circuit of 220 kV
- Existing T. M. Khan Road 220/132 kV grid station connected to Jamshoro 500/220/132 kV grid station by a double circuit of 220 kV

The 132 kV network under HESCO has been shown only for the circuits that emanate from Hyderabad, Jamshoro and Kotri to connect to the substations of 132 kV lying South of Hyderabad. There are four existing branches of network of 132 kV that stretch southward and near Jhimpir, as follows:

- Jamshoro-Old - Nooriabad – Kalukuhar 132 kV single circuit
- Kotri-Jhimpir-Thatta-P.Patho-M.P.Sakro-Garho 132 kV single circuit
- Hyderabad-T.M.Khan-B.S.Karim-Sujawal-Thatta 132 kV single circuit
- The Jhimpir-Nooriabad 132 kV single circuit on double-circuit-towers (SDT) provides parallel reliability with the other two branches up to Thatta and Nooriabad.

Two of the branches connecting Thatta provide parallel reliability to each other up to Thatta. However the single circuit South of Thatta going to Garho via P.Patho and M.P.Sakro does not support the supply to these substations under an outage condition. The Jhimpir-Nooriabad 132 kV S/C in between Jhimpir and Nooriabad. Jhimpir Nooriabad Double circuit has been stringed.

The network as it is planned with wind power plants scheduled prior to commissioning of Solar PP in 2017 is shown in Sketch-2 in Apendix-B , For further addition of PPs, NTDC, via its letter No. MD/NTDCL/PS/4403-13, has intimated that the 132 kV collector substation at Jhimpir would be completed by June 2015 and the 220 kV Collector Substations at Jhimpir and Gharo would be completed by the end of 2016-2017. Based on this letter, the following interconnection facilities will be in place by the end of 2016-2017:

- 220/132 kV Jhimpir-New substation at suitable location in Jhimpir cluster.
- 500/220 kV Matiari collector Substation connected to Jhimpir 220/132 kV substation via 100 km long Greeley double circuit.
- 70 km long double circuit from Jhimpir-New 220 kV Substation to the existing T.M. Khan Road 220 kV Substation
- A 132kV double circuit of 82 km using Greeley conductor would be constructed to connect Jhimpir-New 220/132 kV Substation with T.M. Khan in HESCO network.
- 220/132 kV Gharo-New substation at suitable location in Gharo cluster
- 75 km long 220 kV double circuit from Gharo-New 220 kV Substation to Jhimpir-New 220 kV Substation
- Six sub-collectors groups will be connected to Jhimpir 220/132 kV collector substation through 132 kV double circuits.
- FFC and Zorlu looped in-out with Jhimpir-Nooriabad 132 kV circuit.
- Four WPPs in the collector system of Gharo 220/132 kV substation
- FWEL-I and FWEL-II through a 64 km long 132 kV D/C on Greeley conductor connected to Thatta.
- Rehabilitation of the existing 132 kV lines in the vicinity of WPP clusters, i.e. Jhimpir-Kotri, Jhimpir-Thatta, Thatta-Sujawal and Nooriabad-Jamshoro Old.

Of the two sub clusters developed in Jhimpir area, one sub-cluster will comprise FFC and Zorlu looped in-out on one circuit of the Jhimpir-Nooriabad 132 kV double circuit whereas the other sub-cluster would comprise the Jhimpir-New 220/132 kV Collector Substation and would connect six sub-collectors groups through 132 kV double circuits prior to the connection of Siachen Solar Power Plant. Another direct double circuit will be added to evacuate 100 MW power from Siachen Solar PP.

We have carried out the studies of the case "without" Siachen Solar PP but including all the other WPPs which have COD by 2017-18 according to the latest schedule by AEDB to ascertain if there are any constraints in the system prior to Siachen Solar PP's commissioning.

3.1.1 Load Forecast

The load forecast of NTDC attached in Appendix-A has been used and in addition 650 MW export to K-Electric has been assumed.

3.1.2 Transmission Expansion

Because of sizable additions of generation scheduled in South, the following transmission expansion has been planned to reinforce 500 kV and 220 kV network in South;

<u>500 kV</u>

- Jamshoro-Moro 500 kV S/C 2016-17
- Moro-R.Y. Khan 500 kV S/C 2016-17
- Dadu-Moro 500 kV S/C 2016-17
- Jamshoro-Moro 500 kV circucit In-Out at Matiari 2017-18
- Engro-Matiari 500 kV D/C 2017-18

<u>220 kV</u>

- Hala Road – T. M. Khan Road 220 kV S/C 2015-16
- Jhimpir-T. M. Khan Rd. 220 kV D/C 2015-16
- Gharo-Jhimpir 220 kV D/C 2015-16
- Jhimpir-New-Matiari 220 kV D/C 2017-18

3.2 Load Flow Analysis

Load flow analysis has been carried out for the NTDC / HESCO network including the connections provided to new wind power plants FFC, Zorlu, TGF, Master, Sapphire, Yunus, Sachal, Hawa ,Wind-Eagle-1 and 2, UEPL, SUNEC, Tapal, Gul Ahmed, JHM WIND , METRO, TCN-A, TCN-B, TCN-C, Hartford, Western Energy, Planet Wind and

DHA-City in the Jhimpir cluster FWEL-I, FWEL-II, HYDROCHINA Dawood (HDPPL) and Tenaga, in the Gharo cluster but without including Siachen Solar PP to see if the network was adequate for dispersal of wind power without it. The case has been studied for the system conditions of June 2018. The month has been selected as NTDC, via its letter No. MD/NTDCL/PS/4403-13, has intimated that the 220 kV Collector Substations at Jhimpir and Gharo would be completed by the end of 2016-2017. We kept the dispatch of the nearby power plant such as Thatta, Nooriabad and Kotri-Site at its maximum therefore we can see the maximum distributed generation on 132 kV network prior to commissioning of Siachen Solar PP. With this dispatch, the power flow conditions on 132 kV network around Jhimpir, Thatta and Nooriabad area would be almost same irrespective of High or Low Water dispatch conditions on the primary network of NTDC. The results are shown plotted in Exhibit 0.0 in Appendix-C which indicates that no circuit is loaded more than its rated power carrying capacity and the voltage profile at all the bus bars of 132 kV, 220 kV and 500 kV is within the permissible range. All power plants are running at lagging power factor within their rated range.

The N-1 contingency check has also been applied for the three Southward branches each, and the results are attached in Appendix-C as below:

Exhibit 0.1	Hartford to Jhimpir-New 132 kV Single Circuit Out
Exhibit 0.2	Saphire to Jhimpir-New 132 kV Single Circuit Out
Exhibit 0.3	UEPL to Jhimpir-New 132 kV Single Circuit Out
Exhibit 0.4	TCN-C to Jhimpir-New 132 kV Single Circuit Out
Exhibit 0.5	Gul Ahmed to Jhimpir-New 132 kV Single Circuit Out
Exhibit 0.6	Zorlu to Jhimpir 132 kV Single Circuit Out
Exhibit 0.7	Jhimpir to Kotri GTPS 132 kV Single Circuit Out
Exhibit 0.8	Jhimpir-New to T.M. Khan 132 kV Single Circuit Out
Exhibit 0.9	Jhimpir-New 220/132 kV Single Transformer Out
Exhibit 0.10	Gharo-New to Jhimpir-New 220 kV Single Circuit Out
Exhibit 0.11	Jhimpir-New to Matiari 220 kV Single Circuit Out

Exhibit 0.12 Jhimpir-New to T.M.Kh.Rd. 220 KV Single Circuit Out

The load flow results of the network in the close vicinity of Siachen Solar shown plotted in Exhibits 0.1 to 0.16 indicate that all the power flows on the lines are within the rated limits of this network.

The load flow results show that the network existing before Siachen PP in the same vicinity in Gharo cluster including the Gharo-New 220/132 kV collector substation is enough to absorb their power, and has no limitations in terms of power transfer capacity under normal as well as N-1 contingency, prior to connection of Siachen Solar PP. We will check the adequacy of network after adding Siachen Solar PP in Chapter 6.

3.3 Short Circuit Analysis

In order to assess the short circuit strength of the network of 132 kV without Siachen Solar PP for the grid of Southern HESCO especially in the vicinity of the site of this Solar Farm, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. The fault levels also include the contributions from Wind Farms such as FFC, Zorlu, TGF and others in the Jhimpir Cluster and FWEL-I, FWEL-II, HDPPL and Tenaga in the Gharo cluster, as mentioned earlier, which are expected to be in operation before Siachen Solar PP as per AEDB's latest generation schedule.

The results of this analysis will not only give us the idea of the fault levels without Siachen Solar PP but also it will, by comparison, let us know as to how much the contribution of fault current from Siachen Solar PP may add to the existing fault levels. From this analysis we also get a feel of the probable nodes to connect the Solar Farm depending on their relative short circuit strength. The calculations have been made for maximum and minimum short circuit levels considering maximum and minimum generation dispatch conditions of the system in high water and low water seasons.

3.3.1 Maximum Fault Levels

A case for the year 2017-18 has been developed in which all the hydel and thermal generating plants have been dispatched to cover the highest possible fault current contributions.

PSS/E software provides an option of calculating the fault currents using the IEC 909 criteria, and we have used this option for all the fault calculations for this study. For maximum fault currents we have applied 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 1.1 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

The short circuit levels have been plotted on the bus bars of 132 kV, 220 kV and 500 kV of substations lying in the electrical vicinity of our area of interest i.e. Jhimpir area, and are shown plotted in the Exhibit 3.0 attached in Appendix-D.

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

The tabular output of the short circuit calculations is also attached in Appendix-D for the 132 kV, 220 kV and 500 kV bus bars of our interest i.e. the substations connecting in the three branches of 132 kV running South of Hyderabad up to Southern Sind coast line. 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 3.1. 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 25 kA or 31.5 kA for older substations and 40 kA for new substations.

Table 3.1

Maximum Short Circuit Levels without Siachen -PP

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Nooriabad 132kV	10.46	10.02
Kotri GTPS 132kV	18.81	17.76
Jamshoro Old 132kV	23.05	20.40
Jamshoro New 132kV	25.01	22.71
Kotri Site 132 kV	15.74	13.82
T.M.KHAN 132 kV	14.76	13.74
Jhimpir-New 132 kV	21.91	18.62
Gharo-New 132 kV	8.38	6.40
Jhimpir-New 220 kV	17.40	13.05
Gharo-new 220 kV	8.19	5.28
Matiari 220 kV	24.07	20.21
Matiari CS 500 kV	27.42	18.77
TM.KH.RD 220 kV	20.24	15.09
Jamshoro 500 kV	26.82	19.77
Sujawal 132 kV	5.27	3.74
Jhimpir 132 kV	9.30	7.38
FWEL-I 132 kV	3.60	2.80
FWEL-II 132 kV	3.60	2.80
Thatta 132 kV	5.88	4.94
Mirpursk 132 kV	2.14	1.50
Pirpatho 132 kV	3.09	2.26
Ghr-wpp6 132 kV	6.91	5.08

Zephyr 132 kV	6.72	4.95
Hyd-TMRD 132 kV	14.55	12.14
Hyd-TMK-2 132 kV	19.91	17.18

3.3.2 Minimum Fault Levels

For minimum fault levels minimum generation dispatches are assumed which in practice may correspond to minimum load conditions. We normally have minimum thermal power dispatch during High Water season and it gets further minimum during off-peak hours. Especially in Southern Sindh, the thermal generation would be at its minimum during minimum load conditions of high water season. Therefore we have calculated the minimum short circuit levels under High Water off-peak conditions. Also the dispatch of WTGs from other wind farms of FFC, Zorlu, TGF and others in the Jhimpir Cluster and FWEL-I, FWEL-II, Tenaga and HDPPL in the Gharo cluster is also assumed as minimum to have the minimum fault contributions from these Farms. The results are shown in Appendix-D.

For minimum fault currents we have applied 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 0.9 P.U. i.e. 10 % lower than nominal, which is the minimum permissible voltage under contingency condition.

The plotted results of the minimum fault currents are attached in Exhibit 3.1 the same way as before focusing on the significant 132 kV, 220 kV and 500 kV bus bars of substations in the electrical vicinity of Jhimpir. The tabular output of minimum fault currents shown in Appendix-D 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 minimum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 3.2.

Table 3.2
Minimum Short Circuit Levels without Siachen-Solar-PP

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Nooriabad 132kV	8.09	7.48
Kotri GTPS 132kV	13.41	11.49
Jamshoro Old 132kV	16.52	14.57
Jamshoro New 132kV	17.87	16.24
Kotri Site 132 kV	11.72	9.67
T.M.KHAN 132 kV	11.60	10.84
Jhimpir-New 132 kV	15.13	12.69
Gharo-New 132 kV	6.84	5.12
Jhimpir-New 220 kV	12.25	9.25
Gharo-new 220 kV	6.50	4.19
Matiari 220 kV	16.97	15.15
Matiari CS 500 kV	13.93	11.59
TM.KH.RD 220 kV	14.21	11.12
Jamshoro 500 kV	14.07	11.92
Sujawal 132 kV	4.41	3.09
Jhimpir 132 kV	7.20	5.69
FWEL-I 132 kV	2.76	1.96
FWEL-II 132 kV	2.76	1.96
Thatta 132 kV	4.54	3.46
Mirpursk 132 kV	1.86	1.27

Pirpatho 132 kV	2.61	1.83
Ghr-wpp6 132 kV	5.69	4.10
Zephyr 132 kV	5.53	3.97
Hyd-TMRD 132 kV	11.33	9.51
Hyd-TMK-2 132 kV	15.36	13.45

3.3.3 Comparison of Fault Levels

Comparing the short circuit strengths, both in terms of maximum and minimum, of the existing substations of 132 kV in the vicinity of Siachen Solar PP *viz.* Gharo-New, Jhimpir-New, Nooriabad, Jhimpir Sujawal and Thatta, we find that Jhimpir-New, Nooriabad and Jhimpir are strong point with relatively higher short circuit levels. In fact Nooriabad draws strength from its direct connection with Jamshoro-old having direct connection with a very strong source of Jamshoro. Jhimpir draws its strength from its direct connection with Kotri where sits a medium size gas turbine power plant and also have connection with Jamshoro. But Thatta and the grids connected in the branches that emanate from Thatta towards Sujawal etc. are poor due to weak sources feeding these branches.

Gharo-New and Jhimpir-New collector substation is showing good circuit strength because of the completion of its 220 kV phase, Jhimpir-New having six sub-collector groups connecting TGF, Master, Sapphire, Yunus, Sachal, Hawa , Wind-Eagle-1, Wind-Eagle-2, UEPL, SUNEC, Tapal, Gul Ahmed, JHM WIND , METRO, TCN-A,TCN-B, TCN-C, Western Energy, Hartford and DHA-City to the Jhimpir-New 220/132 kV Substation at 132 kV level. The other source of fault current is T. M. Khan which is 75 km away connected through a D/C of 132 kV. Together the contribution from these sources makes it a strong node of interconnection for Siachen Solar PP.

4. Development of Interconnection Scheme

4.1 Interconnection of Siachen Solar 100 MW PP

To connect the solar farms to the main grid of NTDC / HESCO, one may think of connecting each Farm with any nearby available 132 kV substation by laying a direct 132 kV circuit from the gantry of each Farm's substation. But it is important to first see if the nearby substation has enough short circuit strength to connect to a Solar farm.

In case there is a potential of developing of several Farms in the same area, then a better interface or common coupling point may be a collector substation where each Farm is connected and then this collector substation is connected to suitable node or nodes of the main national grid system. From suitable node or nodes we mean the nodes (bus bars) having relatively higher short circuit levels to mitigate the impact of time-variant generation.

In case of Siachen Solar PP, the nearest substation is the collector substation of Gharo-New 220/132 kV whose first stage of 132 kV would be completed by June 2015 and the second stage of 220 kV would be completed in 2016-2017.

4.2 Proposed Interconnection Scheme

Given that there can be 22 WPPs coming in commercial operation in the Jhimpir region and 4 WPPs coming in commercial operation in the Gharo region around the time that Siachen Solar PP also comes into commercial operation, the following reinforcements in the system would be pre-requisite before we connect Siachen Solar PP with the system as shown in Sketch-2:

- 220/132 kV Jhimpir-New substation at suitable location in Jhimpir cluster
- 500/220 kV Matiari collector Substation connected to Jhimpir 220/132 kV substation via 100 km long Greeley double circuit.
- 70 km long double circuit from Jhimpir-New 220 kV Substation to the existing T.M. Khan Road 220 kV Substation

- A 132kV double circuit of 82 km using Greeley conductor would be constructed to connect Jhimpir-New 220/132 kV Substation with T.M. Khan in HESCO network.
- 220/132 kV Gharo-New substation at suitable location in Gharo cluster
- 75 km long 220 kV double circuit from Gharo-New 220 kV Substation to Jhimpir-New 220 kV Substation
- Six sub-collectors groups will be connected to Jhimpir 220/132 kV collector substation through 132 kV double circuits
- FFC and Zorlu looped in-out with Jhimpir-Nooriabad 132 kV circuit.
- Four WPPs in the collector system of Gharo 220/132 kV substation
- FWEL-I and FWEL-II through a 64 km long 132 kV D/C on Greeley conductor connected to Thatta
- Rehabilitation of the exiting 132 kV lines in the vicinity of WPP clusters, i.e. Jhimpir-Kotri, Jhimpir-Thatta, Thatta-Sujawal and Nooriabad-Jamshoro Old.

Of the two sub clusters developed in Jhimpir area, one sub-cluster will comprise FFC and Zorlu looped in-out on one circuit of the Jhimpir-Nooriabad 132 kV double circuit whereas the other sub-cluster would comprise the Jhimpir-New 220/132 kV Collector Substation and would connect six sub-collectors groups through 132 kV double circuits.

The connection scheme of Siachen Solar PP for the scenario of 2017-18 in Sketches 3 is as follows:

➢ A 132 kV double circuit of 18 kM has been proposed from Siachen Solar to Gharo-New 132kV grid station to evacuate the maximum of 100 MW power from Siachen Solar PP to National Grid. The Conductors used will be Greeley. As the 100 MW could not have been merged with any sub collector already proposed at Gharo-New 132kV.

5. Modeling of Siachen Solar Farm

5.1 Solar Plant Substation 132/33 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 33 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 HESCO/NTDC. The single line diagram of the substation, as a conceptual design, is shown in Appendix-A for 33 kV and 132 kV.

Keeping in view of the current practices in NTDC and DISCOs, the substations for power plants of this order, the 132 kV bus bars are double bus with a coupler i.e. double bus-single-breaker scheme. However for 132/33 kV substations, the MV bus i.e. 33 kV a single bus with or without sectionalizers. Keeping in view the NTDC/DISCOs practice, we propose to provide good reliability to a power plant as follows:

- Double-bus single-breaker scheme with a Bus Coupler at 132 kV
- Single bus scheme with a sectionalizer to enable to have two bus sections at 33kV

The brief schemes are shown in Appendix-A

5.1.1 Conceptual Design of 132 kV

Single-line-diagram (Appendix–A) shows 132 kV bus bars of the Farm substation, which would comprise as follows:

- Double bus bars with a Bus Coupler
- Two breaker bays to connect two transformers 132/33 kV
- Two breaker bays to connect two circuits of 132 kV i.e. double circuit on single tower overhead line to connect to the grid system.

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity	= 40 kA
Normal continuous current	= 2000 A for line and TF breakers
	= 2500 A for Bus Coupler

The other equipment of the substation consists of:

- Two 132/33 kV, 67/100 MVA ONAN/ONAF OLTC transformers, 132±8×1.25%/33kV, to fulfill N-1 criteria of Grid Code
- Energy meters would be installed on HV side (132 kV) of the 132/33kV transformers.

5.1.2 Conceptual Design of 33 kV

The single line diagram in Appendix-A shows the conceptual design of 33kV (MV) bus bar of the Farm substation. It comprises of

- Two single bus-sections of 33 kV with a bus sectionalizer
- Ten breaker bays to connect ten collector circuits
- Two breaker bays to connect two transformers of 132/33 kV
- One station auxiliary transformer 33/0.4 kV
- Two SVCs each of the size of -5/+20 MVAR
- Two breaker bays to connect two -5/+20 MVAR SVCs

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity = 31.5 kA

Normal continuous current = 1250 A for line breakers

= 2500A for Bus Sectionalizer and Power TF

6. Load Flow Analysis

Load flow analysis has been carried out for the proposed scheme of interconnection of Siachen Solar PP with NTDC / HESCO grid for the base case of 2017-18 as per Sketch-3 in Appendix-A.

6.1 Modeling of Solar Farm in 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. Since we have two bus sections of 33 kV, therefore there are two equivalent collectors assumed for the power plant in this study report.

The Farm Substation is represented by two bus bars as Siachen 33 kV and Siachen 132 kV, with two inter-bus transformers of 67/100 MVA each. These transformers have an overload capacity of 100 MVA for a limited time to cover N-1 contingency criteria of Grid Code i.e. in case of outage of one transformer, the other can take up the full output of Farm i.e. 100 MVA.

5.2 Reactive Power Requirements

Siachen power factor is 0.90 lagging (capacitive/generating) and 0.90 leading (inductive/absorbing). Part of this reactive power will be consumed by the 0.315kV/33 kV step-up transformers and the rest may be consumed in the MV collector cables of the solar plant. However some reactive power might reach the MV bus bar of solar plant substation. That means each inverter is self sufficient to meet VAR absorption requirement of its step-up transformer with some contribution of VARs to the Solar Plant MV network.

The Grid Code Addendum No.2 requires to meet the criteria of ± 0.95 power factor at the point of interconnection with the NTDC/HESCO grid at 132 kV (point of common coupling). Therefore Siachen with its maximum output of 80 MW generating capacity is required to pump 26.28 MVAR to the grid at maximum AC power output of 88 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 of 0.315/33 kV, collector cables and the HV/MV i.e. 132/33 kV transformers at the Solar Plant substation. In order to meet the Grid Code criteria, we have proposed the installation of two SVCs of -5/+20 MVAR each at 33 kV bus of the Solar Plant substation capable of generating 40 MVAR and delivering at 132 kV bus about 26.28 MVAR after VAR loss across 132/33 kV transformers.

6.3 Load Flow Analysis for Peak Load Case of 2017-18

Load flow analysis has been carried out for the NTDC / HESCO network to see the steady state impact of adding the generation of Siachen Solar PP on the network including the connections provided to other solar power plants already scheduled having been connected. These are FFC, Zorlu, TGF, Master, Sapphire, Yunus, Sachal, Hawa ,Wind-Eagle-2, UEPL, SUNEC, Tapal, Gul Ahmed, JHM WIND , METRO, TCN-A,TCN-B, TCN-C, Western Energy, Hartford and DHA-City in the Jhimpir cluster FWEL-I, FWEL-II, HYDROCHINA Dawood (HDPPL) and Tenaga in the Gharo cluster as mentioned earlier. The network configuration is same for Jhimpir and Gharo clusters as indicated in Sketch-3 of Appendix-B and discussed in Ch. 3.

The integrated case has been studied for the system conditions of 2017-18, the time line associated with the COD of Siachen Solar PP and of the 220 kV parts of Jhimpir and Gharo Collector Substations. We kept the dispatch of the nearby power plant at 132 kV at a maximum therefore we can see the maximum distributed generation on 132 kV network.

Load flow simulations have been run for normal and contingency conditions. The results are shown plotted in Appendix-C.

6.3.1 Normal Case

Exhibit 1.0 shows the normal case under the system conditions of 2017-18. All the wind farms in Jhimpir and Gharo clusters with installed capacity of 50 MW or 49.5 MW has been assumed after deducting Farm losses and given some diversity in the maximum output of all the Wind Power Plants at one time. For Siachen PP we assume to deliver 80 MW at the point of delivery to grid at 132 kV.

All these loadings are within the rated limits of these circuits. The bus voltages on all the substations in Southern HESCO grid are within the normal limits of operation.

We see that all the WTGs are running at a power factor above its rated value of 0.90 not using full reactive power capability leaving enough margin to cover contingencies. The switched shunt capacitor bank of 40 MVAR at 33 kV bus bar is supplying 26 MVAR (nearly 0.95 PF) after VAR loss across 132/33 kV transformers, at 132 kV bus i.e. fulfilling the Grid Code criteria at the point of interconnection. The voltage profile on all the bus bars of 132 kV of HESCO grid are well within the normal operating criteria of ± 5 % off the nominal.

6.3.2 Contingency cases and evolving of reliable scheme

The N-1 contingency cases have been run and the results have been shown plotted as under:

Exhibit 1.1	Siachen PP 132/33 KV Single Transformer Out
Exhibit 1.2	Siachen to Gharo-New 132 KV Single Circuit Out
Exhibit 1.3	Hartford to Jhimpir-New 132 kV Single Circuit Out
Exhibit 1.4	Saphire to Jhimpir-New 132 kV Single Circuit Out
Exhibit 1.5	UEPL to Jhimpir-New 132 kV Single Circuit Out
Exhibit 1.6	TCN-C to Jhimpir-New 132 kV Single Circuit Out
Exhibit 1.7	Gul Ahmed to Jhimpir-New 132 kV Single Circuit Out
Exhibit 1.8	Zorlu to Jhimpir 132 kV Single Circuit Out
Exhibit 1.9	Jhimpir to Kotri GTPS 132 kV Single Circuit Out
Exhibit 1.10	Jhimpir-New to T.M.Khan 132 kV Single Circuit Out
Exhibit 1.11	Jhimpir-New 220/132 kV Single Transformer Out
Exhibit 1.12	Gharo-New to Jhimpir-New 220 kV Single Circuit Out
Exhibit 1.13	Jhimpir-New to Matiari 220 kV Single Circuit Out
Exhibit 1.14	Jhimpir-New to T.M.Kh.Rd. 220 KV Single Circuit Out

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The results show that power flows on intact 132 kV circuits remain within their rated limits.

The results also show that under all events of outages the switched shunt capacitor banks at 33 kV bus regulates the voltage under all events. The reactive power being supplied by the 40 MVAR switched shunt capacitor banks connected at 33 kV bus, maintains the supply of VARS to the grid under all contingencies adjusting its output according to the system requirement. Therefore to cover the steady state, normal and outage conditions, we need switched shunt capacitor bank of 40 MVAR at 33 kV bus.

6.4 Load Flow with Siachen Solar Power Peak Load Case September 2019

Detailed load flow studies have also been carried out for an extended term spot year of 2019. The objective is to have a comprehensive total view of Solar power potential expected to be commissioned by 2019 and the adequacy of respective transmission plans to evacuate overall power from the Solar Power Plant 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 Sketches of Appendix-C.

The results of load flow with Siachen Solar Power Plant interconnected as per proposed scheme are shown for each case. The power flows on the circuits under normal conditions, 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 2.1	Siachen PP 132/33 KV Single Transformer Out
Exhibit 2.2	Siachen to Gharo-New 132 KV Single Circuit Out
Exhibit 2.3	Hartford to Jhimpir-New 132 kV Single Circuit Out
Exhibit 2.4	Saphire to Jhimpir-New 132 kV Single Circuit Out
Exhibit 2.5	UEPL to Jhimpir-New 132 kV Single Circuit Out

Exhibit 2.6 TCN-C to Jhimpir-New 132 kV Single Circuit Out

Exhibit 2.7 Gul Ahmed to Jhimpir-New 132 kV Single Circuit Out

Exhibit 2.8 Zorlu to Jhimpir 132 kV Single Circuit Out

Exhibit 2.9 Jhimpir to Kotri GTPS 132 kV Single Circuit Out

Exhibit 2.10 Jhimpir-New to T.M.Khan 132 kV Single Circuit Out

Exhibit 2.11 Jhimpir-New 220/132 kV Single Transformer Out

Exhibit 2.12 Gharo-New to Jhimpir-New 220 kV Single Circuit Out

Exhibit 2.13 Jhimpir-New to Matiari 220 kV Single Circuit Out

Exhibit 2.14 Jhimpir-New to T.M.Kh.Rd. 220 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.

6.4 Conclusion of Load Flow Results

The load flow results of the proposed scheme of interconnection of Siachen PP in 2017-18 shows no bottlenecks or capacity constraints in the adjoining 220 kV and 132 kV network in terms of absorbing all the output of Siachen Solar PP under normal as well as the contingency conditions.

Siachen Solar Power Plant would be connected by a 18 km double circuit of 132 kV to Gharo-New 220/132 kV collector substation.

The Greeley conductor will be used with the capacity of 184 MVA per circuit. In the load flow simulation, however, the MVA capacity is assumed to be 202.4 MVA taking into account the increase in MVA capacity of the conductors at high wind speed during high wind season

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7. Short Circuit Analysis

7.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies. For calculations of maximum fault levels the bus voltage has been assumed as 1.10 PU i.e. 10 % above the nominal as per IEC909. For calculations of minimum fault levels the bus voltage has been assumed as 0.9 PU i.e. 10 below the nominal. That covers the entire ± 10 % range of the ratings of the equipment.

7.1.1 Assumptions for maximum and minimum short circuit levels

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2017-18 to assess the impact of Siachen PP.

The maximum fault currents have been calculated with the following assumptions under IEC909:

- 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 However tabular results of some significant bus bars of 220 kV and 132 kV in the electrical vicinity of Siachen Solar PP have also been produced and placed in Appendix-D.

7.1.1.2 Assumptions-Minimum Short Circuit Levels

The minimum fault currents are important for the evaluation of power quality issues such as flicker, unbalance, sudden voltage dip and harmonics.

For assess the minimum short circuit levels we have considered off-peak conditions of 2017-18 to simulate the minimum short circuit strength of southern grid. For Siachen Solar PP we have assumed dispatch of 25% of its capacity for the minimum short circuit calculations i.e. just one collector group.

For minimum fault currents we have applied 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 0.9 P.U. i.e. 10 % lower than nominal, which is the minimum permissible voltage under contingency condition.

7.1 Fault Currents Calculations

7.1.1 Maximum Short Circuit Levels

The short circuit levels have been calculated and plotted on the bus bars of 500 kV, 220 kV and 132 kV of substations lying in the electrical vicinity of our area of interest i.e. Jhimpir, Thatta and Gharo area, and are shown plotted in the Exhibit 3.2 for the year 2017-18 and 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 500 kV, 220 kV and 132 kV bus bars of our interest i.e. the substations connecting in the three branches of 132 kV running South of Hyderabad up to Southern Sindh coast line. 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 7.1. 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 25 kA or 31.5 kA for older substations and 40 kA for new substations.

The fault levels of Siachen 132 kV are 6.65 kA and 4.75 kA for 3-phase and single phase faults respectively for 2017-18. This is much less than the switchgear rating of 40 kA recommended for Siachen Solar Farm Substation as per NTDC requirements for 132 kV.

The fault levels for Siachen Solar 33 kV are 6.65 kA and 4.75 kA for 3-phase and single-phase faults respectively for 2017-18. Therefore the short circuit rating recommended for 33 kV switchgear is recommended as 25 kA.

Table-7.1

Maximum Short Circuit Levels with Siachen PP– 2017-18

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Siachen PP 33kV	16.56	13.33
Siachen 132kV	6.65	4.75
Nooriabad 132kV	10.48	10.04
Kotri GTPS 132kV	18.85	17.80
Jamshoro Old 132kV	23.10	20.45
Jamshoro New 132kV	25.07	22.76
Kotri Site 132 kV	15.78	13.85
T.M.KHAN 132 kV	14.82	13.80
Jhimpir-New 132 kV	22.07	18.75
Gharo-New 132 kV	8.63	6.59
Jhimpir-New 220 kV	17.54	13.16
Gharo-new 220 kV	8.33	5.38
Matiari 220 kV	24.14	20.27
Matiari CS 500 kV	27.45	18.79
TM.KH.RD 220 kV	20.33	15.15
Jamshoro 500 kV	26.85	19.79

Sujawal 132 kV	5.28	3.75
Jhimpir 132 kV	9.32	7.40
FWEL-I 132 kV	3.61	2.81
FWEL-II 132 kV	3.61	2.81
Thatta 132 kV	5.90	4.95
Mirpursk 132 kV	2.15	1.50
Pirpatho 132 kV	3.10	2.26
Ghr-wpp6 132 kV	7.11	5.24
Zephyr 132 kV	6.92	5.10
Hyd-TMRD 132 kV	14.60	12.18
Hyd-TMK-2 132 kV	19.97	17.23

7.1.2 Minimum short circuit levels

The minimum fault levels have been calculated for minimum dispatch of power in the grid system. The plotted results of short circuit analysis are attached as Exhibit 3.3. 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 faulted bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-D for the 132 kV bus bars of our interest i.e. the substations connecting in the three branches of 132 kV running South of Hyderabad up to Southern Sind coast line. 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 minimum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 7.2.

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Table-7.2

Minimum Short Circuit Levels with Siachen PP 2017-2018

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Siachen PP 33kV	14.31	11.36
Siachen 132kV	5.55	3.93
Nooriabad 132kV	8.12	7.50
Kotri GTPS 132kV	13.46	11.53
Jamshoro Old 132kV	16.57	14.62
Jamshoro New 132kV	17.93	16.30
Kotri Site 132 kV	11.76	9.70
T.M.KHAN 132 kV	11.66	10.89
Jhimpir-New 132 kV	15.24	12.78
Gharo-New 132 kV	7.00	5.24
Jhimpir-New 220 kV	12.34	9.32
Gharo-new 220 kV	6.60	4.25
Matiari 220 kV	17.03	15.21
Matiari CS 500 kV	13.96	11.61
TM.KH.RD 220 kV	14.28	11.17
Jamshoro 500 kV	14.10	11.94
Sujawal 132 kV	4.42	3.10
Jhimpir 132 kV	7.23	5.71
FWEL-I 132 kV	2.77	1.97
FWEL-II 132 kV	2.77	1.97
Thatta 132 kV	4.56	3.47
Mirpursk 132 kV	1.87	1.28
Pirpatho 132 kV	2.61	1.84

Ghr-wpp6 132 kV	5.82	4.19
Zephyr 132 kV	5.66	4.06
Hyd-TMRD 132 kV	11.38	9.55
Hyd-TMK-2 132 kV	15.42	13.50

7.1.3 Maximum Short Circuit Levels for the Year 2019-20

The short circuit levels have been calculated and plotted on the bus bars of 500 kV, 220 kV and 132 kV of substations lying in the electrical vicinity of our area of interest i.e. Jhimpir, Thatta and Gharo area, and are shown plotted in the Exhibit 3.4 for the year 2019-20 and 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 500 kV, 220 kV and 132 kV bus bars of our interest

The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 7.3. 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 25 kA or 31.5 kA for older substations and 40 kA for new substations.

The fault levels of Siachen 132 kV are 6.70 kA and 4.78 kA for 3-phase and single phase faults respectively for 2019-20. This is much less than the switchgear rating of 40 kA recommended for Hartford Farm Substation as per NTDC requirements for 132 kV.

The fault levels for Hartford 33 kV are 16.67 kA and 13.40 kA for 3-phase and single-phase faults respectively for 2019-20. Therefore the short circuit rating recommended for 33 kV switchgear is recommended as 25 kA.

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Table-7.3

Maximum Short Circuit Levels with Siachen Solar PP – 2019-20

Substation	3-Phase Fault Current (kA)	1-Phase Fault Current (kA)
Siachen PP 33kV	16.67	13.40
Siachen 132kV	6.70	4.78
Nooriabad 132kV	10.68	10.22
Kotri GTPS 132kV	19.06	17.81
Jamshoro Old 132kV	23.43	20.63
Jamshoro New 132kV	25.43	22.97
Kotri Site 132 kV	15.95	13.91
T.M.KHAN 132 kV	15.03	13.98
Jhimpir-New 132 kV	22.28	18.81
Gharo-New 132 kV	8.70	6.63
Jhimpir-New 220 kV	17.84	13.23
Gharo-new 220 kV	8.42	5.41
Matiari 220 kV	25.11	20.72
Matiari CS 500 kV	31.14	19.87
TM.KH.RD 220 kV	20.70	15.26
Jamshoro 500 kV	30.04	20.67
Sujawal 132 kV	5.39	3.91
Jhimpir 132 kV	9.54	7.57
FWEL-I 132 kV	3.71	2.88
FWEL-II 132 kV	3.71	2.88
Thatta 132 kV	6.03	5.08
Mirpursk 132 kV	2.20	1.54
Pirpatho 132 kV	3.18	2.33
Ghr-wpp6 132 kV	7.17	5.27

Zephyr 132 kV	6.98	5.13
Hyd-TMRD 132 kV	14.77	12.28
Hyd-TMK-2 132 kV	20.22	17.39

7.2 Conclusions of Short Circuit Analysis

In order to see how much the Siachen Solar PP has contributed to increase the fault levels of the substations in its electrical vicinity, we compare the maximum fault levels in the peak case of 2017-18 with the fault levels of the same bus bars in Table 3.1 (Chapter-3) evaluated without Siachen Solar PP but inclusive of other Wind Farms such as FFC, ZEPL, TGF, Sapphire, Jhimpir Wind and others in the Jhimpir Cluster and FWEL-I, FWEL-II HDPPL and Tenaga in the Gharo to see the impact on the short circuit levels in the area in the vicinity of Siachen Solar PP in the extended term after the adding Siachen Solar PP. We find that the fault levels at Jhimpir and Jhimpir-New have increased. As a whole the fault levels at all the 132 kV bus bars are well below the short circuit rating of the equipment at these substations.

The fault levels of Siachen 33 kV are 16.56 kA and 13.33 kA for 3-phase and single phase faults respectively for 2017-18. This is much less than the switchgear rating of 25 kA recommended for Siachen Solar Farm Substation as per NTDC requirements for 33 kV.

The fault levels for Siachen Solar 132 kV are 6.65 kA and 4.75 kA for 3-phase and single-phase faults respectively in the year 2017-18. Therefore the short circuit rating recommended for 132 kV switchgear is recommended as 40 kA.

Comparing the minimum short circuit levels of the 132 kV substations of HESCO near the Wind Farms, we find that in terms of short circuit strength, the levels at Jhimpir-New and Jhimpir 132 kV get better and the short circuit strength is improved after the interconnection of Siachen PP in 2017-18. The short circuit strength is very important for Power Quality issues like flicker, harmonics and voltage unbalance.

Exhibit 3.3.1 and 3.3.2 show the results of minimum fault levels in MVA to be used in Power Quality analysis carried out in Ch.9

The fault levels indicate that there are no constraints in terms of short circuit ratings of the equipment of the adjoining substations and there is improvement in minimum fault levels. The proposed interconnection scheme holds good on the basis of short circuit analysis as well.

8. Transient Stability Analysis

8.1 Assumptions & Methodology

8.1.1 Stability Models

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

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

Generator	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1

We have done studies with the inverter which has reactive support capability of ± 0.90 PF and LVRT Capabilities as per the data provided by the client.

8.1.2 System Conditions

We have used the system conditions of Peak 2017-18 because this will allow the maximum impact of Siachen Solar Power Plant to be judged.

The proposed scheme of Siachen Solar power plant will be by lying 132 kV double circuit of 18 km has been proposed from Siachen Solar to Gharo-New 132kV grid station to evacuate the maximum of 100 MW power from Siachen Solar PP to National Grid. The Conductors used will be Greeley. As the 100 MW could not have been merged with any sub collector already proposed at Gharo-New 132kV.

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

8.1.3 Presentation of Results

The plotted results of the simulations runs are placed in Appendix - D. 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 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.

8.1.4 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. 180 ms, followed by permanent trip of a 132 kV transmission line emanating from this substation.

8.2 Dynamic Impact of System Disturbances

8.2.1 Three Phase Faults on 33 kV , Normal Clearing Time of 5 Cycles & Trip of Transformer

The system disturbances have been simulated for this model as follows;

Three- phase fault applied at Siachen 33 kV bus bar, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 132/33 kV transformer at Siachen Solar PP.

Fig 1.1 indicates the bus voltages in pre and post fault conditions at 132 kV substations in the vicinity of Siachen Solar PP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in **Fig. 1.2** shows very nominal excursions of frequency that damps down very quickly and smoothly

The pre-fault output of Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value. **Fig 1.3.**

The value for LVACR is restored to its pre-fault value after the fault clears is shown in **Figs 1.4**

Fig 1.5 shows that after clearing of fault, the trip of one 132/33 kV Transformer causes the entire power to flow through the intact 132/33 kV transformer. We plotted the flows of MW and MVAR on this transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 shows the transients of MW and MVAR output of the nearest electrical grid Kotri-GTPS which settles the transients quickly and acquires new steady state levels soon.

The angular stability of other conventional generators of the system can be seen in **Fig. 1.7** The relative rotor angles of Kotri GTPS 132 kV, Kotri-Site 132kV, Nooriabad 132 kV, Thatta 132 kV and Jamshoro 220 kV are plotted w.r.t. Hub 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.2.2 Three Phase Faults on 33 kV, Clearing Time of 9 Cycles (Stuck Breaker): LVRT Test

The worst-case fault on system may be the failure of breaker (stuck-breaker) and fault clearing with backup protection in 9 cycles. It may also be termed as testing the ride through capability (LVRT) of Solar Power Plant for clearing time of 9 cycles i.e. 180 ms which is a criterion set out in the Grid Code to be fulfilled.

The system disturbances have been simulated for this model as follows;

Three- phase fault applied at Siachen 33 kV bus bar, cleared in 9 cycles as normal clearing time i.e. 180 m seconds, followed by trip of 132/33 kV transformer at Siachen Solar PP.

Fig 2.1 indicates the bus voltages in pre and post fault conditions at 132 kV substations in the vicinity of Siachen Solar PP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in **Fig. 2.2** shows very nominal excursions of frequency that damps down very quickly and smoothly

The pre-fault output of Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value. **Fig 2.3.**

The value for LVACR is restored to its pre-fault value after the fault clears is shown in **Figs 2.4**

Fig 2.5 shows that after clearing of fault, the trip of one 132/33 kV Transformer causes the entire power to flow through the intact 132/33 kV transformer. We plotted the flows of MW and MVAR on this transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 shows the transients of MW and MVAR output of the nearest electrical grid Kotri-GTPS which settles the transients quickly and acquires new steady state levels soon.

The angular stability of other conventional generators of the system can be seen in **Fig. 2.7** The relative rotor angles of Kotri GTPS 132 kV, Kotri-Site 132kV, Nooriabad 132 kV, Thatta 132 kV and Jamshoro 220 kV are plotted w.r.t. Hub 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.2.3 Three Phase Faults on Siachen 132kV Bus Bar , Clearing Time of 5 Cycles

The system disturbances have been simulated for this model as follows;

Three-phase fault applied at Siachen 132 kV bus bar, cleared in 5 cycles as normal clearing time i.e. 100 m seconds, followed by trip of 132 kV single circuit between Siachen 132 kV to Gharo-New 132 kV.

Fig 3.1 indicates the bus voltages in pre and post fault conditions at 132 kV substations in the vicinity of Siachen Solar PP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in **Fig. 3.2** shows very nominal excursions of frequency that damps down very quickly and smoothly

The pre-fault output of Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value. **Fig 3.3.**

The value for LVACR is restored to its pre-fault value after the fault clears is shown in **Figs 3.4**

Fig 3.5 shows that after clearing of fault, the trip of 132 kV circuit between the Siachen Solar and Gharo-New 132 kV causes the entire output of Siachen Solar to flow through the intact 132 kV circuit between Siachen Solar and Gharo-New 132 kV. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 3.6 shows the transients of MW and MVAR output of the nearest electrical grid Kotri-GTPS which settles the transients quickly and acquires new steady state levels soon.

The angular stability of other conventional generators of the system can be seen in **Fig. 3.7** The relative rotor angles of Kotri GTPS 132 kV, Kotri-Site, Nooriabad 132 kV, Thatta 132 kV and Jamshoro 220 kV are plotted w.r.t. Hub 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.2.4 Three Phase Faults on Siachen 132kV Bus Bar , Clearing Time of 9 Cycles (Stuck Breaker): LVRT Test

The system disturbances have been simulated for this model as follows;

Three-phase fault applied at Siachen 132 kV bus bar, cleared in 9 cycles as normal clearing time i.e. 180 m seconds, followed by trip of 132 kV single circuit between Siachen 132 kV to Gharo-New 132 kV.

Fig 4.1 indicates the bus voltages in pre and post fault conditions at 132 kV substations in the vicinity of Siachen Solar PP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in **Fig. 4.2** shows very nominal excursions of frequency that damps down very quickly and smoothly

The pre-fault output of Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value. **Fig 4.3.**

The value for LVACR is restored to its pre-fault value after the fault clears is shown in **Figs 4.4**

Fig 4.5 shows that after clearing of fault, the trip of 132 kV circuit between the Siachen Solar and Gharo-New 132 kV causes the entire output of Siachen Solar to flow through the intact 132 kV circuit between Siachen Solar and Gharo-New 132 kV.

We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast

Fig. 4.6 shows the transients of MW and MVAR output of the nearest electrical grid Kotri-GTPS which settles the transients quickly and acquires new steady state levels soon.

The angular stability of other conventional generators of the system can be seen in **Fig. 4.7** The relative rotor angles of Kotri GTPS 132 kV, Kotri-Site, Nooriabad 132 kV, Thatta 132 kV and Jamshoro 220 kV are plotted w.r.t. Hub 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.3 Dynamic impact of Fault on 220 kV Primary System

Three Phase Faults, Normal Clearing Time of 9 Cycles & Trip of 220 kV Circuits

Three- phase fault applied at Gharo-New 220 kV bus bar, cleared in 9 cycles as normal clearing time i.e. 180 m seconds, followed by trip of 220 kV single circuit between Gharo- New and Jhimpir- New, which was significantly loaded in the pre-fault normal load flow case and its outage may cause severe impact.

Fig 5.1 indicates the bus voltages in pre and post fault conditions at 220 kV and 132 kV substations in the vicinity of Siachen Solar PP. We find that the voltages recover smoothly and quickly to their pre-disturbance values.

The system frequency indicated in **Fig. 5.2** shows very nominal excursions of frequency that damps down very quickly and smoothly

The MW and MVAR output of equivalent WTG get back to normal quickly after the fault clearance as shown in **Fig 5.3.**

The value for LVACR is restored to its pre-fault value after the fault clears is shown in **Figs 5.4**

Fig 5.5 shows that after clearing of fault, the trip of 220 kV circuit between the Gharo-New and Jhimpir-New 220 kV causes the entire output to flow through the intact 220 kV circuit between Gharo-New and Jhimpir-New 220 kV. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 5.6 shows the transients of MW and MVAR output of the nearest electrical grid Kotri-GTPS which settles the transients quickly and acquires new steady state levels soon.

The angular stability of other conventional generators of the system can be seen in **Fig. 5.7** The relative rotor angles of Kotri GTPS 132 kV, Kotri-Site 132 kV, Nooriabad 132 kV, Thatta 132 kV and Jamshoro 220 kV are plotted w.r.t. Hub 500 kV. The results show that they remain in synchronism with the system generators and stay stable. The angular swings are also nominal and damp quickly.

8.4 Conclusion of Stability Study

The transient stability analysis performed as discussed above indicates that the NTDC/HESCO system connecting to Siachen Solar PP through the proposed scheme of interconnection is strong enough to absorb the worst disturbances on either side i.e. on Siachen Solar PP side or the Grid side.

There are no constraints of connecting Siachen Solar PP with the NTDC/HESCO grid in terms of transients or dynamic behavior of system under the disturbed conditions either on the Farm side or on the Grid side.

9- Power Quality

The issues of power quality are of particular importance to PV solar power plants that may cause flicker and distortions in the power supply due to harmonics and unbalance. These issues are more significant for weak systems of low short circuit strength. Therefore we have investigated these issues for the case of minimum short circuit for the proposed scheme of interconnection. The same case has been re-evaluated with per unit MVA values and plotted for 3-phase faults in Appendix-C.

9.1 Flicker

We have used IEC61400-21 for the calculations of flicker levels for steady-state continuous operation and for switching conditions [1].

9.1.1 Continuous Operation

The probability of 99th percentile flicker emission from a single inverter during continuous operation for short time $P_{St\Sigma}$ and longer time flicker levels $P_{lt\Sigma}$ are assumed same and calculated by the following formula

$$P_{st\Sigma} = P_{lt\Sigma} = \frac{1}{S_k} \cdot \sqrt{\sum_{i=1}^{N_{wt}} \left(c_i(\psi_k, v_a) \cdot S_{n,i}\right)^2}$$

Where,

c (ψ_k, V_a)	has a maximum value of 1
S_n	is the rated apparent power of one inverter
S_k	is the short circuit apparent power at the PCC
N_{wt}	is the number of inverters connected to the PCC

PCC is the point of common coupling of inverters that is MV bus of Siachen Farm substation.

For minimum short circuit case we have assumed that the output of Siachen Solar Power Plant is reduced as low as 20 % of its rated capacity. Therefore for two inverter groups we have calculated as follows;

S_n= 0.55 MVA

N_{WT} = 40

S_k for MV bus = 820 MVA

The value of c (ψ_k) at 10 minute average speed (v_a) is supplied by the manufacturer after filed measurements of $P_{St,\ fic}$ for different operating conditions using the following formula.

$$c(\psi_k) = P_{st,fic} \cdot \frac{S_{k,fic}}{S_n}$$

Where,

S_n is the rated apparent power of one inverter

$S_{k,\ fic}$ is the short circuit apparent power of the fictitious grid

The value of c (ψ_k) may not be greater than 1, therefore for the present analysis we may assume it as 1 for the worst case.

Putting this data in the above Equation, we find

$$P_{St\Sigma} = P_{lt\Sigma} = 0.00424208 = 0.424208\%$$

Whereas the acceptable value is 4 % as mentioned in Ref. [2]. Therefore we are much less than the maximum permissible level and the inverters at Harappa Solar Power Plant would not cause any flicker problem during steady state operation even in the weakest system conditions of minimum short circuit level.

The values evaluated above are less than the values recommended in the references of above standards.

9.2 Voltage Unbalance

9.2.1 Voltage Step-Change

The voltage step change would occur when a inverter will be energized, assuming just one inverter in the collector for the minimum No. of units in the collector being energized.

The limit on the voltage change is based on the impedance of the circuit between the point of connection and the MV transformer bus bar together with the apparent power of the inverters. The following equation needs to be satisfied [2];

$$\Delta V = \sum S_{WKA} [(1/S_{KE}) - (1/S_{KSS})] \leq 1/33 \text{ or } 3\ \%$$

Where

S_{WKA} = MVA rating of the inverter

S_{KE} = Short circuit MVA at connection point

S_{KSS} = Short circuit MVA at MV bus of the solar plant substation

For the minimum short circuit case, we have calculated minimum fault levels in MVA as shown in Exhibit 3.3.2

S_{WKA} = 0.55 MVA for the equivalent inverter of a collector group for the minimum case

S_{KE1} for one inverter in collector group = 180 MVA (Exhibit 3.3.2)

S_{KSS} = 790 MVA (Exhibit 3.3.2)

Substituting these values we get

$$\Delta V = 0.002054 = 0.2054\ \%$$

Which is much less than the limit of 3 %

9.2.2 Voltage Variation

The operation of a Solar PV unit is acceptable if it is verified that the system complies with the standards IEC 61000-3-3 or IEC 61000-3-11. If this proof is not available, the variations of voltage caused by hooking up and turning off are acceptable, if the values in the following table are not exceeded at the PCC.

Voltage	**Max. Voltage Variation**	**Max. Frequency: once in**
Low Voltage	3%	5 Minutes
Medium Voltage	2%	1.5 Minutes

If there are only few operating cycles, for example one per day, the DNO may allow a higher variation of voltage. The voltage variation can be estimated via:

$$\Delta u_a = k_{i\max} \cdot \frac{S_{rE}}{S_{kV}}$$

$k_{i,max}$ - Maximum inrush current in relation to the nominal current
S_{kv} - Short-circuit power at the PCC
S_{rE} - Nominal apparent power of the Solar PV unit that is to be connected

This calculation gives an upper assessment and is basically a safe margin.

For Solar Power plants $k_{i,max}$ can be assumed to be 1. With this

S_{kv} = 790 MVA
S_{rE} = 0.55 MVA

$$\Delta u_a = 0.0006962 = 0.0696\%$$

Which is much less than the maximum value of 2%.

10- Conclusions & Recommendations

- The project by the name of Siachen Energy Limited Power Plant is expected to start commercial operation by December 2017. Therefore, the month of June 2018 have been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load forecast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-380/ 5243-44 dated 14-12-2015.
- A 132 kV double circuit of 18 km has been proposed from Siachen Solar to Gharo-New 132kV grid station to evacuate the maximum of 100 MW power from Siachen Solar PP to National Grid. The Conductors used will be Greeley. As the 100 MW could not have been merged with any sub collector already proposed at Gharo-New 132kV.
- The scheme of interconnection of Siachen Solar PP presupposes the following reinforcement already in place in Jhimpir and Gharo clusters.
  - 220/132 kV Jhimpir-New substation at suitable location in Jhimpir cluster
  - 500/220 kV Matiari Collector Substation connected to Jhimpir 220/132 kV substation via 100 km long Greeley double circuit.
  - 70 km long double circuit from Jhimpir-New 220 kV Substation to the existing T.M. Khan Road 220 kV Substation.
  - A 132 kV double circuit of 82 km using Greeley conductor would be constructed to connect Jhimpir-New 220/132 kV Substation with T.M. Khan in HESCO network.
  - 220/132 kV Gharo-New substation at suitable location in Gharo cluster
  - 75 km long 220 kV double circuit from Gharo-New 220 kV Substation to Jhimpir-New 220 kV Substation
  - Six sub-collectors groups will be connected to Jhimpir 220/132 kV collector substation through 132 kV double circuits using Greeley Conductor
  - FFC and Zorlu looped in-out with Jhimpir-Nooriabad 132 kV circuit.

- Four WPPs in the collector system of Gharo 220/132 kV substation
- FWEL-I and FWEL-II through a 64 km long 132 kV D/C on Greeley conductor connected to Thatta
- Rehabilitation of the exiting 132 kV lines in the vicinity of WPP clusters, i.e. Jhimpir-Kotri, Jhimpir-Thatta, Thatta-Sujawal and Nooriabad-Jamshoro Old.

➢ The existing grid system of HESCO and NTDC in the vicinity of Siachen Solar PP has been studied in detail by performing load flow, short circuit and dynamic analysis for the conditions prior to commissioning of Siachen Solar PP and no bottlenecks or constraints have been found in the grid system.

➢ The medium voltage level of solar farm has been selected as 33 kV for unit step-up transformers, for collector circuits and step-up from MV to HV (132 kV) at Farm substation to connect to the HESCO/NTDC Grid.

➢ A conceptual design of scheme of 132/33 kV substation of Siachen Solar Farm has been laid down as follows

For 11 kV;

It comprises of

- Two single bus-sections of 33 kV with a bus sectionalizer
- Ten breaker bays to connect ten collector circuits
- Two breaker bays to connect two transformers of 132/33 kV
- One station auxiliary transformer 11/0.4 kV
- Two SVCs each of the size of -5/+20 MVAR
- Two breaker bays to connect two -5/+20 MVAR SVCs

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity = 31.5 kA

Normal continuous current = 1250 A for line breakers

= 2500A for Bus Sectionalizer and Power TF

For 132 kV;

- Double bus bars with a Bus Coupler
- Two breaker bays to connect two transformers 132/11 kV

- Two breaker bays to connect two circuits of 132 kV i.e. double circuit on single tower overhead line to connect to the grid system.

Rating of all the breakers and bus bar equipment would be

Short circuit rupturing capacity	= 40 kA
Normal continuous current	= 2000 A for line and TF breakers
	= 2500 A for Bus Coupler

The other equipment of the substation consists of:

- Two 132/33 kV, 67/100 MVA ONAN/ONAF OLTC transformers, 132±8×1.25%/33kV, to fulfill N-1 criteria of Grid Code
- Energy meters would be installed on HV side (132 kV) of the 132/33kV transformers.

➢ Load flow analysis has been carried out for June 2018 considering the COD targeted by Siachen Solar PP, for the dispersal of load from Siachen Solar PP into HESCO Grid at 132 kV level using the latest load forecast, generation and transmission expansion plans of NTDC and HESCO. The above mentioned interconnection scheme has been evolved by performing the load flow studies testing the steady state performance for normal as well as N-1 contingency conditions fulfilling the Grid Code criteria of Power Plants. The reactive power requirement at point of common coupling to meet PF of ± 0.95, voltage and line loading criteria are fulfilled by these studies. The grid facilities of HESCO are found adequate to absorb output power of Siachen PP. The load flow results for these scenarios also establish that the proposed scheme of interconnection of Siachen Solar PP shows no bottlenecks or capacity constraints in the adjoining 500 kV, 220 kV and 132 kV network in terms of absorbing all the output of Siachen Solar PP under normal as well as the contingency conditions.

➢ Maximum and minimum short circuit levels for three-phase faults and single-phase faults have been evaluated. The maximum short circuit level has been evaluated for the year 2017-18 and the minimum short circuit level has been evaluated for 2017-2018 to evaluate the most stringent conditions, the fault levels of Siachen 132 kV are 6.65 kA and 4.75 kA for 3-phase and single phase faults respectively for 2017-18. This is much less than the switchgear rating of 40 kA recommended for Siachen Farm Substation as per NTDC requirements for 132 kV. The fault levels for Siachen 33 kV are 16.56 kA and 13.33 kA for 3-phase and single-phase faults respectively for year 2017-18. Therefore the short circuit rating for 11 kV switchgear is recommended as 25 kA. It has been found that the proposed scheme provides maximum SC strength for the evacuation of Siachen Solar PP power to the grid.

The switchgear ratings for Siachen Solar substation are as follows:

132 kV:

Short circuit rating = 40 kA (3 sec.)

Continuous rating = 2500 A

33 kV:

Short circuit rating = 25 kA (3 sec.)

Continuous rating = 2500 A

- Transient Stability analysis has been carried out for Siachen Solar PP, with connectivity of proposed scheme. Different disturbances have been simulated to apply stresses from the system faults on the solar farm and vice versa and it was found that Siachen Solar unit's dynamic characteristics and the grid connectivity is strong enough to maintain stability under all disturbances. In turn, any disturbance from Siachen Solar PP side did not cause any stress on the main grid or the power plants in HESCO area viz. Kotri, Lakhra or Jamshoro such that the whole system remained stable under all events.
- 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 power quality; and is therefore recommended to be adopted.
- The issues of power quality like flicker, unbalance and harmonic resonance have been studied in detail. The results have indicated that the levels of flicker and unbalance are within the permissible limits of IEC and other International Standards.

Siachen Energy Limited

There are no technical constraints whatsoever in the way of bringing in the 100 MW of Siachen Solar Power Plant at the proposed site and scheduled time of commissioning, in any respect of steady state (load flow) or short circuit or dynamic performance (stability) or power quality issues related to this plant.