APPLICATION FOR GENERATION LICENSE FOR 50MW$_P$ KUCHLAK- III SOLAR PV PLANT

AT

KUCHLAK, BALOCHISTAN

IS SUBMITTED TO

NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA)

FOR THE GRANT OF A GENERATION LICENSE UNDER SECTION 15 OF THE REGULATION OF GENERATION, TRANSMISSION AND DISTRIBUTION ACT 1999 OF NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA)

ON BEHALF OF

engro energy

ENGRO ENERGY LIMITED

DATED: 19TH APRIL 2019

ENGRO ENERGY LIMITED

16TH FLOOR, HARBOUR FRONT BUILDING, MARINE DRIVE, CLIFTON, BLOCK 4, KARACHI 75600, PAKISTAN, PHONE: +92.213.35297501-10, FAX: +92.213.5296018

16th Floor, The Harbor Front Building
HC-3, Marine Drive, Block 4, Clifton
Karachi 75600 Pakistan

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engro energy

19th April, 2019

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

Subject: **Application for Grant of Generation License for a 50MWp Kuchlak- III Solar PV Plant at Kuchlak, Balochistan by Engro Energy Limited.**

Dear Sir,

I, **Ahsan Zafar Syed,** being the duly authorized representative of **Engro Energy Limited** by virtue of **Board Resolution** dated 17th April 2019, hereby apply to the National Electric Power Regulatory Authority for the grant of a **Generation License** to the **Engro Energy Limited** pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

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

A BANK DRAFT/ PAY ORDER dated 19th April 2019 in the sum of Rs. 334,608/- (Rupees Three hundred and Thirty-Four thousand and Six hundred and Eight only), being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

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

Sincerely,

Ahsan Zafar Syed
CEO Engro Energy Limited

Certificate No: 000884

SECP

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN
COMPANY REGISTRATION OFFICE
KARACHI

CERTIFICATE OF INCORPORATION

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

Company Registration No. 0065768

I hereby certify that **ENGRO POWERGEN (PRIVATE) LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is limited by Shares.

Given under my hand at **Karachi** this **13th** day of **May Two Thousand and Eight.**

Fee Rs. 172,000/- (One Hundred Seventy Two Thousand Only)

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

(Muhammad Naeem Khan)
Joint Registrar of Companies
Karachi

Dy. No. Inc/JR-I/ 1602

Dated: 14/5/08

Certified to be True Copy

Joint Registrar of Companies 30/3/17

B 026263

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

SECP

CERTIFICATE OF INCORPORATION ON CHANGE OF NAME

[Under Section 13 of the Companies Act, 2017 (XIX of 2017)]

Company Registration No. 0065768

I hereby certify that pursuant to the provisions of Section 12 of the Companies Act 2017 (XIX OF 2017), the name of ***ENGRO POWERGEN LIMITED*** *has been changed to* ***ENGRO ENERGY LIMITED*** *and that the said company has been duly incorporated as a company limited by shares as a public company under the provisions of the said Act.*

This change is subject to the condition that for period of 90 days from the date of issue of this certificate, the company shall continue to mention its former name along with its new name on the outside of every office or place in which its business is carried on and in every document or notice referred to in clauses (a) and (d) of Section 22.

Given under my hand at Karachi this 29th day of November Two Thousand and Seventeen.

MUHAMMAD NAEEM KHAN
ADDITIONAL REGISTRAR / INCHARGE
CRO, Karachi

Certified to be True Copy

30/3/17

Joint Registrar of Companies

MEMORANDUM OF ASSOCIATION

OF

ENGRO ENERGY LIMITED

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

II. The Registered Office of the Company will be situated in the Province of the SIND, Pakistan.

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

1. To develop business plans, feasibility studies, carry out surveys and other activities pertaining to the power generation business.

2. To carry on at suitable locations within Pakistan and outside Pakistan, the business of power generation, distribution, transmission and sale in all its branches and aspects and by the use of such forms of energy and in such manner as may be deemed feasible and sell and deliver the electricity thus generated.

3. To finance, design, construct, own, operate and maintain power stations together with all machinery, equipment and works ancillary thereto (hereinafter referred to as "power stations") and to do all such acts, deeds, and things, without limitation whatsoever as may be necessary or desirable in that connection.

4. To carry on anywhere in Pakistan the business of power generation, transmission, sale and distribution in all its branches and aspects and in particular to construct, lay down, establish, maintain and fix all necessary power stations together with ancillary works, cables, wires, lines, accumulators, lamps, and to generate, accumulate, distribute, sell and supply electricity.

5. To provide engineering, construction, consultancy and design services and any facilities, equipment and installations whether related to such services and systems or otherwise.

6. To carry on the businesses of manufacturing, supplying, servicing, engineering, contractors, consultants, agents and import, export, buying, selling, manufacturing and/or dealing in all types of machinery, plant or equipment used in connection with the generation, transmission, distribution and supply of electricity or any other form of energy.

7. To buy, sell, import, hire, manufacture, deal in, plant, machinery, implements, conveniences, provisions, articles, and products capable of being used in connection with the operations of or required by workmen and others employed by the Company or incidentally or conveniently connected with any such business as aforesaid.

8. To conduct, promote and commission research of all kinds and research and development activities of all kinds, whether related to the generation, transmission, distribution and supply of electricity or other form of energy or otherwise, and to exploit and turn to account the results of any such research or research and development carried out by or for the Company.

9. To abstract and divert water from any appropriate source for use in connection with the generation of electricity.

10. To carry on any other trade or business whatever which, in the opinion of the Directors of the Company, can be advantageously carried on in connection with or ancillary to any of the above mentioned businesses or is calculated directly or indirectly to enhance the value of, or render profitable any of, the property or rights of the Company.

11. To carry on any other trade, commerce, industry and/or business whatsoever, which, in the opinion of the Directors of the Company, is or may be capable of being carried on directly or indirectly for the benefit of the Company.

12. To purchase or by any other means acquire and take options over any property whatever, and any rights or privileges of any kind over or in respect of any property.

13. To acquire or undertake the whole or any part of the business, goodwill, and assets of any person, firm, or company carrying on or proposing to carry on any of the businesses which the Company is authorised to carry on and as part of the consideration for such acquisition to

undertake all or any of the liabilities of such person, firm or company, or to acquire an interest in, amalgamate with, or enter into partnership or into any arrangement for sharing profits, or for co-operation, or for mutual assistance with any such person, firm or company, or for subsidising or otherwise assisting any such person, firm or company, and to give or accept, by way of consideration for any of the acts or things aforesaid or property acquired, any shares, debentures, debenture stock or securities that may be agreed upon.

14. To enter into any arrangements with any government or authority (municipal, local, or otherwise) that may seem conducive to the attainment of the Company's objects or any of them, and to obtain from any such government or authority any charters, decrees, rights, privileges or concessions which the Company may think desirable and to carry out, exercise, and comply with any such charters, decrees, rights, privileges, and concessions.

15. To carry on in or outside Pakistan the business of manufacturers, transmitters, suppliers, importers, exporters, indentors, transporters, dealers in all articles and commodities akin to or connected with any of the business of the Company capable of being conveniently carried on or necessary for the promotion of the objects herein contained, as permissible under law.

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

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

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

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

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

21. To arrange local and foreign currency loans from scheduled & other banks, leasing companies and modarbas and other financial institutions for the purpose of purchase, manufacture, market, supply, export and import of machinery, construction of factory, building and for the purpose of working capital or for any other purpose.

22. To sell or otherwise dispose of the whole or any part of the undertaking of the Company, either together or in portions for such consideration as the Company may think fit and in particular, for shares, debenture-stock or securities of any Company purchasing the same.

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

24. To pay all costs, charges, and expenses preliminary or incidental incurred in formation or about the promotion and establishment of the Company and to remunerate any person, firm or company for services rendered or to be

rendered in or about the formation or promotion of the Company or the conduct of its business.

25. To give any servant or employee of the Company commission in the profits of the Company's business or any branch thereof and for the purpose to enter into any agreement or scheme of arrangement as the Company may deem fit and to procure any servants or employees of the Company to be insured against risk of accident in the course of their employment by the Company.

26. To establish and support or aid in the establishment and support of associations, trusts, institutions, funds and conveniences calculated to benefit persons who are or have been Directors of or who have been employed by or who are serving or have served the Company or any other Company which is a subsidiary or associate of the Company or the dependents of such persons and to grant pensions, gratuities, provident funds, allowances, relief and payments in any other manner calculated to benefit the persons described herein.

27. To distribute any of the Company's property and assets among the members in specie or in any manner whatsoever in case of winding up of the Company.

28. To guarantee the performance of contracts and obligations of the Company or any of its associated companies or persons or any other person or company whatsoever.

29. To cause the Company to be registered or recognised in any foreign country.

30. To do and perform all other acts and things as are incidental or conducive to the attainment of the above objects or any of them.

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

32. It is declared that the company shall not engaged in business of banking company, banking, leasing, investment, managing agency or insurance business or directly or indirectly as restricted under the law or any unlawful operation and the company shall not indulge in multi level

marketing, launching of ponzy or pyramid schemes for marketing purposes.

33. Notwithstanding any thing stated in any object clause, the company shall obtain such other approval or license from Competent Authority, as may be required under any law or the time being in force, to undertake a particular business.

IV. The liability of the members is limited.

V. The authorised Share Capital of the Company is Rs. 4,000,000,000/- (Rupees Four Billion) divided into 400,000,000 (Four Hundred Million) Ordinary shares of the nominal value of Rs. 10 (Rupees Ten) each with the rights, privileges and conditions attached thereto as are provided for the time being, with power to increase and reduce the capital of the Company and to divide the shares in the capital for the time being, into several classes.

We, the several persons, whose names and addresses 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 our respective names.

Sr. No	Name and Surname (Present and Former in full in Block Letters)	Father's/Husband's Name in full	Nationality & I.D. Card #	Occupation	Residential Address in full	Number of Shares take by each subscriber	Signature
1.	KHALID MANSOOR	MANSOOR-UL-HAQ	42301-4500955-5	BUSINESS EXECUTIVE	124/12th STREET, KHAYABAN-E-RAHAT, PHASE VI, DHA, KARACHI	1 (ONE)	[signature]
2.	RUHAIL MUHAMMAD	YOUSUF MUHAMMAD	42301-6895452-9	BUSINESS EXECUTIVE	101/I, KHAYABAN-E-BADBAN, PHASE VI, DHA, KARACHI	1 (ONE)	[signature]
3.	ANDALIB ALAVI	MEHER ALAVI	42301-7581[illegible]	BUSINESS EXECUTIVE	79/II, 50th Street, Off Khayaban-e-Sehr, Phase VI, DHA, Karachi	1 (ONE)	[signature]
					(Total)	3 (THREE)	[signature]

Dated the17th day of April, 2008

Witness of above Signature	Occupation	Full Address	Signature
Bahman N. Masani	Accountant	House no.A-4, Cyrus Colony, Parsi Gate, Mehmoodabad, Karachi	[signature]

Serial No. ...... Name of the Company ...... (Private) Limited ...... Brief Description of the document including ...... Memorandum ...... of Association ...... The date on which the document is registered 13-5-2008

Joint Registrar of Companies
Companies Registration Officer
Karachi.

Certified to be True Copy
3/5/10
Deputy Registrar of Company

Company Registrar Karachi


Company Registry
Securities and Exchange Commission

ARTICLES OF ASSOCIATION

OF

ENGRO ENERGY LIMITED

1. The regulations in Table A in the first Schedule to the Companies Ordinance 1984, shall not apply to the Company except in so far as the same are reproduced or contained in or expressly made applicable by these Articles.

2. **Definitions:**

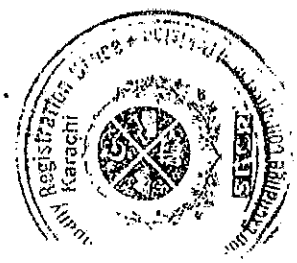
"The Ordinance" means the Companies Ordinance, 1984, or any statutory modification or re-enactment thereof for the time being in force.

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

"Special Resolution" has the meaning assigned to it by Section 2 (l) (36) of the Ordinance.

"The Company" means Engro Energy Limited.

"Member" means member of the Company in accordance with the provisions of Sections 2(1) (21) of the Ordinance.



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

"Chief Executive" means the Chief Executive for the time being.

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

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

"Secretary" means the Secretary for the time being of the Company.

"Office" mean the Registered Office for the time being of the Company.

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

"Dividend" includes bonus.

"Seal" means the Common Seal of the Company.

"Month" means calendar month according to the Gregorian calendar.

"Proxy" includes an attorney duly constituted under power of attorney.

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

"Person" includes the Government of Pakistan, the government of the Provinces, corporations, associations as well as individuals.

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

Words importing the masculine gender shall include the feminine gender.

Unless the context otherwise requires, words or expressions contained in these regulations shall have the same meaning as in the Ordinance.

BUSINESS

3. The business of the Company shall include all or any of the objects enumerated in the Memorandum of Association and can be commenced, subject, to any other provision of the Ordinance to which the Company is subject, immediately after the incorporation of the Company as the Directors may think fit, notwithstanding that only part of the capital has been subscribed.

SHARE CAPITAL & SHARES

4. The authorized share capital of the Company is Rs. 4,000,000,000 (Rupees Four Billion) divided into 400,000,000 (Four Hundred Million) ordinary shares of Rs. 10 each.

For the purpose of sub-section (8) of Section 68 of the Ordinance the minimum subscription upon which the, Directors may proceed to allotment shall be Rs. 50,000 (Rupees Fifty Thousand Only).

5. The Company in General Meeting may from time to time increase the share capital by such sum to be divided into shares of such amount as may be deemed expedient.

6. The new shares shall be issued upto such terms and conditions and with such rights and privileges annexed thereto as the General Meeting creating the same shall direct and if no direction be given the Directors shall comply with the provisions of these Articles. The new shares shall be subject to the same provisions with reference to transfer, transmission and otherwise as the shares in the original share capital.

7. The Directors may from time to time increase the issued share capital by such sum as they think fit. In respect of any intended issue of shares, the Directors shall be entitled to seek a resolution of the company in General Meeting as to any person or class of persons to whom the shares may be offered or as to any other matter relating to the issue. Subject to any resolution to the contrary that may be given by the company in General Meeting, all shares intended to be issued by the Directors shall, before issue, be offered to the Members strictly in proportion to the amount of the

issued shares held by each Member (irrespective of class) in accordance with the provision of Section 86 of the Ordinance.

8. Subject to the provisions of Section 92 of the Ordinance the company may;

   a) consolidate and divide the whole or any part of its share capital into shares of larger amount than its existing shares;

   b) sub-divide shares or any of them into shares of smaller amount than is fixed by the Memorandum of Association;

   c) cancel any shares which at the date of passing of the resolution have not been taken or agreed to be taken by any person.

   The resolution by which any share is sub-divided or consolidated may determine that as between holders of shares resulting from sub-division or consolidation rights of profits, votes and other benefit attaching to them will be proportionate to their paid up value and where shares issued as sub-divided or consolidated shares are of same class as those previously issued that rights attaching to them, subject as aforesaid, shall be the same as those attaching to the shares previously held.

9. Subject to Section 96 of the Companies Ordinance, the Company may by special resolution reduce its share capital.

10. Except to the extent permitted by Section 95 of the Ordinance no part of the funds of the Company shall be employed in the purchase of any shares of the Company, and the Company shall not give, whether directly or indirectly, and whether by means of a loan, guarantee, the provisions of security or otherwise, any financial assistance for the purchase of or in connection with a purchase made or to be made by a person of any shares of the Company or give any loan upon the security of any shares of the Company.

11. 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 or debentures or redeemable capital of the Company or procuring or agreeing to procure subscriptions (whether absolute or conditional) for any shares or debentures or redeemable capital of the Company. In case any commission shall be paid the Company shall comply with the provisions of Section 82 of the Ordinance. The Company may also pay such brokerage as may be lawful on any issue of shares or debentures.

SHARES

12. Shares may be registered in the name of any individuals, limited Company or other corporate body but not more than four persons shall be registered as joint-holders of any shares.

13. If any share stands in the name of two or more persons, the person first named in the Register shall, as regards receipt of dividend or service of

notice, and all or any other matters connected with the Company except voting at a meeting and the transfer of shares, be deemed the sole holder.

14. In the case of the death of anyone or more of the persons named in the Register as the joint-holders of any share, the survivor or survivors shall be the only person or persons recognized by the Company as having any title to or interest in such share, but nothing herein contained shall be taken to release the estate of a joint-holder from any liability on shares held by him jointly with any other person.

15. Every member shall name to the Company a place in Pakistan, to be registered as his address and such address shall for all purposes be his place of residence.

CERTIFICATES

16. Every member whose name is entered as a Member in the Register shall without payment be entitled to receive, after allotment or registration of transfer, one certificate for all his shares or several certificates each for one or more of his shares and upon payment of such charges, if any, as the Directors may determine for every certificate after the first.

17. The certificates of shares and duplicates or replacements thereof when necessary shall be issued under the seal of the Company and signed by two Directors, or by one Director and the Secretary.

18. The Company shall not issue more than one share certificate in respect of a share or shares held jointly by two or more persons, and delivery of a certificate for a share to anyone of the joint holders shall be sufficient delivery to all.

19. The Company shall, within ninety days, after the allotment of any of its shares, and within forty five days after the date, on which the application for the registration of transfer has been lodged, complete and have ready for delivery the certificates of all shares, allotted or transferred.

20. If any certificate be worn out, defaced, destroyed or lost, or if there is no further space on the back thereof for endorsement of transfer it may be renewed or replaced on payment of such sum, as the Directors may from time to time prescribe. Provided however, that such new certificate shall not be granted except upon delivery of the worn out or defaced or used up certificate for the purpose of cancellation or upon proof of destruction or loss to the satisfaction of the Directors and on such indemnity as the Directors may deem adequate in case of certificates having been lost or destroyed.

TRANSFER OF SHARES

21. The Directors shall not refuse to register a transfer of fully paid shares unless the transfer deed is defective or invalid or is not accompanied by the certificate of the shares to which it relates. The Directors may also decline to recognize any instrument of transfer unless it is accompanied, in addition

to the certificate of the shares to which it relates, by such other evidence as the Directors may require, to show the right of the transferor to make the transfer.

If the Directors refuse to register a transfer of any shares they shall, within thirty [30] days after the date on which the instrument of transfer was lodged with the Company send to the transferee and the transferor notice of the refusal indicating the reason for such refusal; provided that if the Directors refuse to register a transfer of shares on account of a defect in or invalidity of the instrument of transfer, the transferee shall be entitled, after removal of such defect and invalidity to re-lodge the instrument of transfer with the Company.

22. The instrument of transfer of any share in the Company shall be duly stamped and executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the Register in respect thereof.

23. The instrument of transfer of any share shall be in writing in the following form or in any usual or common form:

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

As witness our hands this _____ day of _____

TRANSFEROR	**TRANSFEREE**
Signature	Signature
Full Address	Full Name, Father's Husband's Name
	Nationality
	NIC Number
	Occupation
	Full Address
Signature	Witness
Full Address	Signature
	Full Address

24. Where it is proved to the satisfaction of the Directors that an instrument of transfer signed by the transferor and the transferee has been lost, the Company may, if the Directors shall think fit, by any application in writing made by the transferee and bearing the stamps required by an instrument of

transfer, register the transfer on such terms as to indemnity as the Directors may think fit.

25. No fee will be charged for registering transfer of shares.

26. The transfer books of the Company may be closed for any time or times not exceeding fifteen days at a time.

27. Nominees, if any, appointed under the provisions of Section 80 of the Ordinance, or legal representatives of a deceased Member shall be the only persons recognized by the Company as having title to his share except in case of joint-holders in which case the surviving holder(s) or the executors or administrators of the last surviving holder shall be the only person(s) entitled to be so recognized. The Company shall not be bound to recognize such nominee or legal representative except as provided in Section 80 of the Ordinance unless he shall have obtained probate or letter of administration or other legal representation, as the case may be, from a duly constituted court in Pakistan. Provided nevertheless that in special cases it shall be lawful for the Directors to dispense with the representation upon such terms as to indemnity or otherwise as the Directors may deem fit.

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

29. Save as herein otherwise provided, the Company shall be entitled to treat the registered holder of any share as the absolute owner thereof and, accordingly, shall not except as ordered by a court of competent jurisdiction or as required by statute, be bound to recognize any equitable contingent future or other claim to or interest in such share on the part of any other person.

GENERAL MEETINGS

30. The Company shall comply with all requirements of the Ordinance regarding General Meetings.

31. 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 three months following the close of its financial year and not more than fifteen months after the holding of its last preceding Annual General Meeting on a date and time as may be decided by the Directors.

32. The Directors may, whenever they think fit, and they shall on the requisition of the holders of not less than 10% of the issued capital of the Company, forthwith proceed to convene all Extraordinary General Meeting

of the Company and in case of such requisition, the provisions of Section 159 of the Ordinance shall apply.

NOTICE OF MEETING

33. Subject to the provisions of Section 158 and 159 of the Ordinance twenty one days 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 along with a statement complying with Section 160 (1)(b) of the Ordinance shall be given in the manner hereinafter provided or in such other manner, if any, as may be prescribed by the Company in General Meeting or in the manner provided by the Ordinance, to such persons as are under the Ordinance or under these Articles, entitled to receive such notice from the Company.

34. The accidental omission to give notice of a meeting to or the non-receipt of notice of a meeting, by any person entitled to receive notice shall not invalidate the proceedings at the meeting.

35. With the consent in writing of all the Members entitled to receive notice of some particular meeting, that meeting may be convened by such shorter notice and in such manner as all such members shall have so consented to in writing.

PROCEEDINGS AT GENERAL MEETINGS

36. The ordinary business of a General Meeting shall be to receive and consider the balance sheet, profit and loss account and the reports of the Directors and of the Auditors, to elect Directors, to declare dividends, to appoint Auditors and fix their remuneration. All other business transacted shall be deemed special.

37. No business shall be transacted at any General Meeting unless the quorum of Members is present at the time when the meeting proceeds to business and throughout its proceedings. Two members personally or by proxy present at the meeting representing in the aggregate not less than 51 percent of the total voting power of the company shall be the required quorum.

38. If within half-an-hour from the time appointed for the meeting, a quorum is not present, the meeting, if called upon 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 at the adjourned meeting the quorum shall be the same as provided in the above Article.

39. The Chairman, if any, of the Board of Directors shall preside as Chairman at every General Meeting of the Company, or if there is no such Chairman, or if he shall not be present within fifteen minutes after the time appointed for the holding of the meeting or is unwilling to act, the Directors present shall elect one of their number to be, Chairman of the Meeting, or if no Directors be present or if all the Directors present decline to take the chair, the Members present shall choose one of their number to be Chairman of the Meeting.

40. The Chairman may with the consent of any meeting at which a quorum is present (and shall if so directed by the meeting) adjourn any meeting from time to tine and from place to place, but no business shall be transacted at any adjourned meeting except the business left unfinished at the meeting from which the adjournment took place.

41. 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 show of hands) demanded in accordance with the provision of Section 167 of the Ordinance.

    a) by the Chairman of the meeting on his own motion; or

    b) by atleast five members having the right to vote on the resolution and present in person or proxy or

    c) by any Member or Members present in person or by proxy and having not less than one tenth of the total voting power in respect of the resolution.

Unless a poll is so demanded, a declaration by the Chairman of the meeting that a resolution has on a show of hands been carried or carried unanimously or by a particular majority, or lost, and an entry to that effect in the book containing the minutes of the proceedings of the Company, shall be conclusive evidence of the fact without proof of the number or proportion of the votes recorded in favour of or against such resolution.

42. If a poll is demanded on any matter other than the election of a Chairman or on a question of adjournment, it shall be taken in the manner laid down in Section 168 of the Ordinance at such time, not more than fourteen days from the day on which it is demanded, as the Chairman of the meeting may direct. The results of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded. The demand for a poll may be withdrawn at any time by the person or persons who make the demand.

43. The demand of a poll shall not prevent the continuance of the meeting for the transaction of any business other that the question on which the poll has been demanded.

44. The Chairman of any meeting shall be the sole judge of the validity of every vote taken at such meeting. The Chairman present at the taking of a poll shall be the sole judge of the validity of every vote tendered at such poll.

VOTES OF MEMBERS

45. On a show of hands every Member present in person shall have one vote. In the case of joint holders the vote of the senior Member present 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 their names stand in the Register. The Chairman shall have the casting vote.

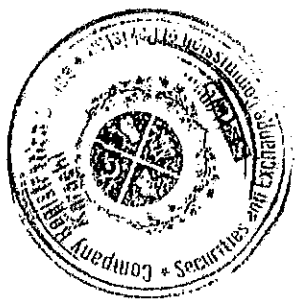
46. A Member of unsound mind, or in respect of whom an order has been made by any court having jurisdiction in lunacy, may vote, whether on a show of hands or on a poll, by his committee or other legal guardian or their proxy.

47. On a poll every Member present in person or by proxy shall have one vote in respect of each share held by him. The Chairman shall have the casting vote.

48. No objection shall be raised to the qualification of any vote except at the meeting or adjourned meeting at which the vote objected to is given or tendered, and every vote not disallowed at such meeting shall be valid for all purposes. Any such objection made in due time shall be referred to the Chairman of the meeting whose decision shall be final and conclusive.

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

50. The instrument appointing a proxy shall be in writing under the hands of the appointer or of his attorney duly authorized in writing, or if the appointer is a corporation, under its common seal or the hand of a duly authorized officer or attorney. A proxy need not be a Member of the Company.



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

52. An instrument appointing a proxy may be in the following form, or in any other usual or common form.

Engro Energy Limited

I,_____of_____
appoint_____ of _____ or failing him
_____of_____ as my proxy to vote for me and on my behalf at the annual or extra-ordinary (as the case may be) general meeting of the Company to be held on the _____ day of _____ and any adjournment thereof.

SIGNED this _____ day of _____, _____.

53. The instrument appointing a proxy shall be deemed to confer authority to demand or join in a demand for a poll.

54. 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 shares 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.

55. Any corporation which is a Member of the Company may by resolution of its Directors or other governing body authorise such person as it thinks fit, to act as its representative at any meeting of the Company or of any class of Members of the Company, and the person so authorised shall be entitled to exercise the same powers on behalf of the corporation which he represents as that corporation could exercise if it were an individual Member of the Company, present in person. A corporation attending a meeting through such representative shall be deemed to be present at the meeting in person.

DIRECTORS

56. The number of Directors shall not be less than three.

The names of the first Directors shall be determined in writing by the subscribers to the Memorandum of Association and until the first Directors have been appointed, the subscribers to the Memorandum of Association shall be deemed for all purposes to be the Directors.

57. The Directors shall fix the number of Directors not later than thirty five days before the convening of the General Meeting at which the Directors are to be elected and the number so fixed shall not be changed except with the prior approval of the Company in General Meeting. The Directors shall, unless the number of persons who offer themselves to be elected is not more than the number of Directors fixed under this Article, be elected by the Members of the Company in General Meeting in the following manner, namely:

(a) every Member present in person or by proxy or by representative shall have such number of votes as is equal to the product of the number of voting shares held by him and the number of Directors to be elected.

(b) the number of votes calculated in accordance with the preceding clause may be given to a single candidate or may be divided between two or more candidates in such manner as the person voting may choose; and

(c) the candidate who get the highest number of votes shall be declared elected as Director and then the candidate who get the next highest number of votes shall be so declared and so on until the total number of directors to be elected has been so elected.

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

59. A Director must be a Member, unless he represents the Government an institution or authority which is a Member or is a whole time working director who is an employee of the Company;

60. Subject to the provisions of Section 177 of the Ordinance, retiring Directors shall continue to perform their functions until their successors are elected. Retiring Directors shall be eligible for reelection.

61. A Director elected by the Members in General Meeting, not being a Director appointed in accordance with section 183 of the Ordinance, shall hold office for a period of three years following the date from which his election is effective unless he earlier resigns, becomes disqualified from being a Director or otherwise ceases to hold office.

62. The remuneration to be paid to the Directors for attending the meetings of the Directors or a committee of Directors shall be determined by the Board from time to time.

63. Any Director appointed to any executive office including for the purpose of this Article the office of Chief Executive or Chairman, or to serve in any Committee or to devote special attention to the business of the Company or who otherwise performs extra services, which in the opinion of the Directors are outside the scope of the ordinary duties of the Directors, may be paid such extra remuneration by way of salary, fees, percentage of profits or otherwise as shall from time to time be determined by the Board of Directors.

64. Subject to the provisions of Section 181 of the Ordinance, at any time the Company may by resolution in General Meeting remove a Director elected under Section 178 of the Ordinance.

65. Any casual vacancy occurring among the elected Directors may be filled up by the Directors and the person so appointed shall hold office for the remainder of the term of the Director in whose place he is appointed.

66. A Director who is about to leave or is absent for a period of three months or more from Pakistan may with the approval of the Directors appoint any person to be an alternate Director during his absence from the country and such appointment shall have effect and such appointee, whilst he holds office as an alternate Director, shall be entitled to exercise in place of his appointer all the functions of appointer as a Director of the Company but he shall ipso facto vacate his office as and when his appointer returns to the country or vacates office as a Director or removes the appointee from office. Any appointment or removal under this Article shall be effected by notice in writing under the hand of the Director making the same. Such alternate Director may be one of the Directors of the Company. In such case he shall be entitled to act in both capacities. An alternate Director need not he a Member of the Company.

67. The Directors shall elect one of their member as the Chairman of the Board upto terms and conditions as the Board may decide from time to time.

68. The Directors may from time to time delegate any of their powers except those powers required to be exercised by the Board under Section 196(2) of the Ordinance to a committee or committees consisting of such number of members of their body as they think fit. Any committee so formed shall conform to any regulations that may be imposed upon it by the Directors and shall be governed, in the exercise of the powers so delegated, by the provisions herein contained for regulating meetings and proceedings applicable to the Directors.

POWERS AND DUTIES OF DIRECTORS

69. The business of the Company shall be managed by the Directors who may pay all expenses incurred in setting up and registering the Company and may exercise all such powers of the Company as are not by the Ordinance' or by any other law or these Articles, required to be exercised by the Company in General Meeting but no regulation made by the Company in General Meeting shall invalidate any prior act of the Directors which would have been valid if the regulation had not been made.

70. Subject to the provisions in these Articles, the Directors may exercise all the powers of the Company to borrow money and to mortgage or charge its undertaking, and property, or any part thereof, and to issue securities and debentures whether outright or as security for any debt, liability or obligation of the Company or of any third party.

71. Subject to the provisions Section 196(2) of the Ordinance, the Directors may from time to time and at any time by power of attorney appoint any company, firm or person or body of persons, to be the attorney or attorneys of the Company for such purposes and with such powers, authorities and discretions not exceeding those vested in or exercisable by the Directors under these Articles for such period and subject to such conditions if any as they may think fit.

72. A Director of the Company or a firm of which such Director is a partner or a private company of which such Director is a director may with the consent of the Directors hold any office of profit in the Company provided that no such consent is required where the office held is that of chief executive or a legal or technical adviser or banker.

73. Subject to the provision of the Ordinance, the Directors shall not be disqualified from contracting with the Company either as vendor, purchaser, or otherwise, nor shall any such contract or agreement entered into by or on behalf of the Company with any company or partnership of or in which any Director of the Company shall be a member or partner or otherwise interested be avoided nor shall any such Director so contracting or being such member or partner or so interested be liable to account to the Company for any profit realised by any such contract or arrangement by reason of such Director holding that office or of the fiduciary relation thereby established but the nature of his interest must be disclosed by him at the meeting of the Directors at which the contract or arrangement is determined on, if the interest then exists, or in any other case at the first meeting of the Directors after the acquisition of the interest. A general

notice that any Director of the Company is a director or a member of any other company or a member or partner of any named firm and is to be regarded as interested in any subsequent transaction with such company or firm shall as regards any such transaction be sufficient disclosure under this Article and subject to the provision of Section 214 of the Ordinance, after any such general notice it shall not be necessary to give any special notice relating to any particular transaction with such firm or company. A copy of each such general notice shall be provided to each Director including alternate Directors.

74. A Director of the Company may be, or become a director of all or any other company promoted by the Company or in which in the Company may be interested as a vendor shareholder or otherwise, and no such Director shall be accountable for any benefits received as director or member of such other company.

75. In accordance with the provisions of Section 219 of the Ordinance a Register shall be kept by the Directors in which shall be entered particulars of all required contacts or arrangements and which shall be open to inspection by any Member at the office during business hours.

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

77. The Directors shall duly comply with the provisions of the Ordinance, and in particular with the provisions with regard to the registration of the particulars of mortgages and charges affecting the property of the Company or created by it, and to keep a Register of the Directors and Managers and to send to the Registrar all returns and statements required under the Ordinance.

78. The Directors shall cause Minutes to be made in books provided for the purposes:

    (a) of the name of the Directors present at each meeting of the Directors and of any committee of the Directors;

    (b) of all resolutions and a fair and accurate summary of proceedings of all General Meetings of the Company and of the Directors and of committees of Directors,

    A copy of each such minutes shall be provided to each Director including alternate Directors. Every Director present at any meeting of Directors or committee of Directors shall sign his name in a book to be kept for the purpose and any such minute of such a meeting if purporting to be signed by the Chairman thereof, or by the Chairman of the next succeeded meeting of the same body shall be sufficient evidence without any further proof of the facts therein stated.

79. The office of a Director shall be vacated if:

(a) he is ineligible on anyone or more grounds enumerated in Section 187 of the Ordinance;

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

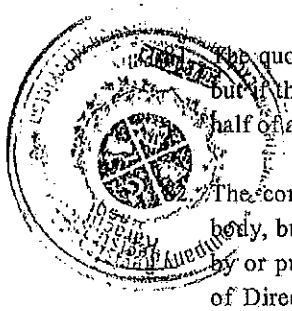
(c) he or any firm of which he is a partner or any private company of which he is a director without the sanction of the Directors accepts or holds any office of profit under the Company other than that of chief executive or a legal or technical adviser or banker;

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

PROCEEDINGS OF DIRECTORS

80. The Directors may meet together for the despatch of business, adjourn and otherwise regulate their meetings, as and where, subject to the provisions of the Ordinance and these Articles, they deem fit. The Chairman may, and the Secretary shall, on the requisition of one Director, at any time, summon a meeting of Directors.

Notice of a Board meeting setting forth the agenda shall be sent to every Director (including a person who is an alternate Director for the time being) not less than 7 days before the meeting is scheduled to take place and such notice may be sent by fax. However, in urgent situations, the Board Meetings may be called at shorter notice.



81. The quorum required for the Board of Directors shall be 2 (two) Directors, but if the number of Directors exceed five (5), the quorum shall be at least half of all the Directors.

82. The continuing Directors may act notwithstanding any vacancy in their body, but if and so long as their number is reduced below the number fixed by or pursuant to the regulations of the Company as the necessary quorum of Directors, the continuing Directors may act for the purpose of filling vacancies in their body or summoning a General Meeting of the Company, but for no other purpose.

83. All acts done at any meeting of the Directors by any person acting as a Director shall notwithstanding that it shall afterwards be discovered that there was some defect in the appointment or continuance in office of any such Director or person acting as aforesaid, or that they or any of them were disqualified or had vacated office, or were not entitled to vote, be as valid as if every such person had been duly appointed or had duly continued in office and was qualified and had continued to be a Director and had been entitled to be a Director.

84. Except as provided for by Section 196 of the Ordinance, a resolution in writing signed by all the Directors for the time being present in Karachi shall be as valid and effectual as if it has been passed at a meeting of the Directors duly called and constituted.

85. If at any meeting the Chairman is absent, the Directors may elect any Director to act as the Chairman for the meeting.

CHIEF EXECUTIVE

86. The Directors may from time to time appoint any person as Chief Executive in accordance with the provisions of Section 199 to 201 of the Ordinance and may subject to the provisions of Section 202 of the Ordinance from time to time remove or dismiss him from office and appoint another in his place. The remuneration of a Chief Executive shall from time to time be fixed by the Directors.

87. The Directors may from time to time entrust or confer upon a Chief Executive for the time being such of the powers exercisable under these presents by the Directors as they may think fit and may confer such powers for such time and to be exercised for such objects and purposes, and upon such terms and conditions and with such restrictions as they think expedient, and they may confer such powers either collaterally with or to the exclusion of and in substitution for all or any of the powers of the Directors in that behalf, and may from time to time revoke, withdraw, alter or vary all or any of such powers.

SECRETARY

88. The Secretary shall be appointed by the Directors for such term, at such remuneration and upon such conditions as they may think fit, and any Secretary so appointed may be removed by them. Where there is no Secretary capable of acting, the Directors may appoint an assistant or deputy secretary or any other officer of the Company to perform the duties of the Secretary.

THE SEAL

89. The Directors shall provide for the safe custody of the seal which shall he used by the authority of the Directors and every instrument to which the seal shall be affixed shall either be signed by one Director and countersigned by the Secretary or by a second Director or by some other person appointed by the Directors for the purpose.

DIVIDENDS AND RESERVES

90. The Company in General meeting may declare Dividends, but no Dividend shall exceed the amount recommended by the Directors.

91. No Dividend shall be paid by the Company otherwise than out of the profits of the Company and to the extent recommended by the Board or in contravention of Section 249(2) of the Ordinance.

92. The Directors may from time to time pay to the Members such interim Dividend as appear to the Directors to be justified by the profits of the Company

93. The Directors 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 Directors, be applicable for meeting contingencies, or for any other purpose 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 the Company or be invested in such investments (other than shares of the Company) as the Directors may from time to time think fit.

94. When any shareholder is indebted to the Company all Dividends payable to him or a sufficient part thereof, may be retained and applied by the Directors in or towards satisfaction of the debt.

95. Any Dividend or other moneys payable in cash in respect of shares may be paid by cheque or warrant sent through the post direct to the registered address of the holder or, in the case of joint holders to the registered address of that one of the joint holders who is first named on the Register or to such persons and to such address as the holder or joint holders may in writing direct. Every such cheque or warrant shall be made payable to the order of the person to whom it is sent. Any of two or more joint holders may give effectual receipt for any dividends, bonuses, or other money payable in respect of the shares held by them as joint holders. The dividend shall be paid within the period laid down in Section 251 of the Ordinance.

96. No dividend or other moneys payable on or in respect of shares shall bear interest against the Company. Dividends unclaimed after having been declared may be invested or otherwise used by the Directors for the benefit of the Company until claimed.

CAPITALIZATION OF PROFITS

97. The Company in General Meeting may upon the recommendation of the Directors resolve that it is desirable to capitalize any part of the amount for the time being standing to the credit of the Company's reserve accounts or to the credit of the profit and loss account or otherwise available for distribution and accordingly that such sum be set free for distribution amongst the Members who would be entitled thereto if distributed by way of dividend and in the same proportion on condition that the same be not paid in cash but be applied in paying up in full unissued shares of the Company to be allotted and distributed/credited as fully paid up to and amongst such Members in the proportion aforesaid, and the Directors shall give effect to such resolution.

ACCOUNTS

98. The Directors shall cause proper books of account to be kept as required by Section 230 of the Ordinance.

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

100. The Directors shall from time to time determine whether and to what extent and at what time and places and under what conditions or regulations the accounts and books or papers of the Company or any of them shall be open to 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 Directors or by the Company in General Meeting.

101. The Directors shall, as required by Sections 233, 234 and 236 of the Ordinance cause to be prepared and to be laid before the Company in General Meeting such balance sheet and profit and loss account duly audited and reports as are referred to in those sections.

102. A balance sheet, profit and loss account, and other report referred to in following Article shall be made out in every year and laid before the Company in Annual General Meeting made up to a date not more than four months before such meeting. The balance sheet and profit and loss account shall be accompanied by a report of the auditors of the Company and the report of the Directors.

103. A copy of the balance sheet and profit and loss account together with reports of the Directors and Auditors shall, at least twenty one days preceding the Annual General Meeting, be sent to the persons entitled to receive notices of General Meeting in the manner in which notices are to be given hereunder and a copy thereof shall be deposited at the registered office of the Company for the inspection of Members for a period of twenty one days prior to such meeting.

AUDIT

104. Auditors shall be appointed and their duties regulated in accordance with Sections 252 to 255, of the Ordinance or any statutory modifications thereof for the time being in force.

NOTICES

105. 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. 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 that the letter would be delivered in the ordinary course of post.

106. A notice may be given by the Company to the joint holders of a share by giving the notice to the joint holder named first in the Register in respect of the share and a notice so given shall be sufficient to all the holders of such shares.

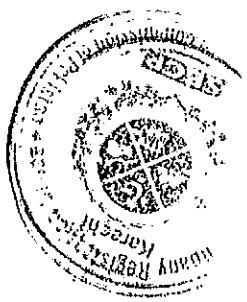
107. A notice may be given by the Company to the persons entitled to a share in consequence of the death or insolvency of a Member through the post in a prepaid letter addressed to them by name or by title or to representatives of the deceased or to an assignee of the insolvent at the address, (if any) in Pakistan supplied for the purpose by the persons claiming to be 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.

108. Notice of every General Meeting shall be given in the manner herein before authorized to (a) every Member of the Company, except those Members who have no registered address or have not supplied to the Company an address for giving of notice to them, and also (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.

WINDING UP

109. (1) Subject to the provisions of the Ordinance, if the Company is wound up, the liquidator may, with the sanction of a Special Resolution of the Company and any other sanction required by the Ordinance, divide amongst the Members, in specie or kind the whole or any part of the assets of the Company, whether they consist of property of the same kind or not.

(2) 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 division shall be carried out as between the Members or different classes of Members.



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

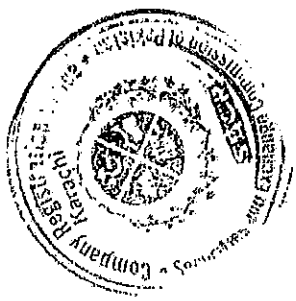
SECRECY

110. Save as otherwise provided in the Ordinance no Member or other person (not being a Director) shall be entitled to visit and inspect any of the Company's premises or properties of the Company without the permission of the Directors of the Company for the time being or any person authorised in this behalf by the Directors or to require discovery of or information respecting any detail of the Company's trading or any matter whatsoever which may relate to the conduct of the business of the Company and which in the opinion of the Directors will be inexpedient in the interest of the Members of the Company to be communicated to the public.

INDEMNITY

111. Every Director or officer of the Company and every person employed by the Company as auditor shall be indemnified out of the funds of the

Company against all liability incurred by him as such Director, officer or auditor in defending any proceedings, whether civil or criminal, in which judgment is given in his favour, or in which he is acquitted, or in connection with any application under Section 488 of the Ordinance in which relief is granted to him by the court.



We, the several persons, whose names and addresses are subscribed are desirous 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 our respective names.

Sr. No.	Name and Surname (Present and Former in full in Block Letters)	Father's/Husband's Name in full	Nationality & I.D. Card #	Occupation	Residential Address in full	Number of Shares take by each subscriber	Signature
1.	KHALID MANSOOR	MANSOOR-UL-HAQ	42301-4000955-5	BUSINESS EXECUTIVE	124/12th STREET. KHAYABAN-E-RAHAT. PHASE VI, DHA, KARACHI	1 (ONE)	[signature]
2.	RUHAIL MUHAMMAD	YOUSUF MUHAMMAD	42301-[illegible]	BUSINESS EXECUTIVE	10/1,KHAYABAN-E-BADBAN,PHASE VI,DHA,KARACHI	1 (ONE)	[signature]
3.	ANDALIB ALAVI	MEHER ALAVI	42301-[illegible]	BUSINESS EXECUTIVE	79/II, 30th Street, Off Khayaban-e-Sehr, Phase VI, DHA, Karachi	1 (ONE)	[signature]
					TOTAL	3 (THREE)	

Dated the 17th day of April, 2008

Witness of above Signature	Occupation	Full Address	Signature
Bahman N. Masani	Accountant	House no.A-4,Cyrus Colony, Parsi Gate, Mehmoodabad, Karachi	[signature]

Serial No ....
Name of the Company [illegible]
Brief Description of the document including its encloses [illegible]
Date on which the documents is registered filed or recorded 13.5.2008
Joint Registrar of Companies
Company Registration Officer, Karachi.

Certified to be True Copy
5/5/17
Deputy Registrar of Company

Company Registration Office Karachi
Securities and Exchange Commission
SECP

ANNEXURE XII

THE TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF THE FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

2.0 INTRODUCTION

2.1 The Project

2.1.1 Engro Energy Limited (the 'Applicant' or the 'Company') is developing a 50 MWp Solar PV Plant at Kuchlak, Balochistan Province, Pakistan (the 'Project').

2.1.2 The Company obtained Letter of Intent ('LOI') dated 22nd February 2018 from Balochistan Power Development Board ('BPDB') and is diligently working towards the early implementation of the Project.

2.1.3 Power produced by the Project will be exported to CPPA-G at 132kV via a power evacuation point located within the Project site.

2.1.4 The plant and its equipment will be designed, manufactured, assembled, and tested in accordance with internationally recognized standards and statutory regulations. Plant operations shall be compliant to Pakistan National Environmental Quality Standards (NEQS) and International Finance Corporation (IFC) guidelines (whichever is more stringent).

2.2 The Project Company

2.2.1 As required under the Section 24 of Regulation of Generation, Transmission, and Distribution of Electric Power Act, 1997 (the 'Act') of National Electric Power Regulatory Authority ('NEPRA' or the 'Authority'), the Company is an entity incorporated under the Companies Ordinance, 1984 to act as a Special Purpose Vehicle (the 'SPV') and develop the Project, sponsored by Engro Corporation. Refer *Annexure IV* for Certificate of Incorporation of the Company.

2.2.2 The Company is a wholly owned subsidiary of Engro Corporation and is incorporated for the purpose of development of Power Plant(s).

2.3 The Sponsor

2.3.1 Engro Energy Limited (EEL) previously Engro Powergen Limited (EPL) is a limited liability company incorporated in Pakistan on 13th May 2008 under the Companies Ordinance, 1984 is a wholly owned subsidiary of Engro Corporation.

2.3.2 Engro Corporation is one of Pakistan's largest conglomerates with businesses ranging from fertilizer production to power generation. Currently, Engro Corporation's portfolio consists of seven businesses that include Chemical Fertilizers, Power Generation, Foods, LNG Terminal, PVC Resin, Bulk Liquid Chemical terminal and Commodity Trade.

2.3.1 The subsidiaries/ associated companies of EEL are:

a. Engro Powergen Qadirpur Limited (EPQL)

217 MW Power plant and Engro Corporation's first initiative in the power sector of Pakistan is presently the only green facility of its kind in Pakistan to utilize permeate gas for reduced carbon emissions. EPQL has a unique concept in energy conservation since it utilizes high sulfur gas which was being flared through Qadirpur Gas Field for almost a decade.

b. Sindh Engro Coal & Mining Company Limited (SECMC)

SECMC is a joint venture between the Government of Sindh and EPL. The primary objective of SECMC is making effective use of the ample coal reserves in the Thar desert to meet Pakistan's power generation needs, spur economic development, and bring energy security to the country.

c. Engro Powergen Thar (Private) Limited (EPTL)

SECMC, on commencement of commercial production of its Thar mining project, will supply 3.8 million tons per annum of coal to EPTL which will then be utilized as the primary fuel for production of electricity and dispatch to the national grid. EPTL is developing a 2 x 330 MW mine mouth power plants at Thar Block II, Sindh in the first phase of the project.

2.4 The Project Site

2.4.1 The project site is located at a distance of 35 km in north of Quetta at Kuchlak on main Quetta Chaman highway at Balochistan, Pakistan. 250 acres of land is to be designated to the Project, out of 1000 acres for the Solar PV park to be developed and owned by EEL.

2.4.2 The geographical coordinate/ location of the proposed Project site is 30° 25'57.48" E and 66° 56'1.5" N. Refer to the Feasibility Study Report attached as *Annexure XIII* for Project site location.

2.5 Power Purchaser

2.5.1 The Company is to enter into a Energy Purchase Agreement (EPA) with CPPA-G for the sale of energy generated by the Project for a term of twenty five (25) years.

2.5.2 The Grid Interconnection Study for the Project is under review with the NTDC, refer *Annexure XIV* for 'Grid Interconnection Study'.

2.6 Current Status of the Project

2.6.1 The Project is being developed and managed by experienced Project team of EEL which has been working diligently for its early implementation. Refer *Annexure VII* and *Annexure VIII* for the Resumes and profiles of EEL's management and technical staff.

2.6.2 The Project has already reached an advanced stage and accomplished the following:

a. Initial Environmental Examination with No Objection Certificate from Balochistan Environmental Protection Agency (BEPA) as *Annexure XV*

b. Grid Interconnection Study submitted to NTDC for review and attached as *Annexure XIV*

c. Feasibility Study Report submitted to BPDB Panel of Experts (PoE) and attached as *Annexure XIII*

2.6.3 The Company will support a short duration from tariff negotiation to financial close, provided critical Project elements like the EPA (Energy Purchase Agreement) is addressed on a timely basis.

3.0 PLANT CHARACTERISTICS & TECHNOLOGICAL CONFIGURATION

3.1 Technical Description

The details on technology and its configuration, water resources, grid interconnection, electrical diagrams, plant characteristics etc., are available in the Feasibility Study Report attached as *Annexure XIII*, however a brief technical summary of the Project is given hereunder:

3.2 Technology

3.2.1 The Project will be a Solar PV plant with a maximum installed electrical generation capacity of 50MWp and a nominal net generation of 45 MW AC.

3.2.2 The power plant will be based on Photovoltaic (PV) technology with single axis tracking. The plant will have central inverters to convert the Direct Current (DC) current to Alternate Current (AC).

3.3 Grid Interconnection

3.3.1 The power generated from the 50 MWp Solar PV plant shall be dispersed to CPPA-G.

3.3.2 The Project will transmit power via its 132kV switchgear and the interconnection would be made at 132kV Quetta-Industrial and Pishin of QESCO.

3.3.3 The interconnection scheme would be double circuit loop in-out of Quetta-Industrial to Pishin with 1 km looping length.

3.3.4 Refer *Annexure XIV* for Single Line Diagram showing interconnection arrangement.

3.4 Major Technical Parameters

3.4.1.1 Plant Generation Technology and Capacity

- Installed Capacity	50 MWp
- Type of Technology	Photovoltaic (PV) with single-axis tracking
- System Type	Grid Connected

3.4.1.2 Technical Details of Equipment

A- Solar Panels- PV Modules	
- Maximum Power (Pmax)	335 watts or equivalent
- Module Efficiency	17.26 %
- Manufacturer	PhonoSolar or equivalent
- Dimension of Module	1956mm X 992mm
- Weight of Module	22.5 kg
- Total Module Area	289679m2
- No. of cells in each module	72
- Maximum Power Current (Imp)	8.61 A
- Maximum Power Voltage (Vmp)	38.94 V
- Maximum Power Voltage (Vmp)	9.20 A
- Open Circuit Voltage (Voc)	47.12 V
- Temperature Coefficient of Voc	-0.31 % C
- Temperature Coefficient of Isc	+0.06 % C
- Temperature Coefficient of Pmax	-0.40 % C
- Nominal Operating Cell Temperature (NocT)	45° C ± 2° C
- Maximum System Open Circuit Voltage	1000 V
- Panel's frame	Anodized Aluminum Alloy
B- PV. ARRAY	
- No. of Sub-Arrays	286
- Modules in a String	29
- Total No. of Strings	5148
- Total No. of Modules	149,292
C- PV CAPACITY	
- Total	50.013 MWp
D- INVERTERS	
- Capacity of each unit	2500 kW
- Inverter Model	Central
- Manufacturer	Sungrow or equivalent
- Rated Input Voltage	1000 V
- Input operating Voltage Range	800-1300 V
- Number of Inverters	18
- Efficiency	99.0%
- Max Allowable Input Voltage	1500 V
- Max. Input Current	3508 A
- Output Electrical System	2750 kVA@ 45 °C / 2500 kVA@ 50 °C

- Rated Output Voltage	550 V	
- Rated Frequency	50 Hz	
- Power Factor	Adjustable >0.99	
- Power Control	Three Phase Control	
- Environmental Enclosures	Cooling Method	Temperature controlled forced air cooling
	Altitude	4000 M
	Compliance	CE, IEC 62109, IEC 61727, IEC 62116
- Grid Operation Protection	Ground Fault Monitoring, Grid Monitoring, Insultation Monitoring, Overheat Protection, Overvoltage Protection, Night SVG function.	
E- ISOLATING TRANSFORMER		
- Rating	5500 kVA	
- Type of Transformer	Oil Cooled Type	
- Output Voltage	22 kV	
- Purpose of Transformer	For stepping up to intermediate voltage level of 22kV	
- Efficiency	99%	
F- OTHER DETAILS		
- CoD of the Project (Anticipated)	Q2 2020	
- Expected Life of the Project (years)	25	

3.4.1.3 All above figures are preliminary based on the Feasibility Study Report. Any change in the above-mentioned figures shall be communicated to the Authority in due course of time.

3.5 Project Timeline

The Project life and EPA term has been assumed as 25 years from COD and all equipment is being procured corresponding to the same.

Construction period of 10-months following financial close has been assumed for the Project. Financial Close is targeted in 2Q 2019 with a target Project commercial operations date ("COD") of June 2020. A schedule of activities and key milestones is provided below.

3.6 Project Cost

Based on the previously discussed assumptions the break-down of the estimated project cost is provided below;

Description	Estimated Project Cost (USD Mn)
EPC Cost	
Modules	10.5
Inverters	2
Mounting System and Trackers	6
BoS, Civil and General Work	12.7
Total	31.2
Non- EPC Cost	
Land Cost	1.3
Project Development Cost	2.1
Financing fee and charges	0.7
Interest During Construction (IDC)	0.8
Total Project Cost	36.1
EPC Cost per MW	0.62
Project Cost per MW	0.73

3.7 Financing Assumptions

The Project financing will be based on a debt to equity ratio of 80:20. Under the base case financial projections, debt is assumed to be 100% locally financed using concessionary financing scheme of State Bank of Pakistan for renewables with debt servicing tenor of 10 years.

Key parameters of the Project funding are provided in Table below;

Description	Value
Project Cost	USD 36 Mn
Debt	USD 29 Mn
Equity	USD 7 Mn
Lending Rate (%)	6%
Debt Repayment years	10 years

3.8 EPC

EEL does not intend to award EPC contracts for either whole or part of the Project and shall implement the Project in self- EPC mode through direct supervision and management of multiple consultants, suppliers and contractors. Accordingly, the NEPRA (Selection of Engineering, Procurement and Construction Contractor by Independent Power Producers) guidelines, 2017 are not applicable to the instant petition.

ANNEXURE XIII

FEASIBILITY STUDY REPORT

engro energy

Kuchlak- III

50MW Solar Power Plant

Feasibility Study

by

SUMEC
苏美达能源

January,2019

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Disclaimers

This report is prepared for the benefit of Engro Energy and may not be relied upon or disclosed to any other person for any purpose, other than as stated below, without the Client's prior written consent in each specific case. The information contained in this report is intended to be used by the Client for such other purpose as may be necessary for the development and implementation of the Project.

Abbreviations

ADB	Asian Development Bank
AEDB	Alternative Energy Development Board
BEPA	Balochistan Environmental Protection Agency
BEPA	Balochistan Environmental Protection Act
BHw	Hot desert climate
CDM	Clean Development Mechanism
CSR	Corporate Social Responsibility
CPPA	Central Power Purchasing Agency
DA	District Administration
DC	Direct Current
DISCOs	Distribution Companies
ED	Energy Department
EE	Energy Efficiency
EIA	Environmental Impact Assessment
EEL	Engro Energy Limited
EM	Environmental Monitoring
ESMC	Environmental and Social Management Cell
EMP	Environmental Management Plan
EP	Equator Principle
GoP	Government of Pakistan
GoB	Government of Balochistan

IPPs	Independent Power Producers
IEE	Initial Environmental Examination
IFC	International Financial Corporation
KWh	Kilo watt hour
kWac	Kilo Watts Alternating Current
km	Kilometers
LOI	Letter of Intent
LoS	Letter of Support
MW	Megawatt
MWac	Mega Watts Alternating Current
M/S	Meter Per Sec
MJ	Mega Joules
MPPT	Maximum Power Point Tracking
NEPRA	National Electricity Power Regulatory Authority
NOCs	No Objection Certificates
NTDC	National Transmission and Dispatch Company
NEQS	National Environmental Quality Standards
MVA	Million Volt-Ampere
O & M	Operation & Management
PEPA	Pakistan Environmental Protection Act
QESCO	Quetta Electricity Supply Company
WAPDA	Water and Power Development Authority

1. Executive Summary

Pakistan is located on the western stretch of the South Asian Subcontinent with the Arabian Sea to the south, China to the north, India to the east, and Afghanistan and Iran to the west. It covers an area of 796,000km2 and has a coastal line of 980km. Almost three fifth of Pakistan's total area is mountains and hills, deserts spreading along the southern coastal areas, and plateau pastures and fertile agricultural land stretching the north. The Indus River, which originates from China, traverses 2300km from north to south into the Arabian Sea.

According to the report of NEPRA- National Electric Power Regulatory Authority "Pakistan is facing chronic electricity shortages due to demand growth, high system losses, seasonal reductions in the availability of hydropower and circular debt etc. Rotating power outages ("load shedding") are common and many villages are not yet electrified. The power sector of Pakistan is a mix of thermal, hydro, nuclear and renewable energy power plants. Originally the ratio of hydel to thermal installed generation capacity, in the country was about 67% to 33% (1985) but with the passage of time, due to different reasons more of thermal generation was added thereby reducing the share of hydel generation. At present, ratio of hydel to thermal installed generation capacity is about 30% to 65%. The dilemma for Pakistan is that its power production is dominated by thermal power plants running on oil and gas." (State of industry report 2017).

In above scenario solar power generation appears to be a viable and environmental friendly alternative for meeting Pakistan's urgent electricity demands. Solar energy source is widely distributed and abundantly available in the country. The total energy through solar has been recorded at 635 GWh for an increase of 410 GWh over the energy generated through solar during the FY 2015-16. (State of industry report 2017).

The mean global irradiation falling on horizontal surface is about 200-250 watt per

sq.m in a day. This amounts to about 2500-3000 sun shine hours and 1.9 - 2.3 MWh per sq.met in a year. It has an average daily global insolation of 19 to 20 MJ/sq.met per day with annual mean sunshine duration of 8 to 8.5 hours (6-7hrs in cold and 10-12 hrs in hot season). To summarize, the sun shines for 250-300 days per years in Pakistan with average sun shine hours of 8-10 per day. This gives huge amount of energy to be used for electricity generation by solar power plants.

Engro Energy Limited

Engro Energy was incorporated in 2008 as a (100%) wholly-owned subsidiary of Engro Corporation to develop power projects in Pakistan and abroad. Currently, Engro Corporation's portfolio consists of varied businesses, which include fertilizers, foods, chemical storage & handling, commodity trading, energy and petrochemicals. EEL has recently been awarded the development rights, in the form of an LoI from the provincial government of Balochistan, to develop a 50 MWp solar PV power plant in Kuchlak, on approximately 250 acres of land. The power from the plant will be evacuated into the national grid.

The project sponsors have a strong track record of developing large power plants, nearing 5 decades of successful business operations Engro have an enormous depth of skill and resources to successfully deliver large projects from conceptualization, commissioning, startup/training support to operations & maintenance programs. Engro can deliver complete project management, EPC Management, last mile funding, token equity, to projects where value addition can increase bottom line returns. Engro having inherited Exxon's DNA and best management practices in industrial operations the ability operate & maintain plants are above and beyond global benchmarks.

1.1 Project Size

Engro Energy Limited (EEL) previously Engro Powergen Limited (EPL), has recently been awarded the development rights, in the form of an LoI from the provincial government

of Balochistan, to develop a 50 MWp solar PV power plant in union council Kuchlak, district Quetta of Balochistan.

1.2 Overview and Site

Engro Energy Limited (EEL) previously Engro Powergen Limited (EPL), has recently been awarded the development rights, in the form of an LoI from the provincial government of Balochistan, to develop a 50 MWp solar PV power plant in union council Kuchlak, district Quetta of Balochistan on approximately 250 acres of land. The power from the plant will be evacuated into the national grid. The key features of the project location include 'Hot and Dry' climatic zone of the area comprises extreme weather conditions of the hot desert. There are no shading elements like high mountains, large sand dunes, trees available on the site. The entire area is shadow free. NHA (N 25) road is located on 100 to 150m from project area. Whereas construction of bypass near project area is underway connecting Quetta and Kuchlak. The Airport of Quetta (nearest to project area) is about 25 km from location. Kuchlak bazar is the nearest market at a distance of 06 km. Kuchlak station is the nearest railway station from the location. The available health facility in Yaro- BHU which is at a distance of 3km from the project site and the catchment areas comprise population of around 18,000 individuals.

For transportation of material, the sponsor company may consider direct road from Karachi to Quetta and then Kuchlak. Subsequently, the second route may be from Gwadar to Quetta and project site. It's worth mentioning that Quetta-Karachi National Highway is already in use for heavy transportation of material. This is metal road and have no security issue with total distance of 715 km. Whereas the route from Gwadar to Quetta is 915 km with time of 16-18 hours. Heavy material can also be transported through train from Karachi to Quetta with estimated time of 20-24 hours. Other two communication routes are Quetta DG khan and Quetta DI khan connecting Punjab and KPK respectively.

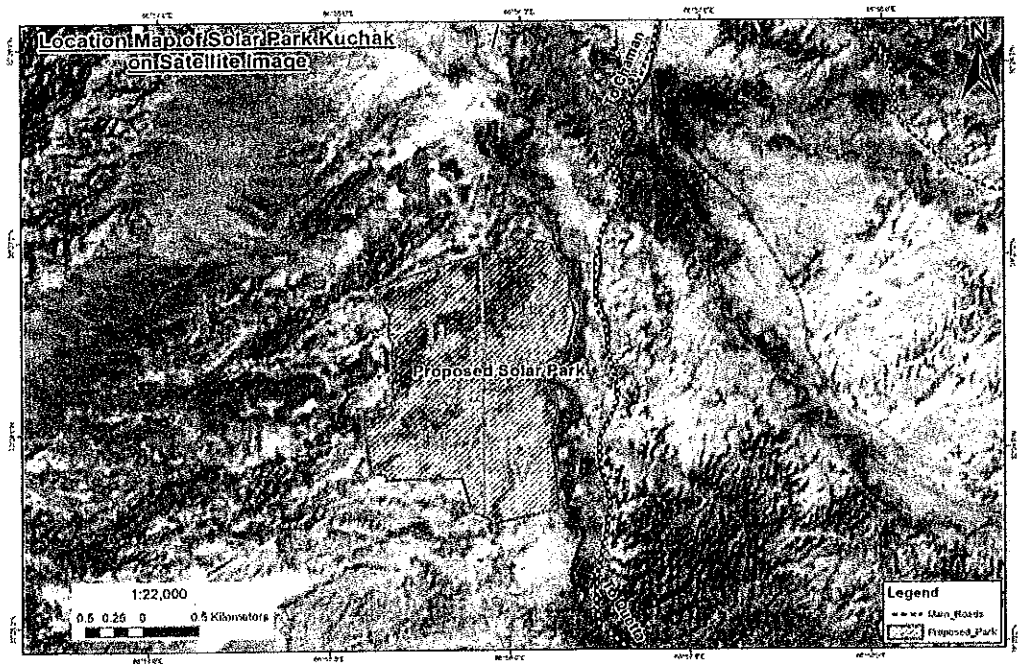


Figure 1: Satellite image of project area

1.3 Project Development and Construction Schedule

Planned Project Development Schedule

Milestone	2018				2019			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Letter of Intent (LoI) from BPDB								
Identification of Land								
Preparation of Feasibility Study (FS)								
Initial Environmental Examination								
Approval of FS from BPDB								
Generation License								
Tariff Determination								
Signing of EPA								
Signing of IA								
Letter of Support (LoS)								
Financial Close								

Planned Project Construction Schedule

Milestone	2019			2020					
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Engineering & Mobilization									
Temporary Construction									
Land leveling and civil works									
Supply & installation of solar panels									
Construction of substation									
E&M Works									
Testing and Commissioning									

1.4 Energy Yield Estimates

The energy yield estimates have been generated using PVSyst software including determination of energy yields and uncertainty assessments.

1.5 Topography

The assignment of topographic survey of land, measuring 1000 acres, located in Kuchlak, was awarded to M/s Cameos Consultants Quetta in September 2018. M/s Engro Energy Ltd. Intends to establish 4 x 50MW solar power plant here. The project site is geographically located at 30° 25'57.48" east and 66° 56'1.5" north, at a distance of 35 km to the north-west of Quetta city in Balochistan. Immediately after issuance of permission, the consultant mobilized its team on the site. Before starting the survey, the consultant held a meeting with the local administration and apprised them with the purpose of survey.

Information related to the environmental management works is given in Section 9 and detailed topographic survey of Engro's intended solar park of 200 MW is attached as Annexure- 5.

1.6 Geology

Quetta district lies between 30° - 03′ and 30° -27′ N and 66° - 44′ and 67° - 18′ E. The total geographical area of Quetta district is 2653 km^2. The general character of the district is mountainous. The hill ranges are fairly uniform in character consisting of long central ridges from which frequent spurs descend. These spurs are intersected by innumerable gorges and torrent beds. They vary in elevation from about 1,254 to 3,500 meters. The Mashlakh, the Chiltan, the Murdar and Zarghoon are the important mountain ranges in the district. Quetta lies in the active seismic region; therefore, earthquakes occur from time to time. The worst earthquake occurred in May 1935. There is no perennial river in the district. Whereas Quetta Lora (non-perennial channel) comes out near Sariab and traverses the western side of the Quetta valley. Lora carries rain and waste water near Baleli and continues northward through the Kuchlak valley. Water of Quetta Lora is used for irrigation in villages like Khazi Samungli and Nohsar.

The proposed location and surrounding areas are a part of the Sulaiman Fold-Thrust Belt in western Pakistan and northern Balochistan. The Sulaiman Fold-Thrust Belt is a curved range of mountains on the western margin of Indian Plate. The belt was uplifted due to the oblique convergence of northwestern margin of Indian Plate with Afghan Block (Asia). The uplifting and folding has given rise to tight folds and thrusts. The rocks surrounding the area are mostly of limestone composition and they are forming appreciable peaks in the area.

1.7 Environment

Information related to the environmental management works is given in Section 9.

A separate environment study has been carried out. The Initial Environment Examination (IEE) report is attached as Annexure- 4.

There are no significant hazards. The minor adjustments required during construction

phase have been addressed and mitigation plan provided. A data collection survey was also done that included geology, meteorology, hydrology, ambient air quality, water quality, soil characteristics, noise levels, shadow forecasting, flora and fauna, land use pattern, and socioeconomic conditions.

1.8 Weather Conditions

The climate in the Quetta district is "desert." There is virtually no rainfall during the year. This climate is considered to be BWh according to the Köppen-Geiger climate classification. The average annual temperature in Quetta is 24.5 °C. (Due to climate change and global warning phenomenon the temperature in summer from last three years ranges upto 38°C). The average annual rainfall is 249 mm. The driest month is November, with 3 mm of rain. In July, the precipitation reaches its peak, with an average of 63 mm. June is the warmest month of the year. The temperature in June averages 34.4 °C. At 12.1 °C on average, January is the coldest month of the year. There is a difference of 60 mm of precipitation between the driest and wettest months. The variation in annual temperature is around 22.3 °C.

1.9 CDM Aspect

The Project is a power generation project using a renewable resource with zero emissions. When put into operation, the project can provide power supply to the southern Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. It can deliver substantial environmental and social benefits. It is also consistent with the spirit of the Kyoto Protocol and qualified for the application of CDM projects.

The Project Company intends to develop a CDM project according to the provisions of the prevailing Policy.

2. Country and Energy Overview

2.1 General Overview of Pakistan

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

Pakistan has a tropical climate, it is hot and dry in the most of its areas, with relatively high average annual temperatures. The southern coastal areas have an average yearly temperature of 26°C. Most areas show temperatures higher than 40°C around noon during June and July. Some parts of Sindh and Balochistan have temperatures as high as 50°C. The yearly precipitation in Pakistan is less than 250mm, with one fourth of Pakistan having annual rainfall less than 120mm. Pakistan obtains ample rains originating monsoon from the Indian Ocean, which brings both precious rain and abundant energy resources.

2.2 Energy Regulatory Regime

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

- Ministry of Water and Power

- National Electricity Power Regulatory Authority (NEPRA)
- National Transmission and Dispatch Company (NTDC)
- Central Power Purchase Agency Guarantee Ltd. (CPPA-GL)
- Energy Department, Government of Balochistan
- Quetta Electricity Supply Company (QESCO)

2.2.1 Ministry of Water and Power

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

2.2.2 National Electric Power Regulatory Authority (NEPRA)

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

2.2.3 National Transmission and Dispatch Company (NTDC)

NTDC shall be the power purchaser. National Transmission & Dispatch Company (NTDC) Limited was incorporated on 3rd August 1998 and commenced commercial operation on 1st March 1999. It was organized to take over all the properties, rights

and assets obligations and liabilities of 220kV and 500kV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA). The NTDC operates and maintains nine 500kV Grid Stations, 4,160 km of 500 kV transmission line and 4,000km of 220kV transmission line in Pakistan.

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

2.2.4 Central Power Purchase Agency Guarantee Limited (CPPA-GL)

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

2.2.5 Energy Department, Govt. of Balochistan (ED, GOB)

The Energy Department, Govt. of Balochistan is responsible for harnessing the alternative/renewable energy resources, addressed the relevant issues/matters at provincial level, facilitates local and foreign investors and donors for promotion and implementation of alternative energy/renewable energy projects, plan and implement project through public funding, foreign grants, loans etc. and design alternative energy policy for province and review it from time to time.

2.2.6 Quetta Electricity Supply Company (QESCO)

QESCO is operating as a Power Distribution Company dealing with power supply system in the whole Balochistan less district Lasbela. QESCO was one of the 8 AEBs,

which were constituted through amendments in WAPDA Act during 1981. Government of Pakistan approved revamping of WAPDA power sector and as a result 12 distribution companies were formed. It is smallest in terms of consumers but largest as it covers 43 % area of Pakistan. The peak demand at the moment is approximately 1800 MW evaluating measures and anticipated to be 2000 MW by the year 2019 with 8 % uniform annual growth. QESCO system is under stress due to huge number of Agri: Consumers contributing about 70-80 % of power demand and Low voltage profile prevails due to long distances from generating sources.

2.3 Energy Overview

Pakistan' s energy requirements are met through Oil, Gas, Hydro Power and Nuclear Power. While Hydro and Nuclear are used only for electricity generation with reference to energy, Oil and Gas are used to supply other areas also. Although Pakistan has one of the largest coal reserves in the world, they remain under-utilized and their share in energy supply is insignificant at the moment.

The total nominal power generation capacity of Pakistan as on 30th June 2017 was 28,399 MW; of which 18,676 MW (65.76%) was thermal, 7,116 MW (25.06%) was hydroelectric, 1,142 MW (4.02%) was nuclear and 1,465 MW (5.16%) was renewable energy (wind, solar and bagasse). The following tables explain the total installed capacity of Pakistan from July 2013 to June 2017:

Installed Capacity by Type (MW)

As on 30th June		2013	2014	2015	2016	2017
HYDEL						
WAPDA Hydel		6,733	6,902	6,902	6,902	6,902
IPPs Hydel		214	214	214	214	214
Sub-Total		**6,947**	**7,116**	**7,116**	**7,116**	**7,116**
% Share (Hydel Installed Capacity)		29.28	30.02	28.51	27.99	25.06
THERMAL						
GENCOs with PEPCO		4,785	4,590	5,762	5,897	5,897
KEL Own		2,359	1,951	1,874	1,874	1,874
IPPs	Connected with PEPCO	8,342	8,700	8,696	8,643	10,566
	Connected with KEL	252	252	252	252	252
CPPs/SPPs connected with KEL		203	200	35	35	87
Sub-Total		**15,941**	**15,693**	**16,619**	**16,701**	**18,676**
% Share (Thermal Installed Capacity)		67.19	66.21	66.58	65.70	65.76
NUCLEAR						
CHASNUPP (I, II & III)		650	650	650	615	1005
KANUPP		137	137	137	137	137
Sub-Total		**787**	**787**	**787**	**752**	**1,142**
% Share (Nuclear Installed Capacity)		3.32	3.32	3.15	2.96	4.02
RENEWABLE ENERGY (WIND, SOLAR AND BAGASSE)						
RE Power Plants connected with PEPCO		50	106	439	852	1,465
Sub-Total		**50**	**106**	**439**	**852**	**1,465**
% Share (RE Installed Capacity)		0.21	0.45	1.76	3.35	5.16
Total Installed Capacity of the Country		**23725**	**23702**	**24,961**	**25,421**	**28,399**

Source: NTDC/KEL

Figure 2: Pakistan installed capacity (State of Industry Report 2017)

The generation sector of Pakistan has witnessed a major transformation over the last five years (2013-2018), by moving towards a reliable supply system through large base-load power plants using indigenous and imported coal and through highly efficient gas-based plants. A number of large hydropower plants have also achieved completion, whereas till date around 1,500 MW of solar and wind power plants, have also been inducted to encourage clean energy. Furnace Oil-based power generation plants which remained face of Pakistan power sector for over three

decades, have been planned to be phased out over next few years and it is expected that the share of furnace oil-based energy will decline from around 30% to a negligible level in the overall mix in the coming years.

2.4 Solar Resource Analysis

Solar energy has excellent potential in areas of Pakistan that receive high levels of solar radiation throughout the year. Every year, the country receives an average of about 19

Mega Joules per square meter of solar energy.

Being in the Sun Belt, Pakistan is ideally located to take advantage of solar energy technologies. This energy source is widely distributed and abundantly available in the country. The mean global irradiation falling on horizontal surface is about 200-250 watts per m^2 in a day. This amounts to about 2,500-3,000 of sunshine hours and 1.9-2.3 MWh per m^2 in a year. It has an average daily global insolation of 19 to 20 MJ/m^2 per day with an annual mean sunshine duration of 8 to 8.5 hours (6-7 hours in winters and 10-12 hours in summers), and these values are among the highest in the world. For daily global radiation, up to $23MJ/m^2$, 24 (80%) consecutive days are available in this area for solar energy.

To summarize, the sun shines for 250-300 days per year in Pakistan with average sunshine hours of 8-10 per day. This means that there is tremendous potential for electricity generation by solar power plants in Pakistan.

A quick idea for the potential of solar energy in Pakistan can be obtained from the satellite map of solar radiation released by Solar GIS and World Bank, shown as below.

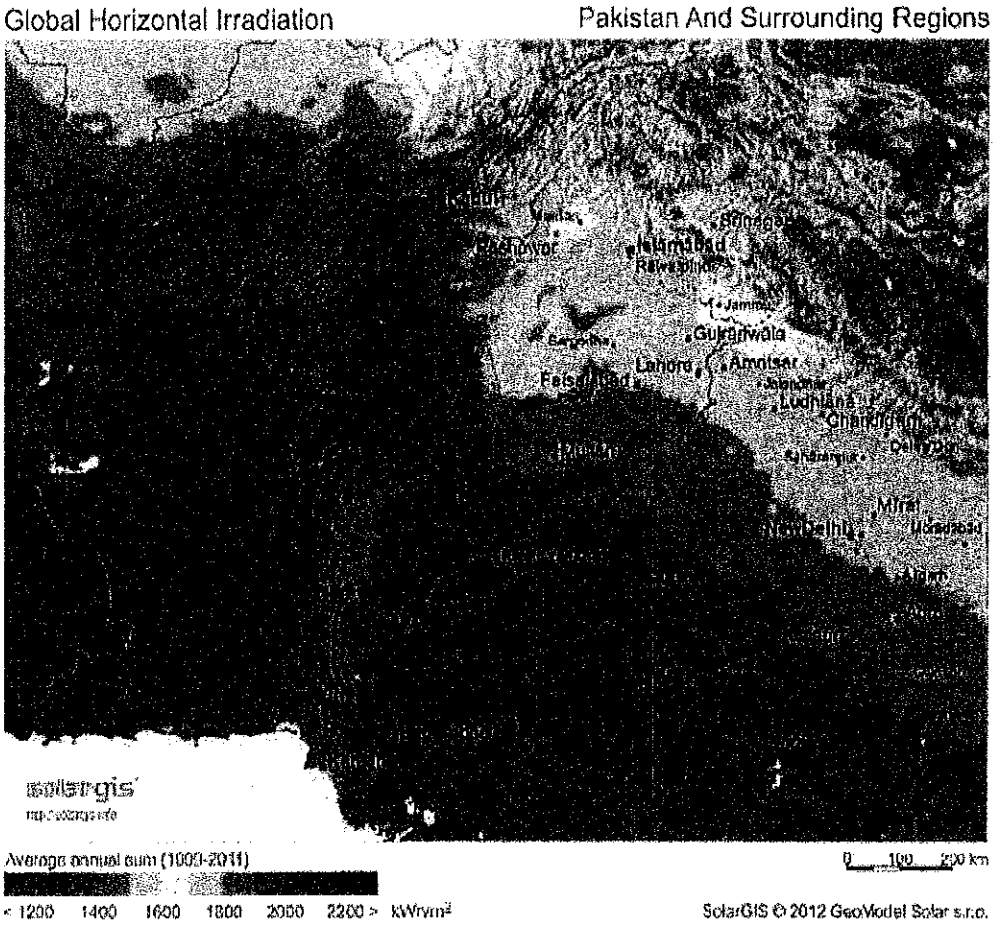


Figure 3: Solar irradiation map (Solargis)

2.5 Renewable Energy Policy

The Government of Pakistan (GoP) is taking measures to ensure energy security and sustainable development in the country. The Government, in its bid to diversify its energy mix, has been giving due attention towards the fast track development of Alternative/Renewable Energy (ARE) resources in the country.

Several supportive measures to promote ARE technologies and to attract private sector investments are being pursued, which include:

- Announcement of upfront tariffs for wind, solar, biomass projects. Upfront Tariff for small/mini hydel projects in process.

- Announcement of Framework for Power Co-generation (Biomass/Bagasse) 2013 for generation of power from sugar mills for supply to national grid.
- Detailed resource assessment of wind, solar and biomass in the country is being carried out through ESMAP (World Bank) assistance.
- Standardized project agreements (EPA/IA) for investors have been developed.
- Grid code has been amended for solar power projects.
- Ensuring availability of grid structure.
- Encouraging local manufacturing.
- Use of solar energy for power generation and water heating in domestic, commercial and industrial sectors is being promoted.

In solar energy, 4 projects have been completed with the total capacity of 400 MW and several are at various stages of development.

2.6 Tariff Regime in Pakistan

The initial regime was of a negotiated tariff, which is still applicable. The Project Company justifies all expenses and financial position to NEPRA through a petition. The NEPRA in return determines the project tariff on a "cost plus" basis. The Project Company is allowed an IRR on the equity.

3. Project in terms of BPDB Power Policy, 2007

3.1 LETTER OF INTENT (LOI)

First step as per the BPDB Power Policy of 2007 was to obtain **Letter of Intent (LoI)** from **BPDB, Energy Department, GoB**, which was accomplished on **23rd February 2018**. This letter entitled the Project Company to start working on solar power project at official level and get support from the Energy Department, GoB and other government departments in the preparation of feasibility study and acquisition of land for the project. The feasibility is being submitted before expiration of LOI and in accordance with the permissible timeline of 12 months.

3.2 ACQUISITION OF LAND

A piece of government land has been identified by the project company which is in the ownership of Energy Department, GoB.

3.3 FEASIBILITY STUDY

The feasibility study of the Project is being finalized in this document.

3.4 Initial Environmental Examination (IEE)

As per the conditions of the LoI the project company shall carry out an IEE and obtain NoC from Balochistan Environmental Protection Agency (BEPA) for the development of the project.

3.5 GENERATION LICENSE

Rights to produce and sell electricity in Pakistan are granted by NEPRA through

"Generation License". Project Company will file an application to NEPRA for Generation License which authorizes a company to produce and sell electricity in the country.

3.6 TARIFF DETERMINATION

A separate application shall be prepared for NEPRA to seek approval of cost plus tariff.

3.7 LETTER OF SUPPORT (LOS)

Once the tariff is approved, the project company is required to move for arrangement of financing. Energy Department, GoB will issue tripartite Letter of Support (LoS) for the project company giving government guarantees until EPA and IA are fully effective to ensure sponsors and lender of the full government support. A bank guarantee of US$ 5000 / MW shall be required to be submitted by the project company before issuance of LOS.

3.8 ENERGY PURCHASE AGREEMENT (EPA)

Agreement between the Power Purchaser and the project company is called Energy Purchase Agreement (EPA). This agreement lists terms and conditions for the sale and purchase of electricity between the two companies. As soon as the feasibility study is submitted, and a tariff is filed, the project company shall enter into the discussions of EPA. This is going to be a significant step in the project development.

3.9 IMPLEMENTATION AGREEMENT (IA)

The Implementation Agreement (IA) provides security to the sponsors and lenders against the performance of the power purchases through guarantees from Government of Pakistan. Its discussions shall start alongside the EPA.

3.10 FINANCIAL CLOSE

Upon approval of feasibility study, grant of generation license, determination of tariff and the signing of project documents (EPA and IA); the Project Company shall move forward to complete the financial close. However, the discussions with lenders have already been initiated.

4. Solar PV Project Description

4.1 General

Engro Energy was incorporated in 2008 as a (100%) wholly-owned subsidiary of Engro Corporation to develop power projects in Pakistan and abroad. Currently, Engro Corporation's portfolio consists of varied businesses, which include fertilizers, foods, chemical storage & handling, commodity trading, energy and petrochemicals.

EEL has recently been awarded the development rights, in the form of an **Letter of Intent (LoI)** from **Balochistan Power Development Board (BPDB)** of the Energy Department of Balochistan, to develop a 50 MWp solar PV power plant in Kuchlak, on 250 acres of land. The power from the plant will be evacuated into the national grid.

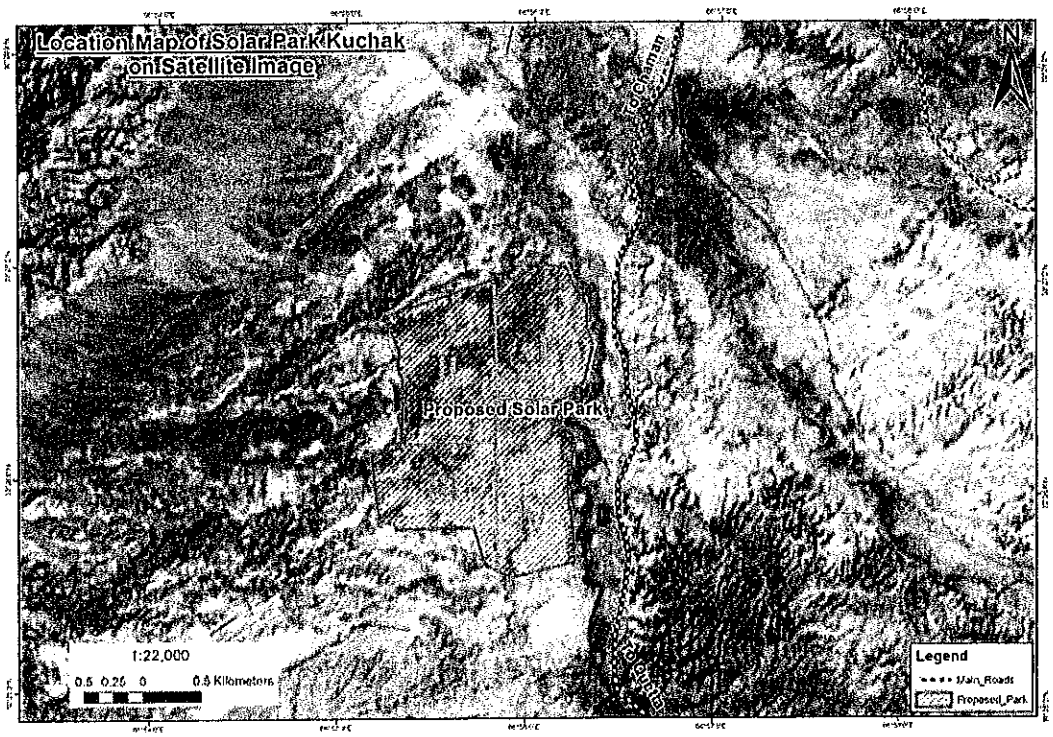


Figure 4: Google earth image of plant location.

4.2 Baseline Conditions at Site

4.2.1 Site Description

The project site is located at a distance of 35 km in north of Quetta at Kuchlak on main Quetta Chaman highway at Balochistan, Pakistan.

4.2.2 Geology

Quetta district lies between 30° - 03' and 30° -27' N and 66° - 44' and 67° - 18' E. The total geographical area of Quetta district is 2653 km^2. The general character of the district is mountainous. The hill ranges are fairly uniform in character consisting of long central ridges from which frequent spurs descend. These spurs are intersected by innumerable gorges and torrent beds. They vary in elevation from about 1,254 to 3,500 meters. The Mashlakh, the Chiltan, the Murdar and Zarghoon are the important mountain ranges in the district. Quetta lies in the active seismic region; therefore, earthquakes occur from time to time. The worst earthquake occurred in May 1935. There is no perennial river in the district. Whereas Quetta Lora (non-perennial channel) comes out near Sariab and traverses the western side of the Quetta valley. Lora carries rain and waste water near Baleli and continues northward through the Kuchlak valley. Water of Quetta Lora is used for irrigation in villages like Khazi Samungli and Nohsar.

4.2.3 Site Condition

Project site is located 6km in the north direction of Kucklack Bazar. Dry weather with severe cold in winter and hot in summer. The project site is flat barren land and topographically the general character of the surrounding area is mountainous and consists of long central ridges with numerous spurs.

4.2.4 Grid connection

Two main grids are available near the project area. In this regard the first one is Yaro

Grid which is at a distance of 3km in the north towards Pishin. The other connectivity option is Sheikhmanda Grid Station, which is at a distance of 15-17 km from Kuchlak in south east toward Quetta. Connectivity options from both the grid will be decided after technical review.

4.3 Weather Condition

The climate in the Quetta district is "desert." There is virtually no rainfall during the year. This climate is considered to be BWh (B classification refer to hot desert climate) according to the Köppen-Geiger climate classification. The average annual temperature in Quetta is 24.5 °C. (Due to climate change and global warning phenomenon the temperature in summer from last three years ranges upto 38°C). The average annual rainfall is 249 mm. The driest month is November, with 3 mm of rain. In July, the precipitation reaches its peak, with an average of 63 mm. June is the warmest month of the year. The temperature in June averages 34.4 °C. At 12.1 °C on average, January is the coldest month of the year. There is a difference of 60 mm of precipitation between the driest and wettest months. The variation in annual temperature is around 22.3 °C.

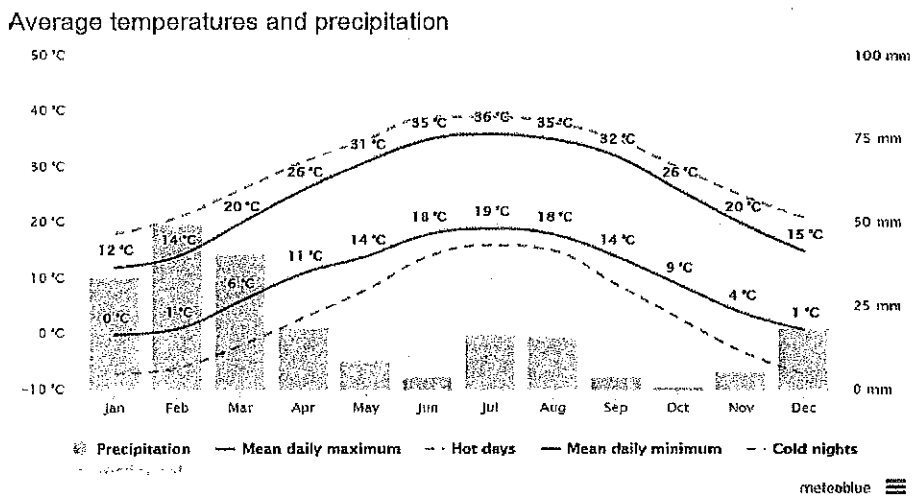


Figure 5: Average temperature and precipitation.

The wind rose diagram for seasonal has been drawn on the basis of hourly wind speed and direction data. South West and east west wind is dominant throughout the season.

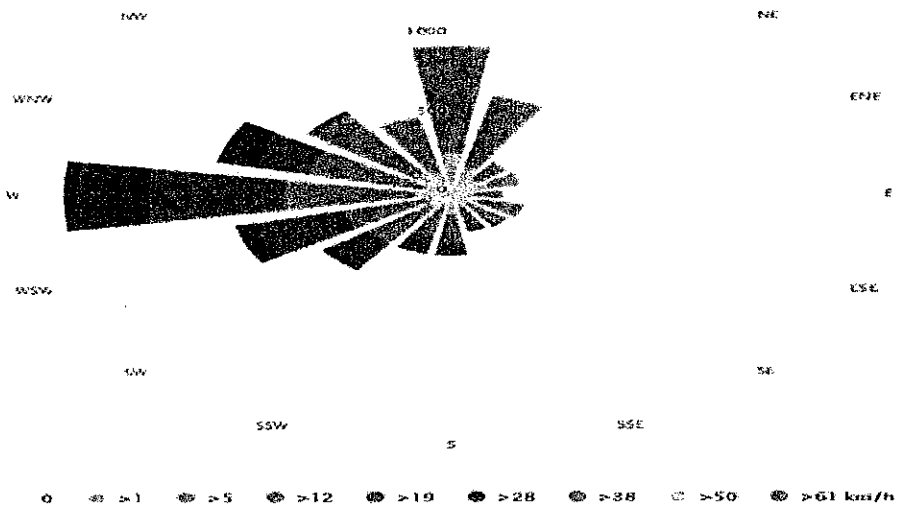


Figure 6: Wind pattern in Quetta.

4.4 Transportation and Site Access

For transportation of material, the sponsor company may consider direct road from Karachi to Quetta and then Kuchlak. Subsequently, the second route may be from Gwadar to Quetta and project site. It's worth mentioning that Quetta-Karachi National Highway is already in use for heavy transportation of material. This is metal road and have no security issue with total distance of 715 km. Whereas the route from Gwadar to Quetta is 915 km with time of 16-18 hours. Heavy material can also be transported through train from Karachi to Quetta with estimated time of 20-24 hours. Other two communication routes are Quetta DG khan and Quetta DI khan connecting Punjab and KPK respectively.

4.5 Telecommunication

PTCL telephone service is not available now but a connection can be made in the future beside that mobile carriers have coverage on the site area.

5. Topography

The assignment of topographic survey of land, measuring 1000 acres, located in Kuchlak, was awarded to M/s Cameos Consultants Quetta in September 2018. M/s Engro Energy Ltd. Intends to establish 4 x 50MW solar power plant here. The project site is geographically located at 30° 25'57.48" east and 66° 56'1.5" north, at a distance of 35 km to the north-west of Quetta city in Balochistan. Immediately after issuance of permission, the consultant has mobilized its team on the site. Before starting the survey, the consultant held a meeting with the local administration and apprised them with the purpose of survey.

A Topographical Survey, sometimes referred to as a Land Survey, is the process required to produce an accurate and detailed map identifying both the natural and man-made feature within an area. The collected data may be presented in many formats, from a simple paper plan to a full three-dimensional (3D) digital model, depending on the requirements. Today the most common presentation is as a digital data set which is also plotted out as drawings. After reviewing project requirements vis-à-vis topographic survey, following field teams were mobilized with their equipment:

- Monument Fixing Team
- GPS Survey Team
- Traverse Survey Team
- Control Leveling Team
- Topographic & X-Sec Survey Teams

Detailed topographic survey of Engro's intended solar park of 200 MW is attached as Annexure- 5.

6. Technical Design of PV Plant

6.1 Solar PV Power Generation

Solar PV plants can be designed for any capacity right from a fraction of kW rating for roof top installation to hundreds of MW capacity for ground mounted plants by repeating modular blocks.

Solar Photovoltaics (PV) are the most widely deployed solar electric technology in the world today. Fueled by light, solar cells operate at near ambient temperature and in contrast to thermal generators or wind turbines do not lose efficiency with reduced scale.

A solar PV array consists of one or more electrically connected PV modules — each containing many individual solar cells — integrated with balance-of-system (BOS) hardware components, such as combiner boxes, inverters, transformers, racking, wiring, disconnects, and enclosures.

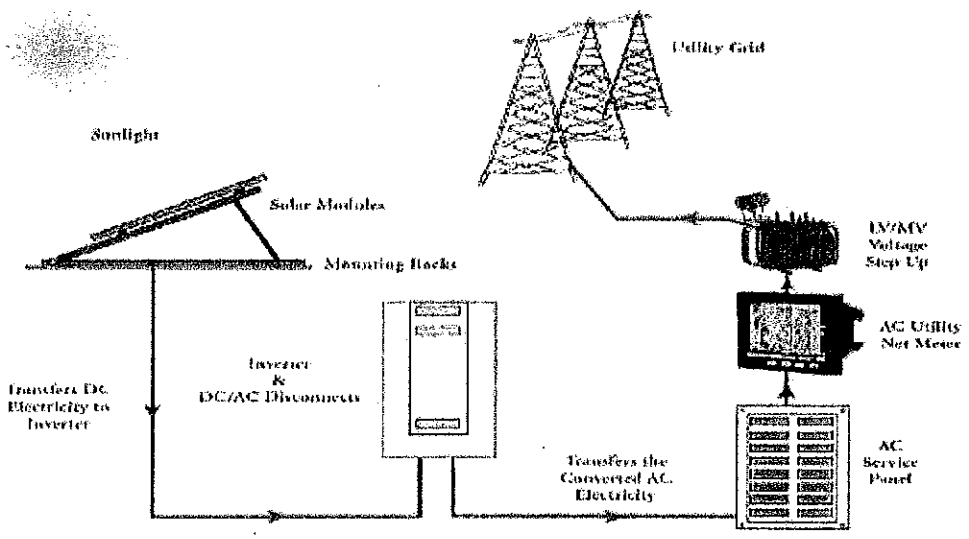


Figure 7: How solar PV works.

In a grid-connected system, combiners, inverters, and transformers convert the low-voltage direct current (dc) output of many individual PV modules into high-voltage alternating current (ac) power that is fed into the grid.

Major components of a utility scale solar pv power plant can be identified as below;

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

6.1.1 Design and Specifications of the Proposed Plant

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

The design considers 29pcs of 335Wp modules connected in series as one string to the and 24 strings are connected in parallel to one DC combiner box. 12 sets of DC combiner boxes are connected in parallel to a double split central inverter with LV/MV transformer, which has the 2500kVA capacity. As a result, one PV generation unit consists of one set of 2500kVA box transformer plus central inverter, 12 sets DC combiner box and 8352 pcs PV modules.

6.2 Selection of Solar PV Technology

The prevailing PV modules technology currently used in the market are mainly based on mono crystalline silicon cells and poly crystalline silicon cells, the visual difference of the two-type module can be clearly distinguished in the below image.

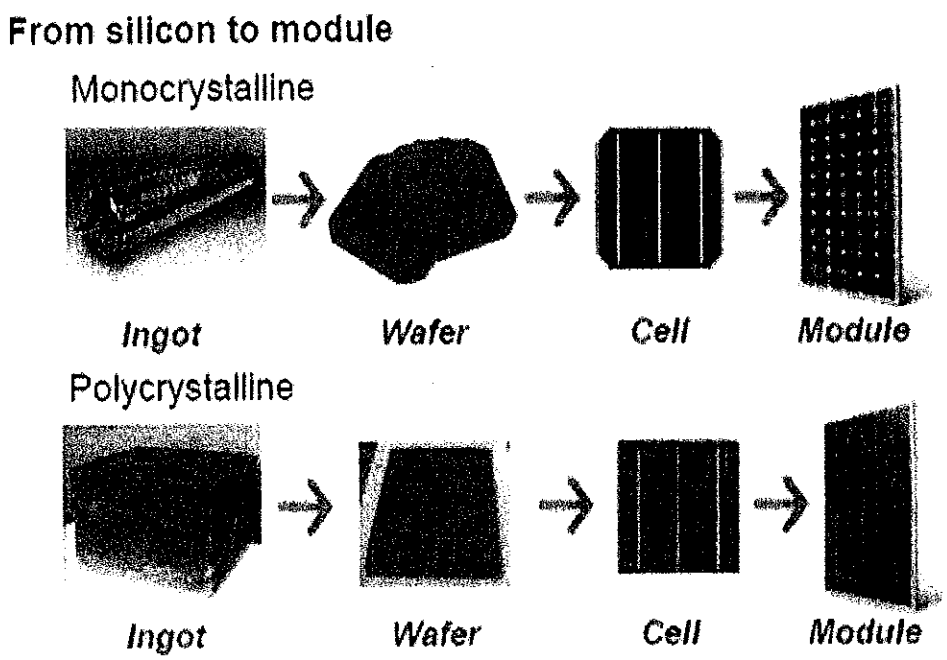


Figure 8: Solar panel Poly vs Mono

Due to the conventional polycrystalline fabrication process is simpler than poly crystals, and the manufacturing cost is slightly lower than mono crystalline components, the

market share of polycrystalline module is around 70%. Take the 72 cells mounted module as example, the maximum capacity can reach to 330W to 340W.

6.2.1 Introduction of Perc Module

Passivated Emitter Rear Contact (PERC) Technology increases conversion efficiency by adding a dielectric passivation layer (ALO) and Si-Nitride coating at the rear side of the cell, in the below theory:

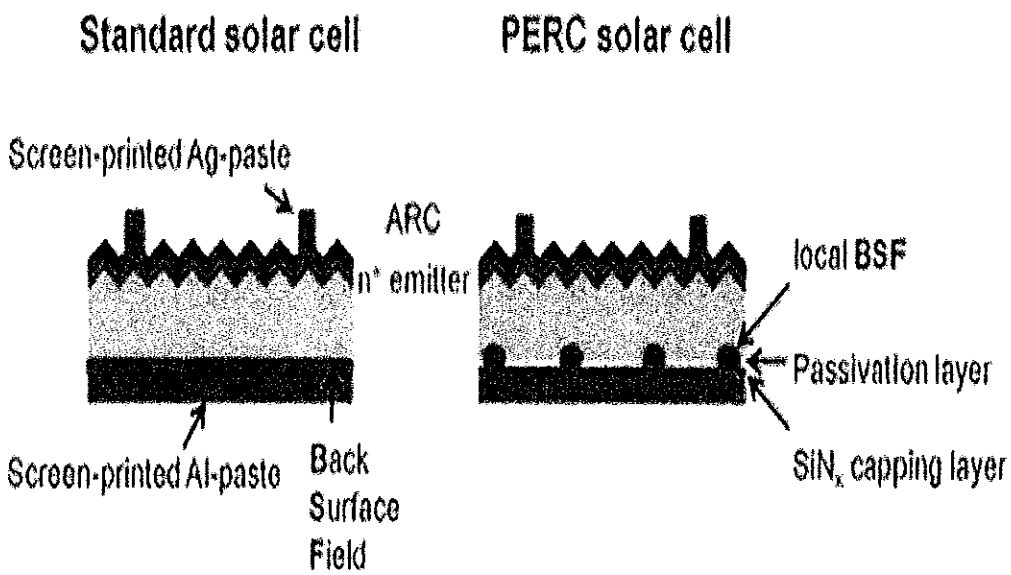


Figure 9: PERC cell microgram.

The major benefit of Perc Module is reducing rear recombination of photo-generated electron and increasing long wavelength response, increasing rear side inner reflection so that more light is absorbed. Compared to the conventional poly crystalline module, the power gain can be up to 15-20W for one 72-cell module.

6.2.2 Introduction of Bi-facial Module

In contrast to a standard PERC cell, the bifacial solar cell features openings in the screen-printed rear contact to allow light to reach the active region of the cell from the back. The full-area aluminum screen printing of the PERC cell has been replaced

with an optimized grid, similar to the front of the cell.

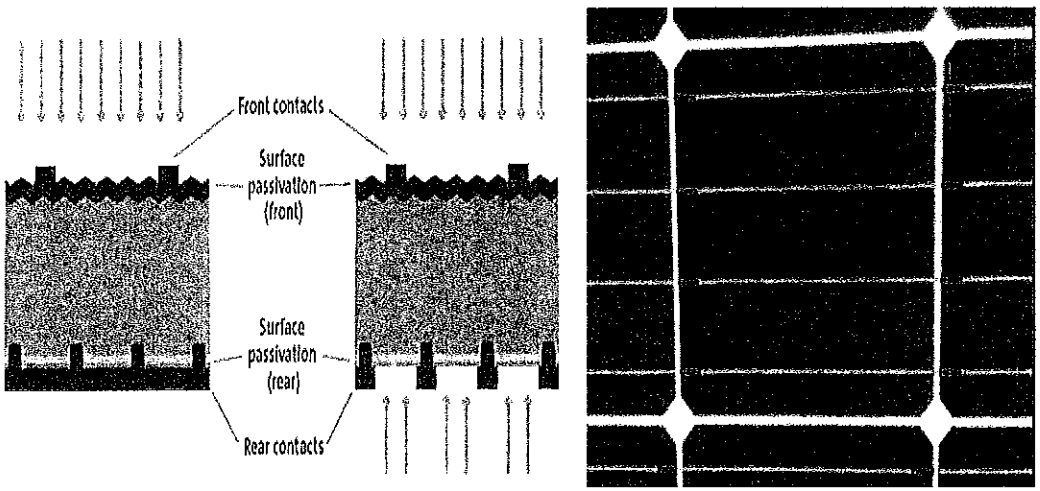


Figure 10: Bi-facial cell microgram.

Bi-facial modules provides the additional power gain through incident light on front side and diffused & reflected light on back side of cell. The reflective sunlight reflected by the ground irradiates on cell backside and activates the movement of Electron and Hole, accordingly, the electric field forms and produces more power.

For the rated power of bi-facial module, the installation field shall be considered due to different background has different diffused & reflected light irradiation. So, the market leading manufacture can only mark the front capacity of the module, the rear side capacity cannot be guaranteed because the site condition is various everywhere.

6.3 Conclusion

It is proposed to consider 335Wp polycrystalline modules, from Tier-1 PV module manufacturers (Phono Solar or equivalent). Polycrystalline modules are preferred due to their lower prices and the fact that the increase in efficiency of PERC and Bi- Facials does not off-set their higher prices. The modules shall be protected by high transmission tempered glass covered with anodized aluminum alloy frames. Serially connected cells shall be terminated to IP65 junction boxes at bottom with 4 Sq.mm

multi-strand copper cables. Positive & Negative terminals shall be terminated with MC4 connectors and Y- connectors, for making module interconnections.

Design Parameters of the module:

Description	Data
Maximum Power (Pmax)	335 watts
Module Efficiency	17.26 %
Maximum Power Current (Imp)	8.72 A
Maximum Power Voltage (Vmp)	38.4 V
Short Circuit Current (Isc)	9.04 A
Open Circuit Voltage (Voc)	47.2 V
Temperature Coefficient of Voc	-0.33 % K
Temperature Coefficient of Isc	+0.06 % K
Temperature Coefficient of Pmax	-0.43 % K
Nominal Operating Cell Temperature (NocT)	45° C ± 2° C

6.4 Selection of Inverters

In the recent years, new design methods have been employed in utility scale solar photovoltaic (PV) systems to allow developers to continue decreasing installation cost and operating cost. The selection of string inverters versus central inverters has a measurable impact on the capital cost, operating cost and potentially the energy yield of nowadays PV systems. As the PV industry continues to search for opportunities to reduce the costs associated with capital and operating expenses the choice between the two designs will become more important. In the end, inverter component, balance of system, commissioning, operating and maintenance, and replacement/refurbishments costs all must be evaluated when choosing the system design for a specific project.

In both string and central solution architectures, PV modules are arranged in strings where the modules are connected in series with each other. The number of modules in a string can vary and will depend on the specific module voltage. In order to connect to the grid, the output from the inverters passes through a MV transformer to match

the voltage of the grid at the point of interconnection. The table below compares a number of attributes from both inverter types.

Table 1: Comparison of String vs Central inverters.

Attribute	String Inverter	Central Inverter
Capacity	Up to 100 kWac	Up to 4 MWac
Installation	Rack mountable	Concrete pad or steel skid
Cooling	Natural Convection by air	Air or liquid cooled
Cable losses	Shorter DC cable	Shorter AC cable
Maximum Power Point Tracker (MPPT)	Multiple, 6 MPPTs for a 90kW inverter	Only 1-6 MPPTs for a 4MWac inverter

String inverters have multiple inputs where the module strings can connect directly to the inverter without using DC combiner boxes. Typically, string inverters will be clustered in groups at the end or back of one of the module arrays. AC combiner boxes are utilized to collect the various string inverter outputs and feed into a MV transformer.

In architectures utilizing central inverters, module strings are combined in parallel using DC combiner boxes before connection to the inverter. In larger designs, the central inverter will be integrated into a skid that may include a medium voltage transformer, meteorological station, data acquisition panel, and auxiliary power.

6.4.1 Performance Comparison between String and Central Inverter

In both string and central inverter plant designs, the output power of the various inverters can be adjusted dynamically to maintain optimal performance of the attached arrays while meeting any power exporting requirements at the plant point of interconnection. For the past decade, the string inverter has shown better efficiency than the central inverter. But with the development of technology for central inverters, the mainstream central inverter can also achieve the 99% high efficiency.

6.4.2 CAPEX Comparison between String and Central Inverter

The balance of plant (BOP) costs also has to be considered for each approach. BOP costs may include the integration of components into a skid, combiner boxes, various connectors and cabling for routing DC and AC power, as well as the installation labor for those components. The below equipment list indicated the required BOP investment for central inverter and string inverter.

CAPEX-System Architecture

Central Solution brings lower CAPEX by saving the costs of inverters, cables, and transformer station.

e.g. 1500V system, Utility Scale

	Difference	Central	String
	Block Size	2.5MW	2.5MW
1	Inverter	2 units, 1.25MW	25 units, 100kW
2	Combiner	12 units 24 strings DCCB	13 units 2in-1out
3	Cables	2 cables 1500V	3 cables 1.8/3kV
4	Transformer (XFMR)	No LV switchboard needed	With LV Switchboard

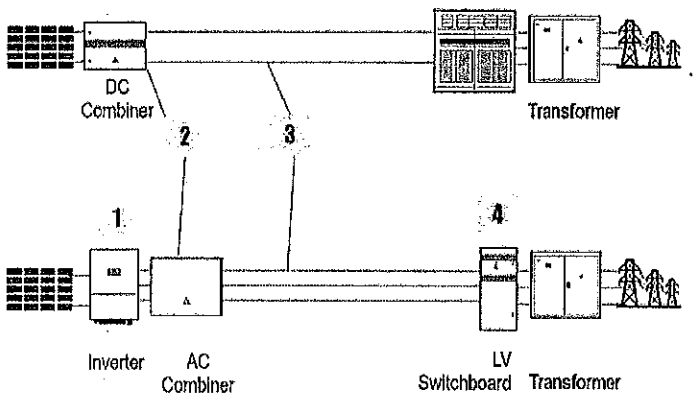


Figure 11: BoP comparison between Central and String Inverters.

6.4.3 Conclusion

There are many aspects to consider when choosing between a central or string inverter approach to a given project. The central inverter has a lower cost compared with the string inverter, and the DC cable loss will be lower than the AC cable loss which is more used in the string inverter system, furthermore, central inverter has a central location for the installation, commissioning and maintenance, it will be convenient for the site operation and maintenance.

Solar inverters represent critical equipment in the solar PV plant, as the reliability and performance of the inverters greatly influences the overall plant generation. It is

proposed to use **central inverters** of **eighteen (18) numbers,** with nominal rated AC capacity of **2500 kW each.** Negative earthing in inverters shall be planned to counter PID effect for the modules. Inverter are expected to be from Sungrow or equivalent and shall meet the performance requirements stipulated in the national Grid Code for Solar Power Plants.

Parameters (typical) of the proposed inverter:

Model	**2500kW**
Input (DC)	
DC voltage MPPT range (Umpp)	800 to 1500 V
Maximum DC voltage (Umax (DC)	1500 V
Maximum PV input current	3508 A
Number of DC inputs	20~24
Output (AC)	
Nominal power (Pn(AC))	2500 kW
Maximum output power at PF=1	2750 kW
THD	< 3%
Efficiency	
Maximum	99%
Euro-eta	98.7%

6.5 Selection of PV Mounting Structure

There are simple fixed supports and complex tracking systems for PV system array bracket. The tracking system can move accurately so that the incident angle of the incident rays on the surface of the solar array will be minimized and the radiation intensity of the sun will be the largest.

In the design of Photovoltaic power generation system, the installation form of PV modules has a great influence on the total solar radiation received by the system, which affects the power generation capacity of the photovoltaic power supply system. The installation of PV modules consists of two types: fixed installation and automatic tracking. The automatic tracking system includes single axis tracking system and two axis tracking system. The system of single axis tracking (East and West angle tracking

and polar axis tracking) tracks the trajectory of the sun from east to west with a fixed angle. The dual axis tracking system can change azimuth and inclination with the change of the seasonal position of the solar trajectory.

6.5.1 Fixed Bracket

Considering the installation and safety, the most mature technology of the installation of photovoltaic modules is fixed installation. And the fixed installation has relatively the lowest cost and is the most widely used method of mounting solar modules. Below image shows a fixed bracket installation.

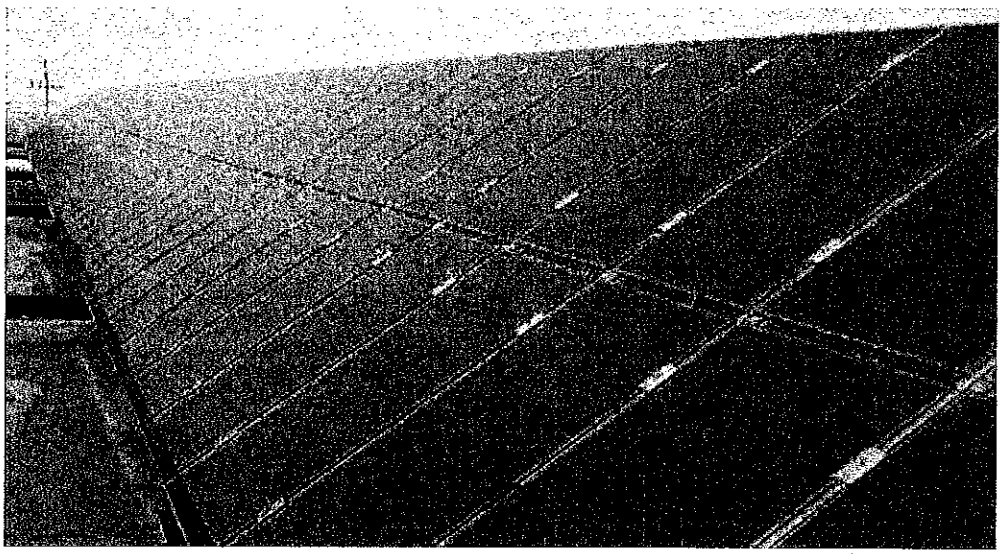


Figure 12: Fixed bracket installation.

6.5.2 Single Axis Tracker

The single axis tracker is used to carry the traditional PV modules, and the average daily power generation can be increased by **20~35%**. If the angle of the single axis and the ground is 0 degrees, it is a horizontal single axis tracker. If the axis of the single axis has a certain angle with the ground and the azimuth angle of the photovoltaic module is not 0, it is called the uniaxial tracking of the polar axis. According to the overall project practice, the horizontal single axis tracker can increase the generating capacity

by about **15-20%**, And the single shaft tracking with polar axis can increase the generating capacity by about **25-30%.** However, compared with the horizontal single axis tracker, the cost of the single axis tracker of the polar axis is higher and the wind resistance is relatively poor.

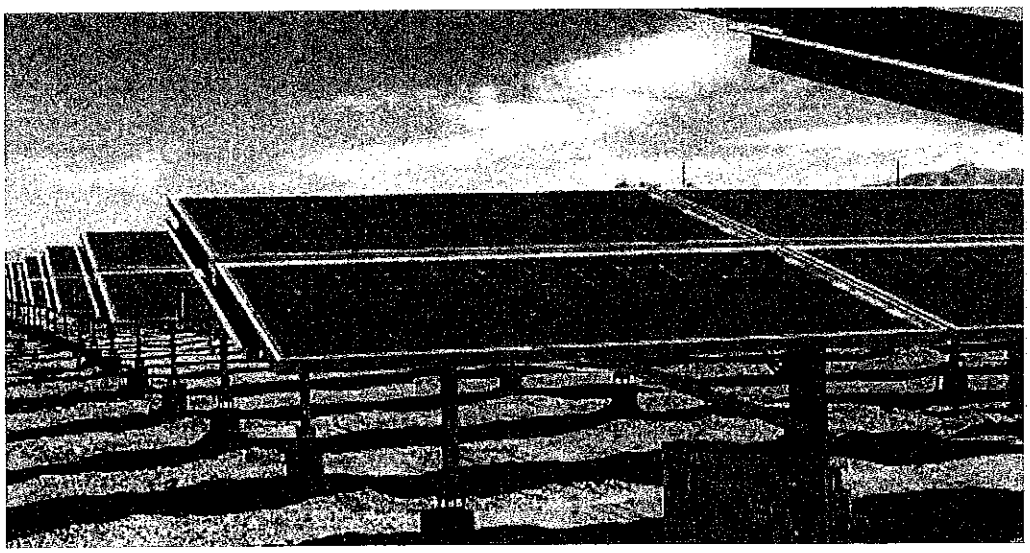


Figure 13: Horizontal single axis tracker.

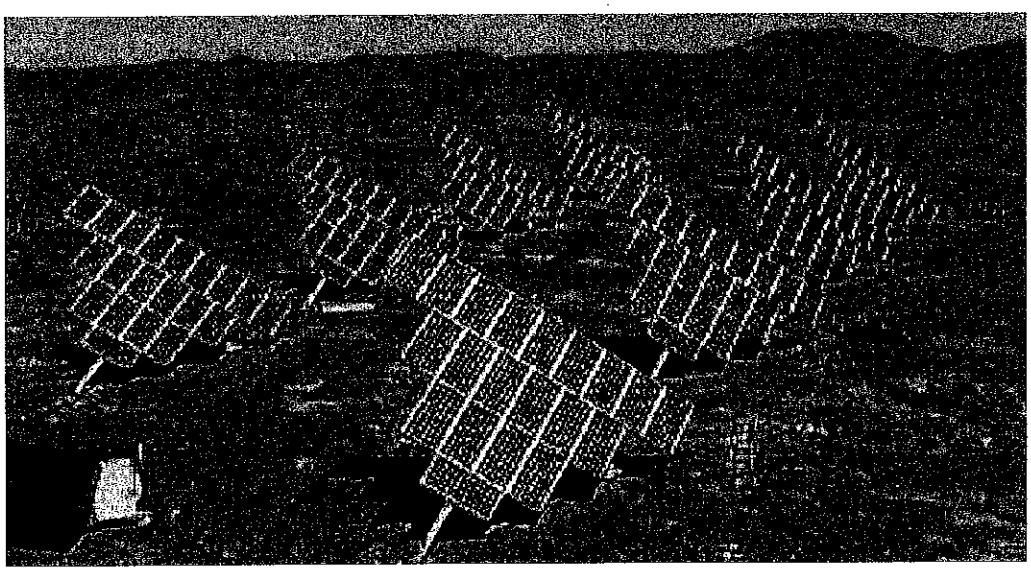


Figure 14: Polar axis tracker.

6.5.3 Two-axis Tracker

Two axis tracking is a tracking method that can be moved in two directions of azimuth and inclination. The dual axis tracking system can maximize the utilization of solar cells to sunlight. In different places and different weather conditions, the degree of improvement of the solar power generation is also different: In a very cloudy and foggy place, Two-axis Tracker can increase the solar power generation by **30~35%.**

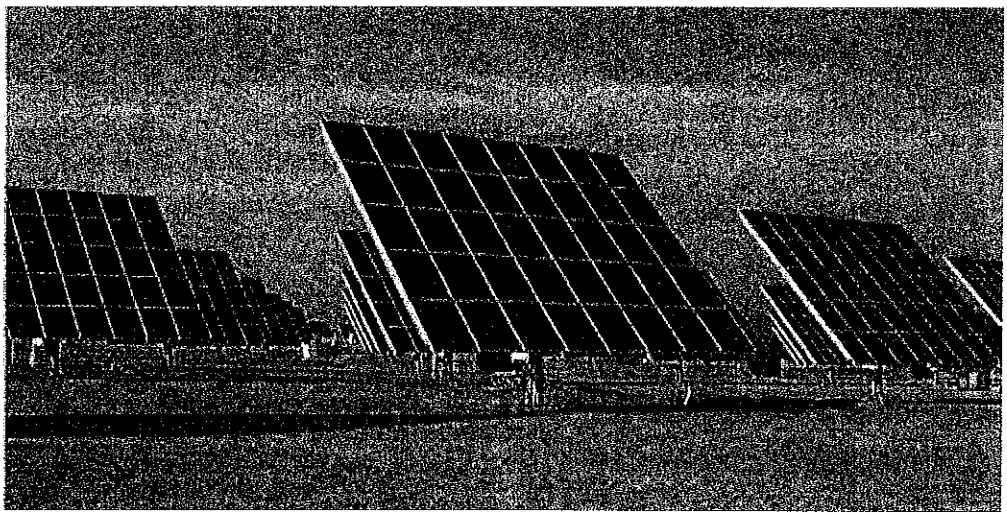


Figure 15: Two axis tracker

The total amount of solar radiation that can be received from the inclined plane to the maximum extent for tracking systems, thus increasing the power generation.

For tracking system, the amount of total solar radiation that can be received from the inclined plane to the maximum extent increases the power generation. Theoretically the power generation of the system can be increased by **15-20%** through horizontal single-axis tracking, Theoretical power generation of the system can be increased by **25-30%** if the polar axis tracking method is adopted, the theoretical power generation of the system can be increased by **30%-35%** if the two-axis tracking method is adopted. The actual working efficiency of the system is usually less than the theoretical value. The reason of this phenomenon is solar panels project shadows on each other, and tracking mounts are difficult to synchronize. According to the survey data of the built

project, If the inclined single-axis tracking method is adopted, the actual power generation of the system can be increased by about **18%**. If the two-axis tracking method is adopted, the actual power generation of the system can be increased by about **25%**.

6.5.4 Conclusion

Considering the reliability, economy and maintenance of the system, combined with the geological and topographic features and in order to improve the efficiency of the system the **horizontal single axis tracking** support scheme is adopted for the feasibility of this project. The photovoltaic module mounting structure will be selected of a reasonably reliable material, the structure scheme and construction measure will ensure that transportation, installation and using of mounting structure meet the requirement of strength, stability and rigidity. Further, it shall satisfy the requirements of the seismic, wind resistance and anti-corrosion. Each PV string is composed of 29 solar modules in series. 2x29 of tracking bracket have 2 PV string and a total number of 58 PV modules.

6.6 String Combiner Boxes & DC Cabling

The modules will be connected with DC cables, in series & parallel combinations and hooked-up to the central inverters through DC combiner boxes. In total 5184 strings (29 modules in series per string) shall be connected in 18 inverters. The String Combiner Boxes (SCBs) shall connect 24 strings with current monitoring arrangement. All solar field cables up to SCBs shall be of single core electron beam / UV resistant cables with multi-strand copper conductors. SCB to inverters shall be with single core armored multi- strand Aluminum cables with XLPE insulation.

Typical specifications of DC connectors are;

High current rating	30 A
Minimal contact resistance	0.35 mΩ

Convenient handling	Crimping by special tool, snap in locking system
Broad compatibility	Use of MC4 connector

6.7 MV Transformer and switchgear

It is proposed to provide 22 kV main switchboard at plant main control building and more in inverter room. Proposed hook-up arrangement is shown in the attached single line diagram in Appendix- 2. Power evacuation to QESCO grid through the plant shall be planned by providing another step-up level of voltage at 132kV level. The power evacuation will be through 2 nos. of 55 MVA power transformers with outdoor substation with double main bus arrangement. The specifications of the 22kV switch yard shall be as below;

Rated Voltage	22 kV, 3 phases, 50 Hz
Maximum Voltage	22 kV
Power Frequency Voltage	24 kV rms
Impulse withstand Voltage	125 kV
Related Short Circuit Current	31.5 kA
Related Duration of Short Circuit Current	3s

6.8 HV Transformer and switchgear

The HV Substation shall consist of following:

- **MV switchgear**

1. 22 kV incoming switchgear
2. 22 kV Bus bar PT switchgear
3. 22 kV SVG switchgear
4. 22 kV Arc-suppression coil and earthing transformer switchgear
5. 22 kV station transformer switchgear
6. 22 kV outgoing switchgear

- **MV/HV transformer**

The 22 kV/ 132 kV main transformer will be designed with a rated capacity of 55 MVA

for this solar power plant, 2 units as per NTDC grid requirement.

- **HV portion of HV substation**

One 132 kV overhead line bay AIS solution will be designed for HV port. SCADA, PLC, protection scheme, control and monitoring scheme and other designing factors will meet the NTDC grid code requirements.

Typical MV/ HV transformer specifications are as below;

Item	Description	Data
1	Rating power	55,000kVA
2	Phase	3
3	HV Rating Voltage	145.2kV
4	LV Rating voltage	23.1kV
5	Cooling Type	Oil cooled
6	Frequency	50 Hz
7	Vector Group	YNd11
8	Switch Type/Range	on-load / ±8x1.25%
9	Highest System Voltage	145kV
10	Primary insulation level (Lightning Impulse Withstand Voltage/ Power-frequency Withstand Voltage	650 / 275kV
11	Secondary insulation level (Lightning Impulse Withstand Voltage/ Power-frequency Withstand Voltage	125 / 50kV
12	Winding material	Cooper
13	Maximum ambient Temperature	+50ºC
14	Minimum ambient Temperature	-25ºC
15	Altitude	≤1000 M
16	Oil Type	
17	Temperature Rise	
17.1	Winding	55K
17.2	Top Oil	50K
17.3	Tank and structure surface	80K
17.4	Iron core	80K
18	Impedance (Rating Tap)	10.5% (tolerance±10%)

19	Accessories	• oil temperature indicator • pressure relief valve oil level indicator • HV bushings • LV bushings • On-load tap changer • Oil filling tube • Oil drain device • Thermometer pocket • Gas relay • Terminal box • 110kV phase bushing CT • 110kV neutral bushing CT • 110kV neutral point integrated equipment

The energy metering system will be placed on the HV side of the substation, which will comply with the NTDC specifications.

6.9 Cabling and earthing

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

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

Good lighting in the plant will be ensured for maintenance requirement in control

buildings and security / surveillances of the boundaries. All lighting supplies shall be extended through lighting inverters. Fence lighting shall be envisaged with low wattage LED lamps. Portable emergency lights shall be planned for security personnel.

6.10 SCADA and Relay Protection System

6.10.1 SCADA system

- Contents of computer monitoring system

Computer monitoring system adopts a comprehensive automated monitoring system includes 1 operator station and engineer station, this system integrates solar plant operation data acquisition, display, data transmission and other functions. Based on intelligent electrical equipment and by taking serial communication bus (fieldbus) assists carrier, this system organizes the solar module, grid-connected inverter, online intelligent monitoring and controlling equipment of 132 kV booster station and other components as a real-time network.

Through flow of information within the network data, this system can collect comprehensive electrical data of the foresaid systems, analyze and process the data, establish a real-time database and historical database, complete reporting preparation, index management, protection of deterministic analysis and management, equipment failure prediction and detection, equipment state maintenance, and other solar plant electrical operation optimization, control and professional management functions.

- Structure of computer monitoring system

The advanced computer control system is applied to substation automation system. The Substation automation system is based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence, the system can be divided into station control layer and interval layer.

Station control layer is the monitoring, measurement, control and management center

of the station, and it is connected with interval layer through optical cable or shielded twisted pair. Interval layers are disposed in the corresponding inverter cabinet, switch cabinet in accordance with the different electrical devices. In case of failure of the station control layer, the interval layer can still complete device monitoring and breaker control function independently. Computer monitoring system can communicate with the grid dispatch center through tele control workstation.

- Scope of the SCADA

The monitor scope of the PV plant includes: input current of the inverter, voltage, current, power, frequency and internal temperature of the inverter、the operation state and internal parameters of the inverter, power generation, environmental temperature, wind speed, wind direction, radiation intensity. The changing current, voltage, non-electric quantity, switch state of the 22 kV box, etc. The monitor scope of step-up substation includes 132/22 kV transformer, 20 kV switchgear, SVG, fire alarm, DC &UPS system, 132 kV line and other equipment data information, and realize the routine electrical control, protection and alarm o of the power station. And realize the routine electrical control, protection and alarm o of the PV plant.

- Monitoring unit of 132 kV HV substation

All electrical equipment of 132 kV HV substation are monitored and controlled by comprehensive automated monitoring system. The circuit breaker can not only be controlled locally, but also be subjected to the central monitoring and controlling system. The action signals will be sent to the computer monitoring system.

6.10.2 Relay protection and Security Equipment

- Protection configuration for equipment on PV plant site

a) Protection of grid-connected inverter

Grid-connected inverter has islanding protection, DC overvoltage/ over-current

protection, reverse polarity protection, short circuit protection, ground protection (with fault detection function), AC under voltage/ over voltage protection, overload protection, over heating protection, over frequency/ under frequency protection, three-phase unbalance protection and alarm, phase protection and monitoring of resistance to ground and alarm functions.

b) 22kV step-up transformer protection

In case internal and external faults of transformer happen, MV side and LV side will be disconnected.

- Protection configuration for 132kV HV substation equipment

a) Protection of 132 kV main transformer

The 132 kV main transformer protection devices adopt a single set of configuration, all devices are installed in a protective cabinet and shall have the following protections: Transformer differential protection, non-electricity protection, HV side backup protection, LV side backup protection, transformer mechanical protection relay;

b) Protection of 132kV electric transmission line

132 kV electric transmission line shall be protected by one set of line differential protection.

c) Protection of 22 kV collection line, SVG line, auxiliary transformer line

The 22 kV line takes current quick-breaking protection as its main protection, over current protection as backup protection, and drives the breaker's action. The incoming line is equipped with overload protection and acts on signals.

6.11 Module Cleaning System

Module cleaning system shall be envisaged for spraying the soft water over the modules manually by providing storage tanks, water pumps, high pressure piping

network & valves. This cleaning process is to be carried out periodically depending upon the intensity of dust deposition over the PV modules. As an alternative, automated cleaning system shall also be evaluated and considered depending on techno commercial viability.

6.12 A/C and Ventilation System

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

6.13 Firefighting System

The function of fire-fighting system is to supply water to the main risk areas of the power plant. The fire protection system is required for early detection, containment and suppression of fires. A comprehensive fire protection system shall be provided to meet the above objective and all statutory and insurance requirements of National Fire Protection Association (NFPA).

6.14 Electrical control room and administration building

One administration and office building with car park for 10 vehicles shall be provided, with sufficient space for operating personal, control room, security office, regular office rooms for permanent and visiting staff, meeting room, kitchen sanitary systems (toilet, showers separate for male and female), first aid, control room, electrical rooms, etc. The building shall have windows for office rooms and air conditioning system (split units) for all office rooms.

7. Yield Assessment and Energy Yield of Plant

7.1 Solar Irradiation

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

Table 2: Solar potential across Pakistan.

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

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

7.1.1 Global Horizontal Irradiation (GHI)

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

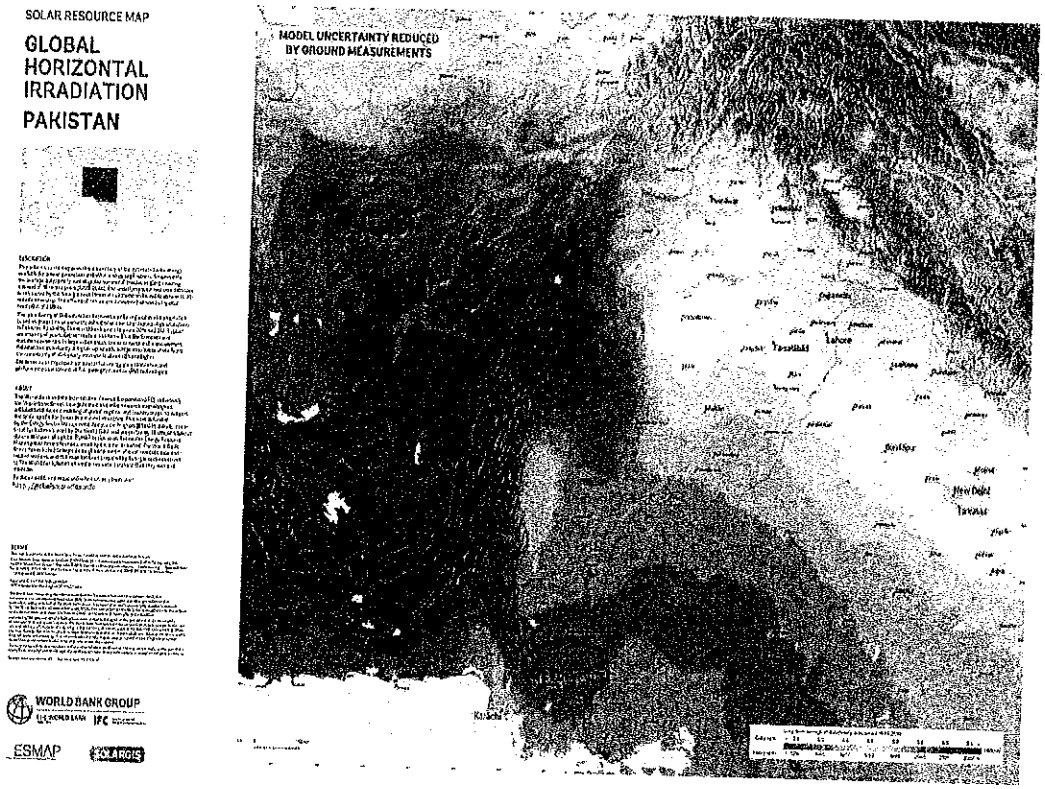


Figure 16: GHI Pakistan.

7.1.2 Direct Normal Irradiation (DNI)

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

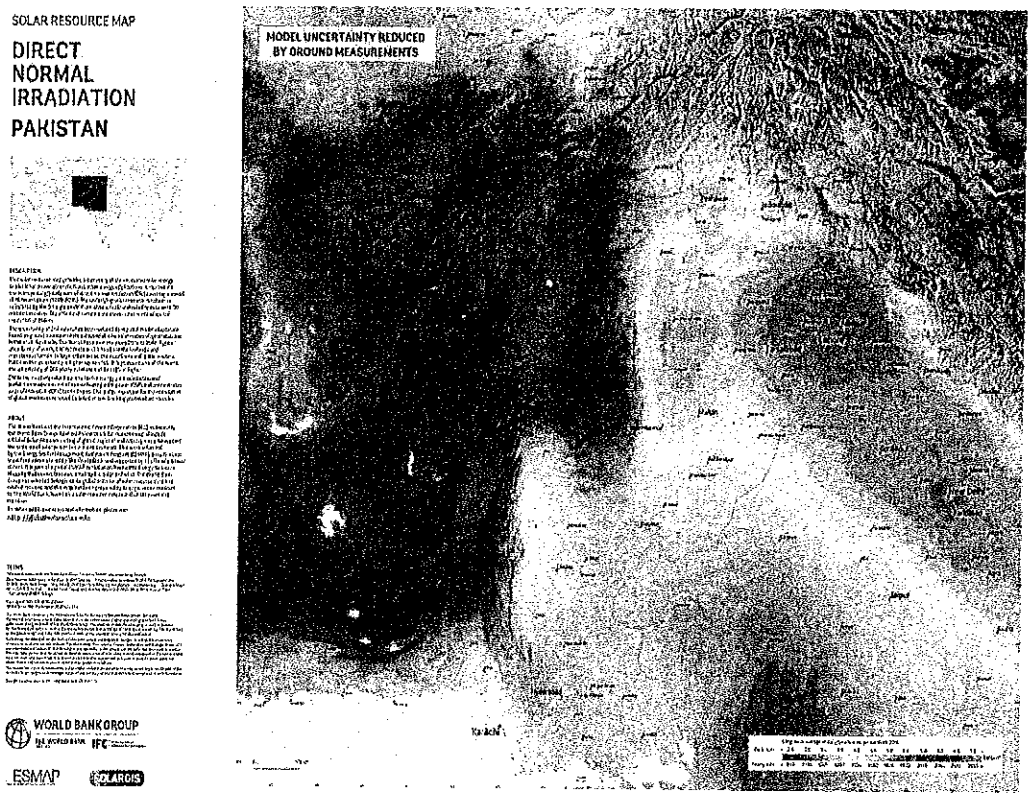


Figure 17: DNI Pakistan.

7.1.3 Diffuse Horizontal Irradiation (DHI)

DHI is the energy received on a unit area of horizontal surface from all directions when radiation is scattered off the atmosphere or surrounding area. Variability and characteristics of solar radiation are influenced by a number of factors. Many reasons, such as day-night cycle, seasonal cycle, and shading by cloud formations or surrounding terrain, are quite obvious. Others are not so easy to track e.g. content of water vapor and aerosols in atmosphere, thickness of ozone layer, etc. In the past only, simple observations were possible. These obstacles have been overcome by calculation of solar radiation from satellite and atmospheric data. This approach has several benefits:

- Satellite sensors are precisely calibrated and maintained during the whole life-cycle, data delivery is stable (e.g. reliability of MeteoSat is more 99%)

- Geostationary satellites provide near-real-time global coverage data, which allows monitoring, now-casting and forecasting
- Historical sets of satellite and meteorological data enable backward analysis of solar radiation components. Thus, a statistically comprehensive dataset (representing 10+ years of data) can be acquired
- Atmospheric data come from physical models, run by leading meteorological institutions;

New models are more and more accurate.

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

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

7.2 Energy Yield of Plant using PV Syst

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

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

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

7.2.1 Losses in Solar PV power generation

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

a. Incident Angle Losses

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

b. Low Irradiance Loss

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

c. Module Temperature

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

d. Module Quality

Most PV modules do not match exactly the manufacturer's nominal specifications. Modules are sold with a nominal peak power and a given tolerance within which the actual power is guaranteed to lie. In practice PV modules usually lie below the nominal

power but within the tolerance. For this project, it is proposed to use only positive tolerance modules.

e. Module Mismatch

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

f. DC Cable Resistance

Electrical resistance in the wires between the power available at the modules and at the terminals of the array gives rise to ohmic losses (I2R).

g. Inverter Performance

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

h. Soiling

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

i. Degradation

The performance of a PV module can decrease over time. The degradation rate is typically higher in the first year upon initial exposure to light and then stabilizes.

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

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

7.2.2 Inputs for PVSyst

Description	Values
Plant Site Co-ordinates	30.43°N 66.93°E
Altitude	1523 m
Albedo	0.20
Meteo Data Source	Solargis (Monthly Average)

7.2.3 Outputs of PVSyst

Description	Values
Horizontal Global Irradiation	2169 kWh/m2
Irradiance Loss	(-)0.1 %
IAM factor on global loss	(-)1.8 %
Soiling loss factor	(-)3.0 %
PV loss due to temperature	(-)6.5 %
Light Induced Degradation (LID) loss	(-)2.5 %
Mismatch loss, modules and strings	(-)1.1 %
Ohmic wiring losses	(-)2.1 %
Inverter loss during operations	(-)1.2 %

AC Ohmic losses	(-)0.7 %
External transformer losses	(-)1.3 %
Specific Production	2277 kWh/ kWp/year
Produced Energy	113,874 MWh/year
Performance Ratio	80.14 %

7.2.4 Evaluation of Production Probability forecast

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

Description	Data
Average yearly variability	2.5 %
PV Module modelling parameter variability	1 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainty	1 %
Degradation uncertainty	1 %
Global variability (meteo + system)	3.1 %
Annual Production Probability- P50	113,874 MWh/year
Annual Production Probability- P75	111,508 MWh/year
Annual Production Probability- P90	109,374 MWh/year

PVSyst simulation report has been attached in Appendix- 1.

8. Grid Connection Study

A detailed grid interconnection study for the project has been carried out by Power Planners International ltd and submitted for approval to the NTDC. Key findings of the report are summarized in this section, for reference complete study has been attached as Appendix- 3.

8.1 Summary

Engro intends to install 4x50 MW Solar Power Plants at Kuchlak near Quetta, Balochistan. The Draft Report of the first 50 MW Solar Power Plant by Engro Energy at Kuchlak, Balochistan, referred to as Kuchlak- III Solar PP, is submitted to the NTDC for approval. The maximum net AC output of this plant would be 45 MW.

The latest generation, transmission plan and load forecast of NTDC has been used for the study. The nearest grid facilities are the 132 kV substations of Quetta-Industrial and Pishin. Due to the location of Kuchlak- III Solar PP, the most feasible interconnection scheme would be double circuit loop in-out of Quetta Industrial to Pishin with 1 km looping length. Rail conductor will be used. The upcoming chapters discuss in detail the location and interconnection of the Kuchlak- III Solar PP.

In view of planned COD of Kuchlak- III Solar PP by Mid-2020, the above proposed interconnection scheme has been assessed for steady state conditions through detailed load flow studies, short circuit analysis and stability criterion for summer 2020 for maximum hydel power dispatches in the grid. Detailed load flow studies have also been carried out for peak load conditions of Winter 2021 to assess the impact of plant for maximum thermal power dispatches and for future scenario of Summer 2022 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.

Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the maximum power of 45 MW of the plant under normal and contingency conditions.

The short circuit levels of the Kuchlak- III Solar PP 132 kV are 6.53 kA and 7.61 kA for 3-

phase and 1-phase faults, respectively, in the year 2020. Therefore, industry standard switchgear of a short circuit rating of 40 kA would be sufficient for installation at 132 kV switchyard of Kuchlak- III Solar PP, as the maximum short circuit levels for the year 2022 were also found to be within this range, taking care of any future generation additions and system reinforcements in its electrical vicinity and also fulfilling the NEPRA Grid Code requirements specified for 132 kV switchgears. There are no violations of the power rating of the equipment in the vicinity of Kuchlak- III Solar PP in the event of fault conditions.

The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability has been tested for the worst cases, i.e. three phase faults right on the 132 kV bus bar of Kuchlak- III Solar PP substation followed by trip of a 132 kV single circuit from Kuchlak- III Solar PP to Quetta Industrial has been performed for fault clearing of 5 cycles (100 ms), as understood to be the normal fault clearing time of 132 kV protection system. Also, the extreme worst case of stuck breaker (breaker failure) has been studied where the fault clearing time is assumed 9 cycles i.e. 180 ms for single phase fault. The stability of the system for far end fault of 3-phase occurring at Pishin 132 kV bus bar has also been checked. The system is stable for all the tested fault conditions.

9. Initial Environmental Examination (IEE)

The construction and implementation of the Plant will have an impact on the surroundings, not only at an environmental level but at a social level as well. To assess the impacts and propose mitigation a detailed IEE study has been carried out by Hope Environmental Consultancy Services herein after referred as 'HECS'. The IEE report is attached as Appendix- 4 and summary from the same has been shared hereunder.

Detailed analysis of major environmental and social impacts was performed, their corresponding mitigation measures were identified for the viability of the project. For the effective implementation and management of the mitigation measures and monitoring requirements, an Environmental Managements Plan (EMP) has been prepared. The EMP is based on the requirements of the Pakistan Initial Environmental Examination, Environmental Impacts Assessment Review Procedures, 2000 and Balochistan Environmental Protection Act 2012. The relevant standard of Asian Development Bank (ADB) guidelines, equator principles and International Finance Corporation (IFC) were also considered during the preparation of the IEE study.

The management of the project shall supervise and monitor all the mitigation measures and their effectiveness. It explains and assigns the roles and responsibilities of work to the individuals of management and makes it easy to handle the issues with care. Procedures to work on EMP shall further develop by project proponent. The main aspects covered in the EMP include processes, management approach, organizational structure, roles, responsibilities, implementation levels and timelines. EMP encourages mitigation plans during installation, operation and needs of training.

Project Owner and their subsequent contractor(s) are required to follow the EMP. It is recommended that where necessary, proponent shall amend this EMP as per unaddressed matters and same must be shared with EPA-Balochistan for endorsement.

Based on the findings of the environmental assessment, and the suggested mitigation measures it is reasonable to suggest that the environmental impacts of construction and operation of proposed project are minor and can be mitigated by implementing the environmental management plan (EMP), which forms an integral part of the IEE.

Based on the conclusions of the IEE Study and on the assessment made with professional judgment, it is safe to recommend approval of the findings since the proposed development meets the provisions of sustainability principles in providing the benefits of economic gains while sustainably modifying the social and physical environment.

10. EPC Procedure and O&M

10.1 Project Management

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

The Project personnel supervise construction activities from the start of the project. The sponsors team will monitor construction schedules, owner's engineers and the EPC contractor to complete the project frame and in-line with Health Safety and Environmental (HSE) guidelines.

The Project Company shall prepare a Construction Management Master Plan, which shall consider all relevant aspects. The master plan shall be regularly reviewed, updated and shared with all project stakeholders.

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

10.2 Procurement, System preparation

Upon completion of a complete bill of quantities for the system, all equipment will be purchased and imported into Pakistan. During this phase system schematics and other system documentation will be finalized.

10.3 Construction

The first step in the installation procedure is to install the array frame, followed by solar panels and inverters and completion of wiring of each inverter. From this point the AC and communications cabling can be put in. Depending on number of personnel the transformers and AC distribution cabinets can installed concurrently. The final step is to connect the two transformers to the grid in order to output electricity to the existing network.

10.4 Commissioning

After completion of installation, the lead engineer will come to check all system components are not only working correctly but have been installed according to standards and the design.

Programming of inverters and complete system testing will be undertaken, also during this stage, EEL will need to come and confirm the system has been installed according to their standards and sign off on system acceptance.

10.5 Operations & Maintenance (O&M)

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

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

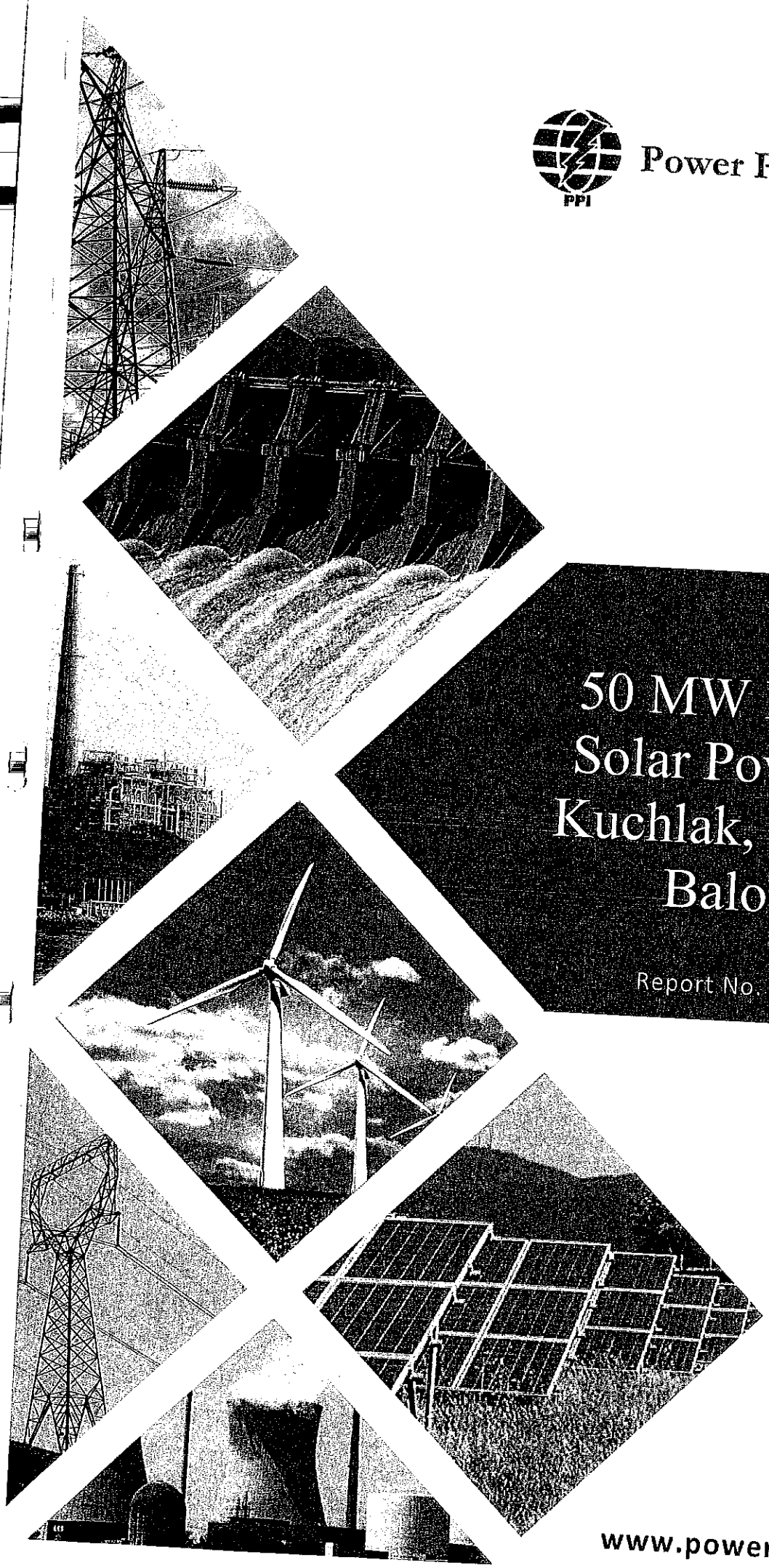
Operations and Maintenance tasks shall include:

- Periodic cleaning of PV Panels (every 7 — 10 days)
- Periodic operational checks and tests of equipment in accordance with OEM recommendations
- Regular plant inspections
- Routine maintenance services
- Implement and regulate the facility's preventive and corrective maintenance program
- Critical / non-critical reactive repairs
- Plant security covering entire fenced area
- General shift operations for coordinating plant operation, maintenance & liaison with power purchaser; and
- Maintain critical spares for plant & equipment.

ANNEXURE XIV

GRID INTERCONNECTION STUDY

Power Planners International



50 MW Kuchlak-III Solar Power Plant at Kuchlak, near Quetta, Balochistan

Report No. PPI-318.1-Draft/19

www.powerplannersint.com

Interconnection Study of 50 MW Kuchlak-III Solar Power Plant

By

Engro Energy at Kuchlak, near Quetta, Balochistan

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Executive Summary

- Engro intends to install 4x50 MW Solar Power Plants at Kuchlak near Quetta, Balochistan. The Draft Report of the third 50 MW Solar Power Plant by Engro Energy at Kuchlak, Balochistan, referred to as Kuchlak-III Solar PP, is submitted herewith. The maximum net AC output of this plant would be 45 MW.
- The latest generation, transmission plan and load forecast of NTDC has been used for the study, attached in Appendix – A.
- The study objective, approach and methodology have been described and the plant's data received from the Client validated.
- The nearest grid facilities are the 132 kV substations of Quetta-Industrial and Pishin.
- Due to the location of Kuchlak Solar farm, the most feasible interconnection scheme would be looping in-out of QuettaIndustrial to Pishin 132 kV Single Circuit with 1 km looping length. The distance between substations of each plant is 0.1 km and Rail conductor will be used. The upcoming chapters discuss in detail the location and interconnection of the Kuchlak-III Solar PP. A few approximate sketches are shown in Appendix-B.
- In view of planned COD of Kuchlak-III Solar PP by Mid-2020, the above proposed interconnection scheme has been assessed for steady state conditions through detailed load flow studies, short circuit analysis and stability criterion for summer 2020 for maximum hydel power dispatches in the grid.
- Detailed load flow studies have also been carried out for peak load conditions of Winter 2021 to assess the impact of plant for maximum thermal power dispatches and for future scenario of Summer 2022 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the maximum power of 45 MW of the plant under normal and contingency conditions.
- The short circuit levels of the Kuchlak-III Solar PP 132 kV are 6.54 kA and 7.64 kA for 3-phase and 1-phase faults, respectively, in the year 2020. Therefore, industry standard switchgear of a short circuit rating of 40 kA would be sufficient for installation at 132 kV switchyard of Kuchlak-III Solar PP, as the maximum short circuit levels for the year 2022

were also found to be within this range, taking care of any future generation additions and system reinforcements in its electrical vicinity and also fulfilling the NEPRA Grid Code requirements specified for 132 kV switchgears. There are no violations of the power rating of the equipment in the vicinity of Kuchlak-III Solar PP in the event of fault conditions.

- The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability has been tested for the worst cases, i.e. three phase fault right on the 132 kV bus bar of Kuchlak-III Solar PP substation followed by trip of a 132 kV single circuit from Kuchlak-I Solar PP to QuettaIndustrial has been performed for fault clearing of 5 cycles (100 ms), as understood to be the normal fault clearing time of 132 kV protection system. Also the extreme worst case of stuck breaker (breaker failure) has been studied where the fault clearing time is assumed 9 cycles i.e. 180 ms for single phase fault. The stability of the system for far end fault of 3-phase occurring at Pishin 132 kV bus bar has also been checked. The system is stable for all the tested fault conditions.

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1. Introduction

1.1. Background

Engro Solar Energy (Pvt.) Ltd. is developing a 4x50 MW Photovoltaic (PV) based Solar Farm at Kuchlak, near Quetta, Balochistan. The site of the proposed project is located in the concession area of Quetta Electric Power Company (QESCO). A general idea of the grid stations in the vicinity of the plant can be viewed in Sketch-1 attached in Appendix - B.

The maximum net AC output of the solar plant will be 45 MW. The project is expected to start commercial operation by the Mid 2020. The electricity generated from this project would be supplied to the grid system of QESCO through 132 kV grids available in the vicinity of this project. The location of Kuchlak-III Solar PP can be seen in Sketch-2 attached in Appendix - B.

1.2. Objectives

The overall objective of the Study is to evolve an interconnection scheme between Kuchlak-III Solar PP and QESCO network, for stable and reliable evacuation of 45 MW of electrical power generated from this plant, fulfilling the N-1 reliability criteria. The specific objectives of this report are:

- To develop scheme of interconnections at 132 kV for which right of way (ROW) and space at the terminal substations would be available.
- To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
- To check if the contribution of fault current from the plant unit increases the fault levels at the adjoining substations at 132 kV voltage levels to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at Kuchlak-III Solar PP.
- To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping.

1.3. Planning Criteria

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

Steady State:

Voltage	± 5 %, Normal Operating Condition
	± 10 %, Contingency Conditions
Frequency	50 Hz Nominal, continuous
	49.8 Hz to 50.2 Hz variation in steady state
	49.4 - 50.5 Hz, Min/Max Contingency Freq. Band
Power Factor	± 0.95 (as per Grid Code Addendum No.2 for Solar Power Plants)

Short Circuit:

132 kV Substation Equipment Rating of 40 kA

Dynamic/Transient:

The system should revert to normal condition after transients die out with good damping, without losing synchronism. The system is tested under the following fault conditions:

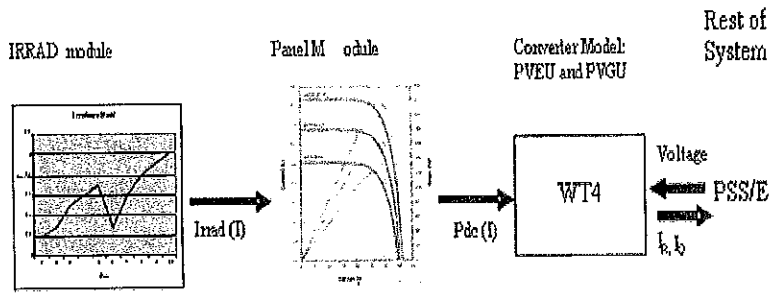
a) Permanent three-phase fault on any primary transmission element; including: transmission circuit, substation bus section, transformer or circuit breaker. It is assumed that such a fault shall be cleared by the associated circuit breaker action in 5 cycles.

b) Failure of a circuit breaker to clear a fault ("Stuck Breaker" condition) in 9 cycles after fault initiation.

2. Assumptions of Data

2.1. Solar Power Plant Data

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



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

Steady State Data:

Maximum Net AC Output of Solar PP to Grid	= 45 MW
Size of a single inverter	= 2.5 MW
MVA Rating of Transformer	= 2.5 MVA
% Impedance of GSU Transformer	= 6.5 %

Dynamic Data:

Converter time constant for IQ_{cmd} seconds = 0.02 s

Converter time constant for IQ_{cmd} seconds = 0.02 s

Voltage sensor for LVACR time constants = 0.02 s

Voltage sensor time constant = 1.1 s

2.2. Network data

The 132 kV networks available for interconnection to Kuchlak-III Solar Power Plant are as shown in Sketches 1 and 2 in Appendix-B. The lengths of the nearby circuits are also mentioned in the sketches.

The Solar Power Plant data as provided by the client has been used and it is attached in Appendix - B. The latest load forecast and the generation expansion plan provided by NTDC has been used as shown in Appendix A.

3. Study Approach and Methodology

3.1. Understanding the Problem

The 45 MW (Net AC Output) Solar Power Plant by Kuchlak-III Solar, is going to be a photovoltaic (PV) based solar project in Balochistan embedded in the 132 kV distribution network of QESCO. It would run almost all the months of the year though with some variation in its output due to variation in the strength of light in winter and in rainy season.

The existing nearest QESCO grid stations are Quetta-Industrial and Pishin 132 kV substations. The addition of this source of power generation combined with the power from other solar power plant in its vicinity shall provide relief to the transformers at Quetta-Industrial 220/132 kV and the sources feeding this area from further away. The 132 kV network of QESCO in the electrical vicinity of Kuchlak-III Solar PP has significant load demand and low reactive power sources, therefore a considerable portion of the power from Kuchlak-III Solar PP will be utilized in meeting this load demand on substations including Pishin, Huramzai, and Alizai.

The adequacy of QESCO network of 132 kV in and around the proposed site of Kuchlak-III Solar Power Plant would be investigated in this study for absorbing and transmitting this power fulfilling the reliability criteria.

3.2. Approach to the Problem

The following approach has been applied to the problem:

- A base case network model has been prepared for the peak load case of Summer 2020, after COD of Kuchlak-III Solar Power Plant, comprising all 500 kV, 220 kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year particularly in QESCO.
- The expected COD of the project is by mid of 2020. In view of the planned COD of Kuchlak-III Solar PP, the above proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for peak load conditions of Summer 2020, peak load conditions of Winter 2021 and peak load conditions of Summer 2022.
- Load flow and short circuit studies have also been performed for Summer 2022 to gauge the performance of the proposed plant in an extended term scenario.
- An interconnection scheme without any physical constraints, such as right of way or availability of space in the terminal substations, have been identified.

- Technical system studies have been conducted for peak load conditions, to confirm technical feasibility of the interconnection. The scheme will be subjected to standard analyses such as load flow, short circuit, and transient stability to gauge the strength of the machines and the proposed interconnection under disturbed conditions.
- The relevant equipment for the proposed technically feasible scheme has been determined.
- Finally, the most technically feasible interconnection scheme has been recommended.

4. Development of Interconnection Scheme

4.1. The Existing Network

The existing 132 kV network available around the proposed location of Kuchlak-III Solar PP is shown in Sketch-1 in Appendix-B.

Kuchlak-III Solar PP is located near Kuchlak, Balochistan, embedded in the distribution network of QESCO. The network is being fed from the 220/132 kV substation of QuettaIndustrial. The nearest existing QESCO interconnection facilities at the time of commissioning of the plant are QuettaIndustrial 132 kV and Pishin 132 kV Substations.

4.2. The Interconnection Scheme of Kuchlak-III Solar PP

Keeping in view of the above mentioned 132 kV network available in the vicinity of the site of the Kuchlak-III Solar PP, the most feasible interconnection scheme for Kuchlak Solar Farm would be looping in-out of 132 kV Single Circuit connecting QuettaIndustrial with Phish. The Looping distance is 1 km and the conductor used will be Rail. A few approximate sketches are shown in Appendix-B.

5. Detailed Load Flow Studies

The base cases have been developed for the peak conditions of Summer 2020 using the network data of NTDC and QESCO available with PPI. The peak loads of the year 2020 for QESCO have been modeled as per the latest PMS Demand forecast as provided by NTDC. Detailed load flow studies have been carried out for Summer 2020, Winter 2021 and future case Summer 2022.

5.1. Modeling of Solar Power Plant in the Load Flow

Representation of all the individual inverters in a large solar power plant is inappropriate in most grid impact studies. There is a provision in the model structure of PSS/E to allow single equivalent collector model to represent multiple collectors. For grid system impact studies, simulations are typically performed with the irradiance sufficient to produce the rated output on all the inverters. Though simulations of bulk system dynamics using a single inverter equivalent are adequate for most planning studies.

5.2. Reactive Power Requirements

Kuchlak-III Solar Power Plant power factor is used as mentioned in the data sheet provided attached in Appendix-B. Part of this reactive power will be consumed by the step-up transformers and the rest may be consumed in collector cables of the solar plant. However, some reactive power might reach the bus bar of solar plant substation. That means each inverter is self sufficient to meet VAR absorption requirement of its step-up transformer with some contribution of VARs to the Solar Plant MV network.

The Grid Code Addendum No.2 requires to meet the criteria of ± 0.95 power factor at the point of interconnection with the NTDC/QESCO grid at 132 kV (point of common coupling). Therefore, Kuchlak-III Solar with its maximum AC output of 45 MW generating capacity is required to pump around 14 MVARs to the grid at maximum AC power output of 45 MW to fulfill the criteria. The VAR generating capability of the inverters will not be able to fully meet this VAR demand of the system because of VAR loss in step-up transformers, collector cables and the transformers at the Solar Plant substation.

In order to meet the Grid Code criteria, we need to install reactive power compensation equipment. For a Solar Power Plant delivering 45 MW Net AC output, we need to have around 14 MVAR at 132 kV bus bar after farm losses. Hence a Static VAR Compensator (20 MVAR) with contactors and PLC (Programmable Logic Controller) is proposed at 22 kV bus bar of the Solar PP.

5.3. Base Case Peak Summer 2020, Without Solar Power Plant

A base case has been developed for the peak load of Summer 2020, using the network data of QESCO and NTDC. Peak Load Demand of QESCO for FY 2020-21 is **2043.45 MW** while the month factor for September is 0.95, as specified by NTDC. There is very limited generation in the QESCO network and 220kV grid station of Mastung has been delayed. Moreover the commissioning of Reactive Compensation Devices at major feed stations is also delayed by a couple of years. To ensure a stable system, **276.25 MW** load has been shed in the QESCO area. The load in the PSSE case comes out to be **1767.2 MW.**

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit shows 132 kV network in the vicinity of Kuchlak-III Solar (Pvt.) Ltd. Solar PP including the substations of QuettaIndustrial and other substations.

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

For N-1 contingency conditions we have performed the following cases

Exhibit-0.1	Quettaln To Pishin 132kV Single Circuit Out
Exhibit-0.2	Khanozai To Pishin 132kV Single Circuit Out
Exhibit-0.3	Pishin To Yaru 132kV Single Circuit Out
Exhibit-0.4	Yaru To Huramzai 132kV Single Circuit Out
Exhibit-0.5	Huramzai To Q.Abdulla 132kV Single Circuit Out

We see that the power flows on all circuits remain within their ratings. Thus we find that there are no capacity constraints in terms of MW or MVA flow in the 132 kV network available in the vicinity of Kuchlak-III Solar PP for its connectivity under normal conditions and the N-1 contingency conditions considered.

5.4. Base Case Peak Summer 2020, With Solar Power Plant

After the introduction of Kuchlak-III Solar PP into the system, the amount of load shedding required to maintain a steady state supply of power is reduced. In this scenario, **185.35 MW** load has been shed out of QESCO's peak load. The load in the PSSE case comes out to be **1858.1 MW.**

The results of load flow with Kuchlak-III 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. Also the voltages on the bus bars are within the permissible operating range of ± 5 % off the nominal we find no capacity constraints on the 132 kV circuits under normal conditions i.e. without any outages of circuits.

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

Exhibit-1.1	Kuchlak-III 132/22 kV Single Transformer Out
Exhibit-1.2	Kuchlak-I To Quettaln 132kV Single Circuit Out
Exhibit-1.3	Kuchlak-I To Kuchlak-II 132kV Single Circuit Out
Exhibit-1.4	Kuchlak-II To Kuchlak-III 132kV Single Circuit Out
Exhibit-1.5	Kuchlak-III To Kuchlak-IV 132kV Single Circuit Out
Exhibit-1.6	Kuchlak-IV To Pishin 132kV Single Circuit Out
Exhibit-1.7	Khanozai To Pishin 132kV Single Circuit Out
Exhibit-1.8	Pishin To Yaru 132kV Single Circuit Out
Exhibit-1.9	Yaru To Huramzai 132kV Single Circuit Out
Exhibit-1.10	Huramzai To Q.Abdula 132kV Single Circuit Out

We find that power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 10 % off the nominal for contingency conditions' criteria. We find no capacity constraints on 132 kV circuits under normal and contingency conditions.

5.5. Peak Load Case Winter 2021

We have considered the peak scenario of Winter 2021 so that we can judge the impact of the project on the system when the load of the system is at its minimum. No load shedding is required as the system load is 64% of maximum demand.

The power flows on the circuits 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. We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits.

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

Exhibit-2.1	Kuchlak-III 132/22 kV Single Transformer Out
Exhibit-2.2	Kuchlak-I To Quettaln 132kV Single Circuit Out
Exhibit-2.3	Kuchlak-I To Kuchlak-II 132kV Single Circuit Out
Exhibit-2.4	Kuchlak-II To Kuchlak-III 132kV Single Circuit Out
Exhibit-2.5	Kuchlak-III To Kuchlak-IV 132kV Single Circuit Out
Exhibit-2.6	Kuchlak-IV To Pishin 132kV Single Circuit Out
Exhibit-2.7	Khanozai To Pishin 132kV Single Circuit Out
Exhibit-2.8	Pishin To Yaru 132kV Single Circuit Out
Exhibit-2.9	Yaru To Huramzai 132kV Single Circuit Out
Exhibit-2.10	Huramzai To Q.Abdula 132kV Single Circuit Out

We find that power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 10 % off the nominal for contingency conditions' criteria. We find no capacity constraints on 132 kV circuits under normal and contingency conditions.

5.6. Peak Load Case Summer 2022: Extended Term Scenario

We have considered the scenario of Summer 2022 so that we can judge the maximum impact of the project on the system in extended term when the load of the system would be at its maximum according to load forecast.

All the future reinforcements that were proposed till 2022 are modeled in the case and no load shedding is required in QESCO region. The results of this scenario are plotted in Exhibit 3.0. We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits 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. We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits.

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

Exhibit-3.1	Kuchlak-III 132/22 kV Single Transformer Out
Exhibit-3.2	Kuchlak-I To Quettaln 132kV Single Circuit Out
Exhibit-3.3	Kuchlak-I To Kuchlak-II 132kV Single Circuit Out
Exhibit-3.4	Kuchlak-II To Kuchlak-III 132kV Single Circuit Out
Exhibit-3.5	Kuchlak-III To Kuchlak-IV 132kV Single Circuit Out
Exhibit-3.6	Kuchlak-IV To Pishin 132kV Single Circuit Out
Exhibit-3.7	Khanozai To Pishin 132kV Single Circuit Out
Exhibit-3.8	Pishin To Yaru 132kV Single Circuit Out
Exhibit-3.9	Yaru To Huramzai 132kV Single Circuit Out
Exhibit-3.10	Huramzai To Q.Abdula 132kV Single Circuit Out

We find that power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 10 % off the nominal for contingency conditions' criteria. We find no capacity constraints on 132 kV circuits under normal and contingency conditions.

We find that there are no capacity constraints in the proposed connectivity scheme even in the upcoming years i.e. 2023.

5.7. Conclusion of Load Flow Analysis

From the analysis discussed above, we conclude that the proposed interconnection scheme of connecting Kuchlak-III Solar Power Plant ensures reliability and availability under all events of contingencies, i.e. planned or forced outages studied in this report for the base year 2020 as well as for the future scenario of 2022. The bus bar voltages remain well within the permissible limits in all the contingency events.

6. Short Circuit Analysis

6.1. 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.

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

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence

For maximum short circuit levels, the desired voltage magnitude at bus bars was set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition. For calculations of minimum short circuit levels, the bus voltage has been set equal to 0.9 P.U. i.e. 10% below the nominal.

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 years 2020 and 2022 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

The assumptions about the generator and the transformers data are the same as mentioned in Chapter.2 of this report.

6.2. Fault Current Calculations without Kuchlak-III Solar PP Year 2020

In order to assess the short circuit strength of the 132 kV network without Kuchlak-III Solar PP, three-phase and single-phase fault currents have been calculated for QESCO in the vicinity of the site of the Plant near Kuchlak, for the year 2020. These levels will give us the idea of the fault levels without Kuchlak-III Solar PP which we can use to determine the impact of the addition of the Plant later on. The results are attached in Appendix – D.

The short circuit levels have been calculated and plotted on the bus bars of 132 kV of substations lying in the electrical vicinity of our area of interest and are shown plotted in the Exhibit 4.0 attached in Appendix-D. Both 3-phase and 1-phase fault currents are indicated in the Exhibit 4.0 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 and 22 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 6.1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 132 kV substations which normally are which normally are 20 kA, 25 kA or 31.5 kA for older substations and 40 kA for new substations.

Table-6.1
Maximum Short Circuit Levels without Kuchlak-III Solar PP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Quettaln 132 kV	10.68	8.69
Pishin 132 kV	8.51	7.10
Khanozai 132 kV	7.07	4.86
Gulistan 132 kV	4.37	3.20
Maizai Addah 132 kV	5.28	3.94
Yaru 132 kV	7.69	6.89
Huramzai 132 kV	5.46	4.28
Alizai 132 kV	4.32	3.21
Q. Abdulla 132 kV	4.86	3.69
Kuclak 132 kV	7.55	6.17
Q.S Mand 132 kV	9.74	9.66
Sorrange 132 kV	7.62	6.27

6.3. Fault Current Calculations with Kuchlak-III Solar PP Year 2020

6.3.1. Maximum Short Circuit Levels

Maximum fault currents have been calculated for the electrical interconnection of proposed scheme. Fault types applied are three phase and single-phase at the 132 kV bus bar of Kuchlak-III Solar PP itself and other bus bars of the 132 kV and 22 kV substations in the electrical vicinity of Kuchlak-III Solar PP. The graphic results are shown in Exhibit 4.1.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV bus bars of the network in the electrical vicinity of

Kuchlak-III Solar PP and the 132 kV bus bars of Kuchlak-III Solar PP itself are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.2.

Table-6.2
Maximum Short Circuit Levels with Kuchlak-III Solar PP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Kuchlak-III 22kv	19.01	23.47
Kuchlak-III 132 kV	6.54	7.64
Quettaln 132 kV	10.93	9.33
Pishin 132 kV	8.84	8.40
Khanozai 132 kV	7.27	5.24
Gulistan 132 kV	4.52	3.45
Maizai Addah 132 kV	5.48	4.36
Yaru 132 kV	7.94	7.53
Huramzai 132 kV	5.64	4.61
Alizai 132 kV	4.46	3.42
Q. Abdulla 132 kV	5.03	3.96
Kuclak 132 kV	7.76	6.59
Q.S Mand 132 kV	9.96	10.24
Sorrange 132 kV	7.79	6.58

6.4. Fault Current Calculations with Kuchlak-III Solar PP Year 2022

Fault currents have been evaluated for the case of 2022 in order to observe the maximum fault current on Kuchlak-III Solar PP and the bus bars in its vicinity considering the future additions in the system. Fault types applied are three phase and single-phase at 132 kV bus bars of Kuchlak-III Solar PP itself and other bus bars of the 132 kV and 22 kV substations in the electrical vicinity of Kuchlak-III Solar PP. The graphic results showing maximum 3-phase and 1-phase fault levels are indicated in Exhibit 4.3. Both 3-phase and 1-phase fault currents are indicated in the Exhibit 4.3 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 tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV bus bars of the network in the electrical vicinity of Kuchlak-III Solar PP are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.4.

Table-6.4
Maximum Short Circuit Levels with Kuchlak-III PP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Kuchlak-III 22kv	19.33	23.84
Kuchlak-III 132 kV	6.82	7.99
Quettaln 132 kV	12.59	10.42
Pishin 132 kV	9.25	8.86
Khanozai 132 kV	7.42	5.33
Gulistan 132 kV	4.62	4.06
Maizai Addah 132 kV	5.62	4.65
Yaru 132 kV	8.31	7.94
Huramzai 132 kV	5.81	4.93
Alizai 132 kV	4.56	3.59
Q. Abdulla 132 kV	5.16	4.32
Kuclak 132 kV	8.09	6.79
Q.S Mand 132 kV	10.56	10.74
Sorrange 132 kV	8.16	6.79

Comparison of Tables 6.1, 6.2 and 6.3 shows an increase in short circuit levels for three-phase and single-phase faults due to connection of Kuchlak-III Solar PP on the 132 kV bus bars in its vicinity. We find that even after some increase, these fault levels are much below the rated short circuit values of the equipment installed on these substations.

6.5. Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of Kuchlak-III Solar PP with QuettaIndustrial and Pishin 132 kV Grid Station, we don't find any

violations of short circuit ratings of the already installed equipment on the 132 kV bus bars in the vicinity of the plant due to fault current contributions from Kuchlak-III Solar PP. The short circuit levels of the Kuchlak-III Solar PP 132 kV are 6.54 kA and 7.64 kA for 3-phase and 1-phase faults, respectively, in the year 2020. Therefore industry standard switchgear of the short circuit rating of 40 kA would serve the purpose as per NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

7. Dynamic Stability Analysis

7.1. Assumptions & Methodology

7.1.1. Dynamic Models

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

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

Generator	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANEL1

We have done studies with the inverter which has reactive support capability and LVRT Capabilities as per the data provided by the client.

7.1.2. System Conditions

The month of Summer 2020 has been selected for the study because it represents the load scenario immediately after the COD of Kuchlak-III Solar PP, allowing us to judge the impact of the plant during high water season.

The proposed Kuchlak-III Solar PP has been modeled in the dynamic simulation as per data provided by client. All the power plants of WAPDA/NTDC from Tarbela to Hub have been dynamically represented in the simulation model.

Due to the nature and quantum of the load at QESCO, stability studies have been performed with composite load modeling. The model of the load can be seen in Table 7.1.

Table 7.1

Description	Value
% Large Motor	0.0000
% Small Motor	70.0000
% Transformer Exciting Current	1.0000
% Discharge Lighting	10.0000
% Constant Power	10.0000

Kp of Remaining	1.0000
Branch R (pu load MW base)	0.0100
Branch X (pu load MW base)	0.1000

7.1.3. Presentation of Results

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

7.1.4. Worst Fault Cases

Three phase faults are considered as the worst disturbance in the system. We have considered 3-phase fault in the closest vicinity of Kuchlak-III Solar PP i.e. right at the 132 kV bus bar of Kuchlak-III Solar PP substation, cleared in 5 cycles, as normal clearing time for 132 kV i.e. 100 ms, followed by a permanent trip of a 132 kV single circuit from Kuchlak-I Solar PP to QuettaIndustrial. Also to fulfil the Grid Code criteria case of stuck breaker (breaker failure) single phase fault has also been studied where the fault clearing time is assumed 9 cycles i.e. 180 ms.

7.2. Dynamic Stability Simulations' Results - Summer 2020

7.2.1. Fault at 132 kV Kuchlak-III Solar Power Plant

We applied Three-phase fault on Kuchlak-III Solar PP 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of a 132/22 kV Kuchlak-III Solar single transformer. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows:

Fig. 1.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Kuchlak-III Solar power plant was 45 MW and it recovers to the same output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 1.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 1.5 MW /MVAR flow on 132/22 kV Kuchlak-III Solar Transformer

Followed by clearing of fault, the trip of 132/22 kV transformer of Kuchlak-III Solar causes the entire output of Kuchlak-III Solar to flow through the other 132/22 kV transformer of Kuchlak-III Solar. We plotted the flows of MW and MVAR on this intact transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Voltage Sensor for LVACR

The value of voltage sensor for LVACR is restored to its pre-fault value after the fault clears.

Fig. 1.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 1.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 1.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.2. Fault at 132 kV Kuchlak-III Solar Power Plant- Stuck Breaker

We applied Single-phase fault on the Kuchlak-III Solar Power Plant 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 132/22 kV transformer. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 2.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 2.5 MW /MVAR flow on 132/22 kV Kuchlak-III Solar Transformer

Followed by clearing of fault, the trip of 132/22 kV transformer of Kuchlak-III Solar causes the entire output of Kuchlak-III Solar to flow through the other 132/22 kV transformer of Kuchlak-III Solar. We plotted the flows of MW and MVAR on this intact transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 2.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 2.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clearance

Fig. 2.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results

show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.3. Fault at 132 kV Kuchlak-III Solar Power Plant

We applied Three-phase fault on the Kuchlak-III Solar Power Plant 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132kV circuit connecting Kuchlak-I to QuettaIndustrial. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 3.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 3.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 3.5 MW/MVAR Output of Kuchlak-IV to Pishin 132kv Circuit

Followed by clearing of fault, the trip of 132 kV circuit from Kuchlak-I Solar to QuettaIn causes the entire output of Kuchlak Solar farm to flow through adjacent 132 kV Kuchlak-IV circuit. 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 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 3.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 3.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 3.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.4. Fault at 132 kV Kuchlak-III Solar Power Plant

We applied Three-phase fault on the Kuchlak-III Solar Power Plant 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132 kV circuit between Kuchlak-IV and Pishin. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 4.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 4.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 4.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 4.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 4.5 MW/MVAR Output of Kuchlak-I to QuettaIndustrial 132kv Circuit

Followed by clearing of fault, the trip of 132 kV circuit from Kuchlak-IV Solar to Pishin causes the entire output of Kuchlak Solar farm to flow through adjacent 132 kV Quettaln circuit. 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 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 4.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 4.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 4.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.5. Fault at 22 kV Kuchlak-III Solar Power Plant

We applied Three-phase fault on the Kuchlak-III Solar Power Plant 22 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of one the collector groups of 15 MW. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 5.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and 22 kV bus bar of Kuchlak-III are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 5.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 5.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 5.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 5.5 MW /MVAR flow on 132/22 kV Kuchlak-III Solar Transformer

Followed by clearing of fault, the trip of one collector Kuchlak-III Solar causes the output of Kuchlak-III Solar to change. We plotted the flows of MW and MVAR on this intact transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 5.6 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 5.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 5.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 5.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.6. Fault at 132 kV Pishin

We applied Three-phase fault on the Pishin 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of one circuit connecting Pishin with Kuchlak-IV. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 6.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 6.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 6.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 6.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 6.5 MW /MVAR flow on 132 kV Kuchlak-I to Quettaln 132kV circuit

Followed by clearing of fault, the trip of circuit connecting Pishin to Kuchlak-IV Solar causes the entire output to flow through Kuchlak-I to Quettaln circuit. We plotted the flows of MW and MVAR on this intact transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 6.6 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 6.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 6.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 6.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3. Dynamic Stability Simulations' Results - Summer 2022

7.3.1. Fault at 132 kV Kuchlak-III Solar Power Plant

We applied Three-phase fault on Kuchlak-III Solar PP 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of a 132/22 kV Kuchlak-III Solar single transformer. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows:

Fig. 1.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Kuchlak-III Solar power plant was 45 MW and it recovers to the same output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 1.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 1.5 MW /MVAR flow on 132/22 kV Kuchlak-III Solar Transformer

Followed by clearing of fault, the trip of 132/22 kV transformer of Kuchlak-III Solar causes the entire output of Kuchlak-III Solar to flow through the other 132/22 kV transformer of Kuchlak-III Solar. We plotted the flows of MW and MVAR on this intact transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Voltage Sensor for LVACR

The value of voltage sensor for LVACR is restored to its pre-fault value after the fault clears.

Fig. 1.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 1.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 1.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.2. Fault at 132 kV Kuchlak-III Solar Power Plant- Stuck Breaker

We applied Single-phase fault on the Kuchlak-III Solar Power Plant 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 132/22 kV transformer. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 2.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 2.5 MW /MVAR flow on 132/22 kV Kuchlak-III Solar Transformer

Followed by clearing of fault, the trip of 132/22 kV transformer of Kuchlak-III Solar causes the entire output of Kuchlak-III Solar to flow through the other 132/22 kV transformer of Kuchlak-III Solar. We plotted the flows of MW and MVAR on this intact transformer and see

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

Fig. 2.6 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 2.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 2.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 2.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.3. Fault at 132 kV Kuchlak-III Solar Power Plant

We applied Three-phase fault on the Kuchlak-III Solar Power Plant 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132kV circuit connecting Kuchlak-I to QuettaIndustrial. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 3.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 3.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 3.5 MW/MVAR Output of Kuchlak-IV to Pishin 132kv Circuit

Followed by clearing of fault, the trip of 132 kV circuit from Kuchlak-II Solar to Quettaln causes the entire output of Kuchlak Solar farm to flow through adjacent 132 kV Pishin circuit. 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 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 3.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 3.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 3.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.4. Fault at 132 kV Kuchlak-III Solar Power Plant

We applied Three-phase fault on the Kuchlak-III Solar Power Plant 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132 kV circuit between Kuchlak-IV and Pishin. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 4.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 4.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 4.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 4.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 4.5 MW/MVAR Output of Kuchlak-I to QuettaIndustrial 132kV Circuit

Followed by clearing of fault, the trip of 132 kV circuit from Kuchlak-IV Solar to Pishin causes the entire output of Kuchlak Solar farm to flow through adjacent 132 kV QuettaIn circuit. 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 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 4.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 4.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 4.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results

show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.5. Fault at 22 kV Kuchlak-III Solar Power Plant

We applied Three-phase fault on the Kuchlak-III Solar Power Plant 22 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of one the collector groups of 15 MW. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 5.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and 22 kV bus bar of Kuchlak-III are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 5.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 5.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 5.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 5.5 MW /MVAR flow on 132/22 kV Kuchlak-III Solar Transformer

Followed by clearing of fault, the trip of one collector Kuchlak-III Solar causes the output of Kuchlak-III Solar to change. We plotted the flows of MW and MVAR on this intact transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 5.6 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 5.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 5.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 5.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.6. Fault at 132 kV Pishin

We applied Three-phase fault on the Pishin 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of one circuit connecting Pishin with Kuchlak-IV. We monitored different quantities for one second pre-fault and fourteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and are discussed as follows;

Fig. 6.1 Bus Voltages

The bus voltages of 132 kV bus bars of Kuchlak-III, Kuchlak-I, Yaru, Huramzai, Pishin and Quetta Industrial are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 6.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 6.3 MW/MVAR Output of Generators of Kuchlak-III Solar PP

The MW/MVAR output of Kuchlak-III Solar PP gets back to the pre-fault output quickly after fast damping of the oscillations in its output.

Fig. 6.4 MW/MVAR Output at Adjacent Plant (Kuchlak-II Solar PP)

The post-fault output of Kuchlak-II Solar Power Plant gets back to the same pre-fault output quickly after fast damping of the oscillations in its output. Similarly, MVAR output acquires equilibrium at a same value.

Fig. 6.5 MW /MVAR flow on 132 kV Kuchlak-I to Quettaln 132kV circuit

Followed by clearing of fault, the trip of circuit connecting Pishin to Kuchlak-IV Solar causes the entire output to flow through Kuchlak-I to Quettalndustrial circuit. We plotted the flows of MW and MVAR on this intact transformer and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 6.6 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 6.7 Output of Quetta Solar SVC

The output of SVC attains a steady state value after the clearance of fault

Fig. 6.8 Speed Deviation

The value for speed deviation of motor load is restored to its pre-fault value after the fault clears

Fig. 6.9 Rotor Angles

The rotor angles of the generators of Uch-1 220 kV, Uch-2 220 kV, Guddu 220 kV, Guddu New 500 kV and Habib 132 kV are plotted relative to machines at Kapco 220 kV. The results show that the rotor angles get back after the first swing and damp down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.4. Conclusion of Dynamic Stability Analysis

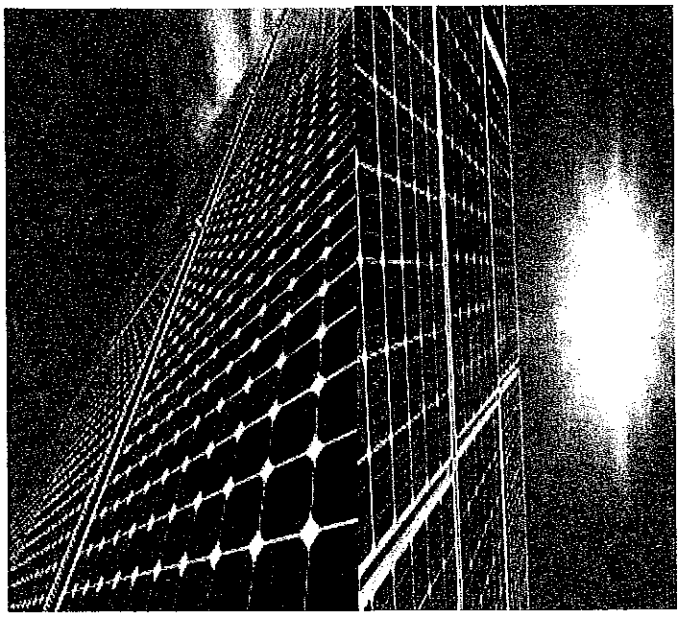
The results of dynamic stability carried out for Summer 2020 and Summer 2022 shows that the system is very strong and stable for the proposed scheme for the severest possible faults of 132 kV systems near to and far from Kuchlak-III Solar PP under all events of disturbances. Therefore there is no problem of dynamic stability for interconnection of Kuchlak-III Solar PP; it fulfills all the criteria of dynamic stability.

8. Conclusions

- The Draft Report of 50 MW Solar Power Plant by Engro Energy at Kuchlak, near Quetta, Balochistan, referred to as Kuchlak-III Solar PP, is submitted herewith. The maximum net AC output of this plant would be 45 MW.
- The latest generation, transmission plan and load forecast of NTDC has been used for the study, attached in Appendix – A.
- The study objective, approach and methodology have been described and the plant's data received from the Client validated.
- The nearest grid facilities are the 132 kV substations of QuettaIndustrial and Pishin.
- Due to the location of Kuchlak Solar farm, the most feasible interconnection scheme would be looping in-out of QuettaIndustrial to Pishin 132 kV Single Circuit with 1 km looping length. The distance between substations of each plant is 0.1 km and Rail conductor will be used. The upcoming chapters discuss in detail the location and interconnection of the Kuchlak-III Solar PP. A few approximate sketches are shown in Appendix-B.
- In view of planned COD of Kuchlak-III Solar PP by Mid-2020, the above proposed interconnection scheme has been assessed for steady state conditions through detailed load flow studies, short circuit analysis and stability criterion for Summer 2020 for maximum hydel power dispatches in the grid.
- Detailed load flow studies have also been carried out for peak load conditions of Winter 2021 to assess the impact of plant for maximum thermal power dispatches and for future scenario of Summer 2022 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the maximum power of 45 MW of the plant under normal and contingency conditions.
- The short circuit levels of the Kuchlak-III Solar PP 132 kV are 6.54 kA and 7.64 kA for 3-phase and 1-phase faults, respectively, in the year 2020. Therefore, industry standard switchgear of a short circuit rating of 40 kA would be sufficient for installation at 132 kV switchyard of Kuchlak-III Solar PP, as the maximum short circuit levels for the year 2022 were also found to be within this range, taking care of any future generation additions and system reinforcements in its electrical vicinity and also fulfilling the NEPRA Grid

Code requirements specified for 132 kV switchgears. There are no violations of the power rating of the equipment in the vicinity of Kuchlak-III Solar PP in the event of fault conditions.

- The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability has been tested for the worst cases, i.e. three phase fault right on the 132 kV bus bar of Kuchlak-III Solar PP substation followed by trip of a 132 kV single circuit from Kuchlak-I Solar PP to QuettaIndustrial has been performed for fault clearing of 5 cycles (100 ms), as understood to be the normal fault clearing time of 132 kV protection system. Also the extreme worst case of stuck breaker (breaker failure) has been studied where the fault clearing time is assumed 9 cycles i.e. 180 ms for single phase fault. The stability of the system for far end fault of 3-phase occurring at Pishin 132 kV bus bar has also been checked. The system is stable for all the tested fault conditions.



ENGRO ENERGY LIMITED

IEE- December, 2018

Initial Environmental Examination (IEE)

50 MW Solar PV Power Project, Kuchlak- III

PROJECT CONSULTANT:

Hope Environmental Consultancy Services, Balochistan

engro energy

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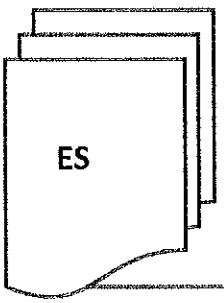
Glossary:

ADB	Asian Development Bank
BEPA	Balochistan Environmental Protection Agency
BEPA	Balochistan Environmental Protection Act
BHw	Hot desert climate
CSR	Corporate Social Responsibility
DA	District Administration
EIA	Environmental Impact Assessment
EEL	Engro Energy Limited
EM	Environmental Monitoring
ESMC	Environmental and Social Management Cell
EMP	Environmental Management Plan
EP	Equator Principle
FGD	Focus Group Discussion
GoB	Government of Balochistan
IEE	Initial Environmental Examination
IFC	International Financial Corporation
KWAC	Killo Watts Alternating Current
MWAC	Mega Watts Alternating Current
M/S	Meter Per Sec
MJ	Mega Joules
MPPT	Maximum Power Point Tracking
NCS	National Conservation Strategy
NEQS	National Environmental Quality Standards
PEPA	Pakistan Environmental Protection Act
WAC	Watts Alternating Current



Engro Energy Limited, 50 MW solar PV power Project, Kuchlak- III

EXECUTIVE SUMMARY

According to the report of NEPRA- National Electric Power Regulatory Authority "Pakistan is facing chronic electricity shortages due to demand growth, high system losses, seasonal reductions in the availability of hydropower and circular debt etc. Rotating power outages ("load shedding") are common and many villages are not yet electrified. The power sector of Pakistan is a mix of thermal, hydro, nuclear and renewable energy power plants. Originally the ratio of hydel to thermal installed generation capacity, in the country was about 67% to 33% (1985) but with the passage of time, due to different reasons more of thermal generation was added thereby reducing the share of hydel generation. At present, ratio of hydel to thermal installed generation capacity is about 30% to 65%. The dilemma for Pakistan is that its power production is dominated by thermal power plants running on oil and gas." (State of industry report 2017).

In above scenario solar power generation appears to be a viable and environmental friendly alternative for meeting Pakistan's urgent electricity demands. Solar energy source is widely distributed and abundantly available in the country. The total energy through solar has been recorded at 635 GWh for an increase of 410 GWh over the energy generated through solar during the FY 2015-16. (State of industry report 2017).

The mean global irradiation falling on horizontal surface is about 200-250 watt per sq.m in a day. This amounts to about 2500-3000 sun shine hours and 1.9 - 2.3 MWh per sq.met in a year. It has an average daily global insolation of 19 to 20 MJ/sq.met per day with annual mean sunshine duration of 8 to 8.5 hours (6-7hrs in cold and 10-12 hrs in hot season). To summarize, the sun shines for 250-300 days per years in Pakistan with average sun shine hours of 8-10 per day. This gives huge amount of energy to be used for electricity generation by solar power plants. (Electricity mix of Pakistan (2013-2014)

Engro Energy was incorporated in 2008 as a (100%) wholly-owned subsidiary of Engro Corporation to develop power projects in Pakistan and abroad. Currently, Engro Corporation's portfolio consists of varied businesses, which include fertilizers, foods, chemical storage & handling, commodity trading, energy and petrochemicals. EEL has recently been awarded the development rights, in the form of an LoI from the provincial government of Balochistan, to develop a 50 MWp solar PV power plant in Kuchlak, on approximately 250 acres of land. The power from the plant will be evacuated into the national grid (Shaikmanda).

Hope Environmental Consultancy Services herein after referred as 'HECS' was engaged by the EEL to develop the Initial Environmental Examination (IEE) study for 50 MW Solar PV project at Kuchlak.

Detailed analysis of major environmental and social impacts was performed, their corresponding mitigation measures were identified for the viability of the project.

For the effective implementation and management of the mitigation measures and monitoring requirements, an Environmental Managements Plan (EMP) has been prepared. The EMP is based on the requirements of the Pakistan Initial Environmental Examination, Environmental Impacts Assessment Review Procedures, 2000 and Balochistan Environmental Protection Act 2012. The relevant standard of Asian Development Bank (ADB) guidelines, equator principles and International Finance Corporation (IFC) were also considered during the preparation of the IEE study.

The management of the project shall supervise and monitor all the mitigation measures and their effectiveness. It explains and assigns the roles and responsibilities of work to the individuals of management and makes it easy to handle the issues with care. Procedures to work on EMP shall further develop by project proponent. The main aspects covered in the EMP include processes, management approach, organizational structure, roles, responsibilities, implementation levels and timelines. EMP encourages mitigation plans during installation, operation and needs of training.

Project Owner and their subsequent contractor(s) are required to follow the EMP. It is recommended that where necessary, proponent shall amend this EMP as per unaddressed matters and same must be shared with EPA-Balochistan for endorsement.

Based on the findings of the environmental assessment, and the suggested mitigation measures it is reasonable to suggest that the environmental impacts of construction and operation of proposed project are minor and can be mitigated by implementing the environmental management plan (EMP), which forms an integral part of the IEE.

Based on the conclusions of the IEE Study and on the assessment made with professional judgment, it is safe to recommend approval of the findings since the proposed development meets the provisions of sustainability principles in providing the benefits of economic gains while sustainably modifying the social and physical environment.

Chapter 1

CHAPTER:1 INTRODUCTION

1. Project Proponent:

Engro Energy Limited (EEL) previously Engro Powergen Limited (EPL), intends to install 50 MWp solar PV power project in union council Kuchlak, district Quetta of Balochistan. Engro Energy was incorporated in 2008 as a (100%) wholly-owned subsidiary of Engro Corporation to invest and develop power projects in Pakistan and abroad. Currently, Engro Corporation's portfolio consists of varied businesses, which include fertilizers, foods, chemical storage & handling, commodity trading, energy and petrochemicals. EEL has recently been awarded the development rights, in the form of an LoI from the provincial government of Balochistan, to develop a 50 MWp solar PV power plant in Kuchlak, on approximately 250 acres of land. The power from the plant will be evacuated into the national grid.

Engro engagement in CSR: Among other corporate responsibilities engro strongly believe in social sector reforms in nearby communities of project area. In this regard Engro give prime focus to education, health, livelihood, and other social sector development. In the proposed project Engro intends to work in surrounding communities of target area, by establishing schools, rehabilitation and coping with other school needs.

1.1 Project Consultant:

HECS is registered with Security & Exchange Commission of Pakistan (SECP). HECS has conducted several Environmental Assessment reports for diversified clientele. The company has a qualified and experienced team of Environmental Experts having more than 20 years of experience in the field of environmental management and monitoring. The company has all the capabilities and expertise to carry out the activities and prepare the documents related to EIA & IEE.

Name	Title
Mr. Kaleem Ullah Khan	Environmentalist/Sociologist
Dr. Zahoor Ahmad Bazai	Environmentalist & Biodiversity Expert
Mr. Asad Agha	Geologist
Miss Humaira Shah	Community Development Expert
Eng. Meer Ahmad	Project Engineer
Mr. Haji Muhammad Ali	Field Surveyor
Mr. AmanUllah Khan	Monitoring Specialist

Table 1 HECS's IEE Team

1.2 Project Background and Justification:

According to NEPRA report (2017) The Government of Pakistan has been pursuing broad objectives for the power generation development including, renewable energy, moving to environmental friendly fuels and reduced dependence on imported fuels. Also, diversification of fuel resources and security of fuel supply were among its priorities. The addition of different new generation technologies shown above will change the power mix of the sector from Furnace Oil-based to Coal, RLNG and Renewables as no major addition has been planned on Furnace Oil. The following fig-1 shows installed capacity mix 2016-17 of NEPRA.

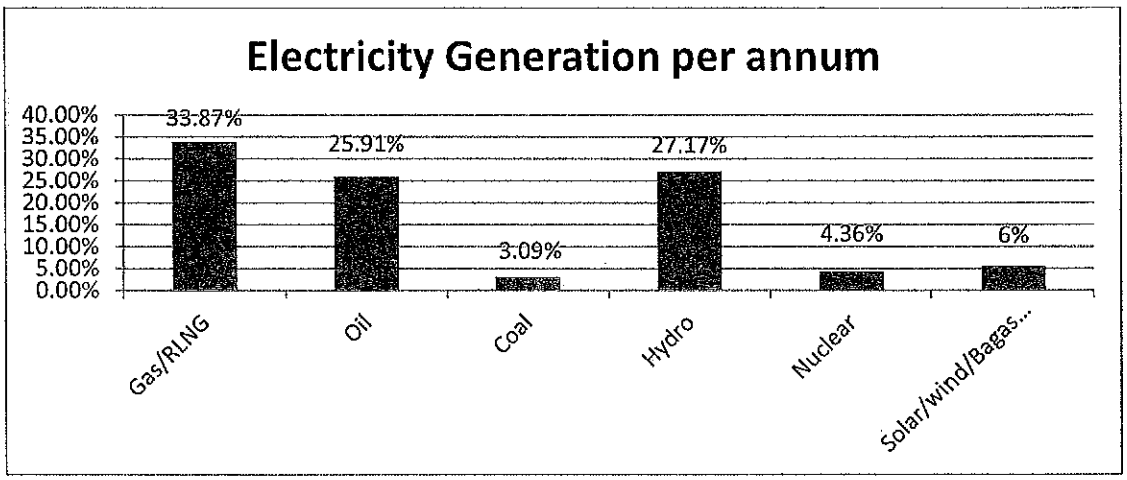


Figure 1: Installed Capacity Mix of Pakistan

Import of gas is a feasible option to overcome the reducing domestic reserves. However, gas import has significant issues, mainly the need for considerable capital investment in infrastructure, security difficulties and physical terrain concerns. Moreover, it would increase Pakistan's reliance on imported fuels with associated foreign exchange burdens. This must be considered in the context of rising fuel costs for gas and oil-based fuels as a result of uncertainty over future supply. In addition to this further fuel imports for electricity generation are the production of domestic coal, generation from hydro-electric power, or other renewable sources, such as wind and solar power. These options will assist in reducing Pakistan's reliance on imported oil and protect against resulting vulnerability to changes in global oil prices, which will in turn also have a positive effect on the current trade deficit and inflating import bill.

Regarding gas, safeguarding prospect provisions of domestic coal and hydro-electric power would require significant spending on infrastructure. While Pakistan has domestic reserves of coal, it currently makes up a very small proportion of the country's total power generation. This is due, in part, to the fact that most of the reserves are located in the remote Thar Desert region. Exploiting the coal reserves would require significant upfront investment in local infrastructure (including provision of water supplies), development of mines, housing and related infrastructure, and investment in transmission lines, as a pre-requisite to any power plant development. Thar coal power project by Engro Energy and Sindh Government (JV) is under completion with the capacity of 660 MW. In this regard 1st unit of 330 MW will be completed by December 2018 and the 2nd unit of same capacity will be completed by June 2019. (Source: NEPRA).

Hydroelectric power already supplies almost 27.17% of the domestic electricity that is generated, and numerous sites for future investment exist. However, due to their locations, this would also require significant investment in transmission and other infrastructure.

In above scenario solar power generation appears to be a viable and environmental friendly alternative for meeting Pakistan's urgent electricity demands. The development of solar power generation projects could reduce dependence on oil based thermal power generation, increase diversity in Pakistan's electricity generation mix, and reduce greenhouse gas emissions, all of which will contribute towards projecting a positive image of Pakistan within the international community. Also, the per kWh tariff for solar power projects globally are now comparatively lower than that of thermal projects; particularly the rental power projects, which were previously inducted to meet the urgent needs of electricity shortfalls.

1.3 Solar Resource Analysis of Pakistan:

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

To summarize, the sun shines for 250-300 days per years in Pakistan with average sun shine hours of 8-10 per day. This gives huge amount of energy to be used for electricity generation by solar power plants. A quick idea for the potential of solar energy in Pakistan can be obtained from the satellite map of solar radiation released by Solar GIS and World Bank, shown in Figure 1 as below

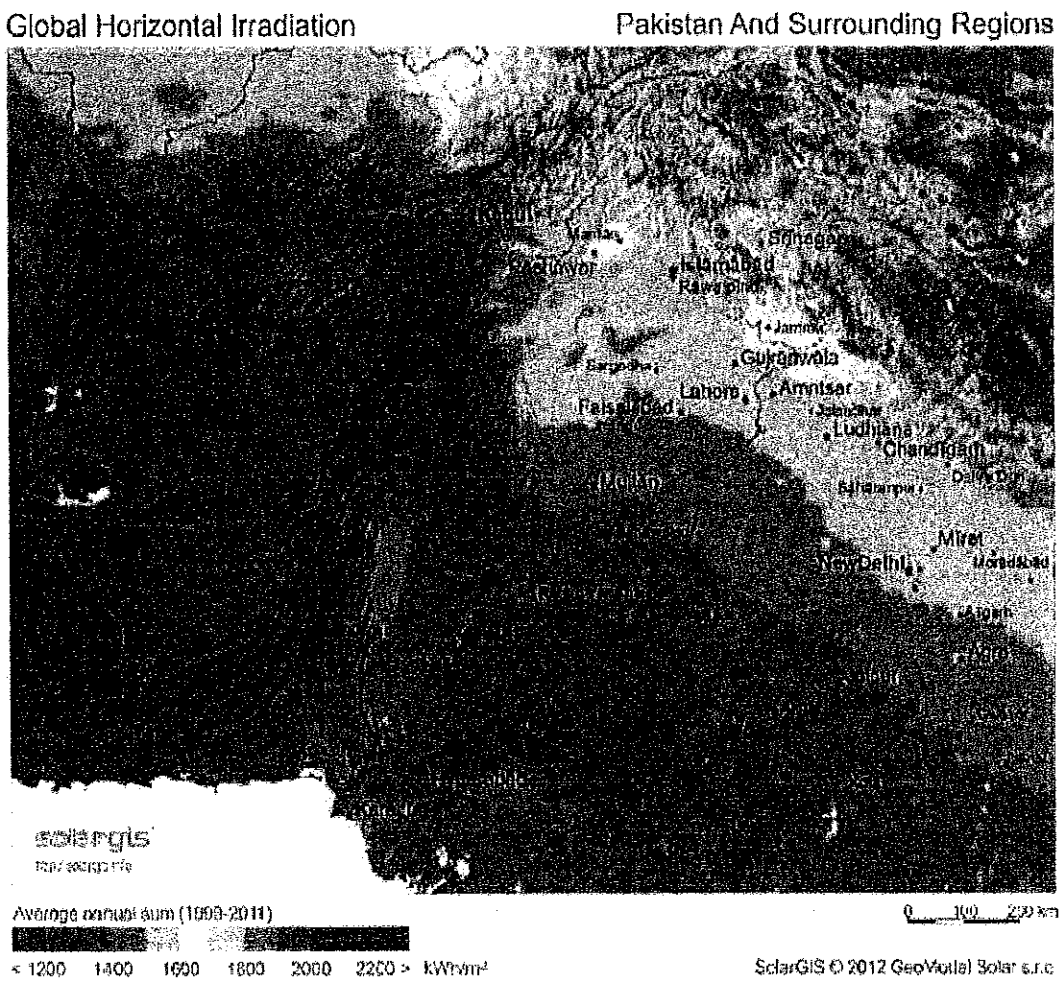


Figure 2: Global Horizontal Irradiation

1.4 Nature and Location of Project:

The proposed solar pv project of 50 MW will be installed in UC Kuchlak at District Quetta. The solar energy is radiant light and heat from sun which has been harnessed since generation for cooking, heating, lightening and power generation. The key features of the project location include 'Hot and Dry' climatic zone of the area comprises extreme weather conditions of the hot desert. There are no shading elements like high mountains, large sand dunes, trees available on the site. The entire area is shadow free. NHA (N 25) road is located on 100 to 150m from project area. Whereas construction of bypass near project area is underway connecting Quetta and Kuchlak. The Airport of Quetta (nearest to project area) is about 25 km from location. Kuchlak bazar is the nearest market at a distance of 06 km. Kuchlak station is the nearest railway station from the location. The available health facility in Yaro- BHU which is at a distance of 3km from the project site and the catchment areas comprise population of around 18,000 individuals. (Data collected from staff of BHU Yaro). Sheikhmanda and Yaro are the main grids for power evacuation.

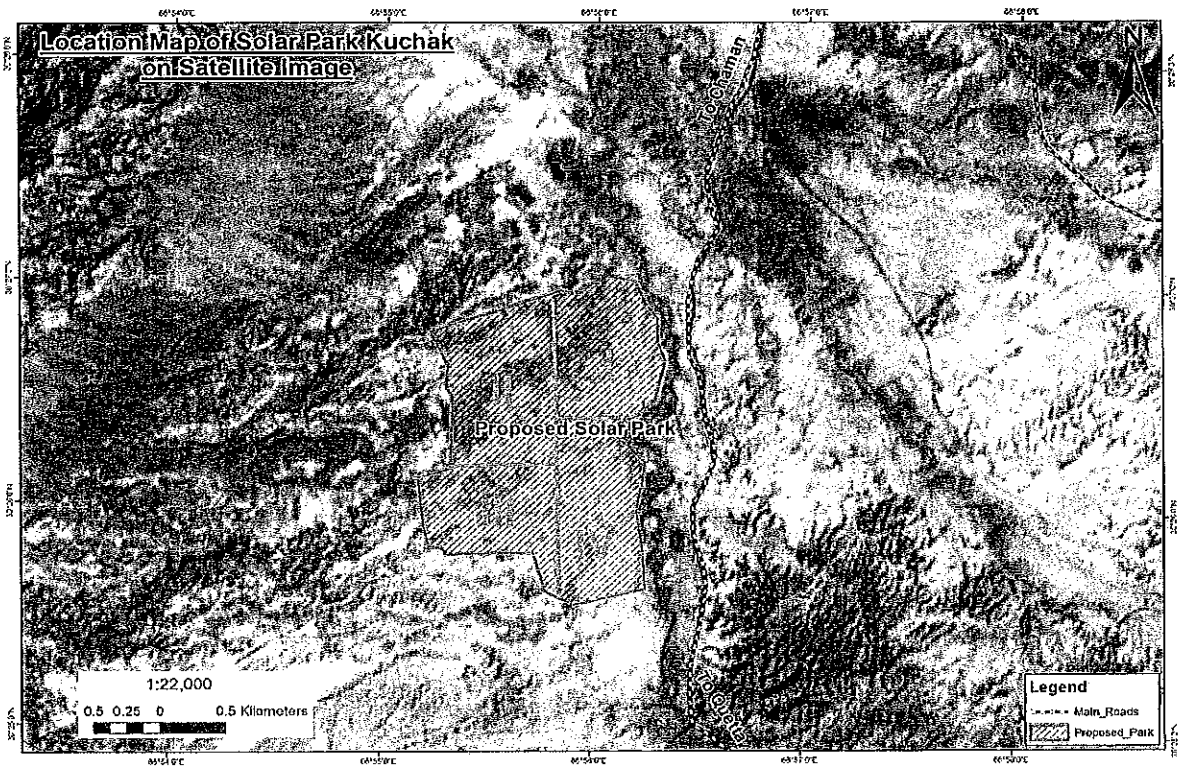


Figure 3: Satellite image of project area

Figure 4 -Tehsil Map of Project area

1.5 Category of the Project:

The section 12 of Balochsitan Environmental Protection Act 2012 states that "No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an initial environmental examination or, where the project is likely to cause an adverse environmental effect, an environmental impact assessment, and has obtained from the Federal Agency approval in respect thereof". Since Balochistan government is in process of development of own regulations therefore EIA/IEE regulation 2000 is practiced/implemented in the province for identifying the project categories under schedule I & II. The present IEE report has identified the significant environmental and social aspects and screened the potential aspects to ensure that the likely impacts due to proposed activities during construction, installation of Solar PV and operation of the proposed project, and the residual impact on adoption of mitigation measures have been critically assessed with respect to compliance with the Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000, Punjab Environment Protection Act 1997 (Amended 2012) and Sindh Environmental Protection Agency (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations, 2014.

The document has also been made to comply with the requirements of ADB's safeguard policy statement, 2009 as well as local and national standards. To comply with other lender's requirement, the IEE report also addresses equator principles, IFC's and World Bank group performance standards which will be met by the project.

1.6 Approach and Methodology of IEE:

A team of experts was involved in the study conducted by HECS. EEL sponsored 10 students (as interns) from three different universities of Balochistan to be the part of the study under the guidance and supervision of HECS team. The study team along with students made walk through and meandering survey of the project site to identify the environment structure and potential aspects which need to be taken into account. The consultants have addressed environmental aspects by furnishing information on physical, biological and socio-economic environments. The methods followed for each are given under the respective heading below.

1.6.1 Orientation Session:

Meetings and discussions were held with the relevant key officials of project and students to achieve a common ground of understanding on the IEE study of solar PV 50MW power project. The consultants followed best practices and standards to complete this assignment within the agreed scope of work. Environmental checklist was developed to collect all the concerned environmental data relevant to the project. Documentation check was carried out in detail during meeting session with proponent. The team physically and visually observed the project site. Photographic evidence was taken to verify the information gathered through, observation, interviews with the community and other stakeholders.

1.6.2 Data Analysis:

Based on the information collected through primary and secondary sources, various actions or activities having potential to cause damage to environment were listed. The aspects were identified for all various process of the project. For evaluation and prediction of various

environmental impacts, quantitative and qualitative descriptions of the anticipated project impacts were made. The identified impacts were further evaluated for their significance level.

Based on the significance of the impacts, mitigation measures for each negative impact were suggested. Approach for suggesting mitigation measure was as follows, in the descending order of preference:

Avoiding the impact altogether by not taking a certain action or parts of an action i.e. evaluation of project alternatives;

Minimizing impacts by limiting the degree or magnitude of the action and its implementation;

Rectify the impact by repairing, rehabilitating, or restoring the affected environment;

Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action; and compensate for the impact by replacing or providing substitute resources or environments.

A conceptual environmental management plan (EMP) for smooth and effective implementation of all recommended mitigation measures was developed and included in the report.

1.6.3 Legislative Review:

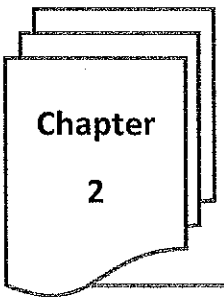
Information on relevant legislation, regulations, guidelines, and standards reviewed and compiled.

1.6.4 Reporting:

This IEE report has been prepared under the guidelines of BEPA and shared with the proponent for their comments/feedback. The draft report is finalized, after review and comments by the proponent. The consultants discussed the comments with proponent before incorporating them in the final report. After the comments are incorporated, the final report is submitted to the proponent, for onwards submission to BEPA.

1.6.5 Limitations:

This document has been prepared drawing inferences from site visits, primary data and secondary information. The study has been conducted by the consultants in a manner consistent with the level of care and skill exercised by members of environmental experts and consulting profession. The consultants have tried to cover all important aspects and relevant impacts of the proposed project. It should be recognized that the passage of time affects the information given in this report, environmental conditions of a site can change. Opinions relating to the specific conditions are based upon information that existed at the time the conclusions were formulated.



CHAPTER:2 PROJECT DESCRIPTION

2. The Project Overview:

Engro Energy Limited (EEL) previously Engro Powergen Limited (EPL), intends to install 50 MWp solar PV power project in union council Kuchlak, district Quetta of Balochistan. Engro Energy was incorporated in 2008 as a (100%) wholly-owned subsidiary of Engro Corporation to develop power projects in Pakistan and abroad. Currently, Engro Corporation's portfolio consists of varied businesses, which include fertilizers, foods, chemical storage & handling, commodity trading, energy and petrochemicals. EEL has recently been awarded the development rights, in the form of an LoI from the provincial government, to develop a 50 MWp solar PV power plant in Kuchlak, on approximately 250 acres of land. The power from the plant will be evacuated into the national grid.

2.1 Project Area & Location:

The proposed project of 50 MW solar pv will be installed in UC Kuchlak at District Quetta. The solar energy is radiant light and heat from sun which has been harnessed since generation for cooking, heating, lightening and power generation. The key features of the project location include 'Hot and Dry' climatic zone of the area comprises extreme weather conditions of the hot desert. There are no shading elements like high mountains, large sand dunes, trees available on the site. The entire area is shadow free. NHA (N 25) road is located on 100m to 150m from project area. Whereas construction of bypass near project area is underway connecting Quetta and Kuchlak. The Airport of Quetta (nearest to project area) is about 25 km from location. The available health facility in Yaro- BHU which is at a distance of 3km from the project site and the catchment areas comprise population of around 18,000 individuals. (Data collected from staff of BHU Yaro). Kuchlak bazar is the nearest market at a distance of 06 km. Kuchlak station is the nearest railway station from the location. Sheikhmanda and Yaro are the main grids for power evacuation.

2.2 Project Description:

S. No.	Particulars	Details
A.	Nature of project	50 MW Solar PV Power Project
B.	Size of project:	
1.	Total land required	250 Acres

2.	Proposed Production capacity	50 MW
C.	Project Location	
3.	UC	Kuchlak
4.	Tehsil	Quetta
5.	District	Quetta
6.	Province	Balochistan
7.	Latitude	30^0 25' 66.54" N
8.	Longitude	66^0 55'10.46" E
D.	Environmental Settings Details	
10.	Nearest Famous Location	Kuchlak Bazar
11.	Nearest Highway	Main Quetta Chaman Road
12.	Nearest Airport	Quetta International Airport
13.	Ecological Sensitive Areas (National Park, Wild Life Sanctuaries, Biosphere Reserves etc.)	Nil
15.	Seismic Zone	Most Active Seismic Zone of Pakistan
16	Type of System	Solar PV Technology
17	Type of PV module	Mono Perc
18	Proposed Capacity	50 MW
19	Proposed capacity of each Module	370 watts
20	Model of Solar PV Module	JA Solar 370 Mono Perc
21	Total Number of PV Module	135,184
22	Inverter Model	SG2500HV
23	Annual Electricity Supply to Grid	112,759 MWh

Table 2 Project Description summary

2.3 General:

Quetta is the provincial capital and largest city of Pakistan with population of 2 2 , 0 0 0 , 0 0 individuals (2017 census). The city has been known as the fruit garden of Pakistan, due to the numerous fruit orchards in and around it, and the large variety of fruits and dry fruits produced there. The immediate area has long been one of pastures and mountains, with varied plants and animals relative to the dry plains to the west. Quetta is at an average elevation of 1,680 meters (5,510 feet) above sea level, making it Pakistan's only high-altitude major city. Located in northwestern Baluchistan near the Pakistan-Afghanistan border, Quetta is a trade and communication center between the two countries. The city lies on the Bolan Pass route which was once one of the major gateways from Central Asia to South Asia.

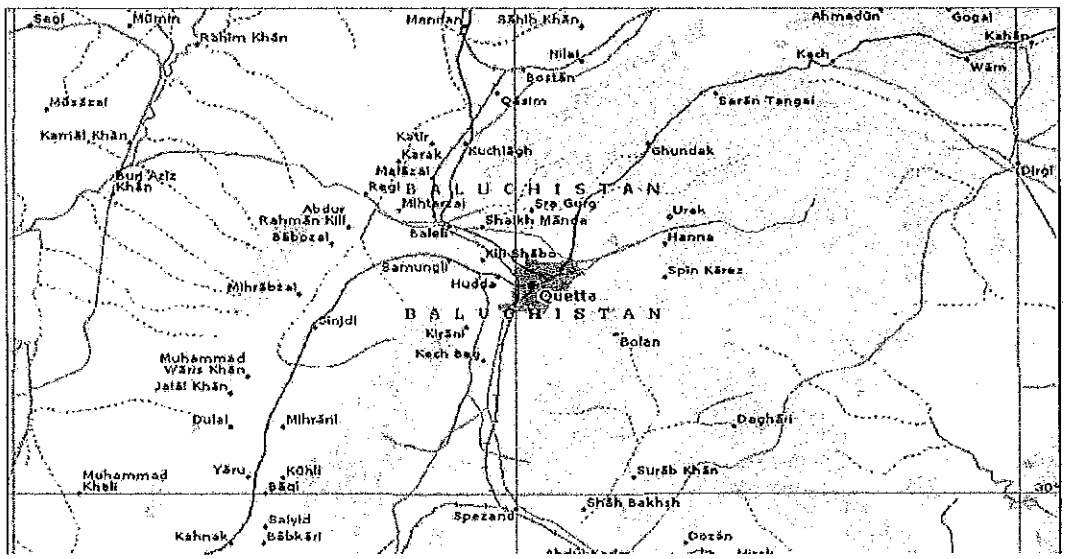


Figure 5- Target district Location

2.4 Accessibility to project area:

For transportation of material, the proponent may consider direct road from Karachi to Quetta and then Kuchlak. Subsequently, the second route may be from Gwadar to Quetta and project site. It's worth mentioning that Quetta-Karachi National Highway is already in use for heavy transportation of material. This is metal road and have no security issue with total distance of 715 km. Whereas the route from Gawadar to Quetta is 915 km with time of 16-18 hours. Heavy material can also be transported through train from Karachi to Quetta with estimated time of 20-24 hours. Other two communication routes are Quetta DG khan and Quetta DI khan connecting Punjab and KPK respectively.

Figure 6 - Quetta to Karachi road access map

Figure 7 Quetta to Gwadar access map

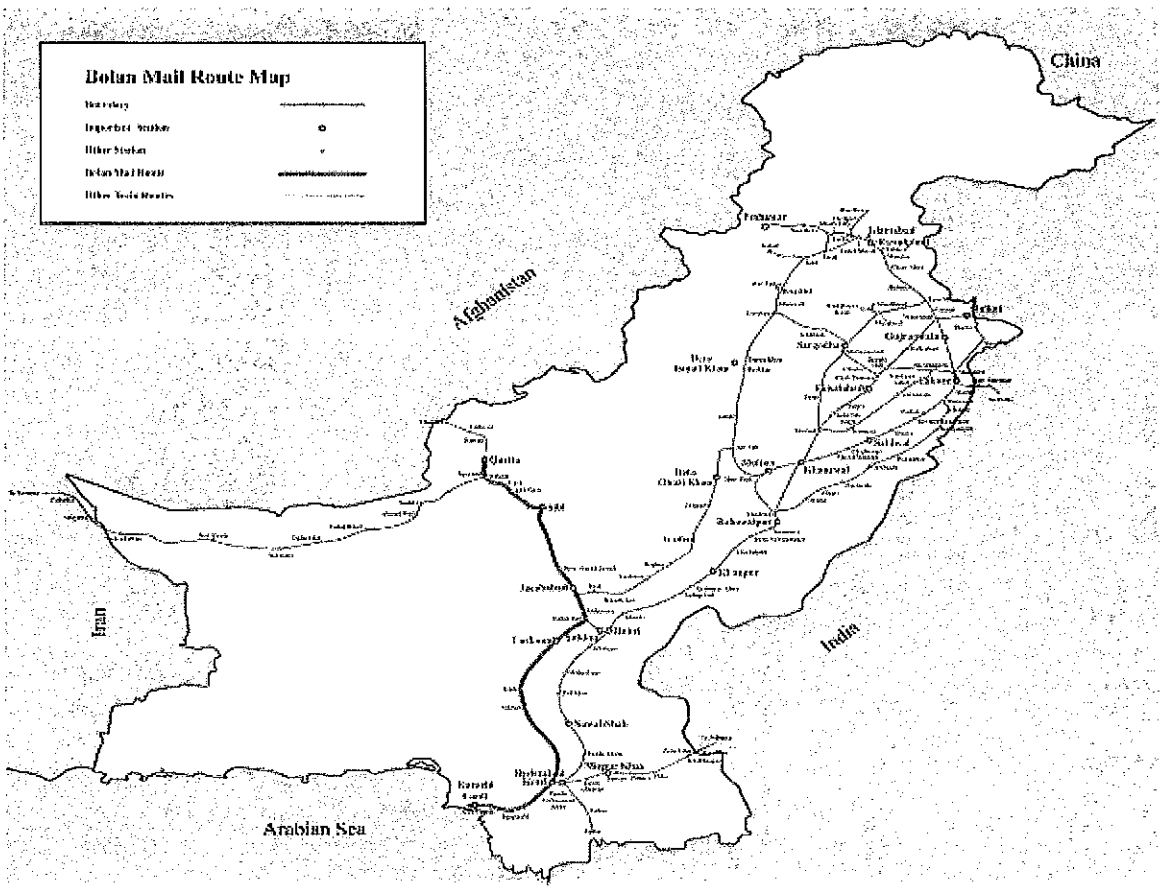


Figure 8 Train route from Karachi to Quetta

2.5 Baseline Condition:

2.5.1 Site Description:

The project site is located at a distance of 29 km in north of Quetta at Kuchlak on main Quetta Chaman highway at Balochistan, Pakistan. Based on the site visit information, publicly available information and past experience in conducting similar projects, HECS and EEL have prepared this study report on Initial Environment Examination. This report describes the various features of Initial Environment Examination of the project site in line with local and international standards.

2.5.2 Geology:

Quetta district lies between 300 - 03' and 300 -27' N and 660 - 44' and 670 - 18' E. The total geographical area of Quetta district is 2653 Km2. The general character of the district is mountainous. The hill ranges are fairly uniform in character consisting of long central ridges from which frequent spurs descend. These spurs are intersected by innumerable gorges and torrent beds. They vary in elevation from about 1,254 to 3,500 meters. The Mashlakh, the Chiltan, the Murdar and Zarghoon are the important mountain ranges in the district. Quetta lies in the active seismic region; therefore, earthquakes occur from time to time. The worst earthquake occurred in May 1935. There is no perennial river in the district. Whereas Quetta Lora (non-perennial channel) comes out near Sariab and traverses the western side of the Quetta valley.

Lora carries rain and waste water near Baleli and continues northward through the Kuchlak valley. Water of Quetta Lora is used for irrigation in villages like Khazi Samungli and Nohsar.

The proposed location and surrounding areas are a part of the Sulaiman Fold-Thrust Belt in western Pakistan and northern Balochistan. The Sulaiman Fold-Thrust Belt is a curved range of mountains on the western margin of Indian Plate. The belt was uplifted due to the oblique convergence of northwestern margin of Indian Plate with Afghan Block (Asia). The uplifting and folding has given rise to tight folds and thrusts. The rocks surrounding the area are mostly of limestone composition and they are forming appreciable peaks in the area. The beds generally strike in northeast and southwest direction and dips towards northwest. The age of rocks exposed range from Triassic to Holocene age. According to Geological Survey of Pakistan following formations are exposed in the area:

Sibi Group (Miocene) Sandstone, shale, clays, siltstone and occasional conglutinate beds intercalated.
Spintangi limestone (U. Eocene) Foraminiferal limestone with beds of shale. The limestone is cream, yellow to light grey, pinkish white or chalky white. It is medium to thick bedded.
Ghazij Shale (Mid Eocene) it contains olive colored, soft, fissile, in places having soft, cleared, grey limestone layers with abundant foraminifera.
Dunghan limestone (Paleocene) Medium- to thick-bedded, grey, dark grey. Sometimes marly limestone.
Parh limestone: The parh limestone is grey or chalky white and It is lithographic to porceilaneous
In addition to above chiltan limestone (mid jurrasic and shirinab formation are also found in Quetta.

2.5.3 Site Condition

Project site is located 6k in the north direction of Kucklack Bazar. Dry weather with severe cold in winter and hot in summer. The project site is flat barren land and topographically the general character of the surrounding area is mountainous and consists of long central ridges with numerous spurs.

2.5.4 Grid connection

Two main grids are available near the project area. In this regard the first one is Yaro Grid which is at a distance of 3km in the north towards Pishin. The other connectivity option is Sheikhmanda Grid Station, which is at a distance of 15-17 km from Kuchlfak in south east toward Quetta. Connectivity options from both the grid will be decided after technical review.

2.5.5 Weather Condition:

The climate in the Quetta district is "desert." There is virtually no rainfall during the year. This climate is considered to be BWh(B classification refer to hot desert climate) according to the Köppen-Geiger climate classification. The average annual temperature in Quetta is 24.5 °C. (Due to climate change and global warning phenomenon the temperature in summer from last three years ranges upto 38°C). The average annual rainfall is 249 mm. The driest month is November, with 3 mm of rain. In July, the precipitation reaches its peak, with an average of 63 mm. June is the warmest month of the year. The temperature in June averages 34.4 °C. At 12.1 °C on average,

January is the coldest month of the year. There is a difference of 60 mm of precipitation between the driest and wettest months. The variation in annual temperature is around 22.3 °C.

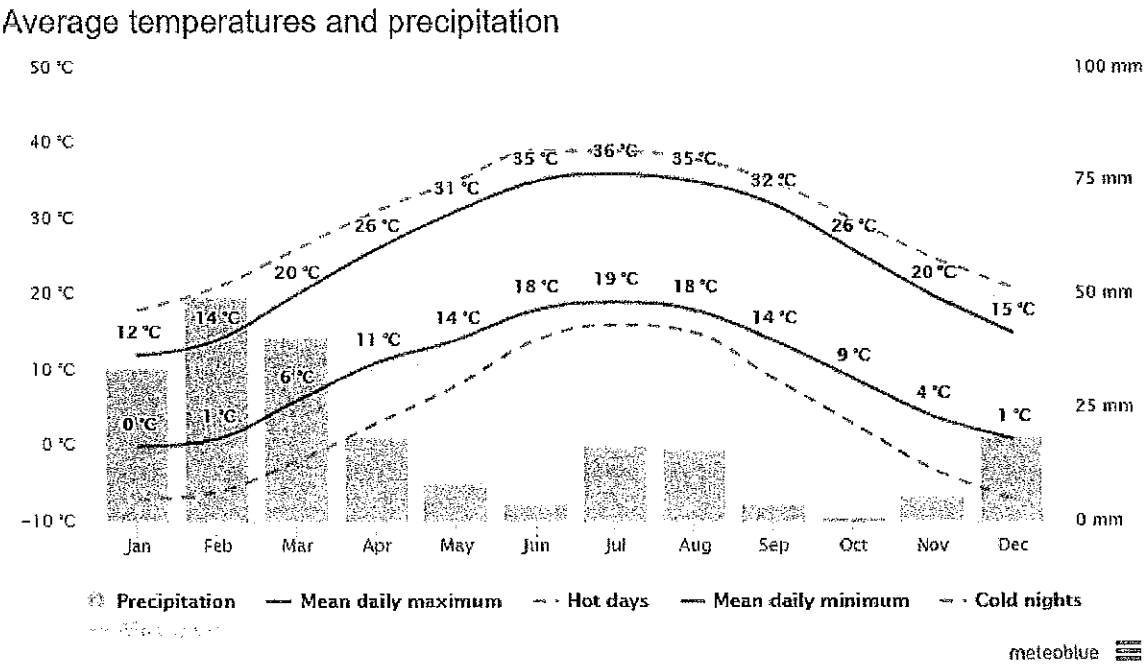


Figure 9- Average weather data for Quetta district

2.5.6 Micro Climate:

The project area is located in the 'Hot and Dry' Climatic Zone-1 of the country. According to Surface Meteorology and Solar Energy (SMSE) of NASA, site location receives daily global solar radiation from 3.31 kWh/m2 (in December) to 6.78 kWh/m2 (in June) over the year. The annual global solar radiation over the horizontal surface has been estimated as 1883 kWh/m2. The annual global solar radiation over the inclined surface (i.e. at the latitude of the location) has been estimated as 1995 kWh/m2. The microclimatic parameters namely ambient temperature, relative humidity, and prevailing wind speed of the project area are given in figure 10 for each month of the year. Month wise rain fall data of the region has also been presented in the figure 11.

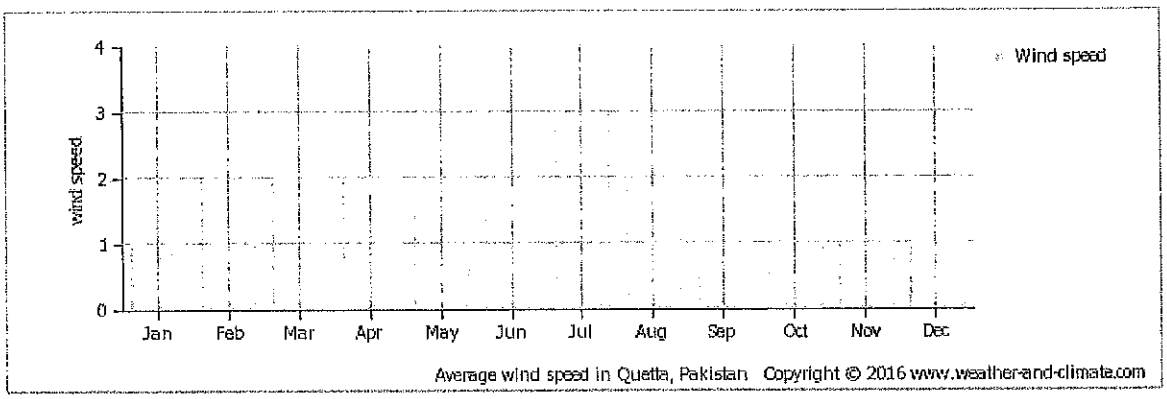


Figure 10 Average Wind speed Quetta (meter/sec)

Analysis of hourly wind speed shows that the winds are generally light to moderate in this area. The annual mean wind speed varies from 1.30 to 6.30 Km/hr.

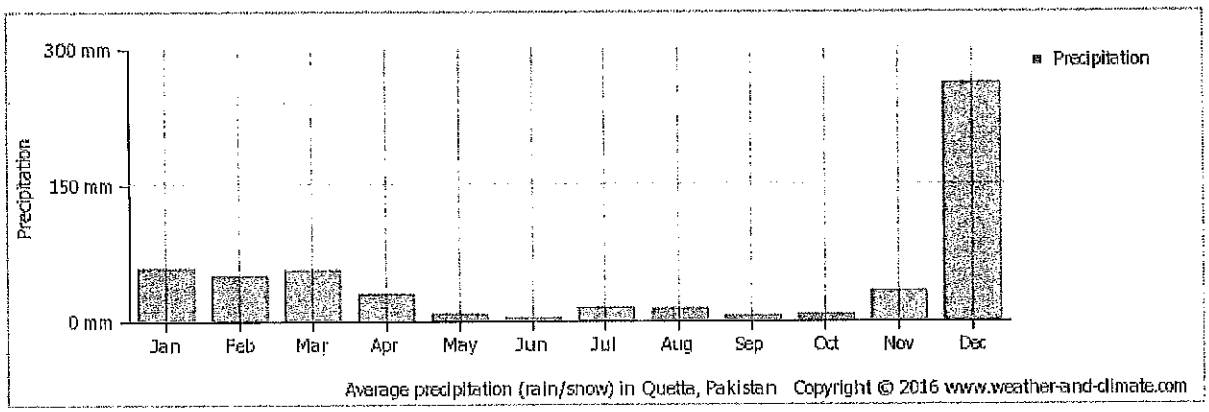


Figure 11 Average Precipitation in Quetta

WIND PATTERN: The wind rose diagram for seasonal has been drawn on the basis of hourly wind speed and direction data. South West and east west wind is dominant throughout the season.

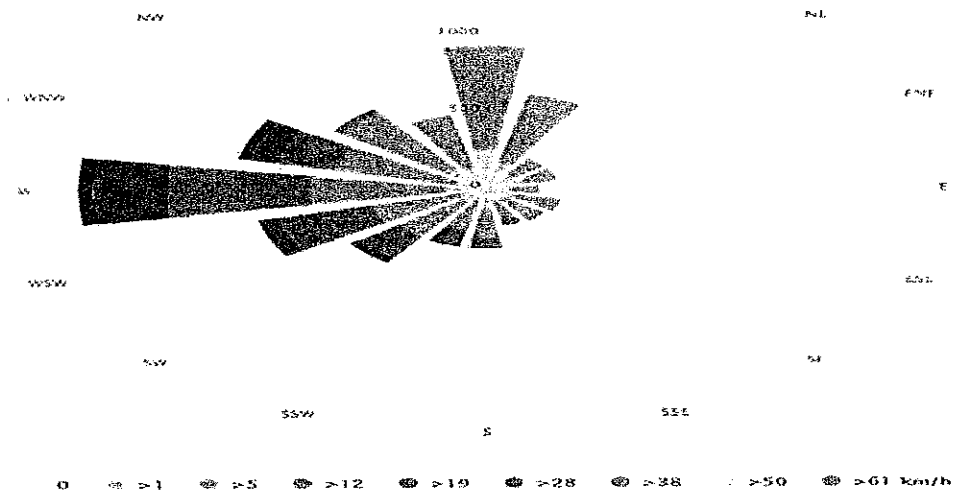


Figure 12 Wind Pattern in Quetta

2.6 Description about Process of PowerGeneration:

2.6.1 Selection of PV Mounting Structure:

There are simple fixed supports and complex tracking systems for PV system array bracket. The tracking system can move accurately so that the incident angle of the incident rays on the surface of the solar array will be minimized and the radiation intensity of the sun will be the largest.

In the design of Photovoltaic power generation system, the installation form of PV modules has a great influence on the total solar radiation received by the system, which affects the power generation capacity of the photovoltaic power supply system. The installation of PV modules consists of two types: fixed installation and automatic tracking. The automatic tracking system includes single axis tracking system and two axis tracking system. The system of single axis tracking (East and West angle tracking and polar axis tracking) tracks the trajectory of the sun from east to west with a fixed angle. The dual axis tracking system can change azimuth and inclination with the change of the seasonal position of the solar trajectory.

Fixed Bracket:

Considering the installation and safety, the most mature technology of the installation of photovoltaic modules is fixed installation. And the fixed installation is relatively lowest cost and most widely used method. Relative to the ground by the sun in the northern hemisphere midday Angle is equal to the local latitude during the vernal equinox and autumnal equinox, minus the sun in the winter solstice is equal to the local latitude declination Angle, when the summer solstice is equal to the local latitude and solar declination Angle. If the condition allows, can take two times throughout the year to adjust Angle, that is to say, in the spring - summer solstice - equinox using small Angle, the autumnal equinox, winter solstice - the vernal equinox with large dip Angle.

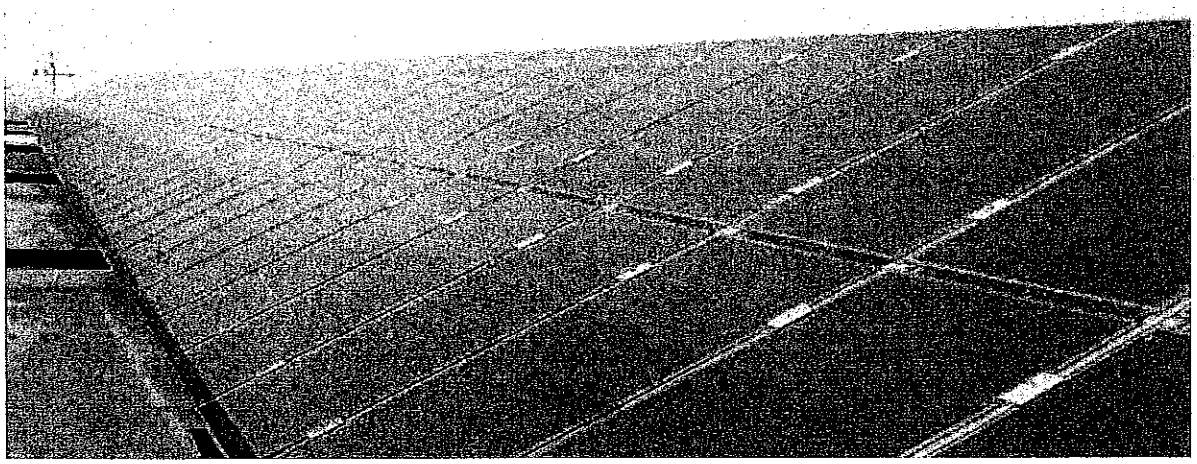


Figure 13 Fixed Bracket

Single axis tracker:

The single axis tracker is used to carry the traditional PV modules, and the average daily power generation can be increased by 20~35%. If the angle of the single axis and the ground is 0 degrees, it is a horizontal single axis tracker. If the axis of the single axis has a certain angle with the ground

and the azimuth angle of the photovoltaic module is not 0, it is called the uniaxial tracking of the polar axis. In The area of 30~40 degree in the north latitude, the horizontal single axis tracker can increase the generating capacity by about 15-20%, And the single shaft tracking with polar axis can increase the generating capacity by about 25-30%. However, compared with the horizontal single axis tracker, the cost of the single axis tracker of the polar axis is higher and the wind resistance is relatively poor, and the single axis tracker system usually adopts the horizontal single axis tracker method.

Figure 14 The horizontal single axis tracker

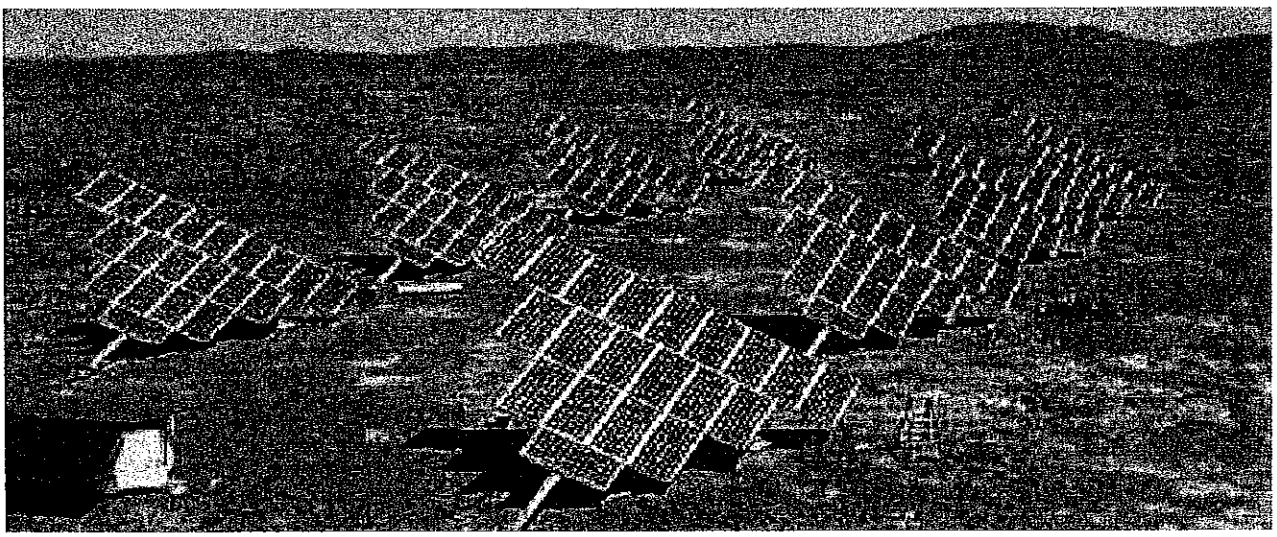


Figure 15 The polar axis tracker

Two-axis Tracker:

Two axis tracking is a tracking method that can be moved in two directions of azimuth and inclination. The dual axis tracking system can maximize the utilization of solar cells to sunlight. In different places and different weather conditions, the degree of improvement of the solar power

generation is also different: In a very cloudy and foggy place, Two-axis Tracker can increase the solar power generation by 30~35%.

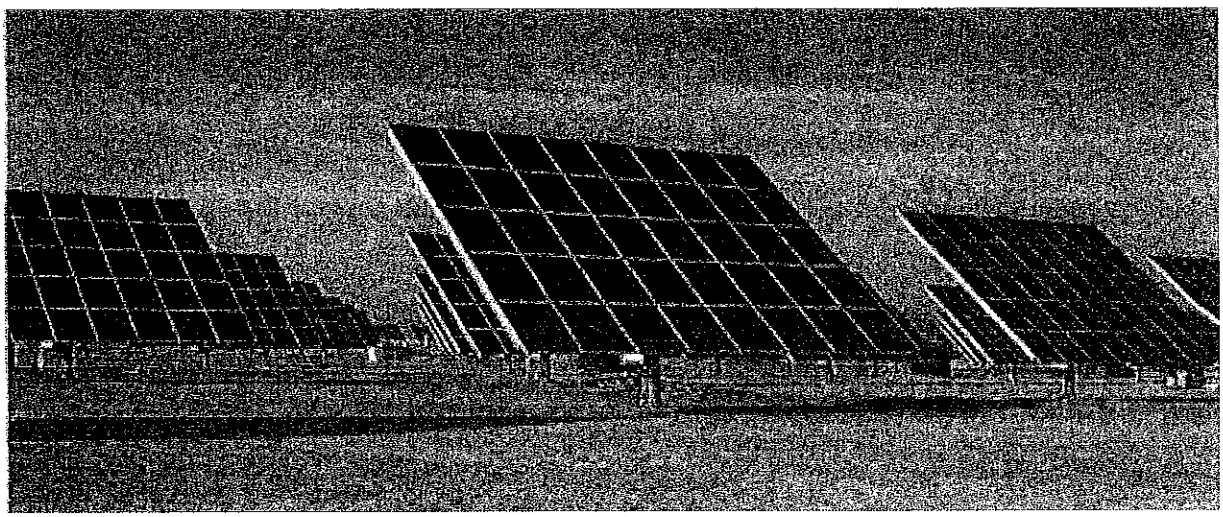


Figure 16 Two-axis Tracker

The total amount of solar radiation that can be received from the inclined plane to the maximum extent for tracking systems, thus increasing the power generation.

For tracking system, the amount of total solar radiation that can be received from the inclined plane to the maximum extent increases the power generation. By theoretical calculation, the theoretical power generation of the system can be increased by 15-20% by horizontal single-axis tracking, the theoretical power generation of the system can be increased by 25-30% if the polar axis tracking method is adopted, the theoretical power generation of the system can be increased by 30%-35% If the two-axis tracking method is adopted. The actual working efficiency of the system is usually less than the theoretical value. The reason of this phenomenon is Solar panels project shadows on each other, and tracking mounts are difficult to synchronize. According to the survey data of the built project, If the inclined single-axis tracking -method is adopted, the actual power generation of the system can be increased by about 18%. If the two-axis tracking method is adopted, the actual power generation of the system can be increased by about 25%.

Considering the reliability, economy and maintenance of the system, combined with the geological and topographic features, and in order to improve the efficiency of the system, the advanced photovoltaic technology is introduced, and the horizontal single axis tracking support scheme is adopted in this project.

2.6.2 Selection of Inverter:

Introduction to String Inverter and Central Inverter

In the recent years, new design methods have been employed in utility scale solar photovoltaic (PV) systems to allow developers to continue decreasing installation cost and operating cost. The selection of string inverters versus central inverters can has a measurable impact on the capital cost, operating cost, and potentially the energy yield of nowadays PV systems. As the PV industry

continues to search for opportunities to reduce the costs associated with capital and operating expenses the choice between the two designs will become more important.

In the end, inverter component, balance of system, commissioning, operating and maintenance, and replacement/refurbishments costs all must be evaluated when choosing the system design for a specific project. Today, central inverters are the most widely used and tested type of inverters when it comes to development of large scale power plants.

Chapter 3

CHAPTER 3: LEGAL POLICIES AND INSTITUTIONAL FRAMEWORK

3. Introduction:

This portion of report encapsulates the findings, analysis, conclusions and recommendations of the review of Environmental legislation and policy analysis focusing on solar energy power.

EEL has commissioned an IEE study and report to EPA, Balochistan as part of its initiatives to promote renewable energy sector for clean environment. The aim of this chapter is to evaluate the potential for localizing solar energy interventions and its targets for preparing IEE report. The main purpose is to understand, assess and overcome the legal challenges hindering the achievement of project in the Kuchlak and support relevant provincial line agencies to understand existing legislative and policy framework relevant to renewable energy.

This section presents key findings and analysis on the existing legislative provisions and policy framework in Balochistan pertaining to IEE of Solar/Renewable Energy. The key findings are drawn from secondary and primary sources. The secondary sources include reviewing available literature review on the subject matter as well as legislation provisions currently in place or at formulation stage i.e. available in draft form. The primary sources include Focus Group Discussions (FGDs) and Corner Meetings with relevant stakeholders and sector actors, Key Informant Interviews (KIIs) with officials in key government departments.

Policy and a legislative framework for protection of the environment has been in place in Pakistan since the late 1970s. For the implementation of the policies and enforcement of legislation, necessary amendments have been made periodically to environmental policy, regulations and guidelines. The requirement of these policies, legislations have been duly considered in the preparation of this Initial Environmental Examination (IEE) of the Kuchlak- III Solar Power Plant Project.

Findings and Gap Analysis:There exist a number of legislative and policy provisions in Balochistan province and Pakistan relevant to the Environmental Protection.

Relevant Legislations	Relevant Policies/Plans
Pakistan Environment Protection Act (PEPA), 1997	National Policy Framework, 1970
Pakistan Environmental Protection Agency (Review of IEE/EIA) Regulations 2000	Pakistan National Conservation Strategy (NCS), 1992
Balochistan Environmental Protection Act (BEPA), 2012	National Environmental Policy, 2005
Forest Act, 1927	National Environmental Quality Standards (NEQS)
The Balochistan Wildlife Protection Act, 1974	

Antiquity Act, 1975 Mines, Oil Field and Minerals Development Act, 1948	National Forest Policy Pakistan, 2001 National Resettlement Policy (DRAFT), 2002 The Biodiversity Action Plan, 2000

Table 3 Policies relevant to Environmental protection

3.1 Pakistan Environment Protection Act (PEPA) 1997:

Pakistan Environment Protection Act (PEPA) 1997 is the basic legislative tool empowering the Government of Pakistan to frame regulations for protection of the environment. The Act is applicable to a broad range of issues and extends to air, water, soil, marine and noise pollution, as well as to the handling of hazardous waste. Penalties have been prescribed for those contravening the provisions of the Act. Key features of the law applicable to the Kuchlak Solar PV Power Plant Project are:

KEY FEATURES

Section 12(1) requires that "No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an initial environmental examination or, where the project is likely to cause an adverse environmental effect, an environmental impact assessment, and has obtained from the Federal Agency approval in respect thereof." The PakEPA has delegated the power of review and approval of environmental assessments to the provincial environmental protection agencies. As the proposed project will be located in the Kuchlak, Quetta District Balochistan province, it falls under the jurisdiction of the EPA Balochistan.

3.1.1 Other Relevant section of PEPA can be:

Section 11(1) states that "subject to the provisions of this Act and the rules and regulations made there under, no person shall discharge or emit or allow the discharge or emission of any effluent, waste, air pollutants or noise pollutants in an amount, concentration or level which is in excess of the National Environmental Quality Standards" The Pakistan Environmental Protection Agency (PAK-EPA), the body mainly responsible for enforcing the PEPA 1997, has published National Environmental Quality Standards (NEQS).

Section12(2)(b) requires that the federal agency shall review the environment impact assessment report and accord its approval subject to such conditions as it may deem fit to impose or require that the environmental impact assessment be resubmitted after such modifications as may be stipulated, or reject the project as built up contrary to environmental objectives. For the current solar project in Kuchlak it is required that an IEE report be submitted to the Concerned EPA (Balochistan EPA) and approval attained before undertaking any construction activity.

Section 14 states that: "subject to provision of this Act no person shall generate, collect, consign, transport, treat, dispose of, store, handle, or import any hazardous substance except (a) under a license issued by the government agency and in other law for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement or other instrument to which Pakistan is a party".

In order to accomplish effective implementation of the provisions of PEPA 1997, the PAK-EPA was constituted, headed by the Director General, with its head office located in Islamabad. On the same lines, EPAs/EPD have been created in all the four provinces of the country as well as Azad Jammu & Kashmir (AJK).

3.2 Pakistan Environmental Protection Agency (review of IEDD/EIA) Regulations 2000:

The Pakistan Environmental Protection Agency (PAK-EPA), under the process conferred upon it by the Pakistan Environmental Protection Act (PEPA 1997), provides the necessary details on the preparation, submission, and review of the Initial Environmental Examination (IEE) and the Environmental Impact Assessment (EIA).

Categorization of projects for IEE and EIA is one of the main topics of the Regulations.

Projects have been classified on the basis of the expected degree and magnitude of environmental impacts and included in different schedules contained in the Regulations. The projects listed in Schedule II are generally major projects likely to have adverse environmental effects. They also include projects in environmentally sensitive areas. Projects not included in Schedule II require an IEE for the issuance of NOC by the concerned agency prior to the construction of the project. The proposed Kuchlak PV plant Project requires an IEE.

The Regulations stipulate that within ten (10) working days of the IEE or EIA having been submitted, the federal/provincial agency will confirm that the document is complete for the purpose of review. During this time, should the agency require the proponent to submit additional information, it will return the IEE or EIA to the proponent for revision, clearly listing those aspects that need further attention.

3.3 Guidelines for Environmental Assessment:

The Federal EPA has published a set of environmental guidelines for conducting environmental assessments and the environmental management of different types of development projects. The guidelines that are applicable to the proposed Solar PV Energy Project, Kuchlak are listed below:

Guidelines for Preparation and Review of Environmental Reports

These guidelines describe the format and content of IEE/EIA reports to be submitted to the Federal and Provincial EPA's/EPD for obtaining the necessary environmental approval/ No Objection Certificate (NOC). The major topics, which are covered by these guidelines include:

The Environmental Assessment Report format (e.g. scope, type and category of the project, description of the project, alternatives, site selection and baseline data); Assessing impacts (identification, analysis and significance);

Mitigation and impact management and preparing an environmental management plan;

Reporting (format, main features, shortcomings, other forms of presentation);

Review and decision making (role, steps, remedial options, checks and balances);

Monitoring and auditing (systematic follow up, effective data management); and

3.3.1 Guidelines for Public Consultation:

The Federal EPA provides guidelines to deal with possible approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures the incorporation of their concerns in any impact assessment study.

3.3.2 Consultation, involvement and participation of stakeholders:

Effective public consultation (planning, stages of EIA where consultation is appropriate) Facilitation involvement (including the poor, women and NGOs).

3.4 Balochistan Environmental Protection Act 2012:

After the 18th Constitutional amendments, to regulate and effectively address the peculiar environmental issues of the province of Balochistan this act namely "Balochistan Environmental Protection Act 2012" is submitted as per provisions of the Article 270-A, Sub-Article (6) of 18th Constitutional amendments.

The Act defines IEE and its implementation status is capsulated in section-15 of Act.

No proponent of a project of public and private sector shall commence construction or operation unless he has filed an Initial Environmental Examination with the Government Agency designated by Balochistan Environmental Protection Agency, as the case may be, or, where the project is likely to cause an adverse environmental effect an environmental impact assessment and has obtained from the Government Agency approval in respect thereof.

The Government Agency shall subject to standards fixed by the Balochistan Environmental Protection Agency—

A. Review the initial environmental examination and accord its approval, or require submission of an environmental impact assessment by the proponent; or
B. Review the environmental impact assessment and accord its approval subject to such conditions as it may deem fit to impose, require that the environmental impact assessment be re-submitted after such modifications as may be stipulated or reject the project as being contrary to environmental objectives.

C. International relations, national security or maintenance of law and order, except with the consent of the Government of Balochistan; or
D. Matters covered by legal professional privilege.

The Government Agency shall communicate its approval or otherwise within a period of four months from the date the initial environmental examination or environmental impact assessment is filed complete in all respects in accordance with the prescribed procedure, failing which the initial environmental examination or, as the case may be, the environmental impact assessment shall be deemed to have been approved, to the extent to which it does not contravene the provisions of this Act and the rules and regulations.

Subject to sub-section (4) the appropriate Government may in a particular case extend the aforementioned period of four months if the nature of the project so warrants.

The provisions of sub-sections (1), (2), (3), (4) and (5) shall apply to such categories of projects and in such manner as may be prescribed.

The Government Agency shall maintain separate registers for initial environmental examination and environmental impact assessment projects, which shall contain brief particulars of each project and a summary of decisions taken thereon, and which shall be open to inspection by the public at all reasonable hours and the disclosure of information in such registers shall be subject to the restrictions specified in sub-section (3).

No concession areas for any developmental activities shall be awarded to any International/National groups or firms without consultation and concurrence of the Government of Balochistan/Environmental Protection Agency. (9) The prospect licenses for mining, quarrying, crushing etc. shall only be awarded/ granted in compliance with the sub section (1), (2), (3), (4) and (5).

The proponent of the project shall remit fifty thousand rupees as review fee of an Initial Environmental Examination (IEE) and one hundred thousand as review fee for Environmental Impact Assessment (EIA).

The Act also recommends the establishment of the Balochistan Environmental Protection Council for the approval of comprehensive environmental policies, provide guidelines for the conservation, rehabilitation and improvement of the environment and the sustainable development of resources or to undertake research in any aspect of environment. The Act also recommends the establishment of Balochistan Environmental Protection Agency and defines the function and powers of the Balochistan EPA.

The Act clearly describes the requirement of Initial Environmental Examination and Environmental Impact Assessment. The Act states that "No proponent of a project of public and private sector shall commence construction or operation unless he has filed an Initial Environmental Examination with the Government Agency designated by Balochistan Environmental Protection Agency, as the case may be, or, where the project is likely to cause an adverse environmental effects an Environmental Impact Assessment, and has obtained from the Government Agency approval in respect thereof".

3.5 Balochistan Environmental Protection Agency:

The Govt. has also established the Balochistan Environmental Protection Agency (EPA), to exercise the powers and perform the functions assigned to it under the provisions of the Act and rules and regulations made accordingly.

3.5.1 The major functions of Balochistan EPA are:

Administer and implement the provisions of Environmental Protection Act 2012 and the rules and regulations made there under.

- Prepare environmental policies for approval by the Council in coordination with the relevant Govt. agency and in consultation with the concerned sectors Advisory Committees.
- Take all necessary measures for the implementation of the national environmental policies approved by the Council.
- Prepare and establish an annual environmental report on the state of the environment.
- Prepare or revise and establish the environmental quality standards with the approval of the council.
- Ensure enforcement of the environmental quality standards.
- Establish standards for the quality of the ambient air, water and land by notification in the official gazette.
- Coordinate environmental policies and programs nationally and internationally.
- Establish systems and procedures for different working.
- Take measures to promote research and the development.
- Certify and approve laboratories for conducting test and analysis as environmental research.
- Identify the needs for and initiate legislation in various sectors of environment.
- Render advice and assistance in environmental matters.
- Assist the local Govt. /agencies to implement environmental laws and regulations.

3.5.2 The Balochistan-EPA has the authority to:

- Lease, purchase, acquire, own, hold, improve, use or otherwise deal in and with any property both movable and immovable.
- Fix and realize fees, rates and charges for rendering any service or providing any facility, information or data under this Act or the rules and regulations made there under.
- Enter into contracts, execute instruments subject to approval of the Provincial Government, necessary for proper management and conduct of its business made thereunder.
- Enter and inspect and under the authority of a search warrant issued by the Environmental Tribunal or Environmental Magistrate.
- Take samples of any materials, products, articles or substances or of the effluents, wastes or air pollutants.

3.6 National Environmental Quality Standards (NEQS):

The Government of Pakistan developed the National Environment Quality Standards (NEQS) for municipal and industrial liquid effluents, industrial gaseous emissions, motor vehicles exhaust and noise. The NEQS were first developed in 1993 and have been amended in 1995, 2000 and 2010. The standards specify the following;

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluent discharged to inland waters, sewage treatment facilities and the sea.
- Maximum allowable concentration of pollutants (16 parameters) in gaseous emission from

industrial resources.

- Maximum allowable concentration of pollutants (2 parameters) in gaseous emission from vehicle exhaust and noise emission from vehicles.

3.7 Forest Act, 1927:

This Act provides rules and regulations for the protection of forests, control of timber and other forest-produce transit, village forest and social forestry. The Act is being revised as the law was framed for regulating forests all over undivided India before independence in 1947. It was adopted as it is, after the creation of Pakistan and it continues to remain in force till date.

This act has been comprehensively formed and allocates power to the concerned agency to declare protected and reserved forests through government notification and specifies powers allocated to the forest officers. It also contains the description of power to acquire land and the powers to stop ways and water-courses in reserved forests, dealing of claims relating to shifting of cultivation, power to issue and publish notification to reserve trees, power to make rules for protected forests, power to declare forest no longer reserved, order on rights of pasture or transit forest-produce, record keeping by the forest officer(s), commutation of right to appeal, time limit for resolution of claims and appeals, notification of acts prohibited in such forests (unlawful cutting of trees), awarding penalties on violations etc.

3.8 The Balochistan Wildlife Protection Act, 1974:

The Balochistan Wildlife Protection Act, 1974 was passed by the Provincial Assembly of Balochistan in 1974. This Act is applicable to the whole of the Balochistan Province except the tribal areas for protection, conservation, preservation and management of wildlife. The Act accommodates the issuance and validity of licenses and permits, empowering the government officers to issue such permits to public or V.I.Ps, prohibition of cooking of wild animals/birds meat in any public place, trapping or shooting near Game Reserves or Sanctuaries, warranting seizure or inspection of any person or hunting equipment at any given time by the park rangers, as well as providing a set of fee structure for various permits including hunting, trapping, possession or import and export of wild animals/birds.

3.9 Antiquities Act, 1975:

The Antiquities Act relates to the protection, preservation and conservation of archaeological/historical sites and monuments.

The Antiquities Act 1975 ensures the production of cultural resources of Pakistan. This act is designed to protect antiquities, from destruction, theft, negligence, unlawful excavation, trade and export. Antiquities have been defined in the act as ancient product of human activity, historical sites, or sites of anthropological or cultural interest; national monuments etc. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area which may contain details of archeological significance. The guideline procedure for environmental assessment recommended by Pakistan EPA reacts as follows;

"If the proponent or consultant identifies an archeological site that appears to be of importance, but the site is not listed they should discuss the site with the relevant conservation authority,"

The relevant conservation authority should inform the responsible authority of their assessment of the significance of likely impact of the proposed development early in the process in order for the responsible authority to determine the level of documentation required. The EPA will then be in a position to review the level of reporting required in the light of advice from the archaeology department.

Land Acquisition Act (LAA), 1894:

The only available national legislation relating to land acquisition and compensation is the Land Acquisition Act (LAA) of 1894. The LAA provides for the acquisition of private properties for public purposes, including development projects, in Pakistan. It comprises of fifty-five sections dealing with area notifications, survey, acquisition, compensation, apportionment awards, disputes resolutions, penalties and exemptions. The LAA is, however, limited to a cash compensation policy for the acquisition of land and built-up property, and damage to other assets, such as crops, trees, and infrastructure. The LAA does not consider the rehabilitation and resettlement of disrupted populations and the restoration of their livelihoods.

3.10 Asian Development Bank (ADB) Policies & Standards:

Following ADB policies and standards to manage social and environmental risks and impacts are considered;

- Safeguard Policy Statement 2009
- Policy on Gender and Development
- Social Protection Strategy
- Public Communications Policy 2011
- Core Labor Standards

The brief description of above policies and standards are as given:

ADB Safeguard Policy Statement 2009:

This safeguard policy statement applies to all ADB-financed and/or ADB-administered sovereign and non-sovereign projects, and their components regardless of the source of financing, including investment projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees (hereafter broadly referred to as projects):

ADB operational policies include basic safeguard policies mentioned below.

- Involuntary Resettlement Safeguards (elaborates ADB's involuntary resettlement safeguards aim to avoid involuntary resettlement wherever possible; to minimize involuntary resettlement by exploring projects and effective planning and implementation)
- Indigenous Peoples Safeguards ADB's indigenous peoples' safeguards aim to ensure that the design and implementation of projects foster full respect for indigenous peoples' identity and dignity.
- Environmental Policy provides an overarching framework for addressing the environmental

issues particularly contamination of clean water bodies and coastal waters, air contamination, lack of proper waste management, deforestation, loss of biodiversity, desertification and natural resource management among others.

- Gender sensitivity, analysis and main streaming: This defines ADB's gender categorization system that assesses the extent to which projects integrate gender issues.
- 2011 Public Communications Policy the Public Communications Policy aims to enhance stakeholders' trust in and ability to engage with ADB, and thereby increase the development impact of ADB operations. The policy promotes transparency, accountability, and participatory development. It establishes the disclosure requirements for documents ADB produces or requires to be produced.
- 2001 Social Protection Strategy The 2001 Social Protection Strategy defines social protection as a set of policies and programs designed to reduce poverty and vulnerability by promoting efficient labor markets, diminishing people's exposure to risks, and enhancing their capacity to protect themselves against hazards and interruption/loss of income.
- Labor Law: ADB also has a memorandum of understanding with the International Labour Organization (ILO) to facilitate collaboration in matters of common interest, including international labor standards. The core labor standards endorsed by all ILO members include (1) freedom of association and collective bargaining, (2) elimination of forced and compulsory labor, (3) elimination of discrimination in employment and occupation, and (4) abolition of child labor.

3.11 World Bank Guidelines on Environment:

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

Environmental Assessment Operational Policy 4.01. Washington, DC, USA. World Bank 1999. Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross Sectorial Issues. World Bank Technical Paper Number 139, Environment Department, the World Bank, 1991, Pollution Prevention and Abatement Handbook: Towards Cleaner Production, Environment Department, the World Bank, United Nations Industrial Development Organization and the United Nations Environment Program, 1998.Environmental Health and Safety (EHS) guidelines, International Finance Corporation (IFC) World Bank Group, 2007.

The first two publications listed here provide general guidelines for the conduct of an IEE and address the IEE practitioners themselves as well as project designers. While the Sourcebook in particular has been designed with Bank projects in mind and is especially relevant for the impact assessment of large-scale infrastructure projects, contains a wealth of information which is useful to environmentalists and project proponents.

The Sourcebook identifies a number of areas of concern, which should be addressed during impact assessment. It sets out guidelines for the determination of impacts, provides a checklist of tools to identify possible biodiversity issues and suggests possible mitigation measures. Possible development project impacts on wild lands, wetlands, forests etc. are also identified and mitigation measures suggested. The Sourcebook also highlights concerns in social impact assessment and emphasizes the need to incorporate socio-economic issues in IEE exercises.

3.12 Equator Principles:

The Equator Principles are a set of guidelines, promoted by the International Finance Corporation (IFC) that address the environmental and social issues associated with major development projects worldwide. They provide a common baseline and framework for the implementation of internal environmental and social procedures and standards for project financing activities across all industries.

Principles;

1. Review and Categorization (of projects) Principle
2. Social and Environmental Assessment Principle
3. Applicable Social and Environmental Standards Principle
4. Action Plan and Management System Principle
5. Consultation and Disclosure Principle
6. Grievance Mechanism Principle
7. Independent Review Principle
8. Covenants Principle
9. Independent Monitoring and Reporting Principle
10. EPFI Reporting

3.13 IFC Performance Standards on Social and Environmental Sustainability:

International Finance Corporation (IFC) applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. The Performance Standards are also applied to the projects in emerging markets. Together, the eight Performance Standards establish standards that the Proponent is to meet throughout the project.

The objectives of Performance standards are given below:

To identify and assess social and environment impacts, both adverse and beneficial, in the project's area of influence

- To avoid, or where avoidance is not possible, minimize, mitigate or compensate for adverse impacts on workers, affected communities and the environment
- To promote improved social and environment performance of companies through the effective use of management systems.

Total, the eight Performance Standards establish standards that the Proponent is to meet throughout the project which are named as:

- Performance Standard-1: Social & Environmental Assessment and Management System
- Performance Standard-2: Labor and Working Conditions
- Performance Standard-3: Pollution Prevention and Abatement
- Performance Standard-4: Community Health, Safety and Security
- Performance Standard-5: Land Acquisition and Involuntary Resettlement
- Performance Standard-6: Biodiversity Conservation and Sustainable Natural Resource Management
- Performance Standard-7: Indigenous Peoples
- Performance Standard-8: Cultural Heritage objectives have been set in the IFC performance

standards to achieve sustainable development.

3.14 Institutional Setup for Environmental Management:

The apex environmental body in the country is the Pakistan Environmental Protection Council (PEPC), which is presided by the Chief Executive of the Country. Other bodies include the Pakistan Environmental Protection Agency (Pak-EPA), provincial EPAs (for four provinces, AJK and Northern Areas), and environmental tribunals. The EPAs were first established under the 1983 Environmental Protection

Ordinance; the PEPA 1997 further strengthened their powers. The EPAs have been empowered to receive and review the environmental assessment reports (IEEs and EIAs) of the proposed projects and provide their approval (or otherwise). The proposed project of solar PV would be located in Balochistan Province, hence this IEE report will be sent to the EPA Balochistan for review.

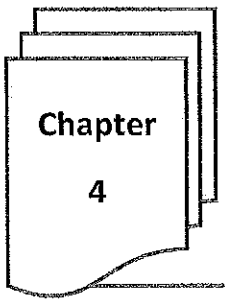
OBLIGATION UNDER INTERNATIONAL LEGAL ENTITIES/TREATIES

There are also International obligations relevant to the Environmental Protection like World Bank Guidelines on Environment, Equator Principles promoted by International Finance Corporation (IFC), IFC Performance Standards on Social and Environmental Sustainability.

Pakistan is signatory of several Multilateral Environmental Agreements (MEAs), including:

- Basel Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal,
- Convention on Biological Diversity (CBD),
- Convention on Wetlands (Ramsar)
- Convention on International Trade in Endangered Species (CITES),
- UN Framework Convention on Climate Change (UNFCCC),
- Kyoto Protocol,
- Montreal Protocol on substances that deplete the ozone layer,
- UN Convention to Combat Desertification.
- Convention for the Prevention of Pollution from Ships (MARPOL),
- UN Convention on the Law of Seas (LOS),
- Stockholm Convention on Persistent Organic Pollutants (POPs),
- Cartina Protocol.

These MEAs impose requirements and restrictions of varying degrees upon the member countries, in order to meet the objectives of these agreements. However, the implementation mechanism for most of these MEAs is weak in Pakistan and institutional setup nonexistent. Although almost all of the above MEAs would apply to the projects in one way or the other, the ones which have direct relevance for the proposed project include the Basel Convention Montreal Protocol, Stockholm Convention, UNFCCC and Kyoto Protocol. Kyoto protocol applies for the proposed project because it's used in CDM (Clean Development Mechanism). A CDM project activity might involve, for example, a rural electrification project using solar panels or the installation of more energy-efficient supply system. The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.



CHAPTER 4: ENVIRONMENTAL & SOCIAL BASELINE

4. Portrayal of Baseline Environment:

4.1 General:

This section pronounces the baseline conditions, covering the existing physical, ecological, and socio-economic environment of the Project Area. The provided data on these features has been derived from both the desk review of available secondary information and collection of primary data through field visits to the study area and meeting with nearby community and relevant line departments.

4.2 Physical Environment:

4.2.1 Geology and Soil:

The Kuchlak town is also known as Kuchlagh near Quetta, in the province of Balochistan, Pakistan. It is governed by a union council in Chiltan Town, Quetta. The province Balochistan is indeed a piece of geological wonderland on Earth. Very few segments of the globe may have so many geological marvels congregated in a piece of land equal in area to that of Balochistan.

Project Area lies in Balochistan Basin, which consists of unconsolidated surficial and older alluvial deposits of Holocene age followed by poorly consolidated assemblage of sandstone, conglomerates and shale of Pleistocene rocks mainly of Lacustrine or fluvial origin. The surrounding mountains comprises mainly of slate, shale at some locations, conglomerate, dolomite, lime stone, sand stone, gypsum, glacial till and hard rock. The scarcity of water in the area and the semi-desert climatic conditions has limited trees and shrubs to grow. Geotechnical investigation reflects mainly the very stiff lean clay in the subsurface up to 30-meter depth. There are no mines and minerals found in the project site.

4.2.2 Topography:

The project site is flat barren land and topographically the general character of the surrounding area is mountainous and consists of long central ridges with numerous spurs. These spurs vary in elevation from 1,500 to 3,300 meters but will have no impact reduction on receipt of solar radiations due to its sufficient distance from project site.

4.2.3 Seismology:

The Project Area is considered as seismically active. Frequent small to moderate earthquakes have been recorded along the tectonic features located within and around the Project Area. The Project

Area falls in Seismic Zone 4 of the Seismic Zoning Map of Pakistan. Zone 4 falls in very high-risk areas with peak horizontal ground acceleration greater than 0.32g.

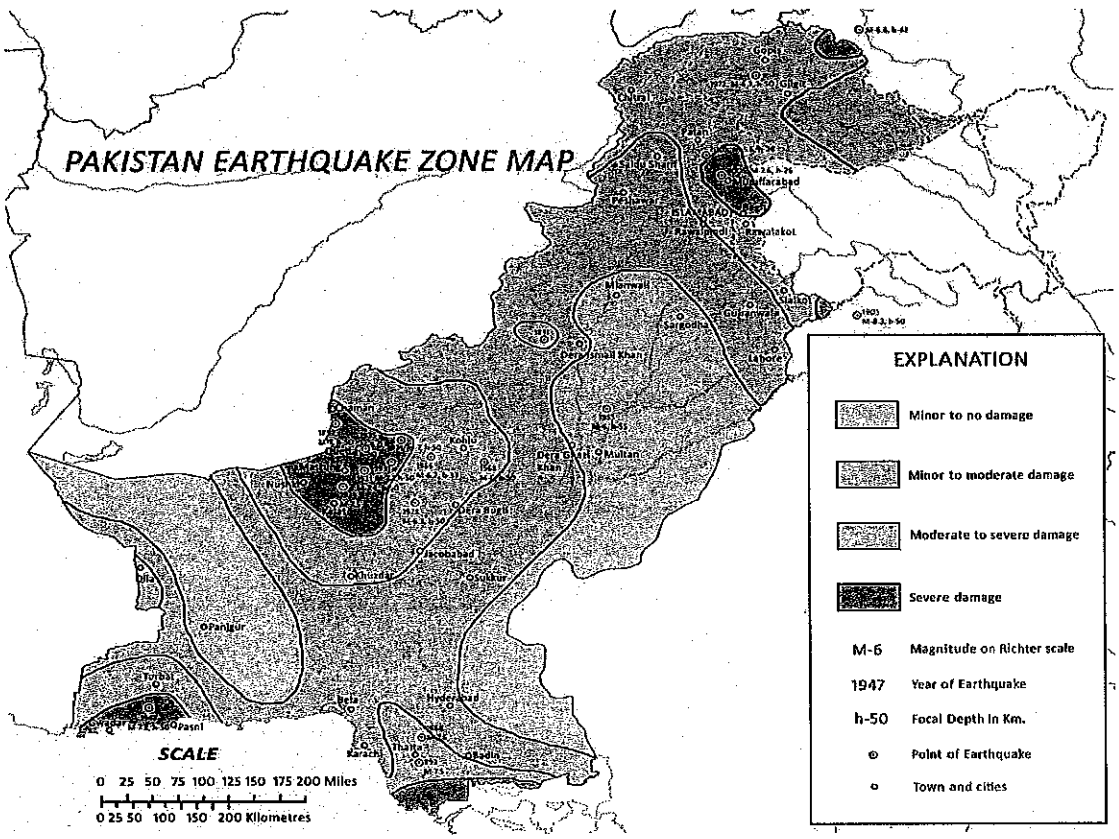


Figure 17 Seismic Map Showing Location of the Project Area

4.3 Geographical Features:

Kuchlak is geographilly located in bordering area between Quetta and Pishīn districts as one of the major towns of District Quetta. Quetta district is bounded north by Pishīn district, in the west by Afghanistan, in the east by Sibi district and in the south by Kalāt and Chāgai districts. Physically it comprises a series of long valleys which are 4,500–5,500 ft above sea level enclosed by the Central Brāhui range in the south and drained by the Pishīn Lora River and its tributaries. Area-wise district Quetta ranks 4th smallest district in Balochistan and has an area of 2,653 square kilometers, Quetta District lies between 66°41'40"-67°17'25" East longitudes and 30°01'29"-30°28'25" North latitudes consisting of 2Tehsils and 67 Union councils. Location of Quetta is at 690 km (aerial distance) south-west (237degrees bearing) of Pakistan's capital city, Islamabad.

Climatic and weather features:

Kuchlak has a continental arid climate with great variation between summer and winter temperatures. Summer highs can reach 40 °C (104 °F) while winter temperatures can drop to −16 °C (−2 °F). Summer begins in late May and continues until early September, with average temperatures ranging from 24–26 °C (75–79 °F). Autumn runs from late September to mid-November, with average temperatures in the 12–18 °C (54–64 °F) range. Winter starts in late

November and ends in late March, with average temperatures near 4– 5 °C (39–41 °F) and snow during the months of January and February. Spring starts in early April and ends in late May, with average temperatures close to 15 °C (59 °F). Unlike most of Pakistan, Kuchlak does not have a monsoon with sustained, heavy rainfall; snowfall during the winter months is the principal mode of precipitation. The climate of Balochistan has a wide variation. The coastal belt of Makran is hot and humid. The hilly areas in the north have bracing cool dry climate. Kachhi Plain and Kharan Desert are the hottest places in the Province. Most of the area is arid with very low precipitation. Except for the juniper forest around Ziarat and some Pinus forests in Shinghar and Shirani areas, the rest of the hills are barren. The winters are very severe and are affected by Siberian winds. Balochistan has the four climatic regions i.e. Tropical Coastal Area, Sub-Tropical Continental Low Lands, Sub-Tropical Continental High Lands and Sub-Tropical Continental Plateau. The meteorological data of the Quetta District is discussed here in terms of temperature, relative humidity and rainfall as the most relevant and nearest weather station to the Project Area.

4.3.1 Temperature:

The temperature in the Quetta District varies greatly. January is the coldest month with the average temperature of 4.7°C temperature from 1980 to 2010. The daily temperature at Quetta District seldom drops below 0°C in December and January. The highest temperatures are observed in the months of June and July, which is 28.7°C on average basis.

4.3.2 Rainfall:

Rainfall data was collected for Quetta District from 1980 to 2010. The analysis was carried out for monthly basis and graph shows that there is wide variation in the rainfall. Maximum rainfall occurs in the month of January with the value of 55.3 mm and minimum occurs in the month of September with the value of 2.3 mm.

4.4 Water Source:

4.4.1 Water Quality:

In order to determine the existing water quality of ground water, samples were collected from Jaloger (Nearby Village) of project site and Kuchlak for laboratory analysis. Groundwater samples were tested and for Air, Noise parameters as per NEQS for physical, chemical analysis. A copy of NEQS is attached as Annex- II for ready reference. The laboratory test results of groundwater samples are listed in the table below;

4.5 Air and Noise Quality Monitoring Results:

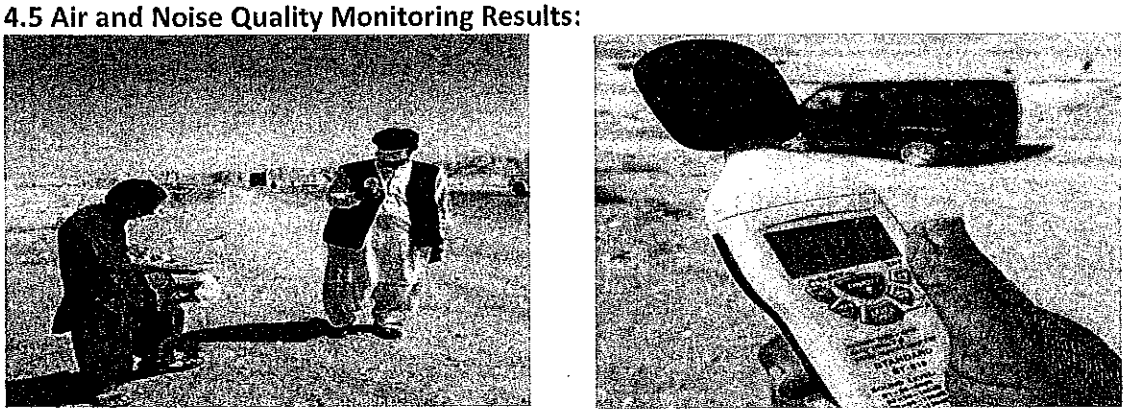


Figure 18 Pictures of noise test

S.NO	Parameters	Units	NEQS Limits	Concentration				
				Location-1	Location-2	Location-3	Location-4	Location-5
1	Ozone (O_3)	ug/m^3	130	4	3	3	4	3
2	Oxides of Nitrogen (NOx)	ug/m^3	120	2.2	3.53	3.48	3.23	2.12
3	Oxides of Sulphur (SOx)	ug/m^3	120	4.32	6.51	5.33	4.32	5.12
5	Particulate Matter (PM_{10})	ug/m^3	150	71	67	84	61	57
6	Particulate Matter ($PM_{2.5}$)	µg/m^3	35	24	28	27	27	25
7	Noise	dB	75	64	52	74	56	51

Table 4 Parameters

S.No	Parameters	Units	Concentration	Method
1.	Temperature	0C	29	Thermometer
2.	pH Value	....	6.89	pH meter
3.	Manganese	mg/l	0.12	AAS
4.	Zinc	mg/l	0.14	AAS
7.	Total Dissolved Solids	mg/l	2143	APHA 2540 C
8.	Chloride	mg/l	644.9	APHA 4500 Cl B
9.	Lead	mg/l	0.27	AAS
10.	Fluoride	mg/l	2.38	Hach Method 8029
11.	Sulphate	mg/l	530	Hach Method 8051
12.	Ammonia	mg/l	0.09	Hach Method8038
13.	Boron	mg/l	1.32	Merck Test 1.00826

Table 5 Laboratory analysis report of PCSIR and Labs of University for Air, Noise & Ground Water quality Chemical Analysis of Sample 01 (Tubewell Water, Kuchlak)

S.No	Parameters	Units	Concentration	Method
1.	Temperature	0C	27	Thermometer
2.	pH Value	....	6.81	pH meter
3.	Manganese	mg/l	0.14	AAS
4.	Zinc	mg/l	0.18	AAS
5.	Cadmium	mg/l	0.03	AAS
6.	Total Dissolved Solids	mg/l	1989	APHA 2540 C
7.	Chloride	mg/l	578.1	APHA 4500 Cl B
8.	Lead	mg/l	0.21	AAS
9.	Fluoride	mg/l	2.38	Hach Method 8029
10.	Sulphate	mg/l	580	Hach Method 8051
11.	Ammonia	mg/l	0.07	Hach Method8038
12.	Boron	mg/l	1.56	Merck Test 1.00826

Table 6 Chemical Analysis of Sample 02 (Tap Water, Killi Jalogeer). Chemical Analysis of Sample 02 (Tap Water, Killi Jalogeer)

The laboratory test report reveals that all the above ground water parameters are within the allowable limit of NEQS. A laboratory analysis report of PCSIR and Labs of University for Air, Noise & Ground Water quality is as given with comparative analysis with NEQS (Attached as Annex III).

4.6 Wetlands:

There is no wetland of national or international importance located in the district; however, Hanna Lake and Spin Karez support migratory bird population during their seasonal migration. The solar project will have no significant effect on birds and other mammals of the area.

4.7 Ecological Environment:

4.7.1 Flora:

The Project Area has a scanty vegetation cover as it falls in arid zone, characterized by low rainfall, scarcity of moisture and long dry spells. These factors resulted in lack of natural vegetation except for very few, likewise the area mostly consist of xerophytes species. Overall natural vegetation, including shrubs, bushes and grasses cannot be seen. In general, the province Balochistan is aptly termed as encompassing potential rangelands which support a good number of livestock. These rangelands are also substantially contributing to the ecological stability of important ecosystems in the area. The rangelands have degraded due to overgrazing and fuel wood collection, and the only remnants are less palatable and poisonous plants like Ghuzera (*Sophora grifithii*). Degradation has been further aggravated by traditional nomadic migrants and Afghan refugees.

Kuchlak valley, where the project is located, is comprising of barren wasteland, except the areas, close to settlements or villages, where people have installed tube wells and brought the area irrigation to grow crops, vegetables and fruit orchards. But these human settlements are away from the exact location of project area. Trees Natural tree cover, in the Kuchlak valley, has been extensively reduced, due to cutting by both local inhabitants and traditional nomads for fuel wood and thatching of roofs.

In Quetta District, major tree species, which once existed and are still sparsely found in the remote hills are Bought Apurs or (Juniperous excelsa polycarpos), Wild Ash (Fraxinus anthoxyloides), Shinay or Wild pistachio (Pistatio khinjjak), Surai (Rosa beggeriana), Anjir (Ficus johannis), etc. In the valleys, Ghaz (Tamarix spp) is found in stream beds. Mesquit (Prosopis juliflora) is common in graveyards and barren areas. It appears that people have no tendency to raise trees in their houses or lawns, however in some houses eucalyptus (Eucalyptus camaldulensis) and Ber (Zizyphus jujuba) trees were seen. Roadside plantations, mostly of mulberry, eucalyptus and tamarix, were raised, along almost all major roads in Quetta district including Quetta Chaman Road.

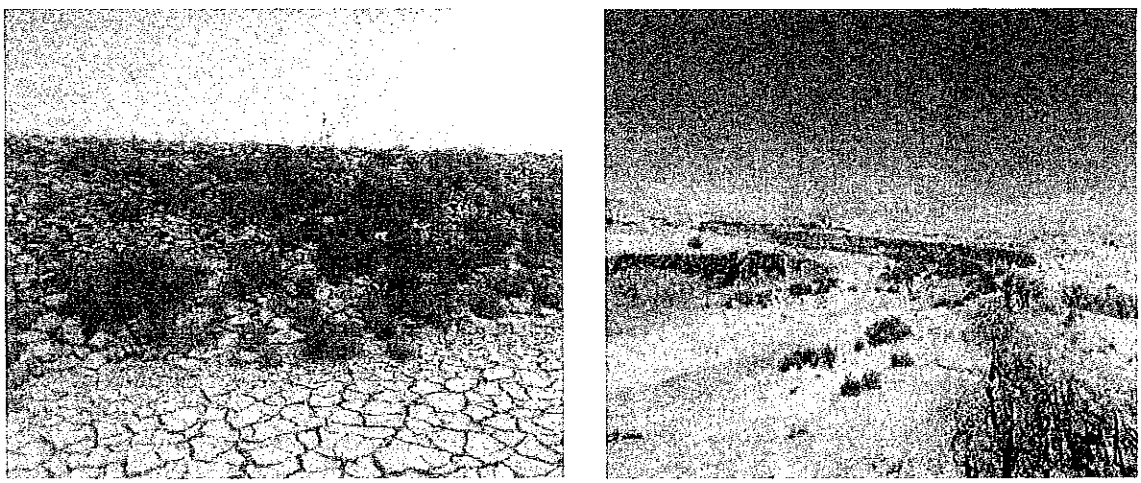


Figure 19 Project areas

The project area has no plantation except some scanty shrubs and hurbs and most of the land has been levelized by the project company so there is no or minor impact on the species. There is no such threatening or endangers species exist as indicated by IUCN red list of the species. There is

not any environmentally sensitive area located in or near to the buffer zone of the project. There is no impact of project activity on environmental sensitive area.

4.7.1.1 Shrubs:

Some of the shrubs found in the area include: Gung (*Vertex agnus-castus*), Ghureza (*Sophora lopcuroides*), Tharkha (*Artemisia maritime*), Zawal (*Achillea santolina*), Zoz (*Alhagi camalorum*), Spanda (*Peganum harmala*), Washta (*Stipa pennata*) etc. Shrubs and bushes like Delako (*Convolvulus spinosus*), Makhi (*Caragana ambigua*), Mateto (*Salvia cabulica*), Mazhmunk (*Amygdalus brahuica*), Oman (*Ephedra nebrodensis*), Wild almond (*Prunus ebernea*), Zralg (*Berberis lyceum*), etc. also exist, especially in the hilly areas. Picture below shows the shrubs in the Project Area.

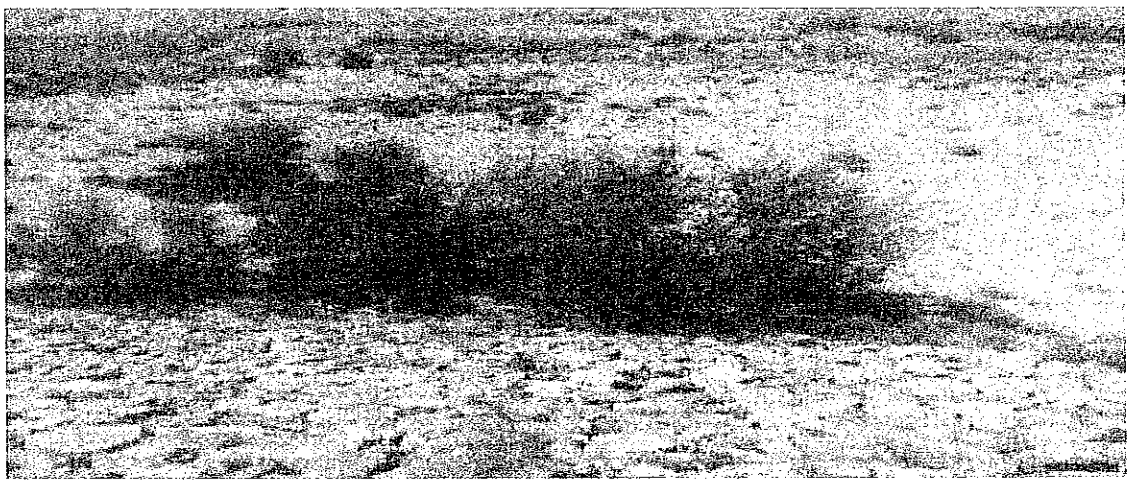


Figure 20 Shurbs in target site

4.7.1.2 Grasses and Herbs:

The ground cover is constituted rarely by grasses like Weezh (*Pennisetum orientale*), Sargarai (*Cymbopogon jawarancusa*), Margha (*Pennisetum annulatum*) Kaj (*Chrysopogon aucheri*), Holambae (*Avena sterilis*), Lashabae (*Poa bulbosa*), Sarandu (*Biossiera squarrosa*), Gasht (*Stipa trichoides*) etc. The drought has affected these herb, and these are now available in small quantity. Most of these are used by animals. Some of herb like sargarai and sparkai were previously used in medicines but due to course of time and shortage of these herbs people are going to medicine options. Since animals are also affected by drought therefore people are now dependent on feed of market and some food arranged from rain feed agriculture like sorghum or sun flower. The solar project will not affect any of the above herb because these are not available due to drought in project area.

4.7.1.3 Agriculture:

The Project Area falls in the tropical agro-ecological zone. Agriculture in the Project Area and its vicinity is only marginal and is dependent on rainfall (Barani). However, in the areas where irrigation is possible from tube wells or other sources the mainstay of the population is characterized by its commercial temperate fruit orchards and vegetables for marketing. As mentioned above lack of rain and drought has badly affected agriculture. Rain water is major source of agriculture for around 20-25% houses. But this agriculture is at very minimal level. A small

quantity of sorghum, barley, sun flower and melon are produced from rain water. The project area is barren with very few wild grass. Whereas rain fed water harvesting is away from project area.

4.7.1.4 Crops:
Areas where irrigation through tube wells or other sources is available have two cropping seasons. Rabi Crops; Wheat, Barley, Cumin, Vegetables and Fodder. These crops are sown in winter or during the early summer and harvested in the late summer. Kharif Crops; Melons, Fruits, Vegetables, Potato, Fodder and Onion, come under cash crops; they are sown in the summer and harvested in the late summer or early winter. The project area is barren with very few wild grass. Whereas rain fed water harvesting is done at a distance of 3-5 km from project area.

4.7.1.5 Horticulture:
Fruit production is very important and dominant in district Quetta as 48.7% of the irrigated area is under fruit production. Apple, apricot, grapes, peach, plum, pear and cherry are the leading fruits of district Quetta. However, in Project no horticulture land may come along the proposed site.

4.7.1.6 Rare or Endangered Species of Flora:
No rare or endangered species was observed and neither reported by the locals as well as officials of the Forest Department.

4.7.2 National Parks, Reserves and Protected Areas:
There are no national parks, reserves or protected areas in the vicinity of the Project Area.

4.7.3 Fauna:
There are different birds and mammal species are present in the area. Like; Caracal, Chinkra, Houbara Bustard, Great Indian Bustard, Sand, Groud, Desert Costal, Grey Baridrige, Doves, Raptors, Vultures, Diversified Lizards and snakes, Diversified song birds, different types of shrikes, Jackal and Jungle cat. As for the birds, there is no impact on the birds due to the solar panels; the panels that are used in the project are lined with anti-reflection coting which helps to reduce the reflection of the panels to almost zero. The fences will be made at the project boundary to control the movement of animals in the area.

4.7.3.1 Livestock:
Kuchlak is the area has enormous potential for livestock, which provides livelihood to many poor families. Mostly the nomadic population which resides in this area depends on livestock. Livestock farming is a traditional activity here and comprises mostly goats, sheep, cows, cattle, camels and asses. Goat constitutes the major portion of the livestock population in Quetta district. Livestock Department in Quetta manages and controls all the activities pertaining to livestock including animal health coverage and husbandry. Vaccination is being carried out free of cost, whereas, the treatment is provided at 50% subsidized rates. In the Kuchlak area, people prefer to keep and grow sheep, as compared to any other livestock species probably due to the suitable weather conditions and the ease of keeping it. The project area due to drought and overgrazed has become barren land and cannot be considered as rangeland currently.

4.7.3.2 Wildlife:
Wildlife here consists of mammals, reptiles and birds, as detailed below;

Mammals:
In Kuchlak, mammals such as markhor (wild sheep), wolves, hyena, which were common in the past are now a rarity and are only occasionally seen in the hilly areas. Mammals, which are still common in the area are rabbits, wild cats and porcupines, fox, jackal, hedgehog, migratory hedgehog, grey hamster, Persian jird etc. As a preventive measure project can prevent these mammals from any possible risk by constructing fens around project site.

Reptiles:
Reptiles include Lizards (Agama, Monitor), Afghan Tortoise (Agrionemys horsfieldii), Saw-scale viper (Echis carinatus), Levantine viper (Macrovipera lebetina) etc. These reptiles are not endangered because they are not found in project areas.

Birds:
Local birds' species include, sparrows, crows, partridges, warblers, shikra, the blue rock pigeon, rock nuthatch, hawks, accentor, bulbul, bunting, chat, chough, chukar, eagle, falcon, lark, magpie, owl, vulture etc. Most of the mentioned birds are now extinct except for crow, sparrow, shikra and pigeon. The project has no significant effect on the lives of these birds.

Wildlife Sanctuaries and Game Reserves:

No wildlife sanctuary or Game Reserve is located within 10 km on either side of the proposed alignment for the bypass.

Critical Habitats:

No critical habitats exist within the project area and therefore it can be stated that this Project does not affect any critical habitat as, no critical habitat is located close to it.

4.8 Socio Economic Environment:

The socio-economic situation is a significant part of the environmental baseline conditions. The Project Area is located in District Quetta, so the socio-economic environment of Quetta is explained here for the proposed Kuchlak Solar Energy Project.

4.8.1 Population and Ethnic Clans:

Population of the Quetta district, is 1,001,205 as of 2017 census while the Quetta District has a population of 2,275,699. According to 1998 Census report was 760 thousand persons which has increased to 1452 thousand persons in 2014, by applying a growth factor of 4.13 percent for Quetta district. The number of males and females works out to be 787 thousand and 665 thousand, respectively. The male to female ratio works out as 1:1.18. The average household size is 8.5 persons.

Quetta district is a multicultural and multi-linguist area. The principal ethnic groups in the district are Pashtoon, Baloch, Brahvi, Hazara and Punjabi. The Kasi, Bazai, Mashwani and Syed are sub-tribes residing in the area. The predominant religion in Quetta is Islam, with about 99% of the people referring to themselves as Muslim. A negligible proportion of the population belongs to other religions, including Christianity, Hinduism, Qadiani/Ahmadi, etc.

4.8.2 Administrative and Socio–Political Setup:

Quetta is the provincial capital and largest city of Baluchistan Province, Pakistan. It is also known as the Fruit Garden of Pakistan, due to the numerous fruit orchards in and around it. The district is located in northern Balochistan near the Pak Afghan border. District Quetta has two Tehsils i.e. Quetta and Panjpai. Quetta tehsil is further subdivided into two towns, namely Chiltan Town and Zargoon Town. The Kuchlak falls in Chiltan Town. The people's participation in the political process is ensured through the elected institutions of District Council, Tehsil Councils and Union Councils, with elected Chairman at each level. Local government of district Quetta consists of the Municipal Corporation. It is headed by a Mayor and consists of 66 ward members. In the rural areas of, there are 8 Union Councils. They constitute a District Council; each union Council is represented by a member in the District Council. In addition, there is special representation of 2 women, 1 peasant, 1 non-muslim and 1 worker. Thus, District Council is composed of 13 members; the Deputy Commissioner and Assistant Directors of various Departments are Ex-Official members of this Council.

The administrative set up consists of Deputy Commissioner (DC), Executive Development Officer (Revenue) and District Officer (Revenue). The DO (Revenue) directly looks after the matters of the DDO (Revenue) offices at tehsil level. Each tehsil (sub–division) has a revenue setup consisting of Tehsildar and Naib Tehsildar, who have a number of Quanugos. Each Qanugo looks after the work of several Patwaries of his Patwar Circle. The Patwaries stay in their villages and maintain an updated land record of their 'Mouzas'.

4.8.3 Community Organization:

By far the biggest uniting force of in Quetta society for individuals as well as groups is ethnic or tribal identity. The society being patriarchal the decision making is solely vested in elderly males of the family/ tribe which becomes binding for females under their charge. Society in general is structured on kinship basis. Even on petty issues the ethnic groups can get polarized. Each ethnic group tends to stick to its culture and traditions, a blending of culture and customs amongst various groups takes place inevitably. The society is modelled on the authoritarian system linking the relationship between father and his sons. The head of the family is called "Sardar" whose authority flows to the lowest tier of the tribe or family through an authoritarian hierarchy of males.

The Sardari System is well entrenched in Baloch, Barahvi and Pakhtun tribes while others also try to have it with laxity and variation. However, life of people of Quetta, particularly of Project Area, is built on two principles; hereditary authority and personal bond of allegiance in which protection is exchanged with loyalty. Most of the tribal chiefs get elected to the parliament. Quetta experiences different ethnic socio-cultures. Among the Brahvis, the element of central authority exists. The hierarchical system of authority is vertical, with downward flow from the Sardar (head of tribe) to Takkari (head of sub clan) following the younger men in the clan and family. Sardar's position is supreme. Pushtoons lack central authority while religious leaders are the influential ones. Tribes have an almost equal social position, with the exception of the occupational groups, who enjoy higher status.

Occasions like births, deaths, illness, marriage; serve as socializing accessions for women and common people who can, when they meet exchange information and ideas and reinforce social

ties and alliances. With some modifications and re–adjustment the Sardari System will continue to be a corner stone of society in Quetta for a long time to come.

4.8.4 Language:

The Quetta district is multi-linguistic. Balochi/ Barahivi and Pashto are the main languages spoken in the district. Urdu, Punjabi, Sindhi, Siraki, Hindko and Persian are also spoken in the district. Urdu and English are widely used among the more educated segment of the local population.

Settlement Pattern:

The total geographical area of Quetta district comes to 2653 km2. The population density works out as 547 persons per km2. As far as their settlement pattern is concerned, 26 percent of the population resides in rural areas while the remaining 74 percent reside in urban areas of the district. The figures indicate that overwhelming majority of the people live in urban areas.

Family System:

People in vicinity of the project live in joint families and extended families. Usually people live with parents and brothers. Women usually take care of the household matters and external matters are in the hands of the head of the household i.e. a man. Major caste of the area is Kakar, Syed, Tareen and mulazai.

People get married within the family as first choice. Girls are rarely brought from outside the family but not given to others. Women are not given inheritance by parents and usually the in–laws pay an amount for the girl as dowry before marriage. Polygamy is common among the males; there is no restriction for marrying a second woman if the couple does not have male children. Similarly, there is no restriction to marry a second woman if it is a widow of a brother.

Fuel and Energy:

In rural areas 90% of the population uses fuel wood, agricultural waste or dried cow dung of the cattle. Eight percent of village inhabitants use gas cylinders while 2% use kerosene oil stoves. Petrol pumps exist along the road to fulfill the energy requirements of the area.

4.8.5 Conflicts Resolution Mechanism and Laws:

The conflicts in Quetta District are resolved through two systems, official and un-official. The official system involves formal judicial system and the unofficial system is based on the traditional laws. The Qazi court is not functional in the district.

Statutory Laws: The Project Area is "settled area" where provincial and federal statutory laws apply. The judicial system functions through civil and criminal courts. People file suits in courts to resolve their disputes. Under the statutory law, the cases are registered at police stations, in case of violation of the country laws. Once a case is registered the legal course takes place through normal courts starting from civil court, District and Session court, High Court and ultimately the Supreme Court of Pakistan. Sometimes, the Court appoints an arbitrator with the consent of the concerned parties, who resolves their disputes.

Un-official (Customary Laws): Unofficial system is based on the traditional Markka or Mairh (among Balochs and Brahvis) or Nanawati (among Pashtoons) system. This system is effective in the area especially in the matters of disputes among the tribes. People prefer the Biradri (brotherhood), or Mairh or Nanawati system, where they take their issues to a senior and influential person of the community, and after a lengthy discussion and debate, their disputes are settled.

4.9 Economy of the Area:

4.9.1 Trade and Industry:

The city of Quetta is the center of commercial activities of the province. It lies on the main trading routes to Afghanistan and Iran. Moreover, it is a gateway to the Central Asian states. Trade also involves the inflow and outflow of goods and services from other provinces. The value of legal inflow and outflow of goods is recorded at the borders. Illegal trading activities do take place. There is a general belief that the magnitude of illegal trade (smuggling) is far greater than the legal one. The last two decades have witnessed substantial industrial growth in Quetta. Now Quetta is not only a commercial and trading centre, but also is becoming an industrial city.

There are two industrial estates in Quetta. The first one is located at Sirki road, it is considered as Mini Industrial Estate. The other is located at Sariab Bypass, 13 km away from Quetta, which was established in 1986-87. All the utility requirements are available.

4.9.2 Irrigation:

There is no prominent irrigation water source in the entire Quetta district. However, the main sources of irrigation in the district are streams, dug-wells and tube wells. In the recent past, the Karezes (man-made underground water channels to fetch groundwater from the foot of hills) were a major source of irrigation but with the over-extraction of groundwater through tube wells, this unique source has abandoned.

4.10 Health Facilities:

The availability of healthcare facilities such as Hospitals, Rural Health Centers, Basic Health Units and Rural Dispensaries is, although encouraging, but these are not sufficient to provide a satisfactory health care to the people. Moreover, the level of services provided at these centers is not to the expectations of the peoples. In addition, a number of private clinics and hospitals are also working in the district. Information relating to health facilities in public sector in Quetta district is provided in Table 9.

Hospitals	6
RHCs	3
BHUs	34
CDs	9
MCH centers	13
TBC	1
Other	1
Total	67

Table 7 Health facilities in Quetta

4.11 Transportation and Accessibility:

Quetta lies on the western side of Pakistan but is connected to the rest of the country by a network of roads, railways and its international airport close to its centre. PIA and private airlines operate regular flights to and from the other major cities of Pakistan including Islamabad, Gwadar, Karachi, Lahore and Peshawar. Quetta Railway Station is one of the highest railway stations in Pakistan at 1,676 meters (5,499 feet) above sea level. The railway track was laid in the 1890s during the British era to link Quetta with rest of the country. The extensive network connects Quetta to Karachi in the south, Lahore in the northeast and Peshawar further northeast. A track from the Iranian city of Zahedan links to Quetta via Taftan, Balochistan. Quetta is connected by metaled roads to the rest of the country. A road connects it with Karachi through Mastung, Kalat, Khuzdar and Lasbela. Other major roads are Quetta to Karachi following the Sibi, Jacobabad, Sukkur and Hyderabad route and two roads from Quetta to Lahore one (the older) via Sibi, Sukkur, Rahim Yar Khan, and Multan the other route via Khanozai, Muslimbagh Loralai, Fort Mondro, Dera Ghazi Khan and Multan. Quetta is connected with Afghanistan through Chaman and to Iran through Mastung, Nushki, Dalbandin and Taftan. Land line and mobile phone facilities are available in the district. Access to the project area is through metallic road with multiple transportations means availability.

4.12 Land Requirements:

The proposed Kuchlak Solar Energy Project of 50 MW will require approximately 1000 acres of public (Government) owned land. The land will be acquired by EEL according to the provisions of lease basis. The Land Acquisition Act, 1894 is the only governing legislation relating to the lands and other land related assets. Letter of Land Acquisition is attached in this report.

Chapter 5

CHAPTER 5: INTENDED IMPACTS AND MITIGATION MEASURES

5. Intended Impacts and Mitigation Measures:

Screening process is an integral part of the environmental assessment for identifying all significant environmental and social aspects during construction, installation, and operation phases. Environmental aspects identified during the stakeholder's meetings and using the screening process were assessed for their severity and mitigation measures have been proposed as a result of the assessment. The mitigation measures proposed here will be adopted by the Proponent to reduce, minimize and compensate for the negative impact as far as possible. However, the proposed project has overall positive impacts due to its competitiveness, efficiency, effectiveness in terms of pollution free reliable Solar energy source, contributing to the power need and to bridge the Gap between Demand and Supply of Power.

The main aspects associated with potential impacts are as follow:

- Soil;
- Water resources (aquifer and surface water quality);
- Air quality;
- Waste discharges;
- Noise pollution;
- Ecology of the area, including flora and fauna
- Vehicle movement;
- Socio-economic conditions;

5.1 Impacts Associated with Project Phases:

A Screening Process of project activities reflects that there are following two phases where environmental and social impacts may be witnessed:

1. Construction and installation phase
2. Operation phase

The project overall has positive impacts by providing a competitive, cost-effective, pollution free reliable mode of Solar power. However, during the construction phase, the impacts may be observed for a short term; while long term impacts may be observed during the operation stage.

5.2 Nature of Activities Causing Impacts:

Both the cited phases i.e. construction and operation phase include different activities that may cause impact on environmental parameters. Here are details of different activities that may have impacts on environment:

- Sub structural work like site preparation, excavation, leveling, trenches etc. (minor level)
- Mobilization to project site /traffic
- Transportation of waste material
- Drilling through mechanical means
- Use of mechanical equipment's for erection of concrete and steel structures
- Road work/ construction (access to site)
- Cleaning/ finishing work
- Sewage waste from residence of labor and staff

Work at sub structural phase may cause dust pollution to the environment but this will be at minor level. Whereas super structural work may cause some noise pollution and or burned gases of machines.

In the first step, potential impacts of the project are identified by desktop screening exercise, professional judgment, published literature on environmental impact of similar projects and standard environmental guidelines. Another critical step in identifying potential impacts is discussion with project proponent, consultation with stakeholders and communities to identify their concern. Public consultation was carried out to identify the concerns of primary and secondary stakeholders.

5.3 Impact Assessment Methodology:

The impacts have been assessed following standard international guidelines and best available practices. The method defines different levels of consequence (or severity to project and surrounding environment- High, Medium or Low, no impact- of an impact as illustrated below:

Level	Consequence (Severity of Impact)
High	Serious damage to local and regional environment. Direct legislative requirements of EPA and other standards. threat to the ability to do business
Medium	Measurable damage to the environment. Subject to potential future legislation. Potential to affect reputation / cost. Implication / reduced efficiency
Low	Minimal damage to the environment
No Impact	No risk to business

Table 8 Categorical consequences (Severity of Impact)

5.4 Impact & Proposed mitigation during construction & operation phase:

Adverse environment impacts associated with project have been avoided or minimized through careful site selection and route selection. The alignment is sited away from major settlements in design of the proposed project. Adverse impact during construction phase is confined and of short term magnitude. Since the project land is vacant land, the change in land use will be minimum. Impact is mainly related to the civil works and some intensive impact due to erection of the equipment. There are no major impacts from dust emission on workers during construction phase.

Activities	Classification	Impact
Land Acquisition	Land	No significant impact on land-use is expected.
	Socio-Economics.	There is no resettlement and compensation related issues as land for the project is leased by Government of Balochistan.
Site levelling, excavation cleaning	Air	Dust pollution Gas emission from machinery
	Water	Run-off water from storage area
	Land	Soil erosion, removal of top soil contamination, spillage
	Ecology	Diversity loss (Impacts on flora, fauna, birds)
Material transportation	Air Public utility	Dust Road usage continuously
Civil Work	Air	Air emission of machinery
Labor infiltration for employment	Socio Economics	Positive change through employment
Temporary houses by labor	WASH	Water, Sanitation and Hygiene issues
	Land	Change in land use pattern
Transportation of debris and cleaning	Air	Air emission due to transport vehicles Dust

Table 9 Proposed mitigation during construction & operation phase

A suitable space will be required for equipment, materials, vehicles, material, disposal sites, and labor camps resource to avoid environmental impact and public inconvenience. This space can be arranged in boundaries of project site.

5.4.1 Impact on Land & Environmental Resources:

There is no threat to the existing land use or degradation, and there is no net impact on the land use. The construction activities attract a sizeable population and the influx of population is likely to be associated with construction of temporary huts for construction work force, having a minor effect on land use pattern.

Impact	Severity
Extent of displacement of existing land use or other environmental resources	No impact ☐ Low ☒ Medium ☐ High ☐

Table 10 Impact level on land and environment

5.4.2 Impact on Surface Soil:

There will be low impact on soil cover because the construction activities for the main plant units of project would be confined in the land, the impact on soil will be minimal and confined. Only cutting and filling is required during construction. No adverse impact on soil in the surrounding area is anticipated as the area. Clearing, leveling and improving access tracks, storage of chemicals, oil, fuel or waste; Physical disturbance may create impacts like,

- Physical scarring of the landscape;
- Increased risk of land slippage;
- Accelerated soil erosion;
- Alteration of soil quality by loss of topsoil;
- Blockage and contamination of natural water channel;
- Soil and water contamination resulting from spillage, leakage or improper waste disposal;

Construction of solar power plant, access roads, and other project facilities could cause topographic changes, soil erosion and contamination.

Impact	Severity
Impact on top soil cover	No impact ☐ Low ☒ Medium ☐ High ☐

Table 11 Impact level soil

Mitigation Measures:

Paved working areas will be constructed to accumulate surface run-off into retention ditches to minimize soil erosion. A spill prevention and response plan shall be prepared by the contractor in order to control any inadvertent leakage or spillage. Spill response measures shall be implemented (as necessary) to contain and clean up any contaminated soil. Construction of bunds around relevant work and storage areas. In the preliminary design of the project it was found that there will be no use of chemicals in project area, however in case detailed engineering yields use of chemical than Bunds will be constructed in areas of hazardous chemical storage to contain accidental spillage and minimize the potential for migration to the underlying soil. (Note: in the preliminary design there is no use of chemicals but in case detailed engineering yields use of chemical than this shall be followed.) Any spilled chemical shall be immediately collected and disposed of in accordance with Spill Prevention and Response Plan. Contractor shall ensure that accumulated surface soil or other material from cleaning and leveling should not be deposited in the natural water channels/Nala.

5.4.3 Water Sources:

Water is a scarce resource within the project area and its surroundings. There is no tube well and perennial natural surface water resource in the project area. The only source is rain and run-off water that is used for small agriculture purposes. Jalogir Lohra (water channel for run-off water) is located at 50-100 m near to the proposed project area.

For project implementation water will be transported to site through water tankers from nearby tube wells. A number of functional tube wells available in Kuchlak and Yaro Bazar close to the project site. In the construction phase limited use of water will be required whereas in operations 20000-25000 gallons of water will be required per day.

5.4.4 Impact on Solid Waste:

Solid waste disposal shall be followed by maintaining waste inventory with set frequency of time. It will be ensured that excavated materiel is reused unless otherwise non-useable will be stored and sold in Kuchlack recyclers. (this will also include food waste). Apart from this hazardous waste likewise waste oil etc. will be collected and stored in paved and bounded area and subsequently sold to authorized recyclers through contractor. The project will ensure that scrap metal waste generated from erection of structures and related construction activities will be collected and stored separately in a stack yard and sold to local recyclers as per to manage the solid waste handling team. This will be ensured that the wastes which are recyclable are sold to the external contractors and the non-hazardous waste will be dumped through waste collection system and services. The solid waste will be dumped away from the project site and where nearby no settlements or any other affected environment is present. There are some solid wastes in the project site, including the packing material for the equipment, like the wooden pallets and carton boxes. Solid waste management plan will be followed third party EPA certified contractor will be hired for disposal of solid waste. Likely impacts of improper waste management generated from project activities can include;

- Soil contamination
- Odour
- Health hazards
- Aesthetic issues

Impact	Severity	
Impact of Solid Waste	No impact	☐
	Low	☐
	Medium	☒
	High	☐

Table 12 Impact on solid waste

Mitigation Measures

- The proponent may develop proper solid waste management plan before the commencement of project activities.
- Soak pits should be constructed for collection of waste water generated from domestic, maintenance and cleaning activities.
- At the time of restoration, septic tanks and soak pits should be dismantled and backfilled with at least 1m of topsoil cover above the surrounding surface level;

- Solid residue from the septic tanks should be disposed of through waste contractor;
- All chemicals and fuels will be stored in confined buffered areas;
- Pill response kit should be available at chemical and fuel storage areas. In addition to this, ensure the availability of shovels, plastic bags, and absorbent material for the spill management;
- Solid waste disposal should be through waste contractor. The contractor shall establish regular intervals for waste collection and disposal as per contractor's waste management procedures.
- The recyclable waste should be sent to waste contractors/ vender or any other recycling facility for reuse;
- Medical waste should be sent to an approved incineration facility.

5.4.5 Impact on Air Quality:

The impact during construction phase is expected to be minimal. Particulate matter in the form of dust would be the predominant 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 of green dust control cloth 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 sulfur dioxide and particulate matter. The impact is reversible, marginal and temporary in nature. Also, the project company may conduct regular ambient Air Monitory before the construction work and during operation phase. Some brick kilns were observed near project area that may create impact in operation phase in long run of project.

Environmental aspects of proposed project activities related to air quality are:

- Excavation, clearing and levelling work during construction and installation phase
- Use of generators and vehicles during the whole project lifetime

Likely impacts of these aspects / activities include dust emissions and gaseous emissions from the generators and vehicles.

Impact	Severity	
Impact on Air Quality	No impact	☐
	Low	☒
	Medium	☐
	High	☐

Table 13 Impact on air quality

Mitigation Measures:

- Dust emissions during construction activities will be minimized by good management practices such as locating stock piles of construction sand out of the wind direction, keeping the height of the stock piles to a minimum, keeping earthwork areas damp etc.
- Unnecessary handling of dusty materials will be avoided such as minimizing drop heights when loaders dump soils into trucks.
- All generators, and vehicles used during the whole project life cycle will be properly tuned and maintained in good working condition to minimize exhaust emissions.

- All project vehicles will be checked regularly to ensure that engines are in sound working condition and are not emitting smoke.
- Imposing speed limits and encouraging more efficient journey management will reduce the dust emissions produced by vehicular traffic
- Staff will use protective measures by covering mouth in dust.

5.4.6 Noise Impact:

There was no major source of noise detected during site visit of project area. However, sporadic sources of noise such as main Quetta, Chaman road traffic was observed. Other noise generating sources during the construction phase are vehicles like tractor, trucks dumper, 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).

Since there is no population nearby project site therefore the impact of generated noise on the environment during construction period is insignificant, reversible and localized in nature. The noise monitoring has been conducted for the baseline studies as per the guidelines of IFC standards in different points with different time durations.

Impact	Severity
Impact on Noise	No impact ☒ Low ☐ Medium ☐ High ☐

Table 14 Impact on noise

Mitigation Measures:

- Proponent must ensure that generators, vehicles and other potentially noisy equipment used are in good condition.
- Appropriate engineering control will be applied to noise producing sources like generator, vehicles and other equipment and machinery will be kept to the minimum through regular maintenance.
- The use of horns by project vehicles will be minimized. The use of pressure horns will not be allowed. All on-site personnel will use required personal protective equipment (PPE) in high noise areas that will be clearly marked.
- The contractor shall limit idling of engines when not in use to reduce its contribution to noise emissions.

5.4.7 Impact on Ecosystem:

The project site is barren land for the installation of solar power project and there is no settlement or agriculture in the project area, therefore negligible impact is predicted on ecosystem of the area.

Impact	Severity
Extent of displacement of existing land use or other environmental resources	No impact ☐ Low ☒ Medium ☐ High ☐

Table 15 Impact on ecosystem

Mitigation Measures:

The small bushes on the site may be cleared during the project construction activity, but it will be ensured that as soon as the project is operational, plantation is re-grown in and around the plant. Also, the project company shall make a plantation plan for the project after completion of the construction. Thus, the site development works would not lead to any significant loss of important species or ecosystems.

5.4.8 Socio-Economic Impact:

The proposed intervention will bring certain socio-economic changes in the project surrounding area. Some of the impacts would be directly beneficial to the socio-economic environment due to employment potential, improvement in infrastructural facilities, resource utilization from nearby markets by the employees, whereas some of them would be of adverse nature. Local employment during project period will increase socio-economic standards. Positive benefits of the project may arise either from short-term job opportunities during construction, or long-term job opportunities. It is important that during construction and operation phases local community should be given due preference in jobs. As a result, the impact significance can be considered Positive. The adverse impacts on community due to proposed project activities include invasion of privacy; changes in demography; sharing of local resources such as water sources (water tanker mafia may increase rate of water); loss of standing crops in areas where agriculture is being practiced form rain water, excessive dust emissions, improper disposal of waste, damage to community infrastructure, noise pollution and restriction of mobility of local people and livestock etc.

Impact	Severity	
Socio Economic Impact	No impact	☐
	Low	☒
	Medium	☐
	High	☐

Table 16 Social economic Impact

5.4.9 Cultural Sites:

There are no archaeological, historical or cultural sites along the route alignment;

Impact	Severity	
Cultural site	No impact	☒
	Low	☐
	Medium	☐
	High	☐

Table 17 Impact on cultural site

5.4.10 Sanitation and waste removal at construction site and labor camp:

Before commencement of construction activity sanitation, water and drain facilities will be made integral component in the planning stage. Human excreta management with the help of temporary toilet (with hygienic measures) and water facility will be provided on project site. There shall be proper solid waste disposal procedure to enhance sanitation of workers who stay in camps. Septic tank will be used for sanitation purpose. Risks of water borne diseases will be eliminated by adopting improved sanitation procedures. Unacceptable solid waste disposal practices such as open dumping of solid waste and poor sanitation facilities will lead to pollution of surrounding

environment, contamination of water bodies and increase adverse impact to the aquatic; terrestrial lives (if present) and general public inhabited in the area. Surrounding of labor camps, garbage disposal sites and material storage yards provide favorable habitats for vectors of diseases such as mosquitoes, rats and flies. Apart from above a main waste water channel whose catchment area passes through different districts and leads to Afghanistan also lies near the project site at a distance of two kilometers. According to local elders the overflow occurred some 100 years ago but since the depth increased with passage of time because people take sand from the bed of Nalla therefore overflow never occurred in their life. However, it is recommended that a safety wall should be constructed to avoid this risk.

Impact	Severity	
Sanitation and waste removal at construction site and labor camp	No impact	☐
	Low	☒
	Medium	☐
	High	☐

Table 18 Impact on sanitation and waste removal

5.4.11 Impact on ecological resources:

Since there is no inhabited area along the route of transmission line, there will be no disturbance to the life of people, local animals and birds' movement. In transmission there is no dynamic equipment and moving machinery causing noise pollution, water and air pollution. There is no national wildlife park, bird sanctuary, wetland in the route alignment of the proposed transmission line. None of the declared environmentally sensitive areas is located within the route alignment. It is not expected that any flora and fauna that are rare, endangered, endemic or threatened will be affected. Migratory paths of small mammals and reptiles may be affected due to construction activities. However, noise, vibration and emission from construction vehicles, equipment will occur during construction and pre-construction stages in temporary manner.

Impact	Severity	
Impact on ecological resources	No impact	☐
	Low	☒
	Medium	☐
	High	☐

Table 19 Impact on ecological resources

5.4.12 Biodiversity:

Project site is a low rainfall area with high temperatures in summer, apart from this there is high velocity winds, poor soil and low diversity of plant species. This type of climatic conditions hardly supports any considerable vegetation. During the construction and installation activities of solar power plant vegetation clearing can occur along project site area, and access tracks. The potential effects on vegetation will include:

- Loss of vegetation due to land clearing for camp sites (if any) and access roads
- Effects of dust emissions on road side vegetation; and
- Effects on vegetation due to obstruction of natural drainage

The access roads and other project facilities may obstruct natural drainage within the project area. This can affect the survival and or composition and characteristics of vegetation.

Impact	Severity
Impact on biodiversity	No impact ☐ Low ☒ Medium ☐ High ☐

Table 20 Impact on biodiversity

Mitigation Measures:

- Plant installation in surroundings should be give due consideration to contribute to environment of the area.
- The access track to project site will be selected to utilize existing tracks as much as possible
- The construction camp will preferably be located in existing clearing and leveled land
- The access track will be properly compacted (with water sprinkling on daily basis) at the time of construction and thereafter properly maintained throughout the entire construction and operation.
- During construction movement of construction equipment will be minimized only to avoid unnecessary disturbance to soils in the project area.
- Clearing of vegetation and the cutting of trees will be minimized as much as possible
- Off-road travel will be strictly prohibited and observance of this will be monitored during the operation
- Vehicle speeds will be regulated and monitored to avoid excessive dust emissions.
- Use of local vegetation as fuel by crew personnel will be prohibited.
- Construction work near areas which show reptile populations will commence after a soft start up and will be randomly monitored
- Hunting or trapping of wildlife will not be allowed
- Feeding or harassment of wildlife will not be allowed
- Vehicle speeds on access road will be controlled to avoid incidental mortalities of reptiles

5.4.13 Community Grievances:

Community grievances redressal strategy should be developed by proponent. Local complaints on dust, elevated noise, waste from different project activities, spilled oil and chemicals, hiring issues etc may provide basis for conflict between the locals and project proponent.

Impact	Severity
Community grievances	No impact ☐ Low ☒ Medium ☐ High ☐

Table 21 Impact on Community grievances

Mitigation Measures:

Grievance handling system must be established by EEL. A social complaint register should be maintained on site. All complaints received from local communities should be well recorded. Community complaints shall be duly addressed and appropriately resolved. The measures taken to mitigate these concerns shall also be recorded in the social complaint register.

5.4.14 Health and Safety:

There is no any medical facility available in the project area. The closest health care facility to the project area is at Kuchlak bazar where doctors are available. In addition, there are private clinics also present in Kuchlak. Community also uses different local herbs and plants for common diseases like fever. In the case of emergency, patients are taken to Quetta.

Impact	Severity	
Health and safety	No impact	☐
	Low	☒
	Medium	☐
	High	☐

Table 22 Impact on Health safety

Mitigation Measures:

EEL is HSE certified firm and hence HSE policy of EEL will be strictly implemented during construction and operation phases of the project. Safe speed limits for vehicles will be followed to avoid effects of dust emissions. Regular noise exposure assessments and noise level surveys of noisy areas, processes and equipment shall be carried out in order to form basis for remedial actions when necessary. All steps to decrease noise contact levels of employees by means other than that of personal protective equipment shall be taken, such as reducing exposure times, enclosures, silencers, machine covers...etc. Awareness training sessions should be established and delivered to all personnel involved during the construction and operation phase in order to highlight the heat related illnesses of working in hot conditions such as heat cramps, heat exhaustion, heat stroke, dehydration. Proponent must arrange medical camp for all project personnel to screen each staff for communicable diseases prior to induction.

Chapter 6

CHAPTER 6: STAKEHOLDER CONSULTATION

6. Stakeholder Consultation:

Stakeholder Consultation and Participation (Information collection from community regarding socio economic, environmental and risk factors). A detailed consultation was carried out with the respective communities, environmental, forest and wildlife experts of the project site. The aim of these consultations was to assess the socio economic, environmental and risk factors, related to the target community.

Figure 21 Glimpse of community meeting

6.1 Below is the detail for different aspects of consultation and outcome:

Point of discussion	Finding
Community information	
Number of villages in surroundings of project site	There were only two villages i.e. Jalogir and Sheikhan. The nearest village in the north is Sheikhan and Jalogir in the south. 95% of the homes are Kacha with only 5% semi Kacha. The total population of these villages were 1200.
Current living standard and livelihood	
Is the standard of living for most people satisfactory? Who are the	People are living in very poor condition. Most of the people are involved with daily wages i.e. non skill labor make 85% whereas

most vulnerable people in the community?	13% are dependent on rain fed agriculture while 2% are involved in private sector like transportation and shops. 90% youth of the village is unemployed.
What employment opportunities in non-agriculture sector (both in skilled and unskilled) labor Where are skilled and unskilled labor working What % is linked with skilled labor and unskilled labor	Agriculture sector is dependent on rain water, while there is no tube well for this purpose because of shortage of water. People grow melon, water melon, sorghum and wheat. The production is very low because of low precipitation rate. Government has constructed dam for storage of rain water, and a small number of families are involved with this production. There is no skilled person in the community because of no opportunity for this sector. most of the people are involved with daily wage labor.
Drinking water sources	
What is water depth in the area. What are the main sources of drinking water in the community area? How good is the quality of drinking water? How good is the water quality in the project area? Are there any tube wells in the project area?	Water depth is around 700-1000 feet but due to hard shale and brackish in project area people get their water from water tankers from tube wells of Kuchlak. The price of one tanker 1500 gallon is 1500 PKR. There is no tube well in project area.
Waste Disposal (solid and waste water)	
Are there any solid waste disposal services in the area? Where is waste disposed/dump?	No proper sewerage and drainage system exist in the villages. Waste are dumped in open place. Community also use open space for disposal of waste water.
Are there any proper sanitation facilities available in the area? Where is waste water and sewerage water disposed of/dump?	Traditional latrines are used and common. Only 5% use direct pit latrine. Male practice open defecation in the fields.
Access Electricity	
What of % households access to electricity? From what sources (e.g. community generator, public/government electricity, solar panels, private generators, other)? Is the supply reliable? (ask for details) Do you know which grid you are connected	All the houses are connected to WAPDA grid. 25% of the houses are use solar lightning units for lightning purpose. Load shading hours are 8 hours out of 24 hours. People are also familiar that they are connected to Sheikhmanda grid.
Infrastructure (Road and pathway)	
How would you describe the quality of the road network in and around the Project communities? Type of roads used while walking to school or to a local market?	There is no metaled road inside the villages. However, the linked road from main road to village was in good condition. Public Transport is available at a distance of 500 meters from the village.
Health Facility	

Where do most people go to access health care services? How far away is this? What is the quality of health care services like?	There is no health facility in the villages. People use main hospital of Kuchlak Bazar. Common disease is malaria, water borne disease, skin and gestor infections
Education Facility	
Where do children go to primary school? Secondary school? How far away are these? What is the quality of education like?	There is one mix school with 35 boys and 15 girls in primary school. The boundary wall was broken, and other repair and renovation work was also needed. Drop out of children was high due to lack of sanitation facility.
Other Questions	
Name fauna flora and reptile in the area (list all of them)	Fauna Jackal, Fox, lizard, goh and small insects, Red wattled lapwing, pigeon, sparrow, peacock, bulbul, chokkor Flora Ghaz, Zoz, Spalani, Sparikai, bushkee
Are there any brick clines in the area, what is the distance from project site?	There are several brick lines near the project site in its south at a distance of 3-5 km. People were of the view that the smoke of the brick clines is injurious to their health especially chest infection. This smoke emits towards their village when there is north to south wind.
Is there any Nala/Sewage in the surrounding? What is over flow frequency/max height/and damages	Apart from above a main waste water channel whose catchment area passes through different districts and leads to Afghanistan also lies near the project site at a distance of two kilometers. According to local elders the overflow occurred some 100 years ago but since the depth increased with passage of time because people take sand from the bed of Nalla therefore overflow never occurred in their life.
Please discuss security situation of the area	There is one tanna (police station) which is jalogir tanna. Apart from this FC post near the project area. Community were satisfied with the security situation of the area.

Table 23 Stakeholder consultation outcome

6.2 Consultation with experts from wildlife and forest departments:

Team also visited the mentioned offices and met with experts of these departments. Mr. Aslam Buzdar from forest (Conservator Forest) and Mr. Shareef Balochistan (Conservator Wildlife) from wildlife provided information. HECS team provided information about the proposed project site and the solar scheme.

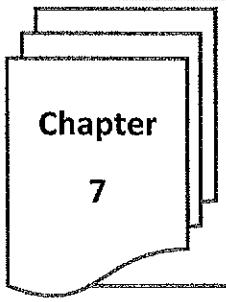
Wild life representative provided information about his department which is separated across Balochistan however He shared that wildlife sanctuary is not existing in the area. The sanctuaries are outside of Quetta District. Fox and Jackal are common in areas of mountains which are also common in whole Balochistan. The department has no concern about this project. Representative of forest department told that there is no forest in the area. However, there are few local herb and

shrubs in the area. The project may cause some risks to these herbs and sherbs but the overall risk factor to local fauna is negligible. Mr. Aslam mentioned that this solar project is very useful to the province. There is no such species regarding trees which are at risk due to this project. Mr Aslam discussed that the proposed project has no such effect on species.

Meeting participants:

Sr.no.	Name of Participant	Age
1	Bashir Ahmed	40
2	Shakoor Ahmed	65
3	Jan Mohammad	67
4	Dawood Khan	36
5	Akhtar Mohammad	66
6	Lal Muhammad	38
7	Abdul Kareem	23
8	Muhammad Noor	27
9	Salahudin	42
10	Bakht Muhammad	55

Table 24 FGD participants



CHAPTER 7: ENVIRONMENTAL MANAGEMENT PLAN

7: Environmental Management Plan:

7.1 Environmental Management Plan:

This section of the IEE report describes the Environmental Management Plan (EMP) to assist the proponent to ensure sound environmental and health safety management during various phases of the project such as development/designing, construction and operation. All environmental aspects relevant to the project were studied in detailed by environmental experts. This IEE report has inspected all negative and positive impacts at each stage of the project covering construction, installation and operations phase of Solar PV power generation plant. To minimize the effects of adverse impacts, the IEE has recommended mitigation measures. The proposed mitigation measures have been based on the understanding of the sensitivity and behavior of environmental receptors in the project area, the legislative controls that apply to the project and a review of good industrial practices while operating in similar environments. For residual impacts (impacts remaining after applying the recommended mitigation measures) and for impacts in which there can be a level of uncertainty in prediction at the IEE stage, monitoring measures have been recommended to ascertain these impacts during the course of the project. For effective implementation and management of the mitigation measures an Environmental Management Plan (EMP) has been prepared. This EMP satisfies the requirement of the Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2000 and BEPA Act 2012. The EMP is a tool that serves as to manage environmental impacts and specifically focuses on implementation of mitigation measures in its true sense against likely environmental impacts.

7.1.1 Purpose and Objectives of the EMP:

- Define the implementation mechanism for the mitigation measures identified during the present study.
- Identify environmental as well as social (if applicable) training requirements at various levels
- Provide the mechanism for taking timely action in the face of unanticipated environmental situations,
- Facilitate the implementation of the mitigation measures identified in the IEE.
- Define legislative requirements, guidelines and best practices that apply to the project.
- Define the roles and responsibilities of the project proponent.
- Define a monitoring mechanism and identify monitoring parameters
- Ensure the complete implementation of all mitigation measures. o Ensure the effectiveness of the mitigation measures.
- Define requirements for environmental monitoring and auditing.
- Provide a mechanism for taking timely action in the face of unanticipated environmental situations.

- Identify training requirements at various levels.

7.1.2 Components of the EMP:

- Organizational structure and responsibilities
- Environmental management matrix
- Environmental monitoring plan
- Communication and documentation
- Change management Plan
- Training program

7.2 INSTITUTIONAL ARRANGMENTS AND STRUCTURE:

EEL will undertake overall responsibility for compliance with the EMP. EHS team of EEL will ensure that all the activities that the management executes comply with environmental sensitivities as well as they will cooperate with the concerned regulatory agencies such as Balochistan Environmental Protection Agency (BEPA).

EEL will establish an Environment & Social Management Cell (ESMC) at Corporate and Site level, headed by a Project Director to be responsible for day-to-day implementation of the Project. EEL will be responsible for undertaking the 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) which will be consistent with the standards set by IFC and World Bank Group.

The ESMC will be 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 EEL to look after environmental, social and safety issues. The ESMC will be empowered to implement safeguards planning and monitor implementation. The safeguards specialist will give 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 of staff and contractor's, to be assigned by the ESMC as necessary.

7.2.1 Roles and Responsibilities:

Roles and Responsibilities of Project Proponent:

As project proponent, EEL will be ultimately responsible for ensuring complete implementation of the EMP. Manager of the project proponent will be responsible for the overall environmental performance of the project in the guidance of Project Director. Project proponent will monitor the environmental performance of the project to ensure that the project is carried out in accordance with set standards of EEL and recommendations of this IEE. The ESMC includes a safeguard specialist and supporting staff, together forming the Environmental and Social Unit, appointed by EEL to look after environmental, social and safety issues. As mentioned above ESMC will be in the lead role in execution of the project management with below roles:

- Social Unit of the ESMC at corporate level will be responsible to Monitor the implementation of mitigation measures during construction and operation phases of the project.
- Social Unit of the ESMC at corporate level will Prepare suitable environmental management reports at various sites. Advise and coordinate field unit's activity towards effective environment management.
- Social Unit of the ESMC at corporate level will prepare environment health and safety manual for the operation of transmission lines/substations. ESMC will also 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. Proponent will also provide training and awareness rising on environmental and social issues related to power transmission projects to the project/contract staff.
- The social unit will make the contractor staff aware of the social issues so that EMP could be managed effectively.
- The duties of the Environmental unit at site level is to:
- Implement the environment policy guidelines and environmental good practices at the sites.
- Advise and coordinate the contractor(s) activity towards effective environment management. Implement environment health and safety manual.
- Carry out environmental in conjunction with project planning cell while route selection of the alignment at the planning stage to avoid negative environmental impact. Also, the cell will make the contractor staff aware of environmental so that EMP could be managed effectively.
- Overseeing compliance with the Health, Safety and Environmental Responsibilities specific to the project management related to project construction.
- Promoting total job safety and environmental awareness by employees, contractors and sub-contractors and stress to all employees and contractors and sub-contractors the importance that the project proponent attaches to safety and the environment.
- Ensuring that each subcontractor shall employ an Environmental Officer to monitor and report on the daily activities on-site during the construction period.
- Ensuring that safe, environmentally acceptable working methods and best practices are implemented, and that sufficient plant and equipment is made available properly operated and maintained, to facilitate proper access and enable any operation to be carried out safely.
- Meeting on site with the Environmental Officer prior to the commencement of construction activities to confirm the construction procedure and designated activity zones.
- Ensuring that all appointed contractors and sub-contractors are aware of this Environmental Management Plan and their responsibilities in relation to the plan; Ensuring that all appointed contractors and sub-contractors repair, at their own cost, any environmental damage as a result of a contravention of the specifications contained in the Environmental Management Plan, to the satisfaction of the Environmental Officer.

Roles and Responsibilities - Supervision by Consultant:

The supervision consultant / Project Monitoring Consultant (PMC) has qualified environment health and safety staff on board which will be responsible for overseeing the implementation of the EMP during the construction. Project proponent will appoint construction contractor(s) for the civil construction and installation contractor(s) for the plant installation of the proposed project.

The contractors will be responsible for implementation of, or adherence to, all provisions of the EMP and with any environmental and other codes of conduct required by project proponent. Overall responsibility for environmental performance of the operation will rest with the senior management of the contractors in Pakistan. Site managers of the contractors will be responsible for the effective implementation of the EMP.

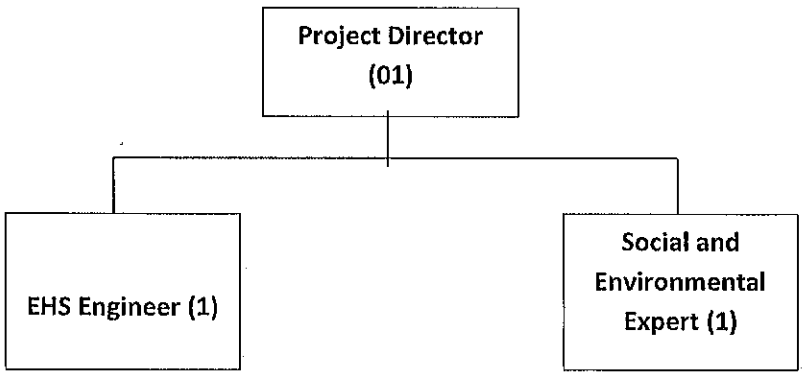


Figure 22 Proposed Framework of ESMC

7.2.3 Responsibilities of ESMC Major actors:

Project Director:

- Development and implementation of environment and social policy and directions.

EHS Engineer:

- Overall in-charge of operation of environment & social management facilities
- Ensuring legal compliance by properly undertaking activities as laid down by regulatory agencies from time to time and interacting with the same

Social and Environment Expert (From contractor Side):

- Secondary responsibility for environment & social management and decision making for all environmental issues including Safety and Occupational Health.
- Ensure environmental monitoring and social issues related to project as per appropriate procedures

7.3 Communication and documentation:

An effective mechanism for storing and communicating environmental information during the project is an essential requirement of an EMP. The key features of such a mechanism are:

- Precise recording and maintenance of all information generated during the monitoring.
- Communicating the information to a central location
- Processing the information to produce periodic reports
- Providing information and answering queries on monitoring originating from various researchers and stakeholders.

7.3.1 Social complaints register for redressal of grievance:

The project proponent Field Community Representative will maintain a register of complaints received from local communities regarding environment and measures taken to mitigate these concerns. All community complaints received will be sent to the HSE Manager for further action.

7.3.2 Training:

Project proponent and its contractors and suppliers will be responsible for the selection and training of their staff which are capable of completing the project activities in an environmentally safe manner. Project proponent and its contractors and suppliers will be responsible for providing orientation to their staff members on the IED, the EMP and their implementation provided in the EMP. The contractors will be responsible for providing awareness training on potential environmental issues of the project to all personnel at site.

7.4 Mitigation and Monitoring Plan:

The mitigation plan is a key component of the EMP. It lists all the potential effects of each activity of the project and their associated mitigation measures identified in the IEE. It should be emphasized that the mitigation measures will have to be translated into environmental as well as social requirements and specifications to be made part of the contracts for the construction activities, with legal binding

- For each project activity, the following information is presented in the plan:
- A listing of the potential impact associated with that project activity
- A comprehensive listing of mitigation measures (actions)
- The person(s) responsible for ensuring the full implementation of the action
- The person(s) responsible for monitoring the action
- The timing of the implementation of the action to ensure that the objectives of mitigation are fully met.

7.4.1 Monitoring:

The aim of environmental and social monitoring during the various phases of the proposed project will be as follows:

- Project proponent and its contractors will be responsible for effective monitoring for efficient operations of the proposed project. Proposed project and its auxiliary systems will be monitored for their performance within the acceptable limits.
- Project proponent will ensure that the restoration of the site after the end of construction and installation activities and after the useful life of proposed project is carried out according to the requirements of the EIA and EMP.
- Ensuring that the mitigation measures included in the IEE are being implemented completely.
- Ensuring the effectiveness of the mitigation measures in minimizing the project's impacts on social and environmental resources
- Systematically observe the activities undertaken by the contractors or any other person associated with the project.
- Verify that the activities are undertaken in compliance with the EIA and other conditions identified by project proponent.

CONCLUSION

The study is based on baseline environmental and socioeconomic information which was collected from a variety of sources, including reports of previous studies, desktop studies, census report etc. Pakistan is facing severe energy crisis and looking for various options to meet the growing energy demand. In order to do so, the Government of Pakistan has intended to diversify its energy mix so as to ensure Energy Sustainability. In this regard, alternative and renewable energies are a strong contributor in the envisaged diversified energy mix.

With the same objective as of Government of Pakistan; EEL Pakistan Limited intends to play a significant role by installing a Photovoltaic (PV) power generation plant with renewable energy resource. This PV power plant will provide clean and environmental friendly alternative energy. In comparison to coal or oil-fired power generation plant, this plant will reduce the greenhouse gas emissions. It will not cause any significant, lasting environmental and social impacts during its construction, installation and operation phases. Only minor and transient environmental disturbances would be experienced at the project site during construction, Installation and operation, and they will be minimized through implementation of the EMP.

This IEE study was based on baseline environmental and socioeconomic information which was collected from a variety of sources, including reports of previous studies, desktop studies, census report etc. A field survey was also carried out in the project area for the collection of primary data. All adequate requirements have been addressed in this report i.e. proposed project activities, environmental conditions of the proposed site and its surroundings Legislative requirements related to the project, environmental impacts of the proposed project activities on the physical and biological and socio-economic receptors. Last but not the least mitigation measures in order to reduce any impact on physical, biological and socio-economic receptors an EMP has been provided that will help in effective implementation of the mitigation measures.

This environmental study has fully examined the potential environmental impacts due to proposed project activities. Mitigation measures for minimizing or obviating these impacts are also suggested. It is concluded that "Proposed installation of Photovoltaic PV Power Plant has low intensity adverse impacts, likely to be of short term duration, minor and of local consequence and are insignificant. A vigilant implementation of mitigation measures and Environmental Management Plan (EMP) will ensure that environmental impacts are managed and minimized and are within acceptable limits."