Ref. No. SKSL/2018/GL/001 Date: 20th November, 2018

The Registrar,
National Electric Power Regulatory Authority
NEPRA Towers, Sector G-5/1, Islamabad

Subject: APPLICATION FOR GRANT OF GENERATION LICENSE OF 50 MW SOLAR PV PROJECT IN KOHAT-KPK, PAKISTAN

Dear Sir,

I, Mohammed Nasir Aku being the duly authorized representative of **Kohat 50MWp PV Project, KPK- Pakistan** by Board Resolution dated 15th of November hereby apply to National Electric Power Authority for the Grant of Generation License to **Kohat 50MWp PV Project, KPK-Pakistan** 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 in belief.

A BANK DRAFT in sum of Rupees **325,952** 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,

Mohammed Nasir Aku
Director
Kohat 50MWp PV Project, KPK- Pakistan

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EXTRACT OF THE MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS OF SIDDIQSONS KOHAT SOLAR LIMITED HELD ON AT 10:00 AM IN KARACHI

BOARD RESOLUTIONS:

The following resolutions were discussed in detail by the Board and approved unanimously:

"**RESOLVED THAT** SIDDIQSONS KOHAT SOLAR LIMITED (a company incorporated under the laws of Pakistan with its registered office located at 27th floor, Ocean Tower, G-3, Main Clifton Road, Karachi) (the **Company**) be and is hereby authorized to submit an application for the grant of a generation license (including any modifications thereto) by National Electric Power Regulatory Authority in respect of its 50 MW solar power generation project to be located at Kohat (the **Project**) and in relation thereto, enter into and execute all required documents, make all filings and pay all applicable fees, in each case, of any nature whatsoever, as required".

"**FURTHER RESOLVED THAT** in respect of submitting an application for the generation license (including any modifications thereto) to National Electric Power Regulatory Authority, **MR. MOHAMMED NASIR AKU AS DIRECTOR** be and are hereby empowered and authorized for and on behalf of the Company to:

(i) review, execute, submit, and deliver the generation license application (including any modifications thereto) for the generation license any related documentation required by National Electric Power Regulatory Authority for the grant of the generation license, including any contracts, affidavits, statements, documents, powers of attorney, letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature whatsoever;

(ii) represent the Company in all negotiations, representations, presentations, hearings, conferences and/or meetings of any nature whatsoever with any entity (including, but in no manner limited to National Electric Power Regulatory Authority, any private parties, companies, partnerships, individuals, governmental and/or semi-governmental authorities and agencies, ministries, boards, departments, regulatory authorities and/or any other entity of any nature whatsoever);

(iii) sign and execute the necessary documentation, pay the necessary fees, appear before the National Electric Power Regulatory Authority as needed, and do all acts necessary for completion and processing of the generation license application (including any modifications thereto) and procuring the generation license;

(iv) appoint or nominate any one or more officers of the Company or any other person or persons, singly or jointly, in their discretion to make communicate with, make presentations to and attend the National Electric Power Regulatory Authority hearings; and

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(vi) do all such acts, matters and things as may be necessary for carrying out the purposes aforesaid and giving full effect to the above resolutions/resolution".

"**AND FURTHER RESOLVED THAT MR. MOHAMMED NASIR AKU AS DIRECTOR** be and is hereby authorized to delegate all or any of the above powers in respect of the foregoing to any other officials of the Company as deemed appropriate."

....

MR. REDA EL CHAAR
DIRECTOR
SIDDIQSONS KOHAT SOLAR LIMITED

Securities & Exchange Commission of Pakistan
SECP
Company Registration Office
Karachi

A008324

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

SECP

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. **0098052**

I hereby certify that **SIDDIQSONS KOHAT SOLAR 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 **Twenty Ninth** day of **February,** Two **Thousand** and **Sixteen**.

Incorporation fee Rs. **7,000/=** only

(Sidney Custodio Pereira)
Additional Registrar of Companies
Karachi

Certified to be True Copy
6/4/15
Joint Registrar of Companies

THE COMPANIES ORDINANCE, 1984

--: o : --

(COMPANY LIMITED BY SHARES)

--: o : -

Memorandum of Association

of

SIDDIQSONS KOHAT SOLAR LIMITED

I. The name of the Company is "**SIDDIQSONS KOHAT SOLAR LIMITED**".

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

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

1. To design, finance, insure, build, establish, own, operate, maintain, manage electric power generating plants for the generation, supply & transmission of electric power and in relation thereto, to establish, fix, carry out and maintain without limitation, any ancillary works, cables, wires, meter, lines, interconnect facilities, grid stations, transmission facilities, civil, electrical and mechanical works.

2. To carry out a feasibility study for and to carry on the business of power generation and in relation thereto, to generate, accumulate, transmit, distribute and sell electric power anywhere in Pakistan to the public sector, including the Water and Power Development Authority, National Transmission and Dispatch Company, Government and Government bodies and private sector subject to any permission required under the Law.

3. To manufacture, purchase, import or otherwise acquire, construct, own, process, operate and maintain buildings, apparatus, fixtures, fittings, plants, machinery, materials, and things as may be necessary, incidental to or convenient in connection with power generating plant for the generation of electric power and or in connection with supply, transmission and distribution of electric power.

4. To enter into any agreement or agreements with any government or other authority, supreme, municipal, local or otherwise, that may seem conducive to all or any of the objects of the Company and/or to obtain from such government or authority including the State Bank of Pakistan or National Electric Power Regulatory Authority (NEPRA) any rights, concessions or privileges, licenses which the Company may think desirable to obtain and to carry out, exercise and comply with any such arrangements, rights, privileges, concessions and licenses.

5. To buy, sell, manufacture, repair, alter, improve, exchange or let out, import, export and deal in all works legally permitted, plant, machinery, engines, tanks, cylinders, valves, regulators, testing equipment, tools, utensils, appliances, cookers, stoves, heaters, apparatus, products, materials, substances, raw materials, chemicals, natural gas, liquefied petroleum gas, fuel oil, coal, lubricants, articles and things and to manufacture, experiment with, render marketable and deal in all products legally permitted, incidental to or obtained in the business carried on by the Company.

6. To purchase, take on lease or tenancy or in exchange, hire, take options over or otherwise acquire for any estate or interest whatsoever and to hold, develop, work, cultivate, deal with and turn to account concessions, grants, decrees, licenses, privileges, claims, options, leases, property, real or personal or rights or powers of any kind which may appear to be necessary or convenient for the business of the Company but not to act as a leasing company or property developer.

7. To sell, exchange, mortgage, let on royalty or tribute, grant licenses, easements, options and other rights over and in any manner deal with or dispose of the Company's property or any part thereof for such consideration as may be thought fit and in particular for stocks, shares or securities of any company but in any event not to act as an investment company or leasing company.

8. To establish laboratories and to employ and promote scientific research and invention, patronize such invention and enter into manufacture in collaboration with outside parties for transfer of technology from abroad and to promote transfer of technology from Pakistan abroad, and to carry on business in all other allied fields permissible by law.

9. To invest and deal with any moneys of the Company not immediately for the time being required for any of the purposes of the Company in such investments as may be thought proper and to hold, sell or otherwise deal with such investments but in any event not to act as an investment company.

10. For the purposes of the business of the Company only, to advance money upon such terms as the Company may approve, and to guarantee the obligations and contracts of customers and others but not to act as a banking company.

11. To apply for, purchase or otherwise acquire and protect, prolong and renew whether in Pakistan or elsewhere any patents, patent rights, brevets d'invention, trademarks, design licenses, protections, concessions and the like conferring any exclusive or non-exclusive or limited right to use any secret or other information as to any invention, process or privilege which may seem capable of being used for any of the purposes of the Company or the acquisition of which may seem calculated directly or indirectly to benefit the Company and to use, exercise, develop, manufacture under grant, licenses, privileges in respect of, or otherwise turn to account the property, rights and information so acquired and to carry on any business in any way connected therewith.

12. To get insured against losses, damages, risks, accidents and liabilities of all kinds which may affect the company whether in respect of its contracts, agreements, advances or securities or in respect of servants or employees of the company, or in respect of property belonging to or leased to or hired by the company, either by setting apart funds of the company or by effecting such insurance and in later case to pay the premium thereon.

13. To train personnel and workers, in Pakistan and/or abroad, to obtain technical proficiency in various specialties connected with the business of the Company.

14. To undertake and execute any project the undertaking whereof may seem desirable, and either gratuitously or otherwise.

15. To procure the Company to be registered or recognized in any foreign country or place.

16. To acquire and undertake all or any part of the business, property, goodwill and liabilities of any person or company carrying on any business which the Company is authorized to carry on or possessed of property suitable for the purposes of the Company.

17. To adopt such means of making known the business and/or services of the Company as may seem expedient and in particular by advertising in the press, or in the other media or by way of participation in exhibitions.

18. For the purposes of the Company, to purchase, manage, acquire by lease, mortgage, dispose of, sell, exchange, turn to account any part of the property and rights of the Company.

19. To employ or appoint any persons, experts, consultants, advisers, contractors (including O&M contractors), brokers other than insurance brokers and stock brokers in connection with the business of the Company.

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

21. Only in connection with the business of the Company to open and operate any current, overdraft, loan, fixed or savings bank accounts for the Company, and draw, make, accept, discount, endorse, execute and issue promissory notes, bills of exchange, bills of lading and other negotiable or transferable instruments or securities and to deposit money, securities or property with any persons, firm or company and on any terms with or without security and to advance money to the Company's executives, officers and employees/agents/customers and others having dealings with the company but in any event not to act as an investment, banking or finance company.

22. In connection with the business of the Company only, to give guarantees and indemnities for the payment of money or the performance of contracts or obligations by this Company but in any event not to act as an investment, banking or finance company.

23. In connection with the business of the Company only, to borrow and where required, to secure the payment of money in such manner as the Company shall think fit and in particular by the creation of mortgages and charges over the (present and future) property, assets and/or undertaking of the Company and/or by issue of debentures, participation term certificates, term finance certificates and other securities charged upon all or any of the Company's property both present and future, and to purchase, redeem and pay off any such securities.

24. To lawfully raise moneys in such manner as the Company shall think fit and in particular by the issue of such securities, bonds and instruments payable to bearer or otherwise, and either permanent or redeemable or repayable convertible into shares and collaterally to secure the repayment of any such moneys so raised or any such securities or instruments of the Company by means of a trust deed or otherwise.

25. To take, or otherwise acquire, and hold shares in any other company having objects altogether or in part similar to those of this Company or carrying on any business capable of being conducted so as directly or indirectly to benefit this Company but in any event not to act as an investment company.

26. To issue all or any part of the original or enhanced share capital of the Company at par or at a premium or discount subject to any permission required under the law.

27. To enter into partnership or into any agreement or agreements for sharing profits, union of interests, cooperation, joint venture, reciprocal concession and/or facilities with any person or company whether or not having objects similar to those of this Company but in any event not to act as managing agents.

28. So far as is permissible in law, to offer stock option schemes to employees, to grant funds, donations, annuities, pensions, allowances, gratuities, bonuses to any employees or Directors or employees of the Company or any dependent thereof or to any charitable, religious, social, scientific, educational, industrial institutions or organization and to establish provident, gratuity and/or superannuation funds for the benefit of present or ex-employees or Directors or former directors of the Company

29. To pay all or any costs charges and expenses preliminary and incidental to the promotion, formation, establishment and registration of the Company and to pay any development costs incurred (whether before or after the incorporation of the Company) by the sponsors of the Company in connection with any project of the Company.

30. To pay brokerage or commission to any person or persons in consideration of his/their subscribing, or agreeing to subscribe, whether absolutely or conditionally, for any shares or debentures of the Company, or for procuring or agreeing to procure subscriptions whether absolute or conditional for the same which brokerage or commission may be paid either in cash or shares of the Company, credited as fully paid up, but not to act as an insurance agents and insurance brokers.

31. To distribute any of the Company's property among the members in the event of winding up of the Company.

32. To amalgamate, consolidate, or merge, either in whole or in part, with or into any other companies, associations, firms or persons carrying on any trade or business of a similar nature to that which this Company is authorized to carry on.

33. To resolve, settle disputes by negotiation, conciliation, mediation, arbitration, litigation or other means, judicial or extra judicial, and to enter in compromise agreement with creditors, members and any other persons in respect of a difference or dispute with them and to exercise the power to sue and be sued and to initial or oppose all actions, steps, proceedings or application which may seem calculated directly or indirectly to benefit or prejudice, as the case may be, the interest of the Company or of its members.

34. To do all or any of the things herein in any part of the world either as principals, agents, contractors or otherwise, and either alone or in conjunction with others but in any event not to act as managing agents.

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

36. To carry on any other business whether manufacturing or otherwise that may seem to the Company capable of being conveniently carried on in connection with the above objects or calculated directly or indirectly to enhance the value of or render profitable any of the Company's property or rights or which it may be advisable to undertake with a view to improving , developing, rendering or turning to account any property real or personal belonging to the Company or in which the Company may be interested and to do all or any of the above things either as principals, agents, contractors or otherwise, and either alone or in conjunction with others and either by or through agents, sub-contractors, trustees or otherwise, and to do all such things as are incidental or conducive to the attainment of the above objects but in any event not to act as managing agents.

37. To do all and everything necessary, suitable or proper or incidental or conducive to the accomplishment of any of the purposes or the attainment of any of the objects or the furtherance of any of the powers hereinbefore set forth, either alone or in association with other corporate bodies, firms or individuals or with any Government authority or public or quasi-public authority or any other authority, and to do every other act or thing incidental or impertinent to or arising out of or connected with the business or powers of the Company or part thereof, provided the same be lawful.

38. It is expressly declared that all the powers expressed therein are to be cumulative but in no case unless the context expressly so requires is the generality of any one sub-clause to be narrowed or restricted by the name of the Company or by the particularity of expression in the same sub-clause or by the application of any rule of construction such as the ejusdem generis rule, and accordingly none of such sub-clauses or the objects therein specified or the power thereby conferred shall be deemed subsidiary or auxiliary merely to the objects mentioned in any other sub-clause of this clause, and the Company shall have full power to exercise all or any of the powers conferred by any part of this clause in any part of the world.

39. IT IS HEREBY UNDERTAKEN that the Company shall not engage in the banking business, business of a finance, investment, leasing or insurance company, or as a Modaraba Management Company, or the business of land development or a managing agent or any unlawful business and that nothing in the objects clause shall be construed to entitle it to engage in such business.

40. AND that none of such-clauses or the objects therein specified or the powers thereby conferred shall be or be deemed to be subsidiary or ancillary or ancillary merely to the objects mentioned in any of the other sub clause of this clause or any of them but the Company have full power to exercise all or any of the power conferred by any part of this clause in any part of the world, notwithstanding that the business undertaking property rights or acts proposed to be transacted, acquired, dealt with or performed do not fall within the objects of the earlier or any other sub-clauses of this clause or any of them.

41. It is hereby undertaken that the Company shall not engage in banking business or Forex, illegal brokerage, or any business of investment company or non-banking finance company or insurance or leasing or business of managing agency or in any unlawful business and that nothing contained in the object clauses shall be so construed to entitle it to engage in such business directly or indirectly and the Company shall not launch multi-level marketing (MLM), Pyramid and Ponzi schemes.

Notwithstanding anything 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 authorized capital of the Company is Rs.10,000,000 (Rupees: Ten Million Only) divided into 1,000,000 (One Million Shares only) shares of Rs.10 (Rupees Ten only) each, with power of the Company, specifically, to increase the authorized share capital to include a further class consisting of preference shares and generally, to increase or reduce the capital and to divide the shares in the capital for the time being into several classes in accordance with the provisions of the Companies Ordinance, 1984 and any rules made thereunder, and to attach thereto respectively such preferential, deferred, qualified or special rights, privileges or conditions as may be determined by or in accordance with the Articles of Association of the Company for the time being, and to vary, modify or abrogate any such rights, privileges or conditions in such manner as may for the time being be provided by the Articles of Association of the Company in accordance with law.

We, the several persons whose name and addresses are subscribed below, are desirous of being formed into a Company in pursuance of this Memorandum of Association, and we respectively agree to take the number of shares in the Capital of the Company indicated herein below against our respective names:

S. No.	Name & Surname (Present & Former) / Father / Husband Names In Full Block Letters.	NIC No. (In Case Of Foreigner, Passport No.)	Nationality With Any Former Nationality And Occupation	Residential Address In Full	Number Of Shares Taken By Each Subscriber	Signature of the Subscriber
1	Mr. Abdur Rahim S/O Muhammad Tariq Rafi	42201-0409988-5	PAKISTAN Business	House No. 34-H-1, Block-6, PE.C.H.S. Karachi.	25,000 (Twenty Five Thousand Shares)	
2	Mrs. Anum Abdur Rahim W/O Abdur Rahim	42201-8648[illegible]	PAKISTAN Business	House No. 34-H-1, Block-6, PE.C.H.S. Karachi.	24,999 (Twenty Four Thousand Nine Hundred Ninety Nine Shares)	
3	Mr. Muhammad Ahmed S/O Haji Ibrahim	42101-1426211-1	PAKISTAN Corporate Executive	House No. A-189/17, Rahimabad, Federal B Area, Azizabad, Karachi.	1 (One Share)	
				Total Number of Shares.	50,000 (Fifty Thousand Shares)	

Dated the 22nd day of February 2016
Witness to above signatures.
Name: National Institutional Facilitation Technologies (Pvt.) Ltd.
Nationality: Pakistani
Address: 5th Floor, AWT Plaza, I. I. Chundrigar Road, Karachi

Certified to be True Copy
13/2/19
Joint Registrar of Companies

THE COMPANIES ORDINANCE, 1984

--: o : --

(COMPANY LIMITED BY SHARES)

--: o : -

Articles of Association

of

SIDDIQSONS KOHAT SOLAR LIMITED

I. PRELIMINARY

1. TABLE "A" Not to Apply

The regulations in Table 'A' in the First Schedule to the Companies Ordinance, 1984 shall not apply to the Company except so far as the same are repeated or contained in these articles.

2. DEFINITIONS

Unless the context otherwise requires, the terms used in these articles shall have the meanings set out below:

(a) **"Articles"** mean these articles of association of the company as originally framed or as from time to time altered by in accordance with the law.

(b) "**Board**" means the group of directors in a meeting duly called and constituted or, as the case may be, the directors assembled at a board.

(c) "**Book and paper**", "book or paper" or "books of account" mean accounts, deeds, vouchers, writings and documents, maintained on paper or computer network, floppy, diskette, magnetic cartridge tape, CD-Rom or any other computer readable media;

(d) "**Buy-back of shares rules**" mean the Companies (Buy-Back of Shares) Rules, 1999 or any modification or re-enactment thereof.

(e) "**Company**" means **Siddiqsons Kohat Solar Limited**.

(f) "**Central depository**" means a central depository as defined in clause (ca) of section 2 of the Securities and Exchange Ordinance, 1969 (XVII of 1969) and registered with the Securities and Exchange Commission of Pakistan under section 32 A of the said ordinance.

(g) "**Central Depositories Act**" means the Central Depository Act, 1997 or any modification or re-enactment thereof.

(h) "**Central Depository Regulations**" mean the central depository company of Pakistan limited regulations made pursuant to section 35(1) of the Central Depository Act, 1997 or any modification or re-enactment thereof.

(i) "**Central Depository Register**" means a computerized electronic register maintained by a central depository in respect of book-entry securities.

(j) "**Code**" means the code of corporate governance.

(k) "**Commission**" means the Securities and Exchange Commission of Pakistan established under section 3 of the Securities and Exchange Commission of Pakistan Act, 1997.

(l) "**Directors**" mean the directors for the time being of the company including alternate directors and, subsequently elected pursuant to Companies Ordinance, 1984 or as the case may be, the directors assembled at a board.

(m) "**Dividend**" includes cash dividend, dividend in species and bonus shares.

(n) "**Electronic**" includes electrical, digital, magnetic, optical, bio-metric, electro-chemical, wireless or electromagnetic technology.

(o) "**Electronic transactions ordinance**" means the Electronic Transactions Ordinance, 2002 or any modification or re-enactment thereof.

(p) "**In Person**" includes attendance and/or voting at a meeting, personally or by video or telephone-conference or other facility whereby all the participants of the meeting can hear and / or see each other unless expressly stated otherwise by the directors.

(q) "**Instrument of transfer**" includes transfer deeds and any record of transfer of book-entry securities in the central depository register, provided by the central depositories act and the central depository regulations.

(r) "**Issue of capital rules**" means Companies (issue of capital) Rules, 1996 or any modification or re-enactment thereof.

(s) "**Listing requirements**" mean the listing regulations of the stock exchanges.

(t) "**Member**" means a person whose name is for the time being entered in the register of members by virtue of his being a subscriber to the memorandum of association of the company or of his holding by allotment or otherwise any share, scrip or other security which gives him a voting right in the company including but not limited to the account holders of a central depository.

(u) "**Memorandum**" means the memorandum of association of the company as originally framed or as from time to time altered in accordance with law.

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

(w) "**Office**" means the registered office for the time being of the company.

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

(y) "**Preference shares**", not being ordinary shares mean preference shares whether redeemable or irredeemable, cumulative or otherwise with the rights, privileges and conditions attaching thereto as are provided by the articles.

(z) "**Preference shareholders**" not being ordinary shareholders mean, in relation to the Company, every person to whom the company has allotted, or who becomes the holder of such shares and whose name is entered in the register of members.

(aa) "**Proxy**" includes an attorney duly constituted under a power of attorney.

(ab) "**Record**" includes, in addition to a written or printed form, any disc, tape, sound-track, film or other device in which sounds and / or other data is embodied so as to be capable (with or without the aid of some other instrument or machine) of being reproduced there from in audible, legible or visual form.

(ac) "**Register**" means, unless the context otherwise requires, the register of members and include the register of debenture-holders or holders of other securities maintained on paper or computer network, floppy, diskette, magnetic cartridge tape, CD-Rom or any other computer readable media; to be kept pursuant to section 147 of the ordinance and / or central depository register under the central depositories act and the central depository regulations.

(ad) "**Registrar**" means a registrar, defined in section 2 (1) (31), performing the duty of registration of companies under the ordinance.

(ae) "**Regulations**" mean the rules of governance of the company made by the board from time to time.

(af) "**Seal**" means the common or official seal of the company.

(ag) "**Section**" means section of the ordinance.

(ah) "**Share Capital Rules**" mean the companies' Share Capital (Variation in Rights and Privileges) Rules, 2000.

(ai) "**Sign**" **and** "**Signature**" unless otherwise provided in these articles, include respectively lithography, printing facsimile, "advanced electronic signature" which is capable of establishing the authenticity and integrity of an electronic document, as defined by section 2(e) of the electronic transactions ordinance, and names impressed with a rubber or other kind of stamp.

(aj) "**Special Resolution**" means the special resolution of the company as defined in section 2(1) (36) of the ordinance.

(ak) "**Stock Exchanges**" mean the Islamabad, Lahore and Karachi stock exchanges and such other stock exchanges as may be established in Pakistan.

3. **INTERPRETATION**

In these articles, unless the context otherwise requires:

(a) the singular includes the plural and vice versa and words denoting any gender shall include all genders;

(b) references to any act, ordinance, legislation, the code, the listing requirements, rules or regulations or any provision of the same shall be a reference to that act, ordinance, legislation, the code, the listing requirements, rules or regulations or provisions, as amended, re-promulgated or superseded from time to time;

(c) the terms "include" or "Including" shall mean include or including without limitation;

(d) Expressions referring to writing shall, unless the contrary intention appears, be construed as including references to printing, lithography, photography, and other modes of representing or reproducing words in a visible form, including but not limited to, electronic transmission such as facsimile, and electronic mail or any other electronic process, as prescribed by section 3 of the electronic transactions ordinance.

(e) words importing persons shall include bodies corporate; and

(f) words and expressions contained in these articles shall bear the same meaning as in the ordinance.

REGISTERED OFFICE

4. The registered office of the company shall be in the Province of Sindh as the directors shall from time to time appoint.

PUBLIC LIMITED COMPANY

5. The company is a public limited company within the meanings of section 2(1), Clause (30) of the Companies Ordinance, 1984.

BUSINESS

6. All branches or kind of business which the company is either expressly or by implication authorized to undertake may be undertaken by the directors at such time or times as they shall think fit, and further may be allowed by them to be in abeyance, whether such branch or kind of business may have been actually commenced or not, so long as the directors may deem it expedient not to commence or proceed with such branch or kind of business.

II. CAPITAL

SHARES

7. The minimum Subscription upon which the Directors may proceed to make First Allotment is fixed at Rs.500,000/- (Rupees: Five Hundred Thousand Only).

8. The Authorized Capital of the Company is Rs.10,000,000/- (Rupees Ten Million Only) divided into 1,000,000 (One Million Only) (ordinary shares of Rs.10/= (Rupees Ten Only) each, but the Company may from time to time by a Special Resolution increase, consolidate, sub-divide, reduce or otherwise re-organize the share capital of the Company, subject to the provisions of Section 108 of the Companies Ordinance, 1984

9. Subject to section 90 of the ordinance and any rules in that regard made under the ordinance and without prejudice to any special rights previously conferred on the holders of any existing shares or class of shares, any share in the company may be issued with different rights, restrictions and privileges, including but not limited to the following as may be approved by the company by special resolution:

(1) different voting rights; voting rights disproportionate to the paid-up value of share held; voting rights for specific purposes only; or no voting rights at all;

(2) different rights for entitlement of dividend, right shares or bonus shares or entitlement to receive the notices and to attend the general meetings;

(3) rights and privileges for indefinite period, for a limited specified period or for such periods as may from time to time be determined by the company;

(4) different manner and mode of redemption, including redemption in accordance with the provisions of these articles, subject to sections 85 and 95 (4) of the ordinance, including but not limited to, by way of conversion into shares with such rights and privileges as determined by the company in the manner and mode provided in these articles; and

(5) Different rights and privileges for listing or non-listing of any class of shares.

10. Subject to section 95(4)(a) of the ordinance and any rules in that regard made under the ordinance, the company may issue shares which are to be redeemed or any other redeemable security, on such terms and in such manner as may be provided in the said section and rules.

11. Subject to provisions of the ordinance and these articles and subject to any special rights or privileges for the time being attached to any issued shares, the shares in the capital of the company for the time being, including any new shares resulting from an increase in the authorized capital, shall be under the control of the directors who may allot or otherwise dispose of the same or any of them to such persons (subject to article 43), on such terms and conditions, and with such rights and privileges annexed thereto as the resolution creating the same shall direct, and if no direction be given, as the directors shall determine and at such times and in such manner as the directors think fit, either at par or at a premium or subject to section 84 of the ordinance at a discount with power to the directors to give any person the right to call for and be allotted shares of any class of the company at par or at a premium or, subject as aforesaid, at a discount, such option being exercisable at such time, and for such consideration as the directors think fit. Provided that the shares in the capital of the company shall always be issued as fully paid shares and no shares shall be issued as partly paid shares. The directors shall, as regards any allotment of shares, duly comply with such of the provisions of sections 67 to 73, the central depositories act, the central depository regulations, the issue of capital rules and the share capital rules, as may be applicable to the company.

12. The directors may allot and issue shares in the capital of the company as payment or part payment for any property sold or transferred, or for services rendered, to the company in the ordinary course of its business, and shares so allotted shall be issued as and shall be deemed to be fully paid shares.

13. The board shall, as regards any allotment of shares, duly comply with such provisions of sections 67 to 73 of the ordinance as may be applicable.

14. The company may at any time pay a commission to any person for subscribing or agreeing to subscribe (whether absolutely or conditionally) for any shares, debentures or debenture stock in the company or procuring or agreeing to procure subscriptions (whether absolutely or conditionally) for any shares, debentures or debenture stock in the company; Provided, that, if the commission in respect of shares shall be paid or payable out of capital, the statutory requirements and conditions shall be observed and complied with, and the amount or rate of commission shall not exceed such percentage on the shares, debentures or debenture stock in each case subscribed or to be subscribed, as may be determined by the board subject to any limits required by law. The commission may be paid or satisfied, either wholly or partly, in cash or in shares, debentures or debenture stock. The company may also on any issue of shares pay such brokerage fees as may be lawful; Provided that such brokerage fees shall not exceed such percentage of the shares, debentures or debenture stock paid-up as may be determined by the board, subject to any limits required by law.

15. Subject to section 95A of the ordinance and any rules in that regard made under the ordinance, the company may purchase its own shares on such terms and in such manner as may be provided in the said section and rules.

16. Except as permitted in the ordinance and any rules in that regard made under the ordinance, no part of the funds of the company shall be employed in the purchase of its own shares or in giving, whether directly or indirectly and whether by means of a loan, guarantee, security or otherwise, any financial assistance for the purpose of or in connection with a purchase made or to be made by any person of or any shares in the company.

17. Except as required by law, no person shall be recognized by the company as holding any share upon any trust, and the company shall not be bound by or be compelled in any way to recognize (even when having notice thereof) any equitable, contingent, future or partial interest in any share or any interest in any fractional part of a share or (except only as by these Articles or by law otherwise provided or under an order of a court of competent jurisdiction) any other rights in respect of any share except any absolute right to the entirely thereof in the registered an absolute right to the entirely thereof in the registered holder.

18. 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 by statute required, be bound to recognize (even when having notice thereof) any benami, equitable, contingent, future, partial or other claim or right to or interest in such share on the part of any other person.

19. Shares may be registered in the name of persons, any limited company or other corporate body. Not more than four persons shall be registered as joint-holders of any share.

20. If any share or shares stand in the name of two or more persons, the person first named in the register shall, as regards receipt of dividend or bonus or service of notices and all or any other matters connected with the company except voting at the meeting and the transfer of shares, be deemed the sole holder.

RIGHTS PRIVILEGES AND CONDITIONS ATTACHED TO SHARES

21. As regards income, the profits which the company may determine to distribute in respect of any financial year or other period for which the accounts shall be made up, shall be applied in the following order of priority;

    (1) In paying the holders of the preferences shares, the right to a cumulative preferential dividend as determined by the board on the capital paid up thereon payable as regards each financial year out of the profits of the company resolved to be distributed in respect of that year, but shall not be entitled to any further participation in profits; and

    (2) Subject to the rights of any class of shares for the time being issued, in distributing the balance amongst the holders of the ordinary shares according to the amounts paid up on the ordinary shares held by them respectively.

22. As regards conversion, the company may partly or wholly convert the preference shares at the option of the holders of the preference shares in accordance, respectively, with the terms and conditions of their issue.

22. As regards capital, on a return of capital in a winding up or otherwise (except upon the redemption of shares of any class of preference shares or the purchase by the company of its own shares), the surplus assets of the company remaining after payment of its liabilities shall be applied in the following order of priority:

    (1) in paying to the holders of the preference shares, the capital paid up on the same without any further right to participate in profits or assets; and

    (2) subject to the rights of any other class of shares for the time being issued, in distributing the balance amongst the holders of the ordinary shares according to the amounts paid up on the ordinary shares held by them respectively.

23. As regards entitlement to bonus or right shares, the holders of preference shares shall not be entitled to bonus or right shares in the event that the company increases its capital by the issue of further shares or otherwise.

24. As regards voting rights, the holders of the preference shares shall not be entitled to receive notice of, attend, or vote at, any general meeting of the company, except as otherwise provided by the ordinance, whereby the holders of such shares would be entitled to vote separately as a class, that is, with respect to voting entitlement of the preference shareholders on matters affecting, respectively, their substantive rights and liabilities. Without prejudices to the foregoing, the holders of preference shares may attend the general meeting of the company as observers with prior permission of the chairman.

CERTIFICATES

25. The Certificates of title to shares and duplicate thereof shall be issued under the seal of the company and signed by two of the directors or by one such director and the secretary

provided that such signatures may if necessary be printed lithographed or stamped subject to the approval of the directors.

26. Every member shall be entitled to one certificate for all the shares registered in his name, or, if the directors so approve, to several certificates each for one or more of such shares, but in respect of each certificate for less than one hundred shares, the directors shall be entitled to charge a fee of Rupees 10 or such lesser sum as they may determine. Every certificate of shares shall specify the number and denoting numbers of the shares in respect of which it is issued.

27. The company shall within ninety days after the allotment of any shares, debentures or debenture stock and within forty-five days (or where the transferee is a central depository, within five (5) days) after receipt by the company of the application for transfer of any such shares, debentures or debenture stock complete and have ready for delivery the certificate (such expression shall hereinafter be deemed to include book-entry security as defined in the central depositories act, and the central depository regulations) of all shares, the debentures and the certificate of all debenture stock allotted or transferred, and unless sent by post or delivered to the person entitled thereto within the period aforesaid the company shall immediately thereafter give notice to that person in the manner prescribed in these articles for the giving of notices to members that the certificate is ready for delivery.

28. If a certificate of shares, debenture or debenture stock is proved to the satisfaction of the company to have been lost or destroyed or, being defaced or mutilated or torn, is surrendered to the company, and the company is requested to issue a new certificate in replacement thereof, the company shall, after making such enquiry as it may deem fit, advise the applicant within thirty days from the date of application the terms and conditions (as to indemnity and otherwise and as to payment of the actual expenses incurred on such enquiry and of a fee not exceeding ten rupees) on which the company is prepared to issue a new certificate and a time for compliance therewith or of the reasons why the company is unable to issue a new certificate, as the case may be, and in the former case if the applicant shall within the time allowed comply with the terms and conditions specified, the company shall issue a new certificate to the applicant within forty five days from the date of application.

29. The company shall not be bound to issue more than one certificate in respect of a share or shares held jointly by two or more persons and delivery of a certificate for a share to any one of joint holders shall be sufficient delivery to all..

TRANSFER AND TRANSMISSION

30.(1) The directors shall not refuse to register the transfer of fully paid shares unless the instrument of transfer is defective or invalid or is not accompanied by the certificate of the share(s) to which it relates. The directors may also decline to recognise 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 reasonably required to show the right of the transferor to make the transfer. The directors may waive the production of any certificate upon evidence satisfactory on them of its loss or destruction.

(2) If the directors refuse to register a transfer of any shares they shall, within thirty (30) days (or where the transferee is a central depository, within five (5) 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 the invalidity of the instrument of transfer, the transferee shall be entitled, after removal of such defect or invalidity, to re-lodge the instrument of transfer with the company.

31. Shares in the company shall be transferred in accordance with the central depositories act and the central depository regulations. If the shares of the company are not registered in the central depository, the same may be transferred through the instrument of transfer. The instrument of transfer of any share shall be in writing in the usual common form, or in the following form, or as near thereto as circumstances will admit:

"I/We, ... of ....
son/daughter/wife of .... being a national(s) of .... in consideration of the sum of Rupees .... only (Rs. ....) paid to me/us by .... of .... son/daughter/wife of .... being a national(s) of .... (hereinafter called the 'said transferee(s)') do hereby transfer to the said transferee(s) share(s) numbered standing in my/our name(s) in the books of **SIDDIQSONS KOHAT SOLAR LIMITED**, to hold onto the said transferee(s) his/her/their executors, administrators and as signs, subject to the several conditions on which I/we hold the same at the time of execution hereof, and I/we the said transferee(s) do hereby agree to take the said share(s) subject to the conditions aforesaid.

As witness our hands the .... day of .... thousand ...."

Signed by the said transferor in the presence of

Transferor's signature ....

Transferor's occupation ....

Witness 1 ....
Occupation ....
Address ....
Signed by the said transferee in the presence of Transferee's occupation

Witness 2 ....
Occupation ....
Address ....
Transferee's signature

Witness 1	Witness 2 ....
Occupation	Occupation
Address....................................	Address....................................

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

33. All registered instruments of transfer shall be retained by the company, but any instrument of transfer which the directors may decline to register shall be returned to the person depositing the same.

34. 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.

35. On giving seven days previous notice in the manner provided in the ordinance and articles, the transfer books and register may be closed during such time as the directors think fit, not exceeding in the whole forty-five days in each year, but not exceeding thirty days at a time.

36. Any member may make and deposit with the Company a nomination in writing specifying one or more eligible persons who or each of whom, in the event of the death of the Member, may be entered in the Register as the holder of such number of shares specified in the nomination for such nominee or each such nominee of which the member remains the registered holder, at the date of his death. A person shall be eligible for nomination for the purposes of this Article only if he is a spouse, parent, brother, sister or child of the member nominating him and the applicable relationship all should be specified in the nomination in respect of each nominee. A member may at any time by notice in writing cancel, or by making and depositing with the company another nomination before his death vary any nomination already made by him pursuant to this Article. In the event of the death of a member any person nominated by him in accordance with this Article may, on written application accompanied by the relative share certificates and evidence establishing the death of the member, request the company to register himself in place of the deceased member as the holder of the number of shares for which the nomination in his favour had been made and deposited with the company, and if it shall appear to the Directors that it is proper so to do, the Directors may register the nominee as the holder of those shares in place of the deceased member.

(a) in the case of the death of a member who was a joint-holder of shares the survivor or survivors shall be the only persons recognized by the company as having any title to his interest in the shares. If the deceased member was a sole holder of shares, the nominee or nominees of the deceased where a nomination under Article 37 is effective, and the legal personal representatives, executors or administrators, of the deceased where no such nomination has been made and deposited with the company, shall be the only persons recognized by the company as having any title to his interest in the shares.

(b) Before recognizing any legal representative or executor or administrator, the Directors may require him to obtain a grant of succession certificate or probate or letters of administration or other legal representation, as the case may be, from some competent Court in Pakistan having effect in Karachi; provided nevertheless that in any case where the Directors in their absolute discretion think fit, it shall be lawful for the Directors to dispense with the production of succession certificates or probates or letters of administration or such other legal representation, upon such terms as to indemnity or otherwise as the Directors, in their absolute discretion, may consider necessary.

37. The executors or administrators or the nominee appointed under section 80 of the ordinance of a deceased member (not being one of several joint-holders) shall be the only person recognized by the company as having any title to the shares registered in the name of such member, and in case of the death of any one or more of the joint-holders of all registered shares (such expression shall hereinafter be deemed to include registration as a sub-account holder of a central depository under the central depositories act and the central depositories regulations) ,the survivors shall be the only persons, recognized by the company as having any title to or interest in such shares, but nothing herein contained shall be taken to release the estate of a deceased joint-holder from any liability on shares held by him jointly with any other person. Before recognizing any executor or administrator, the directors may require him to obtain a grant of probate or nomination as mentioned above or letters of administration or other legal representation, as the case may be, from some competent court in Pakistan having effect in Karachi. Provided nevertheless that in any case where the board in their absolute discretion think fit, it shall be lawful for the directors to dispense with the production of probate or letters of administration or such other legal representation upon such terms as to indemnify or otherwise as the directors, in their absolute discretion, may consider necessary.

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

39. Any committee or guardian of a lunatic or minor member or any person becoming entitled to a share in consequence of the death or bankruptcy or insolvency of any member upon producing such evidence that he sustains the characters in respect of which he proposes to act under this article, or of his title, as the directors think sufficient, shall have the right to be registered as a member in respect of such share, or may, subject to the regulations as to transfer hereinbefore contained, transfer such share.

40. Neither the company nor the directors nor any other officer of the company shall incur any liability for registering or acting upon a transfer of shares apparently made by sufficient parties, although the same may, by reason of any fraud or other cause not known to the company or the directors or any other officer of the company, as aforesaid, be legally inoperative or insufficient to pass the property in the shares proposed or professed to be

transferred, and although the transfer may, as between the transferor and transferee, be liable to be set aside, and, notwithstanding that the company may have notice that such instrument of transfer was signed or executed and delivered by the transferor in blank as to the name of the transferee or the particulars of the shares transferred, or otherwise in defective manner. And in every such case the person registered as transferee, his executors, administrators and assigns alone shall be entitled to be recognized as the holder of such shares and the previous holder shall, so far as the company is concerned, be deemed to have transferred his whole title hereto.

ALTERATION OF CAPITAL

41. The company may by ordinary resolution and subject to compliance with the requirements of section 92 of the ordinance increase the authorized share capital by such sum, to be divided into shares of such amount, as the resolution shall prescribe.

42. Subject to the provisions of section 92 (1) (d), 92(3) and 93 and section 13 of the central depositories act, the company may, by ordinary resolution;

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

    (b) by sub-division of its existing shares or any of them, divide the whole or any part of its share capital into shares of smaller amount than is fixed by the memorandum of association;

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

43. The directors may from time to time increase the issued share capital by such sum as they think fit. Except as otherwise permitted by section 86 of the ordinance , rule 5 of share capital rules, the listing requirements and section 14 of the central depositories act, as are applicable to the company and subject to any special rights or privileges for the time being attached to any issued shares, 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); provided that fractional shares shall not be offered and all fractions less than a share shall be consolidated and disposed of by the company and the proceeds from such disposition shall be paid to such of the entitled members as may have accepted such offer. Such offer shall be made by notice specifying the number of shares offered, and limiting a time within which the offer, if not accepted, will be deemed to be declined, and after the expiration of that time, or on the receipt of an intimation from the person to whom the offer is made that he declines to accept the shares offered, the directors may dispose of the same in such manner as they think fit. In respect of each such offer of shares the directors shall comply with the provisions of section 86 of the ordinance and in particular with the provisions of sub -sections (3), (4) and (5) thereof. Any difficulty in the apportionment of shares amongst the members, such difficulty shall, in the absence of any directions given by the company in general meeting, be determined by the directors.

44. Except so far as otherwise provided by the conditions of issue or by these articles, any capital raised by the creation of new shares shall be considered part of the original capital

and shall be subject to the provisions herein contained with reference to transfer and transmission and otherwise.

45. Subject to the provisions of sub-section (2) of section 86 of the ordinance, if, owing to any inequality in the number of new shares to be issued and the number of shares held by a member entitled to have the offer of such new shares, any difficulty shall arise in the apportionment of such new shares or any of them amongst the members, such difficulty shall, in the absence of any direction in the resolution creating the shares or by the company in general meeting, be determined by the directors.

46. The company may, by special resolution, reduce its share capital in any manner, with and subject to, any incident authorized and consent required by law.

47. The share premium account maintained pursuant to section 83(1) of the ordinance may, be applied by the company:

(a) in writing off the preliminary expenses of the company;

(b) in writing off the expenses of, or the commission paid or discount allowed on, any issue of shares or debentures of the company;

(c) in providing for the premium payable on the redemption to any redeemable preference shares or debentures of the company; or

(d) in paying up un-issued shares of the company to be issued as fully paid bonus shares.

48. Subject to the provisions of section 96 to 105 inclusive of the ordinance, the company may accept from any member the surrender on such terms and conditions as may be agreed of all or any of his shares.

VARIATION OF SHAREHOLDERS' RIGHTS

49. Whenever the capital is divided into different classes of shares, all or any of the rights and privileges attached to each class may, subject to the provisions of section 108 of the ordinance, be modified, commuted, affected, abrogated or dealt with by agreement between the company and any person purporting to contract on behalf of that class provided such agreement is (a) ratified in writing by the holders of at least three-fourths in nominal value of the issued shares of the class or (b) confirmed by a special resolution passed at an extraordinary general meeting of the holders of shares of that class and all the provisions hereinafter contained as to general meetings, shall, mutatis mutandis, apply to every such meeting. This article shall not by implication curtail the power of modification which the company would have if this article were omitted.

III. MEETINGS

CONVENING OF GENERAL MEETINGS

50. Except as may be allowed under section 158(1) of the ordinance and listing requirements,

the company shall hold a general meeting once at least in every calendar year within a period of four months following the close of its financial year in the town in which the office is situate and at such time and place as may be determined by the directors, provided that no greater interval than fifteen months shall be allowed to elapse between two such general meetings. The company may, for any special reason and with permission of the commission, extend the time within which any annual general meeting, not being the first such meeting, shall be held.

51. The company shall hold its annual general meeting in the town in which the registered office is situate; provided that, it may, for any special reason and with permission of the commission, hold the said meeting at any other place. Save as aforesaid, the company may hold its general meeting at two (2) or more venues using any technology that gives the members as a whole a reasonable opportunity to participate in the meetings.

52. All general meetings of the company, other than the statutory meeting or any annual general meeting, shall be called extraordinary general meetings, and shall be subject to listing requirements.

53. The directors may, whenever they think fit, and they shall, on the requisition of the holders of not less than one-tenth of the issued capital of the company, forthwith proceed to convene an extraordinary general meeting of the company. If at any time there are not within Pakistan sufficient directors capable of acting to form a quorum, any director of the company may call an extraordinary general meeting in the same manner as nearly as possible as that in which meetings may be called by the directors, and in the case of such requisition the following provisions shall have effect:

(1) The requisition must state the objects of the meeting and must be signed by the requisitioners and deposited at the office and may consist of several documents in like form each signed by one or more requisitioners.

(2) If the directors do not proceed within twenty-one days from the date of the requisition being so deposited to cause a meeting to be called, the requisitioners or a majority of them in value may themselves convene the meeting, but any meeting so convened shall not be held after three months from the date of the deposit.

(3) Any meeting convened under this article by the requisitioners shall be convened in the same manner as nearly as possible as that in which meetings are to be convened by the directors but shall be held at the office.

(4) A requisition by joint-holders of shares must be signed by all such holders.

54. (1) Notice of a general meeting shall be sent in the manner hereinafter mentioned at least twenty one (21) days before the date on which the meeting is to be convened to all such persons as are under these articles or the ordinance entitled to receive such notices from the company and shall specify the place and the day and hour of the meeting and the nature of the business to be transacted thereat.

(2) In the case of an emergency affecting the business of the company, an extraordinary general meeting may be convened by such shorter notice than that specified in article 54(1) as the registrar may authorize.

(3) Where any special business, that is to say, business other than consideration of the accounts, balance sheet and the reports of the directors and auditors, the declaration of dividend, the appointment and fixation of the remuneration of auditors and, where the notice convening the meeting provides for the election of directors, the election of directors (all such matters being herein referred to as ordinary business) is to be transacted at a general meeting, there shall be annexed to the notice of such meeting a statement setting out all such facts as may be material for the consideration of such business including the nature and extent of the interest (whether direct or indirect) of any director, and where the item of business involves approval of any document, the time and place appointed for inspection thereof, and to the extent applicable such a statement shall be annexed to the notice also in the case of ordinary business to be transacted at the meeting.

(4) Where a resolution is intended to be proposed for consideration at a general meeting in some special or particular form, a copy thereof shall be annexed to the notice convening such meeting.

(5) If a special resolution is intended to be passed at a general meeting, the notice convening that meeting shall specify the intention to propose the resolution as a special resolution.

(6) A notice for a general meeting at which an election of directors is to take place shall state the number of directors to be elected at that meeting and the names of the retiring directors.

(7) The notice of every general meeting shall prominently specify that a proxy may be appointed who shall have the right to attend, demand or join in demanding a poll and vote on a poll and speak at the meeting in the place of the member appointing him and shall be accompanied by a form of proxy acceptable to the company.

(8) The company shall comply with the provisions of section 1[illegible] and section 50 of the ordinance with regard to giving notices of general meetings.

55. The accidental omission to give any such notice to, or the non-receipt of notice by, any of the members shall not invalidate the proceedings at any such meeting.

PROCEEDINGS AT GENERAL MEETINGS

56. No business shall be transacted at any general meeting unless a quorum of members is present at the time when the meeting proceeds to business; save as herein otherwise, provided ten (10) members present in person or by proxy representing twenty five percent (25%) of the total voting power shall be a quorum.

57. The chairman 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 in person within fifteen minutes after the time appointed for the holding of the meeting or is unwilling to act, the chief executive shall preside as chairman of the meeting, or if the chief executive is absent or unwilling to act, any one of the directors present in person may be elected to be chairman of the meeting, or if no director be present in person, or if all the directors present in person decline to take the chair, the members present in person shall choose one of their member to be chairman of the meeting.

58. If within half-an-hour from the time appointed for the meeting, a quorum is not present, the meeting if convened upon such requisition as aforesaid shall be dissolved, but in any other case it shall stand adjourned to the same day in the next week at the same time and place, and if at such adjourned meeting a quorum is not present within half an hour from the time appointed for it, the meeting shall be dissolved.

59. The chairman may adjourn the meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place. When a meeting is adjourned for more than seven days, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid it shall not be necessary to give any notice of an adjournment or of the business to be transacted at an adjourned meeting.

60. In the case of an equality of votes the chairman shall, both on a show of hands and at the poll, have a casting vote in addition to the vote or votes to which he may be entitled as member.

61. (1) At any general meeting a resolution put to the vote of the meeting shall be decided on a show of hands, unless a poll is (before or on the declaration of the result of the show of hands) demanded in accordance with paragraph (2) of this article, and 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 or electronic record of the proceeding 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, the resolution.

(2) Any of the following persons may demand a poll:

(a) The chairman of the meeting; or

(b) Ten members having the right to vote on the resolution and present in person or by proxy; or

(c) Any member or members present in person or by proxy having not less than one-tenth of the total voting power in respect of the resolution.

62. If a poll is demanded as aforesaid, it shall be taken (subject to section 168 of the ordinance) in such manner and at such time and place as the chairman of the meeting directs, and either at once or after an interval or adjournment of not more than fourteen days from the date on which the poll is demanded, and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was held. The demand for a poll may be withdrawn at any time by the person or persons who made the demand. In case of any dispute as to the admission or rejection of a vote, the chairman of the meeting shall determine the same, and such determination made in good faith shall be final and conclusive.

63. Any poll duly demanded on the election of a chairman of a meeting or on any question of adjournment shall be taken at the meeting and without adjournment. A poll demanded on any other question shall be taken at such time, not being more than 14 days from the day

on which the poll is demanded as the chairman of the meeting directs.

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

VOTES OF MEMBERS

65. Subject to section 160 and any rights or restrictions for the time being attached to any class or classes of shares, every member present in person (where all the participants of a general meeting can see each other) shall have, whether on a show of hands or on a poll, votes proportionate to the paid up value of the shares or other securities carrying voting rights held by him according to the entitlement of the class of such shares or securities, as the case may be provided that , the provisions of section 178 shall apply in the case of the election of directors.

66. Without prejudice to articles 69 and 79, on a show of hands, every member present in person shall have one vote and upon a poll every member present in person or by proxy shall have one vote in respect of each share held by him. Provided always that in the case of an election or removal of a director, the provisions of articles 91 and 94 respectively shall apply.

67. On a poll a member entitled to more than one vote need not, if he votes, use all his votes or cast all the votes he uses in the same way.

68. Any company or other corporation which is a member of the company may by resolution of its directors or other governing body authorize 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 authorized shall be entitled to exercise the same powers on behalf of the company or corporation which he represents as that company or corporation could exercise if it were an individual member of the company, present in person. The production before or at the meeting of a copy of such resolution purporting to be signed by a director or the secretary of such company or corporation, and certified by him as being a true copy of the resolution shall be accepted by the company as sufficient evidence of the validity of the appointment of such representative.

69. Any person entitled under article 39 to any shares may vote at any general meeting in respect thereof in the same manner as if he were the registered holder of such shares, provided that forty-eight hours at least before the time of holding the meeting or adjourned meeting, as the case may be, at which he proposes to vote he shall satisfy the directors of his right to such shares, or the directors shall have previously admitted his right to vote at such meeting in respect thereof. If any member be a lunatic, idiot or non compos mentis, he may vote, whether by a show of hands or at a poll, by his committee, curator bonis or other legal curator and such last mentioned persons may give their votes by proxy.

70. Where there are jointly registered holders of any share, any one of such persons may vote at any meeting either in person or by proxy in respect of such share as if he were solely entitled thereto; and if more than one of such joint-holders be present at any meeting, either in person or by proxy, that one of the said persons so present whose name stands

first in the register in respect of such share shall alone be entitled to vote in respect thereof. Several executors or administrators of a deceased member in whose name any share stands shall for the purposes of this article be deemed joint holders thereof.

71. On a poll votes may be given either in person (including without limitation a representative of a company duly authorized under article 68) or by proxy.

72. No objection shall be raised to the qualification of any voter 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.

73. The instrument appointing a proxy shall be in writing under the hand of the appointer (such expression shall exclude any reference to the electronic transactions ordinance in accordance with section 31 (1) of the electronic transactions ordinance) or of his attorney duly authorized in writing (such expression shall exclude electronic transmission as prescribed by section 3 of the electronic transactions ordinance) or if such appointer is a corporation under its common seal or signed by an officer or an attorney duly authorized by it (such expression shall exclude any reference to the electronic transactions ordinance in accordance with section 31 (1) of the electronic transactions ordinance). Save as provided by article 80, no person shall be appointed a proxy who is not a member of the company and qualified to vote.

74. Subject to article 73 hereof, the instrument appointing a proxy and the power of attorney or other authority (if any) under which it is signed, or a copy of that power or authority duly notarized, shall be deposited (such expression shall hereinafter include, where permitted by law, receipt in accordance with section 15 of the electronic transactions ordinance) 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.

75. A vote given in accordance with the terms of an instrument appointing a proxy shall be valid notwithstanding the previous death or insanity of the principal or revocation of the instrument or transfer of the share in respect of which the vote is given, provided no intimation in writing of the death, insanity, revocation or transfer of the share shall have been received at the office before the meeting. Provided nevertheless that the chairman of any meeting shall be entitled to require such evidence as he may in his discretion think fit of the due execution of an instrument of proxy and that the same has not been revoked.

76. Every instrument appointing a proxy shall, as nearly as circumstances will admit, be in the form or to the effect following and shall be retained by the Company:

SIDDIQSONS KOHAT SOLAR LIMITED

I, ____________________________ of ______________________, being a member of **SIDDIQSONS KOHAT SOLAR LIMITED**, hereby appoint ___________________of ____________________ (or failing him _________________________________ of _______________________ or failing him _____________________________ of _________________) as my proxy in my absence to attend and vote for me and on my behalf at the (Annual or Extraordinary, as the case may be) general meeting of the company to be held on the ______ day of ________and at any adjournment thereof.

As witness my hand this ________ day of ______________.

Signed by the said

In the presence of

Provided always that an instrument appointed a proxy may ~~be in~~ the form set out in regulation 39 of table A of the first schedule to the ordinance.

IV. DIRECTORS

NUMBER OF DIRECTORS

77. Subject to the provisions of these articles and the ordinance, the directors shall be elected by the members in general meeting.

78. The company shall have at least three directors. Subject to the said minimum, the directors themselves shall determine from time to time in the manner provided in this article the number of directors that the company shall have at least thirty-five (35) days before the date of every general meeting at which directors are intended to be elected, the directors shall fix the number of elected directors that the company shall have from the effective date of the election and the number of such directors who shall be elected at the meeting. The number of elected directors so fixed by the directors shall not be changed except with the prior approval of the company in general meeting. The following persons shall be the first directors of the Company and shall hold the office up to the date of First Annual General Meeting.

(1) Mr. Abdur Rahim

(2) Mrs. Anum Abdur Rahim

(3) Mr. Muhammad Ahmed

ALTERNATE DIRECTORS

79. When any director intends to be, or is living outside Pakistan, he may with the approval of the directors appoint any person to be his alternate director, and such alternate director during the absence of the appointer from Pakistan, shall be entitled to receive notice of and to attend and vote at meeting of directors and shall be subject to and entitled to the provisions contained in these articles with reference to directors and may exercise and perform all such powers, directions and duties as his appointer could have exercised or performed including the power of appointing another alternate director. An alternate director so appointed shall not be required to hold any qualification. Such appointment shall be recorded in the director minute book. A director may at any time by notice in writing to the company remove an alternate director appointed by him. The alternate director shall cease to be such provided that if any director retires but is re-elected at the meeting at which such retirement took effect any appointment made by him pursuant to this article which was in force immediately prior to this retirement and re-election and which has not otherwise ceased to be effectively shall continue to operate after his re-election as if he had not so retired. An alternate director shall not be deemed to be the agent of the director appointing him but shall be reckoned as one with his appointer. All appointments and removals of alternate directors shall be effected by writing under the hand of the director making or revoking such appointment and left at the office. For the purpose of assessing a quorum in accordance with the provisions of article 99 hereof an alternate director shall be deemed to be director. Any director may act an alternate director for any one or more directors, as well as being able to act as a director in his own right. An alternate director may resign as such upon giving thirty (30) days prior notice to the board to this effect. An alternate director need not be a member of the Company.

80. Notwithstanding article 164, an alternate director, even if not a member, shall, in the absence of a direction to the contrary in the instrument appointing him, be entitled to notice of general meetings of the company and (subject to the provisions of article 73) to vote at such meetings on behalf of his appointer, if his appointer is a member of the company, and generally to represent his appointer.

81. Directors shall have power at any time and from time to time to appoint any person as Technical/Executive Director and such Technical/Executive Director may be appointed only for a fixed period in such special remuneration as may be determined by the Board. The number of such directors appointed shall not be counted within minimum or maximum fixed for number of directors in these articles. Such Technical/Executive Directors would be the senior executives of the company and will not have any representation on the Board of the company unless specially invited by the members to assist them in the proceedings of the meeting of the Board of Directors of the company.

CHIEF EXECUTIVE AND OTHER PRINCIPAL OFFICERS OF THE COMPANY

82. The company shall have an office of chief executive which shall be filled from time to time by the directors who may appoint a director or (subject to section 201 of the ordinance) any other person to be the chief executive of the company for a period not exceeding three years and on such terms and conditions as the directors may think fit, and such appointment shall be made within fourteen days from the date on which the office of chief executive falls vacant. If the chief executive at any time is not already a director he shall be deemed to be a director of the company notwithstanding that the number of directors shall thereby be increased and he shall be entitled to all the rights and privileges and shall be subject to all liabilities of the office of director. Upon the expiry of his period of office, a chief executive shall be eligible for re-appointment. The chief executive may be removed from office in accordance with the provisions of section 202 of the ordinance notwithstanding anything contained in these articles or in any agreement between the company and the chief executive.

83. No person who is ineligible to become a director of the company shall be appointed or continue as the Chief Executive except as permitted by Section 187.

84. The Chief Executive retiring under Article 82 continue to perform his functions until his successor is appointed unless non-appointment of his successor is due to any fault on his part or his office is expressly terminated.

85. The directors may appoint other principal officers of the company including chief operating officer, chief financial officer, head of internal audit and the company secretary (who is to be a full time employee of the company as required by section 204 A), and give such officer such designations and with such terms and conditions as the directors may determine from time to time.

86. A chief executive of the company shall receive such remuneration as the directors may determine and it may be made a term of his appointment that he be paid a pension and/or gratuity and/or other benefits on retirement from his office.

87. The directors may from time to time entrust to and confer upon the chief executive for the time being such of the powers exercisable under these articles 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.

QUALIFICATION AND REMUNERATION OF DIRECTORS

88. Any director who serves on any committee or who devotes special attention to the business of the company, or who otherwise performs services which in the opinion of the directors are outside the scope of the ordinary duties of a director, may be paid such extra remuneration as the directors may determine from time to time. The remuneration of a

director for attending meetings of the board shall from time to time be determined by the directors.

89. Each director of the company may, in addition to any remuneration receivable by him, be reimbursed his reasonable travelling and hotel expenses incurred in attending meetings of the directors or of the company or otherwise whilst employed on the business of the company.

90. The qualification of an elected director, in addition to his being a member, where required, shall be his holding share of the nominal value of Rs. 10 at least in his own name, but a director representing the interests of a member or members holding share of the nominal value of Rs. 10 at least shall require no such share qualification. A director shall not be qualified as representing the interests of a member or members holding shares of the requisite value unless he is appointed as such representative by the member or members concerned by notice in writing addressed to the company specifying the shares of the requisite value appropriated for qualifying such director. Shares thus appropriated for qualifying a director shall not, while he continues to be such representative, be appropriated for qualifying any other director. A director shall acquire his share qualification within two (2) months from the effective date of his appointment as director.

91. The continuing directors may act notwithstanding any vacancy in their body so long as their number is not reduced below the number fixed by or pursuant to these articles as the necessary quorum of directors.

92. The office of a director shall ipso facto be vacated if:

(a) he ceased to hold the share qualification, if any, necessary for his appointment; or

(b) he is found to be an unsound mind by a court of competent jurisdiction; or

(c) he is adjudged an solvent; or has applied to be adjudicated as an insolvent and his application is pending or is an un-discharged insolvent; or

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

(e) 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 company in general meeting accepts or holds any office of profit under the company other than that of a chief executive or legal or technical adviser or a banker in contravention of the provisions of section 188 (i) (?) of the ordinance;

(f) 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; or

(g) he or any firm of which he is a partner or any private company of which he is a director accepts a loan or guarantee from the company in contravention of section 195 of the ordinance; or

(h) he acts in contravention of section 214 of the ordinance; or

(i) by notice in writing to the company he resigns his office; or

(j) he is removed from office by resolution of the company in general meeting in accordance with section 181 of the ordinance; or

(k) his appointment is withdrawn by the authority nominating him as director; or

(l) he has betrayed lack of fiduciary behavior and a declaration to the effect has been made by the court under section 217 of the ordinance at any time during the preceding five years.

93. Subject to authorization being given by the directors in accordance with section 196(2)(g) of the ordinance, a director shall not be disqualified from contracting with the company either as vendor, purchaser or otherwise, nor shall any such contract or arrangement entered into by or on behalf of the company with any company or partnership of or in which any director of the company shall be a member or otherwise interested, be avoided, nor shall any such director so contracting or being such member or so interested be liable to account to the company for any profit realized by any such contract or arrangement by reason of such director holding that office or of the fiduciary relationship so established. A director who, or whose spouse or minor child, is in any way, whether directly or indirectly, concerned or interested in any contract or arrangement or proposed contract or arrangement with the company shall disclose the nature of such concern or interest in accordance with section 214 of the ordinance that is to say:

(a) in the case of a contract or arrangement to be entered into, at the meeting of the directors at which the question of entering into the contract or arrangement is first taken into consideration or, if the director was not, on the date of that meeting, concerned or interested in the contract or arrangement, at the first meeting of the directors held after he becomes so concerned or interested; and

(b) in the case of any other contract or arrangement, at the first meeting of the directors held after the director becomes concerned or interested in the contract or arrangement.

A general notice that any director of the company is a director or a member of any other named company or is a member of any named firm and is to be regarded as interested in any subsequent transaction with such company or firm shall, as regards any such transaction, be sufficient disclosure under this article. Provided, however, that any such general notice shall expire at the end of the financial year in which it was given and may be renewed for a further period of one financial year at a time by giving fresh notice in the last month of the financial year in which it would otherwise expire.

94. Except as provided in Section 216 of the Ordinance, a Director shall not vote in respect of any contract or arrangement in which he is either directly or indirectly concerned or interested nor shall his presence count for the purpose of forming a quorum at the time of any such vote and if he does so vote, his vote shall not be counted.

95. Whereby any contract or resolution of the directors an appointment or a variation in the terms of an existing appointment is made (whether effective immediately or in the future) of a chief executive, whole time director or secretary of the company, in which appointment of any director of the company is, or after the contract or resolution becomes, in any way, whether

directly or indirectly, concerned or interested, or whereby any contract or resolution of the directors, an appointment or a variation in the terms of appointment is made (whether effective immediately or in the future) of a chief executive, the company shall inform the members of such appointment or variation in the manner required by section 218 of the ordinance and shall comply with the requirements of that section in regard to the maintaining of such contracts and resolutions open for inspection by members at the office, the provision of certified copies thereof and extracts there from and otherwise.

96. In accordance with section 219, the company shall maintain at its office a register or electronic record, in which shall be entered separately particulars of all contracts, arrangements or appointments in which the directors are interested. Such register or electronic record shall be open to inspection to the members during business hours, subject to any reasonable restriction that may be imposed by the company in general meeting.

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

ELECTION OF DIRECTORS

98. The number of directors determined by the directors under articles 78 shall be elected to office by the members in general meeting in the following manner, namely:

(a) a member present in person or by proxy shall have such number of votes as is equal to the product of voting shares held by him and the number of directors to be elected,

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

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

If the number of persons who offer them to be elected as directors is not more than the number of vacancies for which elections are being held, such persons being otherwise eligible shall be deemed to have been elected as directors from the date on which the election was proposed to be effective.

99. A director elected under article 98 shall hold office for a period of three years unless he earlier resigns, becomes disqualified from being a director, or otherwise ceases to hold office.

100. A retiring director of the company shall be eligible for re-election.

101. The company in general meeting may remove a director from office by a resolution passed with the requisite number of votes determined in accordance with the provisions of section 181 of the ordinance.

102. Any casual vacancy occurring among the directors may be filled up by the directors within a time period prescribed by the code, and the person so appointed shall hold office for the remaining period of the director in whose place he is appointed. Provided that the directors may not fill a casual vacancy by appointing any person who has been removed from the office of a director of the company under article 101.

103. No person including a retiring director of the company shall be eligible for election to the office of director of the company at any general meeting unless he has, not less than fourteen days before the date of the meeting, left at the office, a notice in writing, and duly signed, signifying his candidature for the office.

104. The company shall keep at the office a register of the directors and officers, containing the particulars required by section 205 of the ordinance and the company shall otherwise comply with the provisions of that section as regards furnishing returns to the registrar and giving inspection of the register.

PROCEEDINGS OF DIRECTORS

105. The directors shall meet together at least once in each quarter of a year for the despatch of business, adjourn and otherwise regulate their meetings and proceedings as they may think fit in accordance with the ordinance, the code and the listing requirements. Questions arising at any meeting shall be decided by a majority of votes and in case of an equality of votes the chairman shall have a second or casting vote.

106. The quorum necessary for the transaction of the business of the directors shall be one-third of the number of directors or two directors, whichever is greater, present in person. An alternate director whose appointment is effective shall be counted in the quorum. If all the directors except one are disqualified from voting, the matter shall be decided in general meeting.

107. A director may, and the secretary on the requisition of a director shall, at any time summon a meeting of the directors. Such meetings may be held using any technology consented to by all the directors, including but not limited to telephone and video conferencing. The consent may be a standing one, withdraw able by a director only within a reasonable period of time before the meeting. It shall not be necessary to give notice of a meeting of directors to any director for the time being absent from Pakistan.

108. The board of directors of the company shall from time to time elect one of the directors as chairman of the board of directors of the company and determine the period for which he is to hold office and his remuneration. The chairman or in his absence the chief executive shall preside over all meetings of the board of directors, but if at any meeting neither the chairman nor the chief executive is present in person within half an hour of the time appointed for holding the same, the directors present in person may choose one of their member to be chairman of the meeting.

109. A meeting of the directors at which a quorum is present shall be competent to exercise all or any of the authorities, powers and discretion by or under these articles for the time

being vested in or exercisable by the directors generally.

110. The directors may from time to time delegate of their powers to committees consisting of such two members or more members of their body as they think fit, and may from time to time revoke such delegation. Any committee so formed shall, in the exercise of the powers so delegated, conform to any regulations that may from time to time be imposed upon it by the directors.

111. The meeting and proceedings of any such committee consisting of two or more members shall be governed by the provisions herein contained for regulating the meetings and proceedings of the directors, so far as the same are applicable thereto and are not superseded by any regulations made by the directors under article 110.

112. All acts done by any meeting of the directors or by a committee of the directors or by any person acting as a director of the company shall, notwithstanding that is shall afterwards be discovered that there was some defect in the appointment or continuance in office of any such directors 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. Provided that nothing in this article shall be deemed to give validity to acts done by any such director after the appointment of such director has been shown to be invalid.

113. A resolution, other than resolution in respect of any matter specified in section 196(2) of the ordinance circulated through fax or email or any form of electronic transmission to all the directors for the time being entitled to receive notice of a meeting of the directors, passed without any meeting of the directors or of a committee of directors and signed or affirmed through fax or email or any form of electronic transmission, by a majority of all directors in writing under the hands of all directors (or in their absence their alternate directors) for the time being in Pakistan, being not less than the quorum required for meetings of the directors, or as the case may be of the members of the committee, shall be valid and effectual as if it had been passed at the meeting of the directors, or as the case may be of such committee, duly called or constituted. The resolution in writing of the company may consist of several copies of a document signed by one or more director(s) and takes effect at the date and time on which the last director, necessary for the resolution to be passed, signs a copy of the resolution; or a record of several signed electronic messages indicating the identity of the sender, the text of the resolution and the sender's agreement or disagreement to the resolution, as the case may be and such a resolution takes effect of the date on which the last director's message, necessary for the resolution to be passed, is received.

114. If any director of the company, being willing, shall be called upon to perform extra services or to make any special exertions in going or residing away from his place of business for the time being for any of the purposes of the company or in giving special attention to the business of the company as a member of a committee of the directors, the company may remunerate such director so doing either by a fixed sum or by a percentage of profits or otherwise as may be determined by the directors, and such remuneration may be either in

addition to or in substitution for his or their share in the remuneration above provided for the directors.

MINUTES

115. The directors shall cause minutes to be duly entered in books provided for the purpose of or as an electronic record, of;

(a) all appointments of officers;

(b) the names of the directors present in person at each meeting of the directors and of any committee of the directors;

(c) all orders made by the directors and committees of the directors;

(d) all resolutions and proceedings of general meeting and of meetings of the directors and of the committees of the directors;

and any such minutes of any meeting of the directors or of any such committee or of the company, if purporting to be signed by the chairman of such meeting or by the chairman of the next succeeding meeting, shall be prima facie evidence of the matter stated in such minutes.

POWERS AND DUTIES OF DIRECTORS

116. The directors shall duly comply with the provisions of the ordinance, the listing requirements and the code. In particular and without prejudice to the generality of the foregoing, the company shall comply with the provisions of the ordinance in regard to the registration of the particulars of mortgages and charges affecting the property of the company or created by it, to the keeping of a register of the directors and to the sending to the registrar of an annual list of members and a summary of particulars relating thereto, and notice of any consolidation or increase of share capital, subdivision of shares and copies of special resolutions and a copy of the register of directors and notifications of any changes therein. All such information may be stored as an electronic record and transmitted accordingly, where possible.

117. The control of the company shall be vested in the directors, and the business of the company shall be managed by the directors who may exercise all such powers of the company and do all such acts and things as may be exercised or done by the company as by the ordinance or by these articles or by a special resolution expressly directed or required to be exercised or done by the company in general meeting, subject nevertheless to any regulations of these articles, to the provisions of the ordinance, and to such regulations being not inconsistent with the aforesaid regulations or provisions, as may be prescribed by the company in general meeting; but no regulation made by the company in general meeting shall invalidate any prior act of the directors which would have been valid if that regulation had not been made.

118. Without prejudice to the general powers conferred by article 117 and to any other powers or authorities conferred by these articles on the directors, it is hereby expressly declared that the directors shall have the following powers, that is to say, power:

(1) To purchase or otherwise acquire for the company any property, rights or privileges which the company is authorized to acquire at such price and generally on such terms and conditions as they think fit, and to sell, let, exchange or otherwise dispose of absolutely or conditionally any part of the property, privileges and undertaking of the company upon such terms and conditions, and for such consideration, as they may think fit.

(2) At their discretion to pay for any property, rights, privileges acquired by or services rendered to the company either wholly or partially in cash or in shares (subject to the provisions of section 86 of the ordinance) bonds, debentures or other securities of the company. Any such bonds, debentures or other securities may be either specifically charged upon all or any part of the property of the company or not so charged.

(3) To open account with any bank or financial institution and deposit into and withdraw money from such accounts from time to time.

(4) To make, draw, endorse, sign, accept, negotiate and give all cheques, bills of lading, drafts, orders, bills of exchange, and other promissory notes and negotiable instruments required in the business of the company.

(5) To secure the fulfillment of any contracts, agreements or engagements entered into by the company by mortgage or charge of all or any of the property of the company for the time being or in such other manner as they may think fit.

(6) Subject to the provisions of the ordinance, to appoint and at their discretion remove or suspend such agents (other than Managing Agents), managers, secretaries, officers, employees for permanent, temporary or special services as they may from time to time think fit, and to determine their powers and duties and fix their salaries or emoluments and to require security in such instances and to such amount as they think fit.

(7) To appoint any person or persons (whether incorporated or not) to accept and hold in trust for the company any property belonging to the company or in which it is interested or for any other purposes, and to execute and do all such deeds, documents and things as may be requisite in relation to any such trust and to provide for the remuneration of such trustee or trustees.

(8) To institute, conduct, defend, compound or abandon any legal proceedings by or against the company or its officers or otherwise concerning the affairs of the company and also to compound and allow time for payment or satisfaction of any debts due and of any claims or demands by or against the Company.

(9) To refer claims or demands by or against the company to arbitration and observe and perform the awards.

(10) To make and give receipts, releases and other discharges for money payable to the company and for the claims and demands of the Company.

(11) To act on behalf of the company in all matters relating to bankrupts and insolvents.

(12) To determine who shall be entitled to sign on the company's behalf bills, notes, receipts, acceptances, endorsements, cheques, releases, contracts and documents.

(13) From time to time to provide for the management of the affairs of the company either in

disposal thereof, and otherwise in relation to the working and management of the said fund as the directors shall from time to time think fit.

(23) To delegate all or any of the powers hereby conferred upon them to such person or persons as they may from time to time think fit.

(24) Subject to section 213 of the ordinance to authorize the having an official seal of the company for use abroad.

REGISTER OF DIRECTORS SHAREHOLDINGS

119. In accordance with section 220, the company shall maintain at its office a register or electronic record of the directors, chief executive officer, chief financial officer (chief accountant), company secretary or head of internal audit who is or has been the beneficial owner of listed securities and every person who is directly or indirectly the beneficial owner of not less than ten percent (10%) of the beneficial interest in the company. This register or electronic record shall be open to inspection during business hours subject to sub-sections (5), (6) and (7) of section 220.

POWER OF ATTORNEY

120. The directors may from time to time and at any time by power of attorney appoint any company, firm or person (including any director or officer of the company) or body of persons, whether nominated directly or indirectly by the directors, to be the attorney or attorneys of the company for such purposes and with such powers, authorities and discretions and for such period and subject to such conditions as they may think fit, and any such powers of attorney may contain such provisions for the protection and convenience of persons dealing with any such attorney to delegate all or any of the powers, authorities and discretions vested in him; and without prejudice to the generality of the foregoing any such power of attorney may authorize the attorney to institute, conduct, defend, compound or abandon any legal proceedings by or against the company, whether generally or in any particular case.

AUDIT COMMITTEE

121. The Directors shall establish an Audit Committee which shall comprise not less then three members, including the chairman. Majority of the members of the Committee shall be from amongst the non-executive directors of the company and the chairman of the Audit Committee shall preferably be a non-executive director. The names of member of the Audit Committee shall be disclosed in each annual report of the company.

MANAGEMENT COMMITTEE

122. The Directors shall establish management committees to comply with the requirements of the code of the corporate governance and their own requirements for effective

management and control. The Directors shall nominate members for each committee which may be from the board of directors or outside the board.

BORROWING POWERS

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

(2) In exercising the powers of the company aforesaid the directors may, from time to time and on such terms and conditions as they think fit, raise money from banks and financial institutions and from other persons under any permitted system of financing, whether providing for payment of interest or some other form of return, and in particular the directors may raise money on the basis of the mark up on price, musharika, modaraba or any other permitted mode of financing, and without prejudice to the generality of the foregoing the directors may exercise all or any of the powers of the company arising under section 19(2) of the ordinance.

(3) In regard to the issue of securities the directors may exercise all or any of the powers of the company arising under sections 19(2), 87 and 120 of the ordinance and in particular the directors may issue any security as defined in section 2(1)(34) of the ordinance or may issue any instrument or certificate representing redeemable capital as defined in section 2(1)(30A) of the ordinance or participatory redeemable capital as defined in section 2(1)(25) of the ordinance.

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

125. Any debentures, debenture-stock, bonds or other securities may be issued at a discount, premium or otherwise and with any special privileges as to redemption, surrender, drawing, allotment of shares, attending and voting at general meetings of the company, appointment of directors of the company or otherwise.

126. The directors shall cause a proper register to be kept in accordance with the provisions of section 135 of the ordinance, of all mortgages and charges specifically affecting the property of the company, and shall duly comply with the provisions of the sections of the ordinance, namely, sections 121 and 122 (Registration of mortgages and charges), section 128 (Endorsement of certificates), section 129 (Filing of prescribed particulars), section 130 (Keeping of a copy of every instrument creating any mortgage or charge by the company at the office) and section 132 (Giving of intimation of the payment or satisfaction of any charge or mortgage created by the company).

127. Every register of holders of debentures of the company may be closed for any periods not exceeding in the whole forty five days in any year and not exceeding thirty days at a time. Subject as aforesaid, every such register shall be open to the inspection of members or

debenture holders. But the company may in general meeting impose any reasonable restrictions, so that at least two hours, in each day when such register is open, for inspection.

128. Subject to the provisions of section 76 of the ordinance, no transfer of registered debentures shall be registered unless a proper instrument of transfer duly stamped and executed by the transferor and transferee has been delivered to the company together with the certificate or certificates of the debentures.

129. If the directors refuse to register the transfer of any debentures, they shall, within thirty days from the date on which the instrument of transfer was lodged with the company, send or cause to be sent to the transferee and transferor notice of the refusal.

130. The company shall comply with the provisions of section 136 of the ordinance as to allowing inspection of copies kept at the office in pursuance of section 130 of the ordinance, and as to allowing inspection of the register of mortgages to be kept at the office in pursuance of section 135 of the ordinance.

131. The company shall comply with the provisions of sections 113 and 150 of the ordinance as to supplying copies of any register of holders of debentures or of any trust deed for securing any issue of debentures.

LOCAL MANAGEMENT

132. Subject to the provisions of sections 206 and 207 of the ordinance, directors may from time to time provide for the management of the affairs of the company outside Pakistan or in any special locality in Pakistan in such manner as they shall think fit and the following provisions shall operate without prejudice to the general powers hereby conferred.

(1) The directors may from time to time and at any time establish any local boards or agencies for managing any of the affairs of the company outside Pakistan or in any specified locality in Pakistan and may appoint any persons to be members of such local board or any managers or agents and may fix their remuneration.

(2) The directors may from time to time and at any time delegate to any persons so appointed any of the powers, authorities and discretions for the time being vested in the directors, and may authorize the members for the time being of any such local board or any of them to fill up any vacancies therein and to act notwithstanding vacancies and any such appointment or delegation may be made on such terms and subject to such conditions as the directors may think fit; and the directors may at any time remove any person so appointed and may annul or vary any such delegation.

(3) The directors may at any time and from time to time, by power of attorney under the seal of the company, appoint any person to be the attorneys of the company for such purposes and with such powers, authorities and discretions (not exceeding those vested in or exercisable by the directors under these articles) and for such period and subject to such conditions as the directors may from time to time think fit; and any such appointment may, if the directors think fit, be made in favour of all or any of the members of any local board established as aforesaid, or in favour of any

company or of the members directors, nominees or managers of any company or firm, and any such power of attorney may contain such provisions for the protection or convenience of persons dealing with such attorneys as the directors think fit.

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

V. ACCOUNTS AND DIVIDENDS

BOOKS OF ACCOUNT

(References to books of account, balance sheet, profit and loss accounts and auditors' report shall hereinafter mutatis mutandis include all electronic forms of record or storage of the company.)

133. The directors shall cause to be kept proper books of account with respect to the matters set out in section 230 of the ordinance.

134. The books of account shall be kept at the office or at such other place as the directors think fit, and shall be open to inspection by the directors during business hours. If the directors decide to keep the books of account at a place other than the office they shall comply with the directions contained in the proviso to section 230(1) of the ordinance.

135. The company shall preserve in good order the books of account of the company in respect of any financial year for a period of ten years following the close of that year or otherwise as provided in the section 230(6) of the ordinance.

136. The directors shall from time to time determine whether and to what extent and at what times and places and under what conditions or regulations the accounts and books of the company or any of them shall be open to the inspection of the members, and no member (not being a director of the company) shall have any right of inspecting any account or book or document of the company except as conferred by law or authorized by the directors or by the company in general meeting.

137. (1) The directors shall arrange to place before the annual general meeting of the company in every year a duly audited balance sheet and profit and loss account, conforming to the requirements of section 234, 237 and 238 of the ordinance and made up to a date not more than four months before the date of such meeting and having the auditor's report attached thereto, and a report of the directors conforming to the requirements of section 236 of the ordinance.

(2) As required by section 241 of the ordinance the balance sheet and profit and loss account shall first be approved by the directors and when so approved shall be signed by the chief executive and at least one director but if on account of his absence from Pakistan or other reason the signature of the chief executive cannot be obtained, the balance sheet and profit and loss account shall be signed by at least two directors for the time being in Pakistan, and in every such case a statement signed by those two directors shall be subjoined to the balance sheet and profit and loss

account stating the reason why the signature of the chief executive was not obtained.

(3) The directors may authorize the chairman or the chief executive to sign the report of the directors which may then be signed accordingly, but in the absence of any such authority the report of the directors shall be signed as required by section 236(3) of the ordinance in the same manner as the balance sheet and profit and loss account.

138. (1) A copy of the balance sheet, profit and loss account and the reports of the directors and auditors shall be sent not less than twenty one (21) days before the date of the annual general meeting to the members and other persons entitled to receive notices of general meetings in the manner in which notices are to be given hereunder and a copy thereof shall be kept for a period of at least fourteen (14) days before the meeting at the office for inspection by members. The company shall send, each stock exchange listing the shares of the company three hundred copies (or such number as may be prescribed from time to time), and to the registrar of companies and to the commission, five copies (or such number as may be prescribed from time to time), each of the balance sheet, profit and loss account and the reports of the directors and auditors at the same as they are dispatched to the members and other persons in accordance with this article.

(2) After the balance sheet, profit and loss account and the reports of the directors and auditors have been laid before the annual general meeting of the company, three copies thereof (or, such larger number as may be prescribed under section 242(1) of the ordinance) signed by the signatories thereto shall be filed with the registrar within thirty days from the date of the meeting and the company shall also comply with the provisions of section 242(2) of the ordinance where applicable.

(3) Subject to provisions of sections 245 and the listing requirements, the company shall, within one month from the close of the first and third quarters and two month from the close of the second quarter, of the year of account of the company, prepare and transmit to the members one copy and to stock exchange listing the shares of the company three hundred copies (or such number as may be prescribed from time to time), each of the profit and loss account for that quarter and of the balance sheet as at the end of that quarter. Such quarterly profit and loss accounts and balance sheets need not to be audited but must be signed in the same manner as the annual profit and loss accounts and balance sheets are required to be signed. The directors shall also send to the commission and to the registrar three copies (or such number as may be prescribed for the time being under section 245(1) (b) of the ordinance), each of such quarterly profit and loss accounts and balance sheets at the same time as they are sent to the members in accordance with this article.

(4) The company may with the consent of shareholders and consultation of respective stock exchange(s), transmit quarterly accounts through web site of the company subject to the approval of the commission.

139. The directors shall in all respects comply with the provisions of sections 230 to 247 of the ordinance, or any statutory modification thereof for the time being in force.

ANNUAL RETURNS

140. The company shall make the requisite annual returns in accordance with the provisions of section 156 of the ordinance.

DIVIDENDS

141. The company in general meeting may declare dividends, but no dividend shall exceed the amount recommended by the directors, provided that the company in general meeting may declare a smaller dividend.

142. No dividend shall be paid otherwise than out of the profits of the year or any other undistributed profits, and in the determination of the profits available for dividends the directors shall have regard to the provisions of the ordinance and in particular to the provisions of sections 83, 235 and 248 of the ordinance.

143. The declaration of the directors as to the amount of the net profits of the company shall be conclusive.

144. The directors may from time to time pay to the members such interim dividends as in their judgment the position of the company justifies.

145. All dividends shall be declared and paid according to the amounts paid on the shares. All dividends shall be apportioned and paid proportionally to the amounts paid or credited as paid on the shares during any portion or portions of the period in respect of which the dividend is paid; but if any share is issued on terms providing that it shall rank for dividend as from a particular date such share shall rank for dividend accordingly.

146. All dividends declared shall be paid within the periods specified in section 251 of the ordinance.

147. No dividend payable in respect of a share shall bear interest against the company.

148. The directors may retain any dividends on which the company has a lien and may apply the same in or towards satisfaction of the debts, liabilities or engagements in respect of which the lien exists.

149. Any general meeting declaring a dividend may resolve that such dividend be paid and satisfied wholly or in part in cash or by the distribution of specific assets, and in particular by the distribution of paid-up shares, debentures, debenture-stock or other security of the company, or paid-up shares, debentures, debenture-stock or other security of any other company, or in any one or more of such ways.

150. Any general meeting may resolve that any moneys, investments, or other assets forming part of the undivided profits of the company standing to the credit of the reserve fund referred to in article 157 or in the hands of the company and available for dividend (or representing premiums received on the issue of shares and standing to the credit of the

share premium account) be capitalized and distributed amongst such of the members as would be entitled to receive the same if distributed by way of dividend and in the same proportion on the footing that they become entitled thereto as capital and that all or any part of such fund be applied on behalf of such members in paying up in full any un-issued shares, debentures, debenture-stock or other security of the company, which shall be distributed accordingly, and that such distribution or payment shall be accepted by such members in full satisfaction of their interest in the said capitalized sum.

151. For the purpose of giving effect to any resolution under article 149 or article 150, the directors may settle any difficulty which may arise in regard to the distribution as they think expedient and may fix the value for distribution of any specific assets and may determine that cash payments shall be made to any members upon the footing of the value so fixed in order to adjust the rights of all parties and may vest any such cash or specific assets in trustees upon such trusts for the persons entitled to the dividend or capitalized fund as may seem expedient to the directors. Where requisite a proper contract shall be filed in accordance with the provisions of section 73 of the ordinance, and the directors may appoint any person to sign such contract on behalf of the persons entitled to the dividend or capitalized fund, and such appointment shall be effective.

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

153. The directors may retain the dividends payable upon shares in respect of which any person is under article 38 entitled to become a member or which any person under that article is entitled to transfer until such person shall become a member in respect thereof or shall duly transfer the same.

154. Any one of several persons who are registered as the joint-holders of any share may give effectual receipts for all dividend and payments on account of dividends in respect of such share.

155. The dividend in respect of any share shall be paid to the registered holder of such share or to his banker or to a financial institution (as defined in section 2(1) (15A) of the ordinance) nominated by him for the purpose. Unless otherwise directed, any dividend may be paid by cheque or warrant sent through post to the registered address of the member or person entitled thereto or, in the case of joint-holders, to the registered address of that one whose name stands first on the register in respect of the joint-holding, or to such financial institution or bank as the member or person entitled thereto or such joint-holders, as the case may be, direct, and every cheque or warrant so sent shall be made payable to the order of the person to whom it is sent, or to the order of the institution or bank, directed as aforesaid.

156. All dividends unclaimed for one year after having been declared may be invested or otherwise made use of by the directors for the benefit of the company until claimed and all dividends unclaimed for three years after having been declared may be forfeited by the directors for the benefit of the company, but the directors may annul the forfeiture wherever they may think proper.

RESERVE AND DEPRECIATION FUNDS

157. The directors may from time to time before recommending any dividend set apart any and such portion of the profits of the company as they think fit as a reserve fund to meet contingencies or for the liquidation of any debentures, debts or other liabilities of the company, for equalization of dividends or for repairing, improving, and maintaining any of the property of the company, and for such other purposes of the company as the directors in their absolute discretion think conducive to the interests of the company; and may invest the several sums so set aside upon such investments (other than shares of the company) as they may think fit, and from time to time deal with and vary such investments, and dispose of all or any part thereof for the benefit of the company, and may divide the reserve fund into such special funds as they think fit, with full power to employ the reserve funds or any part thereof in the business of the company, and that without being bound to keep the same separate from the other assets.

158. The directors may, from time to time before recommending any dividend, set apart any and such portion of the profits of the company, as they think fit, as a depreciation fund applicable at the discretion of the directors, for providing against any depreciation in the investment of the company or for rebuilding, restoring, replacing or for altering any part of the buildings, work, plant, machinery, or other property of the company destroyed or damaged by fire, flood, storm, tempest, earthquake, accident, riot, wear and tear, or any other means whatsoever, and for repairing, altering and keeping in good condition the property of the company, or for extending and enlarging the buildings, machinery and property of the company with full power to employ the assets constituting such depreciation fund in the business of the company, and that without being bound to keep the same separate from the other assets.

159. All moneys carried to the reserve fund and depreciation fund respectively shall nevertheless remain and be profits of the company applicable subject to due provision being made for actual loss or depreciation, for the payment of dividends and such moneys and all the other moneys of the company not immediately required for the purposes of the company may be invested by the directors in or upon such investments or securities as they may select or may be used as working capital or may be kept at any bank on deposit or otherwise as the directors may from time to time think proper.

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

VI. AUDIT

161. Auditors shall be appointed and their duties regulated in accordance with sections 252 to 255 of the ordinance or any statutory modification thereof for the time being in force.

VII. SEAL

162. The directors shall provide a common seal of the company which shall not be affixed to any instrument except by the authority of a resolution of the board or by a committee of directors authorized in that behalf by the directors, and two (2) directors, or one (1)

director and the secretary of the company, shall sign every instrument to which the common seal is affixed.

163. The directors may provide for the use in any territory, district or place not situated in Pakistan, of an official seal which shall be a facsimile of the common seal of the Company, with the addition on its face of the name of every territory, district or place where it is to be used. The official seal shall not be affixed to any instrument except by the authority of a resolution of the board or by a committee of directors authorized in that behalf by the directors, and two (2) directors, or one (1) director and the secretary of the company, or such other person as the directors may appoint for the purpose, shall sign every instrument to which the official seal is affixed. The provisions of section 213 shall apply to the use of the official seal.

VIII. NOTICES

164. (1) A notice may be given by the company to any member either personally or by sending it by post to him at his registered address or (if he has no registered address in Pakistan) to the address, if any, within Pakistan supplied by him to the company for the giving of notices to him or in electronic form as prescribed by section 3 of the electronic transactions ordinance.

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

165. In accordance with section 15 of the electronic transactions ordinance, a notice dispatched by electronic transmission shall be deemed to be received by the addressee at his place of business or where he ordinarily resides when it reaches the designated information system of the addressee. If no information system has been so designated, receipt will occur when the electronic notice reaches an information system of the addressee.

166. If a member has no registered address in Pakistan, and has not supplied to the company an address within Pakistan or an electronic address, for the giving of notices to him, a notice addressed to him or to the shareholders generally and advertised in a newspaper, circulating in the Province in which the office is situated and in at least one issue each of a daily newspaper in the English language and a daily newspaper in the Urdu language circulating in the province in which the stock exchange on which the company is listed is situate, shall be deemed to be duly given to him on the day on which the advertisement appears.

167. A notice may be given by the company to the joint-holders of a share by giving the notice to the joint-holder named first in the register in respect of the share.

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

and dispatching it to a designed electronic address or until any such address has been so supplied, by giving the notice in any manner in which the same might have been given if the death or insolvency had not occurred.

169. Notice of every general meeting shall be given in same manner hereinbefore authorized to (a) every member of the company except those members who (having no registered address within Pakistan) have not supplied to the company either a postal address within Pakistan or electronic address for the giving of notices to them, and also to (b) every person entitled to a share in consequence of the death or insolvency of a member, who but for his death or insolvency would be entitled to receive notice of the meeting. Subject to the provisions of articles 80 and section 255(6), no other person shall be entitled to receive notices of general meetings.

170. Any notice required to be given by the company to the members or any of them and not expressly provided for by these articles shall be sufficiently given, if given by advertisement.

171. Any notice required to be or which may be given by advertisement shall be advertised once in a newspaper circulating in the province in which the office is situate and in at least one issue each of a daily newspaper in the English language and a daily newspaper in the Urdu language circulating in the province in which the stock exchange on which the company is listed is situate.

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

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

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

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

176. In the event of a winding up of the company, every member of the company who is not for the time being normally resident in the town in which the office is situate shall be bound, within eight weeks after the passing of an effective resolution to wind up the company voluntarily or the making of an order for the winding up of the company, to serve notice in writing on the company appointing some householder residing in that town upon whom all

summonses, notices, process, orders and judgments in relation to or under the winding up of the company may be served, and in default of such nomination the liquidator of the company shall be at liberty on behalf of such member to appoint some such person, and service upon any such appointee, whether appointed by the member or the liquidator, shall be deemed to be good personal service on such member for all purposes, and where the liquidator makes any such appointment he shall with all convenient speed give notice thereof to such member by advertisement in some newspaper circulating in the province in which the office is situated and in at least one issue each of a daily newspaper in the English language and a daily newspaper in the Urdu language circulating in the province in which the stock exchange on which the company is listed is situated or by a registered letter sent through the post and addressed to such member at his address as mentioned in the register, and such notice shall be deemed to be served on the day on which the advertisement shall first appear or on the day following that on which the letter is posted, as the case may be. The provisions of this article shall not prejudice the right of the liquidator to serve any notice or other document in any other manner prescribed by the regulations of the company.

PUBLICATION OF NOTICES IN NEWSPAPERS

177. Subject to such provisions of the listing requirements as may apply specifically to the manner in which certain notices are to be published in the newspaper(s):

1. Every prospectus issued by or on behalf of the company or by or on behalf of any person who has been engaged or interested in the formation of the company shall, in its full text or in such abridged form as may be prescribed, be published by the company in at least one (1) Urdu and one (1) English daily newspaper, in accordance with the provisions of sections 53, 57 and 64 not less than seven (7) days or more than thirty (30) days before the subscription list, as specified in the prospectus, is due to open. Provided that the company may, for special reasons and with permission of the commission, publish the advertisements of a prospectus more than thirty (30) days before the subscription list is due to open.
2. The company may, on giving not less than seven (7) days notices by advertisement in a newspaper having circulation in the Province, or part of Pakistan not forming part of a province, in which the office of company is situated and, in addition, in a newspaper having circulation in the Province, or other part as aforesaid, in which the stock exchange(s) on which the company is listed is / are situated, close the register of members or debenture holders, as the case may be, for any time or times not exceeding in the whole forty-five (45) days in a year and not exceeding thirty (30) days at a time, in accordance with section 151.
3. The notice of a general meeting of the company, whether annual or extraordinary general meeting, shall be published in at least one (1) issue each of daily newspaper in English language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 158(1) and 159(7).
4. All notices received by the company in pursuance of section 178 (3) for election as a director, shall be transmitted to the members not later than seven (7) days before the date of the general meeting at which the directors are to be elected, by publication in at least one (1) issue each of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the Province in which the stock exchange(s) on which the Company's securities are listed is / are situated, in accordance with section 178 (4).

5. If a resolution is to be passed at the company's annual general meeting appointing as auditors a person other than a retiring auditors, the company shall, not less seven (7) days before the date fixed for the annual general meeting, publish in at least one (1) issue each of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 253 (2).

6. Notice of any resolution for winding up a company voluntarily under section 358, shall be given by the company within ten (10) days of the passing of the same by advertisement in the official Gazette of Pakistan, and also in a newspaper circulating in the province where the office of the company is situated and, in addition, shall also published in at least one (1) issue of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 361 (1).

IX. AMALGAMATION, DIVISION AND RECONSTRUCTION

178. Subject to and in accordance with the provisions of section 287, the company may reconstruct, amalgamate into another company or divide into two (2) or more companies in the process of which the whole or any part of the undertaking, property or liabilities of the company or any other company, may be transferred to any other company or the company, respectively, as the case may be. Provided that any sale of the undertaking of the company, the directors, or the liquidator on a winding up may, if authorised by a special resolution, accept fully paid shares, debentures or securities of any other company, whether incorporated in Pakistan or not, either then existing or to be formed, for the purchase in whole or in part of the property of the company and the directors (if the profits of the company permit) or the liquidator (in a winding up) may distribute such shares, or securities, or any other property of the company amongst the members without realization, or vest the same in trustees for them, and any special resolution may provide for the distribution or appropriation of the cash, shares or other securities, benefits or property, otherwise than in accordance with the strict legal rights of the members or contributories of the company, and for valuation of any such securities or property at such price in such manner as the meeting may approve, and all holders of shares shall be bound to accept and shall be bound by any valuation or distribution so authorised, and waive all rights in relation thereto, save only in case the company is proposed to be or is in the course of being wound up, such statutory rights (if any) under section 367 of the ordinance as are incapable of being varied or excluded by these articles.

X. SECRECY

179. Every director, manager, adviser, auditor, trustee, member of a committee, officer, servant, agent, accountant or other person employed in the business of the company shall, if so required by the directors before entering upon his duties, sign a declaration pledging himself to observe a strict secrecy respecting all transactions of the company with its customers and the state of accounts with individuals and in matters relating thereto and shall by such declaration pledge himself not to reveal any of the matters which may come to his knowledge in the discharge of his duties except when required to do so by the directors or by any meeting or by any court of law and except so far as may be necessary

in order to comply with any of the provisions in these articles contained.

180. No member or other person (not being a director) shall be entitled to enter upon the property of the company or to inspect or examine the company's premises or properties of the company without the permission of the directors for the time being or, subject to the provisions of article 119, to require discovery of or any information respecting any detail of the company's trading or any matter which is or may be in the nature of a trade secret, mystery of trade, or secret process or of any matter whatsoever which may relate to the conduct of the business of the company and which in the opinion of the directors it will be inexpedient in the interest of the members of the company to communicate.

XI. ARBITRATION

181. Whenever a difference arises between the company on the one hand and any of the members, their executors, administrators, or assignees on the other hand touching the true intent or construction or the incident or consequences of these presents, or of the status of enactment's of the legislature, or touching anything then or thereafter done, executed, omitted or suffered in pursuance of these presents or of the status of enactment's touching any breach or alleged breach or otherwise relating to the premises or to these presents, or to the status or to any of the affairs or officers of the company, the company by written agreement refer to arbitration in accordance with the Arbitration Act 1940 (X of 1940) and every such difference shall be referred to the decision of an arbitrator to be appointed by the parties in difference or if they cannot agree upon a single arbitrator, to the decision of two arbitrators, one appointed by such party, or in the event of disagreement of the arbitrators, to that of an umpire appointed by arbitrators themselves. The provisions of Arbitration Act 1940 (X of 1940) shall apply to all arbitrations between the company and persons having such difference.

182. The costs of, or incidental to any such reference and award shall be in the discretion of the arbitrator/arbitrators, or umpire as the case may be who may determine the amount thereof and may award by whom, and to whom, and in what manner the same shall be borne and paid.

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

XII. WINDING UP

184. If the company shall be wound up and the assets available for distribution among the members, subject to the rights attached to any preference share capital, as such shall be insufficient to repay the whole of the paid-up capital, such assets shall be distributed so that as nearly as may be the losses shall be borne by the members in proportion to the capital paid up on the shares held by them respectively. And if in a winding up the assets available for

distribution among the members shall be more than sufficient to repay the whole of the capital paid up at the commencement of the winding up, the excess shall be distributed amongst the members in proportion to the capital at the commencement of the winding up, paid up on the shares held by them respectively. But this article is to be without prejudice to the rights of the holders of shares issued upon special terms and conditions.

185. If the company shall be wound, whether voluntarily or otherwise, the liquidator may with the sanction of a special resolution divide among the members in specie or kind any part of the assets of the company, and may with the like sanction vest any part of the assets of the company in trustees upon such trusts for the benefit of the members or any of them as the liquidator with the like sanction shall think fit.

XIII. INDEMNITY

186. 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 name and addresses are subscribed below, are desirous of being formed into a Company in pursuance of this Article of Association, and we respectively agree to take the number of shares in the Capital of the Company indicated herein below against our respective names:

S. No.	Name & Surname (Present & Former) / Father / Husband Names In Full Block Letters.	NIC No. (In Case Of Foreigner, Passport No.)	Nationality With Any Former Nationality And Occupation	Residential Address In Full	Number Of Shares Taken By Each Subscriber	Signature of the Subscriber
1	Mr. Abdur Rahim S/O Muhammad Tariq Rafi	42201-0409988-5	PAKISTAN Business	House No. 34-H-1, Block-6, PE.C.H.S., Karachi.	25,000 (Twenty Five Thousand Shares)	
2	Mrs. Anum Abdur Rahim W/O Abdur Rahim	42201-8648714-6	PAKISTAN Business	House No. 34-H-1, Block-6, PE.C.H.S., Karachi.	24,999 (Twenty Four Thousand Nine Hundred Ninety Nine Shares)	
3	Mr. Muhammad Ahmed S/O Haji Ibrahim	42101-1426211-1	PAKISTAN Corporate Executive	House No. A-189/17, Rahimabad, Federal B Area, Azizabad, Karachi.	1 (One Share)	
				Total Number of Shares.	50,000 (Fifty Thousand Shares)	

Company Registration Office Karachi * Securities & Exchange Commission

Dated the 22nd day of February 2016
Witness to above signatures.
Name: National Institutional Facilitation Technologies (Pvt.) Ltd.
Nationality: Pakistani
Address: 5th Floor, AWT Plaza, I. I. Chundrigar Road, Karachi

Certified to be True Copy
13/2/15
Joint Registrar

BRIEF PROJECT INFORMATION

Project Background

Access Infra Central Asia ("Access") and **Siddiqsons Limited** ("Siddiqsons") (the "Developers") have developed a 50 MWp photovoltaic plant at Kohat, KPK, Pakistan (the 'Project' or the 'Plant').

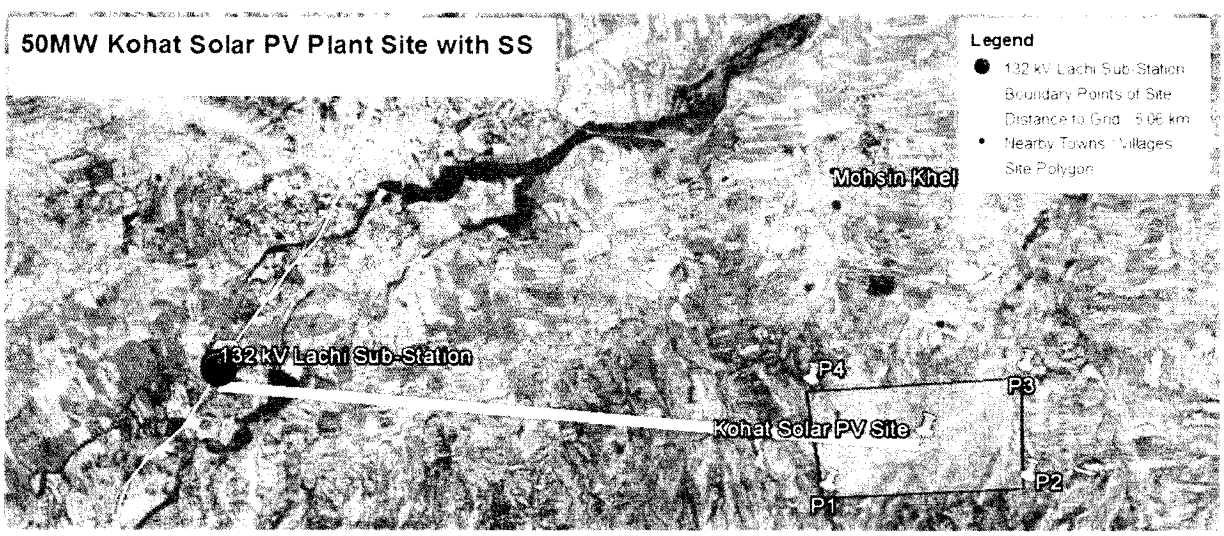
The site is, located 25.06 km to the south of the town of Kohat, 4.61 km south east of Lachi on Indus Highway (N55) and approximately 75 km south of the provincial capital, Peshawar in Khyber Pakhtunkhwa, Pakistan. The available site, of approximately 284 acres, is privately owned land. The climate in Kohat is hot, sometimes extremely hot summers and mild to warm winters. It is mainly hot semi-arid climate range from 2°C in January to almost 43°C in July.

Since the issuance of the LOI in 2016 which was further extended in 2018**,** the Applicant conducted various studies to assess the feasibility of the Project. These studies included the Solar Resource Assessment, Geo Technical investigation, Digital topographic map, Initial Environmental Examination and Grid interconnection Study. The Project Company submitted the complete feasibility to PEDO and it has been approved by PEDO on 19th February, 2018.

Project Site

The 50 MWp Solar Power Project is in Kohat, KPK-Pakistan. The site is, located 5.06 km to the south east of the town of Lachi, in Khyber Pakhtunkhwa, Pakistan.

The available site, of approximately 284 acres is privately owned land. The site is based on in a complex terrain consisting of multiple depression and ridges. Most of the terrain is covered with wild bushes & shrubs with only a few small trees along the west boundary of the site. There are scattered villages near the eastern boundary of the site and a few houses are located within the site on a ridge towards the north east. The overview of Site is shown in Figure below.

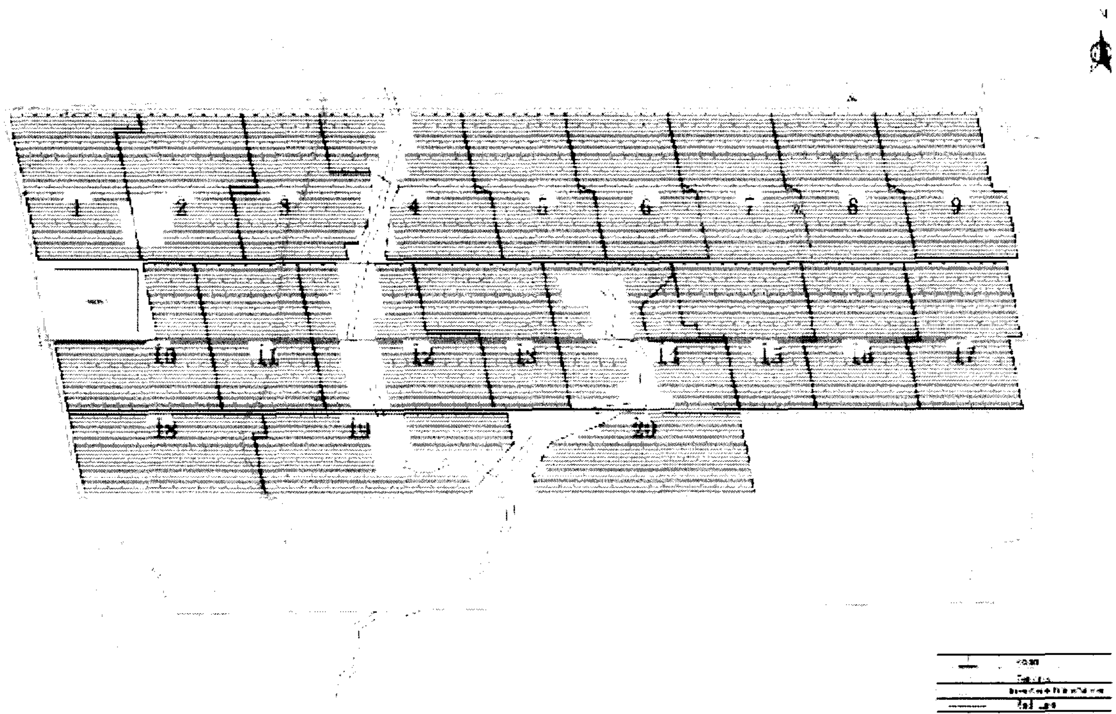


The project site coordinates and details are as listed in Table below:

Item	Description
Site coordinates	33°21'39.86"N, 71°22'44.06"E
Altitude (meters above sea level)	457
Site Area (Hectares)	115
Global Horizontal Irradiation (kWh/m2/year)	1799.2

Solar Farm Layout at Project Site:

The tentative layout at the project site is shown in Figure below.



Topographical and Geological Conditions at Project Site:

The geotechnical report has been prepared by AJK Engineers with the findings of geotechnical and electrical resistivity surveys as well as sample test results from soil test lab of AJK Engineers and UET Laboratory in Lahore.

17 boreholes were carried out using light percussion method, and 10 undisturbed soil samples were collected. During these investigations, the subsurface was explored to a maximum depth of 15 feet below the existing ground surface. Furthermore, Standard Penetration Tests (SPT) were performed at 3-to 5-feet regular intervals up to the investigated depth. The location of the samples and boreholes is considered to draw an appropriate grid to cover the large size of the proposed area.

At the time of these investigations, the depth of groundwater was not encountered. However, several fields within the site have a sole layer of dense gravel with silt that may hinder the drilling or driving of the foundations.

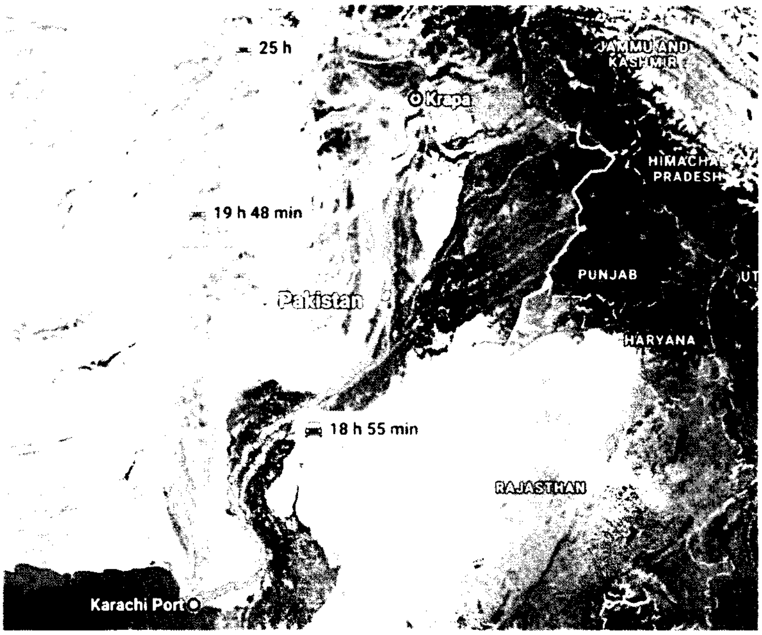
To avoid possible attack of chloride on cement and minimize corrosion potential the concrete mix should be designed using a water cement ratio not greater than 0.45. A layer of bitumen coating should be applied to the exterior of all the foundation and other concrete coming in contact with soil. Additionally, the electric soundings conducted show low resistivity values at the upper soil depths (0 to 1.5 m), i.e. the top soil layer has high conductivity that implies high potential for corrosiveness. In addition, the resistivity tests conducted in the northernmost fields have found that the underlying soil layer (depths of 1.5 m to 4 m) have medium conductivity.

Site Accessibility:

The site is accessed by an inroad leading in from the Indus Highway as shown in below Figure. By road, Lachi town is 27.9 km from Kohat.

Most deliveries of equipment are expected to be made via Kohat and Lachi. Several of the in-roads splitting away from the main Indus Highway are observed to be muddy or poorly laid roads which could potentially cause delays in deliveries to the site once the trucks/cranes have reached the vicinity of the Kohat site. All deliveries to the site would be received at the site entrance and a turn-out bay will be required to allow trucks to turn off and merge on to the link road safely.

The most logical location for the site entrance and laydown area is in north-west of the site, adjacent to the road leading to the site. This location offers not only easy access but will minimize disruption to construction activities within the solar field. Fencing and security should be provided for the laydown area at the site from commencement. Main and alternate routes are available at the site as shown in below figure. The same has been included in the proposed access to the site in the layout.



Availability of Semi-Skilled and Skilled Labor:

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

Grid Connectivity:

The Project would be connected to 132 kV PESCO Network.

Annual Energy production:

The predicted Annual Energy Production of the project is 85071 MWh. The tables below show key details relating to power generation from the Project.

Pant Capacity	**50 MW**
Annual Energy (Year 1)	87,622
Capacity Factor (Year 1)	20%

Technology of Panels

Technology of Inverters

Technology of Inverters:

The details of panel are given in table below.

Parameters	Make (Sungrow)
DC Part - Input	
Vmax DC	1500
MPP range (at Pacr and Vacr)	875 - 1300
Max. input current DC	4178
AC Part - Output	
Rated AC power at 25°C/ 50°C	3593/ 3125
AC voltage range	10 - 35 kV
Minimum efficiency	98.7%
Frequency	50 Hz / 45 – 55 Hz, 60 Hz / 55 – 65 Hz
Power Factor	> 0.99 / 0.8 leading – 0.8 lagging
Ambient Condition and Classification	
Ambient Temperature (operating)	-35 to 60 °C (> 50 °C derating)
Maximum relative humidity	0 – 95 %
Altitude (m)	1000 m (standard) / > 1000 m (optional)
IP protection	IP54

CONTROL, METERING INSTRUMENTATION & PROTECTION

Control, Metering Instrumentation & Protection for 50 MWp PV Plant:

Operation Control:

The main task of the operation control is to ensure an automatic and safe operation of the Solar Plant in all situations by monitoring and constantly keeping the parameters within the set range as stored in the control computer of the plant.

To achieve this, a real-time control system will be used, that will query relevant data and processes it further. The parameters will be provided by Solar Module Manufacturer and are adapted to the respective site. The objective is a safe and automatic operation of the Solar Plant in all situations.

Control of Solar Plant:

The propriety Solar Plant monitoring software will be used for Solar Power Plant. It offers comprehensive options to monitor and control a Solar Power Plant. The two essential tasks of a Solar Plant controller are:

- The optimum fulfillment of the grid operator feed-in regulations
- Ensuring output of the maximum possible power from the Solar Plant in case of error (internal or external)

The above tasks can, among other things, be realized by:

- Starting and stopping the Panels in a staggered sequence
- Active power limitation.
- Reactive power management.

PLANT CHARACTERISTICS

Plant Characteristics:

The characteristics of Solar Plant are as follows:

Plant Characteristic	Value
Generation Voltage	132 kV
Power Factor	0.95
Frequency	50 Hz
Automatic Generation Control	SCADA controlled

SAFETY & EMERGENCY PLANS

Safety & Emergency Plans:

Fire Protection:

The fire prevention design of 132 kV plant substation in this project will follow the IEEE-979 Standard for substation fire protection.

Because the plant substation won't be close to town, one full-time firefighter will be hired on site. In the case of minor fire, the fire will be fought by the control center. In the event of a major fire, the fire should be put out with the support of the local fire brigade.

Fire hydrants, sand boxes, portable fire extinguishers etc. will be set in the plant substation. The width of pathways inside and outside of the station will be more than 4m, to allow easy access. Main buildings will have emergency exits which open to the outside. Power supply for fire prevention will adopt an independent double loop, both of which will be respectively connected through the 33kV busbar. The fire prevention monitoring system would be set, and the fire prevention planning would be made during the construction period.

Labor Safety:

During the project construction and operation, adherence to the principle of "safety first, prevention crucial" to realize a full, whole-process, and all-around management and supervision and assurance of safe and economic operation of various types of equipment and the personal safety of the staff will be complied.

The hygiene and safety management institution may be set up in the Solar Plant, which would be responsible for the education, training and management on aspects of health and safety after the project is put into operation. A part time safety management personnel may be determined in production department, who will be responsible for labor safety and industrial hygiene daily.

Tour inspection regulations, operation monitoring regulations, and maintenance regulations should be established, and daily safety maintenance on the relevant apparatus, instrument and equipment for production should be done.

As per features of the project, the hygiene and safety management institution should be configured monitoring equipment such as sound level meter, and the necessary safety propaganda apparatus.

The main contents of labor safety and industrial hygiene design are to analyze the hazard factors which may exist during the operation period ,such as fire and explosion protection, electrical injury, mechanical injury, and electromagnetic radiation, and risk factors which are possibly existing in high-altitude operations, excavation, lightning and electrical protection and other work during the construction period, to formulate the corresponding measures, establish the corresponding institution and emergency plan, and put forward a special investment and implementation plan.

Accident Emergency Rescue Preplan:

The enterprise managing and operating the Solar farm shall conscientiously implement relevant national laws and regulations for production safety, perfect the rules and regulations, put into effect layer upon layer the production safety responsibility system, enhance the current management of production safety and on-site safety inspection, and organize production and operating activities strictly as per relevant regulations. The enterprise shall search out in time any hidden dangers, rectify and reform the hidden dangers conscientiously, work out safety countermeasures, assure labor resources material resources and registered capital required for the production safety, improve the safety education training of employees, and prevent new accident potential from occurring. The Solar farm shall establish accident emergency rescue system, work out accident treatment preplans (including salvage preplans and technological preparation preplans) in view of potentially affected areas, study out operable responding measures, and designedly organize actual training exercises so as to grasp the preplans, find out the errors and detects of the emergency preplans in process of training exercises, hereby work out analysis reports on training exercises, set forth corrective measures, and finish the improvement of emergency preplans.

The Solar farm shall establish an early-warning mechanism, emergency treatment capacity and accident emergency rescue action project against sudden major accidents. Corresponding emergency preplans shall be worked out for typical accidents related to Solar prevention and moisture protection etc., and more detailed, normative and complete accident emergency preplans shall be worked out for potential major accidents such as typhoon, fire, explosion, electric-power secondary system accidents, and construction-period major artificial accident prevention.

SCHEDULE-I

The Location, Size (i.e. Capacity in MW), Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facilities of the Licensee are described in this Schedule

Land Coordinates of the Generation Facility/Solar Farm

Total Project Land: Approx. 284 Acres

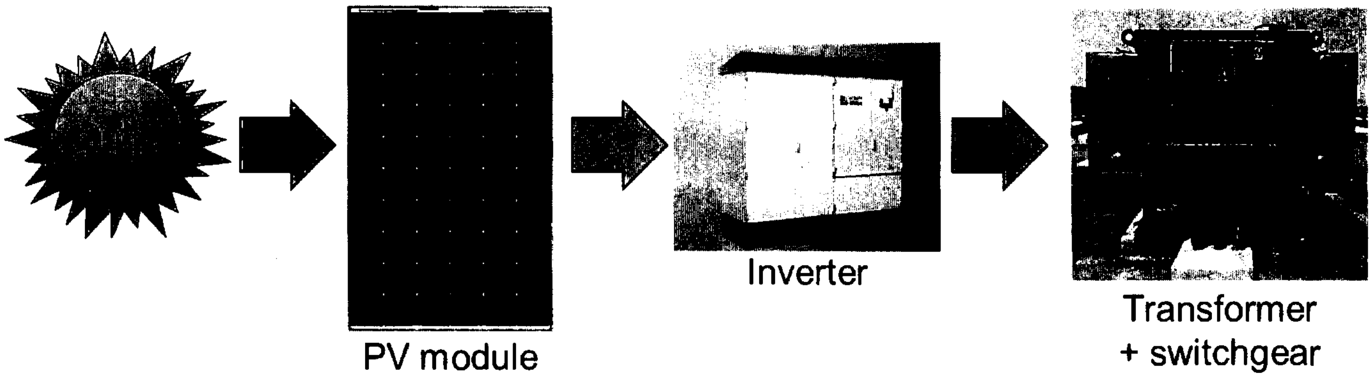
S. No.	Latitude	Longitude
P1	33.358092°	71.371181°
P2	33.357964°	71.386617°
P3	33.365006°	71.387036°
P4	33.364936°	71.370408°

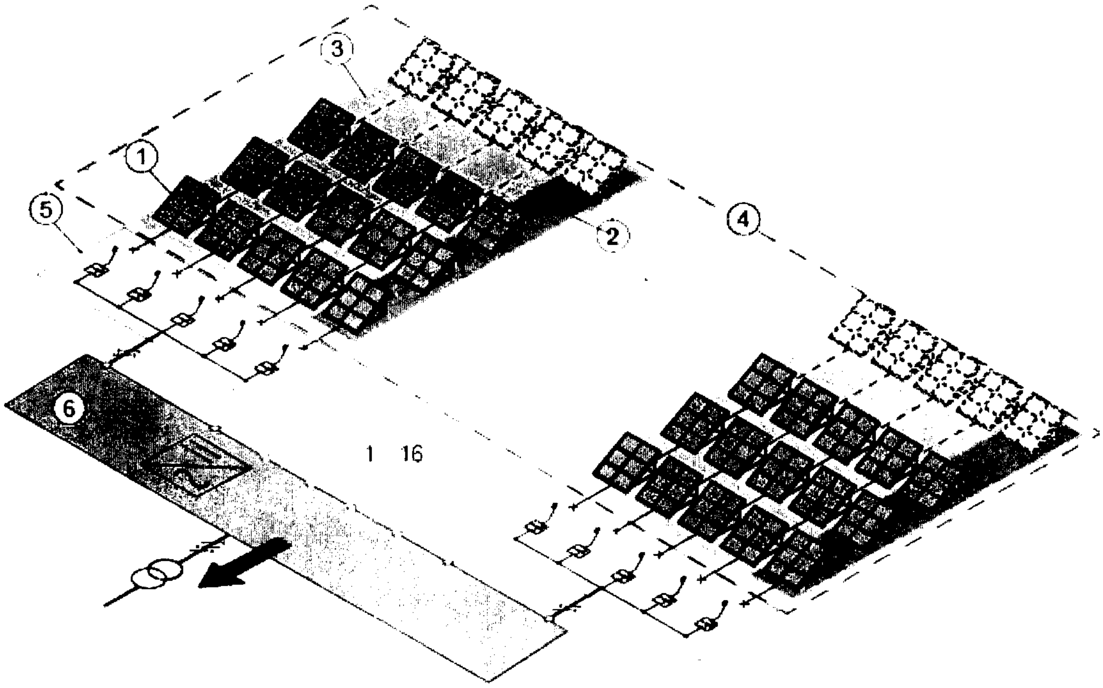
Land Coordinates of the Generation Facility/Solar Farm

Total Project Land: Approx. 284 Acres

[redacted]		
P1	33.358092°	71.371181°
[redacted]		
P3	33.365006°	71.387036°
[redacted]		

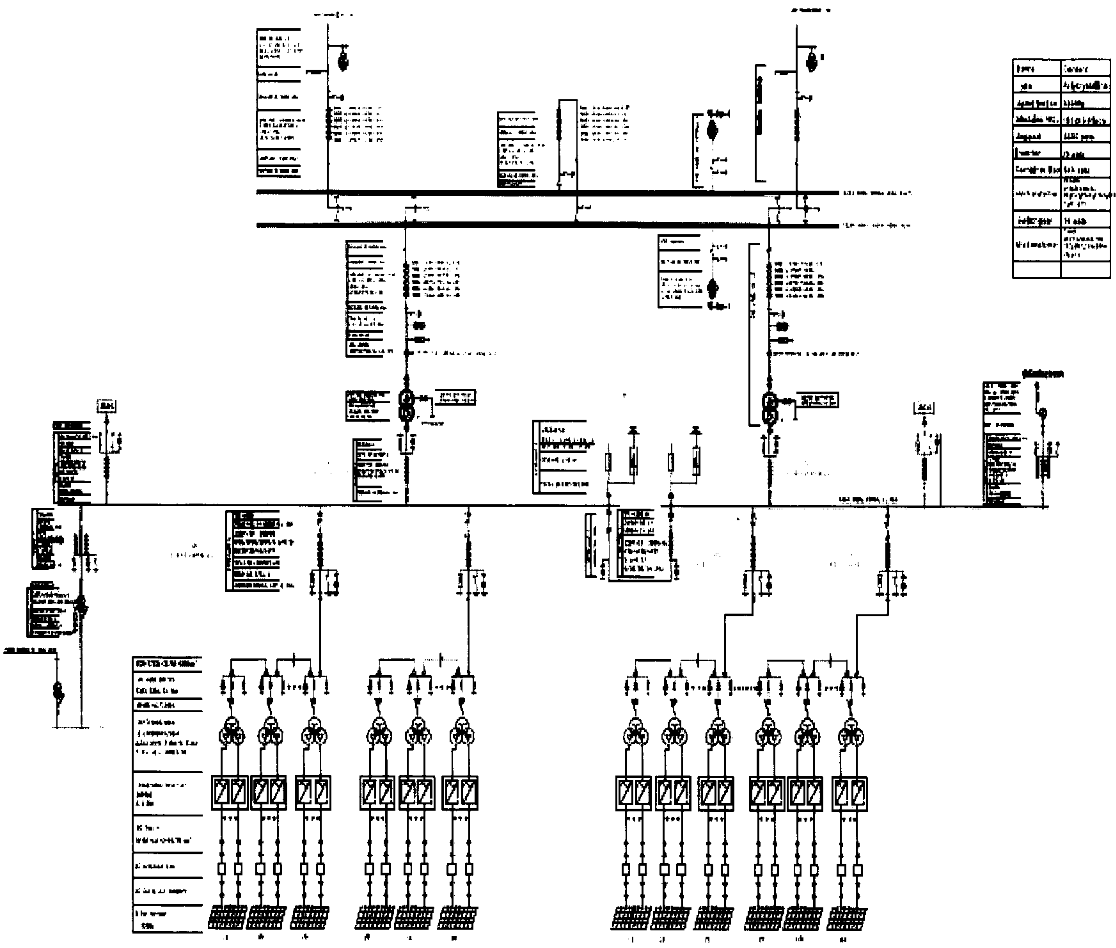
Process Flow Diagram of the Solar Power Plant/Solar Farm





1	Solar module (photovoltaic module)	3	Solar array	5	Solar array junction box
2	Solar string	4	Solar generator	6	Inverter

Single Line Diagram (Electrical) of the Generation Facility/Solar Farm



Interconnection Arrangement/Transmission Facilities for Dispersal of Power from the Generation Facility/Solar Farm

The inter-connection will be done by a double circuit line of length 7.5 km originating from Solar PV plant Kohat to Lachi 132 kV substation.

Solar PV power plant would be interconnected to the 132 kV Lachi line. Hence, the grid interconnection scope for power transfer of '50 MW Kohat Solar PV Power Plant' in particular is projected with;

- A 132kV double circuit transmission line, approximately of 7.5 km length from 50MW Kohat Solar PV Plant is connected to 132kV Lachi Grid Station under PESCO jurisdiction.
- Two step-up Power Transformers of 132/33kV, 60MVA capacity for '50 MW Kohat Solar PV Power Plant'.

The national grid system after addition of the solar PV plant was analyzed for load flow, short circuit, transient stability and power quality studies to determine whether the plant connection with the PESCO grid meets the NEPRA/NTDC Grid Code requirements.

Detail of
Generation Facility/Solar Farm

(A). General Information

(i).	Name of Licensee	Siddiqsons Kohat Solar Limited
(ii).	Registered/ Business Office	27th floor, Ocean Tower, G-3, Main Clifton Road, Karachi
(iii).	Location of the generation facility	Kohat, KPK - Pakistan
(iv).	Type of generation facility	Solar Photovoltaic (PV)

(B). Solar Power Generation Technology & Capacity

(i).	Type of Technology	Photovoltaic (PV) Cell
(ii).	System Type	Grid Connected
(iii).	Installed Capacity of Solar Farm(MW)	50 MWp

(C). Technical Details of Equipment

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	Poly-PERC Module
(ii).	Type of Cell	Poly-crystalline, 6 inch
(iii).	Dimension of each Module	1960 × 992 × 35 mm
(iv).	No. of Panel /Modules	147,057
(v).	Module Area	287,200 m^2
(vi).	Panel's Frame	Anodized aluminium alloy
(vii).	Weight of one Module	22.4 kg
(viii).	No of Solar Cells in each module	72 cells
(ix).	Efficiency of module	17.49%
(x).	Maximum Power (P_{max})	340 Wp

(xi).	Voltage @ P_{max}	37.6 V	
(xii).	Current @ P_{max}	9.05 A	
(xiii).	Open circuit voltage (V_{oc})	45.9 V	
(xiv).	Short circuit current (I_{sc})	9.62 A	
(xv).	Maximum system open Circuit Voltage	1500 V	
(b).	**PV Array**		
(i).	Nos. of Strings	5054	
(ii).	Modules in a string	28	
(c).	**Inverters**		
(i).	Capacity of each unit	3125 kW	
(ii).	Manufacturer	Sungrow	
(iii).	Input Operating Voltage Range	875 – 1500 V	
(iv).	Number of Inverters	12	
(v).	Efficiency of inverter	99.0%	
(vi).	Max. Allowable Input voltage	1500	
(vii).	Max. Current	4178 A	
(viii).	Max. Power Point Tracking Range	875 – 1300 V	
(ix).	Output electrical system	33 kV	
(x).	Rated Output Voltage	10 – 35 kV	
(xi).	Power Factor (adjustable)	> 0.99 / 0.8 leading – 0.8 lagging	
(xii).	Power control	active & reactive power control and power ramp rate control	
(xiii).	Rated Frequency	50 Hz / 60 Hz	
(xiv).	Environmental Enclosures	Relative Humidity	0 – 95%
		Audible Noise	N.A.
		Operating Elevation	1000 m (standard) / > 1000 m (optional)

(xv).		Operating temperature	-35 to 60 °C (> 50 °C derating)
(xvi).	Grid Operating protection	A	DC input protection
		B	Inverter output protection
		C	AC MV output protection
		D	Overvoltage protection
		E	Grid monitoring / Ground fault monitoring
		F	Insulation monitoring
		G	Overheat protection
		H	Night SVG function
(d).	**Junction Boxes Installed and fixed on main steel structure in Array yard.**		
(i).	Number of J/Box units	330	
(ii).	Input circuits in each box	16	
(iii).	Max. input current for each circuit	24 A	
(iv).	Protection Level	IP65	
(v).	Over current protection	Yes	
(vi).	Surge protection	Yes	
(e).	**Data Collecting System**		
(i).	System Data	SCADA system	
(f).	**Power Transformer**		
(i).	Rating	50 MVA	
(ii).	Type of transformer	Oil-immersed	
(iii).	Purpose of transformer	Step-up transformer	
(iv).	Output Voltage	132 kV	

(D). <u>Other Details</u>

(i).	Project Commercial Operation date (COD)-Anticipated	Q1 2020
(ii).	Expected Life of the Project from Commercial Operation date (COD)	25 years

Prospectus

Siddiqsons Nowshera Solar Limited (herein after "SNSL") is Special Purpose Entity for 50 MW Solar Power Plant in Nowshera - KPK, Pakistan formed by Access Power Limited and Siddiqsons Group in 2016.

Access Infra Central Asia Limited

Access Infra Central Asia Limited ('AICA') was established as a special investment vehicle to propel investments in the sustainable energy and infrastructure domains in the Central Asian region with a keen focus on Pakistan and CIS countries. AICA's main shareholders are Access Power and Total EREN SA.

Access Power ('Access') was founded in 2012 with the ambition of becoming a leading developer of power assets in Africa and the Middle East. Access Power is actively developing a portfolio of renewable energy projects in 17 African countries and has a dedicated investment budget of USD 800 million. Access focuses on developing affordable and sustainable power assets across a range of technologies.

Founded in 2012 by Pâris Mouratoglou and David Corchia, Total Eren ('TEren') has built up a substantial and diversified portfolio of wind, solar and hydroelectric assets representing an installed gross capacity of more than 1500 MW in operation or under construction worldwide. Through partnerships with local developers, TEren is currently developing numerous energy projects in countries and regions where renewable energy represents an economically viable response to growing energy demand, such as in Asia-Pacific, Africa and Latin America. Its objective is to achieve a global net installed capacity of more than 3 GW by 2022. On 1 December 2017, Total, the major energy company, has acquired an indirect 23% interest in Total Eren.

Through its various subsidiaries, Access is currently developing a portfolio of power assets in over 23 countries in Africa and Asia and has significant experience in working with Development Finance Institutions such as IFC, KFW, FMO, EBRD, ADB, PROPARCO among others.

Below are some of Access Power's notable accomplishments on the African continent since its inception in 2012.

- Financial Close and Commissioning of one of the first and largest solar PV IPP projects in East Africa: a 10 MW PV solar plant in Uganda as part of the national GET FIT program organized by KfW and the Government of Uganda. The project reached financial close in record time and has commenced operations as of November 2016. Access has also recently begun construction of the 126 MW Benban solar PV project in Aswan, Egypt funded by EBRD. PPAs were signed In April 2017.

- Development of 50 MW solar PV in Nigeria and 130 MW wind in Zambia: Access is currently under advanced financing stages for a 50 MW solar PV project under the FiT program launched by the Government of Nigeria, and a 130 MW WPP in Zambia. Both projects are in advanced stages of development. Access is also expanding its portfolio in Central Asia with the development of a 150 MW wind energy project in Armenia, a 130 MW solar PV and 50 MW wind energy project in Kazakhstan.

Siddiqsons Power Limited

Siddiqsons Power is the Power Sector Development division of Siddiqsons Group with the mandate to establish Coal and Renewable Energy IPPs for a sustainable energy-secured future of Pakistan. Siddiqsons Group entered the power sector through Siddiqsons Energy Limited, with the initiative to establish an imported-coal based IPP in Pakistan and contributing to the elimination of power crisis in the country. This 350 MW Coal Project, is being established in Eastern Industrial Zone, Port Qasim, Karachi and is in its advanced stages of development and expected to come online in 2019. Engro Corporation recently announced its investment of USD 21.375 million by way of subscription of ordinary shares in Siddiqsons Energy Limited, the SPV formed to develop the coal projects. Siddiqsons Group's renewable energy portfolio consists of the following assets:

1. 50 MW (Gross) Solar IPP in Chakwal, Punjab ("Chakwal Solar")
2. 50 MW (Gross) Solar IPP in Nowshera, KPK ("Nowshera Solar")
3. 50 MW (Gross) Solar IPP in Lachi, Kohat, KPK ("Kohat Solar")
4. 50 MW (Gross) Solar IPP in Sukkur, Sindh ("Sindh Solar")
5. 35 MW (Gross) Run-of-the-river Hydro IPP, Jagran-III, in Neelum District, AJK ("Jagran-III Hydro")

The proposed Solar Project use clean and renewable solar resource with zero emission, when put into operation, the project can provide power supply to the central 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. By estimating, after the completion of the station, it is expected to provide electricity grid each year about 87,622 MWh, compared with the same capacity of thermal power, equivalent to annually save about 27000 tons of Sulfur oxides (SOx) of about 2500 tons of nitrogen oxides (NOX) about 1250 tons coal, reducing various atmospheric pollutant emissions, which reduce carbon dioxide (CO2) about 8000 tons.

Therefore, the proposed Solar project has no impact for surrounding society and environment.

PESHAWAR ELECTRIC SUPPLY COMPANY
PROJECT MANAGEMENT UNIT PESCO PESHAWAR
Phone # 091-9210987, Fax # 091-9213018

No. CE (Dev) / 2(8)-19

Dated 8 /03/2018

Chief Commercial Officer
PESCO Peshawar

Subject: **GRID INTERCONNECTION STUDY ASSESSMENT OF 50 MW KOHAT SOLAR POWER PROJECT AT LACHI, KPK, PAKISTAN**

Reference
(1) Project Director Siddiqsons, Kohat Solar Limited letter. SS-Solar/PESCO/Kohat-002 dated 23.01.2017.
(2) This office letter No. CE (Dev)/208-10 dated 05.01.2018.
(3) Project Director Siddiqsons, Kohat Solar Limited letter No. SEL/PESCO/180129 dated 30.01.2018.

The site has already been visited by the representatives of PMU office, GSO office and GSC office.

The Grid Interconnection Study report of the subject Power Project has been vetted for Load Flow, Contingency, Short Circuit and Stability analysis. The proposed interconnection scheme through 7.5 km Double Circuit Transmission Line from proposed 132 kV Kohat Solar Power Project to 132 kV Grid Station Lachi using Lynx conductor for connecting the said Power Project is found technically feasible and approved.

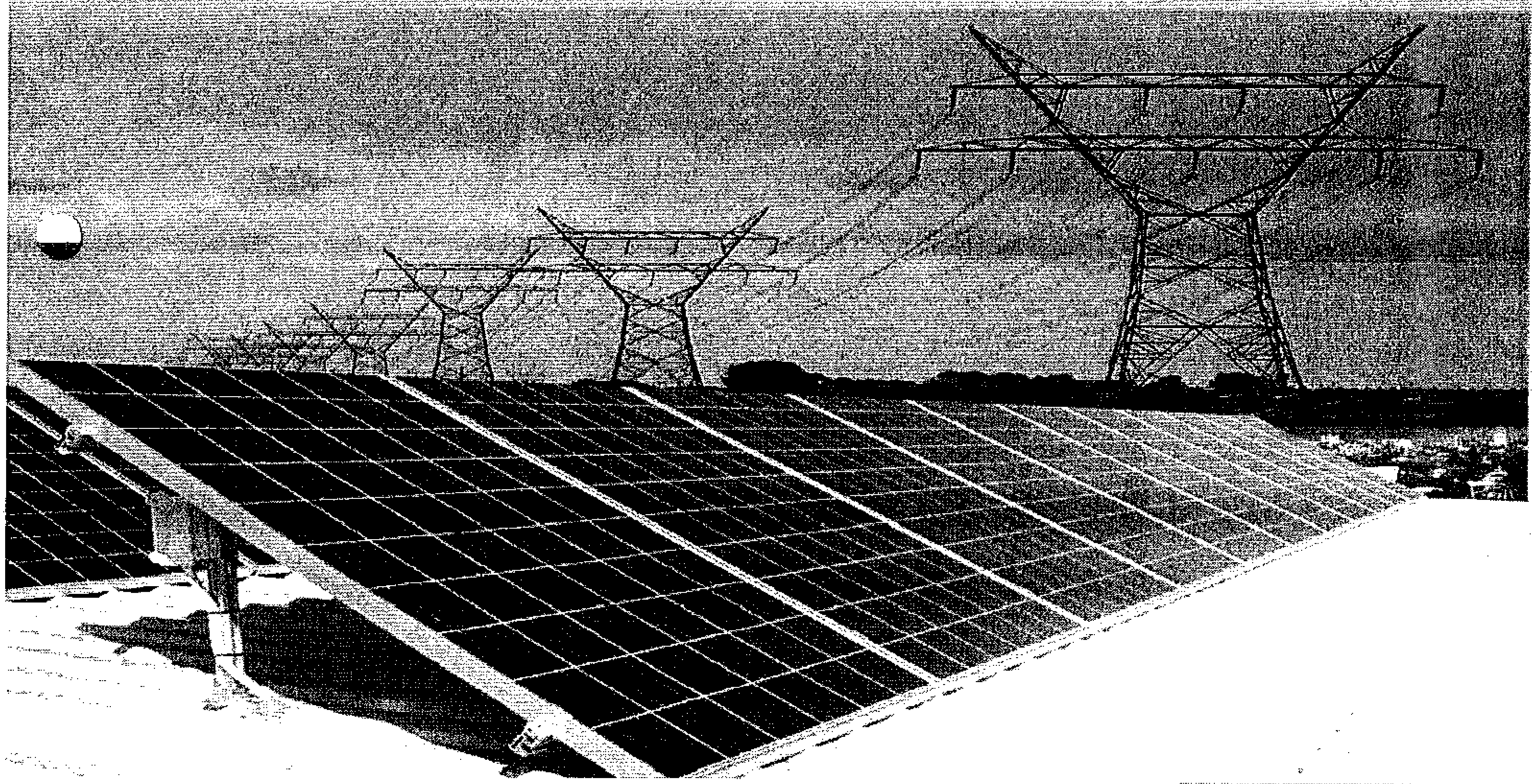
Chief Engineer (Development)
PMU PESCO Peshawar

Copy to:

1. Project Director Siddiqsons, Kohat Solar Limited 27th Floor, Ocean Tower, G-3, Block-9, Scheme # 5, Main Clifton Road, Karachi w.r.t his letter referred above.

Grid system impact study of 50 MW solar power plant Kohat, KPK

Siddiqsons Power Karachi, Pakistan



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Draft report

Grid System Impact Studies of 50 MW solar power plant Kohat,KPK

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Submitted to:
Siddiqsons Power
January 2017

DOCUMENT UPDATE RECORD

Document Name		Grid Interconnection Studies of Siddiqsons 50 MW Solar Kohat PV Power Project.		
Electronic File Name		Siddiqsons-Solar-Report-r0-mfa-13 January 2017		
Document number		PPK16-Siddiqsons-R0		
Date	Revision	Reviewed by	Approved by	Issued by
13TH January'2017	0	M.Fayyaz Akram	M.Fayyaz Akram	Jawaria Arshad

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The data, information, simulation work and its results in this report are subject to confirmation and updating by field measurements by the direct customer or its contractors.

Table of Contents

Executive Summary

Pakhtunkhwa Energy Development Organization (PEDO), Pakistan has issued a "Letter of Intent" (LOI) for this 50 MW Solar Kohat PV Project to Access Energy with expected Commercial Operation Date (COD) as December 2017. The project is situated in Kohat district of Khyber Pakhtunkhwa Province, Pakistan. The inter-connection will be done by a double circuit line of length 7.5 km originating from Siddiqsons Kohat bus to Lachi 132 kV substation.

Siddiqsons Solar PV power plant would be interconnected to the 132 kV Lachi line. Hence, the grid interconnection scope for power transfer of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' in particular is projected with;

- A 132 kV double circuit transmission line, approximately 7.5 km length from Siddiqsons Kohat is connected to Lachi 132 kV grid station.
- 2 transformers 132/33 kV of 60MVA capacity for 'Siddiqsons 50 MW Kohat Solar PV Power Plant'.

The national grid system after addition of the solar PV plant was analysed for load flow, short circuit, transient stability and power quality studies to determine whether the plant connection with the PESCO grid meets the NEPRA/NTDC Grid Code requirements.

The latest and up-to-date network model base cases were used as provided by 50 MW Solar Kohat PV Power Project. Generation and Transmission expansion plans have also been incorporated as delivered by PESCO, whereas steady state, sequence and dynamic data for the Siddiqsons PV plant is processed to build the steady state, short circuit and dynamic models in PSSE software format.

The analysis has been performed for September 2018, winter 2018 and summer 2021, peak cases of the interconnection year 2018-19 and horizon year 2021-22 of studies respectively. The power flow analysis shows that the bus voltages and line loadings in all the cases, with and without addition of the subject solar PV plant are within acceptable limit of defined planning criteria. The results were also validated as per the standards of line loading and bus voltage limits in associated N-1 post-contingency conditions.

Maximum short circuit level at LV, MV and HV (POI) buses of 'Siddiqsons 50 MW Kohat Solar PV Power 'Plant' in both the year of commissioning and horizon year were computed. Moreover, in order to see the short circuit current contribution of 'Siddiqsons 50 MW Kohat Solar PV Power Plant', maximum short circuit levels at the substations located in vicinity of the project are also computed. The results show that fault levels are within the circuit breaker duties with the addition of the subject project to the 132 kV network of 50 MW Solar Kohat PV Power Project.

The transient stability studies were carried out to check the dynamic impact on the solar PV power plant due to potential faults in national grid system and, in turn, the impact of disturbances in the solar power plant on national grid system. The solar power plant is found to meet all the transient stability requirements as per defined by the NEPRA Grid Code. The results of transient stability analysis shows that the power system is stable for the suggested interconnection scheme of the 'Siddiqsons 50 MW Kohat Solar PV Power Plant' and it fulfils all the criteria for the generation connection with the power system.

In the power quality analysis, the major criterion of the power quality i.e. flicker, voltage un-balance, frequency operating range, harmonics and power factor has been investigated at the subject solar PV plant for the worst case scenario. Moreover, the obtained values are compared with the standards of IEC (IEC61400-21 and IEC-61727) and the results show that the all the parameters remains within the acceptable range of the IEC criteria.

Based on the study results, overall it is concluded that proposed generation connection for 'Siddiqsons 50 MW Kohat Solar PV Power Plant' meets the NEPRA/NTDC Grid Code and Planning Criteria.

1. Introduction

1.1 Project Background

Pakhtunkhwa Energy Development Organization (PEDO), Pakistan has issued a "Letter of Intent" (LOI) for this 50 MW Solar Kohat PV Power Project to Access Energy with expected Commercial Operation Date (COD) as December 2017. The project is situated in Kohat district of Khyber Pakhtunkhwa Province, Pakistan. The inter-connection will be done by a double circuit line of length 7.5 km originating from Siddiqsons bus to Lachi 132 kV substation.

'50 MW Kohat Solar PV Power Plant' can be interconnected with the power system network of 50 MW Solar Kohat PV Power Project at 132 kV voltage level. The transmission line passing nearby the land acquired for the subject project is 132 kV Lachi grid station. In this study, a stable and reliable interconnection for 50 MW Solar Photovoltaic (PV) Power Plant by Siddiqsons is considered at 132 kV 50 MW Solar Kohat PV Power Project network.

1.2 Objective of the Study

The principal objective of this study "Connection assessment of Siddiqsons 50 MW Kohat Solar PV Power Plant to the National Grid System of Pakistan" is to assess the impact of the suggested interconnection for the 'Siddiqsons 50 MW Kohat Solar PV Power Plant' on the PESCO transmission system and vice versa. In this study a most appropriate interconnection with the PESCO network is presented for the project.

The following studies and tests are carried out in order to check the robustness of solar power plant and the interconnection strategy of the desired system.

1. Field survey and data processing.
2. Load flow analysis.
3. Short circuit analysis.
4. Transient stability analysis.
5. Power quality analysis.
6. Recommendations.

The above studies were carried out to demonstrate that the proposed connection plan of this plant meets the National Electric Power Regulatory Authority (NEPRA) Grid Code Planning Criteria.

The system operational capability is analysed by the steady state analysis under normal and contingency conditions. This particular assignment also aims at investigating that the connection of the solar power plant with the PESCO system fulfils the criteria of transient stability. The criteria is that the system should be stable enough that it should return to the normal state following the fading of a momentary actions in current, voltage or frequency, without losing connectivity.

The proposed connection of this Solar PV Power Plant, operating up to 50 MW, subject to the requirements specified in this report, is expected to have no material adverse impact on the reliability of the integrated power system of PESCO.

1.3 Terms of reference

The studies package include, load flow studies, short circuit studies, transient stability and power quality studies to determine whether the plant connection with the PESCO grid meets the NEPRA/NTDC Grid Code requirements.

- The load flow study investigates and addresses the voltage profile and overloading issues of the transmission networks as a result of the proposed interconnection scheme, with and without contingencies.
- A short circuit study evaluates the short circuit levels of power plant's switchyard and contiguous network.
- The transient stability study covers the worst case scenario of the three phase faults including stuck breaker conditions, without loss in synchronism of power plant.
- Power quality analysis ensures that there is no potential risk of power quality deterioration by bringing on this converter based Solar PV Power Plant to the power system.

2. Methodology and Assumptions

2.1 Methodology

The methodology of the gird interconnection study follows the NEPRA/NTDC Grid Code planning criteria and the studies are carried out in following sequence:

- POWER-tek collected the following network data of National Grid System of Pakistan from PESCO, with authorization and support of Siddiqsons:
  - Existing generation capacity and their dispatch in summer and winter seasons.
  - Future generation expansion plans up to horizon year of study.
  - Transmission plans of PESCO and 50 MW Solar Kohat PV Power Project up to horizon years of studies.
  - Load forecast of PESCO for the year of commissioning (base year) of 'Siddiqsons 50 MW Kohat Solar PV Power Plant', up to horizon year of studies.
  - Base and horizon years' PSSE base cases of load flow, short circuit and transient stability.
  - Existing and future planned network data (steady state, sequence and dynamic and sequence) of the whole National Grid System in PSSE readable format.

  All the technical data both steady state and dynamic (solar PV panel model data sheet and inverter model data sheet etc.), relating to the specification of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' is collected from Siddiqsons.
  All the above mentioned data/information provided by Siddiqsons is attached in Appendix C.
- The information and data regarding the interconnection arrangements for the subject power plant involves discussion made with subject plant engineers and site surveys.
- The power plant data is processed and then modeled in the overall PESCO network model. Updated system network is then reviewed and tested for its validity.
- Multiple options for power transfer of subject power plant are prepared and analyzed; however, the most appropriate interconnection proposal is adopted on the basis of results obtained by system studies.
- Comprehensive load flow, short circuit, transient stability and power quality analysis are carried out to determine the adequacy of the proposed interconnection arrangement as per NEPRA/NTDC Grid Code planning criteria.
- Results are compiled and analyzed in detail for above-simulations effectively in order to conclude the study and complete the report accordingly.
- Recommendations are submitted based on study results and findings.
- All the system data processing, modeling and simulations are carried using PSSE software.

2.2 General assumptions

Following are some of the important assumptions used for this study:

- The generation plan used for the subject study is up-to-date, as it has an important role in planning of power system.
- Dispatch of the generation power plants is taken as per information provided by PESCO based on the weather and seasonal conditions.

- The transmission expansion plans of PESCO and 50 MW Solar Kohat PV Power Project are the optimal ones as per load demand and generation requirements.
- The transmission plans of PESCO and 50 MW Solar Kohat PV Power Project would optimistically be implemented as per their expected CODs, especially around the subject study region.
- PESCO provided load demand forecast is most recent and revised.
- The existing and already proposed shunt compensation capacitors of 50 MW Solar Kohat PV Power Project are considered.
- Steady state and dynamic data for 'Siddiqsons 50 MW Kohat Solar PV Power Plant' is provided by Siddiqsons. Else otherwise, reasonable assumptions are made by POWER-tek based on prudent industry practices for any missing or unavailable data.
- Applicable seasonal conditions and appropriate study years for the subject system study are incorporated as suggested by PESCO, which are;
  - **Year 2018:**
    Peak load September and peak load winter load flow cases were selected as base year cases for this study.
  - **Year 2021-22:**
    Peak load summer 2021 load flow case was selected as horizon year case for this study.

3. Interconnection Scope

The particular objective of this study is to develop and simulate a connection plan for the subject solar power plant with a nearby transmission line/substation such that there is no physical limitation regarding the Right Of Way (ROW) and free available capacity is accessible at the substation. POWER-tek analysed multiple options for power evacuation of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' and on the basis of system studies the most feasible interconnection proposal is suggested.

The grid interconnection scope for power transfer of 'Siddiqsons50 MW Kohat Solar PV Power Plant' is projected with,

- A 132 kV double circuit transmission line, approx. 7.5 km length from Siddiqsons 50MW bus is connected to Lachi 132 kV grid station.
- 2 transformers 132/33 kV of 60 MVA capacity for 'Siddiqsons50MW Solar PV Power Plant'.

Present Status Site Map with Interconnection of 50 MW Solar PV project is attached in Appendix B.

4. Field Survey and Data Processing

4.1 Site Surveys and Related Meetings

The 'Siddiqsons 50 MW Kohat Solar PV Power Plant' is located in Kohat district of Khyber Pakhtunkhwa Province, Pakistan. Lachi 132 kV grid station is approximately 7.5 km away from Siddiqsons Solar PV project. The field survey of site was carried out in order to ensure the Right of Way (ROW) and space availability at interconnection points.

There is no problem identified during the site visit and meetings with Siddiqsons engineers pertaining to the interconnection arrangements.

4.2 Collection of Data

The system study is based on the data and information provided by PESCO, 50 MW Solar Kohat PV Power Project, CPPA and Siddiqsons. Power plant's location with coordinates, generation units and transformation requirements, steady state and dynamic data of Solar PV Plant is provided by Siddiqsons. However, reasonable assumptions were made by POWER-tek to complete the study and the report, whenever certain information was unavailable or needed correction in the provided steady and dynamic data and attached in Appendix C and D.

As per requirements of system studies the following data was collected from PESCO;

- Existing and future generation capacity with their dispatch in summer and winter seasons.
- Load flow base cases for the base year and future case for the horizon year modelled in PSSE.
- Short circuit base cases for the horizon year of study modelled in PSSE.
- Transient stability base cases for the COD year modelled in PSSE or Dynamic RAW data (.dyr) file of the complete network of PESCO and DISCO systems.

4.3 Processing of Power Plant Data

After receipt of PESCO network data simulated in PSSE format and Siddiqsons power plant data, POWER-tek reviewed the data in order to verify the available and/or missing information. POWER-tek processed the received raw data from Siddiqsons into the PSSE software format in order to model the Siddiqsons plant in PSSE and to perform the simulation studies.

This processed plant data is modelled in the overall PESCO network model as per proposed connection scheme. POWER-tek assumed the missing or incorrect data based on prudent industry practices. PESCO network model is then updated by inclusion of the subject power plant. Updated PESCO network base case is then simulated by considering the N-1 contingency analysis for each case using standard checks like convergence, mismatch, number of iterations, voltage and thermal limits, and 15 seconds drift-run tests for dynamics run.

The Siddiqsons plant data is processed to build the following basic models in PSSE software format:

i. Steady state data for load flow analysis.

ii. Sequence data for short circuit analysis.

iii. Dynamic data for transient stability analysis.

4.3.1 Steady State System Modeling

Siddiqsons solar PV power plant would have the net active power output of 50 MW as communicated by them.

Steady state models of generator and transformers at Siddiqsons solar power plant in PSSE software as under:

- For modeling in PSSE 'Siddiqsons 50 MW Kohat Solar PV Power Plant' is modeled having 5 collector groups of 10 MW AC (lumped solar PV generation) active power of solar PV generators with G.S.U transformers of apparent power 11 MVA, 7 % reactance and transformation voltage levels of 11/0. 4 kV each.
- As solar PV generator is a full converter based machine, therefore it is identically modelled as a type-4 wind machine having control mode set as 2, which controls a remote bus voltage within the given range of reactive power capability limits [Q_{min}; Q_{max}] in MVAR based on lead and lag power factor. Whereas, schedule voltage controls this reactive power within the limits of power factor offered by the solar PV inverters used.

  Please note the following reference;
  North American Reliability Corporation (NERC) Report on Standard Models for Variable Generation, 2010.
  "The NERC Working Group recommends that grid side structure of the Type 4 WTG model may be used for solar PV technologies since it represents a VSC. This is because PV is typically connected to the grid with a VSC and it will behave electrically similar to a Type 4 WTG that has a similar electrical interface with the grid—this is from a grid perspective looking at the electric response and neglects any of the effects of the energy source.
  From a steady-state, power flow and short-circuit analysis perspective, the behavior of the PV technologies will behave in a similar fashion to a Type 4 WTG because of the VSC interface, and because its power factor can be controlled based on the control functionality of the VSC design. Its short-circuit response will be limited to the current limit effected by the VSC under grid fault conditions".
- PV panels are decoupled from the grid by a power converter which is actually connected to the grid. As for load flow models of most power electronic devices, the source reactance of this machine is set as infinite: X_{source} = 99999.
- HV/MV (132/11 kV) transformers are modelled having11% reactance at 60 MVA ratings.
- 132 kV double circuit transmission line of length 7.5 km for interconnection of the Solar PV Project is modeled having its per unit (p.u) resistance, reactance and susceptance according to 7.5 km line length and 112 MVA rating.
- Positive sequence parameters are employed in the steady state model of the under study power plant.

4.3.2 Sequence Data Modeling

The short circuit model of the solar PV plant is used to carry out short circuit studies at its own switchyard and existing adjacent substations.

Short circuit model of the solar PV plant has been prepared by representing a solar PV collector group as one generator having a certain MVA rating and by using the following parameters of the generating units;

- Positive sequence data.
- Negative sequence data.
- Zero sequence data.

Since, this is a full converter based type solar PV power plant having X_{+ve}, X_{-ve}, X_{zero}, $X_{source} = \infty$ or in PSSE its value used is 9999. Therefore, ideally, it is not expected to affect the short circuit levels of adjacent substations.

4.3.3 Dynamic Data Modeling of Solar PV Power Plant

PSSE Solar PV Unit dynamic stability model is developed to simulate performance of a photovoltaic (PV) plant connected to the grid via a power converter. PSSE Solar PV Unit dynamic stability model is largely based on the generic type 4 wind model, WT4, with the added ability to simulate output changes due to solar irradiation.

It is the power converter/generator module that calculates the desired value of injected current in the system as a result to the MW and MVAR current commands from the electrical control module. The converter control module develops both active and reactive current control commands.

The reactive control calculates the reactive current command for the various control options, which could be any of the following:

- Remote bus voltage control
- Power factor control
- Reactive power control

However, the real power control does not depend on the idea that in order to fulfill the required real power the machine should work. It compares the active power injected to the bus bar versus the power reference, VAR (L+3), and changes the active component of the injected current accordingly. Hence, the active current signal is set up the produce power output from the power flow.

The converter/generator and electrical control modules for solar PV power plant are very close to respective modules of the generic WT4 wind model. The wind type 4 converter is based on the induction or synchronous generators and generators are decoupled from the grid via back to back converters.

(Reference: Program Application Guide of PSSE Version 32, Volume-II, October 2010).

5. Load Flow Analysis

5.1 Load Flow Study Objectives

A power flow study (or load flow study) is an analysis of the magnitude of bus voltages, line loadings, phase angles of the bus voltages and power flows in a power system under steady-state conditions.

The main goal of load flow analysis is to develop a reliable connection arrangement between the 'Siddiqsons 50 MW Kohat Solar PV Power Plant' and the PESCO grid system, for the evacuation of 50 MW power from the solar PV power plant thus satisfying the N-1 contingency conditions.

The proposed solar plant is planned to be connected to the nearby 132 kV Lachi grid station. A base case model has been prepared, consisting of 220kV and 132kV system, and studies for the entire system have been carried in order to assure that the proposed connection of the solar power plant is realistic for the maximum load settings.

The analysis has been performed for September 2018, winter 2018 and summer 2021, peak cases of the interconnection year 2018-19 and horizon year 2021-22 of studies respectively. The power flow conditions are studied on the system study cases that include up-to-date generation, transmission facilities, and load forecast representing the queue position applicable to this project.

Following are the important objectives of load flow analysis:

- Confirmation that no voltage and thermal loading limits are exceeded as per NERPA Grid Code Planning criteria.
- Voltage profile of PESCO system.
- Transmission line loadings in terms of Active (MW) and Reactive Power (MVAR) flows.
- Active Power (MW) loss in the network.
- Transmission network and transformation reactive losses (MVAR).
- Proposal of remedial solutions to any identified limitations or issues.

A relative approach is used in the power flow analysis in order to determine the impact of the Siddiqsons 50 MW Kohat Solar PV Power Plant project on the performance of the PESCO power system network in the vicinity of Lachi and vice versa. First, performance of the base case system without Siddiqsons PV project is evaluated in order to establish the baseline. Later, the analysis was performed with the addition of Siddiqsons PV plant and plotted on single line diagrams.

5.2 Load Flow Study Criteria

Load flow analysis is performed under the following conditions;

- Steady state normal (N) operating conditions.
- N-1 contingency operating conditions around the plant.

The gird interconnection studies are carried out by considering the operational data defined by NEPRA Grid Code and PESCO planning criteria, which is listed as under;

5.2.1 Voltage limits

For the purpose of system planning, following voltage limits are defined for steady-state load flow analysis;

i. Under normal operating conditions (N condition) all bus voltages shall be within the bandwidth of ±5 % of Nominal System Voltage.

ii. Under N-1 contingency conditions all bus voltages shall be within the bandwidth of ± 10 % of Nominal System Voltage.

5.2.2 Component loading limits

Loading criteria for current carrying components (transmission circuits, transformers, substation bus bars, circuit breakers, disconnect switches and auxiliary equipment) for the purpose of evaluating steady-state load flow studies is as follows;

i. Under normal operating conditions (N conditions), all components shall be loaded below their Normal Continuous Maximum Ratings.
ii. Under contingency conditions (N-1 conditions), all components shall be loaded below their Emergency Ratings.

5.2.3 Frequency limits

The frequency of the PESCO Transmission System shall be nominally 50Hz and shall be maintained within the following limits defined for exceptional circumstances.

i. Frequency Sensitive Mode shall be 49.8 Hz - 50.2 Hz. Such a variation is permissible to allow frequency variations while ramping up generation and load pick-up.
ii. Protected periods of operation of the system at the frequency in the range of 49.5 Hz - 50.5 Hz (Tolerance Frequency Band).
iii. Minimum/Maximum Acceptable Frequency Band shall be 49.4 Hz - 50.5 Hz (Load Shedding Threshold or Contingency Frequency Band), which is well within the applicable IEC Standards.

5.2.4 Power factor

A renewable power project will manage reactive power control to maintain the power factor within the range of ± 0.95 (lagging/leading), at full active power output at its interconnection point.

(Reference: NEPRA/NTDC Grid Code).

5.3 Reactive Power Control

IEC standard 61727 titled *"Photovoltaic (PV) systems – Characteristics of the utility interface"* states that;

"The PV system shall have a lagging power factor greater than 0.9 when the output is greater than 50 % of the rated inverter output power".

However, the NEPRA/NTDC Grid Code criterion of ± 0.95 (lagging/leading) power factor at POI defines the reactive power requirements for renewable power plants at their full active power output.

The POI for 'Siddiqsons 50 MW Kohat Solar PV Power Plant' is 132 kV level and the reactive power required at 132 kV @ ±0.95 = ± 16.4 MVAR.

5.4 Load Flow Analysis without Addition of Siddiqsons PV Plant

The power flow analysis without connecting the solar PV power plant to the base year 2018 power network of PESCO system was simulated first. This section summarizes the pre-contingent steady state analysis for the PESCO system load flow study.

The load flow analysis of network has been performed for the base year 2018 and Horizon year 2021. System study cases of following scenarios were analysed and presented on single line diagrams (SLDs);

- September 2018 peak load conditions.
- Winter 2018 peak load conditions.

- Summer 2021 peak load conditions.

The results of the system are presented for normal (N condition) only, which shows that the power flows on all the circuits are within their defined current carrying capacity and the bus voltages are in the permissible range.

Normal (N) load flow study without addition of Siddiqsons PV Plant is attached in Appendix E.

It is observed that prior to connecting the solar PV power plant to the PESCO power network all the current carrying capacities are within the range. No limitation is seen in any of the MW and MVAR flows.

5.5 Load Flow Analysis with Addition of Siddiqsons PV Plant

'Siddiqsons 50 MW Kohat Solar PV Power Plant' is then modeled in power flow using data supplied by Siddiqsons. The updated power flow cases are developed in order to determine the impacts resulted from this generator addition with proposed interconnection. The analysis has been performed for the following years and plotted on SLDs.

- Basecase Year 2018.
- Horizon Year 2021-22.

5.5.1 Basecase Year 2018.

Two base year cases are considered for the system impact study that are;

- September 2018 peak load conditions.
- Winter 2018 peak load conditions.

5.5.1.1 September 2018 Peak Load conditions

Extreme weather peak load demand condition was adopted for the system analysis. The results of the power flow after connecting a solar PV power plant to power system shows that all the MW and MVAR power flows on all the circuits are within the rated capacities and lies within the allowable range.

Normal (N) load flow study of September 2018 Peak Load conditions is attached in Figure F-1A of Appendix F.

Contingency analysis was also carried out to evaluate the power system network under the standard functioning conditions. Contingency conditions were simulated for numerous selected outages. N-1 contingency analysis ensures a power system's capability to meet the demands as well as remain in specified voltage and flow limits even after outage of any one component. The N-1 contingency analysis is carried out for the interconnection of solar power plant with the proposed substation in order to illustrate the maximum impact of the solar power plant on a power system.

Following are some selected contingency simulations that are carried out while performing contingency analysis and results of the analysis are presented on SLDs with referred figure numbers below:

- Lachi 132 kV to Karak 132 kV circuit outage. (Figure F-1C).
- Kohat 132 kV to Gurguri 132 kV circuit outage. (Figure F-1D)
- Kohat 132 kV to Daudkhel Id-2 132 kV circuit outage. (Figure F-1E)

Results of contingency analysis demonstrate that the resulting MW and MVAR power flows on the circuits and transformers after N-1 outage of selected components are within the rated capacities.

N-1 contingency load flow study of September 2018 Peak Load conditions is attached in Figure F-1B of Appendix F.

5.5.1.2 2018 Winter Peak Load conditions

The results of the power flow after connecting a solar PV power plant to power system shows that all the MW and MVAR power flows on all the circuits are within the rated capacities and lies within the allowable range.

Normal (N) load flow study of winter 2018 Peak Load conditions is attached in Figure F-2A of Appendix F.

Contingency analysis was also carried out to evaluate the power system network under the contingency operational conditions. Contingency conditions were simulated for numerous selected outages.N-1 contingency analysis ensures a power system's capability to meet the demands as well as remain in specified voltage and flow limits even after outage of any one component. N-1 contingency analysis is carried out for the interconnection of solar power plant with the proposed substation in order to illustrate maximum impact of the solar power plant on a power system.

Following are some selected contingency simulations that are included while performing contingency analysis and results of the analysis are presented on SLDs with referred figure numbers below:

- Lachi 132 kV to Karak 132 kV circuit outage. (Figure F-2C).
- Kohat 132 kV to Gurguri 132 kV circuit outage. (Figure F-2D)
- Kohat 132 kV to Daudkhel Id-2 132 kV circuit outage. (Figure F-2E)

Results of contingency analysis demonstrate that resulting MW and MVAR power flows on the circuits and transformers after N-1 outage of certain components are within rated capacities.

N-1 contingency load flow study of 2018 Winter Peak Load conditions is attached in Figure F-2B of Appendix F.

5.5.2 Horizon Year 2021-22

2021 summer peak load condition case is considered for the load flow analysis of horizon year with addition of 'Siddiqsons 50 MW Kohat Solar PV Power Plant'.

5.5.2.1 2021 Summer Peak Load conditions

Extreme weather peak load demand condition was adopted for the system analysis. The dispatch of generation for the horizon year of 2021 summer is kept as per base case provided by PESCO.

The results of the power flow with addition of Siddiqsons 50 MW Kohat Solar PV Power Plant' to the network of PESCO shows that the MW and MVAR power flows on all adjacent circuits are within the rated capacities and lies within the allowable range.

Normal (N) load flow study of 2021 Summer Peak Load conditions is attached in Figure F-3A of Appendix F.

Contingency analysis was also carried out to evaluate the power system network under the contingency operational conditions and to illustrate the maximum impact of the solar power plant on the power system network of PESCO in horizon year. Following are some selected contingency simulations that are carried out while performing contingency analysis and results of the analysis are presented on SLDs with referred figure numbers below:

- Lachi 132 kV to Karak 132 kV circuit outage. (Figure F-1C).
- Kohat 132 kV to Gurguri 132 kV circuit outage. (Figure F-1D)
- Kohat 132 kV to Daudkhel Id-2 132 kV circuit outage. (Figure F-1E)

Results of contingency analysis demonstrate that the resulting MW and MVAR power flows on the circuits and transformers after N-1 outage of certain components are within the rated capacities.

N-1 contingency load flow study of 2021 Summer Peak Load conditions is attached in Figure F-3B of Appendix F.

5.6 Conclusions of Load Flow Analysis

No incremental pre-contingent system overloads or voltage violations resulting from interconnection of Siddiqsons 50 MW Kohat Solar PV power plant were found within the local study area of 50 MW Solar Kohat PV Power Project transmission system. This finding was also validated through associated pre-contingent steady state system and post-contingency steady state system, overload and voltage violation screening outputs generated for the system model.

Thus, it can be concluded that the power flow on all the circuits in all the cases with and without connecting Siddiqsons 50 MW Kohat Solar PV power plant are within defined limits and the voltages and loadings are in acceptable range of defined study criteria.

6. Short Circuit Analysis

6.1 Short Circuit Study Objectives

This section covers the short circuit analysis performed for the 'Siddiqsons 50 MW Kohat Solar PV Power Plant'. When generation is added to a system, the available fault current of that system increases. Therefore, short circuit study has been performed to determine if the circuit breakers of existing substations near the new generation have adequate short circuit interruption duties.

Short circuit analysis includes the three-phase simulation at MV and HV bus bars in the switchyard of subject solar power plant. The fault currents computed at the solar PV plant buses would be used for selection of circuit breaker ratings.

Short circuit studies would determine the following;

- Maximum fault current levels at the solar PV plant.
- Total fault currents and contribution from the associated network.
- Adequacy of short circuit capacity of switchgears at neighboring existing substations.

6.2 Short Circuit Study Assumptions and Criteria

Short circuit studies were carried out for evaluating the following short circuit level of power plant's 11 kV bus bar, 132 kV bus bar of switchyard and contiguous network;

- Balanced 3 phase and fault levels.

Analysis was performed for horizon year 2021 scenario, as the future case would have all the planned generation and transmission systems components in service, which would produce the worst scenario with extreme fault level calculations.

Short circuit currents were calculated for maximum fault level according to International Electro technical Commission (IEC) standard IEC-909, with the following assumptions;

- For calculations of maximum fault levels;
  - Bus voltage has been assumed as 1.10 per unit (p.u) i.e. 10 % above the nominal.
  - Maximum dispatch of all the generation in the system has been taken.
- Taps ratios of all the transformers to be assumed at unity.
- Charging of all the transmission lines to be assumed at zero.
- All the shunt compensations to be assumed at zero in positive sequence.

6.3 Maximum Short Circuit Study

In order to analyze the impact of the solar PV power plant on the system, Short circuit analysis is performed after connecting the solar power plant for the horizon year 2021.

The total maximum short circuit levels at the Siddiqsons 50 MV bus bar, HV bus bar of common solar PV switchyard 220KV and 132KV bus bars of substations located in the electrical vicinity of the area of interest have been calculated in the both years of study and tabulated below;

Table – 6.1: Maximum Short circuit levels with addition of Siddiqsons in horizon year 2021.

	Substation	Bus bar Voltage	3 Phase Short Circuit Level (kA)
1.	Siddqsons Kohat	11 kV	7.994
2.	Siddiqsons Kohat	33 kV	11.898
3.	Siddiqsons Kohat	132 kV	6.523
4.	Lachi	132 kV	6.529
5.	Gurguri	132 kV	7.404

Maximum Short Circuit Study Report of horizon year 2021 is attached in Appendix G.

6.4 Conclusions of Short Circuit Analysis

Maximum short circuit level horizon year is computed at the solar PV plant for selection of circuit breaker ratings and relay coordination respectively.

Moreover, in order to see the short circuit current contribution of 'Siddiqsons 50 MW solar PV power plant', maximum short circuit level at the substation located in electrical vicinity of the project is also calculated. The findings show that with addition of this project, fault levels do not exceed the standard circuit breaker ratings of existing installed equipment at the neighboring substations.

Therefore it is concluded that the proposed interconnection scheme holds good on the basis of short circuit analysis as well.

7. Transient Stability Analysis

7.1 Transient Stability Study Objectives

The transient phase is the passage from the initial to the final conditions emanating from the disturbances in its operating conditions either on the switchyard of power plant or in the national grid system. In order to analyze these conditions, detailed transient stability studies were carried out for the subject power plant.

These studies begin by matching the specific dynamic model of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' with the Solar PV model available in PSSE model library by considering the transient behavior characteristics of the equipment (machines, regulation systems, etc.) and then modeling of the subject power plant switchyard.

The stability studies are carried out to check the dynamic impact on the solar PV power plant due to faults or disturbance in national grid system and, in turn, the impact of disturbances in national grid system on the solar power plant.

The studies involved choice of equipment and optimum regulation through control strategies which allows the system to remain in stable conditions under potential risks. Transient stability studies provide the basis of power system for the subject power plant as it determines the following;

- Transient stability of the solar PV power plant after any fault occurs in the system by damping of fluctuations in voltage and frequency etc.
- Risk of dynamic instability (loss of synchronization between the generators).
- The capability of system to damp the oscillations timely.
- Operating limits of frequency and voltage for solar PV power plant as imposed by the NEPRA/NTDC Grid Code standards.
- Proposal of remedial solutions in the event of a problem.

7.2 Transient Stability Study Criteria

The benchmark criteria for transient stability analysis are;

- Three phase short circuit fault application at important and selected buses (for N-1 fault contingencies locations) is evaluated as per standards of NEPRA/PESCO stability criteria.
- Transient stability analysis is simulated for the two following circuit breaker fault clearing time durations;
  - Normal 5 cycle opening time, with opening of the faulted system component.
  - Stuck breaker conditions of delayed breaker opening after 9 cycles. Please note as per PESCO practices, three phase fault is assumed to simulate the worst possible fault. Additionally as per PESCO practices and requirements, opening of adjacent breakers as contingencies has been ignored.
- Transient response of the adjacent network system in case of minimum / loss of generation of solar PV power plants.
- Transient stability of solar PV power plant after tripping a nearby or significant size of generator among existing surrounding power plants in the national grid system.

7.3 Transient Stability Performance of Solar PV Power Plant

Transient stability analysis of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' is simulated only on September 2018 Peak Load conditions by applying maximum stress on the 50 MW Solar Kohat PV Power Project network around the subject solar PV power plant.

The base case provided by PESCO for transient stability analysis was tested and analyzed. In order to study the transient behavior of power plant and system towards the disturbances, following faults are subjected:

I. 3 Phase fault at solar PV plant cleared in 5 cycles.

II. 3 Phase fault at adjacent ends cleared in 5 cycles.

III. 3 Phase fault at far end cleared in 5 cycles.

IV. 3 Phase fault at solar PV plant cleared in 9 cycles (stuck breaker case).

V. 3 Phase fault at adjacent ends cleared in 9cycles (stuck breaker case).

VI. 3 Phase fault at far end cleared in 9 cycles (stuck breaker case).

VII. Minimum (Zero) generation of solar PV power plants and response of the network system.

The following important parameters / quantities are monitored and plotted for these faults in the transient stability studies;

Table – 7.1: Parameters / quantities plotted for the faults.

No.	Description of Plot	Location and Parameter Plotted
1	**PV Plant Parameters** (Active (MW), reactive (MVAR) output, of the solar PV power plant)	MW generation output of one collector group.
		MVAR generation output of one collector group.
		Frequency Siddiqsons Kohat 0.4kV
2	**Bus Voltages** (Voltage swings of selected adjacent buses)	Bus Voltage of Siddiqsons Kohat 132kV
		Bus Voltage of Kohat 132kV
		Bus Voltage of Lachi 132kV
		Bus Voltage of Karak 132kV
4	**P Line Flows** Active (MW) flows on connecting transmission lines	Active Power (P) Line Flow of Siddiqsons 132kV to Siddiqsons 11kV
		Active Power (P) Line Flow of Lachi 132kV to Siddiqsons 132kV
		Active Power (P) Line Flow of Karak 132kV to Lachi 132kV
		Active Power (P) Line Flow of Kohat 132kV to Lachi 132kV
5	**Q Line Flows** Reactive (MVAR) flows on connecting transmission lines	Reactive Power (Q) Line Flow of Siddiqsons 132kV to Siddiqsons
		Reactive Power (Q) Line Flow of Lachi 132kV to Siddiqsons 132kV
		Reactive Power (Q) Line Flow of Karak 132kV to Lachi 132kV
		Reactive Power (Q) Line Flow of Kohat 132kV to Lachi 132kV

In order to obtain the results, every simulation is carried for the steady state condition for one second, to ensure that the system is completely stable and steady before the fault is applied in the system (pre fault conditions / drift run test). Then fault is applied and system is simulated for the fault clearance time. After the clearance of the fault from the system (post-fault conditions) followed by a certain contingency, the system is observed for 15 seconds to ensure that oscillations in various quantities are damped and the system has re-instated the stability conditions.

7.3.1 3 Phase fault at solar PV plant cleared in 5 cycles

Three phase fault is applied on certain locations at 'Siddiqsons 50 MW Kohat Solar PV Power Plant', then each fault is removed in 5 cycles (100 m sec). accompanied by a particular N-1 contingency and transient stability response of the system is monitored, which is summarized in the table below:

Table – 7.2: Transient stability results for 3 Phase fault at solar PV plant cleared in 5 cycles.

Fault Description	* Plot No.	Contingency / Outage Equipment	Transient Stability Response
3-phase fault at 0.4 kV bus bar of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' cleared in 5 cycles (100 m sec).	F-1	Siddiqsons 0.4kV to Siddiqsons 11kV	Stable

*Plot number refers to the plot file name in the attached plots (e.g. F-1 is plotted with F-1.out file name).
(Transient stability plots of 3 Phase fault at solar PV plant cleared in 5 cycles are attached in Plots F-1 of Appendix F).

7.3.2 3 Phase fault at adjacent ends cleared in 5 cycles

Three phase fault is applied on certain adjacent end locations of the line the fault is removed in 5 cycles (100 m sec) accompanied by a range of possible outages. Transient stability response of the system is monitored for these conditions, which is summarized in the table below:

Table – 7.3: Transient stability results for 3 Phase fault at adjacent ends cleared in 5 cycles.

Fault Description	* Plot No.	Contingency / Outage Equipment	Transient Stability Response
3 Phase fault at 132 kV bus bar of SS kohat cleared in 5 cycles (100 m sec)	F-2	SS Kohat – Lachi 132kV S/C Out.	Stable
3 Phase fault at 132 kV bus bar of Karak cleared in 5 cycles (100 m sec).	F-3	Karak 132kV–Lachi 132kV S/C Out.	Stable
3 Phase fault at 132 kV bus bar of Lachi cleared in 5 cycles (100 m sec).	F-4	Lachi 132kV – Siddiqsons 132 kV Out.	Stable
3 Phase fault at 132 kV bus bar of Kohat cleared in 5 cycles (100 m sec).	F-5	Kohat 132 kV – Lachi 132 kV Out.	Stable

* Plot number refers to the plot file name in the attached plots (e.g. F-1 is plotted with F-1.out file name).
(Transient stability plots of 3 Phase fault at adjacent ends cleared in 5 cycles are attached in Plots F-2 to F-5 of Appendix F).

7.3.3 3 Phase fault at solar PV plant cleared in 9 cycles (stuck breaker case)

Three phase fault is applied on certain locations at 'Siddiqsons 50 MW Kohat Solar PV Power Plant' and the fault is cleared in 9 cycles (180 m sec) to simulate stuck breaker situation, followed by a trip of a single circuit. If a system is able to overcome this fault after the stuck breaker time of 9 cycles then it is assumed to be the stable in any of the possible delayed breaker opening conditions up to 180 m sec.

Please note that as per PESCO practices, three phase fault is assumed to simulate the worst possible fault while stuck breaker conditions. Additionally as per PESCO practices and requirements, opening of adjacent breakers as contingencies has been ignored.

Transient stability response of the system under these special conditions is monitored, which is summarized in the table below:

Table – 7.5: Transient stability results for 3 Phase fault at solar PV plant cleared in 9 cycles.

Fault Description	* Plot No.	Contingency / Outage Equipment	Transient Stability Response
3-phase fault at 0.4 kV bus bar of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' cleared in 9 cycles (180 m sec).	F-6	Siddiqsons 0.4kV to Siddiqsons 11kV	Stable

* Plot number refers to the plot file name in the attached plots (e.g. F-1 is plotted with F-1.out file name). *(Transient stability plots of 3 Phase fault at solar PV plant cleared in 9 cycles are attached in Plots F-6 of Appendix F).*

7.3.4 3 Phase fault at adjacent ends cleared in 9 cycles (stuck breaker case)

Three phase fault is applied on certain adjacent end locations, the fault is cleared in 9 cycles (180 m sec) accompanied by a range of possible trips. Transient stability response of the system is monitored for these conditions, which is summarized in the table below:

Table – 7.6: Transient stability results for 3 Phase fault at remote ends cleared in 9 cycles.

Fault Description	* Plot No.	Contingency / Outage Equipment	Transient Stability Response
3 Phase fault at 132 kV bus bar of SS kohat cleared in 9 cycles (180 m sec)	F-7	SS Kohat – Lachi 132kV S/C Out.	Stable
3 Phase fault at 132 kV bus bar of Karak cleared in 9 cycles (180 m sec).	F-8	Karak 132kV–Lachi 132kV S/C Out.	Stable
3 Phase fault at 132 kV bus bar of Lachi cleared in 9 cycles (180 m sec).	F-9	Lachi 132kV – Siddiqsons 132 kV Out.	Stable
3 Phase fault at 132 kV bus bar of Kohat cleared in 9 cycles (180 m sec).	F-10	Kohat 132 kV – Lachi 132 kV Out.	Stable

* Plot number refers to the plot file name in the attached plots (e.g. F-1 is plotted with F-1.out file name). *(Transient stability plots of 3 Phase fault at adjacent ends cleared in 9 cycles are attached in Plots F-7 to F-10 of Appendix F).*

7.4 Conclusions of Transient Stability Analysis

The transient stability studies are carried out to check the dynamic impact on the solar PV power plant due to faults or disturbance in national grid system and, in turn, the impact of disturbances in the solar power plant on national grid system. The results of transient stability analysis shows that the power system is stable for the suggested interconnection scheme of the 'Siddiqsons 50 MW Kohat Solar PV Power Plant' for the faults on the substations that might be near to or distant from the solar PV power plant.

It is therefore concluded that, with the addition of the Siddiqsons 50 MW solar power plant in the grid, there are no stability issues seen and it fulfils all the criteria for the generation connection with the power system.

8. Power Quality Analysis

8.1 Power Quality Study Objectives

Power quality problems associated with solar power plants are due to the involvement of power electronics components. These problems are created by the switching of power electronic devices and can cause damage and malfunctions to power system equipment on the utility side and sensitive loads on the customer side. Power quality issues regarding voltage and flicker are primarily prominent in the weak power systems having low short circuit strength. Hence, these issues have been inspected in the following scenarios for the proposed interconnection strategy.

i. Maximum short circuit of horizon year 2021-22

The objective of this analysis was to study the behavior of solar PV power plant and the related possible power quality issues. Following power quality parameters have been evaluated;

a. Flicker.
b. Voltage Un-balance.
c. Normal frequency operating range.
d. Power factor.
e. Harmonic analysis

8.2 Power Quality Study Criteria

Power quality analysis is performed under the following criteria;

- Maximum short circuit case of 2021-22 has been used to calculate the parameters which are required for the power quality analysis.
- Power quality analysis is conducted according to International Electro technical Commission (IEC) standard IEC61400-21 titled *"Measurement and assessment of power quality characteristics of grid connected wind turbines"*

  And

  IEC-61727 standard titled *"Photovoltaic (PV) systems – Characteristics of the utility interface"*
- NEPRA/NTDC Grid Code planning criteria are followed in the parameters of power factor and frequency operating ranges for power quality analysis.
- IEEE standard 519 requires, distortion limits for voltage range of 120 V to 69 kV as given in Table 8.1 below.

Table-8.1: Harmonic Current limits

Isc/Il	THD (%)
<20	5.0
20<50	8.0
50<100	12.0
100<1000	15

Isc = Maximum short circuit current
Il = Maximum demand load current (fundamental frequency component)
Isc/Il =32.76 at JA 22 kV bus,

8.3 Flicker

For the computation of flicker quantity in the steady- state continuous performance, IEC 61400-21 standard has been used. The probability of 99th percentile flicker, during the continuous operation for the brief momentary from single inverter is Pst Σ and for the prolong time, the flicker level is P1tΣ. Following formula is used to calculate the flicker level:

$$P_{st\Sigma} = P_{lt\Sigma} = \frac{1}{S_k} \cdot \sqrt{\sum_{i=1}^{N_{wt}} (c_i(\Psi_k, \upsilon_a) . S_{n,i})^2} \quad (8.1)$$

Where;

S_n is the rated apparent power of the one inverter.

S_k is the short-circuit apparent power at POI.

N_{wt} is the number of inverters connected to the POI.

c (Ψ_k) cannot be greater than 1, its value ' 1 ' is considered here assuming its worst case.

System network was modeled for the maximum short circuit case and short circuit calculations were done at 0.9 p.u. Following values are used to calculate flicker level:

i. **Horizon year 2021-22**

S_n = 0.55 MVA

N_{wt} = 300

S_k for 220 kV bus = 3567.54MVA

Using equation (8.1), we get

PStΣ = PltΣ= 0.002670= 0.27 %

However the admissible flicker value for the IEC 61400-21 standard is less than 4 %. In contrast to this the obtained flicker value Siddiqsons 50 MW solar PV power plant is far less than the value, which shows that the inverters at this 50 MW Kohat Solar PV Power Plant would not cause any flicker issue during the steady state operation even in the weakest system conditions.

8.4 Voltage Un-balance

There are two conditions that occur in the voltage un-balancing;

- Voltage step up change.
- Voltage variation.

For voltage step up change, the voltage rise of the solar PV power plant at the POI should remain less than 3 % , as per IEC 61400-21 standard. For one cluster at POI and 50 % generation, following formula is used to evaluate it:

$$K_{k1} = \frac{S_{kV}}{\Sigma S_{Amax}} \quad (8.2)$$

Where;

S_{kV} = Short circuit power at the POI.

S_{Amax} = Maximum apparent power of one collector group connected to the POI.

If K_{k1}> 33 then it means that voltage step up change is less than 3 %. The obtained short circuit power and apparent power of the solar power plant is:

i. **Horizon year 2021-22**

S_{kV} = 3567.54 MVA

S_{Amax} = 11 MVA

Using equation (8.2) we get;

K_{k1} = Voltage Step-change factor = 324.32

It corresponds to 0.31 % (1/324.32) step-change in voltage which is quite less than the permissible limit of 3 %.

Whereas the voltage variation for one cluster at the POI of the solar power plant can be computed by the following formula:

$$\Delta u_a = k_{imax} \cdot \frac{S_{rE}}{S_{kV}} \tag{8.3}$$

Where;

k_{imax}= Maximum inrush current in relation to the nominal current.

S_{kV}= Short-circuit power at the POI.

S_{rE}= Nominal apparent power of the Solar PV unit that is to be connected.

The formula discussed above is primarily for computation of the upper safe margin. $k_{imax}$is assumed to be 1 in this case. The apparent power and short circuit value obtained are as follows:

i. **Horizon year 2021-22**

S_{kV} = 3567.54 MVA

S_{rE} = 0.6 MVA

Using equation (8.3), we get;

u_a = 0.000168 = 0.0168 %

The above voltage variation is far less the acceptable limit of 2.34 % in IEC 61400-21 standard.

8.5 Normal frequency operating range

Nominal frequency of the national grid system is 50 Hz therefore it is recommended that EPC contractor would make sure that the inverters to be used are capable to maintain the frequency in the range from 49.4 Hz to 50.5 Hz, as per NEPRA/NTDC Grid Code criteria.

8.6 Power factor

As per IEC standard 61727, this states that;

"The PV system shall have a lagging power factor greater than 0.9 when the output is greater than 50 % of the rated inverter output power."

Furthermore, to check the reactive power limitations of the solar PV inverters and evaluate the size of switched shunt capacitor banks at Medium Voltage level of '50 MW Kohat Solar PV Power Plant', NEPRA/PESCO Grid Code criteria of ± 0.95 power factor is followed

8.7 Harmonic Analysis

The total harmonic distortion (THD) of the solar farm as presented in the manufacturer's data sheet of the inverters to be used, attached as Appendix C is less than 3% at 100% output at 22kV of collector system, which is far less than the maximum limit of 8% as per IEEE-519 standard.

The other important aspect would be to see if the resonance for harmonics impedance is found, which is at or near to harmonics generated from the inverters. To perform harmonic analysis, PESCO network model of the base year 2018-19 was read and solved in the DIgSILENT Power Factory software.

For this purpose an impedance frequency scan was carried out for the given power system model. The frequency was scanned through a spectrum of impedance values at the POI.

The frequencies versus the positive sequence impedance without switch shunt capacitor at Siddiqsons 11kV bus are shown in Figure-8.1 below.

The frequencies versus the positive sequence impedance with switch shunt capacitor at Siddiqsons 11kV bus are shown in Figure-8.1 below.

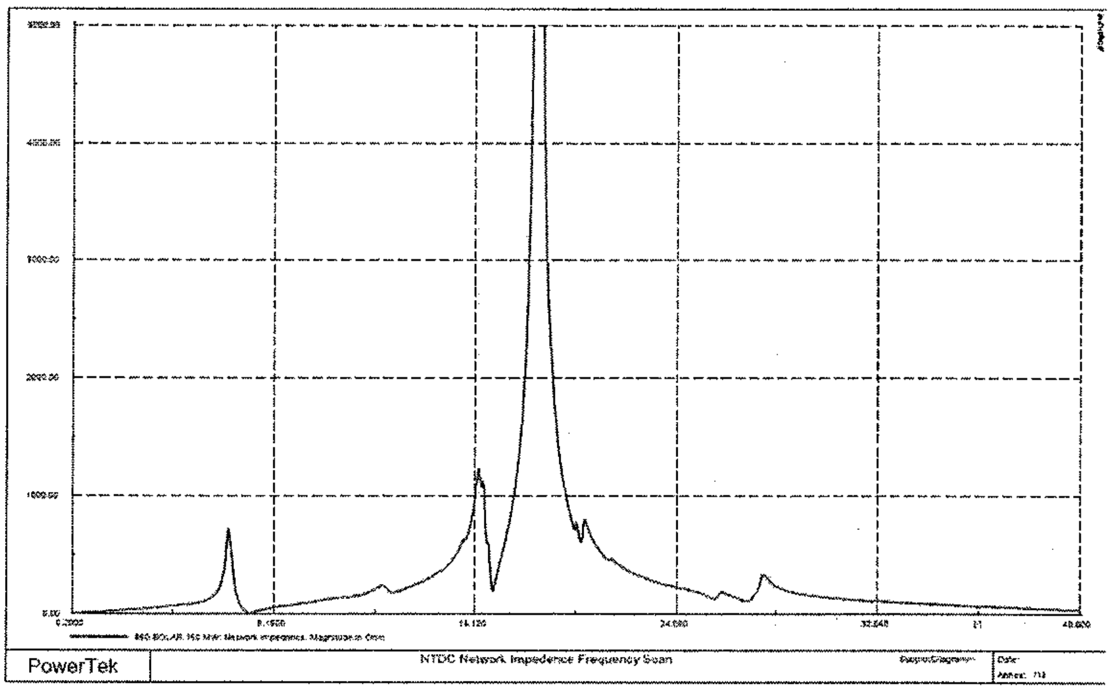

Figure-8.1: Harmonic frequencies versus the positive sequence impedance with switch shunt capacitor at Siddiqsons 11kV bus

As it can be seen in the impedance diagrams above that mostly there are no resonances near or at harmonic frequencies that are mostly produced by inverters. However there is small resonance near to 5th and 7th harmonics that disappears with the other PESCO system components switching and variation or addition of the shunt capacitors. For overall planning purposes the network impedance is suitable and there is no impedance resonance issue foreseen. However this detailed network impedance evaluation and/or capacitor application are reviewed by EPC contractor at detailed engineering level.

Based on manufacturer provided overall maximum THD level of 3% a spectrum of harmonics was injected at plant bus level. Based on harmonics simulations, voltage harmonics distortion level from second to 50th harmonics at POI is shown in Figure-8.2 below.

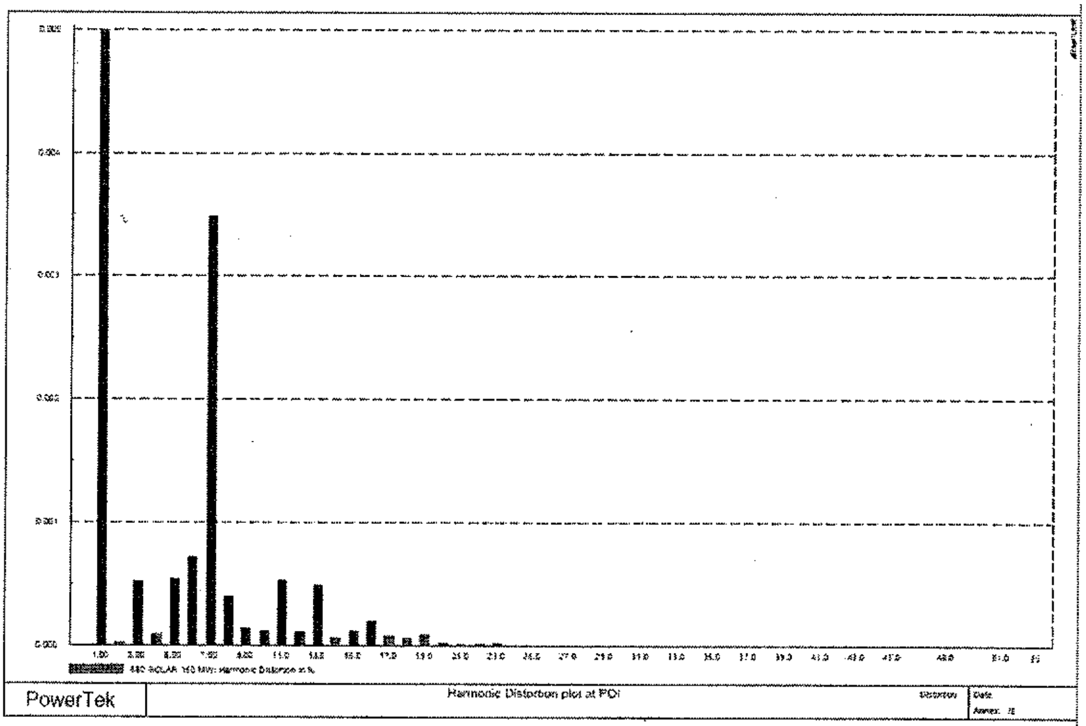

Figure-8.2: Distortion level of voltage harmonics at POI

Voltage THD at POI and Siddiqsons MV (11kV) bus is shown in Figure-8.3 below.

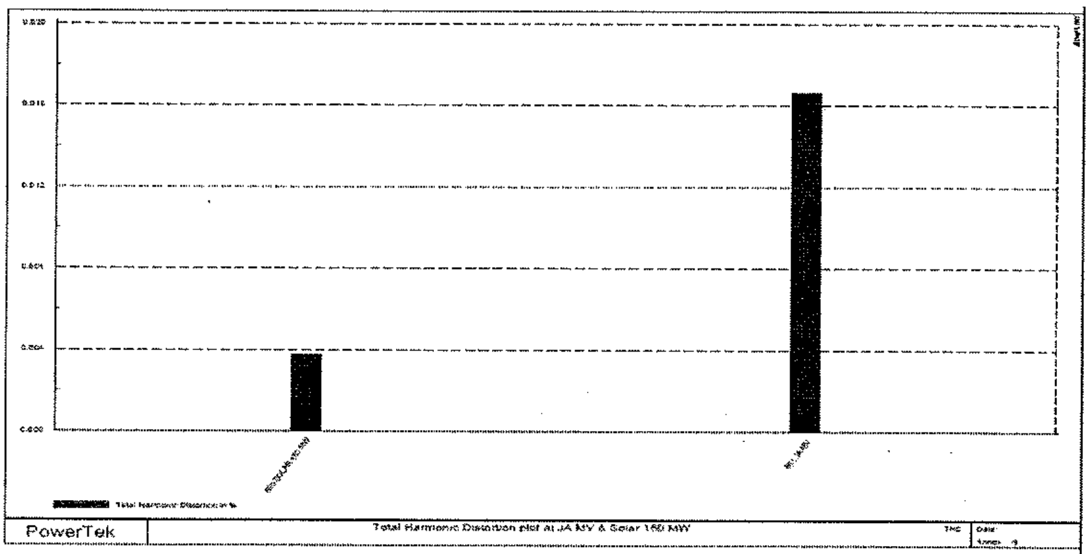

Figure-8.3: Voltage THD at POI and Siddiqsons MV (11kV) bus

Based on Figure8.3; it is reveals that the solar PV farm THD at POI and Siddiqsons MV bus is very low and within the specified harmonic limits.

8.8 Conclusions of Power Quality Analysis

The major criteria of the power quality items i.e. flicker, voltage un-balance, frequency operating range , harmonics and power factor has been investigated for the 'Siddiqsons 50 MW Kohat Solar PV Power Plant' for the worst cases and the obtained values are compared with the standard IEC values. The results show that all the parameters remains within the acceptable range of the IEC standards and NEPRA/NTDC Grid Code criteria. Therefore, it is concluded that 'Siddiqsons 50 MW Kohat Solar PV Power Plant' harmonics generation and propagation towards the grid is below the required limit. Additionally gird system harmonics impedance scan shows no significant resonance at or near significant harmonics generated by inverters with the addition of switch shunt capacitor at Siddiqsons 11kV bus. Hence 'Siddiqsons 50 MW Kohat Solar PV Power Plant' fulfills all the criteria of the power quality analysis.

9. Overall Conclusions and Recommendations

The 'Siddiqsons 50 MW Kohat Solar PV Power Plant' been proposed a generation connection scheme through a POI at 132 kV High Voltage (HV) network of PESCO.

The national grid system with inclusion of the solar PV plant was analyzed by studies of load flow, short circuit, transient stability and power quality.

The power flow outputs depicts that the power on all the circuits in all the cases with and without connecting solar PV power plant are within the defined range and the voltages that appears at the bus bars are within acceptable limit of defined study criteria. Load flow analysis is also validated as per the given standards of line loading and bus voltage limits in associated N-1 post-contingency conditions.

The short circuit studies have been carried out in order to see the contribution of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' to the fault levels of the existing substations in its electrical vicinity, the maximum fault level in the horizon year, with connecting the solar PV plant are calculated. The findings show that with addition of this project, fault levels do not exceed the standard circuit breaker ratings of existing installed equipment at the neighboring substations. The study has also quantified the maximum short circuit levels at LV, MV and HV (POI) buses of 'Siddiqsons 50 MW Kohat Solar PV Power Plant'.

The impact of possible disturbances occurring on the system are analyzed by the transient stability analysis and the results of transient stability analysis shows that the assumed power system is stable for the suggested interconnection scheme of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' for the drastic faults on the substations that might be near to or distant from the solar PV power plant. Thus, there are no constraints found in the stability of the system and it fulfils all the criteria for the generation connection with the power system.

In case of power quality, the major criterion of the power quality i.e. flicker, voltage un-balance, frequency operating range, power factor and harmonic analysis has been investigated for 'Siddiqsons 50 MW Kohat Solar PV Power Plant' for the worst cases. Moreover, the obtained values are compared with the standard IEC values. The results show that the all the parameters remains within the acceptable range of the IEC standards.

Therefore, it is concluded that the proposed generation connection for 'Siddiqsons 50 MW Kohat Solar PV Power Plant' is appropriate on the basis of results of all the system studies.

PEDO

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION
Government of Khyber Pakhtunkhwa Peshawar

No. 377 - 80 /PEDO/DPP/TE
Dated Peshawar: 19/02/2018

To

M/s Siddiqsons Limited,
27th Floor, Ocean Tower, G-3, Block 9, Scheme # 5,
Main Clifton Road, Karachi.
Tel: 021-3516671.

Subject: Approval of Technical Feasibility Studies submitted by M/s Siddiqsons Ltd. for its 50 MW Solar Power Project at Kohat and 50 MW Solar Power Project at Nowshera

Kindly refer to the Panel of Experts Meeting held on November 16th, 2017 at PEDO House Peshawar wherein the Feasibility Studies submitted by M/s Siddiqsons Limited for their 50 MW Solar PV Power Project in Kohat and 50 MW Solar PV Power Project in Nowshera under RE Policy 2006, were reviewed and approved.

In this regard, it is advised to complete all codal formalities including approval of Grid Interconnection Study from concerned department before approaching NEPRA.

Manager Renewable Energy
(Private Power)

Copy for information to:

1. Mr. Irfan Yousuf, Director (CDM/IC/Solar), AEDB, Islamabad.
2. PS to Secretary to Govt. of KP, E&P Department.
3. PS to CEO, PEDO, Peshawar.

Manager Renewable Energy
(Private Power)

CHIEF CONSERVATOR OF FORESTS CENTRAL SOUTHERN FOREST REGION-I KHYBER PAKHTUNKHWA PESHAWAR

Phone: 091-9212177 Fax:091-9211478

No. 73 /GB, Dated Peshawar the 19 / 07 /2017.

To

Mr. Umair Ahmed Project Engineer,
Siddiqsos Nowshera Soar System,
27 Floor, Ocean Tower, G-3, Block-9, Scheme#5,
Main Clifton Road Road, Karachi.

Subject:- **REQUEST FOR NO OBJECTION CERTIFICATE REGARDING ESTABLISHMENT OF 50 MWP SOLAR PV POWER PROJECT IN PABBI, NOWSHERA DISTRICT**

Memo: Reference your letter No. SNSL/CCF/KPK/1838 dated 3/7/2017.

[illegible] reported by the DFO Peshawar Forest Division at Nowshera, that the proposed Solar System installation site, which is in the vicinity of Pabbi at Zao is not Comprised of the Reserved/Protected or Any designated Forest as well as is not under Billion Trees Afforestation Project.
Therefore there is no objection from this Department about the establishment of the said Solar System at the said site.

Moreover it is clarified that the Forest Department has no concern with the ownership of the land at Zao and requires to be got verified and authenticated from the Revenue Department.
This office has no objection on the establishment of the said solar system, however this No Objection Certificate (NOC) will stand cancelled if any way and at any stage the issue of ownership of the forest department cropped up.

Chief Conservator of Forests,
Central Southern Forest Region-I
Peshawar

No. ——— /GB,

Copy forwarded for information to the:-

1) *Conservator of Forests Southern Circle Peshawar with reference to his letter No. 458/GB/Misc dated 19/7/2017.*
2) *Divisional Forest Officer Peshawar Forest Division Nowshera.*

Chief Conservator of Forests,
Central Southern Forest Region-I
Peshawar

Local Disk (F) Moh

KHYBER PAKHTUNKHWA OIL AND GAS COMPANY LIMITED
(KPOGCL)
(KP Government Fully Owned & Provincial Holding Company)
3rd Floor, Ali Tower, Opposite Custom House, University Road, Peshawar, Pakistan
Tele: - +92 91-9216283 Fax: - +92 91-9216295
Web: www.kpogcl.com.pk
In relentless pursuit for Energy Security of Pakistan

File No: KPOGCL/1-59-0209/KN5411/2016
Date: 14-Jun-2017

Mr. Iftikhar Aziz,
Project Director,
Siddiq Sons, Kohat Solar Limited.

27th Floor, Ocean Tower,
G-3, Block-9, Scheme # 5,
Main Clifton Road,
Karachi, Pakistan.
Phone: +92-21 35166571.

Subject: **NO OBJECTION CERTIFICATE**

Sir,

Reference to your letter number SKLS/KPOGCL/001 regarding the subject matter, please be informed "KPOGCL has no plans for seismic and drilling activity in the said area".

2. Submitted please.

Best regards,
Sincerely,

Raziuddin (Razi)
CEO-KPOGCL
+92 333 538 0240
razi.ceo@kpogcl.com.pk

Feasibility Study

Kohat 50 MW$_P$ PV Project

Khyber Pakhtunkhwa Province

Pakistan

Siddiqsons Kohat Solar Limited
June 2017

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Appendices

Glossary / List of Abbreviations

Acronym or keywords	Definition
AC	Alternating Current
AEDB	Alternative Energy Development Board
Capex	Capital Expenditure
CPPA	Central Power Purchase Agency
CUF	Capacity Utilisation Factor – the ratio, given as percentage, of the actual AC output from a solar plant over the year to the maximum output that would be generated if operated continuously at maximum capacity
DC	Direct Current
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Energy Purchase Agreement – in this case the template agreement provided by the AEDB.
EPs	Equator Principles
EPFIs	Equator Principles Financial Institutions
EPC Contractor	Engineering, Procurement and Construction Contractor – the entity that will be contracted to design, buy the necessary materials, and construct the Plant
ESAP	Environmental and Social Action Plan
ESMP	Environmental and Social Management Plan
FRA	Flood Risk Assessment
GHG	Greenhouse Gases
GHI	Global Horizontal Irradiation – the amount of irradiation falling on a horizontal plane over a period of time. Usually measured in kWh of energy falling on a square metre over a set amount of time (hourly, daily, monthly or annually), e.g. kWh/m2/yr
GII	Global Inclined Irradiation – the amount of irradiation falling on an inclined or tilted plane over a period of time. Effective GII is the amount of irradiation that falls on a plane that tracks the sun such as those used in single axis tracking PV systems
GRID	Global Risk Data
HV	High Voltage
IAM	Incidence Angle Modifier
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labour Organisation
IPPs	Independent Power Producers
IRR	Internal Rate of Return – the rate that results in the Net Present Value equal to zero
kV	Kilo-Volts (1 kV = 1000 Volts)
LEP	Labour and Employment Plan

LID	Light Induced Degradation
LV	Low Voltage
MPPT	Maximum Power Point Tracker
MV	Medium Voltage
MVA	Mega-Volt-Amps, a measure of the capacity of a power line or transformer to carry real and reactive power
MWAC	The amount of power the plant is capable of exporting at the point of grid connection
MW_P	The nameplate capacity of PV modules on a site measured in Mega-Watt peak. Also expressed as kWp or Wp
NOCT	Normal Operating Cell Temperature
O&M	Operations and Maintenance
Opex	Operational Expenditure
PPIB	Private Power & Infrastructure Board
PESCO	Peshawar Electric Supply Company
P.F.	Power factor
P50	A value which, based on uncertainties and probabilities, has a 50% chance of being exceeded. For example, the P50 yield number is the estimate for the yield produced and the probability of the actual yield being higher is 50% and lower is also 50%
P90	A value which, based on uncertainties and probabilities, has a 90% chance of being exceeded. For instance, the P90 yield number is the estimate for which the probability of the actual yield being higher is 90% and lower is 10%
PGA	Peak Ground Acceleration
PPI	Power Planners International Ltd
PR	Performance Ratio – a measure of how well the plant performs compared to an ideal case. This parameter, given as a percentage, indicates the ratio between the actual and theoretically possible energy outputs. If multiplied by the GII, this ratio gives the P50 Specific Yield of a project
PV	Photovoltaic
SAT	Single Axis Tracker
SEPA	Sindh Environmental Protection Agency
Siachen	Siachen Energy Limited
SEP	Stakeholder Engagement Plan
SLD	Single Line Diagram
Specific Yield	A measure of the energy produced by the plant over a year divided by its nominal installed capacity which allows for comparison of the performance of different sized plants. Usually measured in kWh/yr of energy produced per kWp of PV installed
SRP	Sulphate Resisting Portland
UNEP	United Nations Environment Programme

USD	United States Dollars
WM	Weighted Mean

Executive Summary

Access Infra Central Asia ("**Access**") and Siddiqsons Limited ("**Siddiqsons**") (the "**Developers**") have conducted this feasibility study for the development of a 50 MWDC photovoltaic plant at Kohat, KPK, Pakistan (the '**Project**' or the '**Plant**').

The site is, located 25.06 km to the south of the town of Kohat, 4.61 km south east of Lachi on Indus Highway (N55) and approximately 75 km south of the provincial capital, Peshawar in Khyber Pakhtunkhwa, Pakistan. The available site, of approximately 284 acres, is privately owned and we are currently negotiating purchase of the land. Land document copies are in our possession. The climate in Kohat is hot, sometimes extremely hot summers and mild to warm winters. It is mainly hot semi-arid climate range from 2°C in January to almost 43°C in July.

The site is based in a complex terrain consisting of multiple low-lying depression and ridges. During site visit, the texture of the top layer of the soil was found to be silty sand, silty clay with small rocks, gravel and light brown to brownish-yellow in colour. The land is currently barren and uncultivated, with scattered vegetation on the site. There are scattered villages near the eastern boundary of the site and a few houses are located within the site on a ridge towards the north.

The Study proposes that the Project is connected to Lachi 132kV grid substation through a new 4.8 km length, double circuit 132kV Over Head Line (OHL). The OHL route and length calculation are not provided and any environmental or land ownership issues in the cable route have not been identified but we note that this has been acknowledged by PESCO and would be addressed in the advanced stages of the project. It is noted that a considerable amount of redundancy is built into the proposed design of the connection works. It appears that there is already a 132-kV transmission line from Kohat Town to Lachi 132 kV Substation passing nearby the Project site, but it is not clear if this is the line being used, reinforced or if a new line will be constructed. The commercial operation date (COD) for the Project is stated as December 2017, which is a very ambition target considering the Project's current stage.

The connection grid studies although they appear to have been conducted to a good standard the report does not provide all the data to verify the statement made, such the power flow (thermal rating not provided) and short circuit (short circuit ratings not provided) studies. The harmonic background measurements appear to have not been considered, which can be a concern if the local network already has already a considerable amount of distortions.

17 boreholes were carried out as per of Geotechnical report. Boreholes failed to reach a depth of 10 m and at shallower depths, mostly clayey or silty sand was encountered. The report classifies two main geotechnical units: an underlying layer of gravel with a consistent overburden consisting of soft to hard clay in the upper 5 to 10 feet. The pH level across the site remains in the range of 6.8 to 7.2 but chemical tests have confirmed mild to moderate aggressiveness of the soil for metal foundations. It is recommended that this be taken into account when considering galvanization in the project's requirements. Additionally, the electric soundings conducted show low resistivity values at the upper soil depths (0 to 1.5 m), i.e. the top soil layer has high conductivity that implies high potential for corrosiveness.

No permanent rivers were visible however there are ponds identified in the north west of the site. Although the area is generally dry, a flood risk assessment has been carried out as part of the feasibility study.

We proposed a concept system design to suit the shape, size and location of the site. An irradiation assessment was carried out to determine the optimum inclination angle for the site to be carried forward for the energy yield estimations. The concept design is based on a Tier -1 polycrystalline modules, central inverters and single axis trackers. However, alternate designs and schemes, including fixed structures, could be considered during the design phase. An energy yield assessment was carried out to determine the expected energy yield of the proposed Plant. The analysis was based on the design information stipulated by Access and Siddiqsons, preliminary designs made and irradiation data from satellite and ground station databases.

Global Horizontal Irradiation (GHI) was assessed from a number of sources before a value of 1,780 kWh/m2/yr was selected. This value was then uplifted to calculate the Global Inclined Irradiation (GII) as appropriate for the proposed tracking systems: horizontal single axis trackers with +60 to -60-degree (East to West) range of motion and backtracking features. A GII value of **2,262 kWh/m2/yr** has been carried forward in the calculation. On the basis of the system design assumptions detailed in the Appendix 1, Appendix 2 and Appendix 3 of this report, a Performance Ratio (PR) has been calculated using industry-standard PVsyst software (v6.52). Calculations have been performed using hourly irradiance and ambient temperature values generated for the site. Shading has been estimated using a 3D model constructed in PVsyst based on the detailed module layout, findings during the site visit and online mapping images.

In order to assess the soiling loss, we have considered 3 cleanings per annum; this assumption could be refined. Additionally, the local meteorological variables (GHI, precipitation, wind direction and velocity, etc.) have been considered to estimate an appropriate soiling loss. Nevertheless, major one-off events such as dust storms have not been considered within the soiling loss estimate.

Two Power Factor (PF) scenarios have been assumed, PF=1 and PF=0.95 at inverter level. Resulting first year energy yield predictions at the export meter are shown in Table 1 below; the export meter location has been assumed to be after the MV: HV transformer at the onsite substation.

Table 1. First Year Energy Yield Summary at PF = 1

PR	Installed Capacity (kWp)	Probability of exceedance	Specific yield (kWh/kWp)	1st year production (kWh)
78.50%	50,033.7	P50	1,780	89,064,110
		P75	1,713	85,707,719
		P90	1,653	82,686,740

Table 2. First year energy yield summary at PF = 0.95

PR	Installed Capacity (kWp)	Probability of exceedance	Specific yield (kWh/kWp)	1st year production (kWh)
78.30%	50,033.7	P50	1,765	88,325,053
		P75	1,708	85,477,689
		P90	1,648	82,464,457

The P50 specific yield already contains an assumption of 0.2% for the first-year degradation. When used to calculate output in subsequent years, a linear degradation of 0.4% should be applied. Plant, tracker and grid availability have been excluded from these yield figures.

1. Introduction

Access Infra Central Asia ("**Access**") and Siddiqsons Limited ("**Siddiqsons**") (the "**Developers**") have conducted this feasibility study for the development of a 50 MW_{DC} photovoltaic plant at Kohat, KPK, Pakistan (the '**Project**' or the '**Plant**').

This report is based on discussions held, site visit and review of shared documentation. This report has the objective to assess the feasibility of the Project and is structured as follows:

- Project overview
- Site assessment
- Review of the site studies
- Concept system design
- Energy Yield Assessment

The report is based on the studies, site visits and review of related relevant documents.

The site is, located 5.06 km to the south east of the town of Lachi, in Khyber Pakhtunkhwa, Pakistan.

The climate in Kohat is hot, sometimes extremely hot summers and mild to warm winters. It is mainly hot semi-arid climate range from 2°C in January to almost 43°C in July.

The available site, of approximately 284 acres is privately owned and Access is negotiating purchase of the land. The site is based in a complex terrain consisting of multiple depression and ridges. During site visit, the texture of the top layer of the soil was found to be gravely, silty clay with small rocks and light brown in colour. The land is currently barren and uncultivated, with very little vegetation on the site. Most of the terrain is covered with wild bushes & shrubs with only a few small trees along the west boundary of the site. There are scattered villages near the eastern boundary of the site and a few houses are located within the site on a ridge towards the north east. **Figure 1** gives an overview of the topography of the site.

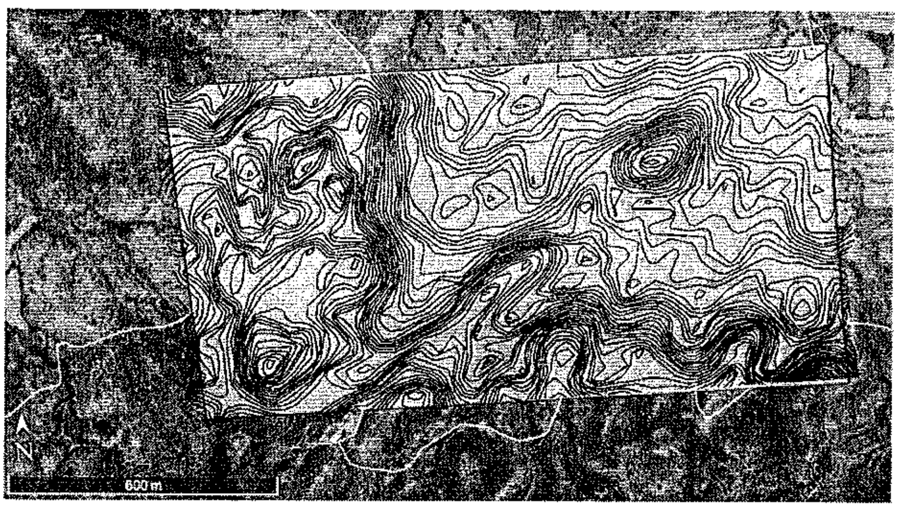


Figure 1. Topographical View of the Site

Approximately 5 km to the north west of the site runs a 132-kV overhead transmission line (OHL). No permanent rivers were visible at the site. Although the water channels were dry during the site visit, we recommend carrying out site specific flood risk assessment study for detailed analysis since the site is situated at the base of the hills to the south. The developers proposed a concept system design to suit the shape, size and location of the site. This concept design is subject to final component selection and has not been fully optimized for cost or performance level. Flat land has been assumed for plant layout and energy yield estimations. Site related studies have recently been provided and are currently under review.

An irradiation assessment was carried out to determine the optimum inclination angle for the site and to be carried forward for the energy yield estimations. The concept design is based on a Tier-1 polycrystalline modules, central inverters and fixed tilt structure at an inclination angle of 25°. However, alternate designs and schemes, including trackers, could be considered during design phase.

The first-year annual energy generation of 78,834 MWh/year was calculated assuming a performance ratio of 78%, however a detailed energy yield assessment has not been completed at this stage. A preliminary plant layout, design and single line diagram is included in Appendix 7. This is the final report.

2. Project Overview

2.1. Site and Works Overview

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

Table 3 Key Project Details

Item	Description
Site coordinates	33°21'39.86"N, 71°22'44.06"E
Altitude (metres above sea level)	457
Site Area (Hectares)	115
Proposed Capacity (MWAC / MWDC)	40.5 / 50.0
Global Horizontal Irradiation (kWh/m2/year)	1780
Proposed layout concept	The proposed layout is a ground mounted SAT system using Tier 1 polycrystalline modules and central inverters. A drawing of the proposed layout is shown in Appendix 9.

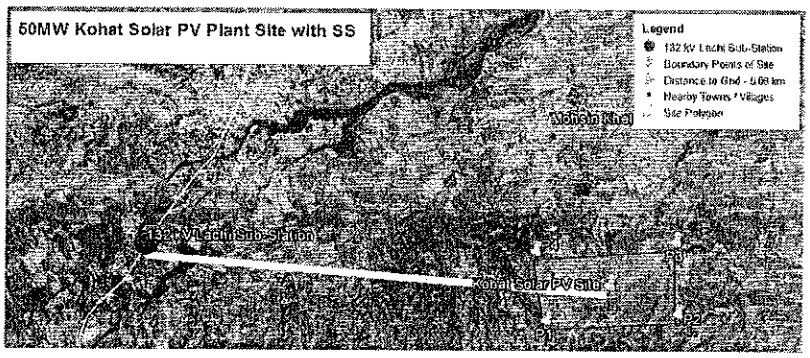


Figure 2. Local Satellite View

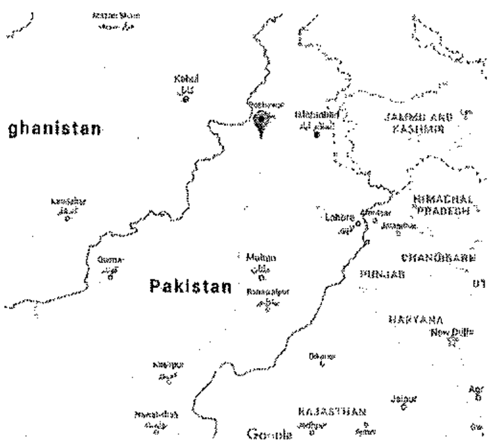


Figure 3. Country Map view

An indicative timeline for the Project is shown in Appendix 12, the Contractor will be required to comply with a prearranged schedule of works and complete the construction and installation of equipment by the required deadline. We would endeavour to procure the permits, equipment, infrastructure logistics and grid application be secured for the project prior to commencement of works.

2.2. Pakistan Power Market

2.2.1. Power Sector Structure Overview

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

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

2.2.2. Electricity Demand & Supply - a Deficit Power Market

Despite political stability and democratic Government, Pakistan is facing huge energy challenges in the form of load shedding in Electricity and Gas and energy crisis has inflicted far reaching effects on the social and economic fabric of the county.

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

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

As per NEPRA industry report and AEDB, Thermal power in total energy mix is 16,633 MW (66.46%), Nuclear is 787 MW (3.2%), Wind and solar is 356MW (1.45%), Hydel Is 7,116 MW (28.90%). National electricity demand is increasing at rate of 3 to 4% and is expected to rise to 56,847 MW by 2024-25. Also, due to a number of factors including seasonality of hydel & renewable resources, lack of maintenance/aging of public sector thermal units and consequent reduced capacity and technical issues with certain private sector producers the sector has been facing an average supply-demand gap of about 6,000 MW in the recent past. Despite an installed capacity of roughly 20,000 MW the sector had a maximum generation of approximately 15,500 MW in September 2015 at which time a demand-supply gap of approximately 4,600 MW still existed. This gap increases significantly during summer, low water or low gas supply months.

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

2.2.3. Pakistan Power – Key Challenges

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

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

2.2.4. Private Sector Participation in Pakistan's Power Sector

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

Private Power & Infrastructure Board (PPIB) and the Alternate Energy Development Board (AEDB) have a track-record of attracting investment in the power sector for two decades or so and provide a one window facility for the processing of private power generation projects. PPIB deals with thermal and hydropower projects above 50 MW whereas AEDB is responsible for providing facilitation for renewable energy based projects (including hydropower projects below 50 MW). Certain provinces also have their own facilitation agencies.

Based on the lucrative fiscal and financial incentives provided by Government of Pakistan along with an effective energy policy, a noticeable surge in interest from national and international inverters is evident which has resulted in development of multiple Solar and Wind energy projects in recent years.

At present, 28 solar PV projects of 956.8 MWp & 29 Wind energy projects of 663 MWp capacity are under development within the framework of AEDB policies and procedures.

3.Site Assessment

The developers have carried out an assessment of the proposed site for the development of the 50 MW_{DC} PV plant to opine on whether the selected area can accommodate the proposed development. This land is currently privately owned, but we, Access and Siddiqsons are negotiating its purchase from the current owners. No option or purchase agreement has been provided for review. This assessment was carried out via a desktop analysis of the general site area and information collected during a site visit undertaken by the developers during September, 2016.

The purpose of the assessment was to evaluate the suitability of the proposed site in terms of:

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

These aspects are discussed in the following sections. The location of the site was provided by representatives of the Access and Siddiqsons, who coordinated the site visit.

3.1. Site Setting

It is important to consider the site setting in order to establish whether the local climate, weather, and landscape is suitable for a solar PV development. Local conditions can affect all aspects of the project including the equipment selection and the operations and maintenance activities, and extreme conditions can affect project viability. The site is, located 25.06 km to the south of the town of Kohat, 4.61 km south east of Lachi on Indus Highway (N55) and approximately 75 km south of the provincial capital, Peshawar in Khyber Pakhtunkhwa, Pakistan.

The site is located at the base of hills a few tens of metres from the southern boundary of the site. The uneven terrain in the south extends up to 370 metres to the centre of the site. A pond approximately 0.12 hectares is located near the north-western boundary of the site with the presence of streams and smaller trailing water bodies running through the site. From the survey, it is concluded that these streams are now dry. A topography survey of the site, approximately 115 hectares, has recently been completed and provided by Access for review. The land is currently barren and uncultivated, with distributed and non-dense vegetation on the site although some evidence of animals grazing was found on the site. The site also contains unused and barren plots which are clearly demarcated through borders / trees. The land is currently barren and uncultivated, with very little vegetation on the site although some evidence of animals grazing was found on the site.

Figure 4 below shows a boundary of the site and its immediate surroundings. The boundary was identified by Access and is highlighted in red.

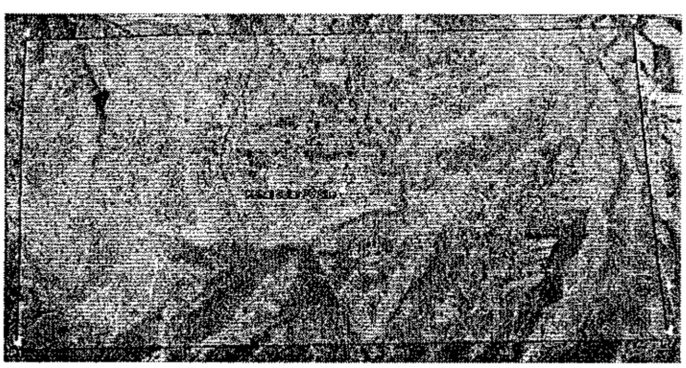


Figure 4. Site and Surroundings. Image is positioned to North

The site has roads marked in white as shown in **Figure 5**Error! Reference source not found.. This makes t he western, northern and southern boundaries accessible. However, the north-eastern and eastern part of the site have limited road access.

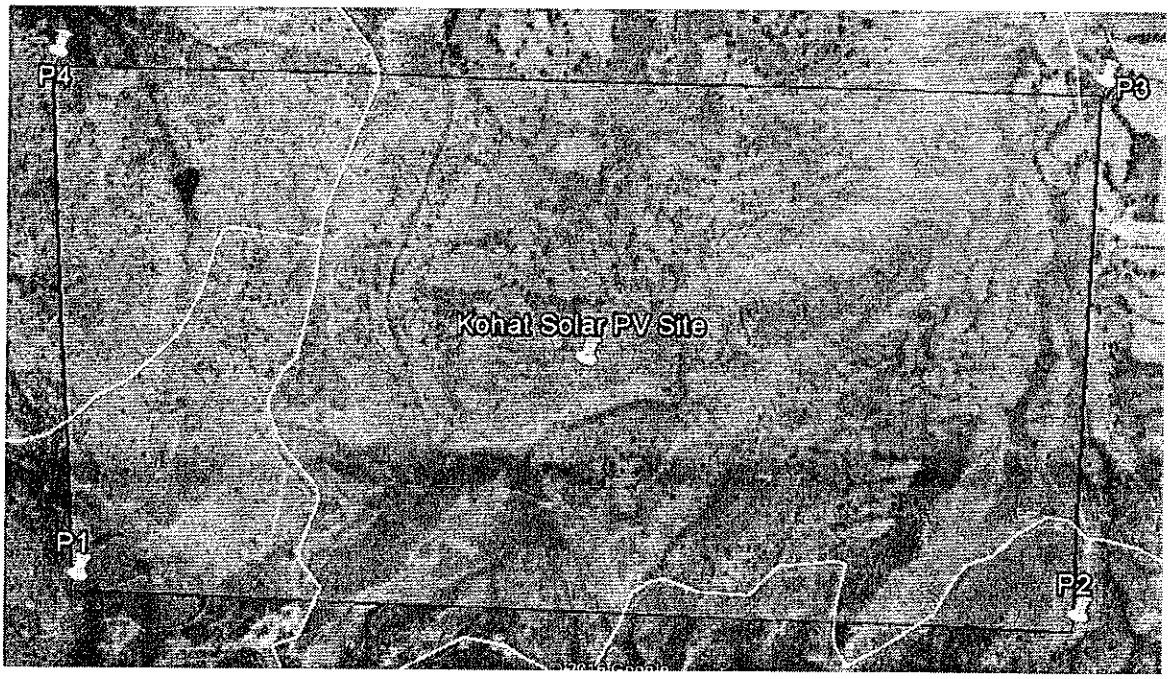


Figure 5. Road Access to the Site

Approximately 5.1 km to the north-west-west of the site is the 132kV Lachi sub-station located along the Indus Highway. Access and Siddiqsons plan to connect to the 132kV Lachi grid station, which is to be confirmed as suitable by the Grid connection study. Representatives of Access and Siddiqsons stated that the transmission line is currently capable of transmitting 45-50MVA. A grid connection study has recently been completed and a summary of the same will be included as part of this report.

Access and Siddiqsons are currently in possession of the Patwari's land documents from the local broker with whom an MoU has been discussed.

There are scattered villages near the eastern boundary of the site and a few houses are located within the site on a ridge towards the north of the site.

Table 4 Summary of site surroundings and impact

Item	Kohat Site
Current Land use	Barren land, unused
Neighbouring properties	No signs of communities in or 100 m near area.
Services	Not identified
Distances from town of Kohat and Lachi	Kohat – 25 km and Lachi – 5.1 km
Neighbouring Settlements	None. Nearest settlement is 1.3 km from northern boundary
Examples of likely Environmental and Social Impacts	• Negative – Increased dust during construction – Mild traffic during construction – Relocation of dwellings

	• Positive – Social Benefits – Employment opportunities

3.2. Topography, Terrain and Hydrology

Certain parameters of the site design, such as row spacing, can be heavily influenced by surface topography. The proposed site comprises of ridges, small hillocks made up of small stones, gravel and clay as shown below in **Figure 6.**

Figure 6. Terrain Features

Ridges, gullies, elevated hillocks and steep depressions are located in the south of the site. During site visit, the area in the centre west was found comparatively flat whereas rest of the site can only be utilised after significant grading. A detailed assessment of the costs involved for land preparation is outside the scope of this report. We recommend that grading costs be considered in the economic analysis of the Project and that preliminary discussions be held at an early stage with potential EPC contractors with regards to the recommendations of the geotechnical report.

A topography survey report is now available and a summary of the same has been included. Based on discussions, a prepared flat site has been assumed for plant layout and average annual yield estimations in this report. Regions with high level of unevenness have been avoided to ensure optimisation of costs for grading.

There is a pocket of vegetation that are mostly small trees and shrubs in the south-eastern region of the site alongside small patches of distributed shrubs and trees along the northern and north-western regions. These would need to be cleared and would not pose a significant issue to the development of the site.

During site visit, the texture of the top layer of the soil was found to be gravely, silty clay with small rocks and light brown in colour. Access has stated that there has not been any incident of flooding on the site in the past. No permanent rivers were visible however two dry water channels pass through the site. Although the water channels were dry, we recommend carrying out site specific flood risk assessment study for detailed analysis.

Internal site roads will need to be prepared and maintained to enable vehicles to move around the site without the risk of getting stuck in the sand or mud during heavy rains. There are multiple dirt tracks that run across the site mainly in the western central part of the site along the access road previously mentioned.

The climate of Kohat and surroundings is hot from May to September. June is the hottest month. The mean, maximum and minimum temperature recorded during June is about 40° C and 27° C respectively. A pleasant change in the weather is noted from October onwards, up till February. The winter is cold and severe. In winter, a wrong west wind known as "Hangu Breeze" often blows down the Miranzai valley towards Kohat for weeks. The mean maximum and minimum temperature, recorded during the month of January, is about 18° C and 6° C respectively.

The rainfall is received throughout the year. The monsoon rain is received from May to October. August is the rainiest month, with an average of about 114 mm. The winter rain occurs from November to April. The highest winter rainfall is received in the month of March. The average annual rainfall is about 638 mm. The maximum humidity has been recorded in the month of August during summer season and in December during the winter season.

The ambient temperature was 28°C during the site visit, which occurred in September.

3.2.1. Flash Flood Risk Assessment

Access has carried out a detailed flood risk assessment of the site based on in-house expertise. The climate in Kohat is referred to as a local steppe climate. There is little rainfall throughout the year. This location is classified as BSh by Köppen and Geiger. The average annual rainfall is 529 mm. The Figure below indicates the slope of the site.

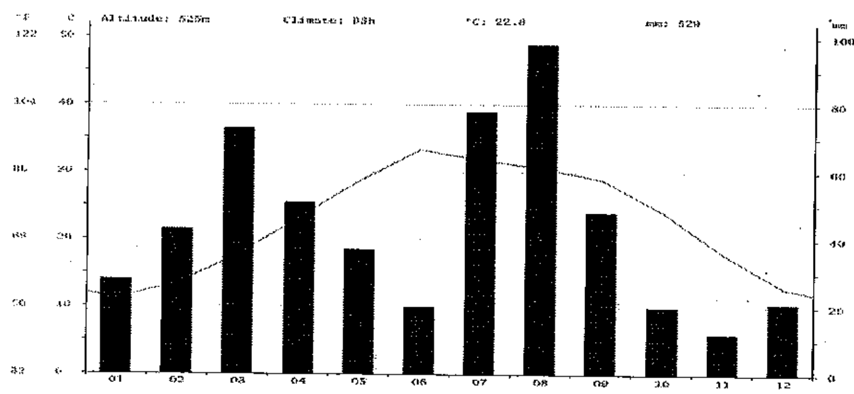


Figure 7. Rainfall patterns – Kohat; Source: https://en.climate-data.org/location/3492/

The least amount of rainfall occurs in November. The average in this month is 12 mm. The greatest amount of precipitation occurs in August, with an average of 98 mm as indicated in **Figure 7** and **Figure 8**.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	11.1	13.4	17.7	23.2	28.7	[illegible]	31.8	30.6	28.9	24.1	17.9	12.8
Min. Temperature (°C)	5.1	7.7	11.9	17	22.2	26.7	26.5	25.7	23.2	17.6	11.3	6.4
Max. Temperature (°C)	17.2	19.1	23.6	29.4	[illegible]	40	37.2	35.6	[illegible]	[illegible]	24.6	19.2
Avg. Temperature (°F)	52.0	56.1	63.9	73.8	83.7	[illegible]	89.2	87.1	84.0	75.4	64.2	55.0
Min. Temperature (°F)	41.2	45.9	53.4	62.6	72.0	80.1	79.7	78.3	73.8	63.7	52.3	43.5
Max. Temperature (°F)	63.0	66.4	74.5	[illegible]	[illegible]	104.0	99.0	96.1	[illegible]	[illegible]	76.3	66.6
Precipitation / Rainfall (mm)	28	43	73	51	37	20	78	98	48	20	12	21

Figure 8. Historical Weather Data - Kohat Source: https://en.climate-data.org/location/3492/

Based on internal research based on validated flood risk assessment sources, Access confirms that the site is not prone to flash flooding risks and any potential rain water accumulation would be adequately re-directed based on a detailed strategy during advanced stages, despite the chances of floods being extremely minimal at this site, owning to the slope as indicated in **Figure 9**.

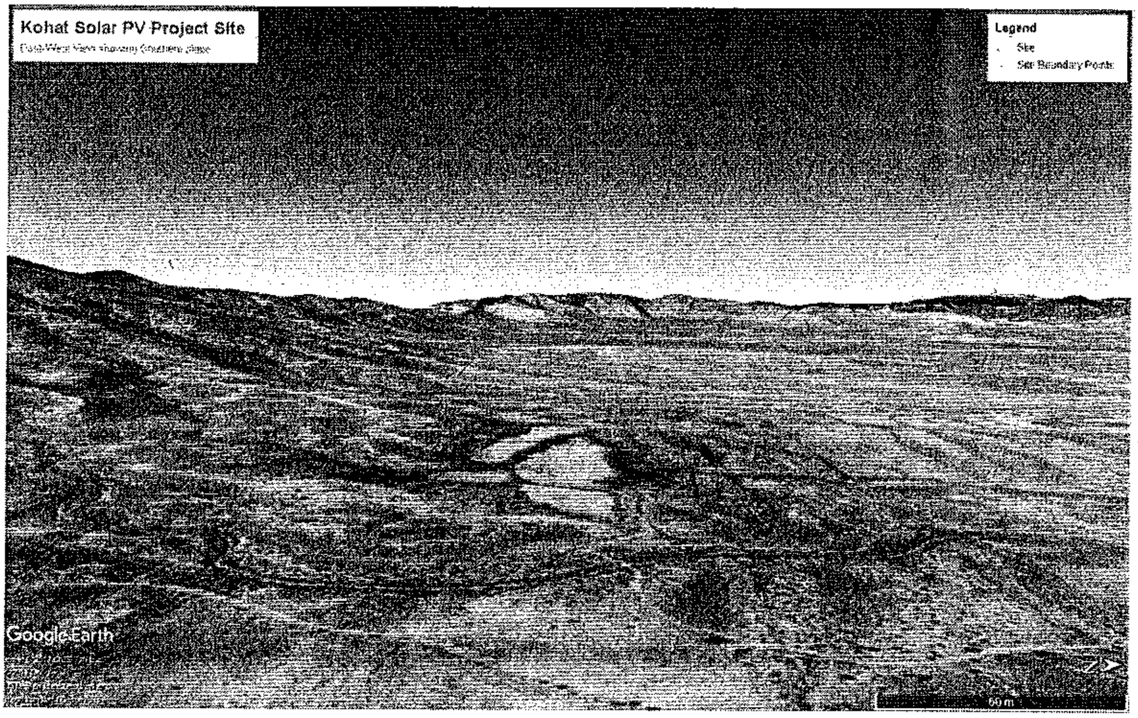


Figure 9. Photo-realistic map showing slope of the site at the base of the southern hill

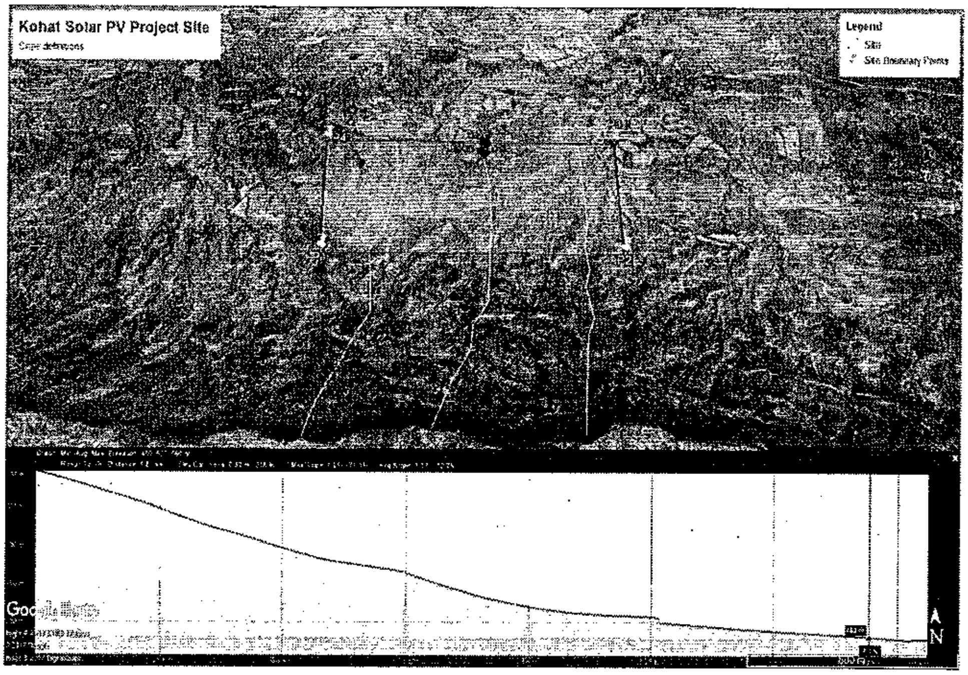


Figure 10. Elevation profile of the site showing gradual slope

From Figure 10, it could be justified that despite an event of flash floods, water stagnation and damage to the site would be minimal as the slope would allow the water to flow further north into the plains closer to the village of Mohsen Khel. In addition to the above rationale, based on the Survey of Pakistan Flood Database Map of affected areas, the Kohat solar PV project site has not been marked as a flood-prone zone which effectively proves that there is very low risk related to flash flooding. **Figure 11** validates our assumptions of low flash flood risk to the site as per Government validated data sources.

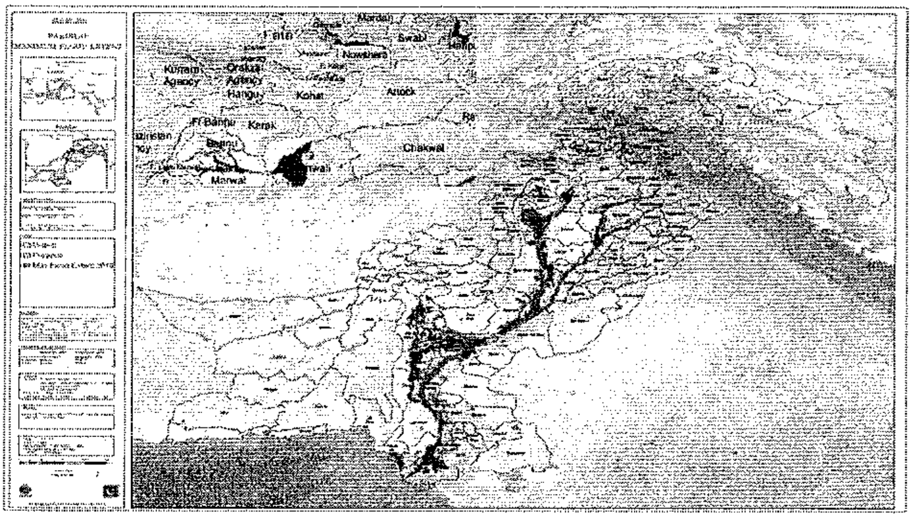


Figure 11. Survey of Pakistan 2011 Flood Extent Map / Source: Survey of Pakistan 2011

3.3. Near and On-Site Shading

Shading on PV modules reduces the amount of electricity generated, consequently it is essential to consider the potential shading from both on-site and near-site objects. In addition to this, it is also important to consider the variation of size and shape of possible shading objects with time. These variations, in fact, may create shading issues where there were none previously. The site consists of ridges and hillocks with hills to the South from East to West translating to uneven surface and excessive shading in the subsequent depressions, mainly in the Southern portion of the site. However, a flat site has been assumed for plant layout.

3.4. Laydown Area and Security

Construction of a solar PV plant requires safe and reliable access for large and heavy vehicles. It is necessary to consider the suitability of the current access, and highlight if any works will be required to enable satisfactory access pre-construction. The hardware and equipment used must be unloaded and stored somewhere before installation. This area is known as the laydown area and will normally also house site offices. Considering the build-up of equipment, personnel, and traffic, its location is important. Security is required to reduce the risk of theft and ensure safe access for authorised personnel. It is recommended that the site has its own security staff located near or on the site. Mitigation measures such as fencing and site management should be among the first things present and installed on site.

A detailed assessment of the security of the project location and possible mitigation measures is outside the scope of this report. We foresee that security costs be considered in the final economic analysis of the project, that preliminary discussions be held at an early stage with potential EPC contractors to ensure that they are able to operate in this location and that major vendors, including inverter suppliers, are confirmed as able to provide specialist staff for commissioning and ongoing service support. Hospitals have been identified in the nearby town of Lachi.

There is currently no municipal water supply or sewerage at the site and therefore water and ablution facilities will need to be provided for the construction of the plant as well as during operations and maintenance.

3.5. Detailed Transportation Study – Main and Alternate Routes

The site is accessed by an inroad leading in from the Indus Highway as shown in **Figure 12**. By road, Lachi town is 27.9 km from Kohat.

Figure 12. Site Access from Lachi via Indus Highway

Most deliveries of equipment are expected to be made via Kohat and Lachi respectively.

Several of the in-roads splitting away from the main Indus Highway are observed to be muddy or poorly laid roads which could potentially cause delays in deliveries to the site once the trucks / cranes have reached the vicinity of the Kohat site. All deliveries to the site would be received at the site entrance and a turn-out bay will be required to allow trucks to turn off and merge on to the link road safely.

The most logical location for the site entrance and laydown area is in north west of the site, adjacent to the road leading to the site. This location offers not only easy access but will minimize disruption to construction activities within the solar field. Fencing and security should be provided for the laydown area at the site from commencement. Main and alternate routes are available at the site as shown in **Figure 13**. All deliveries to the site would be received at the site entrance and a turn-out bay will be required to allow trucks to turn off and merge on to the link road safely. The same has been included in the proposed access to the site in the layout.

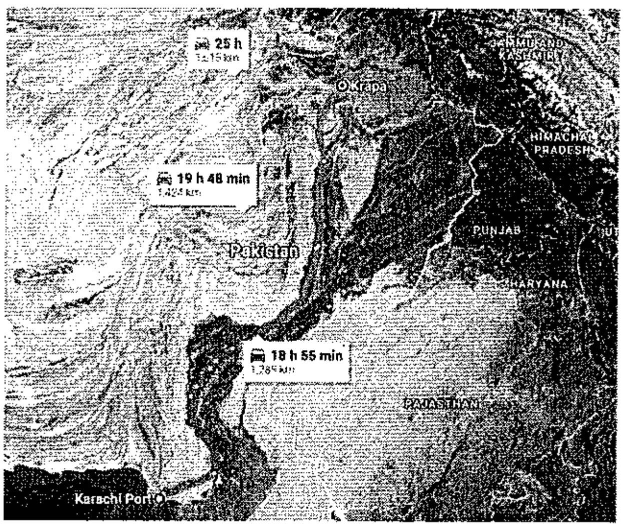


Figure 13. Shipping and Transportation Route - Karachi Port - Kohat.

Table 5 Summary of site access

Site Access	Single lane road access from Lachi
Access Point	North west corner of the site, alongside the access road

Access Road Length from Main Road	6.6 km from Indus Highway cutting through Lachi
Laydown Area	North west corner of the site
Impacts	Potential congestion and disruption to businesses and residences in Lachi and Mohsen Khel Kohat.

The most logical location for the site entrance and laydown area is along the north-western boundary of the site as well as south west corner of the site, adjacent to the road leading to the site. The proposed main access to the site from the western boundary is based on the already available track indicated in the topography survey of the site. The proposed access will minimize disruption to construction activities within the solar field. Fencing and security should be provided for the laydown area at the site from commencement. Figure 14 (white lines) indicate muddy roads leading into the site. Figure 15 and Figure 16 present the Lachi Entrance Road from Kohat and a view of the site from Mohsen Khel village located in the North of the site.

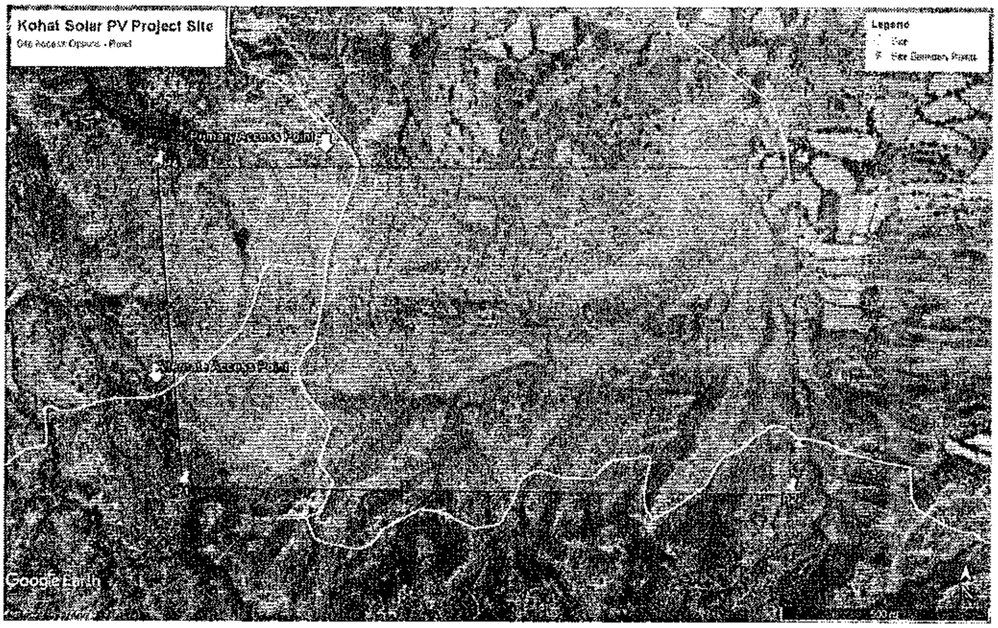


Figure 14. Primary and Alternate Site Access

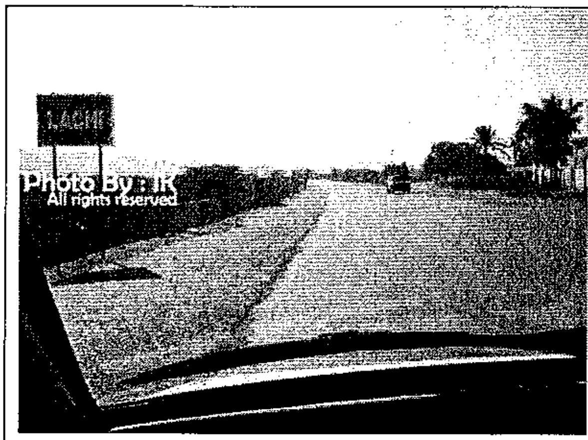


Figure 15. Lachi Entrance Road Track

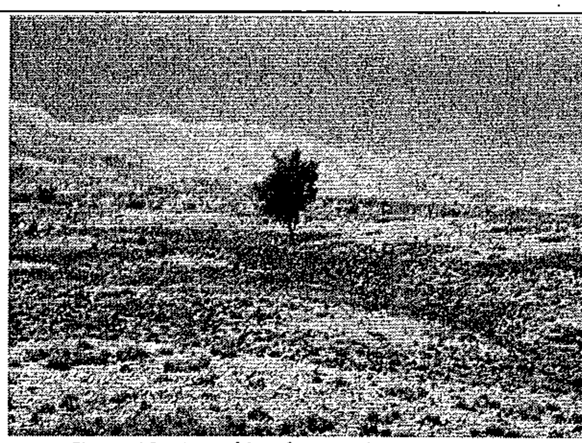


Figure 16. View of Site from Mohsen Khel Village

3.6 Water Requirement

Water is required during the construction as well as during the operational phases of the Power plant. We estimate a litre per m2 of module per wash value, 10000 kl during construction phase and 1000 kl per annum during the operational phase of the power plant.

IEE observes that the local community is supportive of the Plant and expect to be benefitted from the Project. Basic and utmost dire of the local population is access to clean drinking water and this should be catered for the welfare of the local communities, which would be an important component of the Environmental and Social Action Plan (ESAP).

We plan to have solar powered submersible pumps installed coupled with RO/UF plant alongside the boundary of the site to provide clean drinking water to the locals through water supply, beneficial both for the locals and the employees of the solar PV plant.

4. Site Studies

4.1 Geotechnical Report

The geotechnical report has been prepared by AJK Engineers with the findings of geotechnical and electrical resistivity surveys as well as sample test results from soil test lab of AJK Engineers and UET Laboratory in Lahore.

17 boreholes were carried out using light percussion method, and 10 undisturbed soil samples were collected. During these investigations, the subsurface was explored to a maximum depth of 15 feet below the existing ground surface. Furthermore, Standard Penetration Tests (SPT) were performed at 3- to 5-feet regular intervals up to the investigated depth. The location of the samples and boreholes is considered to draw an appropriate grid to cover the large size of the proposed area.

At the time of these investigations, the depth of groundwater was not encountered. However, several fields within the site have a sole layer of dense gravel with silt that may hinder the drilling or driving of the foundations.

To avoid possible attack of chloride on cement and minimize corrosion potential the concrete mix should be designed using a water cement ratio not greater than 0.45. A layer of bitumen coating should be applied to the exterior of all the foundation and other concrete coming in contact with soil. Additionally, the electric soundings conducted show low resistivity values at the upper soil depths (0 to 1.5 m), i.e. the top soil layer has high conductivity that implies high potential for corrosiveness. In addition, the resistivity tests conducted in the northernmost fields have found that the underlying soil layer (depths of 1.5 m to 4 m) have medium conductivity.

Due to the variable nature of the upper layer of soil, several mounting structure foundations could be utilised and / or combined within the proposed area: concrete ballasts, driven piles or screw-in foundations. Further assessment is to be provided by the mounting structure manufacturer, especially load tests to confirm that the soil has sufficient lateral and vertical bearing capacity for the design specifications. Moreover, should any steel foundations be projected, adequate thickness of the galvanised coating is to be determined upon the findings of the geotechnical report.

We additionally note that the sulphate content of the samples is close to the limit for positive sulphate attack (0.10%) according to the Concrete Manual of the U.S. Bureau of Reclamation. Therefore, we would recommend that Type II Portland cement is used for the concrete foundations of key equipment such as inverter and transformer substations. Additionally, a minimum cover of 75 mm should be provided over all reinforcing steel embedded in these concrete foundations. These recommendations are considered to be included in our requirements of the EPC contract.

Groundwater table was not encountered in any of the boreholes drilled nor during the electrical resistivity survey. Samples extracted show low to medium plasticity characteristics of the soil and a moisture content of up to 19.48%, which indicates a dry state that may reach moist state, always below critical levels; while trail pits have not been performed, no issues with the excavatability of the soil are foreseen.

Concerning the seismicity of the area, the Project site is located in Zone 2B as per 'Seismic Provisions-2007' of Building Code of Pakistan, which indicates high degree of damage during the seismic loading. It is therefore recommended that any key structures, such as the grid utility substation, are designed to withstand maximum horizontal peak ground acceleration of 0.16 to 0.24g. Consolidation of the soil strata, mainly gravelly strata, has not been considered relevant; however, liquefaction of gravelly soil has been confirmed in several earthquakes in the United States and Japan. We therefore recommend that a proper analysis is conducted and the findings are reviewed in a next update.

4.2. Grid Connection Report

The grid system impact study of 50 MW solar power plant at Kohat, KPK for the Kohat 50MW PV Project (the 'Study') has been carried out by Power-tek Ltd. ('Power-tek') and dated January 2017.

The study aims to analyse the impact of the Project on the local power Transmission and Distribution (T&D) system and vice-versa. Also, the Study aims to verify if the Project technical parameters are in line with the relevant grid code. The main objectives and topics covered in the Study are:

- Feasibility of connection scheme for the Project to the PESCO/NTDC network at 132kV
- Load flow studies, including consideration for future network conditions to determine load-ability of equipment and voltage profiles
- Reactive power limitations of the Project
- Fault contributions and network short circuit strength
- N-1 Contingency analysis and transient stability analysis
- Power quality issues including voltage flicker, un-balance and harmonic emissions.

Siddiqsons Solar PV power plant would be interconnected to the 132 kV Lachi line. Hence, the grid interconnection scope for power transfer of 'Siddiqsons 50 MW Kohat Solar PV Power Plant' in particular is projected with;

- A 132-kV double circuit transmission line, approximately 7.5 km length from Siddiqsons Kohat is connected to Lachi 132 kV grid station.
- 2 transformers 132/33 kV of 60MVA capacity for 'Siddiqsons 50 MW Kohat Solar PV Power Plant'. The national grid system after addition of the solar PV plant was analysed for load flow, short circuit, transient stability and power quality studies to determine whether the plant connection with the PESCO grid meets the NEPRA/NTDC Grid Code requirements.

The latest and up-to-date network model base cases were used as provided by 50 MW Solar Kohat PV Power Project. Generation and Transmission expansion plans have also been incorporated as delivered by PESCO, whereas steady state, sequence and dynamic data for the Siddiqsons PV plant is processed to build the steady state, short circuit and dynamic models in PSSE software format.

The analysis has been performed for September 2018, winter 2018 and summer 2021, peak cases of the interconnection year 2018-19 and horizon year 2021-22 of studies respectively. The power flow analysis shows that the bus voltages and line loadings in all the cases, with and without addition of the subject solar PV plant are within acceptable limit of defined planning criteria. The results were also validated as per the standards of line loading and bus voltage limits in associated N-1 post-contingency conditions.

Maximum short circuit level at LV, MV and HV (POI) buses of 'Siddiqsons 50 MW Kohat Solar PV Power 'Plant' in both the year of commissioning and horizon year were computed. Moreover, in order to see the short circuit current contribution of 'Siddiqsons 50 MW Kohat Solar PV Power Plant', maximum short circuit levels at the substations located in vicinity of the project are also computed. The results show that fault levels are within the circuit breaker duties with the addition of the subject project to the 132-kV network of 50 MW Solar Kohat PV Power Project.

The transient stability studies were carried out to check the dynamic impact on the solar PV power plant due to potential faults in national grid system and, in turn, the impact of disturbances in the solar power plant on national grid system. The solar power plant is found to meet all the transient stability requirements as per defined by the NEPRA Grid Code. The results of transient stability analysis show that the power system is stable for the suggested interconnection scheme of the 'Siddiqsons 50 MW Kohat Solar PV Power Plant' and it fulfils all the criteria for the generation connection with the power system.

In the power quality analysis, the major criterion of the power quality i.e. flickers, voltage un-balance, frequency operating range, harmonics and power factor has been investigated at the subject solar PV plant for the worst-case scenario. Moreover, the obtained values are compared with the standards of IEC (IEC61400-21 and IEC-61727) and the results show that the all the parameters remain within the acceptable range of the IEC criteria.

Based on the study results, overall it is concluded that proposed generation connection for 'Siddiqsons 50 MW Kohat Solar PV Power Plant' meets the NEPRA/NTDC Grid Code and Planning Criteria.

4.2.1. Network Reinforcement Works

The Study demonstrates that the Project does not trigger any reinforcement works in the PESCO network. With regards to ongoing reinforcement works the Study does not specify if there are any transmission/distribution plans that are required before the Project can be connected to the grid. As part of Power-tek general assumption it states:

- "The transmission plans of NTDC and PESCO would optimistically be implemented as per their expected CODs, especially around the subject study region."
- "The existing and already proposed shunt compensation capacitors of PESCO are considered."

It is advisable to confirm with Power-tek, NTDC and PESCO if there are any planned network reinforcements that affect the Project if it were to be delayed or cancelled and also that the Project is not liable for any additional fees associated with reinforcement works.

4.2.2. Project connection works

The Study proposes that the Project is connects its new 132/33 kV Siddiqsons grid substation to Lachi 132 kV Substation, through a new 7.5 km 132 kV double circuit Over Head Line (OHL). Power-tek states that it has developed a connection plan for the Project with a nearby transmission network, where it fulfils the following criteria:

- No physical limitation regarding the Right of Way (ROW)
- Free available capacity is accessible at the substation

The Study describes briefly what it considers to be the most feasible option.

OHL route and length calculation are not provided and any environmental or land ownership issues in the cable route have not been identified.

The proposed grid connection that this study uses is a direct connection into Lachi substation, via a 15 km 132 kV double circuit overhead transmission line, with two 60 MVA 132/33 kV transformers at the PV plant site.

Previously, the commercial operation date (COD) for the Project was projected to be December 2017. We understand that this COD is very ambitious considering the Project's current stage, it is recommended that the COD be confirmed and programme schedule developed.

4.2.3. Grid connection studies

Load flow analyses confirm whether connecting the Project still keeps the power flow on the modelled network within defined limits and the voltages and loadings are in acceptable range of defined study criteria. It is noted that a considerable amount of redundancy was built into the proposed design to enable the system to continue to operate at full rated power in N-1 conditions, i.e. where one outage of a single piece of equipment is present such as a line or transformer outage due to fault or a maintenance activity. The Study states that N-1 reliability is a condition of the Gird Code.

Short circuit analyses states that with addition of this Project, fault levels do not exceed the standard circuit breaker ratings of existing installed equipment at the neighbouring substations. The inverters parameters to calculate the fault level contribution were not shown and it is recommended to check if the inverter fault level is model correctly. Please note that for the studies above, load flow and short circuit, the Study does not provide the reader the data to determine by itself if the results are indeed below equipment rating.

The transient stability studies show that the power system is stable for the suggested grid connection scheme of the Project for the faults on the substations that might be near to or distant from the solar PV power plant. Therefore, it fulfils all the criteria for the generation connection with the power system.

The power quality items i.e. flicker, voltage un-balance, frequency operating range, harmonics and power factor for the Project using worst case scenarios has been studied. The results show that all the parameters remain within the acceptable range of the IEC standards and NEPRA/NTDC Grid Code criteria. The harmonic injections from the inverters are considerably below the threshold levels and the system resonance frequency is not aligned with the main harmonic injection. Nevertheless, it is worth stating that the Study does appear to consider the background harmonic distortion from the system. This is particular important in network areas where there is a high volume of static generators, such as PV and batteries.

4.2.4. Overall Conclusions and Recommendations

We have reviewed the Grid system impact study of 50 MW solar power plant Kohat, KPK (the 'Study') carried out by Power -tek Ltd. ('Power-tek') and dated January 2017.

The coverage of the Study is detailed and does not appear to omit any major subjects or topics that we would typically expect to see.

The Study concludes that the expect grid system by 2018 will be suitable to cope with the evacuation of power from the Project and no bottlenecks or technical constraints were found in the grid system using the load and generation forecast for the horizon year of 2021. It is not clear if there are specific reinforcements works required as a pre-requisite for the Project connection.

The Study proposes that the Project is connected to Lachi 132kV grid substation through a new 7.5 km length, double circuit 132kV Over Head Line (OHL). The OHL route and length calculation are not provided and any environmental or land ownership issues in the cable route have not been identified. It is noted that a considerable amount of redundancy is built into the proposed design of the connection works. The commercial operation date (COD) for the Project is stated as December 2017, which is a very ambitious target considering the Project's current stage.

The connection grid studies although they appear to have been conducted to a good standard the report does not provide all the data to verify the statement made, such the power flow (thermal rating not provided) and short circuit (short circuit ratings not provided) studies. The harmonic background measurements appear to have not been considered, which can be a concern if the local network already has considerable amount of distortions.

5.Conceptual Design

This section describes the conceptual design of the Plant, which follows conventional and well proven commercial practice. Detailed design will be undertaken by the EPC contractor according to the Technical Specification which will include specific Project's owner requirements, performance requirements and applicable standards including Pakistan Building Code and IEC Standards. The Plant shall be designed for a minimum of 25 years' life.

During the tender evaluation phase, alternative designs, including string inverters, may be considered. A preliminary layout & design for this Project is included in the Appendix 9.

The concept design assumes that the earth works will be carried out to make the site suitable for tracker installation and no material constraints. The proposed design and layout is based on site boundaries provided by the Access and Siddiqsons. The site boundaries and areas to be excluded are assumed based on the information provided by the Access and Siddiqsons and design assumes that all obstructions within the site boundaries, which could shade the PV array, will be removed prior to the installation.

The system is sized for 50.0 MWp and the layout has been adjusted to account for the size and shape of the site. The conceptual design considers Tier 1 polycrystalline Jinko (JKM355M-72-V) modules, SMA central inverters (SC2500EV) and single axis trackers. However, alternate design and other mounting technologies could be considered during the design phase.

5.1. Modelled System Design and Approach

There are a number of losses associated with the harvesting of sunlight for the generation of DC power and there are further losses in the conversion of DC power from the modules to the useful AC power that feeds to the grid, the cumulative loss of which defines the plant Performance Ratio (PR).

These specific losses are dependent on the system design and key plant components. For this plant, the modelled system design characteristics were based on communication with and information provided by the Access and Siddiqsons. This includes single line diagram, site layout (AutoCAD) and topographical map. Details are summarised in Appendix 1 and Appendix 2.

Each individual loss has been modelled taking into account the information provided (and considered sufficient) and using inputs from our internal consultant's proprietary models.

Some specific losses are influenced by factors which cannot always be quantified at an early stage of a project. However, these should be considered in order to accurately determine the performance of the whole plant. Should specific information be provided regarding those losses, then this can be reviewed and the figures adjusted accordingly. Below is a non-exhaustive list describing some of these factors:

- Variation in performance and efficiencies under real operating conditions;
- Characteristics that vary due to the manufacturing and sorting process of PV modules;
- Performance measurements that are not identified on standard data sheets;
- Current technology in the PV industry;
- Quality of design and installation method;
- Power factor different from unity or grid maximum export limitation.

In consideration of the above, the following assumptions have been made in relation to the

expected system design and installation:

- Standard quality of the executed installation method;
- General design and sizing criteria in line with quality standards. Quality standards include cable voltage drop limits, cabin heating and ventilation, control and protection settings etc.;

- Final configuration of plant equipment to be completed using a standard approach;
- We have assumed two Power Factor (PF) scenarios, PF=1 and PF=0.95 at inverter level. There is likely to be a small amount of power factor required to overcome the inductive losses of the electrical transmission from the inverters to obtain unity at the connection point;
- We have been informed that the export meter could be located at the onsite substation or at the point of interconnection. For the purpose of this yield, we have been requested to assume the meter location at the onsite substation; should this assumption be revised at further stages, the yield numbers would have to be updated.

Where relevant PVsyst software (v6.52) is used, calculations are performed using hour-by-hour irradiance and ambient temperature values generated for the site. The shading has been estimated according to the 3D model shown in **Figure 17**. Since the location of the onsite substation and the evacuation line route are yet to be confirmed, any potential shading effect because of the evacuation line has not been modelled at this stage.

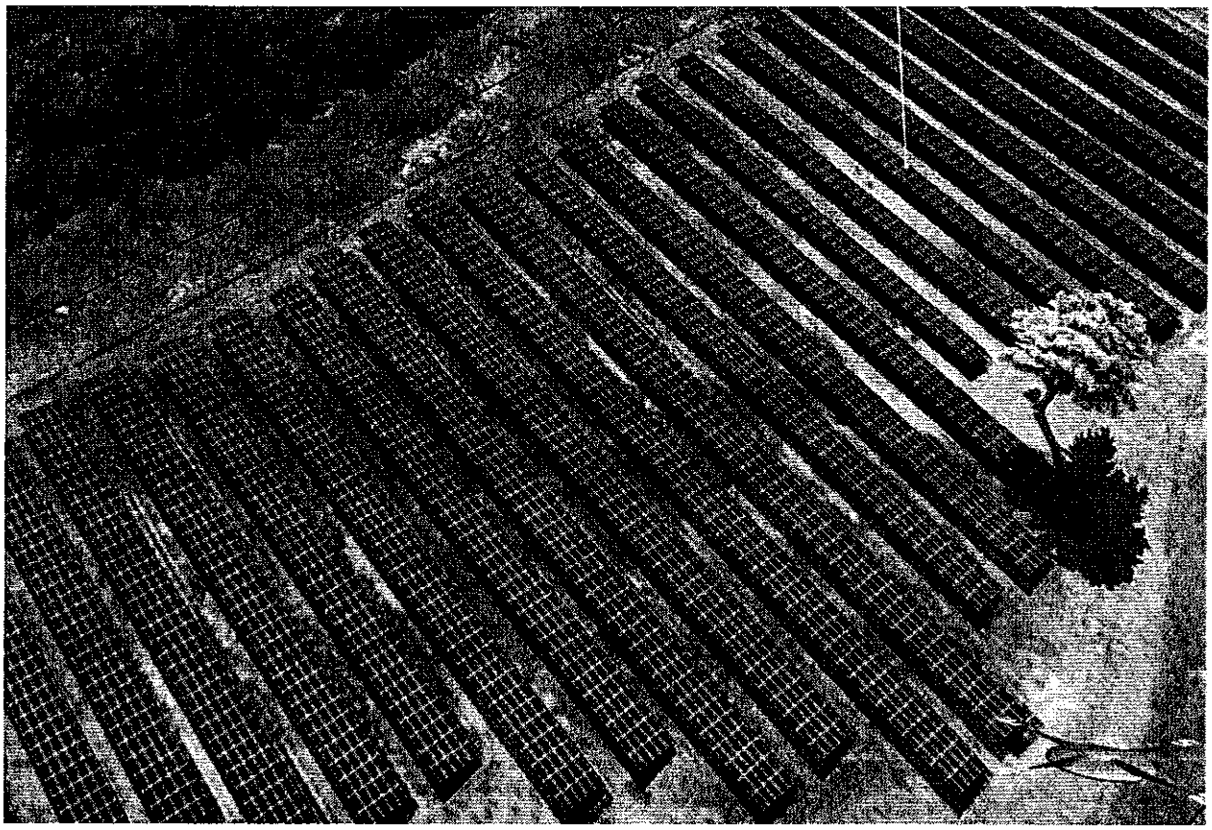


Figure 17. Near Shading Model for the Eastern Boundary - Kohat Solar PV Plant - Sample

5.2 String Sizing

Modules are connected in strings (a number of panels connected in series). A number of strings may then be connected in parallel to an inverter. String and panel arrangements are determined by the following factors:

- The MPP voltage range of the inverter
- The highest MPP current capacity of the inverter and
- The maximum system voltage of the panels.

For this, the electric characteristics of the strings and array are calculated for 70°C and 0°C[1i] module temperature and compared against the above parameters in order to ensure that the plant is suitably designed.

A summary of the string configuration, power ratio, voltage and current compatibility of the string arrangement are detailed in Table 7.

Array size (kWp)	Array configuration	No. of inverters	Power ratio (AC: DC)	Module	Max. voltage compatible	Max. current compatible
50,033.7	20 arrays of 29 modules per inverter	20	1:1.24	Jinko JKM 355M-72- V 4BB	✓	✓

The AC: DC ratio is based on the nominal inverter power (2,250 kVA at 50°C), which is in line with market standard practices.

The maximum voltage and current of the inverters is found to be compatible with the system design.

5.3 Modules and mounting frames

A module is an array of solar cells that converts the energy received from sunlight into electrical energy through use of the photovoltaic effect. Silicon solar cells are made from either mono-crystalline wafer which offer slightly higher efficiency at a higher cost, or poly-crystalline wafers which offer slightly lower efficiency but at a lower cost. Each individual photovoltaic module is approximately 1 x 2m and is of a glass construction, typically set in an outer metal framework. The front surface is generally treated with anti-reflective coatings. Poly-crystalline modules can offer more economic solutions for utility scale projects.

The modules are electrically connected by string cables which run through conduits placed behind the rows of modules. The string cables terminate at junction boxes which are generally found adjacent to module rows. Junction boxes then connect to inverters via larger diameter underground cables.

We have considered a Tier-1 355 Wp polycrystalline module for this report on the basis of site conditions, efficiency, price and module track record under prevailing site conditions. 4860 strings of 29 modules each have been proposed with a total installed capacity 50,033.7 kWp using 140,940 modules.

The mounting structure may be supported on a variety of different foundation designs including steel mini-piles driven directly into the ground or concrete foundations formed in place. The geotechnical report found the upper layer of the soil to be variable in nature and therefore several mounting structure foundations could be utilised and / or combined within the proposed area: concrete ballasts, driven piles or screw-in foundations.

The module support structure is generally arranged in rows, and follows the landform, generally rising no more than approximately 2.57 m above ground level at any point. The rows are separated from one another by an open space, which is determined to be 4.89m for this site in the proposed layout. The unoccupied ground between rows of modules and under the modules can be seeded to produce vegetation. Once constructed, it is viable for farming activity such as grazing of medium-sized animals like sheep provided cables are adequately protected.

5.4 Inverters and transformers

Inverters are required to convert the direct current (DC) electricity generated by the PV modules into alternating current (AC) which is suitable for exporting to the grid. The inverters also manage and optimise specific electrical parameters in order to maximise energy production.

Inverters are most commonly available as either string inverters or central inverters. String inverters are smaller devices, each managing a small number of modules, typically mounted on the module support structures and with a capacity typically less than 50 kW. They are better able optimise electrical parameters and maximise energy production in conditions where orientation or shading vary, particularly rooftops. However, the large number required for a utility scale application often results in higher installation and maintenance costs, including replacement over the Plant lifetime.

Central inverters are larger devices with capacities up to 1,000 kW or more which manage greater sections of the Plant. They are generally able to optimise energy production more efficiently, are less resource intensive to maintain and can be more economical to purchase and install. Central inverters are typically housed within weatherproof skid-mounted enclosures with approximate dimensions 8.5 m long, 2.9 m wide and 3.2 m high. Alternatively, they may be installed in a masonry building with adequate ventilation. Care should be taken to ensure adequate ventilation, particularly considering the high ambient temperatures at this site.

We have considered that for a Project of this scale, location, and landform, central inverters are likely to offer the best solution. A central inverter scheme with 18 x 2250 kVA inverters has been proposed considering the inverter to array ratio, cost effective granular monitoring and reliability of the system. All inverter substations contain 1 x 2250 kVA inverter.

The transformers are required to step-up the relatively low AC voltage as generated by inverters (typically 300-400 V), into the internal 33kV MV network, and then again to 132kV for HV grid connection. All inverter stations contain 1 x 2500 kVA LV/MV transformers installed integrally with the inverter enclosures whereas the 45 MVA MV to HV transformers will be housed adjacent to the switchgear in the HV Substation on site.

Final configuration of inverters and transformers may vary based on PV layout, electrical configuration and Grid connection study. A preliminary single line diagram has been included in Appendix 7.

5.5 Switchgear

Switchgear is used to control the connection between the Plant and the electricity distribution network. We plan to connect to the 132kV Lachi Grid station, 4.61 km west of the site, as confirmed suitable by the approved Grid connection study. Typically, there are two sets; one belonging to the Distribution Network Operator (DNO), PESCO/NTDC/CPPA in this case, and one belonging to the Plant, which are housed in separate cabins or switch rooms. The appearance and size of the cabins will be determined by the requirements of the DNO and the Project, but it is likely they will be fabricated from brick or glass-fibre reinforced plastic with approximate dimensions of 5 to 7.5 m long, 2.75 to 4.75 m wide and 3 to 4 m high. A grid connection report has been approved by PESCO and has been reviewed under Section 4.2 of this report.

5.6 Monitoring and control room

Monitoring systems are required to provide feedback and information on the operational status of the Plant. Systems for monitoring the Plant such as the Supervisory Control and Data Acquisition (SCADA) operating system will be located in an air -conditioned cabin or office, which will also provide a working environment for the Plant operator or manager. The cabin dimensions would typically be 7 m long, 3 m wide and 3 m high and may be fabricated from GRP or masonry.

5.7 Security

From the beginning of construction, security measures are required to prevent unauthorised access into the solar farm, which is an energy generation system, and to protect the solar farm.

We suggest that based on local conditions the security arrangement should consist of a boundary wall of at least 2.2m topped with barbed wire to be installed within the site boundary, and pole mounted security cameras at approximately 3.25 m high positioned around the wall perimeter. The security cameras should employ infra-red technology and site lighting will not be required. Alternative security arrangements based on manned patrols may also be employed.

6 Energy Yield Assessment

6.1 Irradiation

6.1.1. Global Horizontal Irradiation

Irradiance is a measure of the solar electromagnetic power in watts passing through a surface of area 1m2 and is measured in W/m2. Global irradiance means that the irradiance is composed of both direct and diffuse (scattered) sources. Global horizontal irradiance is the global irradiance that is incident on a horizontal plane. GHI is a measure of total energy, or irradiance power incident for one hour, and is expressed in watt hours per unit area (Wh/m2).

The irradiation is the energy source for a solar project and as such it is important that sufficient data is collected for the sites in question. A location at the centre of the site was selected as the point of interest for the irradiation assessment.

There are several databases available that use information from either satellite (along with other observations and models) or ground measurements in order to estimate long term average GHI values at any specified location. A description of the databases used in the irradiation analysis is included in Appendix 4.

We have taken GHI values from a number of databases for comparison and these can be seen in Table 1**Table 6**.

Table 6. Annual GHI from various sources

Data Source	Measurement Duration	GHI (kWh/m^2)	Difference from WM (%)
Meteonorm 7	1991-2010	1,752	-2.2
SolarGIS	1999-2011	1,781	-1.7
NREL SUNY	2000-2014	1,843	2.9
NASA SSE	1983-2005	1,347	-24.4
Average		1,780	

NASA SSE has been displayed for rough indication only, since it comes with an inadequate spatial resolution (110km x 110km) and for the site under consideration this data source also assumes an incorrect altitude.

Meteonorm 7 has been additionally assessed at the site location; however, upon closer examination and communications with the data provider, we note that the Meteonorm 7 estimate is mainly based on ground data relating to the period 1965-1981, which is not considered appropriate for future long-term forecasts. This database has been therefore excluded from our irradiation assessment.

The weighted mean (WM) value above has been weighted accounting for the number of years of data available and inversely weighted based on the spatial resolution of each source. Each parameter contributes 50% to the weighting. Along with the weighted mean, the deviation of each dataset relative to the WM value as well as the corresponding standard deviation has been calculated. Details on our approach to assess long-term GHI is given in Appendix 6.

For this site, above data sources result in a standard deviation of ±2.5%, which informs the GHI uncertainty analysis in Section 6.3 and Appendix 6.

The weighted mean value of **1,780 kWh/m2/year** has been selected for the continuation of our irradiation assessment.

6.1.2 Global Inclined Irradiation

The system design assumptions on which this report is based have modules mounted on single axis trackers mounting system. The single axis trackers axis of rotation is understood to run from south to north, and the panels track from east to west throughout the day. The range of motion for the tracking systems is: from a tilt of 60° inclined to the east, to a tilt of 60° inclined to the west. The south-north tilt for this system is fixed at 0°.

If the tracking system uses its full range of movement to track the sun, then mutual shading can occur at low sun angles (i.e. panels shade each other). In order to prevent this, the tracker control system includes a feature called backtracking. This means that the tracker will arrest the rotation of panels at the point just before mutual shading occurs, and then reverse the rotation to maintain a constant sun shading angle. Note that the incorporation of backtracking reduces the GII, however it also reduces losses due to inter-row shading of the modules.

The industry standard Perez model has been used to uplift the GHI values previously established to corresponding values for the GII on the panels. The resulting GII values for the single axis tracker with Backtracking (BT) are shown in **Table 7.**

Table 7. Monthly and yearly incident irradiation for the Project (kWh/m2)

Tilt	J	F	M	A	M	J	J	A	S	O	N	D	Total[1]
GHI	92	93	144	177	213	211	195	175	161	139	97	84	**1,780**
GII ±60° BT	118	122	187	228	273	265	236	211	207	179	126	110	**2,262**

6.2 Detailed Performance Ratio Calculations

6.2.1 PR Calculations

The PR has been estimated following the process outlined in the previous section and a breakdown can be seen in Table 10; further details explaining these losses are included in Appendix 5.

Two PF scenarios have been modelled upon request from Access and Siddiqsons.

Table 8. Detailed List of Losses

Description	Loss
Near shadings: irradiance loss	3.0%
Spectral	0.0%
Angular / IAM	1.5%
Soiling / snow cover	1.0%
Low irradiance performance	0.8%
Light Induced Degradation (LID)	1.4%
Module quality / power tolerance	-0.7%
Module temperature losses	7.6%
Near shadings: Electrical effect	0.0%
Mismatch	0.5%
Ohmics, DC wiring	1.4%
Inverter efficiency	1.8%
Undersizing of the inverter	0.0%
MPPT performance	0.7%
Ohmics, AC LV wiring	0.1%
Ohmics, AC MV wiring	0.3%

[1] Any apparent discrepancies in the annual totals arise because the monthly values have been rounded to the nearest integer for display purposes

LV-MV transformer	1.1%
MV-HV transformer	0.5%
Self-consumption	0.5%
Max export capacity power limitation	0.0%
Module degradation	0.2%
PR at export meter @PF =1	**78.5%**
Inverter PF clipping	0.0%
AC loss due to PF	0.3%
PR at export meter @PF =0.95	**78.2%**

All subsequent yield calculations in this report are based on the PR modelled at the export meter.

The calculated PR does not include any allowance for plant, grid / or tracker availability losses.

In order to assess the soiling loss, we have considered 3 cleaning per annum; this assumption could be refined at later stages. Major one-off events such as dust storms have not been considered within the soiling loss estimate.

We have conducted a literature review on module degradation with a focus on modern commercial c-Si products. Following this review, we consider a degradation rate of 0.4%/year to be an appropriate assumption for inclusion in the project financial model.

For year one, we take the average degradation of 0% at the starting point and 0.4% a t the end of year 1. Therefore, for the purposes of modelling first year PR numbers a value of 0.2% has been used.

6.2.2 Availability Assumptions

Plant (including tracker) and grid availability can be considered either inside or outside the performance ratio calculation, depending on how the contracts and financial models are constructed.

We recommend that the plant availability should be linked to, and guaranteed within, the EPC and O&M contracts for the lifetime of the Project. Should this be the case then the availability assumption to be considered within the financial model or the performance ratio of the Project can be matched to this. It is common for figures of 99% or 98% to be specified in the contracts.

Grid availability analysis is outside of the scope of this report. We would recommend a detailed grid study is carried out to ensure any current and future grid availability issues / curtailments are accounted for.

6.2.3 Yield Estimations

Specific yield is a measure of the output of a PV system per unit of installed capacity (kWh/kWp). It is a function of the irradiance experienced by a system, and its PR. Year one specific yield calculations for the Project are shown in Table 9.

Table 9. Year one energy yield for the system at PF = 1

PR	Installed Capacity (kWp)	Probability of exceedance	Specific yield (kWh/kWp)	1st year production (kWh)
78.50%	50,033.7	P50	1,780	89,064,110
		P75	1,713	85,707,719
		P90	1,653	82,686,740

Table 10. Year one energy yield for the system at PF = 0.95

PR	Installed Capacity (kWp)	Probability of exceedance	Specific yield (kWh/kWp)	1st year production (kWh)
78.30%	50,033.7	P50	1,765	88,325,053

		P75	1,708	85,477,689
		P90	1,648	82,464,457

Plant, grid and tracker availability has been excluded from our year one specific yield figures in Table 11.

The figures in Table 11 already contain an allowance for the first year's degradation. For future years' output, we recommend that a linear degradation of 0.4% be applied in the financial model. P75 and P90 numbers are based on an uncertainty analysis outlined in Section 6.3.

6.3 Uncertainty Analysis

The uncertainties feeding into our yield analysis can be separated into three discrete parts:

- Variation in year on year irradiation
- Duration of forward modelling period irradiation variability
- Uncertainties in the PR modelling assumptions.

Each of these uncertainties is discussed in turn below.

6.3.1 Long term irradiation variability

Variability of irradiation is a key driver for the income of the Project. Long term irradiation data from the satellite database SolarGIS was used to assess irradiation variability; details are shown in **Table 11.**

Table 11. Satellite long term time series data

Site location	Years of data	Standard deviation	Standard error of the mean
Kohat (33°21'39.86"N, 71°22'44.06"E)	12	3.2%	0.9%

The standard deviations in the table above are applied to the local inclined irradiation to achieve the P75 and P90 values. Table 14 shows the resulting irradiation values for a single year period.

Table 12. GII probability distribution in a single year

Probability of exceedance	GII (kWh/m2/yr)
P50	2,262
P75	2,213
P90	2,170

6.3.2 Irradiation Uncertainty over multiple years

Uncertainties associated with annual irradiation over a longer period of time are dependent upon the number of years within that period. Over a longer modelling period, the standard error would be expected to reduce. Additional uncertainties associated with various forward modelling periods for are shown in **Table 13.**

Table 13. Standard error of irradiation data over various modelling time periods

Number of years	Standard error of the mean
1	3.2%
10	1.0%
20	0.7%

6.3.3 Uncertainty in Yield Modelling Assumptions

Uncertainties in the GHI, GII and PR modelling assumptions are shown in Table 14. A detailed breakdown of these uncertainties can be found in Appendix 6.

Table 14. Yield Modelling Uncertainty

Description	Total for site
Modelling uncertainty	± 4.6%

The overall uncertainty in the yield modelling assumptions is calculated via the standard error approach and corresponds to a value of ± 4.6%.

6.3.4 Combined Uncertainties

The three uncertainties listed above are combined using the common standard error approach. The overall combined uncertainty which will be applied to the calculated specific yield figures in the next section for a one year, 10 years and 20-year period are shown in Table 15.

Table 15. Combined Uncertainties over various modelling time periods

	Uncertainties		
Number of years being modelled	1	10	20
Standard error historic irradiation uncertainty	0.9%		
Standard error irradiation uncertainty over time	3.2%	1.0%	0.7%
Standard error PR uncertainty	4.6%		
Combined uncertainty	**5.6%**	**4.8%**	**4.7%**

6.3.5. Probabilities of exceedance estimation

Specific yields at varying levels of probability and over varying time periods may be calculated by applying the factors in **Table 16** below to the first year P50 value found in previous sections.

Table 16. Specific yield probability adjustment factors beyond year one

Number of years		**1**	**10**	**20**
Probability Level	P50	1.00000	1.00000	1.00000
	P75	0.96203	0.96794	0.96831
	P90	0.92786	0.93909	0.93978

7. Project Financing

7.1. Legal Structure

Access and Siddiqsons have set up a project company, Siddiqsons Kohat Solar Limited, which will sign all the project and financing documents, obtain all permits, authorisations and licenses necessary to develop, construct and operate the PV plant and sell the electricity produced to the utility. *Figure 18* describes the general framework of the transaction.

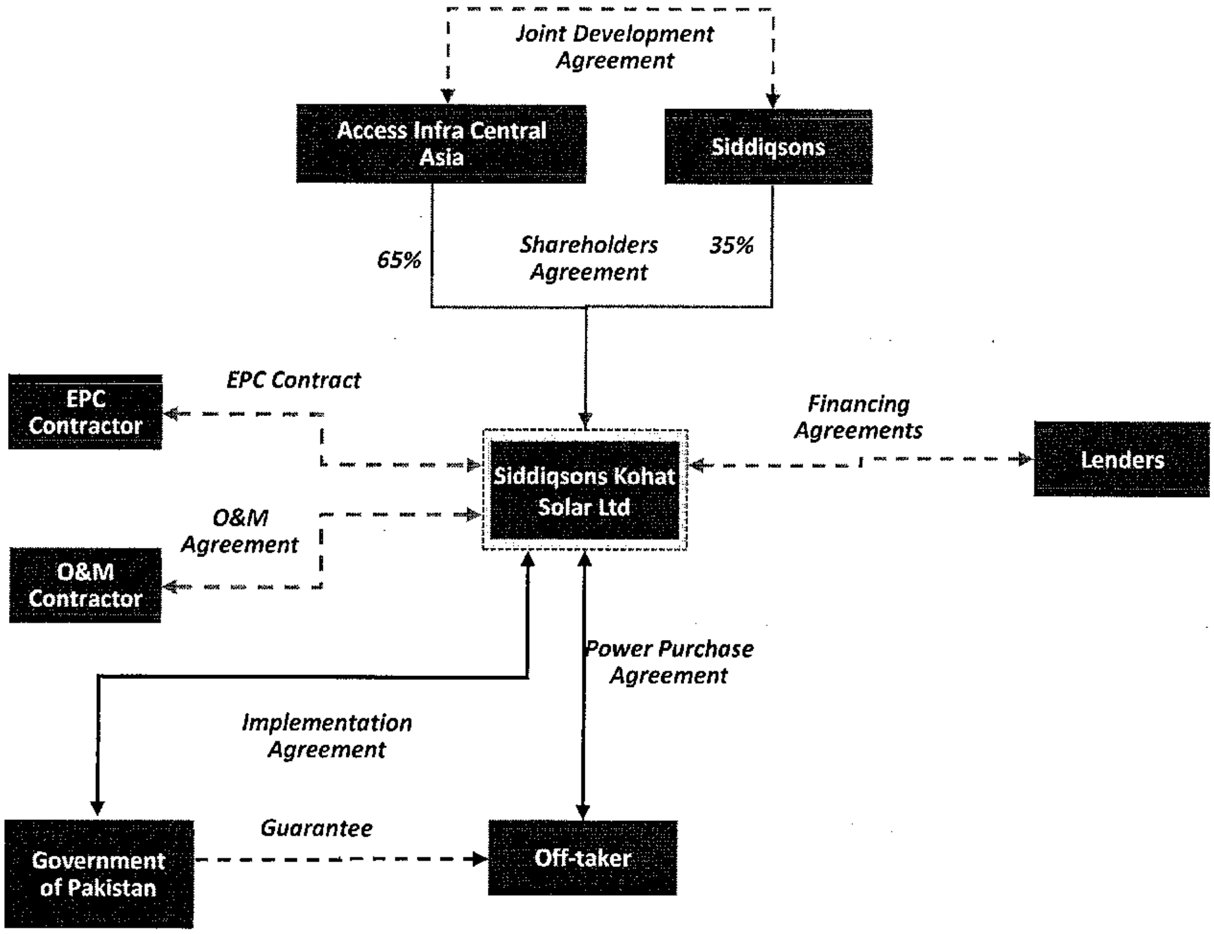


Figure 18 General framework

7.2 Tax Environment

Access and Siddiqsons have assumed the following tax environment summarized in Table 17 below, based on internal analysis and interview with the Pakistanis authorities.

Table 17 Tax environment assumptions

Tax Item	Assumption in model
CIT (incl. education tax)	0%
Exemption Period	25 years
Loss Carryforward	-
WHT on Interest	0%
WHT on O&M	0%
WHT on EPC/Capex	N.A.
Book Depreciation	SLM @ 5%
Capital Allowance	N.A.

Tax Item	Assumption in model
Accelerated Depreciation	N.A.
Investment Allowance	N.A.
VAT/duties on Capex	0%
VAT on sale of electricity	0%
Stamp Tax on Debt	0%
Stamp Tax on Equity	0%
Legal Reserve	N.A.
Thin Capitalization	N.A

7.3 Total Investment Costs

Access and Siddiqsons have made a preliminary estimation of the Total Investment Costs ("**TIC**"), in the order of 58M USD. Table 18 below describes the different items included in the TIC.

Table 18 Breakdown of Investment Costs items

Description	USD MM	Source
EPC Cost	36.25	EPC Contractor
Dev. Costs	2.00	Estimate
Land	1.2	Estimate
Insurance	0.28	Estimate
External Advisors	0.70	Estimate
Contingency	3.5% of EPC	Estimate
O&M Mobilization	0.25	Estimate
Dev. Fee	3.00	Estimate

Regarding the cost of the EPC contract, which constitutes approximatively 80% of the TIC, Access & Siddiqsons will conduct a tender among at least 3 international contractors in order to select the best proposal, in terms of price, quality of the equipment and guarantees.

The final TIC will be updated based on the final technical studies, and the final terms and conditions of all contracts, in particular the EPC contract and the financial documentation.

7.4 Total Operating Costs

The total operating costs ("**TOC**") include the following:

- O&M contract, which covers preventive and corrective maintenance, management of spare parts, facility management
- Inverters guarantee, which covers the replacement of any spare parts of the inverters during the full operating life of the plant
- Insurances
- Management of the project company

The TOC have been evaluated at 805,000 USD/year.

7.5 Financing Structure

We, Access and Siddiqsons, have assumed the following financing scheme, based on preliminary discussions with international lenders, such as IFC.

Equity

We, Access and Siddiqsons, will finance 35% of the investment through equity at financial close. A preliminary target IRR of 18% have been assumed.

Debt

International banks will finance 65% of the TIC with the following conditions:

Junior Debt

- Amount: 33.3%% of total debt
- Maturity: 18 years door to door
- Base Interest rate: 1.50%

Senior Debt

- Amount: 66.6% of total debt
- Maturity: 18 years door to door
- Interest rate: 4.50% all in
- Min DSCR: 1.30xP50

7.6 Tariff Calculation

The calculation of the tariff by Access and Siddiqsons follows a simple rule: this is the minimum tariff that generates enough revenues to cover the TOC and the debt service, while ensuring a minimum return for the shareholders. Appendix 13 shows the indicative Profit and Loss Statements and Balance Sheets of the Project Company which are used as the reference for the tariff calculation.

According to the financial model, the minimum tariff has been evaluated at 7.8USDc/kWh, flat during 25 years. In order to understand the impact of the radiation on the tariff, we have conducted a sensitivity analysis described in Table 19 below.

Table 19 Sensitivity analysis assumptions

	Base Case Scenario	Case A	Case B	Case C	Case D	Case E
Location	Kohat	Multan	Guddu	Dadu	Jamshoro	Quetta
Radiation (GHI)	1780	1887	2000	2017	2063	2201
Other assumptions	Assumptions described in Section 7 of Kohat Feasibility Study	Same as Base Case scenario	Same as Base Case scenario	Same as Base Case scenario	Same as Base Case scenario	Same as Base Case scenario

The results of the financial model are indicated in Table 20.

Table 20 Financial model results

	Base Case Scenario	Case A	Case B	Case C	Case D	Case E
Tariff – USDc/kWh	7.8	7.3	6.9	6.9	6.7	6.3

The sensitivity analysis demonstrates that the price offered by Access and Siddiqsons is highly competitive for the region of Kohat.

However, the final PPA price needs to be adjusted based on the final tax environment agreed with the government, the final EPC price and the final terms and conditions of the debt financing.

8. Environmental and Social Impact Assessment

8.1 Executive Summary

Siddiqsons Kohat Solar Limited is the SPV of 50 MWp PV Solar Power Plant that will be located in Lachi tehsil, District Kohat, KPK.

The prime objectives of the solar power project are:

- Diversification of the company's portfolio and invest in energy sector to exploit untapped energy potential of the country
- To supply the renewable electricity to the national grid, thereby reducing power blackouts

In view of the objectives, Access and Siddiqsons have planned to undertake the project which involves design, layout, engineering, planning and supervision, as well as procurement of components.

The site is located 5.06 km to the south east of the town of Lachi, in Khyber Pakhtunkhwa, and approximately 4.6 km from 132 kV Lachi Sub-Station. The available site is of approximately 115 hectares. The location of the proposed project site is shown in the Figure 19.

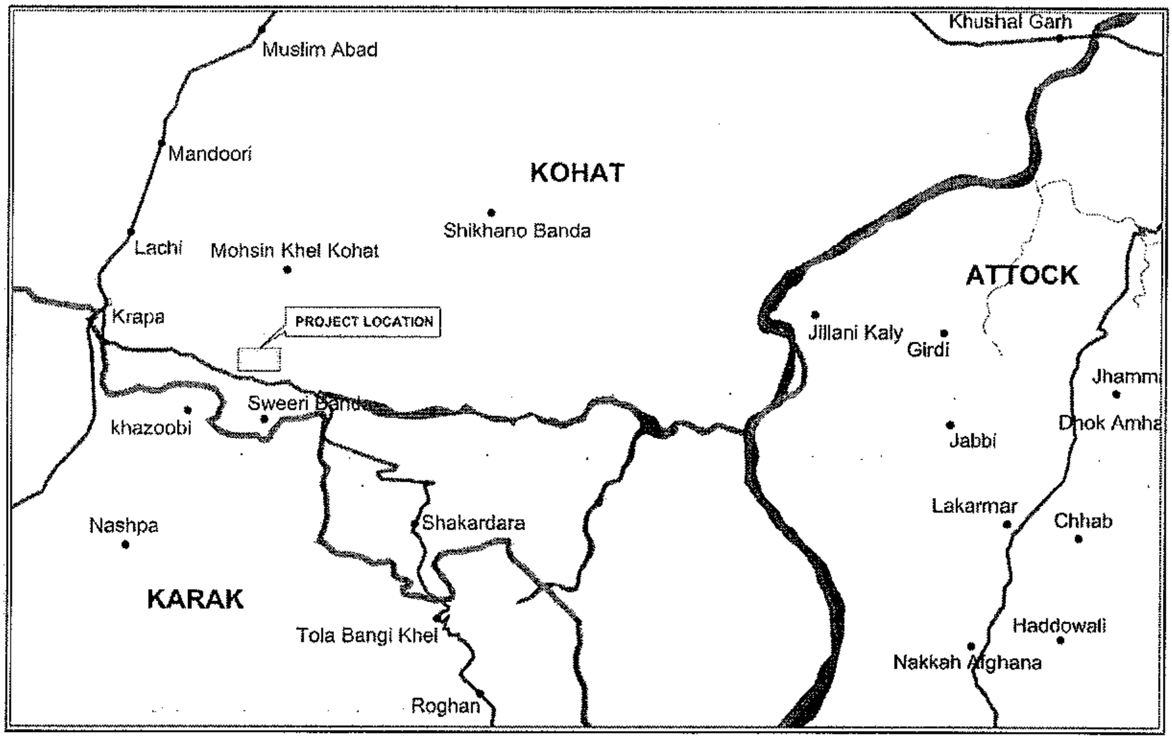


Figure 19 Project location map

The proposed power plant will generate power that would be stepped up to MV by step up transformers attached with the selected inverters. AC power will be stepped up through MV/HV transformer before the metering station. The power will eventually be supplied at 132 kV to grid. Approximately 5 km to the north west of the site runs a 132-kV overhead transmission line (OHL). The preliminary first-year annual energy generation of 82,512 MWh/year was calculated assuming a performance ratio of 78.5%.

The climate in Kohat is hot, sometimes extremely hot summers and mild to warm winters. It is mainly hot semi-arid climate range from 2°C in January to almost 43 °C in July.

During site visit, the texture of the top layer of the soil was found to be gravely, silty clay with small rocks and light brown in color. No permanent rivers were visible at the site. Water channels were dry during the visit.

Being classified as Schedule I under the PEPA EIA/IEE Regulation 2000, the project is required for an Initial Environmental Examination (IEE) to meet the environmental assessment requirements. The findings of impact assessment and visual inspections of existing environment of the project area in the present scenario indicates following main impacts along with simultaneous relevant and appropriate mitigation measures:

- The air-shed of the project site has, according to the assessment of ambient air quality, been classified as unpolluted. The air quality of the air-shed of the macro environment as well as that of the site itself will have no significant impact.
- The project will add to the overall socioeconomic development of the area.
- Project site has no sensitive areas such as protected sites including wildlife sanctuaries, game reserves or national parks, or any archaeological, historical or cultural heritage in its immediate neighbourhood; as such its siting would have no sensitivity in this regard.
- Mostly there is scanty vegetation in and around the project site. The land is currently barren and uncultivated, with very little vegetation on the site. Most of the terrain is covered with wild bushes & shrubs with only a few small trees along the west boundary of the site. There are scattered villages near the eastern boundary of the site and a few houses are located within the site on a ridge towards the north east. There is some patchy vegetation at the project area which will be removed during project execution (with least disturbance to the natural vegetation structure) and replanted in the ratio of 1:5 in the case of matured tree, and in the ratio of 1:3 in the case of small tree after project completion. The vegetation cover loss shall be minimized as much as possible.
- The waste generated during site clearance will be rejected materials, surplus materials, paper bags, empty cartons, empty paint and solvent containers, packing waste; scrap, excess construction materials and debris etc.
- Non-hazardous non-recyclable wastes will be disposed of in landfill site through municipal administration.
- Prior to the commencement of civil works the Environment, Health and Safety (EHS) specialists will develop a construction phase Occupational Health and Safety Plan (OHSP).
- All transformers will be equipped with spill containment berms in accordance with relevant national standards.
- A transformer maintenance schedule will be developed and usage of transformer oils will be monitored on a regular basis.
- Chemicals and oils should be stored in secure designated areas with permanent impermeable bunds at distance of at least 100 m from any watercourse.

This IEE study was carried out to assess the environmental and socioeconomic impact during the design, installation and operational phase of 50 MW Solar PV Power Plant in Lachi, district Kohat. The assessment was carried out according to the requirements of KPK Environmental Protection Act 2014 and all the applicable national and international standards.

The baseline environmental and socioeconomic information was collected from a variety of sources, including reports of previous studies, published literature, and field survey (primary information). The information collected was used to develop baseline conditions of project area with respect to the natural, socioeconomic, and cultural environments likely to be affected by the project.

The proposed project activities were reviewed, and an assessment made of the potential impact of these activities on the area's natural, socioeconomic, and cultural environments is also described in this report. Where appropriate, mitigation measures were recommended to keep the adverse environmental impact within acceptable limits.

It is therefore concluded that if the field activities, including the implementation of all mitigation measures, are carried out in line with recommendations suggested in the report, the impacts from project's construction and operations will not be adverse so as to deteriorate the environmental quality of the project area and a more detailed report will not be required in the form of an Environmental Impact Assessment (EIA). Additionally, careful implementation of the Environmental Management Plan (EMP) will ensure that environmental impacts are managed and minimized and the project proponent meets all statutory requirements.

There are two essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. The proponent shall ensure that:

- All mitigation, compensation and enhancement measures proposed in this IEE report are implemented in full, as described in the document;
- The Environmental Management Plan is implemented in letter and spirit.

Screening of potential impact suggests that the construction & O&M of 50 MW Solar PV Power Plant will, on adoption of the suggested mitigation measures, be an environmentally acceptable proposition and will provide clean energy.

Appendices

A. System Design

Specific losses are dependent on the system design and key plant components. For this Project, the modelled system design characteristics are provided in Table 19.

Description	Assumptions	Source
DC Installed Capacity (kWp)	50,033.7	Plant layout – Access
AC Nominal Capacity (kW) at 50°C	40,500.0	
AC Maximum Capacity (kW) at 25°C	45,000.0	
Grid Maximum Export Capacity (kW)	46,800.0 at the Point of Interconnection	Updated Grid Connection Report.pdf
Power Factor	PF=1 and PF=0.95 have been modelled	Access-Siddiqsons
Table configuration	87 module row (3 strings) with 1 module in portrait orientation	Kohat Layout
Tracker range of rotation (°)	±60	
Pitch (m)	4.89	
Site inclination	The site has been assumed to be flat after civil (levelling) works confirmed	Access-Siddiqsons
Near Shadings	There are no buildings in site. However, grading losses have been assumed given the presence of the hills to the south of the site.	Site visit, satellite imagery,
Metering point location	Assumed to be right after the MV:HV transformer, at onsite substation	Access-Siddiqsons.

Appendix 1. System Design Assumptions Table

The key equipment and string configuration is summarised in Table 20 and Table 21 below.

Equipment type	Assumptions			Source
	Manufacturer and model	Nominal power	Units	Quantity
Modules	Jinko JKM 355M-72-V-4BB	355	Wp	140940
Inverter	SMA SC 2500EV	2250	kVA	20
Transformer	SMA ONAN Trafo	2500	KVA	20

Appendix 2. Key Equipment List

Module string layout	Assumptions				Source: Plant SLD
	Manufacturer and model	Inverter model	No. of Inverters	Modules per String	No. of strings per inverter
String conf. 1	Jinko JKM 355M-72-V-4BB	SMA SC 2500EV	1	36	270

Appendix 3. Assumptions for the Simulation

B. Irradiation Methodology

In order to determine the most accurate long-term GHI estimates, our teams continuously evaluate databases available on the market and data selection or weighting approaches. In this research, currently 23 locations spread over the global and in all relevant climate zones are used as benchmark locations. The benchmark data are predominantly taken from scientific radiation networks, which aim to provide data on climate change and model validation. Monthly and annual reference averages are based on a recent, period spanning several years.

Following our research, weighting methods have been found to provide more accurate long-term GHI estimates and typically outperform single databases; i.e. are superior to data selection. This can be explained by the nature of most databases, which is predominately model-reliant in terms of spatial resolution of information and sourcing. Furthermore, input data can be incomplete or not fully representative for a given location. Thus, location-specific estimates of single databases vary within modelling limits or can be biased. The most accurate single database evaluated so far comes globally with an uncertainty (RMSE) of the annual long-term GHI estimate of 3.0%. Weighting of various datasets appears to overcome partially this deficiency, with appropriate database selection being crucial in this context.

We have reviewed various approaches to combine datasets. Weighting of the databases on the basis of the number of years contained in each dataset and based on the inverse spatial resolution has been found globally most accurate with an uncertainty (RMSE) of the annual long-term GHI estimate of 2.5%. In this regard, spatial resolution and its inclusion in the weighting has shown increased significance when comparing the results obtained for locations binned into continental, coastal and small island sites.

For monthly long-term GHI estimates, similar results have been obtained with WM numbers being globally more accurate than single databases.

C. Irradiation Database

We frequently review database updates available on the market and consider the datasets included in Table 22 to be the most applicable to a detailed irradiation analysis for this site. Other databases may not cover a period that is long enough to be considered representative, may be outdated, may have a poor spatial resolution or may show unrealistic results.

Database	Description
Meteonorm 7	Meteonorm blends ground and satellite data for the period 1991-2010 from a database of approximately 1,325 weather stations with global radiation and temperature data. Where no radiation measurement is available nearer than 200 km (or 50 km in Europe) from the selected location, satellite information is used. If the nearest site is more than 30 km away (or 10 km in Europe), a mixture of ground and satellite information is used. In Europe, the spatial resolution is 3 km and 8 km for the rest of the world. Long term irradiation data purchased by OST Energy from the UK Met Office have been entered into Meteonorm 7.1 to be utilised in the software interpolation algorithm. This additional data provides a higher resolution of data-points for interpolation at the site location.
SolarGIS	This dataset is calculated from satellite observations made by Meteosat, GOES EAST and MTSAT satellite and MACC-II and GFS, CFSR atmospheric data. The data are spatially enhanced to 1km resolution, the averaging periods are: 1994-2010 for Europe, Africa and the Middle East, 1999-2011 for Asia, 1999-2014 for Americas and 2007-2014 for the Pacific.
NREL SUNY	This data provides solar resource for surface cells of 0.1 degrees in both latitude and longitude, or nominally 10 km in size. The solar radiation values represent the resource available to solar energy systems. The data was created using the semi-empirical satellite model developed by Perez et al. as part of the India-US Energy Dialogue. The model uses data from Meteosat 5 and 7 geostationary meteorological satellites. This data was developed in collaboration with SUNY Albany and Solar Consulting Services. The data covers India, Bangladesh Bhutan, Nepal, Sri Lanka and parts of Pakistan, Afghanistan and India. Data collected from years 2000 through 2014.
PVGIS-CMSAF	This dataset provided by the EU Joint Research Institute's Photovoltaic Geographical Information System (PVGIS) is based on calculations from satellite images performed by Climate SAF (CM-SAF). The database represents a total of 17 years of data combining first generation (1996-2005) with second generation Meteosat satellite observations (2007-2013). First generation data is given a weight of 70% and second generation contributes 30% to the long-term averages. The spatial resolution is 3km at nadir and increase with latitude and longitude.
NREL CSR	This model was developed from the National Renewable Energy Laboratory for the U.S. Department of Energy's Climatological Solar Radiation Model. It uses information on cloud cover, atmospheric water vapour and trace gases, and the number of aerosols in the atmosphere, to calculate the monthly average daily total insolation

	(sun and sky) falling on a horizontal surface. The spatial resolution of the model is 40 km x 40 km.

Appendix 4. Irradiation Data

D. PR Losses

The explanation of the PR losses and our approach is detailed in Table 23 below.

Loss	Description	Modelling Approach
Near shadings	Loss of irradiance affecting the modules due to obstruction of direct sunlight from surrounding objects. e.g. external shading from nearby trees or large buildings, and mutual shading from neighbouring modules.	Modelled using PVsyst near shading engine, according to the system design outlined
Spectral	This takes into account the effect of operating at a different air mass and solar spectrum than STC.	Spectral losses are considered to be effectively zero for crystalline silicon modules.
Angular / IAM	The loss due to times when the sun is not 90° to the module. This causes an increase in the reflection of light from the front glass.	We account for this loss in the module pan files within PVsyst using information provided in the module datasheets.
Soiling / snow cover	Loss of light reaching the cells. Over its working life the module will collect dust, dirt, bird droppings and vegetation on its surface.	Potential soiling loss has been estimated based on 3 cleanings per annum and local precipitation records. Major one-off events such as dust storms have not been considered within the soiling loss estimate. We recommend that a cleaning is schedule shortly after these events. We would recommend that soiling is monitored and limited under O&M.
Low irradiance performance	This loss considers the relative efficiency of the module when operating at an irradiance level other than STC.	We account for this loss in the module pan files within PVsyst using information provided in the module datasheets.
LID	This degradation causes performance loss and occurs during a module's first operating hours in outdoor conditions and will reduce the module's performance when compared to the standard values measured at STC.	This loss is estimated based on a review of available literature on LID effects in crystalline silicon modules.
Module quality / power tolerance	The loss / gain due to the module power tolerance is a result of the deviation in the average effective module efficiency with respect to manufacturer specifications.	This loss is estimated based on the datasheet module tolerance information.
Module temperature losses	This takes into account of the loss when operating at a temperature other than STC.	Modelled within PVsyst using module datasheet information and based on ambient temperature information taken from Meteonorm 7.

Shading: electrical effect	Loss due to the current of a string of modules / cells being reduced to the current in the most shaded module / cell, this loss identifies the electrical effect due to the near shadings described above.	Modelled using PVsyst near shading engine, according to the system design outlined
Mismatch	Similar to the previous, this effect takes place when combining modules with varied characteristics, such as variations between allowable manufacturing tolerances, which will again limit the current and ultimately the power for all the modules linked in the string.	This loss is estimated based on the inverter type and module tolerance, informed by our experience of real module test data.
Inverter efficiency	Loss due to inverter inefficiencies in converting DC power from the modules to an AC power the grid can accept.	Modelled in PVsyst based on datasheet inverter efficiency information.
Undersizing of the inverter	This power loss is caused when inverter power is determined by the AC output power rating of the inverter components rather than available DC power at its input from the PV system. This loss typically occurs due to the DC field being oversized with respect to the AC rated output of the inverter.	This is modelled in PVsyst based on module and inverter datasheet information as well as the electrical design for the site.
MPPT performance	Loss due to accuracy of the maximum power point tracking algorithm of the inverter. As operating conditions change, the inverter must determine the maximum power available from the modules and adjusts the operating point as required. The accuracy of this control algorithm incurs a loss.	We have developed a methodology to estimate the MPPT loss, based on climatic information for the site region, and detailed inverter efficiency information if available.
Inverter PF clipping	When the inverter is operating at close to full load under non-unity Power Factor, it may need to reduce its active power (P [kW]) to enable the reactive power (Q [kVar]) to flow.	This is modelled in PVsyst based on the inverter datasheet information as well as the PF requirements for the project.
Ohmics, AC LV wiring	Electrical loss due to the Joule Effect proportional to the voltage drop along the wiring between the inverters and the transformers.	We have assumed a highly efficient three-phase busbar connection from the inverters to the LV:MV transformers.
LV to MV transformer	Loss due to how efficiently the transformer is able to convert the power from LV to MV for	Assuming a low load loss transformer from as part of the SMA turnkey solution in operation.

	compliance with the connection characteristics of the grid.	Similar to the EU Ecodesign Guideline 2009/125/EG compliant transformers.
Ohmics, AC MV wiring	Electrical loss due to the Joule Effect proportional to the voltage drop along the wiring between the transformers and point of connection.	Estimated based on our experience for this type of project design and site conditions. More detailed analysis can be applied if cable loss calculations are provided for review.
MV to HV transformer	Loss due to how efficiently the transformer is able to convert the power from MV to HV for compliance with the connection characteristics of the grid.	Estimated based on our experience for this type of project design and site conditions and the specifications in the provided EPC contract. More detailed analysis can be applied transformer datasheets are provided for review.
Self-consumption	Loss due to energy consumption from the site deducted from the generation, which can include fans, heaters, air conditioning, CCTV, lights, etc. This loss does not account for the imported energy when the plant is not producing energy, i.e. self-consumption during standby and night-time is excluded.	Estimated based on our experience for this type of project and location This loss is also exclusive of any large on-site loads.
AC losses due to PF	Losses due to the reduction in active power capability of the inverter and the reactive current running through the AC components when not running at unity power factor.	Estimated based on our experience for this type of project design and site conditions. More detailed analysis can be applied if cable loss calculations and transformer specifications are provided for review.
Evacuation line loss	Electrical loss due to the Joule Effect proportional to the voltage drop along the wiring between the transformers and point of connection.	We have not calculated any transmission line loss since it was confirmed by the us that the export meters are at onsite substation. Should this assumption change at further stages, the yield numbers would have to be updated.
Module degradation	Loss due to natural degradation of the modules performance during its operating life.	We have undertaken a literature review on module degradation, and considers a linear annual degradation rate of 0.4% to be an appropriate assumption for crystalline silicon modules.

Appendix 5. Loss Assumptions

E. Uncertainty in Yield Modelling Assumptions

Uncertainties in the GHI, GII and PR modelling assumptions are shown in Table 24. Note these figures impact the overall yield of the plant:

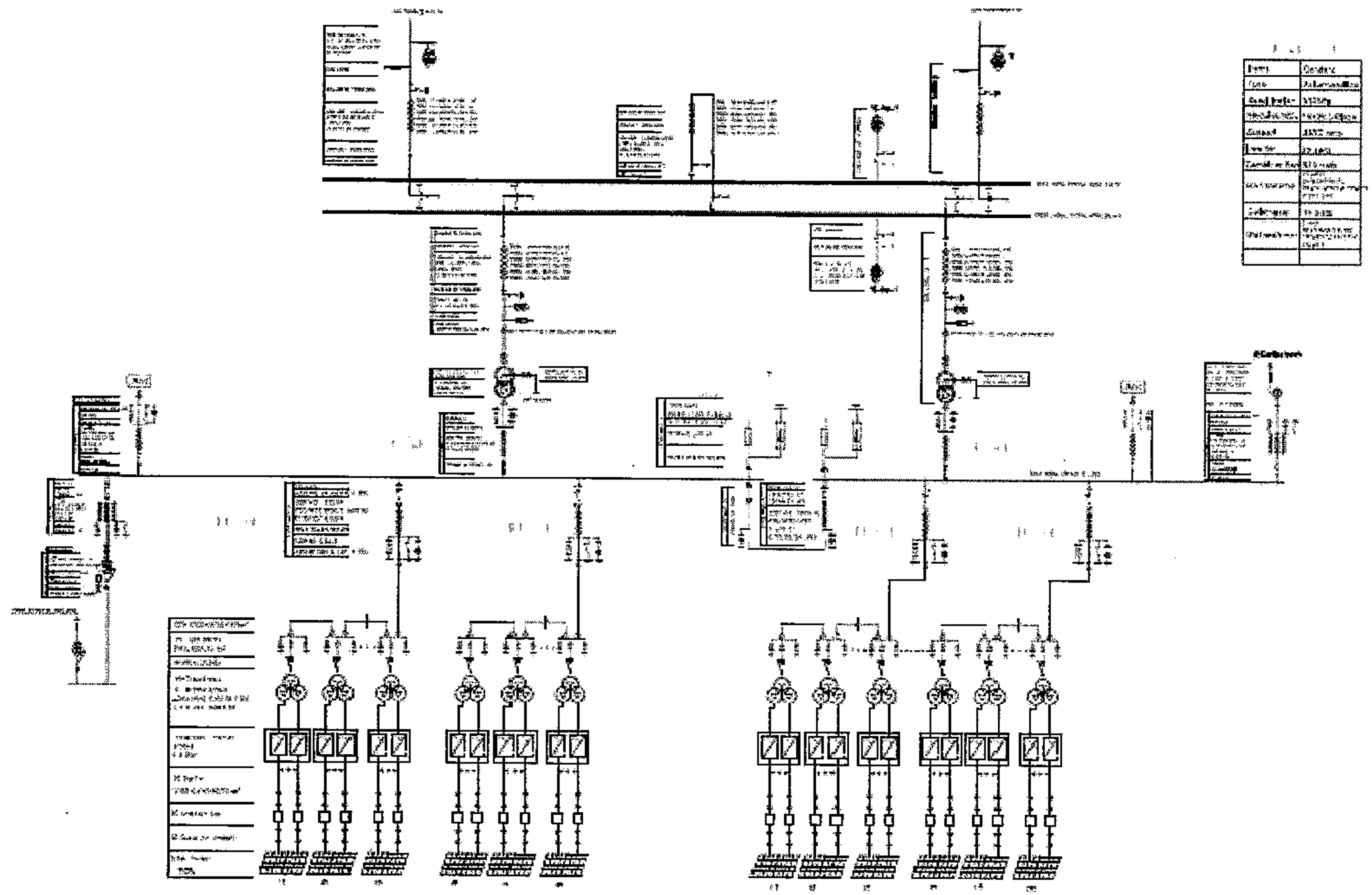
Item	Uncertainty on energy	Explanation
Global Horizontal Irradiance	± 3.2%	Uncertainty associated with metrological and methodical uncertainty of the site-specific solar resource and the applied value in yield calculations.
Horizontal-to-inclined calculation	± 0.8%	Additional uncertainty associated with the calculation model for the different components of inclined surface irradiation.
Near shadings	± 1.0%	Uncertainty arising from the temporal resolution and from the approximations made in the simulation.
Spectral	± 0.5%	Uncertainty due to the estimation of the effect of solar spectrum on modules according to literature.
Angular / IAM	± 0.3%	Uncertainty associated with the calculation model.
Soiling / snow cover	± 2.0%	Uncertainty associated with the estimation of soiling loss and/or losses due to snow cover.
Low irradiation	± 0.3%	Uncertainties of η(G) mainly arise only during periods of low irradiance.
LID	± 0.5%	Uncertainty associated with the estimation of LID loss.
Module quality / power tolerance	± 1.5%	Uncertainty (standard deviation) obtained in round-robin tests performed at international calibration laboratories.
Module temperature losses	± 0.7%	Uncertainty arising from uncertainties of input data.
Mismatch	± 0.4%	Uncertainty coming from input data tolerances as well as approximations made in the calculation.
Ohmics, DC wiring	± 0.5%	Uncertainty arising mainly due to the calculation of low DC power.
Inverter efficiency	± 0.7%	Uncertainty arising from uncertainties of input data as well as approximations made in the model.

Undersizing of the inverter	± 0.0%	Uncertainty induced by temporal resolution and approximations made in the simulation.
MPPT performance	± 0.2%	Uncertainty coming from input data uncertainties and approximations made in the calculation.
Inverter PF clipping	± 0.0%	Uncertainty coming from calculation inputs.
Ohmics, AC LV wiring	± 0.0%	Uncertainty arising mainly due to the calculation of low voltage AC power.
Ohmics, AC MV wiring	± 0.1%	Uncertainty arising mainly due to the calculation of medium voltage AC power.
LV to MV transformer	± 0.4%	Uncertainty in the calculation of transformer losses.
MV to HV transformer	± 0.2%	Uncertainty in the calculation of transformer losses.
Self-consumption	± 0.3%	Uncertainty in the calculation of self-consumption losses.
AC losses due to PF	± 0.1%	Uncertainty coming from calculation inputs.
Degradation	± 0.3%	Uncertainty due to the assumption of published degradation rates.
MV to HV transformer	± 0.2%	Uncertainty in the calculation of transformer losses.
Total uncertainty	**± 4.6%**	

Appendix 6. Uncertainty Analysis Assumptions

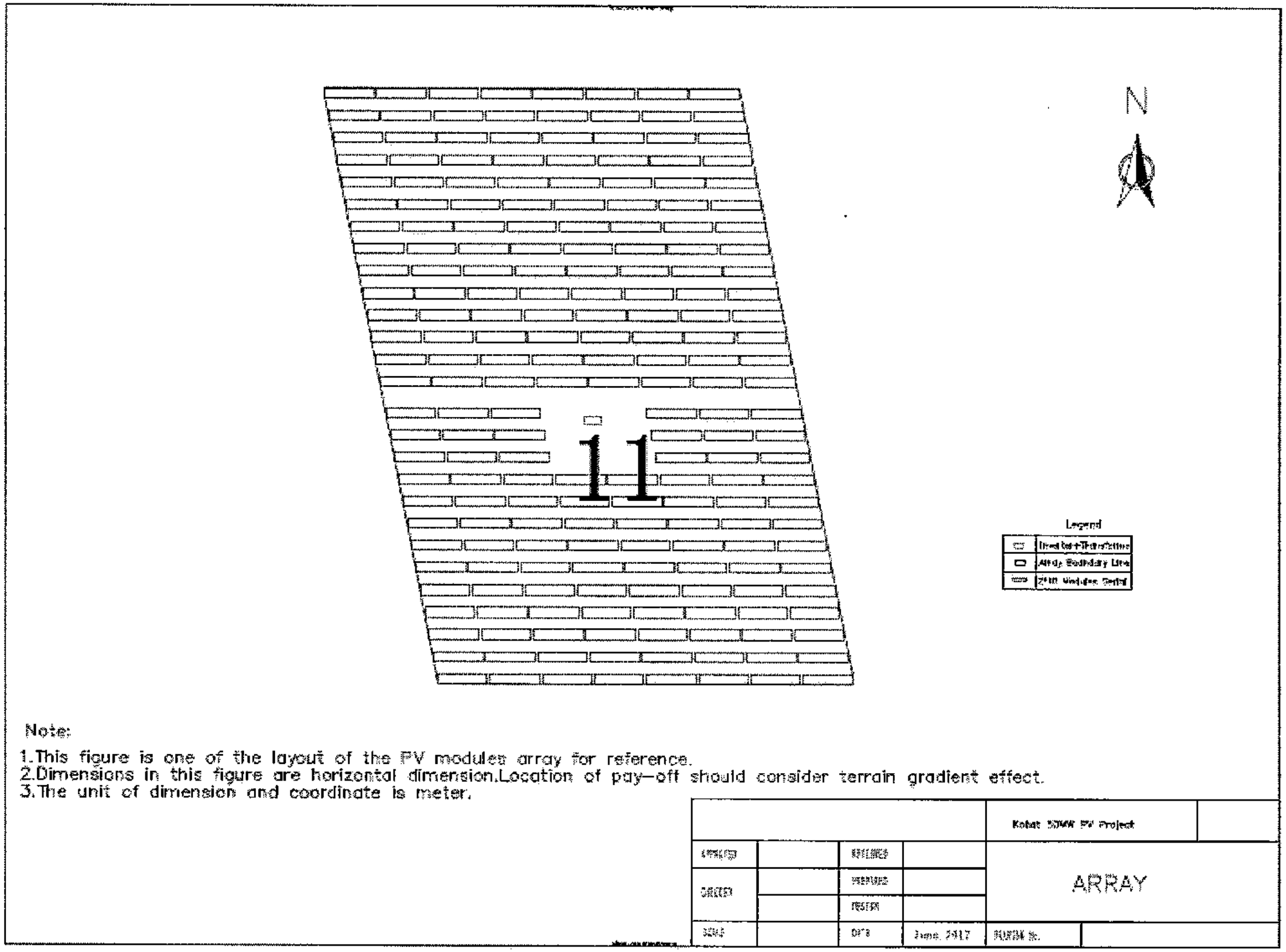
GHI uncertainty is combined uncertainty from basic metrological calibration uncertainty (±1.6%), our approach (±2.5%) and site-specific variance of the solar resource databases as presented in section 6.1.1. Uncertainties are combined using the standard error approach. The overall uncertainty in the PR estimations is calculated via the standard error approach and corresponds to a value of ± 4.6%.

F. Single Line Diagram

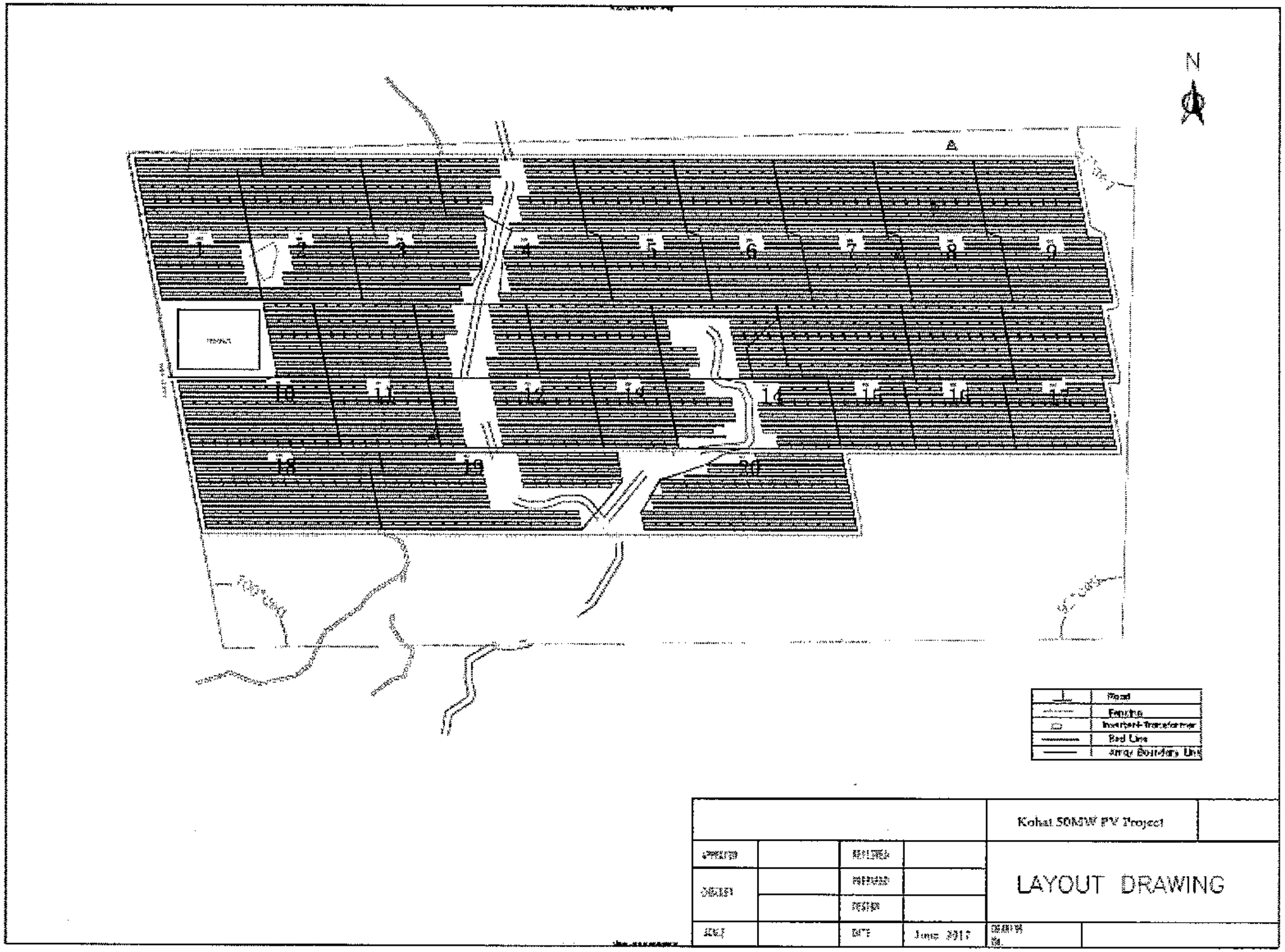


Appendix 7. SLD of 50 MW Solar PV Plant in Kohat

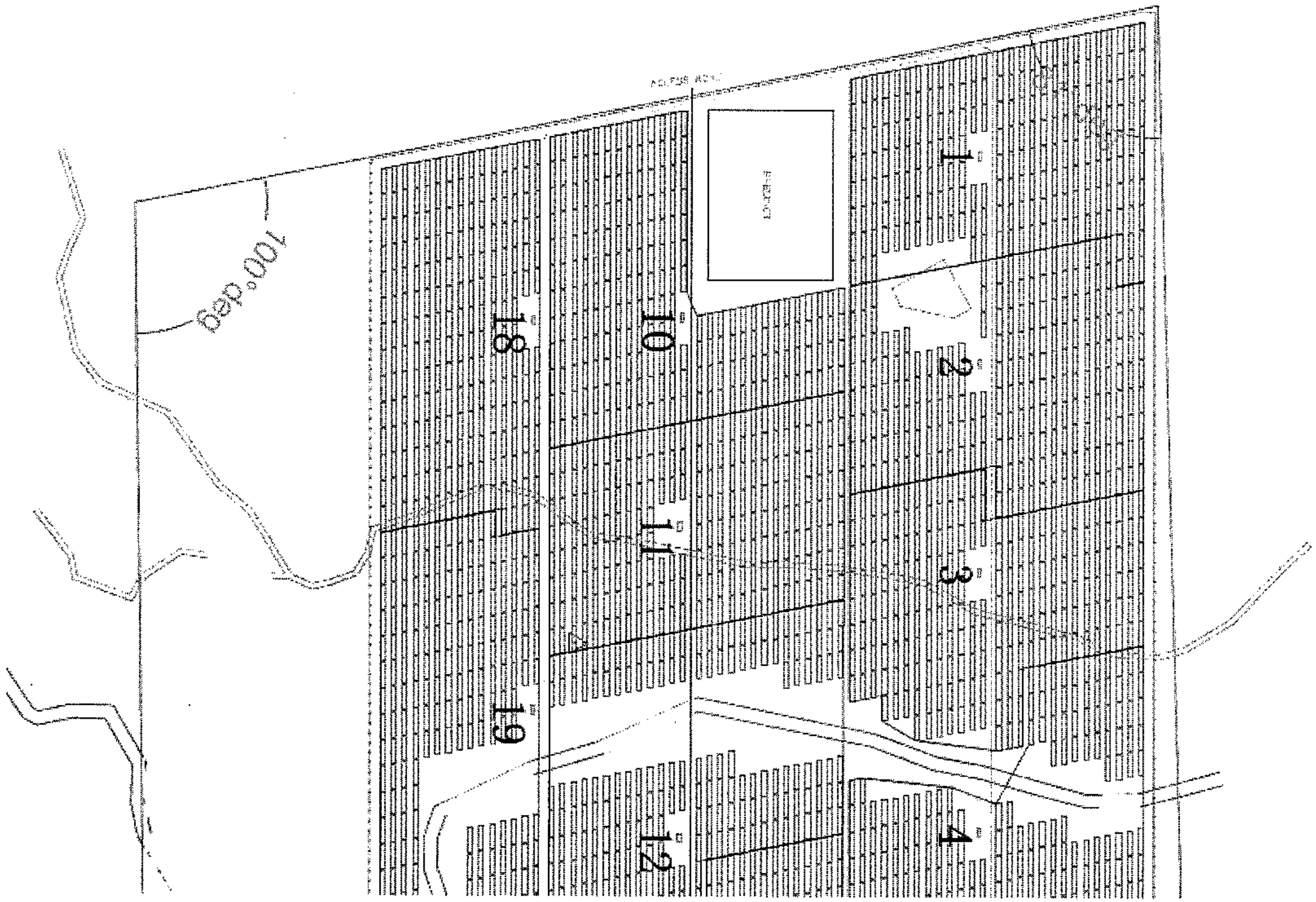
G. Plant Layout & Design



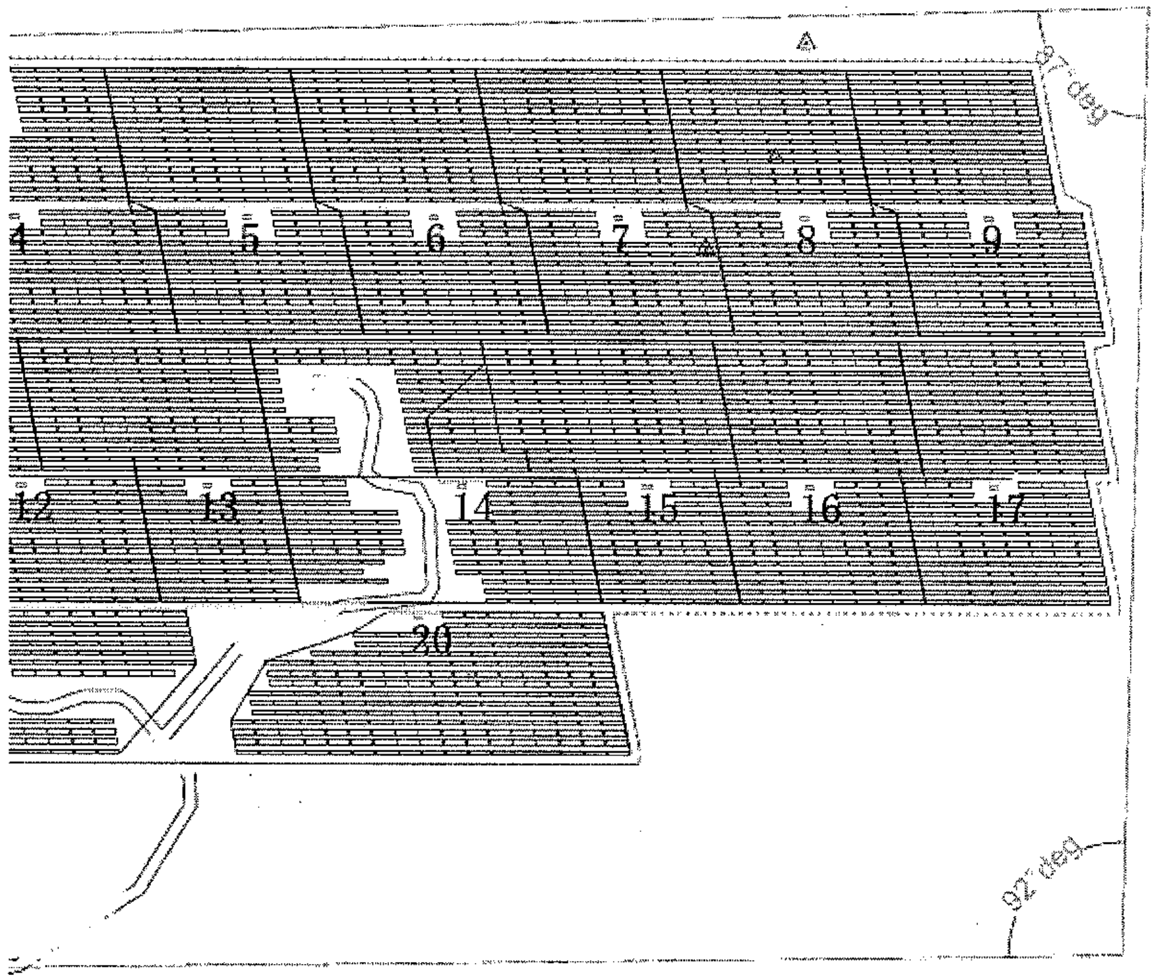
Appendix 8. Single Array Layout – Kohat



Appendix 9. Solar PV Plant - Kohat - Full Layout

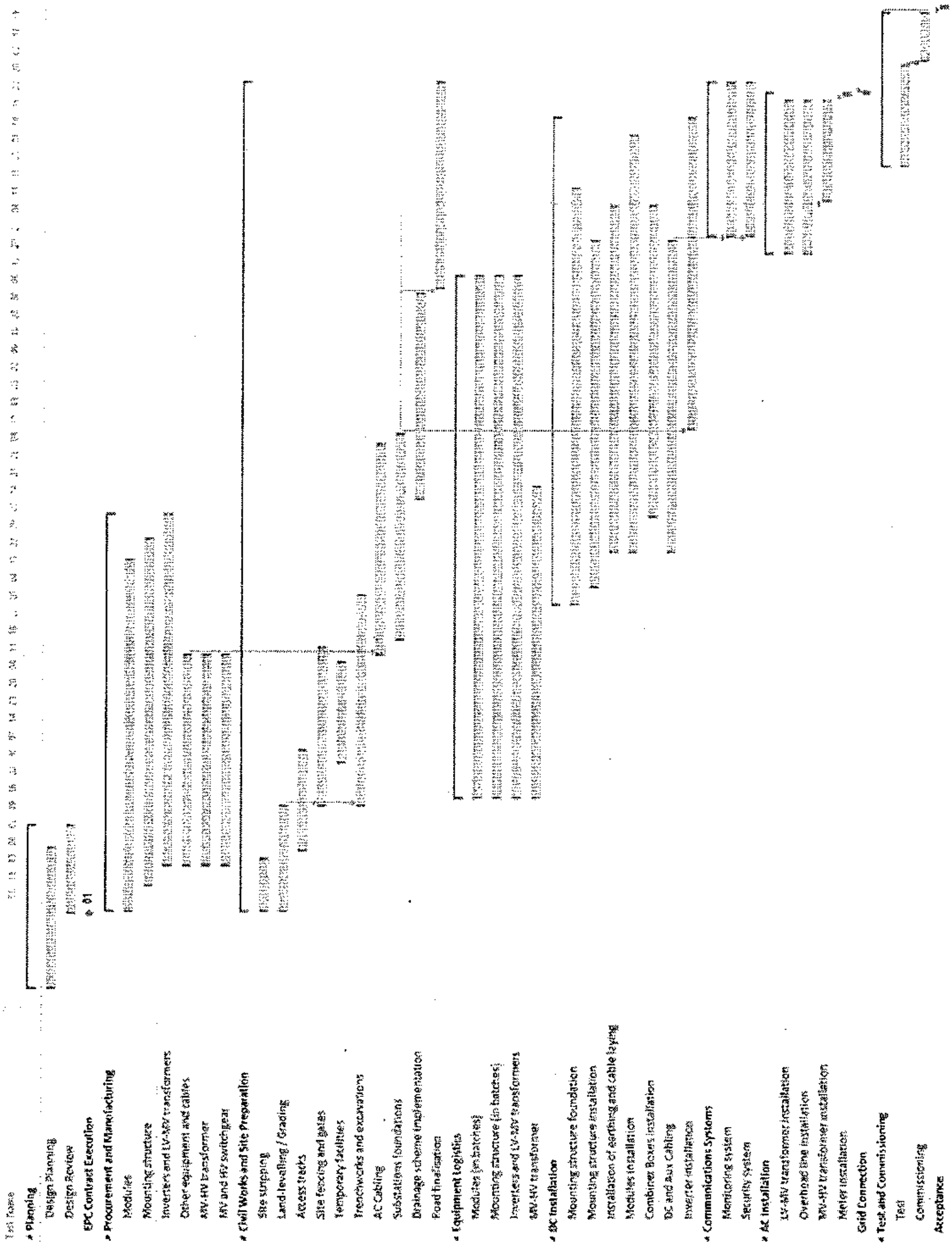


Appendix 10. Detailed Site View - Part I



Appendix 11. Detailed Site View - Part II

H. Project Schedule



Appendix 12. Project Schedule

I. P&L and Balance Sheets

20170531_Pakistan_
solar_for feasbility s

Balance Sheet

20170531_Pakistan_
solar_for feasbility s

Profit & Loss Statement

Appendix 13. Balance Sheet and P&L Statement

Start Date	date		1-May-18	1-May-19	1-May-20	1-May-21	1-May-22	1-May-23	1-May-24	1-May-25
Final Date	date		30-Apr-19	30-Apr-20	30-Apr-21	30-Apr-22	30-Apr-23	30-Apr-24	30-Apr-25	30-Apr-26
BALANCE SHEET										
ASSETS										
Non-Current Assets										
[Spare]										
Capital WIP	PKRk	5,374,328	-	-	-	-	-	-	-	-
Gross Long Term Assets	PKRk	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328
Accumulated Depreciation & Amortization	PKRk	(5,374,328)	(270,111)	(483,369)	(696,045)	(908,721)	(1,121,396)	(1,334,655)	(1,547,331)	(1,760,006)
Sub-total Non-Current Assets	PKRk	5,374,328	5,104,216	4,890,958	4,678,282	4,465,607	4,252,931	4,039,673	3,826,997	3,614,321
Current Assets										
Cash	PKRk	51,007	11,837	12,615	13,441	14,322	15,260	16,253	17,329	18,464
Legal Reserve (cash element)	PKRk	-	-	-	-	-	-	-	-	-
Pre-funded Working Capital at COD	PKRk	79,689	-	-	-	-	-	-	-	-
DSRA	PKRk	458,062	206,107	218,047	231,328	245,014	248,978	260,832	276,464	292,465
MRA	PKRk	-	-	-	-	-	-	-	-	-
DPA	PKRk	-	-	-	-	-	-	-	-	-
Inverters Warranty	PKRk	-	-	-	-	-	-	-	-	-
VAT Receivable	PKRk	-	-	-	-	-	-	-	-	-
Accounts Receivables	PKRk	276,568	101,811	107,903	115,465	122,861	130,776	138,441	148,155	157,684
Sub-total Current Assets	PKRk	748,668	319,756	338,564	360,234	382,217	395,015	415,536	441,947	468,533
TOTAL ASSETS	PKRk	5,655,801	5,423,972	5,229,523	5,038,517	4,847,824	4,647,946	4,455,209	4,268,944	4,082,955
LIABILITIES										
Non-Current Liabilities										
Senior Debt	PKRk	4,304,143	4,222,135	4,271,679	4,300,127	4,304,143	4,279,699	4,247,956	4,183,628	4,079,431
Junior Debt	PKRk	-	-	-	-	-	-	-	-	-
Sub-Debt	PKRk	-	-	-	-	-	-	-	-	-
Sub-total Non-Current Liabilities	PKRk	4,304,143	4,222,135	4,271,679	4,300,127	4,304,143	4,279,699	4,247,956	4,183,628	4,079,431
Current Liabilities										
Accounts Payables	PKRk	101,556	15,168	16,362	17,647	19,033	20,529	25,575	27,602	29,790
VAT Payables	PKRk	-	-	-	-	-	-	-	-	-
Deferred Corporate Tax Liability/(Asset)	PKRk	-	-	-	-	-	-	-	-	-
Sub-total Current Liabilities	PKRk	101,556	15,168	16,362	17,647	19,033	20,529	25,575	27,602	29,790
EQUITY										
Share Capital	PKRk	201,573	201,573	201,573	201,573	201,573	201,573	201,573	201,573	201,573
Legal Reserve Account	PKRk	-	-	-	-	-	-	-	-	-
Retained Earnings	PKRk	(44,398,650)	(429,489)	(815,421)	(1,193,891)	(1,566,965)	(1,933,414)	(2,338,322)	(2,736,371)	(3,139,175)
Shareholders' Loan	PKRk	78,285,705	1,414,585	1,555,329	1,713,061	1,890,040	2,079,558	2,316,425	2,592,512	2,911,336
Sub-total Equity	PKRk	78,487,279	1,186,669	941,482	720,743	524,648	347,716	181,677	57,714	(26,266)
TOTAL EQUITY AND LIABILITIES	PKRk	78,487,279	5,423,972	5,229,523	5,038,517	4,847,824	4,647,946	4,455,209	4,268,944	4,082,955

Start Date	1-May-26	1-May-27	1-May-28	1-May-29	1-May-30	1-May-31	1-May-32	1-May-33	1-May-34
Final Date	30-Apr-27	30-Apr-28	30-Apr-29	30-Apr-30	30-Apr-31	30-Apr-32	30-Apr-33	30-Apr-34	30-Apr-35
BALANCE SHEET									
ASSETS									
Non-Current Assets									
[Spare]									
Capital WIP	-	-	-	-	-	-	-	-	-
Gross Long Term Assets	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328
Accumulated Depreciation & Amortization	(1,972,682)	(2,185,940)	(2,398,615)	(2,611,292)	(2,823,667)	(3,037,226)	(3,249,901)	(3,462,577)	(3,675,253)
Sub-total Non-Current Assets	3,401,646	3,188,387	2,975,712	2,763,036	2,550,360	2,337,102	2,124,426	1,911,750	1,699,075
Current Assets									
Cash	19,674	20,967	22,340	23,804	25,364	27,030	28,802	30,669	32,700
Legal Reserve (cash element)	-	-	-	-	-	-	-	-	-
Pre-funded Working Capital at COD	-	-	-	-	-	-	-	-	-
DSRA	309,423	328,752	345,297	366,284	387,390	408,926	433,290	458,052	-
MRA	-	-	-	-	-	-	-	-	-
DPA	-	-	-	-	-	-	-	-	-
Inverters Warranty	-	-	-	-	-	-	-	-	-
VAT Receivable	-	-	-	-	-	-	-	-	-
Accounts Receivables	167,829	177,681	190,164	202,412	215,454	228,120	244,189	259,918	276,668
Sub-total Current Assets	496,926	525,399	558,802	592,500	628,207	664,077	706,220	748,668	309,368
TOTAL ASSETS	3,898,572	3,713,787	3,534,513	3,355,536	3,178,568	3,001,179	2,830,647	2,660,419	2,008,463
LIABILITIES									
Non-Current Liabilities									
Senior Debt	3,929,486	3,727,933	3,464,775	3,130,866	2,716,534	2,211,201	1,600,719	869,861	-
Junior Debt	-	-	-	-	-	-	-	-	-
Sub-Debt	-	-	-	-	-	-	-	-	-
Sub-total Non-Current Liabilities	3,929,486	3,727,933	3,464,775	3,130,866	2,716,534	2,211,201	1,600,719	869,861	-
Current Liabilities									
Accounts Payables	32,152	34,711	37,457	40,443	43,658	47,139	50,889	54,940	59,315
VAT Payables	-	-	-	-	-	-	-	-	-
Deferred Corporate Tax Liability/(Asset)	-	-	-	-	-	-	-	-	-
Sub-total Current Liabilities	32,152	34,711	37,457	40,443	43,658	47,139	50,889	54,940	59,315
EQUITY									
Share Capital	201,573	201,573	201,573	201,573	201,573	201,573	201,573	201,573	201,573
Legal Reserve Account	-	-	-	-	-	-	-	-	-
Retained Earnings	(3,549,719)	(3,982,092)	(4,434,693)	(4,923,146)	(5,461,852)	(6,076,737)	(6,790,368)	(7,611,599)	(8,808,993)
Shareholders' Loan	3,285,079	3,731,661	4,265,391	4,905,800	5,678,655	6,618,002	7,757,832	9,145,904	10,399,567
Sub-total Equity	(63,066)	(48,858)	32,272	184,227	418,376	742,839	1,179,029	1,735,878	1,849,148
TOTAL EQUITY AND LIABILITIES	3,892,572	3,713,787	3,534,513	3,355,536	3,178,568	3,001,179	2,830,647	2,660,419	2,008,463

Start Date	1-May-35	1-May-36	1-May-37	1-May-38	1-May-39	1-May-40	1-May-41	1-May-42
Final Date	30-Apr-36	30-Apr-37	30-Apr-38	30-Apr-39	30-Apr-40	30-Apr-41	30-Apr-42	30-Apr-43
BALANCE SHEET								
ASSETS								
Non-Current Assets								
[Spare]								
Capital WIP	-	-	-	-	-	-	-	-
Gross Long Term Assets	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328	5,374,328
Accumulated Depreciation & Amortization	(3,888,511)	(4,101,187)	(4,313,862)	(4,526,538)	(4,739,797)	(4,952,472)	(5,165,148)	(5,374,328)
Sub-total Non-Current Assets	1,485,816	1,273,141	1,060,465	847,789	634,531	421,855	209,180	-
Current Assets								
Cash	34,648	37,131	39,564	42,157	44,927	47,870	51,007	-
Legal Reserve (cash element)	-	-	-	-	-	-	-	-
Pre-funded Working Capital at COD	-	-	-	-	-	-	-	-
DSRA	-	-	-	-	-	-	-	-
MRA	-	-	-	-	-	-	-	-
DPA	-	-	-	-	-	-	-	-
Inverters Warranty	-	-	-	-	-	-	-	-
VAT Receivable	-	-	-	-	-	-	-	-
Accounts Receivables	174,247	187,101	190,809	213,386	226,683	243,438	260,004	-
Sub-total Current Assets	208,895	224,233	239,373	255,543	271,609	291,308	311,011	-
TOTAL ASSETS	1,694,911	1,497,374	1,299,838	1,103,332	906,141	713,163	520,191	-
LIABILITIES								
Non-Current Liabilities								
Senior Debt	-	-	-	-	-	-	-	-
Junior Debt	-	-	-	-	-	-	-	-
Sub-Debt	-	-	-	-	-	-	-	-
Sub-total Non-Current Liabilities	-	-	-	-	-	-	-	-
Current Liabilities								
Accounts Payables	64,054	69,160	74,675	80,633	87,088	94,042	101,556	-
VAT Payables	-	-	-	-	-	-	-	-
Deferred Corporate Tax Liability/(Asset)	-	-	-	-	-	-	-	-
Sub-total Current Liabilities	64,054	69,160	74,675	80,633	87,088	94,042	101,556	-
EQUITY								
Share Capital	201,573	201,573	201,573	201,573	201,573	201,573	201,573	201,573
Legal Reserve Account	-	-	-	-	-	-	-	-
Retained Earnings	(10,689,002)	(13,165,249)	(16,157,205)	(19,788,224)	(24,270,065)	(29,641,099)	(36,273,262)	(44,398,650)
Shareholders' Loan	12,118,295	14,391,889	17,180,796	20,609,449	24,847,535	30,058,587	36,490,324	44,197,085
Sub-total Equity	1,630,867	1,428,214	1,225,163	1,022,899	819,053	619,121	418,635	-
TOTAL EQUITY AND LIABILITIES	1,694,911	1,497,374	1,299,838	1,103,332	906,141	713,163	520,191	-

Start Date	date		1-May-18	1-May-19	1-May-20	1-May-21	1-May-22	1-May-23	1-May-24	1-May-25	1-May-26	1-May-27	1-May-28	1-May-29	1-May-30	1-May-31	1-May-32	1-May-33	1-May-34	1-May-35	1-May-36	1-May-37	1-May-38	1-May-39	1-May-40	1-May-41	1-May-42
Final Date	date		30-Apr-19	30-Apr-20	30-Apr-21	30-Apr-22	30-Apr-23	30-Apr-24	30-Apr-25	30-Apr-26	30-Apr-27	30-Apr-28	30-Apr-29	30-Apr-30	30-Apr-31	30-Apr-32	30-Apr-33	30-Apr-34	30-Apr-35	30-Apr-36	30-Apr-37	30-Apr-38	30-Apr-39	30-Apr-40	30-Apr-41	30-Apr-42	30-Apr-43
PROFIT & LOSS STATEMENT																											
Calculation Currency																											
Energy Invoice	PKRk	37,804,026	805,594	859,489	914,742	973,489	1,036,032	1,102,712	1,173,698	1,249,181	1,329,547	1,415,238	1,506,469	1,603,490	1,705,795	1,816,957	1,934,251	2,058,999	2,191,841	1,386,773	1,481,020	1,581,594	1,689,053	1,804,039	1,926,895	2,058,012	2,198,119
Other Income - Land sale	PKRk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liquidated Damages for Delay	PKRk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Income	PKRk	37,804,026	805,594	859,489	914,742	973,489	1,036,032	1,102,712	1,173,698	1,249,181	1,329,547	1,415,238	1,506,469	1,603,490	1,705,795	1,816,957	1,934,251	2,058,999	2,191,841	1,386,773	1,481,020	1,581,594	1,689,053	1,804,039	1,926,895	2,058,012	2,198,119
Operating Expenses	PKRk	(14,970,826)	(181,128)	(195,904)	(210,716)	(227,269)	(245,134)	(306,170)	(329,538)	(355,657)	(383,862)	(415,520)	(447,303)	(482,831)	(521,200)	(564,270)	(607,521)	(655,872)	(708,097)	(766,721)	(825,610)	(891,444)	(962,561)	(1,042,399)	(1,122,615)	(1,212,297)	(1,309,187)
Inverters Warranty Expense	PKRk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Operating Expenses	PKRk	(14,970,826)	(181,128)	(195,904)	(210,716)	(227,269)	(245,134)	(306,170)	(329,538)	(355,657)	(383,862)	(415,520)	(447,303)	(482,831)	(521,200)	(564,270)	(607,521)	(655,872)	(708,097)	(766,721)	(825,610)	(891,444)	(962,561)	(1,042,399)	(1,122,615)	(1,212,297)	(1,309,187)
EBITDA	PKRk	22,833,200	624,467	663,585	704,025	746,220	790,898	795,542	844,160	893,523	945,684	999,718	1,059,166	1,120,659	1,185,595	1,252,687	1,326,729	1,403,127	1,483,744	620,052	655,411	690,150	726,492	761,641	804,280	845,714	888,932
Amortization and Depreciation	PKRk	(5,374,328)	(270,111)	(213,258)	(212,676)	(212,676)	(212,676)	(213,258)	(212,676)	(212,676)	(212,676)	(213,258)	(212,676)	(212,676)	(212,676)	(213,258)	(212,676)	(212,676)	(212,676)	(213,258)	(212,676)	(212,676)	(212,676)	(213,258)	(212,676)	(212,676)	(209,180)
EBIT	PKRk	17,458,872	354,355	450,327	491,349	533,544	578,222	583,284	631,484	680,848	733,009	786,460	846,490	907,983	972,919	1,039,429	1,114,053	1,190,451	1,271,068	406,793	442,735	477,474	513,916	548,382	591,604	633,039	679,752
Interest and Fees - Senior & Junior Debt	PKRk	(2,943,406)	(202,411)	(205,373)	(208,319)	(209,820)	(210,158)	(209,975)	(208,101)	(205,183)	(200,354)	(193,848)	(183,859)	(171,396)	(155,638)	(136,178)	(111,724)	(92,537)	(47,571)	-	-	-	-	-	-	-	-
Interest and Fees - SHL & Sub-debt	PKRk	(39,506,584)	(217,443)	(239,440)	(262,664)	(289,404)	(319,489)	(353,032)	(392,798)	(439,961)	(494,606)	(560,613)	(636,119)	(728,229)	(838,906)	(975,569)	(1,135,577)	(1,333,100)	(1,574,139)	(1,776,865)	(2,096,727)	(2,481,574)	(2,955,250)	(3,572,897)	(4,299,583)	(5,206,113)	(6,325,426)
Senior DSRA - LC Charges	PKRk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LS LC Charges	PKRk	(342,284)	(7,608)	(8,126)	(8,624)	(9,178)	(9,766)	(10,425)	(11,095)	(11,778)	(12,526)	(13,381)	(14,204)	(15,118)	(16,093)	(17,180)	(18,238)	(19,415)	(16,439)	(13,133)	(13,997)	(14,937)	(15,862)	(17,086)	(18,199)	(19,438)	(10,296)
PPI Fee	PKRk	(151,393)	(30,025)	(28,031)	(25,401)	(22,315)	(18,624)	(14,105)	(9,234)	(3,658)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Others - FX and VAT expiry	PKRk	(18,913,946)	(338,711)	(354,269)	(364,811)	(375,901)	(385,632)	(398,553)	(410,394)	(423,072)	(435,047)	(450,951)	(464,900)	(481,893)	(501,026)	(525,387)	(552,144)	(565,732)	(630,213)	(684,804)	(818,267)	(972,920)	(1,162,732)	(1,400,131)	(1,684,806)	(2,035,711)	(2,469,427)
Financial Revenues	PKRk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal Interest, Fees and Charges	PKRk	(61,857,531)	(798,199)	(836,258)	(869,820)	(906,619)	(944,672)	(986,191)	(1,031,533)	(1,083,652)	(1,143,552)	(1,218,832)	(1,299,091)	(1,396,437)	(1,511,625)	(1,654,314)	(1,817,683)	(2,021,784)	(2,268,362)	(2,488,802)	(2,918,981)	(3,469,432)	(4,144,934)	(4,990,114)	(6,002,588)	(7,285,251)	(8,805,149)
Profit Before Tax	PKRk	(44,398,659)	(441,843)	(385,931)	(378,470)	(373,074)	(366,449)	(402,907)	(400,049)	(402,804)	(410,543)	(432,373)	(452,601)	(488,454)	(538,705)	(614,885)	(703,630)	(831,333)	(997,294)	(2,080,009)	(2,476,246)	(2,991,957)	(3,631,118)	(4,441,732)	(5,410,984)	(6,632,223)	(8,125,397)
Current Tax	PKRk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deferred Tax	PKRk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profit After Tax	PKRk	(44,398,659)	(441,843)	(385,931)	(378,470)	(373,074)	(366,449)	(402,907)	(400,049)	(402,804)	(410,543)	(432,373)	(452,601)	(488,454)	(538,705)	(614,885)	(703,630)	(831,333)	(997,294)	(2,080,009)	(2,476,246)	(2,991,957)	(3,631,118)	(4,441,732)	(5,410,984)	(6,632,223)	(8,125,397)

Environmental Protection Agency
Forestry, Environment & Wildlife Department
Govt. of Khyber Pakhtunkhwa

No. EPA/IEE/Solar/50MW/K/924 Dated 26/09/2017

To

Mr. Khawaja Bilal Hussain (CEO),
Renewable Projects,
Siddiqsons Nowshera Solar Limited,
7th Floor, Siddiqsons Tower, 3 J.C.H. Society,
Block 7& 8, Main Shahrah-e-Faisal, Karachi.

Subject: **SUBMISSION OF INITIAL ENVIRONMENTAL EXAMINATION (IEE) REPORT OF 50 MW SOLAR PV PROJECT IN KOHAT DISTRICT, KPK**

I am directed to refer to the subject cited above and to enclose herewith Environmental Approval/Decision Note on IEE Report of "50MW Solar PV Project, District Kohat" for your information and further implementation.

Moreover, Schedule VII must be submitted to this Agency within a month on Stamp Paper as an undertaking for the compliance of terms and conditions as mentioned in the Environmental Approval as well as mitigation measures proposed in the IEE Report. (Copy enclosed).

Assistant Director (EIA-II)

DD \EIA Section 2011\Hydro Power Projects\50 MW Solar Project

3rd Floor, Old Courts Building, Khyber Road, Peshawar Cantt.
Tel: 92(91) 9210263-9210148, Fax: 92 (91) 9210280

SCHEDULE-V
Decision on IEE

1. **Name & address of Proponent:** Mr. Khawaja Bilal Hussain (CEO), Renewable Projects, Siddiqsons Nowshera Solar Limited, 7th Floor, Siddiqsons Tower, 3 J.C.H. Society, Block 7& 8, Main Shahrahe Faisal, Karachi.

2. **Description of Project:** 50MW Solar Power Project is proposed to be at District Kohat for scaling up of power generation capacity of the Peshawar Electric Supply Company (PESCO) by adding 50MW. The total area for the proposed project is 284 Acres. The land for the proposed project is located in 25.06 km to the South of the Kohat town, 4.61 km South East of Lachi on Indus Highway (N55) and approx. 75 km South of Provincial capital Peshawar, Khyber Pakhtunkhwa. The proposed project site is approx 5 km from the nearby Lachi-grid station. The project construction duration is twelve (12) months. The power will eventually be supplied at 132KV to nearby Lachi Grid Station.

3. **Location of Project:** The project site is located at District Kohat.

4. **Date of Filing of IEE:** 11-03-2017

5. After careful review, the Environmental Protection Agency , Govt. of Khyber Pakhtunkhwa has decided to accord approval of the Initial Environmental Examination for "50MW Solar PV Project in District Kohat" in line with the guidelines issued by Khyber Pakhtunkhwa Environmental Protection Act, 2014 and IEE/EIA Regulations, 2000, subject to the following terms & conditions:-

a) The proponent will adopt all precautionary and mitigation measures identified in IEE Report as well as any un-anticipated impacts during the construction and operation phase of project.

b) The proponent shall ensure to avoid dumping of debris into down slope. A proper area should be identified for disposal of debris.

c) Land ownership documents/acquisition/lease agreements duly verified shall be provided to EPA before commencement of construction activities.

d) Existing traffic route must not be disturbed and proper signboards should be installed to avoid any inconvenience in the existing Right of Way (RoW).

e) The proponent should ensure the strict and efficient health and safety measures for the

f) Mature Trees on the project area shall be protected. Moreover Plantation should be carried out in the available open spaces of the proposed project area.

g) Proper security/fences shall be installed around the project area.

h) Drinking Water Tube well shall be provided to the nearby community.

i) Two Concrete cemented tanks (each of 20x15x05 feet) shall be constructed as storage of rain water for the cattle grazing by the local people and being water scarce area..

j) Safety of the social & cultural life of the local community shall be ensured.

k) Non-technical jobs must be provided to local community.

l) All conflicting issues regarding compensation, lease agreement etc if any to be settled down before executing or commencing of the project activities and a certificate in this regard should be submitted to EPA.

m) This approval is only issued for the construction activities of the project and not for any other kind of activities.

n) No extension would be permitted in the future in the existing project without prior approval of the EPA/Govt. of Khyber Pakhtunkhwa.

o) The proponent shall provide the copy of this approval and IEE report to the contractor for information and compliance.

6. The proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.
7. The proponent shall be liable for compliance of Regulations 13, 14, 17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.
8. This approval is accorded only for the installation/ construction phase of the project. The proponent will obtain approval for operation of the hydro power project in accordance with the Regulations 13 (2) (b) and 18 of the IEE/EIA Regulations, 2000.
9. Any change in the approved project shall be communicated to EPA, Khyber Pakhtunkhwa and shall be commenced after obtaining the approval.
10. This approval shall be treated as null and void if all or any of the conditions mentioned above is/are not complied with.
11. This approval does not absolve the proponent of the duty to obtain any other approval or clearance that may be required under any law in force.
12. There is no legal case pending in the courts against the project.
13. In exercise of the power under Section 13 of the Khyber Pakhtunkhwa Environmental Protection Act, 2014, the undersigned is pleased to approve the IEE Report for construction phase of the project with above mentioned terms and conditions.

Dated: Peshawar 26.09.2017
Tracking/File.No. **EPA/IEE/50MWSolar/Kohat/** 924

SCHEDULE VII

UNDERTAKING

I ____

as proponent for ______________________________________

do hereby solemnly affirm and declare that I fully understand and accept the conditions contained in the approval accorded by Provincial Agency bearing tracking No. __________________ dated ____________________ and undertake to design construction and operate the project strictly in accordance with the said condition and the IEE/EIA.

Signature____________________

Proprietor___________________

Witnesses:

(1) ______________________________

____

(2) ______________________________

____

siddiqsons

SSL/EPA/171023

23th October, 2017

Director General
Environmental Protection Agency
Government of Khyber Pakhtunkhwa

SUBMISSION OF IEE NO-OBJECTION CERTIFICATE (NOC) UNDERTAKING FOR 50 MW KOHAT SOLAR PV PROJECT

Reference: IEE NOC no. EPA/IEE/solar/50MW/K/924 dated: 26/09/2017

Dear Sir,

With reference to the IEE NOC granted to Siddiqsons Kohat Solar Limited, attached herewith is the undertaking as per your requirement.

Regards,

Umair Ahmed
Project Engineer

Attachment: Undertaking (Schedule-VII)

K752051

100 Rupees ۱۰۰ روپے

STAMP OFFICE CITY COURT KARACHI
[illegible] M. Sabir Adeem
[illegible] 3309 H/c
[illegible] 24 [illegible] 20-10-17
[illegible] 176 [illegible] 20-10-17
[illegible]
Entry No. 24 [illegible] 20-10-17

S. RIZWAN B.A.LL.B. Notary Public UNDERTAKING KARACHI PAKISTAN

RUPEES One Hundred Only

I, Abdur Rahim son of Muhammad Tariq Rafi holding CNIC No. 42201-0409988-5, as proponent for 50 MWp Solar PV Project in Kohat District, Khyber Pakhtunkhuwa Province being developed by Siddiqsons Kohat Solar Limited do hereby solemnly affirm and declare that I fully understand and accept the conditions contained in the approval accorded by the Provincial Agency bearing tracking No. EPA/IEE/Solar/50MW/K/924 dated 26th September 2017 and undertake to design construction and operate the project strictly in accordance with the said condition and the IEE.

Date: 24th October, 2017

Signature: ______

Abdur Rahim
Director
Siddiqsons Kohat Solar Limited

Witnesses:

(1) Ahsan Bashir
42101-4501392-5

(2) Muhammad Murtaza
41204-9170700

ATTESTED

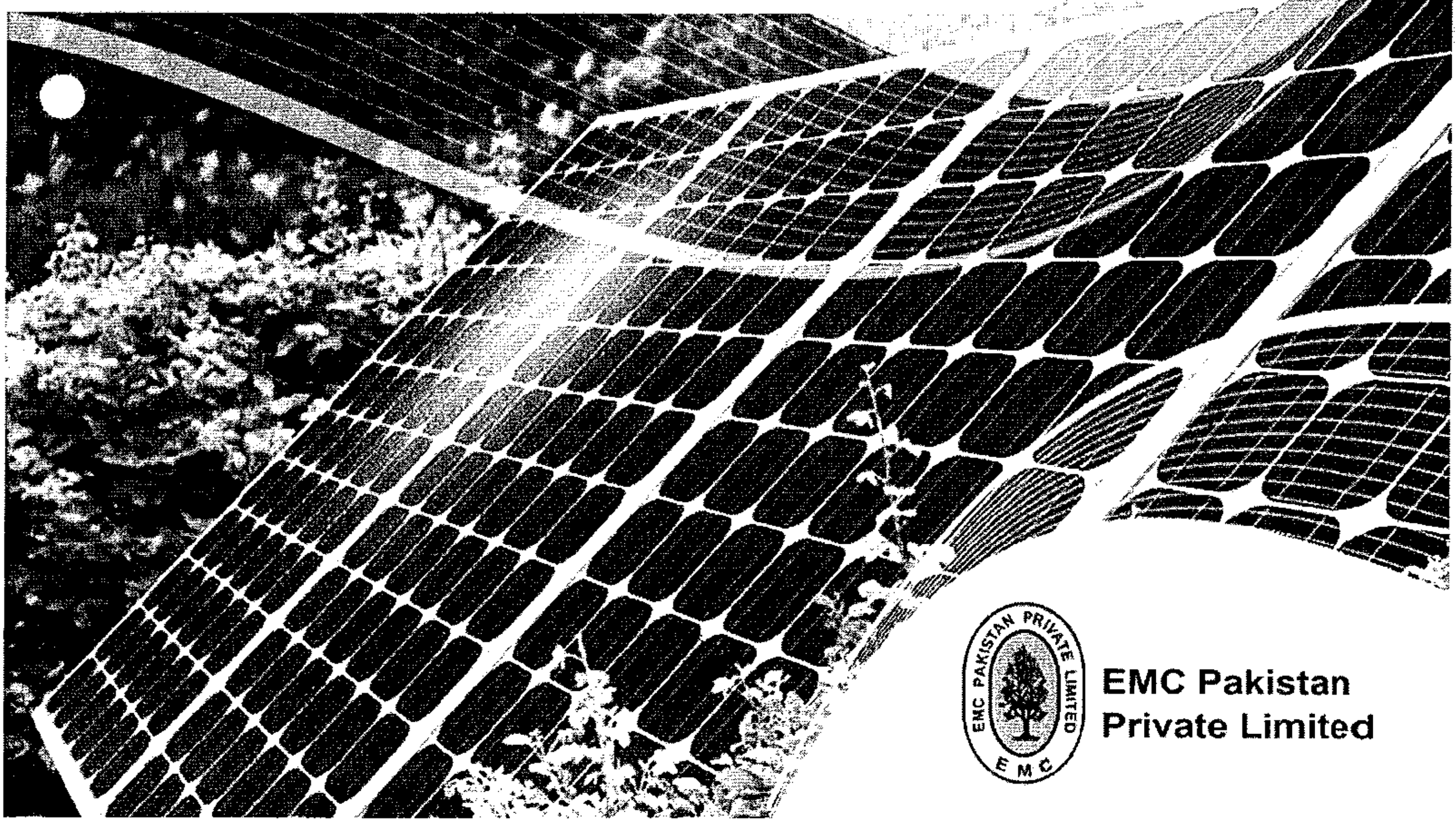
S. RIZWAN ADVOCATE
B.A.L.L.B. NOTARY PUBLIC
KARACHI PAKISTAN

siddiqsons LIMITED

Final Report
February 2017

INITIAL ENVIRONMENTAL EXAMINATION (IEE)

50MW SOLAR PV POWER PLANT IN KOHAT



EMC Pakistan Private Limited

siddiqsons LIMITED

Initial Environmental Examination (IEE)

50 MW Solar PV Power Plant in Kohat

Final Report
March, 2017
Ref: IEE/02/03/17

EMC PAKISTAN PRIVATE LIMITED
EMC

EMC PAKISTAN PVT. LTD.

503, Anum Estate, Opp. Duty Free Shop, Main Shahrah-e-Faisal, Karachi.
Phones(+) 9221- 34311466, 34382860, Fax: (+) 9221-34311467.
E-mail: mail@emc.com.pk, nadeem@emc.com.pk
Website: www.emc.com.pk

Disclaimer:

This report has Attorney – Client Privilege. EMC Pakistan Private Limited has prepared this report in accordance with the instructions of Siddiqsons Kohat Solar Limited for their sole and specific use. Any other persons who use any information contained herein do so at their own risk. This report cannot be used in the court of law for any negotiation or standardization.

Executive Summary

Siddiqsons Kohat Solar Limited is the developer of 50 MWp PV Solar Power Plant that will be located in Lachi tehsil, District Kohat, KPK.

The prime objectives of the solar power project are:

- Diversification of the company's portfolio and invest in energy sector to exploit untapped energy potential of the country
- To supply the renewable electricity to the national grid, thereby reducing power blackouts

In view of the objectives, the proponent have planned to undertake the project which involves design, layout, engineering, planning and supervision, as well as procurement of components.

The site is located 5.06 km to the south east of the town of Lachi, in Khyber Pakhtunkhwa, and approximately 5 kilometres from 132 kV Lachi Sub-Station. The available site is of approximately 115 hectares. The location of the proposed project site is shown in the figure ES.1 below.

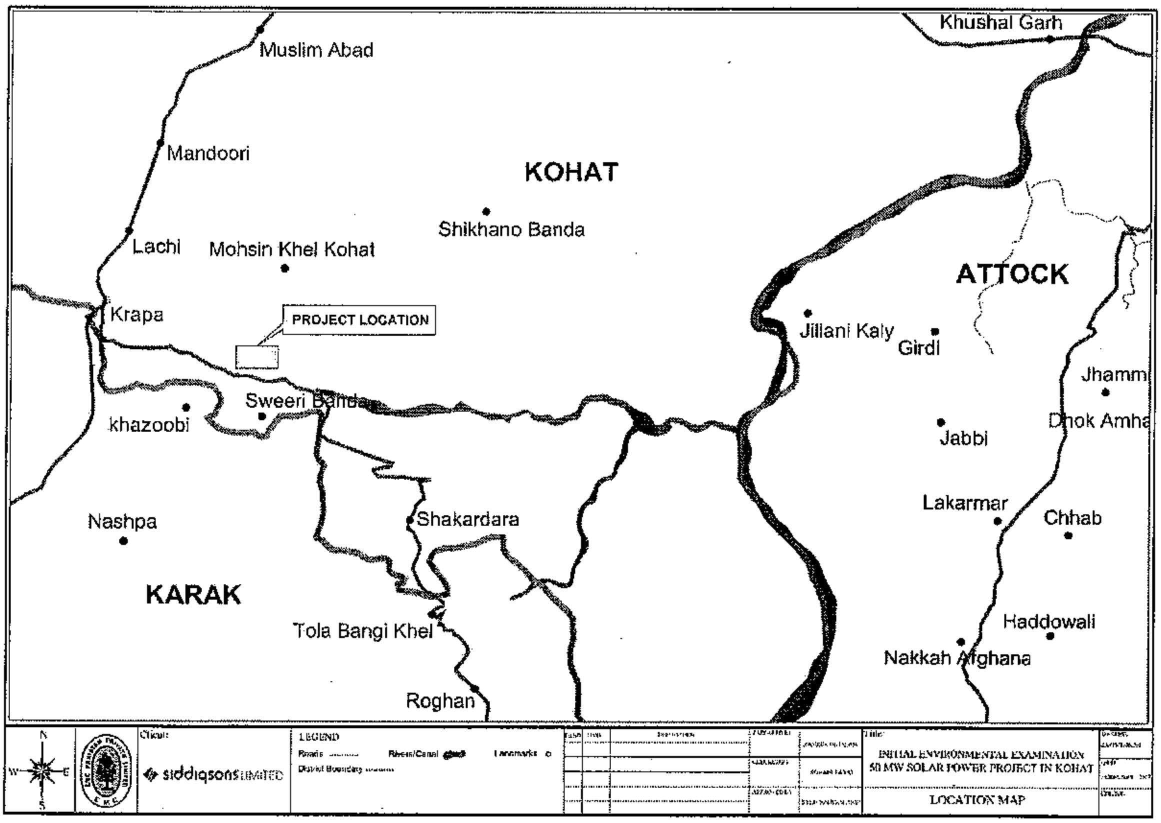


Figure ES.1: Project Location Map

The proposed Power Plant will generate power that would be stepped up to MV by step up transformers attached with the selected inverters. AC power will be stepped up through MV/HV transformer before the metering station. The power will eventually be supplied at 132 kV to grid. Approximately 5 km to the north west of the site runs a 132-kV overhead transmission line (OHL). The preliminary first-year annual energy generation of 78,834 MWh/year was calculated assuming a performance ratio of 78%.

The climate in Kohat is hot, sometimes extremely hot summers and mild to warm winters. It is mainly hot semi-arid climate range from 2°C in January to almost 43 °C in July.

During site visit, the texture of the top layer of the soil was found to be gravely, silty clay with small rocks and light brown in color. No permanent rivers were visible at the site. Water channels were dry during the visit.

Being classified as Schedule I under the PEPA EIA/IEE Regulation 2000, the project is required for an Initial Environmental Examination (IEE) to meet the environmental assessment requirements. The findings of impact assessment and visual inspections of existing environment of the project area in the present scenario indicates following main impacts along with simultaneous relevant and appropriate mitigation measures:

- The air-shed of the project site has, according to the assessment of ambient air quality, been classified as unpolluted. The air quality of the air-shed of the macro environment as well as that of the site itself will have no significant impact.
- The project will add to the overall socioeconomic development of the area.
- Project site has no sensitive areas such as protected sites including wildlife sanctuaries, game reserves or national parks, or any archaeological, historical or cultural heritage in its immediate neighbourhood; as such its siting would have no sensitivity in this regard.
- Mostly there is scanty vegetation in and around the project site. The land is currently barren and uncultivated, with very little vegetation on the site. Most of the terrain is covered with wild bushes & shrubs with only a few small trees along the west boundary of the site. There are scattered villages near the eastern boundary of the site and a few houses are located within the site on a ridge towards the north east. There is some patchy vegetation at the project area which will be removed during project execution (with least disturbance to the natural vegetation structure) and replanted in the ratio of 1:5 in the case of matured tree, and in the ratio of 1:3 in the case of small tree after project completion. The vegetation cover loss shall be minimized as much as possible.
- The waste generated during site clearance will be rejected materials, surplus materials, paper bags, empty cartons, empty paint and solvent containers, packing waste; scrap, excess construction materials and debris etc.
- Non-hazardous non-recyclable wastes will be disposed of in landfill site through municipal administration.
- Prior to the commencement of civil works the Environment, Health and Safety (EHS) specialists will develop a construction phase Occupational Health and Safety Plan (OHSP).
- All transformers will be equipped with spill containment berms in accordance with relevant national standards.
- A transformer maintenance schedule will be developed and usage of transformer oils will be monitored on a regular basis.
- Chemicals and oils should be stored in secure designated areas with permanent impermeable bunds at distance of at least 100 m from any watercourse.

This IEE study was carried out to assess the environmental and socioeconomic impact during the design, installation and operational phase of 50 MW Solar PV Power Plant in Lachi, district Kohat. The assessment was carried out according to the requirements of KPK Environmental Protection Act 2014 and all the applicable national and international standards.

The baseline environmental and socioeconomic information was collected from a variety of sources, including reports of previous studies, published literature, and field survey (primary information). The information collected was used to develop baseline conditions of project area with respect to the natural, socioeconomic, and cultural environments likely to be affected by the project.

The proposed project activities were reviewed, and an assessment made of the potential impact of these activities on the area's natural, socioeconomic, and cultural environments is also described in this report. Where appropriate, mitigation measures were recommended to keep the adverse environmental impact within acceptable limits.

It is therefore concluded that if the field activities, including the implementation of all mitigation measures, are carried out in line with recommendations suggested in the report, the impacts from project's construction and operations will not be adverse so as to deteriorate the environmental quality of the project area and a more detailed report will not be required in the form of an Environmental Impact Assessment (EIA). Additionally, careful implementation of the Environmental Management Plan (EMP) will ensure that environmental impacts are managed and minimized and the project proponent meets all statutory requirements.

There are two essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. The proponent shall ensure that:

- All mitigation, compensation and enhancement measures proposed in this IEE report are implemented in full, as described in the document;
- The Environmental Management Plan is implemented in letter and spirit.

Screening of potential impact suggests that the construction & O&M of 50 MW Solar PV Power Plant will, on adoption of the suggested mitigation measures, be an environmentally acceptable proposition and will provide clean energy.

It is recommended that the IEE be approved with the condition that recommendations given in the IEE and NOC will be duly followed by the proponent.

Table of Contents

ANNEXURES

Chapter 1. Introduction

1.1 General

This Initial Environmental Examination (IEE) Report presents the findings of the Environmental Assessment study which was carried out in response to the requirements of KPK Environmental Protection Act, 2014. According to Section 13 of this Act: "No proponent of a project shall commence construction and operation unless he has filed with the 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 Agency, environmental approval in respect thereof."

Contact Information:	
The Proponent	Siddiqsons Kohat Solar Limited 7th Floor, Siddiqsons Tower, 3 J.C.H. Society, Block 7 & 8, Main Shahra-e-Faisal, Karachi. Tel: +92-21-32361201-10
The Consultant	EMC Pakistan Private Limited 503, Anum Estate, Opp. Duty Free Shop, Main Shahrah-e-Faisal, Karachi. Tel: +92 21-4311466, 4311467, Fax: 9221-4311467. Email:info@emc.com.pk , mail@emc.com.pk

1.2 Project Overview and Location

Project comprises of a 50 MWp capacity power plant based on Solar Photovoltaics (PV) technology. It is located in the Lachi Tehsil, Kohat District of Khyber Pakhtunkhwa (KPK) Province. The project site coordinates are as follows.

Table 1.1: Coordinates of the Project Site

S. No	Point	Latitude	Longitude
1	P1	33°21'29.13"N	71°22'16.25"E
2	P2	33°21'28.67"N	71°23'11.82"E
3	P3	33°21'54.02"N	71°23'13.33"E
4	P4	33°21'53.77"N	71°22'13.47"E

The project location map is depicted in figure 1.1.

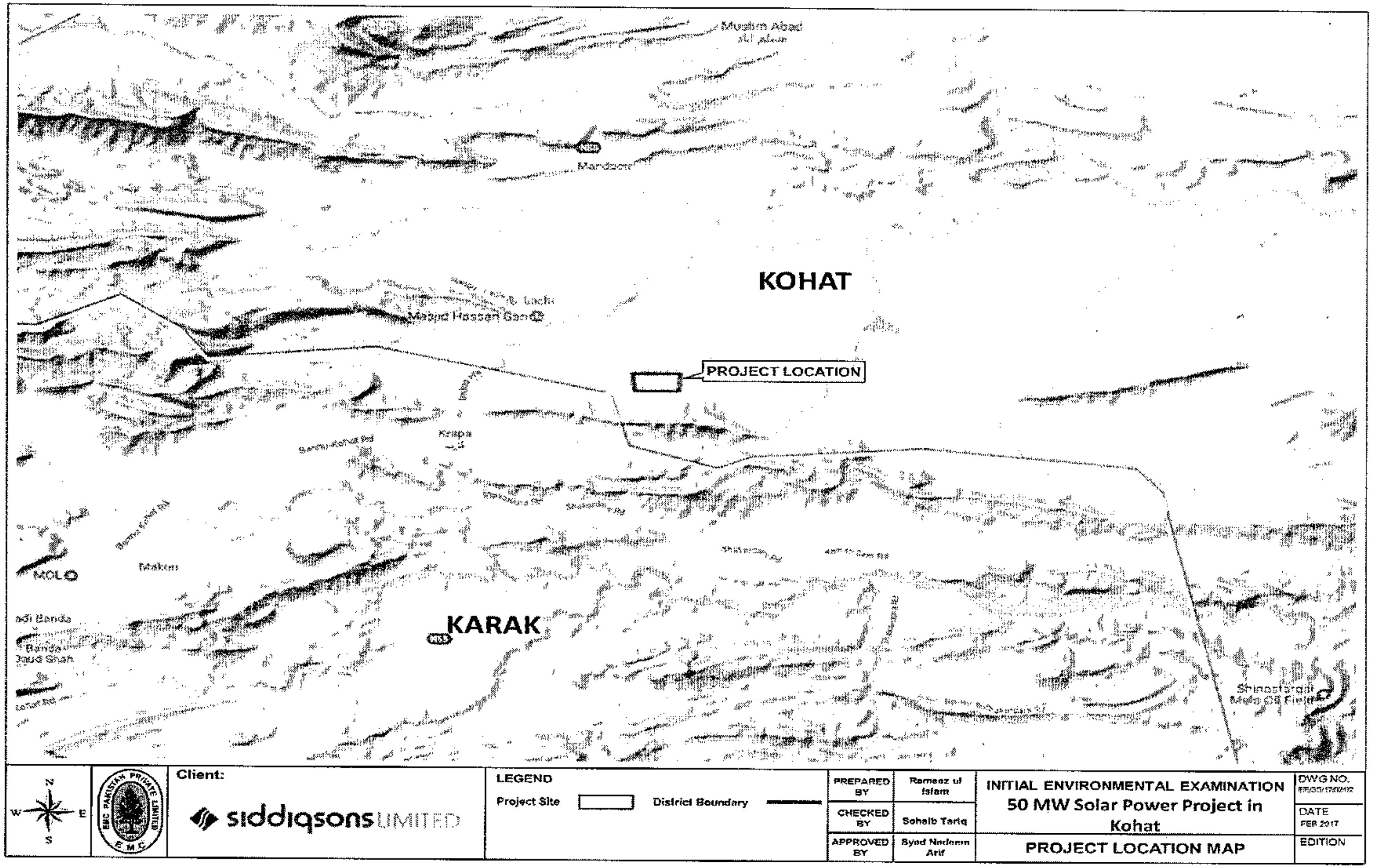


Figure 1.1. Project Location Map

1.3 Project Proponent

Siddiqsons Group is engaged in a diverse portfolio of industry segments including textile, real estate, banking, theme parks, dairy and energy. In textile, Siddiqsons Limited is pioneer of denim manufacturing in Pakistan. The Company has the largest fully integrated denim manufacturing under one roof in Pakistan. Siddiqsons' real estate business includes mega projects such as Ocean Towers in Karachi, the tallest building in Pakistan as of May 2015. It also has over 2 million square feet of real estate projects in pipeline. In Banking, Siddiqsons has significant shares in MCB Bank. Siddiqsons Group, in 2013, has also diversified into dairy business, with an aim to produce high quality milk through strict quality assurance mechanism. Siddiqsons Dairies (Private) Limited has initially started with a herd size of 2000 animals.

Siddiqsons' latest venture is diversifying into Power Sector. Siddiqsons is developing a 350 MW Super-critical Coal-Fired Power Plant in Port Qasim Karachi. Siddiqsons Solar Limited is the Group's initiative to contribute to Green Energy Power Generation in Pakistan and is developing a 50 MW Solar PV Plant in Chakwal, Punjab. The Project has reached advanced stages and is targeting COD in 2016. The group is also developing a 35 MW Hydro project in Azad Kashmir under the name of SJS Private Limited.

1.4 Project Background

The country is facing acute shortage in electrical power. The Government has been trying all round efforts to increase generation capacities and transmission facilities. In this effort, the Peshawar Electric Supply Company (PESCO) has been allowed to arrange for power on their own. While electrical energy is essential fuel all-round economic activities, it is equally important that electrical energy is produced through in-extensive methods and with lesser OR no damage to environment and ecology of the area where the generation facilities are constructed and commissioned. To achieve these two primary objectives, the PESCO is keen to arrange generation facilities based on solar energy.

The proponent aim to establish a 50 MW solar PV in order to support Government of KPK in eliminating load shedding. The project will be constructed in 12 months post financial close.

1.5 Need and Justification of the Project[1]

1.5.1.1 *Power Sector Structure Overview in Pakistan*

The generation, transmission, distribution and retail supply of electricity in Pakistan is presently undertaken by several public and private sector entities comprising of one national transmission company; nine regional public sector-owned distribution companies; four public sector thermal generation companies; one public sector hydropower generation company and 41 independent power producers (IPPs). These entities enable the supply of power to the entire country except for Karachi. The metropolitan city of Karachi and some of its surrounding areas are supplied power by K-Electric, which is a vertically integrated utility owned by the private sector responsible for the

[1] Feasibility Study Kohat 50 MWp PV Project Khyber Pakhtunkhwa Province Pakistan by Access Power/Siddiqsons Limited (Feb 2017)

generation, transmission and distribution of electricity in its region. The Central Power Purchase Agency (CPPA), a public-sector agency, has recently become active for the centralized purchase of power from all existing and upcoming private and public sector power producers. All public-sector agencies/companies are administered/overseen by the Ministry of Water & Power, Government of Pakistan.

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

1.5.1.2 Electricity Demand & Supply – A Deficit Power Market

Despite political stability and democratic Government, Pakistan is facing huge energy challenges in the form of load shedding in Electricity and Gas and energy crisis has inflicted far reaching effects on the social and economic fabric of the county.

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

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

As per NEPRA industry report and AEDB, Thermal power in total energy mix is 16,633 MW (66.46%), Nuclear is 787 MW (3.2%), Wind and solar is 356 MW (1.45%), Hydel Is 7,116 MW (28.90%). National electricity demand is increasing at rate of 3 to 4% and is expected to rise to 56,847 MW by 2024-25. Also, due to a number of factors including seasonality of hydel & renewable resources, lack of maintenance/aging of public sector thermal units and consequent reduced capacity and technical issues with certain private sector producers the sector has been facing an average supply-demand gap of about 6,000 MW in the recent past. Despite an installed capacity of roughly 20,000 MW the sector had a maximum generation of approximately 15,500 MW in September 2015 at which time a demand-supply gap of approximately 4,600 MW still existed. This gap increases significantly during summer, low water or low gas supply months.

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

1.5.1.3 Pakistan Power Sector – Key Challenges

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

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

1.5.1.4 *Private Sector Participation in Pakistan's Power Market*

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

Private Power & Infrastructure Board (PPIB) and the Alternate Energy Development Board (AEDB) have a track-record of attracting investment in the power sector for two decades or so and provide a one window facility for the processing of private power generation projects. PPIB deals with thermal and hydropower projects above 50 MW whereas AEDB is responsible for providing facilitation for renewable energy based projects (including hydropower projects below 50 MW). Certain provinces also have their own facilitation agencies.

Based on the lucrative fiscal and financial incentives provided by Government of Pakistan along with an effective energy policy, a noticeable surge in interest from national and international inverters is evident which has resulted in development of multiple Solar and Wind energy projects in recent years.

At present, 28 solar PV projects of 956.8 MWp & 29 Wind energy projects of 663 MWp capacity are under development within the framework of AEDB policies and procedures.

1.6 Scope and Objectives of Initial Environmental Examination (IEE)

This IEE report has been prepared to conform to the requirements of the KPK Environmental Protection Act, 2014, Pakistan Environmental Protection Agency (Review of IEE/EIA) Regulations, 2000 and the guidelines provided in the Pakistan Environmental Assessment Procedures, 1997.

Field surveys of project area were carried out by a team of environmentalists and sociologist for field data collection including observational surveys; site assessment/ environmental sensitivity analysis, and verification of available secondary information. Secondary information was collected from previous studies conducted in the area, studies conducted by EMC in the project area in past and district census reports etc.

The IEE report has been conducted to achieve the following main objectives:

- Major adverse impacts on the environment (physical, ecological and social) during project activities are identified.
- Adverse environmental and social impacts are appropriately addressed and adequate mitigation measures are incorporated in the project plans.
- Environmental Management Plan (EMP) for sustainable implementation of project is developed for implementation of mitigation measures and monitoring of the project activities.

1.7 Justification for IEE

Initial Environmental Examination (IEE) of the project has been carried out in compliance with the mandatory requirement of Section 13 of KPK Environmental Protection Act, 2014 and Pakistan Environmental Protection Agency (Review of IEE/EIA) Regulations, 2000.

The Section 13 of KPK Environmental Protection Act, 2014 requires that:

"No proponent of a project shall commence construction and operation unless he has filed with the 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 Agency, environmental approval in respect thereof."

Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000 have been notified under section 33 of PEPA 1997 and according to this the proposed project falls in Schedule – I, requiring an Initial Environmental Examination (IEE).

In compliance with the above cited conventions and regulations, an IEE study has been prepared and its report is being filed with the Khyber Pakhtunkhwa Environmental Protection Agency for approval.

1.8 Categorization of IEE Study

On the basis of the categorization given in Schedules I and II of the Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000, the proposed project falls in Schedule I requiring an IEE as the project is categorized as:

J. Other Projects

Any other project for which filing of an IEE is required by the Federal Agency under sub-regulation (2) of Regulation 5.

1.9 Methodology Adopted for IEE Study

The environmental assessment (examination and evaluation) is primarily based on simple comparative evaluation approach. Initially the baseline or the profile of the project area is developed by site surveys, collecting data, records and information on physical, ecological / biological as well as socioeconomic environment. The compiled data is then projected or modelled for different phases of the project. The likely changes in the critical environmental aspects or significant changes in the ambient environmental parameters are identified. Identification, assessment and evaluation of significant impacts, either in qualitative or quantitative terms, are carried out for which appropriate mitigation measures are subsequently proposed.

An overview of the methodology adopted for the IEE study is presented below.

1.9.1. Understanding of the Proposed Operation

This step required collection of information from the proponent on the proposed project activities and understanding these activities for assessment of impacts at later stages of the study.

1.9.2. Review of Legislation and Guidelines

National legislations, international agreements and environmental guidelines were reviewed to set environmental standards that owner would be required to adhere to during the different stages of the project.

1.9.3. Secondary Data Collection

Information from the proponent, available secondary data including environmental studies on similar projects by EMC and other consultants were also reviewed. Available literature on project area was reviewed to gather information for development of social and environmental baseline profiles for the study.

1.9.4. Field Data Collection

IEE study team visited the project area to collect primary data and information on the physical, biological and socio-economic background conditions of the project area. Discussions were also held with the members of community in the project area to collect area specific primary information along with their views and concerns regarding the project activities.

Detailed Groundwork Investigations: For having an over view of the project area and to assess the existing infrastructure / socio-economic activities, a detailed groundwork investigation was carried out at the project site.

1.9.5. Baseline Studies

The environmental profile of the project area was established through secondary data as well as field surveys. The information was collected and compiled on environmentally important areas, ambient air quality, surface and groundwater resources, existing and proposed roads, local communities, agriculture, public services, and sites of archaeological or cultural importance.

1.9.6. Impact Identification and Assessment

Potential impacts which may arise from project related activities were identified. These include effects on physical, biological, socio-economic, archaeological and cultural environment. Impacts were identified and assessed on the basis of field data, secondary data and expert opinion. The issues studied included potential impacts related to:

- Land Use
- Geomorphology
- Hydrology; Groundwater and surface water quality
- Ambient air quality
- Visual Effects

- Noise Effect
- Social issues
- Cultural Heritage and Archaeological Issues
- Flora and Fauna (Wildlife)
- Impact on protected areas
- Impacts during construction
- Impacts during operation

The discussion on impact assessment and mitigation measures is based on following considerations:

- The present baseline conditions
- The change in environmental parameters likely to be affected by project related activities
- Prediction of impact, including all long-term and short-term, direct and indirect, and positive and adverse impact
- Evaluation of the importance or significance of impacts based on available local, national and international standards, or, where such standards were not available, the best practices elsewhere.
- Implementation of mitigation measures (i.e. environmental management)
- Determination of residual impact
- Identification of controls and monitoring of residual impact

1.9.7. Recommendations to Mitigate Impacts

Keeping in view the baseline collected data and impacts identification; mitigation measures were recommended to minimize, eliminate, or compensate for the potential environmental and social impacts on the zone of influence of the project. Mitigation measures were recommended on the basis of past experience, legislative requirements and professional judgement.

1.9.8. Development of Environmental Management Plan (EMP)

Environmental management plan (EMP) was developed for effective implementation of the recommended mitigation measures. EMP included controls to minimize the identified impacts, and monitoring program to monitor residual impacts, if any, during the operation. The EMP also lays down procedures to be followed during the stages of project and identifies roles and responsibilities for all concerned personnel during the operation, including post project reporting.

1.9.9. Reporting

Upon completion of IEE tasks, findings of the IEE study were documented in the form of IEE report.

1.10 Structure of IEE Report

The format of the IEE report conforms to the requirements as stated in the Pakistan Environmental Procedures, 1997. Findings of the IEE study have been documented in this report according to the following structure:

Section 1 Introduction

Section 2 Project Description

Section 3 Legislative Framework

Section 4 Environmental and Socio-economic Baseline

Section 5 Potential Environmental Impacts & Mitigation Measures

Section 6 Environmental Management Plan (EMP)

Section 7 Conclusion

The main text of the report is supported by a series of Annexures which provide auxiliary information.

1.11 IEE Study Team

This IEE study has been conducted by a team comprising environmentalists and sociologists. Valuable input was made by each team member who contributed in compilation of this report. Names and designation / role of the project team members are given as follows:

Table 1.4: IEE Study Team

S. No.	Name	Position
1.	Mr. Syed Nadeem Arif	Director/Team Lead
2.	Mr. Saquib Ejaz Hussain	Environmental Scientist
3.	Dr. Asad Ghufran	Ecologist
4.	Mr. S.M. Sohaib Tariq	Environmental Engineer
5.	Mr. Khurram Shams Khan	Senior Sociologist
6.	Mr. Mustafa Warsi	Renewable Energy Engineer
7.	Mr. S.M. Zaman	Geologist
8.	Ms. Zulekha Soorma	HSE Advisor

Chapter 2. Project Description

2.1 Site Assessment

The developers have carried out an assessment of the proposed site for the development of the 50 MW PV plant to opine on whether the selected area can accommodate the proposed development. This land is currently privately owned and the negotiations are underway for its purchase from the current owners.

The purpose of the assessment was to evaluate the suitability of the proposed site in terms of:

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

These aspects are discussed in the following sections.

2.1.1 Site Setting

It is important to consider the site setting in order to establish whether the local climate, weather, and landscape is suitable for a solar PV development. Local conditions can affect all aspects of the project including the equipment selection and the operations and maintenance activities, and extreme conditions can affect project viability. The site is, located 25.06 km to the south of the town of Kohat, 4.61 km south east of Lachi on Indus Highway (N55) and approximately 75 km south of the provincial capital, Peshawar in Khyber Pakhtunkhwa, Pakistan.

The site is located at the base of hills a few tens of metres from the southern boundary of the site. The uneven terrain in the south extends up to 370 metres to the centre of the site. A pond approximately 0.12 hectares is located near the north-western boundary of the site with the presence of streams and smaller trailing water bodies running through the site. From the survey, it is concluded that these streams are now dry. A topography survey of the site, has recently been completed. The land is currently barren and uncultivated, with distributed and non-dense vegetation on the site although some evidence of animals grazing was found on the site. The site also contains unused and barren plots which are clearly demarcated through borders / trees.

Figure 2.1 below shows a location of the site and its immediate surroundings.

Table 2.1: Coordinates of the Project Site

S. No	Point	Latitude	Longitude
1	P1	33°21'29.13"N	71°22'16.25"E
2	P2	33°21'28.67"N	71°23'11.82"E
3	P3	33°21'54.02"N	71°23'13.33"E
4	P4	33°21'53.77"N	71°22'13.47"E

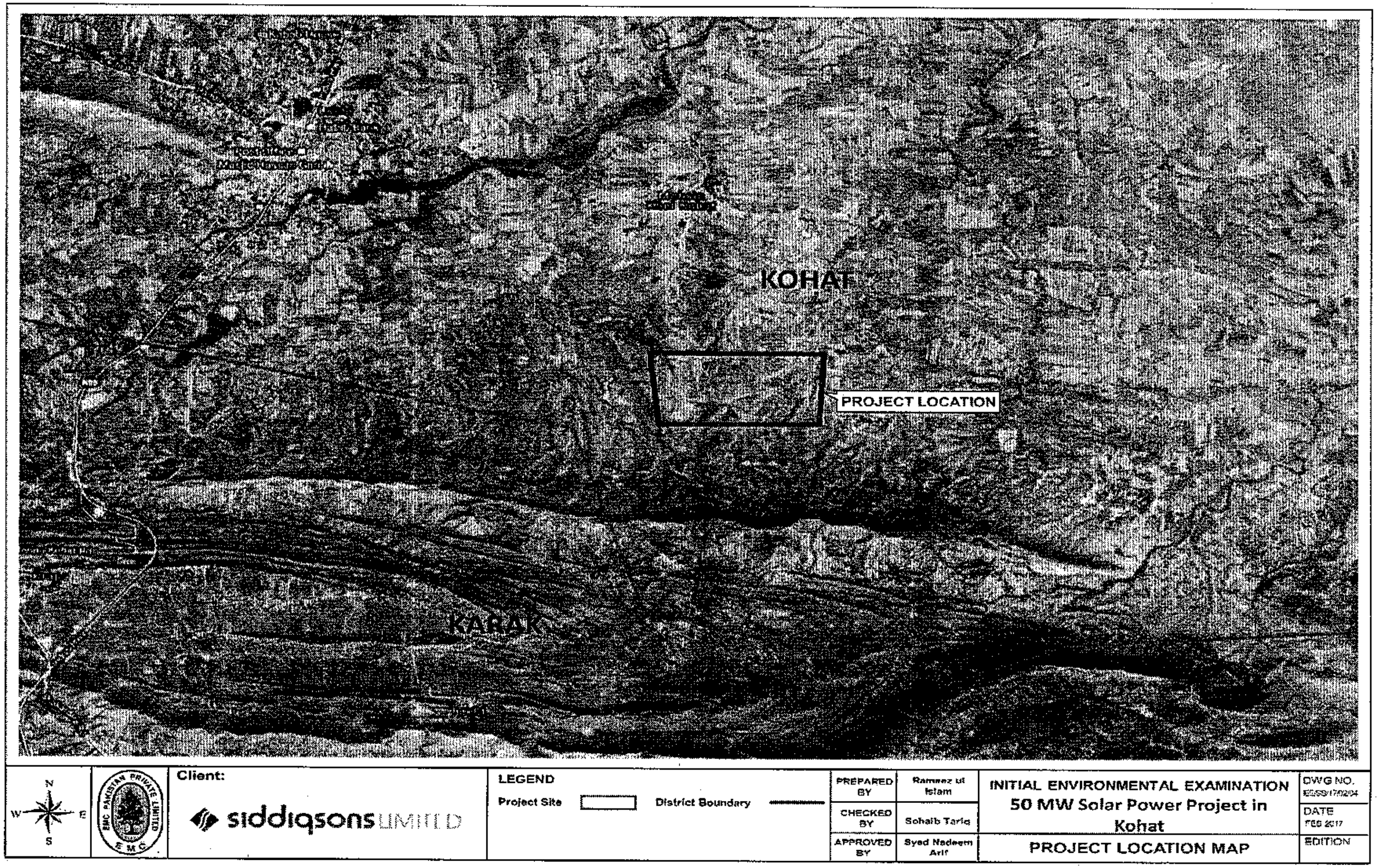


Figure 2.1: Location of Project

The project area is estimated to be 115 hectares. The area is not populated. There is a stream of called Lachi Toi from the Kohat Toi Tributary about 2.38 km northwards from the project site. Stream of Maramzai Algad, which originates from Lachi Toi, is at about 3 km from the project site, in north-western direction.

The site has roads marked in white as shown in Figure 2.2**Error! Reference source not found.**. his makes the western, northern and southern boundaries accessible. However, the north-eastern and eastern part of the site have limited road access.

Internal site roads will need to be prepared and maintained to enable vehicles to move around the site without the risk of getting stuck in the sand or mud during heavy rains. There are multiple dirt tracks that run across the site mainly in the western central part of the site along the access road previously mentioned.

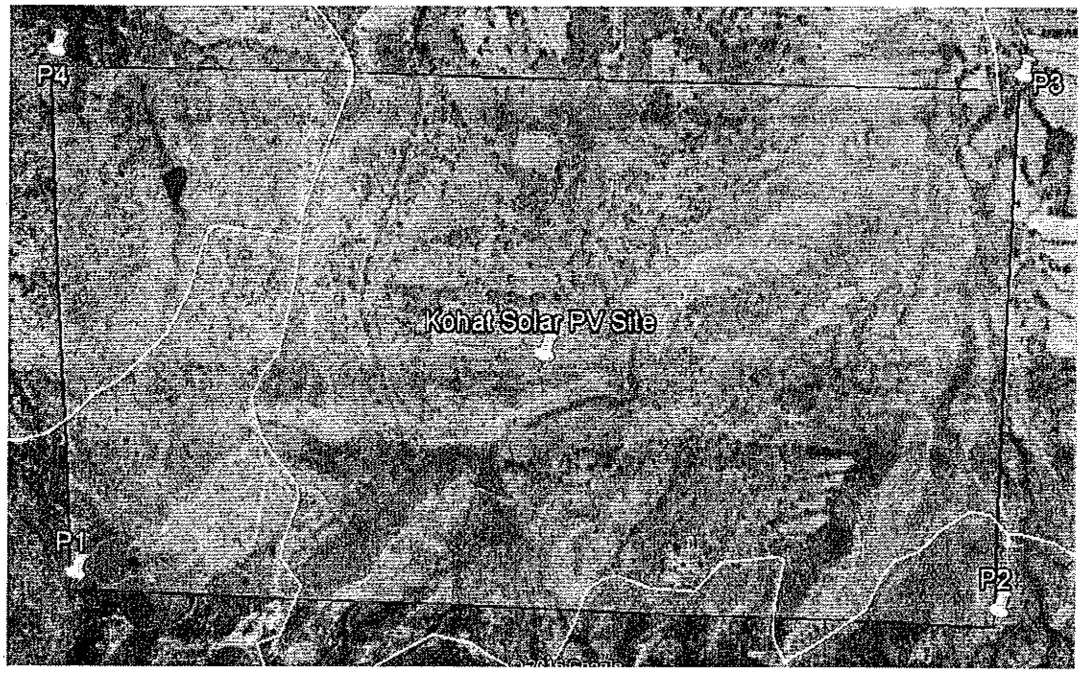


Figure 2.2: Map showing Roads near the Project Site

Source: Feasibility study Kohat 50 MWp PV Project

Approximately 5.1 km to the north-west-west of the site is the 132 kV Lachi sub-station located along the Indus Highway. Proponent plans to connect to the 132 kV Lachi grid station, which is to be confirmed as suitable by the Grid connection study. The transmission line is currently capable of transmitting 45-50 MVA. A grid connection study has been completed.

Water access is made possible by the presence of small ponds located in close proximity to the northern and western boundaries of the site. A pond has been located within the site and could potentially meet all water requirements.

There are scattered villages near the eastern boundary of the site and a few houses are located within the site on a ridge towards the north of the site.

Table 2.2: Summary of site surroundings and impact	
Item	**Kohat Site**
Current Land use	Barren land, unused
Neighbouring properties	No signs of communities in or 100 m near area.
Services	Not identified
Distances from town of Kohat and Lachi	Kohat – 25 km and Lachi – 5.1 km
Neighbouring Settlements	None. Nearest settlement is 1.3 km from northern boundary
Examples of likely Environmental and Social Impacts	Negative – Increased dust during construction – Traffic during construction Positive – Social Benefits – Employment opportunities
Source: Feasibility Study Kohat 50 MWp PV Project	

2.1.2 Topography, Terrain and Hydrology

Certain parameters of the site design, such as row spacing, can be heavily influenced by surface topography. The proposed site comprises of ridges, small hillocks made up of small stones, gravel and clay as shown below in Figure 2.3.

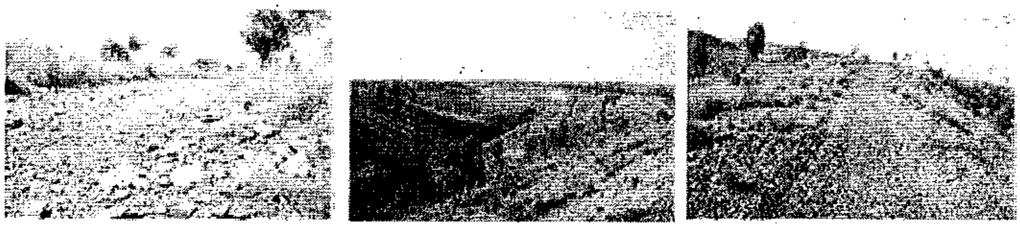


Figure 2.3: Map showing Roads near the Project Site

Source: Feasibility study Kohat 50 MWp PV Project

Ridges, gullies, elevated hillocks and steep depressions are located in the south of the site. The area in the centre west was found comparatively flat whereas rest of the site can only be utilized after significant grading.

No permanent rivers were visible however two dry water channels pass through the site.

Table 2.3: Summary of site characteristics	
Items	**Characteristics**
Topography	Gullies, hillocks, depressions
Terrain	Barren land with uneven terrain with small rocks, gravel and silty clay
Flood Risk	Low, since rainfall is low and area is sloped overall
Seismic Zone	Seismically active region with previous earthquakes in the 5.8-6.8 Richter range
Climate	Hot and arid with some rainfall between July and August
Water Access	Several small ponds have been identified close to the site within a 3 km range from western and northern borders of the site.
Source: Feasibility Study Kohat 50 MWp PV Project	

2.1.3 Near and On-Site Shading

Shading on PV modules reduces the amount of electricity generated, consequently it is essential to consider the potential shading from both on-site and near-site objects. In addition to this, it is also important to consider the variation of size and shape of possible shading objects with time. These variations, in fact, may create shading issues where there were none previously.

The site consists of ridges and hillocks with hills to the South from East to West translating to uneven surface and excessive shading in the subsequent depressions, mainly in the Southern portion of the site. However, a flat site has been assumed for plant layout.

2.1.4 Site Access, Laydown Area and Security

Construction of a solar PV plant requires safe and reliable access for large and heavy vehicles. It is necessary to consider the suitability of the current access, and highlight if any works will be required to enable satisfactory access pre-construction. The hardware and equipment used must be unloaded and stored somewhere before installation. This area is known as the laydown area and will normally also house site offices. Considering the build-up of equipment, personnel, and traffic, its location is important.

Security is required to reduce the risk of theft and ensure safe access for authorized personnel. It is recommended that the site has its own security staff located near or on the site. Mitigation measures such as fencing and site management should be among the first things present and installed on site. The site is accessed by an inroad leading in from the Indus Highway as shown in Figure 2.4.

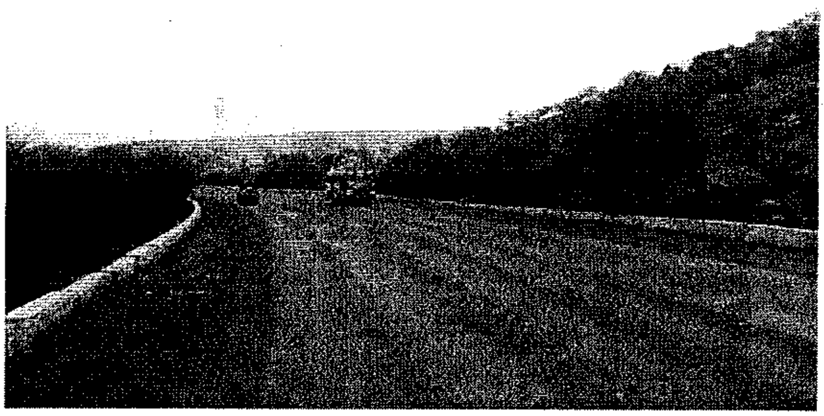


Figure 2.4: Site access from Lachi via Indus Highway

Source: Feasibility study Kohat 50 MWp PV Project

Most deliveries of equipment are expected to be made via Kohat and Lachi respectively.

Several of the in-roads splitting away from the main Indus Highway are observed to be muddy or poorly laid roads which could potentially cause delays in deliveries to the site once the trucks / cranes have reached the vicinity of the Kohat site. All deliveries to the site would be received at the site entrance and a turn-out bay will be required to allow trucks to turn off and merge on to the link road safely.

The most logical location for the site entrance and laydown area is in northwest of the site, adjacent to the road leading to the site. This location offers not only easy access but will minimize disruption to construction activities within the solar field. Fencing and security should be provided for the laydown area at the site from commencement.

A detailed assessment of the security of the Project location and possible mitigation measures is outside the scope of this report. We recommend that security costs be considered in the final economic analysis of the Project, that preliminary discussions be held at an early stage with potential EPC contractors to ensure that they are able to operate in this location and that major vendors, including inverter suppliers, are confirmed as able to provide specialist staff for commissioning and ongoing service support.

The closest hospitals and police station are situated in the town of Peshawar and Kohat, both approximately at 75 km and 25 km respectively from the site by road.

There is currently no municipal water supply or sewerage at the site and therefore water and ablution facilities will need to be provided for the construction of the plant as well as during operations and maintenance.

Table 2.4: Summary of Site Access

Site Access	Single lane road access from Lachi
Access Point	North west corner of the site, alongside the access road
Access Road Length from Main Road	6.6 km from Indus Highway cutting through Lachi
Laydown Area	North west corner of the site
Impacts	Potential congestion and disruption to businesses and residences in Lachi and Mohsen Khel Kohat.

Source: Feasibility Study Kohat 50 MWp PV Project

2.2 Grid Assessment

Pakhtunkhwa Energy Development Organization (PEDO), Pakistan has issued a "Letter of Intent" (LOI) for the Kohat 50 MW Solar PV Project to the Proponent with expected Commercial Operation Date (COD) as December 2017. The project is situated in Kohat district of Khyber Pakhtunkhwa Province, Pakistan. The inter-connection will be done by a double circuit line of length 7.5 km originating from Kohat bus to Lachi 132 kV substation.

The solar PV power plant would be interconnected to the 132 kV Lachi line. Hence, the grid interconnection scope for power transfer of the project in particular is projected with;

- A 132 kV double circuit transmission line, approximately 7.5 km length from Kohat is connected to Lachi 132 kV grid station.
- 2 transformers 132/33 kV of 60MVA capacity for the Project.

The national grid system after addition of the solar PV plant was analyzed for load flow, short circuit, transient stability and power quality studies to determine whether the plant connection with the PESCO grid meets the NEPRA/NTDC Grid Code requirements.

The latest and up-to-date network model base cases were used as provided by 50 MW Solar Kohat PV Power Project. Generation and Transmission expansion plans have also been incorporated as delivered by PESCO, whereas steady state, sequence and dynamic data for the PV plant is processed to build the steady state, short circuit and dynamic models in PSSE software format.

The analysis has been performed for September 2018, winter 2018 and summer 2021, peak cases of the interconnection year 2018-19 and horizon year 2021-22 of studies respectively. The power flow analysis shows that the bus voltages and line loadings in all the cases, with and without addition of the subject solar PV plant are within acceptable limit of defined planning criteria. The results were also validated as per the standards of line loading and bus voltage limits in associated N-1 post-contingency conditions.

Maximum short circuit level at LV, MV and HV (POI) buses of the solar PV plant in both the year of commissioning and horizon year were computed. Moreover, in order to see the short circuit current contribution of the solar PV plant, maximum short circuit levels at the substations located in vicinity of the project are also computed. The results show that fault levels are within the circuit breaker duties with the addition of the subject project to the 132 kV network of 50 MW Solar Kohat PV Power Project.

The transient stability studies were carried out to check the dynamic impact on the solar PV power plant due to potential faults in national grid system and, in turn, the impact of disturbances in the solar power plant on national grid system. The solar power plant is found to meet all the transient stability requirements as per defined by the NEPRA Grid Code. The results of transient stability analysis shows that the power system is stable for the suggested interconnection scheme of the project and it fulfils all the criteria for the generation connection with the power system.

In the power quality analysis, the major criterion of the power quality i.e. flicker, voltage un-balance, frequency operating range, harmonics and power factor has been investigated at the subject solar PV plant for the worst-case scenario. Moreover, the obtained values are compared with the standards of IEC (IEC61400-21 and IEC-61727) and the results show that the all the parameters remain within the acceptable range of the IEC criteria. Based on the study results, overall it is concluded that proposed generation connection for the Project meets the NEPRA/NTDC Grid Code and Planning Criteria.

2.3 Conceptual Design

This section describes the conceptual design of the Plant, which follows conventional and well proven commercial practice. Detailed design will be undertaken by the EPC Contractor according to the Technical Specification which will include specific Project's owner requirements, performance requirements and applicable standards including Pakistan Building Code and IEC Standards. The Plant shall be designed for a minimum of 25 years' life.

During the tender evaluation phase, alternative designs, including the use of trackers or string inverters, may be considered.

2.3.1.1 *Design Assumptions*

A conceptual system design for a 50.0 MWp plant with a minimum life of 25 years has been created. The high-level system design assumes that the land is flat, there are no material constraints and that Tier 1 polycrystalline modules, central inverters and fixed tilt, static steel framework structure are used.

The system design and modelling assumptions are provided in Table 2.5 and Table 2.6 respectively.

Table 2.5: System design assumptions

Array size (kWp)	Module Technology	Module Nominal Capacity (Wp)	No. of Modules	Inverter Type	Inverter Rating (kW)	No. of Inverters	No. of Modules per String	No. of Strings per Inverter
32,448	Polycrystalline	320	10,1400	Central	1000	26	20	195
7,561.6	Polycrystalline	320	54,880	Central	1000	14	20	196

Source: Feasibility Study Kohat 50 MWp PV Project

Table 2.6: System modelling assumptions

Criteria	Assumptions
Inter Row Spacing (Pitch)	7.0 m
Module Inclination	25°
Module Azimuth	Due south (0°)
Array Configuration	4 modules in landscape
Site Terrain	Assumed flat
Horizon Line	Assumed free from material shading
Module Tolerance	0 / +5%
Deliver / Point of Contact	Lachi 132 kV grid station approximately 7.5 km length from the site

Source: Feasibility Study Kohat 50 MWp PV Project

2.3.1.2 *Modules and Mounting Frames*

A module is an array of solar cells that converts the energy received from sunlight into electrical energy through use of the photovoltaic effect. Silicon solar cells are made from either mono-crystalline wafers which offer slightly higher efficiency at a higher cost, or poly-crystalline wafers which offer slightly lower efficiency but at a lower cost. Each individual photovoltaic module is approximately 1 x 2 m and is of a glass construction, typically set in an outer metal framework. The front surface is generally treated with anti-reflective coatings. Poly-crystalline modules can offer more economic solutions for utility scale projects.

The modules are electrically connected by string cables which run through conduits placed behind the rows of modules. The string cables terminate at junction boxes which are generally found adjacent to module rows. Junction boxes then connect to inverters via larger diameter underground cables.

Tier-1 320 Wp polycrystalline module has been considered for this report on the basis of site conditions, efficiency, price and module track record under prevailing site conditions. 7814 strings of 20 modules each have been proposed with a total installed capacity 50,009.6 kWp using 156,280 modules.

The mounting structure may be supported on a variety of different foundation designs including steel mini-piles driven directly into the ground or concrete foundations formed in place. The final design of the foundation should be in line with the recommendations of geotechnical survey of the site.

The module support structure is generally arranged in rows, and follows the landform, generally rising no more than approximately 2.57 m above ground level at any point. The rows are separated from one another by an open space, which is determined by the site and project but generally between 3 m to 8 m.

Generally, less than 30% of the entire site area will be beneath solar arrays or taken up by ancillary buildings, leaving the majority as open space. The unoccupied ground between rows of modules and under the modules can be seeded to produce vegetation. Once constructed, it is viable for farming activity such as grazing of medium-sized animals like sheep provided cables are adequately protected.

2.3.1.3 *Inverters and Transformers*

Inverters are required to convert the direct current (DC) electricity generated by the PV modules into alternating current (AC) which is suitable for exporting to the grid. The inverters also manage and optimize specific electrical parameters in order to maximize energy production.

Inverters are most commonly available as either string inverters or central inverters. String inverters are smaller devices, each managing a small number of modules, typically mounted on the module support structures and with a capacity typically less than 50 kW. They are better able optimize electrical parameters and maximize energy production in conditions where orientation or shading vary, particularly rooftops. However, the large number required for a utility scale application often results in higher installation and maintenance costs, including replacement over the Plant lifetime.

Central inverters are larger devices with capacities up to 1,000 kW or more which manage greater sections of the Plant. They are generally able to optimize energy production more efficiently, are less resource intensive to maintain and can be more economical to purchase and install. Central inverters are typically housed within weatherproof skid-mounted enclosures with approximate dimensions 8.5 m long, 2.9 m wide and 3.2 m high. Alternatively, they may be installed in a masonry building with adequate ventilation. Care should be taken to ensure adequate ventilation, particularly considering the high ambient temperatures at this site.

For a project of this scale, location, and landform, central inverters are likely to offer the best solution. A central inverter scheme with 40 x 1000 kW inverters has been proposed considering the inverter to array ratio, cost effective granular monitoring and reliability of the system. All inverter substations contain 2 x 1,000 kW inverters.

The transformers are required to step-up the relatively low AC voltage as generated by inverters (typically 300-400 V), into the internal 33 kV MV network, and then again to 132 kV for HV grid connection. All substations contain 1 x 2,500 kVA LV/MV transformers installed integrally with the inverter enclosures whereas the MV to HV transformers will be housed adjacent to the switchgear. The LV/MV transformers ratings mentioned on the Single Line Diagram (SLD) are only indicative whereas the MV/HV transformer ratings are to be defined in the finalized version of feasibility report.

2.3.1.4 Switchgear

Switchgear is used to control the connection between the Plant and the electricity distribution network. The client plans to connect to the 132kV Cherat Grid station, 5 km east of the site, which is to be confirmed as suitable by the Grid connection study. Typically, there are two sets; one belonging to the Distribution Network Operator (DNO), PESCO/NTDC/CPPA in this case, and one belonging to the Plant, which are housed in separate cabins or switch rooms. The appearance and size of the cabins will be determined by the requirements of the DNO and the Project, but it is likely they will be fabricated from brick or glass-fibre reinforced plastic with approximate dimensions of 5 to 7.5 m long, 2.75 to 4.75 m wide and 3 to 4 m high.

2.3.1.5 Monitoring and Control Room

A monitoring and control room office will be constructed where feedback and information on the operational status of the Plant will be provided through monitoring systems such as the Supervisory Control and Data Acquisition (SCADA) operating system.

2.3.1.6 Security

By the start of construction, it will be ensured that security measures have been put in place in order to prevent unauthorized access to the plant. It is being considered employing manned security patrols in addition to installing a boundary wall of at least 2.2 m, topped with barbed wire plus to several infra-red technology security cameras mounted on poles.

2.4 High Level Yield Assessment

A preliminary high level yield assessment based on the average GHI and average inclined irradiation was performed, with the results shown in Table 2.7. Assumptions on the performance ratio were based on that of similarly sized projects in Pakistan. The results are specific to the first year of generation by the plant.

Table 2.7: High level Yield Assessment

GHI (kWh/m2/yr)	GII (kWh/m2/yr)	Assumed PR (%)	Specific Yield (kWh/kWp)	First Year Generation (MWh)(AC)
1,792	2,034	0.78	1,587	79,341
1,792	2,034	0.8	1,627	81,375

Source: Feasibility Study Kohat 50 MWp PV Project

Based on typical Tier 1 polycrystalline PV modules, Access expects a linear degradation of 0.4% per year for the PV module energy output. This value can be used to determine the approximate energy generation for the subsequent years after year one if needed.

2.5 Plant Layout and Design

Plant Layout and the Single Line Diagram is provided in the fig 2.5 and 2.6.

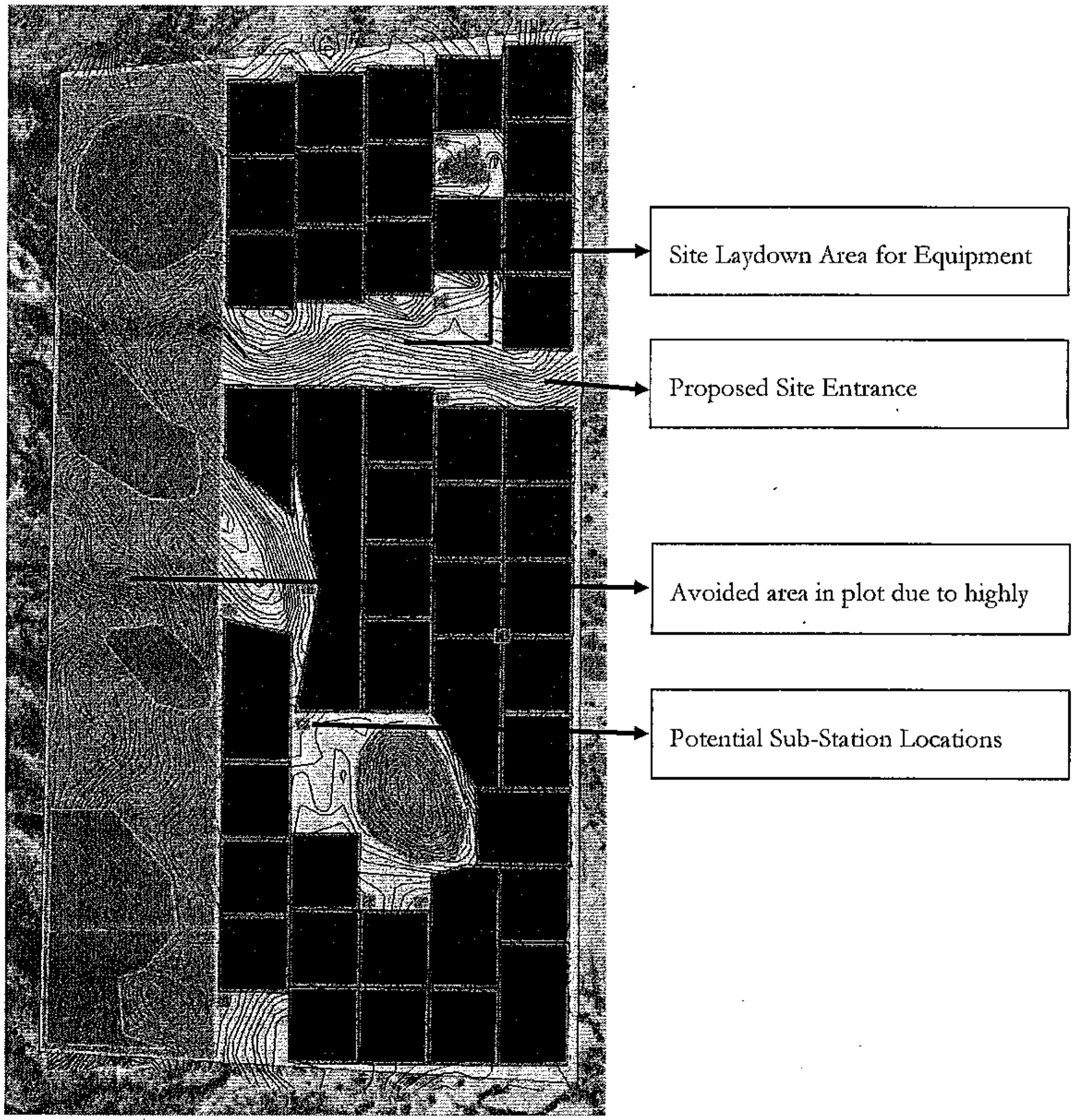


Figure 2.5: Plant Layout and Design

Source: Feasibility study Kohat 50 MWp PV Project

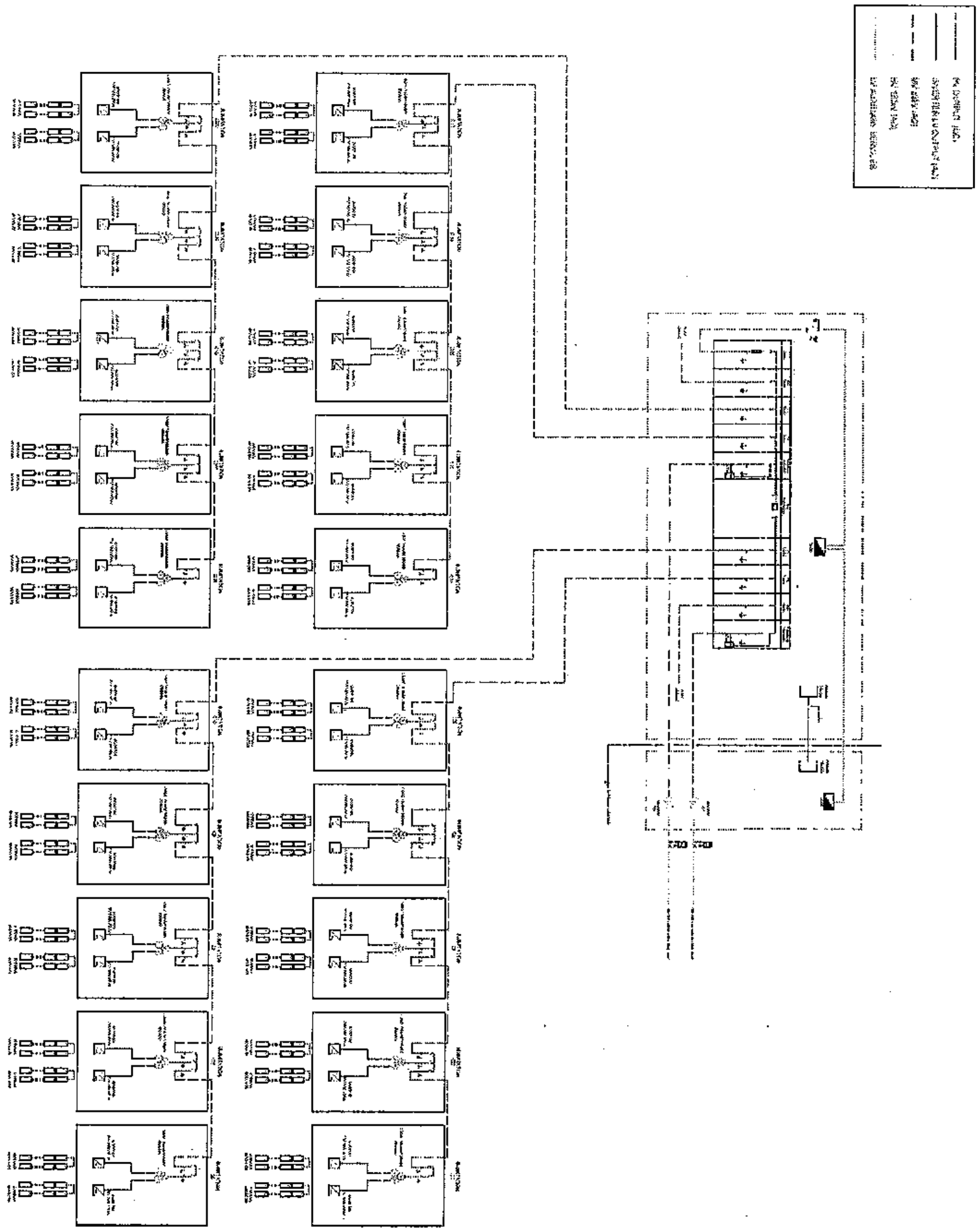


Figure 2.6: Single Line Diagram of the Layout

Source: Feasibility study Kohat 50 MWp PV Project

2.6 Timeline of the Project

Project Timeline is provided in the fig 2.7.

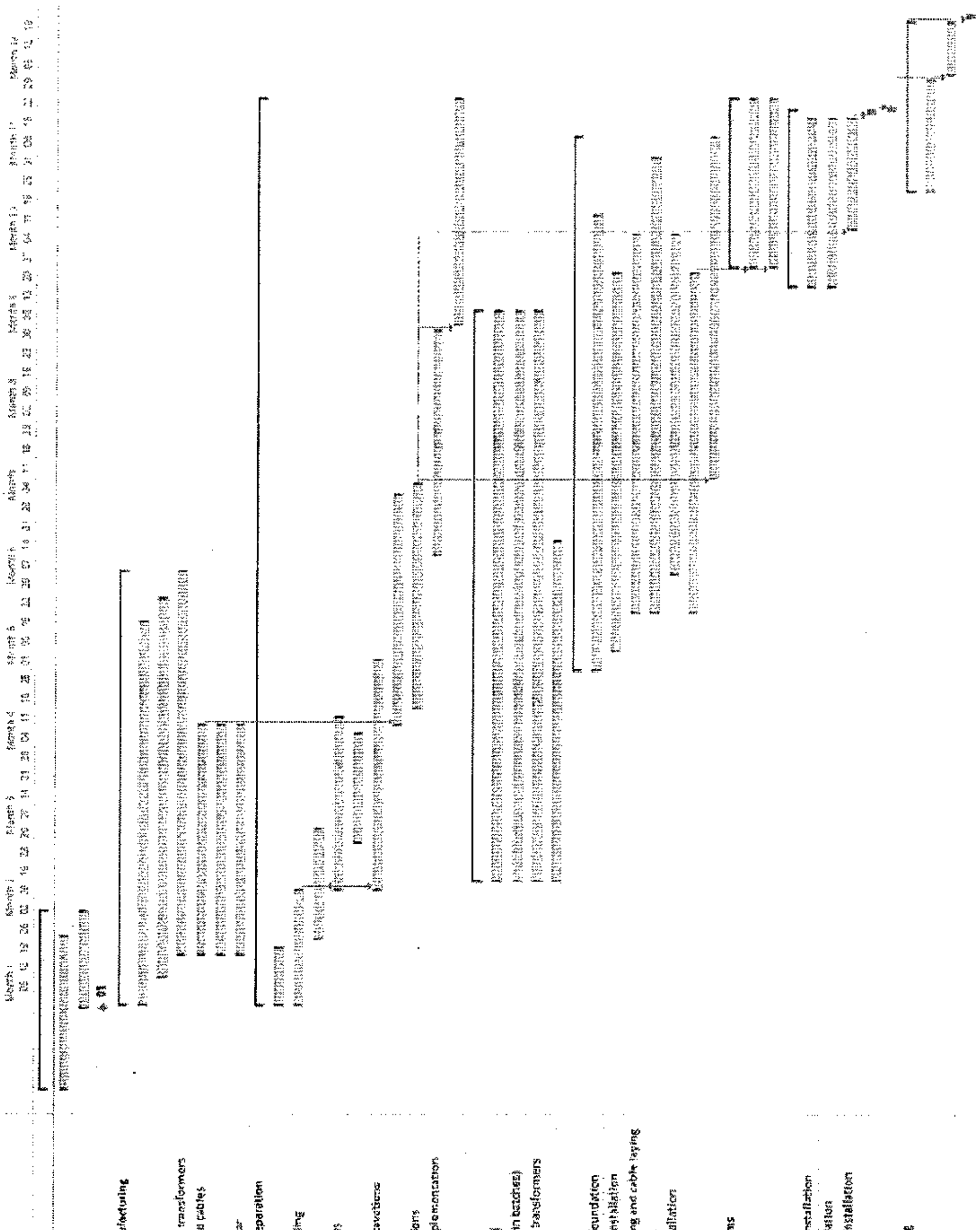


Figure 2.7: Project Timeline

Source: Feasibility study Kohat 50 MWp PV Project

2.7 Photovoltaic (PV) Technology

2.7.1 Basic Principles of Solar Photovoltaic Plant

Solar photovoltaic plants use the global irradiation (GI), which is converted into electric energy. Adequate project locations should offer at least 1,200 kWh/m² per year. The basic concept of a PV power plant is shown in figure 2.3 below.

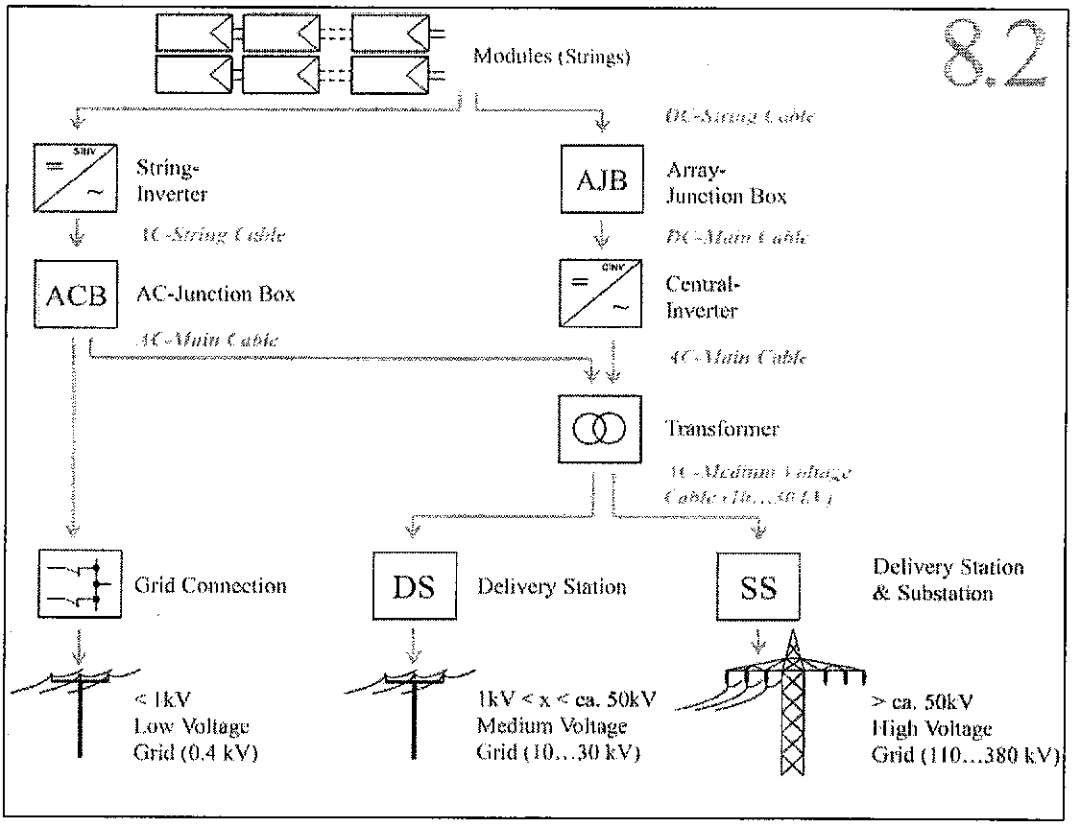


Figure 2.8: Schematic Overview / Principle of Photovoltaic Systems, Single Line Diagram

Source: Feasibility study Kohat 50 MWp PV Project

The solar energy collected by the modules is aggregated in several steps until it reaches the inverter. The inverter converts the DC power provided by the modules into AC power to feed into the grid.

2.7.2 Basic Principles of Photovoltaic Module

Photovoltaic technologies differ primarily by the type of manufacturing process, which leads to different price ranges, manufacturing cost and performance for the different technologies. Photovoltaic technology is based on the photoelectric effect, in which the photons emitted by the sun are converted to electric power by the semiconductor. The semiconductor is typically made of silicon (80% of the global market).

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

The purity level of the conductor material is important as well as the fact that there are no gaps or defects at the molecular and atomic level of the semiconductor material. As a rule, the lesser the microscopic defects, the higher the efficiency of power conversion.

The efficiency of a solar cell (η) is the percentage of power from solar energy, incident on the panel, converted to electrical energy. This term is calculated using the ratio of the maximum power point of the cell, PM, divided by the light power that reaches the cell, the global irradiance (E, in W/m^2) and the surface area of the solar cell (Ac in m^2).

$$\eta = \frac{P_M}{E \times A_c}$$

As this efficiency varies in different irradiance conditions, the PV industry defined certain conditions for efficiency rating of PV panels. These are called Standard Test Conditions (STC).

Another important standardized variable is the Normal Operating Cell Temperature (NOCT) for modules. This is a characteristic cell value defined as the temperature of the cells, which they reach at an irradiance of 800 W/m^2, an ambient temperature of 20°C and a wind speed of 1 m/s – typically given at open circuit.

Three main solar cell technologies are commercially available:

- Monocrystalline
- Polycrystalline
- Thin Film

2.7.3 Monocrystalline Technology

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

Advantages:

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

Disadvantages:

- The initial investment costs are higher
- Higher risk of damages (micro-cracks) during transport or during operation at sites with high wind speeds.

2.7.4 Polycrystalline Technology

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

Advantages:

- Lower production costs

Disadvantages:

- Lower efficiency, due to lower purity of the cell material: 13 – 16 % (module size)
- Because of the lower efficiency, slightly more ground surface area is required to reach the same capacity (as for monocrystalline).
- Higher risk of damages (micro cracks) during transport or during operation at sites with high wind speeds.

2.7.5 Thin Film Technology

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

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

Thin Film technologies have a low market share, except of the CdTe material, with the main manufacturer First Solar. In addition, CIS / CIGS technologies are having an increasing market, because of their higher efficiency. Depending on the technology, standard thin film module efficiencies have reached 7 - 15%. Prototypes of these technologies reach an efficiency of 16% and more which is expected to be transformed to standard products in the future.

Advantages:

- Easier to manufacture, thus lower costs
- Less affected by high temperatures and shadowing

Disadvantages:

- Faster degradation rate of up to 0.7 % per year. However, there are some hints that, nowadays, CIS has degradation rates comparable to crystalline modules.
- Lower efficiency leads to greater surface area requirements, for the same capacity.

Table 2.8: Comparison of the Module Technologies

S. No.	Parameter	Crystalline		Thin Film	
		Monocrystalline	**Polycrystalline**	**CdTe**	**CIS/CIGS**
1	Voltage rating – Vmp and Voc	80% - 85%	80% - 85%	72% - 78%	72% - 78%

Table 2.8: Comparison of the Module Technologies

S. No.	Parameter	Crystalline		Thin Film	
		Monocrystalline	Polycrystalline	CdTe	CIS/CIGS
2	Temperature Coefficient	Higher Losses (ca. -0.4 %/K)	Higher Losses (ca. -0.45 %/K)	Lower Losses (ca. -0.2 %/K)	Higher Losses (ca. -0.35 %/K)
2a	Performance Losses for 40°C ambient temperature (~ 60°C cell temperature) versus STC conditions (25°C cell temperature)	~ 14 %	~ 15.75%	~ 7%	~ 12.25%
3	I-V curve Fill Factor	Higher 70% - 85%	Higher 70% - 85%	Lower 60% - 72%	Higher 70% - 85%
4	Module Construction	Framed with structural or anodized aluminum	Framed with structural or anodized aluminum	Normally Frameless	Normally Frameless
5	Module Efficiency	14% - 20%	12% - 17%	6% - 12%	13% - 15%
6	Inverter Compatibility and Sizing	High efficiency Less modules Less inverters	High efficiency Less modules Less inverters	Low Efficiency More modules More inverters	High efficiency Less modules Less inverters
7	Mounting System	Industry Standard Practices	Industry Standard Practices	Special clips and structures for frameless modules may be needed to hold the module. Mounting system has to be accepted by module manufacturer.	Special clips and structures for frameless modules may be needed to hold the module. Mounting system has to be accepted by module manufacturer.
8	Layout Area	Much smaller size for the same output	Smaller size for the same output	May require up to 50% more space for the given project size. The extra space can't be	Smaller size for the same output

Table 2.8: Comparison of the Module Technologies

S. No.	Parameter	Crystalline		Thin Film	
		Monocrystalline	Polycrystalline	CdTe	CIS/CIGS
				standardized and depends on the design (rows over each other) and the site conditions.	
9	Applications	On grid and off grid usage. More usual as a reference cell and used for scientific tests.	On grid and off grid usage.	On grid and off grid usage.	On grid and off grid usage.
10	PV Plant Cell Cost	More expensive than polycrystalline and CdTe modules due to high cell efficiency	Cost Higher than CdTe due to higher cell efficiency; Production process easier which lowers the basic cost	Cost Lower due to lower efficiency and double pane glass sheeting	Very expensive up to now
11	PV Plant Module Unit Cost	Cost per kWp slightly higher as for polycrystalline modules, but comparable to the cost per kWh due to fewer losses	Cost per kWh comparable	Cost per kWp slightly higher as for polycrystalline modules, but comparable to the cost per kWh due to fewer losses	Cost per kWp slightly higher as for polycrystalline modules, but comparable to the cost per kWh due to fewer losses
12	PV Plant Total Cost	Lower Cost due to higher efficiency of the modules (less modules and less mounting Structures). Entire cost depends on the market situation (module price)	Usually lowest cost (low m^2 cost and less m^2 needed because of the higher efficiency compared to thin film modules). Entire cost depends on the market	Highest cost due to additional space and mounting structures needed. Entire cost depends on the market situation (module price) and the concerned country (m^2 cost)	Highest cost due to additional space and mounting structures needed. Entire cost depends on the market situation (module price) and the concerned country (m^2 cost)

Table 2.8: Comparison of the Module Technologies					
S. No.	Parameter	Crystalline		Thin Film	
		Monocrystalline	Polycrystalline	CdTe	CIS/CIGS
		and the concerned country (m^2 cost)	situation (module price) and the concerned country (m^2 cost)		
13	Module Power Output	Immediate and stable; but zero shadow tolerance, high losses when temperature high and irradiation suboptimal	Immediate and stable; but zero shadow tolerance, high losses when temperature high and irradiation suboptimal	Requires time to stabilize power output; even slightly shadowed output is feasible	Very good weak light performance (best results of the technologies in winter)
14	Degradation	Around 0.3% per year	Around 0.3% per year	Around 0.4% per year	Around 0.2% per year
15	Market Perspective	Some of the providers of the polycrystalline modules also offer monocrystalline modules	Standard technology, many providers	One big provider (First Solar)	Little number of providers, new technology (2009)

Source: Feasibility study Kohat 50 MWp PV Project

2.7.6 Mounting Structures and Tracking System

The photovoltaic modules can be installed on fixed structures or on moving structures tracking the sun. Trackers can be implemented either as a single axis system or as a dual axis tracking system.

2.7.7 Fix Mounted Structure

Fixed structures are usually tilted to face south (north in southern hemisphere) with a fixed angle depending on several parameters e.g. the location. Nowadays, more and more PV power plants are installed with modules tilted to east and west usually with tilt angles between 10° to 15°. This installation type would offer lower peak capacity. However, the generation curve would be less spiked and allow an energy generation distribution to be more spread out over the day. The row shading of these installations is less, such that the rows can be installed closer to each other and more modules can be installed on the same area as it is possible with modules facing south. Depending on the construction, the installation costs of east-west installations are often lower than south oriented systems.

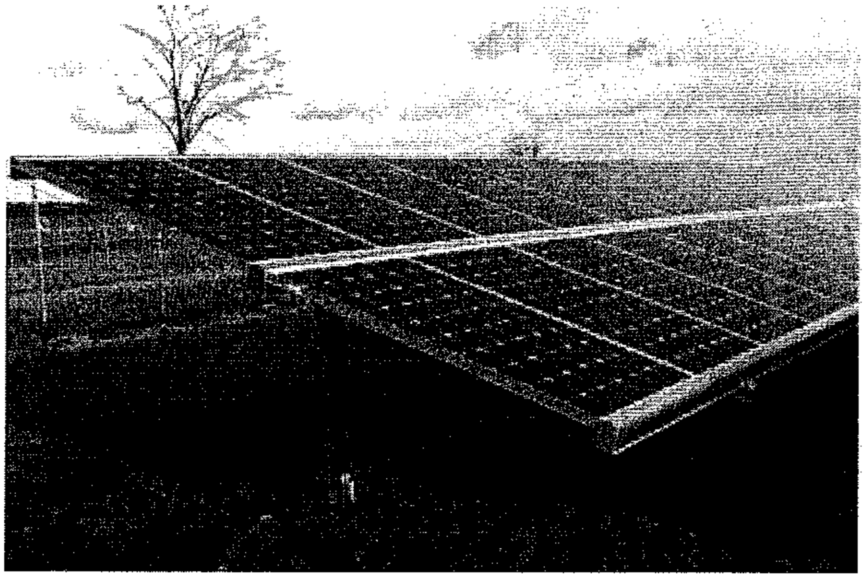


Figure 2.9: Fix Mounted Structure facing South or North

Source: Feasibility study Kohat 50 MWp PV Project

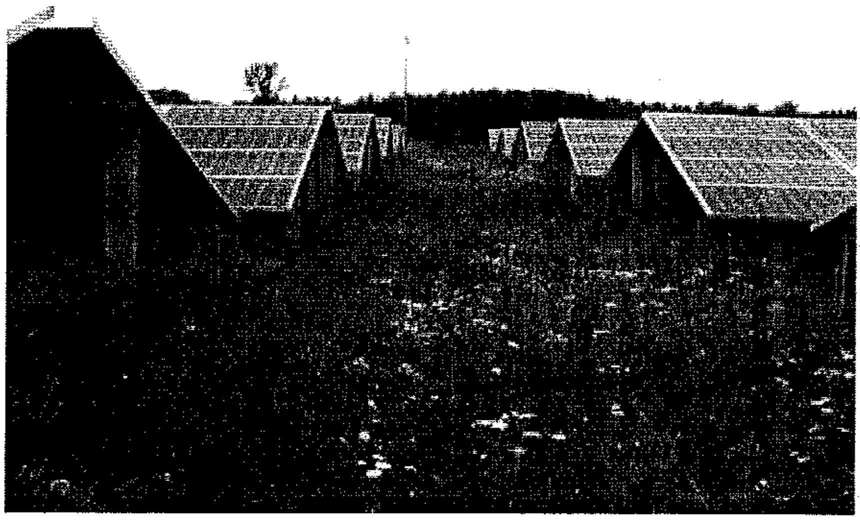


Figure 2.10: Fix Mounted Structure facing East and West

Source: Feasibility study Kohat 50 MWp PV Project

2.7.8 Tracker Systems

The aim of trackers is an optimized adjustment of the module surface to the sun during the day to increase the total irradiation onto the module surface. This can also lead to greater efficiency in converting solar energy. Commonly used tracking systems are single and dual-axis trackers.

Dual-axis trackers follow the sun in azimuth and tilt. With it, the sun can be exactly tracked over the course of the day to achieve an optimized irradiation angle. Dual-axis trackers have one pole which is carrying and tracking a frame with modules mounted on. Usually, between 20 and 30 modules are installed on one tracker. The installed module capacity on the plant has to be lower than with fixed mounted structures to avoid overwhelming shading losses (15-25 Wp/m^2 instead of 50-75 Wp/m^2). Dual-axis trackers are almost independent of the landscape.

The transposition factor for a two-axis tracker for the location is 1.35 and therefore 132% of that of the fixed plane's optimum.

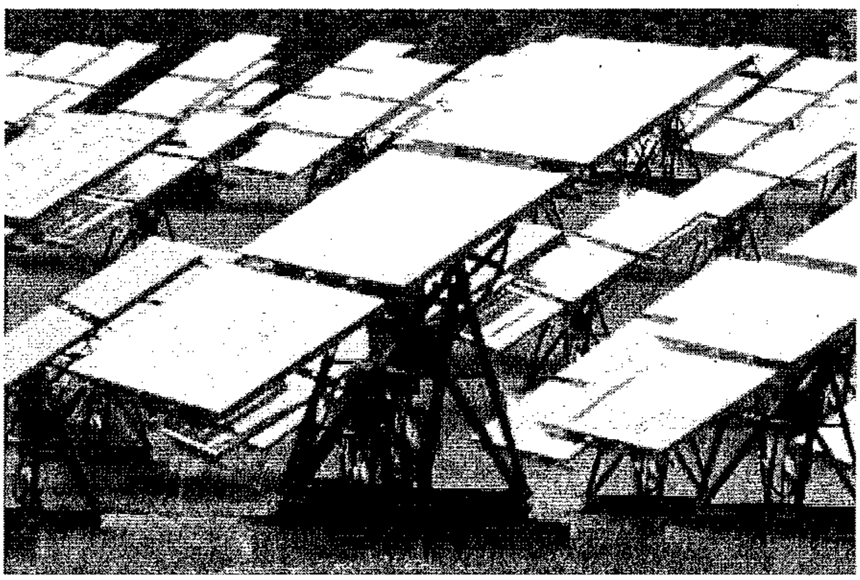


Figure 2.11: Dual Axis Tracker

Source: Feasibility study Kohat 50 MWp PV Project

Single-axis trackers usually follow the azimuth of the sun. Several construction types exist. One is similar to dual-axis trackers with one pole carrying a module frame (vertical axis system). In that case, the module tilt is fixed and the pole is used as rotation axis. The tilt depends on the location. For the location Haasil Village (33.202 N; 72.547 E) the optimal installation has a tilt in between 45° up to 50° (based on SolarGIS and Meteonorm irradiation data).

Because the single-axis tracker, as described above, needs similar space as dual-axis trackers, nowadays another type of single-axis tracker is in use. This one has a horizontal rotation axis oriented from south to north or from east to west. The modules are installed parallel to the rotation axis. Depending on the way of installation and length of horizontal axis the requirements to the flatness of the area can be higher, because the horizontal axis itself is not able to compensate irregularities. The single-axis tracker with the east-west axis has a transposition factor of around 1.09, whereas the tracker with north-south axis has a transposition factor of 1.29 or 126% of that of the fixed plane's optimum.

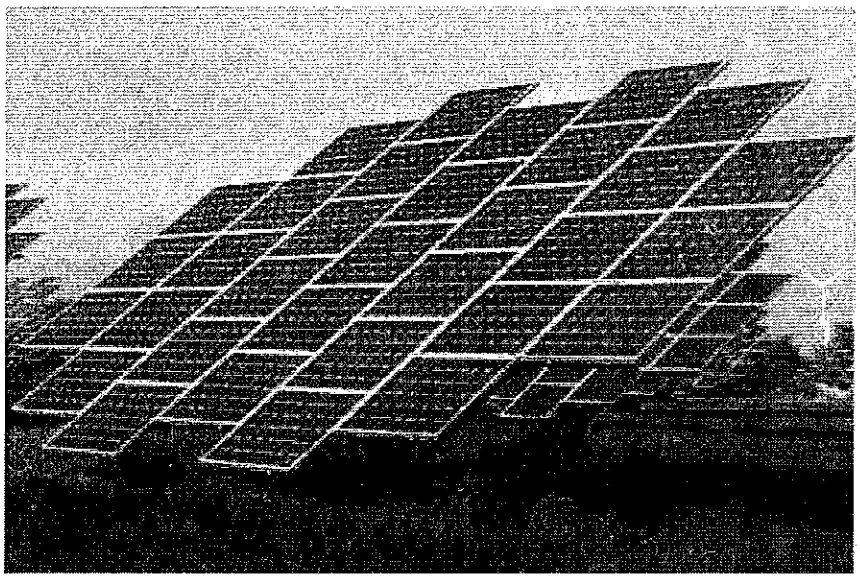


Figure 2.12: Single Axis Tracker, Vertical Axis

Source: Feasibility study Kohat 50 MWp PV Project

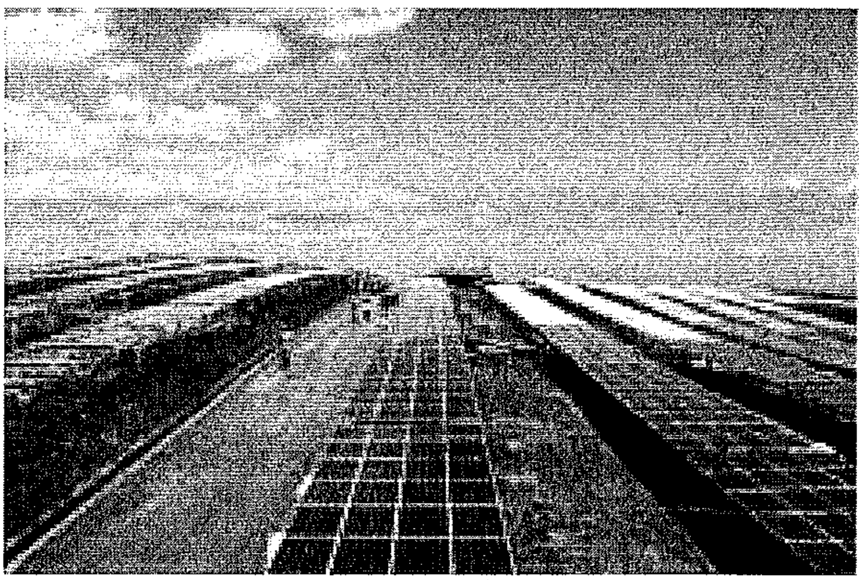


Figure 2.13: Single Axis Tracker, Horizontal Axis

Source: Feasibility study Kohat 50 MWp PV Project

The decision to choose any of the three types of mounting structure is based on a technical and economical evaluation. When choosing a tracking system, the extra energy generation in combination with the energy price must be compared with the additional investment and maintenance costs required for tracking systems.

In general, tracker solutions gather more irradiation per installed module capacity than fixed mounted modules. The peak of the production curve is wider during the day compared to fixed mounted modules. However, the installation effort is higher for tracker solutions based on their design. More attention has to be laid into the resistance against heavy storms.

Table 2.9: Comparison of the Mounting Systems

S. No.	Parameter	Fixed/Tilted		Horizontal Single Axis Tracker		Vertical Single Axis Tracker	Dual Axis Tracker
		South Faced	East-west	East-west	North-South		
1	System Costs	Lower than for tracker solutions, as no mechanical parts		Higher costs than fixed-tilted. High differences between the manufacturers. Higher costs than fixed-tilted. High differences between the manufacturers.		Higher costs than horizontal tracker	The highest costs of all systems
2	Installation Costs	Lower than for tracker solutions, as less complex system. But the difference regarding the total installation cost is minimal compared to the horizontal tracker		Higher costs than the fixed tilted system, but lower than the vertical tracker. Higher costs than the fixed tilted system, but lower than the vertical tracker.		Commissioning Phase	Commissioning Phase
3	Maintenance Costs	Lower than for tracker solutions, as no mechanical parts		Depends on the selected manufacturer (options without mechanical parts available), but cost higher than fixed-tilted		Higher costs based on the mechanical parts	Higher costs based on the mechanical parts
4	Transposition Factor	1.03	0.994	1.09	1.29	1.31	1.35
5	Maximum Pivoting Angle Range	10° to 35°	5° to 20°	-120° to 120°	-120° to 120°	Fixed tilt for site 45° - 50°, vertical axis -180 to 180°	Motorized tilt 00-80° and vertical axis -180° to 180°
6	Site Requirements	System is adaptable to uneven ground and high slopes. Standard system up		Ground might be uneven with	Ground might be uneven with slopes up to 28°. The system	Ground might be uneven but sites with higher	Ground might be uneven but sites with higher slopes are not suitable

Table 2.9: Comparison of the Mounting Systems							
S. No.	Parameter	Fixed/Tilted		Horizontal Single Axis Tracker		Vertical Single Axis Tracker	Dual Axis Tracker
		South Faced	East-west	East-west	North-South		
		to 35°(North/South) and 10°(East/West)		slopes up to 28°	makes just sense if the site is not facing South.	slopes are not suitable without huge extra effort	without huge extra effort
7	Space Requirement	Several rows can be installed over each other. Space requirement low.	No row shading, so the rows can be installed near to each other. Best space requirement	Installation of rows over each other is limited, but space requirement not much higher than fixed-tilted	Installation of rows over each other is limited, but space requirement not much higher than fixed-tilted	The distance between the trackers must be high. Space requirement is high	The distance between the trackers must be high. Space requirement is high
8	Space Factor (W_P/m^2)	50 – 75	60 – 90	40 – 65	45 – 55	15 – 25	15 – 25

Source: Feasibility study Kohat 50 MWp PV Project

2.7.9 Inverter Technology

Because photovoltaic panels generate DC electricity, it must be converted to alternating current before it can be fed into the grid. An electronic device called inverter achieves this.

State of the art inverters offer a broad range of operational stages, which generally fulfill all the requirements of the international grid codes in terms of fault-ride-through and reactive power provision. Inverter stations provide a protective shell in which PV-strings can be connected to inverters. Centralized inverters typically have a capacity from 500 kWp to 1.5 MWp of DC PV-Power, depending on the size of inverter.

From the inverter stations the AC power is stepped-up by a MV or HV-Transformer, and then connected to a medium or high voltage grid (for instance 132 kV and 220 kV as in Pakistan).

Regarding the inverter system, two design types can be selected: a central or a decentralized design.

2.7.10 Central Inverter

Use of central inverters is the standard practice in large PV plants. The strings are combined in string combiner boxes and several combiner boxes are connected to an inverter. Typically, the output power of central inverters is between 500 kW and 1.5 MWp. The inverter can be installed in a compact station, in a container or as an outdoor system depending on the space for installation and the transport opportunities.

Typically, central inverters have a better price per MW and have less start-up and operation problems. However, they require a specific training of the electricians for the commissioning procedure and in case of failures.

The efficiency is around 1 - 2% higher than of string inverters.

2.7.11 String (decentralized) Inverter

String inverters are commonly used in small sized PV plants but there is also a trend to use them in large-scale PV plants. The strings are connected directly to inverters, which are typically up to 50 kW.

String inverters can be installed and exchanged by basic educated electricians and spare parts can be stored near the side. The inverters are easy to transport and handle. In complex terrain, with a lot of shading, the benefit is lesser module strings and therefore fewer modules are combined per inverter. Therefore, in case of partial shading of the PV generator, the mismatch losses are less because fewer modules are affected.

2.7.12 Control System

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

Chapter 3. Legislative Framework

3.1 Introduction

This chapter highlights the applicable laws, regulations and guidelines with regards to the environmental and social considerations in connection to the proposed project. Provisions of many of the guidelines have been incorporated in the mitigation measures and the Environmental Management Plan (EMP), which has been formulated for the better management of environmental and social impacts.

Key legislations governing the current IEE study include the Khyber Pakhtunkhwa Environmental Protection Act, 2014, Khyber Pakhtunkhwa Local Government Act, 2013, National Environmental Quality Standards (NEQS) of 2000 and 2010, and policies and laws on conservation of nature as outlined below;

- National Conservation Strategy, 1992
- Biodiversity Action Plan, 2000
- National Environmental Action Plan, 2001
- National Environment Policy, 2005

3.2 National Environmental Policies and Guidelines

3.2.1 National Conservation Strategy, 1992

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

A mid-term review of the achievements of the NCS in 2000 concluded that achievements under the NCS have been primarily awareness raising and institutional building rather than actual improvement to environment and natural resources and that the NCS was not designed and is not adequately focused as a national sustainable strategy (GoP, November 2000). The need therefore arose for a more focused National Environmental Action Plan (NEAP) required to bring about actual improvements in the state of the national environment with greater emphasis on poverty reduction and economic development in addition to environmental sustainability.

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

The Government of Pakistan and United Nations Development Program (UNDP) have jointly initiated an umbrella support program called the National Environmental Action Plan-Support Program signed in October 2001 and implemented in 2002. The development objective supported by NEAP-SP is environmental sustainability and poverty reduction in the context of economic growth. The objective of new policy has total 171 guidelines on sectoral and cross-sectoral issues. The objectives of new policy include assurance of sustainable development and safeguard of natural wealth of country. The following are the approved sectoral guidelines:

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

3.2.2 Mid-term Review of NCS: Key Findings

An overview of the key environmental issues facing Pakistan is as follows:

- Per capita water availability in Pakistan has been decreasing at an alarming rate. In 1951, the per capita availability was 5,300 m^3 which has now decreased to 1,105 m^3 just touching water scarcity level of 1,000 m^3.
- Almost all fresh water resources are severely polluted due to discharge of untreated industrial and municipal wastes. Pollution of coastal waters due to waste discharges and oil spills coupled with reduced freshwater flows is resulting in declining fish yields.
- About 55% of population has access to a relatively safe drinking water source. Potable water quality, assessed against WHO standards, fails to meet all the specified criteria, confirming evidence of extremely high pollutant loads.
- Approximately 35% of population has access to adequate sanitation facilities.
- Air pollution is on the rise, especially in urban areas. Recent surveys conducted by Pakistan Environmental Protection Agency revealed presence of very high levels of suspended particulate matter (about 6 times higher than the World Health Organization's guidelines). 'Smog' also seriously affects almost entire Punjab during December and January every year.
- Noise pollution has become a serious issue in major urban centers.
- Of about 54,850 tons of solid waste generated daily in urban areas, less than 60 per cent is collected. No city in Pakistan has proper waste collection and disposal system for municipal, hazardous or healthcare wastes.

- The deforestation rate has been estimated at 0.2-0.5 percent per annum. Forest cover, which was 4.8 percent of total land area in 1992, could hardly be increased substantially despite all efforts.
- Degradation and encroachment of natural forests, rangelands and freshwater and marine ecosystems are resulting in loss of biodiversity. At least four mammal species, including tiger, swamp deer, lion and Indian one horned rhinoceros, are known to have become extinct from Pakistan while at least 10 ecosystems of particular value for the species richness and uniqueness of their floral and faunal communities are considered to be critically threatened.
- Desertification affects over 43 million hectares of land annually.
- Pakistan is a highly energy inefficient country. It uses approximately same amount of energy to generate 1 dollar of GNP as the USA.

The situation just mentioned is the result of a number of constraining factors including high population growth rate, prevailing poverty, unplanned urban and industrial expansion, insufficient emphasis on environmental protection in the government policies, lack of public awareness and education and above all the ailing economy which has caused deficiencies in institutional capacity and resources for effective environmental management.

The midterm review of the NCS led the Government of Pakistan (GOP) and United Nations Development Program (UNDP) to jointly initiate an umbrella support program called the National Environmental Action Plan-Support Program (NEAP-SP) that was signed in October 2001 and implemented in 2002. The development objective supported by NEAP-SP is environmental sustainability and poverty reduction in the context of economic growth. The primary objective of NEAP is to initiate actions and programs for achieving a state of environment that safeguards public health, promotes sustainable livelihood, and enhances the quality of life of the people in Pakistan. The NEAP identifies four primary areas, (1) Clean air (2) Clean water (3) Management of solid waste (4) Ecosystem management. The plan also presents five additional areas of concern (i) Management of fresh water resources (ii) Marine pollution (iii) Toxic and hazardous substances handling and disposal (iv) Energy conservation and management (v) Compliance with international treaties and protocol.

3.2.3 Pakistan Biodiversity Action Plan, 2000

Pakistan signed the Convention on Biological Diversity in 1992 and it lead the government of Pakistan to constitute a Biodiversity Working Group, under the auspices of the Ministry of Environment, to develop a Biodiversity Action Plan for the country, which was completed after an extensive consultative exercise in 2000. The plan has been designed to complement the NCS. The proposed provincial conservation strategies identify the causes of biodiversity loss in Pakistan and suggest a series of proposals for action to conserve biodiversity in the country and Pakistan Environmental Protection Council (PEPC) approved the action plan. The steering committees were formed at the federal and provincial levels to implement the plan.

3.2.4 National Environmental Policy, 2005

The National Environmental Policy provides an overreaching framework for addressing the environmental issues facing Pakistan, particularly pollution of fresh water bodies and coastal waters, air pollution of fresh water bodies and coastal waters, air pollution, lack of proper waste management, deforestation, and loss of biodiversity, desertification, natural disasters and climatic change.

It also gives direction for addressing the cross sectional issues as well as the underlying causes of environmental degradation and meeting international obligations.

The National Environmental Policy, while recognizing the goals and objectives of the National Conservation Strategy, National Environmental Action Plan and other existing environment related national policies, strategies and action plans, provide broad guidelines to the Federal Government, Provincial Governments, Federally Administrated, Territories and Local Governments for addressing environmental concerns and ensuring effective management for their environmental resources.

The National Environmental Policy aims to protect, conserve and restore Pakistan's environment in order to improve the quality of life of the citizens through sustainable development.

3.3 National and Provincial Legislations

3.3.1 Environmental Protection Ordinance and Act

Pakistan had its first environmental protection ordinance issued in 1983 (ordinance XXXVII). In the year 1997, a more comprehensive environmental protection act was passed by National Assembly and Senate which was shortly approved by the president of Pakistan repealing the ordinance of 1983. The Act was named as the Pakistan Environmental Protection Act, 1997. The Act had been the principal environmental legislation for control of air, water, noise and other forms of pollution from different activities. The act is no longer valid to provinces after the 18th Amendment.

3.3.2 Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000

These regulations were prepared by PEPA. These regulations divide projects in different Schedules depending upon the severity of environmental impact of the project. The project would fall in Schedule I, if the project has lower environmental impacts and thus requiring an IEE. And, the project would fall in Schedule II, if the project has significant environmental impacts and thus requiring an EIA. But, all projects located in environmentally sensitive areas would require an EIA (Schedule II, i).

The project "50 MW Solar Power Plant in Kohat", falls in Schedule I requiring an IEE as the project is categorized as:

- ***J. Other Projects***
- *Any other project for which filing of an IEE is required by the Federal Agency under sub-regulation (2) of Regulation 5*

These regulations are attached in **Annex - II**.

The EIA/ IEE report submission and approval procedure is summarized below:

- Ten hardcopies of the EIA/ IEE and two soft copies will be submitted together with a review fee and form included as (Schedule IV of the EIA/ IEE Regulations (section 8).
- The EPA will conduct a preliminary scrutiny and reply within 10 days of the submittal of the report a) confirming completeness, or b) asking for additional information, if needed, or c) returning the report requiring additional studies, if necessary (section 9).
- In case of an EIA; if accepted, the EPA will set a date for public hearing and publish a notice in the print media. According to law, a minimum of 30 day notice is required for the public hearing (section 10).
- The EPA will review the EIA/IEE report and reply within (45 days in case of IEE and 90 days in case of EIA) of the submission of the IEE/EIA report. The agency may require additional information if it deems necessary (section 11).
- The approval granted at the end of the review process, is valid for three years to start construction (section 17).
- The agency keeps the rights of entry & inspection, monitoring and even cancellation of the project (section 18).
- Once the project construction is complete, the proponent is required to submit a request to EPA for confirmation of compliance. An environmental management plan for the operation phase is to accompany the request (section 19).
- The EPA is required to communicate its decision within 15 days of receipt of the request. The project can commence operation only after it has received approval from the EPA (section 20).

3.3.3 18th Amendment in Constitution of Pakistan

Prior to the 18th Amendment to the Constitution of Pakistan in 2010, the legislative powers were distributed between the federal and provincial governments through two 'lists' attached to the Constitution as Schedules. The 'Federal list' covered the subjects over which the federal government had exclusive legislative power, while the 'Concurrent List' contained subjects regarding which both the federal and provincial governments could enact laws. The subject of 'environmental pollution and ecology' was included in the Concurrent List and hence allowed both the national and provincial governments to enact laws on the subject. However, as a result of the 18th Amendment this subject is now in the exclusive domain of the provincial government. As a result, the Ministry of Environment at the federal level was abolished on 30th June 2011. Its functions related to the national environmental management have been transferred to the provinces. The ministry of climate change will manage the international obligations in the context of environment.

As a result, the Pakistan Environmental Protection Act, 1997 is no longer applicable to provinces and provinces now need to enact their own environmental protection acts at provincial level.

3.3.4 Khyber Pakhtunkhwa Environmental Protection Act, 2014

The applicable sections of this Act to this project are:

Section 11(1): Subject to the provisions of this Act, rules, notifications and guidelines made thereunder, i) no person shall discharge or emit or allow the discharge or emission of any effluent or wastes or air pollutant or noise, load, concentration or level which is in excess of the Khyber Pakhtunkhwa Environmental Quality Standards or, where applicable, the standards established under sub clause (vii) and (viii) of sub-section (1) of section 6; ii) no person shall discharge effluents, emissions or wastes in excess of load permitted in the conditions of environment permit or environmental approval or license.

Section 13(1): No proponent of a project shall commence construction and operation unless he has filed with the 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 Agency, environmental approval in respect thereof.

The IEE of the proposed Project will be submitted to the Khyber Pakhtunkhwa Environmental Protection Agency (KPK-EPA) for approval and only after the issuance of NOC will the construction activity be commenced.

Section 14: Subject to the provisions of this Act, No person shall carry, import, bring, transport or deliver hazardous waste or cause to carry, import, bring, transport or delivery of hazardous waste into the territorial jurisdiction of the Province of the Khyber Pakhtunkhwa.

Section 15: Subject to the provisions of this Act, no person shall generate, collect, consign, transport, treat, dispose of, store, handle, deal in and use or import any hazardous substance except--- (a) under a licence issued by the Agency and in such manner as may be prescribed; or (b) in accordance with the provisions of any other law for the time being in force, or of any International Treaty, Convention, Protocol, Code, Standard, Agreement or other instrument to which Pakistan or the Province of the Khyber Pakhtunkhwa is a party.

Section 16(1): Subject to the provisions of this Act, and the rules, notification and guidelines made thereunder, no person shall operate a motor vehicle from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the Khyber Pakhtunkhwa Environmental Quality Standards or where applicable the standards established under clauses (vii) and (viii) of sub-section (1) of section 6.

Section 17(1): Where the Agency is satisfied that the discharge or emission of any effluent, waste, air pollutant or noise, or the disposal of waste, or the handling of hazardous substances, or any other act or omission is likely to occur, or is occurring, or has occurred, in violation of the provisions of this Act, rules, notifications and guidelines or of the conditions of a licence or permit or environmental approval , and is likely to cause, or is causing or has caused an adverse environmental effect and violation of Khyber Pakhtunkhwa Environmental Quality Standards, the Agency may, after giving the person responsible for such discharge, emission, disposal, handling, act or omission, an opportunity of being heard, by order direct such person to take such measures that the Agency may consider necessary within such period as may be specified in the order.

Section 18(1): Whoever contravenes or fails to comply with the provisions of sections 11, 13, 14, 15 and 16 or any order passed issued thereunder, shall be punishable with a minimum fine of fifty thousand rupees which may extend to five million rupees, and in the case of a continuing contravention of failure, with a compulsory additional fine which may extend to one hundred thousand rupees for every day during which such contravention or failure continues.

Section 19: Where any contravention of this Act has been committed by a body corporate, and it is proved that such offence has been committed with the consent or connivance of, or is attributed to any negligence on the part of, any director, partner, manager, secretary or other officer of the body corporate, such director, partner, manager, secretary or other officer of the body corporate, shall be deemed guilty of such contravention along with the body corporate and shall be punished accordingly.

The act has been attached as **Annex – I**.

3.3.5 National Environmental Quality Standards (NEQS)

The NEQS were first promulgated in 1993 and were last revised in 2000 and in 2010. They comprise the basic guidelines for liquid effluent and gaseous emissions of municipal and industrial origin to comply with. These standards present the maximum allowable concentration for liquid effluent before its discharge into sea, inland water & sewage (total 32 parameters to comply with) and gaseous emissions in the ambient air from industrial sources (total 16 parameters to comply with).

During the construction and operation phase of the project NEQS will apply to all effluents and emissions. NEQS for municipal and industrial effluents, selected gaseous pollutants from industrial sources, motor vehicle exhaust and noise, ambient air quality & ambient noise and drinking water quality have been provided in the report as **Annex-III**.

A chronology of NEQS is given below:

Table 3.1: Chronology of national environmental quality standards

Year Published	S.R.O. Number	Scope
1993	742 (I)/1993	Liquid Industrial Effluent Industrial Gaseous Emission Vehicle Exhaust and Noise
1995	1023 (I)/1995	Industrial Gaseous Emission from Power Plants operating on coal and oil (added)
2000	549 (I)/2000	Liquid Industrial Effluents (amended); Industrial Gaseous Emission (amended)
2010	1062 (I)/2010	Ambient Air
2010	1063 (I)/2010	Drinking Water Quality

Table 3.1: Chronology of national environmental quality standards		
Year Published	S.R.O. Number	Scope
2010	1064 (I)/2010	Noise

In 2000, Pakistan EPA revised the national standards for liquid effluents and gaseous emissions with full consultation of the private sector, industrialists, trade and business associations and NGOs.

1. **NEQS for Liquid Industrial Effluents**

The municipal and liquid industrial effluent standards cover 32 parameters. The standards cover discharges limits of effluents into inland water, sewage treatment plant and the sea. The NEQS are primarily concentration based.

Table 3.2: National environmental quality standards for Municipal and liquid industrial effluents SRO 549(I)2000 (mg/I, Unless otherwise defined)

S. No	Parameter	Existing Standards	Revised Standards Into Inland Waters	Into Sewage Treatment (5)	Into Sea
1	Temperature or Temperature Increase	40 °C	< 3 °C	< 3 °C	< 3 °C
2	*pH value (H^+)	6-10	6-9	6-9	6-9
3	Biochemical Oxygen Demand $(BOD)_5$ at 20 °C (1)	80	80	250	80**
4	Chemical Oxygen Demand (COD) (1)	150	150	400	400
5	Total Suspended Solids (TSS)	150	200	400	200
6	Total Dissolved Solids (TDS)	3500	3500	3500	3500
7	Oil and Grease	10	10	10	10
8	Phenolic compounds (as phenol)	0.1	0.1	0.3	0.3
9	Chloride (as Cl^-)	1000	1000	1000	SC***
10	Fluoride (as F^-)	20	10	10	10
11	Cyanide (as CN) total	2	1.0	1.0	1.0
12	An-ionic detergents (as MBAS) (2)	20	20	20	20
13	Sulphate (SO_4^{2-})	600	600	1000	SC***
14	Sulphide (S^{2-})	1.0	1.0	1.0	1.0
15	Ammonia (NH_3)	40	40	40	40
16	Pesticides (3)	0.15	0.15	0.15	0.15
17	Cadmium (4)	0.1	0.1	0.1	0.1
18	Chromium (trivalent and hexavalent (4)	1.0	1.0	1.0	1.0
19	Copper (4)	1.0	1.0	1.0	1.0
20	Lead (4)	0.5	0.5	0.5	0.5
21	Mercury (4)	0.01	0.01	0.01	0.01
22	Selenium (4)	0.5	0.5	0.5	0.5
23	Nickel (4)	1.0	1.0	1.0	1.0
24	Silver (4)	1.0	1.0	1.0	1.0

Table 3.2: National environmental quality standards for Municipal and liquid industrial effluents SRO 549(I)2000 (mg/I, Unless otherwise defined)					
S. No	Parameter	Existing Standards	Revised Standards Into Inland Waters	Into Sewage Treatment (5)	Into Sea
25	Total toxic metals	2.0	2.0	2.0	2.0
26	Zinc	5.0	5.0	5.0	5.0
27	Arsenic (4)	1.0	1.0	1.0	1.0
28	Barium (4)	1.5	1.5	1.5	1.5
29	Iron	2.0	8.0	8.0	8.0
30	Manganese	1.5	1.5	1.5	1.5
31	Boron (4)	6.0	6.0	6.0	6.0
32	Chlorine	1.0	1.0	1.0	1.0

1. *Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent*
2. *Methylene Blue Active Substances; assuming surfactant as biodegradable*
3. *Pesticides include herbicides, fungicides, and insecticides*
4. *Subject to total toxic metals discharge should not exceed level given at S. N. 25*
5. *Applicable only when and where sewage treatment is operational and BOD_5=80mg/I is achieved by the sewage treatment system*
6. *Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.*

** The effluent should not result in temperature increase of more than 30C at the edge of the zone where initial mixing and dilution take place in the receiving body. In case zone is not defined, use 100 meters from the point of discharge*

***The value for industry is 200 mg/I*

****Discharge concentration at or below sea concentration (SC)*

Note:

1: Dilution of liquid effluents to bring them to the NEQS limiting values is not permissible through fresh water mixing with the effluent before discharging into the environment.

2: The concentration of pollutants in water being used will be subtracted from the effluent for calculating the NEQS limits"

2. NEQS for Gaseous Industrial Emissions

For industrial gaseous emissions, 16 parameters have been defined.

Table 3.3: National environmental quality standards for industrial gaseous emissions SRO 549(I)2000				
Concentrations in mg/Nm³ unless otherwise defined				
S. No.	Parameter	Source of Emission	Existing Standards	Revised Standards
1.	Smoke		Smoke opacity not to exceed 40% or 2 Ringlemann Scale	40% or 2 Ringlemann Scale or equivalent smoke number
2.	Particulate matter (1)	(a) Boilers and Furnaces (i) Oil fired (ii) Coal fired (iii) Cement Kilns	 300 500 200	 300 500 300
		(b) Grinding, crushing, Clinker coolers and Related processes, Metallurgical	500	500

Table 3.3: National environmental quality standards for industrial gaseous emissions SRO 549(I)2000

Concentrations in mg/Nm^3 unless otherwise defined

S. No.	Parameter	Source of Emission	Existing Standards	Revised Standards
		Processes, converter, blast furnaces and cupolas.		
3.	Hydrogen Chloride	Any	400	400
4.	Chlorine	Any	150	150
5.	Hydrogen Fluoride	Any	150	150
6.	Hydrogen Sulphide	Any	10	10
7.	Sulphur Oxides (2)(3)	Sulfuric acid/Sulphonic acid plants		
		Other plants except power Plants operating on oil and coal	400	1700
8.	Carbon Monoxide	Any	800	800
9.	Lead	Any	50	50
10.	Mercury	Any	10	10
11.	Cadmium	Any	20	20
12.	Arsenic	Any	20	20
13.	Copper	Any	50	50
14.	Antimony	Any	20	20
15.	Zinc	Any	200	200
16.	Oxides of Nitrogen (3)	Nitric acid manufacturing unit.	400	3000
		Other plants except power plants operating on oil or coal:		
		Gas fired Oil fired Coal fired	400 - -	400 600 1200

Explanations: -

1. Based on the assumption that the size of the particulate is 10 micron or more.

2. Based on 1 percent Sulphur content in fuel oil. Higher content of Sulphur will case standards to be pro-rated.

3. In respect of emissions of Sulphur dioxide and Nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to National Environmental Quality Standards (NEQS) specified above, comply with the following standards: -

A. Sulphur Dioxide

Sulphur Dioxide Background levels Micro-gram per cubic meter ($\mu g/m^3$) Standards.

Background Air Quality (SO_2 Basis)	Annual Average	Max. 24-hours Interval	Criterion I Max. SO_2 Emission (Tons/Day /Plant)	Criterion II Max. Allowable ground level increment to ambient ($\mu g/m^3$) (One year avg)
Unpolluted	<50	<200	500	50
Moderately Polluted*				

Low	50	200	500	50
High	100	400	100	10
Very Polluted**	>100	>400	100	10
** For intermediate values between 50 and 100 µg/m3 linear interpolations should be used* *** No projects dioxide emissions will be recommended*				
B. Nitrogen Oxide				
Ambient air concentrations of Nitrogen oxides, expressed as NO_x should not be exceed the following: Annual Arithmetic Mean: 100 µg/m^3 (0.05 ppm) Emissions level for stationary source discharge before missing with the atmosphere, should be maintained as follows: For fuel fired steam generators as Nanogram (10^{-9}-gram) per joule of heat input: Liquid fossil fuel .. .. .. 130 Solid fossil fuel .. .. 300 Lignite fossil fuel 260				
Note:- Dilution of gaseous emissions to bring them to the NEQS limiting value is not permissible through excess air mixing blowing before emitting into the environment.				

3. NEQS for Noise

In 2010, Pak EPA established the National Environmental Quality Standards for noise [S.R.O. 1064(I)/2010]. The standards define noise levels based on four different spatial zones and two temporal settings.

Table 3.4: National Environmental Quality Standards for Noise 2010

S. No.	Category of Area / Zone	Effective from 1st July, 2010		Effective from 1st July, 2012	
		Limits it in dB (A) Leq*			
		Day Time	Night Time	Day Time	Night Time
1	Residential area (A)	65	50	55	45
2	Commercial area (B)	70	60	65	55
3	Industrial area (C)	80	75	75	65
4	Silence Zone (D)	55	45	50	45

Notes
1: Day time hours: 6:00 am to 10:00 pm
2: Night time hours: 10:00 pm to 6:00 am
3: Silence zone; Zones which are declared as such by a competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.
4: Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
**dB (A) Leq: Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.*

4. NEQS for Ambient Air

The Ministry of Environment, Government of Pakistan in 2010, under S.R.O. 1062 (1)/2010 established standards which provide the maximum allowable limits, in the ambient air, of Sulphur Dioxide (SO_2), Oxides of Nitrogen as (NOx) and as (NO), Suspended Particulate Matter–(SPM), Reparable Particulate Matter–PM_{10}, Repairable Particulate Matter–$PM_{2.5}$, Lead and Carbon Monoxide (CO).

Table 3.5. National Ambient Air Quality Standards (2010)

Pollutants	Time–Weighted Average	Concentration in Ambient Air		Method of Measurement
		Effective from 1st July 2010	Effective from 1st January 2013	
Sulfur Dioxide (SO_2)	Annual Average*	80 µg/m³	80 µg/m³	Ultraviolet Fluorescence
	24 hours**	120 µg/m³	120 µg/m³	
Oxides of Nitrogen as (NO)	Annual Average*	40 µg/m³	40 µg/m³	Gas Phase Chemiluminescence
	24 hours**	40 µg/m³	40 µg/m³	
Oxides of Nitrogen as (NO_2)	Annual Average*	40 µg/m³	40 µg/m³	Gas Phase Chemiluminescence
	24 hours**	80 µg/m³	80 µg/m³	
Ozone (O_3)	1 hour	180 µg/m³	130 µg/m³	Non dispersive UV absorption
Suspended Particulate Matter (SPM)	Annual Average*	400 µg/m³	360 µg/m³	High Volume Sampling, (Average flow rate not less than 1.1m3/minute).
	24 hours**	550 µg/m³	500 µg/m³	
Reparable Particulate Matter.PM_{10}	Annual Average*	200 µg/m³	120 µg/m³	βRay absorption
	24 hours**	250 µg/m³	150 µg/m³	
Reparable Particulate Matter.$PM_{2.5}$	Annual Average*	25 µg/m³	15 µg/m³	βRay absorption
	24 hours**	40 µg/m³	35 µg/m³	
		25 µg/m³	15 µg/m³	
Lead (Pb)	Annual Average*	1.5 µg/m³	1.0 µg/m³	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2.0 µg/m³	1.5 µg/m³	
Carbon Monoxide(CO)	8 hour	5 µg/m³	5 µg/m³	Non Dispersive Infra-Red (NDIR)
	1 hour	10 µg/m³	10 µg/m³	

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

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

3.3.6 Khyber Pakhtunkhwa Local Government Act, 2013

This Act was enacted to construct and regulate the local government institutions in the Province of Khyber Pakhtunkhwa and to consolidate laws relating to these institutions and to provide for matters connected therewith and ancillary thereto.

Section 3: Local governments established under this Act shall function within the provincial framework and shall faithfully observe the federal and provincial laws.

Section 4: Defines the local areas for local governments as Village, Neighborhood, Tehsil, Town, District and City District.

Section 5: The Local governments to be constituted under this Act shall be a city district government for district Peshawar; a district government for a district other than Peshawar; a Tehsil Municipal Administration for a Tehsil; a Town Municipal Administration for a Town in the City

District; a Village Council for a village in the rural areas; and a Neighborhood Council for a Neighborhood in areas with urban characteristics.

Sections 13: The authority of district government shall comprise the operation, management and control of offices of the departments which are devolved to it; provided that district government shall exercise such authority in accordance with general policy of Government.

Section 66: Offences, punishments and their cognizance: The offences specified in Fourth and Fifth Schedules shall be liable to punishment by way of imprisonment, fine, seizure, forfeiture, confiscation, impounding and such other penalties as provided in this Act.

3.3.7 NWFP/KPK Fisheries (Amendments) Ordinance, 1961

This Ordinance came with minor modification in the West Pakistan Fisheries Ordinance, 1961. The NWFP Fisheries (Amendments) Ordinance, 1982 regulates fishing in the public waters. It empowers the government of KPK to issue licenses for fishing in public waters, put restriction on the type of equipment that can be used for fishing and restrict fishing in certain areas or of certain species of fish.

3.3.8 NWFP/KPK Wildlife Rules, 1975

N.W.F.P Wildlife Rules, 1975, applies to the whole of Khyber Pakhtunkhwa province and aims to ensure protection, preservation and management of wildlife. These rules have been promulgated to provide guidance on activities such as shooting, hunting, employing of hocks, dogs without license and related activities which if remain uncontrolled or unsupervised can affect the wildlife in a particular area. Government may alter the boundary of wildlife sanctuary, game reserves or national parks and may declare any area to be a game reserve, where hunting and shooting of wild animal shall not be allowed, except under special permit, which may specify the maximum number of animals or birds that may be killed or captured and the area and duration for which; such permits shall be valid (Section 17). The rules also provide guidelines on possession of animals and acquisition of permits to keep, use or transport animals, trophies or meats.

The activities of this solar power project in Kohat will be carried out by the proponent in compliance with the NWFP wildlife rules, 1975 and will give due consideration to protecting any endangered species if sighted during project execution, and will carefully move the animal to a safer but similar habitat or otherwise inform the wildlife department for necessary action.

3.3.9 North West Frontier Province/KPK Protection of Trees and Brushwood Act 1949

The Act was established to protect the trees and brushwood belonging to the Government and Local Bodies. Provided that nothing shall be deemed to be an offence under this Act when done with the permission in writing of the prescribed authority or in accordance with rules framed under this Act.

Section3 (2): Every person who neglects any duty imposed on him by this Section shall be punishable with imprisonment which may extend to three years or fine or both.

3.3.10 NWFP/KPK Irrigation and Drainage Authority Act, 1997 and 2005

N.W.F.P. Irrigation and Drainage Authority Act, 1997 was enacted to adopt a strategy for streamlining the irrigation and drainage system in the province of North-West Frontier (now KPK). The objectives as mentioned in the preamble included making irrigation, drainage and flood control system more efficient and responsive; ensuring just distribution of water; making the irrigation network sustainable; and, improving efficiency of water resources. The irrigation department was transformed into autonomous authority, area water boards and farmer's organizations were established.

The authority was entrusted with various powers and duties such as receiving irrigation supplies at the barrages and/or head works (subject to Indus Water Treaty, 1960), to exercise all the powers under the Canal and the Drainage Act, 1997, fixing of rates to which it would supply irrigation water and imposing of surcharge for late payments. The authority could also formulate policies and regulations in the water resources sector, for proper exercise of the powers, finance & administration of works undertaken or other related issues and conducting research and development programs for addressing various related issues etc.

N.W.F.P. Irrigation and Drainage Authority (Amendment) Act, 2005 amended two sections of the 1997 Act as mentioned below:

Section 2: Amendment of Section 4 NWFP Act No. V of 1997

Section 3: Amendment of Section 8 NWFP Act No. V of 1997

3.3.11 Land Acquisition Act, 1894

This act is generally used to establish the rights on the land being acquisitioned for public purposes. The LAA describes the detailed procedures for acquisition of private properties, but does not appropriately cover resettlement and rehabilitation. Additionally, LAA 1984 treats land acquisition as a provincial subject, and allows each province to use it in different ways based on their own interpretation. Federal EPA prepared the National Resettlement Policy 2002, which described the ways relating to calculation of compensation, public participation and consultation, formulation of resettlement action plan, and provisions for transparency and accountability.

The land will be purchased by the proponent.

3.3.12 Antiquities Act, 1975

The Antiquities Act of 1975 ensures the protection of cultural resources in Pakistan. Section 22 specifically prohibits the execution of development schemes and new constructions in proximity to immovable antiquity. Notwithstanding anything contained in any other low for the time being in force, no development plan, scheme, or new construction on, or within a distance of two hundred feet of, a protected immovable antiquity shall be undertaken or executed except with the approval of the Director.

The Act is designed to protect the antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the GOP to prohibit excavation in any area that may contain articles of archaeological significance. The project site does not have any cultural sensitivity in the vicinity to require protection. The provisions of this law therefore do not apply on the project.

3.3.13 The Forest Act, 1927

The Act is applicable to all regions of Pakistan. It includes procedures for constituting and managing various types of forests, such as reserved forests and protected forests.

The Act empowers the provincial forest departments to declare any forest area as reserved or protected. It also defines the duties of forest related public servants, and penalties of any infringement of the rules. The project management will adopt measures for protection of vegetation and green areas in the surroundings.

3.3.14 Pakistan Penal Code, 1860

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

3.3.15 Self-Monitoring and Reporting by Industry Rules, 2014

These rules classify the industrial units for monitoring and reporting their liquid effluent and gaseous emissions into three and two categories respectively. According to each category, they define the priority parameters to be monitored and reported to KP-EPA according to a specific frequency based on working conditions. This monitoring and reporting is in addition to the monitoring conditions as required by the conditions of approval of IEE. The sampling for testing must be carried out according to Environmental Samples Rules, 2014 and be sent to KP-EPA certified environmental testing laboratories.

3.3.16 National Power Policy, 2013

The Ministry of Water and Power of the Government of Pakistan has developed an ambitious power policy to support the current and future energy needs of the country. This bold strategy will set Pakistan on a trajectory of rapid economic growth and social development. Simultaneously, it will address the key challenges of the power sector in order to provide much needed relief to the citizens of Pakistan.

The power policy aims that the country will develop the most efficient and consumer centric power generation, transmission, and distribution system that meets the needs of its population and boosts its economy in a sustainable and affordable manner.

3.3.17 Power Generation Policy, 2015

In Pursuant to the decision of Council of Common Interest (the Council) held on 18th March, 2015, the Council approved the Power Generation Policy, 2015, which was subsequently finalized in consultation with all provincial representatives during the meeting of the Inter Provincial Coordination Committee (IPCC) on 31-03-2015 and published in the official Gazette of Pakistan.

Main objectives of power policy are:

- To provide sufficient power generation capacity at the least cost

- To encourage and ensure exploitation of indigenous resources
- To ensure that all stakeholders are looked after in the process; a win-win situation
- To be attuned to safeguarding the environment

Scope of the power policy summarized below;

- Private sector power projects
- Public sector power projects, where required by the Project Sponsor
- Public-Private Partnership (PPP) power projects
- Power projects developed by the Public sector and subsequently divested

3.3.18 Pakistan Environmental Assessment Procedures, 1997

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

- Policy and Procedures for Filing, Review and Approval of Environmental Assessments;
- Guidelines for the Preparation and Review of Environmental Reports;
- Guidelines for Public Consultation
- Guidelines for Sensitive and Critical Areas; and
- Sectorial Guidelines

3.4 International Guidelines

3.4.1 IUCN Red List

The Red List is published by IUCN and includes those species that are under potential threat of extinction. These species have been categorized as:

- Endangered: species that are seen to be facing a very high risk of extinction in the wild in the near future, reduction of 50% or more either in the last 10 years or over the last three generations, survive only in small numbers, or have very small populations.
- Vulnerable in Decline: species that are seen to be facing a risk of extinction in the wild, having apparent reductions of 20% or more in the last 10 years or three generations.
- Vulnerable: species that are seen to be facing a high risk of extinction in the wild, but not necessarily experiencing recent reduction in population size.
- Lower Risk: species that are seen to be facing a risk of extinction that is lesser in extent that for any of the above categories.
- Data Deficient: species that may be at risk of extinction in the wild but at the present time there is insufficient information available to make a firm decision about its status.

3.4.2 Convention on Biological Diversity

The Convention on Biological Diversity was adopted during the Earth Summit of 1992 at Rio de Janerio. The Convention requires parties to develop national plans for the conservation and sustainable use of biodiversity, and to integrate these plans into national development programs and policies. Parties are also required to identify components of biodiversity that are important for conservation, and to develop systems to monitor the use of such components with a view to promoting their sustainable use.

3.4.3 Convention of Conservation of Migratory Species of Wild Animals 1979

The Convention on the Conservation of Migratory Species of Wild Animals (CMS), 1979, requires countries to take action to avoid endangering migratory species. The term "migratory species" refer to the species of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries. These parties are also required to promote or co-operate with other countries in matters of research on migratory species.

The Convention contains two appendices. Appendix I contain the list of migratory species that are endangered according to the best scientific evidence available. For these species, the member states to the Convention are required endeavour to:

- Conserve and restore their habitats.
- Prohibit their hunting, fishing, and capturing, harassing and deliberate killing.
- Remove obstacles and minimize activities that seriously hinder their migration.
- Control other factors that might endanger them, including control of introduced exotic species.

3.4.4 Convention on Wetlands of International Importance, Ramsar 1971

Pakistan is the signatory to the said Convention. The principal obligations of contracting parties to the Convention are:

- To designate wetlands for the List of Wetlands of International Importance.
- To formulate and implement planning to promote wise use of wetlands, to make IEE before transformations of wetlands, and to make national wetland inventories. To establish nature reserves on wetlands and provide adequately for their widening and through management to increase the waterfowl populations on appropriate wetlands. To train personnel competent in wetland research, management and widening.
- To promote conservation of wetlands by combining far-sighted national policies with coordinated international action, to consult with other contracting parties about implementing obligations arising from the Convention, especially about shared wetlands and water system.
- To promote wetland conservation concerns with development aid agencies. To encourage research and exchange of data.

3.4.5 Convention on International Trade in Endangered Species of Wildlife Fauna and Flora

The Convention came into effect on 03 March 1973 in Washington. In all 130 countries are signatory to this Convention with Pakistan signing the convention in 1976. The Convention requires the signatories to impose strict regulation (including penalization, confiscation of the specimen etc.) regarding trade of all species threatened with extinction or that may become so, in order not to endanger further their survival.

The Convention contains three appendices. Appendix I include all species threatened with extinction which are or may be affected by trade. The Convention requires that trade in these species should be subject to strict regulation. Appendix II includes species that are not necessarily threatened presently but may become so unless trade in specimens of these species is subject to strict regulation. Appendix III includes species which any contracting party identifies as subject to regulations in trade and requires other parties to co-operate in this matter.

3.4.6 Framework of Environment and Wildlife Institution in Pakistan

Headed by a Federal Minister, the Ministry of Environment, Local Government and Rural Development is the main government organization responsible for the protection of environment and resource conservation. The Ministry works with the Pakistan Environmental Protection Council (PEPC), and the Federal and Provincial Environmental Protection Agencies formed under the PEPA 1997. The roles, responsibilities and authorities of PEPC and the EPA's are defined in the PEPA 1997.

The PEPC has been formed by the Federal Government. Its member includes the President of Pakistan, or someone appointed by the President, as the Chairperson; the Minister of the Ministry of Environment, Local Government and Rural Development as the vice-Chairperson; Governors of the Provinces; Ministers in charge of the subject of environment in the Provinces; Secretary of the Federal Government in-charge of the Ministry of Environment, Local Government and Rural Development; Director General Federal EPA; heads of other federal and provincial departments; environmentalists and community representatives including scientists. The functions and powers of the Council include formulation of national environmental policy, enforcement of PEPA 1997, approval of NEQS, incorporation of environmental considerations in to national development plans and policies and provide guidelines for the protection and conservation of biodiversity in general and for the conservation of renewable and non-renewable resources.

The Federal government has also formed the Federal EPA, which is headed by the Director General and has wide-ranging functions given in the PEPA 1997. These include the preparation and co-ordination of national environmental policy for approval by PEPC, administering and implementing the PEPA 1997 and preparation, revision or establishment of NEQS.

The Provincial Environmental Protection Agencies are formed by the respective Provincial Governments. A Director General who exercises power delegated to him by the Provincial Government heads each Provincial EPA. IEE's and EIA's are submitted to Provincial EPA's for approval.

The National Council for Conservation of Wildlife (NCCW) is responsible for the formulation of national wildlife policies, co-ordination with provincial wildlife department on the implementation of these policies and co-ordination with international organizations on the matter related to the international treaties. The NCCW works under the Ministry of Environment, Local Government and Rural Development and is headed by the IG Forests. NCCW comprises of an advisory council, which is chaired by the Ministry of Environment and includes representatives from provincial wildlife departments, NGO's, members of the civil society and other ministries. A NCCW secretariat based in Islamabad handles the day-to-day affairs and the actual implementation of policies and recommendations of the advisory council. At provincial level almost each province has a wildlife department and a wildlife protection act.

3.4.7 IFC Environmental, Health, and Safety Guidelines

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP).

Environmental issues associated with the construction and maintenance activities may include, among others, noise and vibration, soil erosion, and threats to biodiversity, including habitat alteration and impacts to wildlife.

Examples of the impacts addressed in the General EHS Guidelines include:

- Construction site waste generation;
- Soil erosion and sediment control from materials sourcing areas and site preparation activities;
- Fugitive dust and other emissions (e.g. from vehicle traffic, land clearing activities, and materials stockpiles);
- Noise from heavy equipment and truck traffic;
- Potential for hazardous materials and oil spills associated with heavy equipment operation and fuelling activities.

Environmental issues during the construction phase include the following:

- Terrestrial habitat alteration.
- Hazardous materials.

Chapter 4. Environmental and Social Baseline

4.1. Introduction

This section describes the existing environmental and social conditions of project area situated in the tehsil Lachi of Kohat District, KPK. Information presented in this chapter was collected from both primary and secondary sources to establish a comprehensive profile of the area for further assessment of impacts.

Secondary data was obtained through previous studies conducted in the area, district census reports, similar work done by the consultant in the area and other archives. Authenticity of the data and data source was focused throughout the period of compilation of this chapter.

Field surveys were conducted by EMC team of environmentalists and sociologists to collected primary data on the environmental and social features of project area including natural environment, ecosystems, biodiversity, air shed, water shed, physiography, social status, livelihood, economic activities etc.

4.2. Project Location

4.2.1. Microenvironment

Microenvironment of the project constitutes the 115 hectares project site located at 33°21'39.86"N, 71°22'44.06"E. The project site (microenvironment) is based in a complex terrain consisting of multiple depression and ridges.

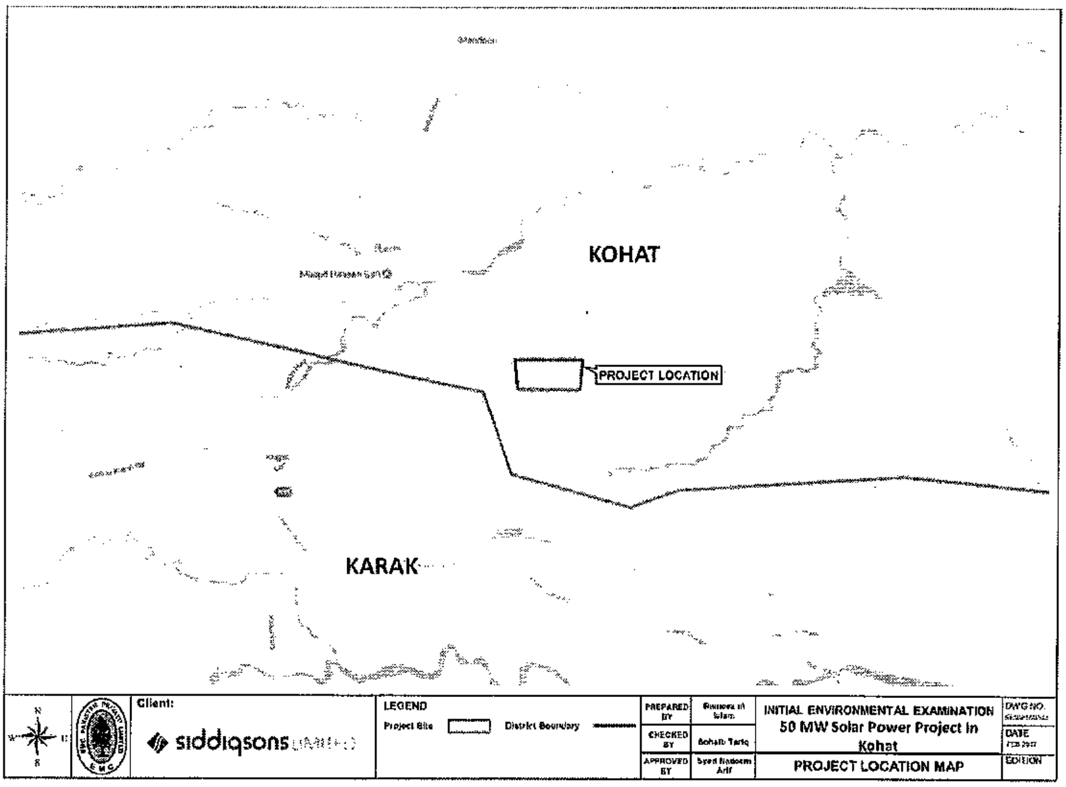
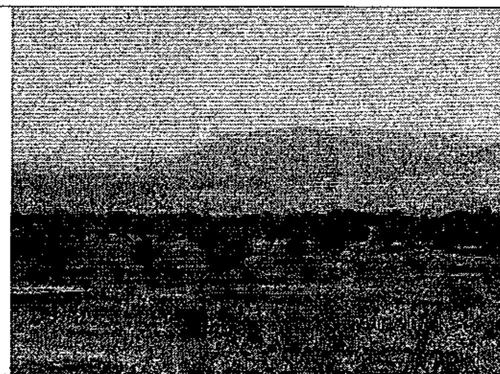
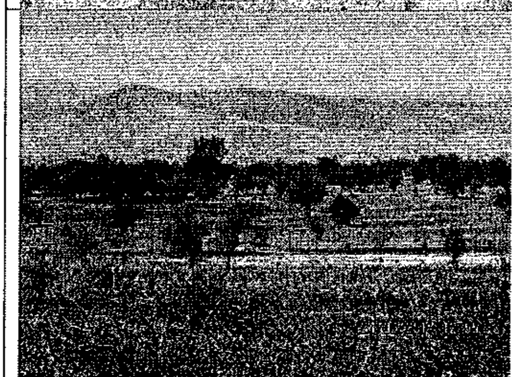
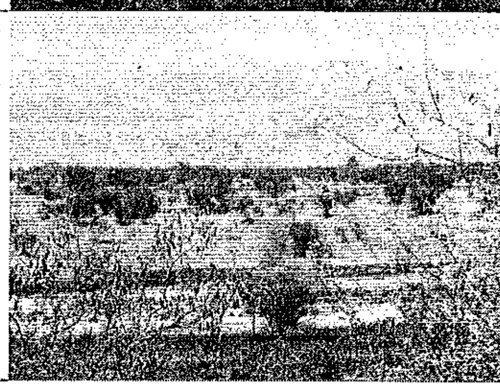


Figure 4.1: Location of Project Area

The land is currently barren and uncultivated, with very little vegetation on the site. Most of the terrain is covered with wild bushes & shrubs with only a few small trees along the west boundary of the site. There are scattered villages near the eastern boundary of the site and a few houses are located within the site on a ridge towards the north east.

General View of the Area

4.2.2. Macroenvironment

Macro environmental includes nearby villages, vegetation and hills. Nearest village is Mohsin Khel Kohat that is about 1.5 km North of the project site. The Tanda Dam is located at approximately 22 kilometres away from project site in North. Town of Lachi is located about 3.5 km northwest from the project site. Unpaved roads exists in the project area, which provide connectivity to the N-55 Indus Highway and Bannu-Kohat Road westwards. There is a stream of water called Lachi Toi from the Kohat Toi Tributary about 2.38 km northwards from the project site. Stream of Maramzai Algad, which originates from Lachi Toi, is at about 3 km from the project site, in north-western direction.

4.3. Physical Environment

4.3.1. Climate

The climate of Kohat and surroundings is hot from May to September. June is the hottest month. The mean, maximum and minimum temperature recorded during June is about 40° C and 27° C respectively. A pleasant change in the weather is noted from October onwards, up till February. The winter is cold and severe. In winter a wrong west wind known as "Hangu Breeze" often blows down the Miranzai valley towards Kohat for weeks. The mean maximum and minimum temperature, recorded during the month of January, is about 18° C and 6" C respectively.

The rainfall is received throughout the year. The monsoon rain is received from May to October. August is the rainiest month, with an average of about 114 mm. The winter rain occurs from November to April. The highest winter rainfall is received in the month of March. The average annual rainfall is about 638 mm. The maximum humidity has been recorded in the month of August during summer season and in December during the winter season. Figure 4.2 summarizes the weather of Kohat;

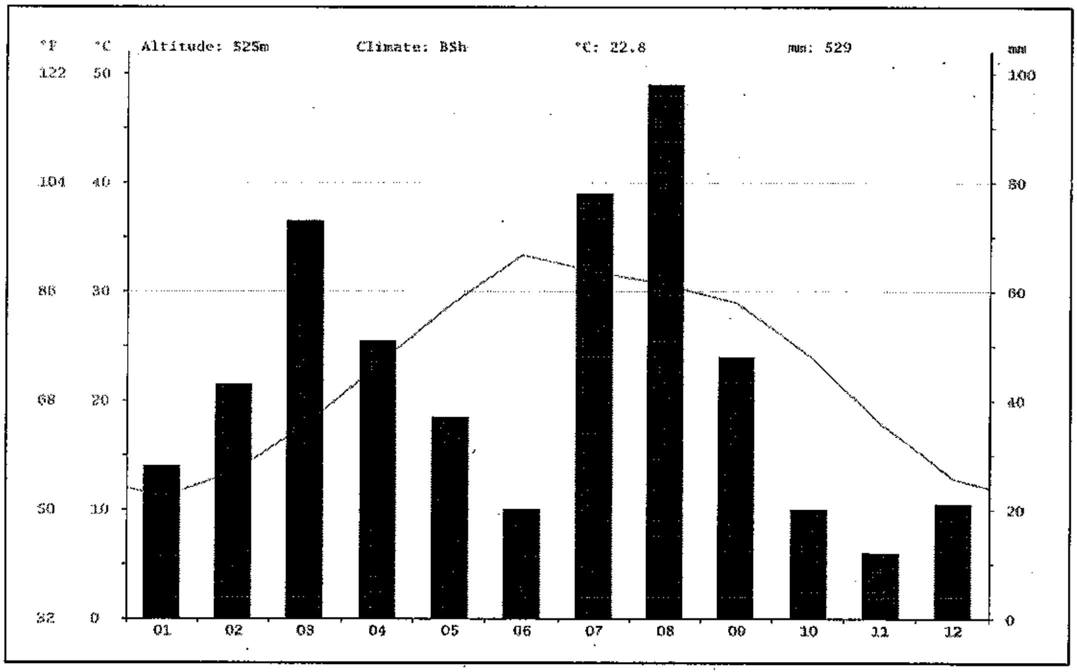


Figure 4.2: Peshawar Weather Indicators
Source: http://en.climate-data.org/

1. **Temperature and Wind Speed**

Data for the site-specific temperature and wind speed at 10 m above ground was obtained from Meteonorm 7 is shown in **Error! Reference source not found.**4.1.

Table 4.1: Onsite Ambient Temperature and Wind Speed data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Amb. Temp. (°C)	10.2	13.5	18.9	24.3	29.6	31.3	30.1	29	27.1	22.5	16	11.7	22

Table 4.1: Onsite Ambient Temperature and Wind Speed data													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Wind Speed (m/s)	2	2.6	3	3.7	4.2	4.5	3.9	3.1	2.5	1.8	1.5	1.5	2.9
Source: Feasibility Study Kohat 50 MWp PV Project													

The temperatures are highest on average in June, at around 33.3 °C. The lowest average temperatures in the year occur in January, when it is around 11.1 °C.

Figure 4.3: Temperature Profile Kohat
Source: http://en.climate-data.org/

2. Precipitation

The variation in the precipitation between the driest and wettest months is 86 mm. Table 4.1 summarizes the average precipitation pattern in Kohat.

Table 4.2: Mean Monthly Precipitation in Kohat (mm)													
Measure	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average	28	43	73	51	37	20	78	98	48	20	12	21	529
Source: http://en.climate-data.org/													

3. Sunshine Hours

Sunshine duration or sunshine hours is a climatological indicator, measuring duration of sunshine in given period (usually, a day or a year) for a given location on Earth, typically expressed as an averaged value over several years. It is a general indicator of cloudiness of a location, and thus differs from insolation, which measures the total energy delivered by sunlight over a given period.

Sunshine duration is usually expressed in hours per year, or in (average) hours per day. The first measure indicates the general sunniness of a location compared with other places, while the latter allows for comparison of sunshine in various seasons in the same location. Another often-used measure is percentage ratio of recorded bright sunshine duration and daylight duration in the observed period.

The Global Horizontal Irradiation values at the site were compared from several suitable databases as shown in Table 4.2. The average annual GHI was calculated to be 1,792 kWh/m^2 at the site.

Table 4.3: Annual Global Horizontal Irradiation (GHI) from various data sources

Data Source	Measurement Duration	GHI (kWh/m^2)	Difference from Average (%)
Meteonorm 7	1991-2010	1,752	-2.2
SolarGIS	1999-2011	1,780	-0.7
NREL SUNY	2000-2014	1,843	2.9
Average		1,792	

Source: Feasibility Study Kohat 50 MWp PV Project

Meteonorm 7 and NREL SUNY combined with PVGIS-CMSAF databases were used to obtain the irradiation at chosen angles. The orientation of the modules was assumed to be due south, with an azimuth angle of 0°. The irradiation values at the site are provided in Table 4.3.

Table 4.4: Monthly and annual On-site irradiation

Meteonorm 7													
kWh/m^2	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
GHI	92	98	150	170	205	192	180	171	158	139	111	89	1,752
20°	126	122	172	180	204	186	177	176	175	171	154	128	1,969
25°	132	126	175	179	201	182	173	174	176	176	163	136	1,995
30°	138	129	177	178	197	177	169	172	177	180	170	143	2,008
NREL SUNY / PVGIS-CMSAF													
kWh/m^2	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
GHI	97	100	162	183	223	202	187	180	163	146	108	93	1,843
20°	134	124	184	192	219	194	182	183	179	179	145	133	2,049
25°	142	129	188	191	216	189	179	182	181	185	152	141	2,074
30°	148	132	190	190	211	184	174	179	182	189	158	148	2,086

Source: Feasibility Study Kohat 50 MWp PV Project

Although the inclination angle of 33° resulted in the highest total irradiation falling on the plane, this would result in a higher inter row distance (pitch) to avoid inter row shading. This would ultimately lead to a reduced installed capacity. As a result, it was decided that the optimum inclination angle at this stage is 25° and this corresponds to an average irradiation value of 2,021 kWh/m^2.

Solar maps of Pakistan are depicted in fig 4.4 and 4.5.

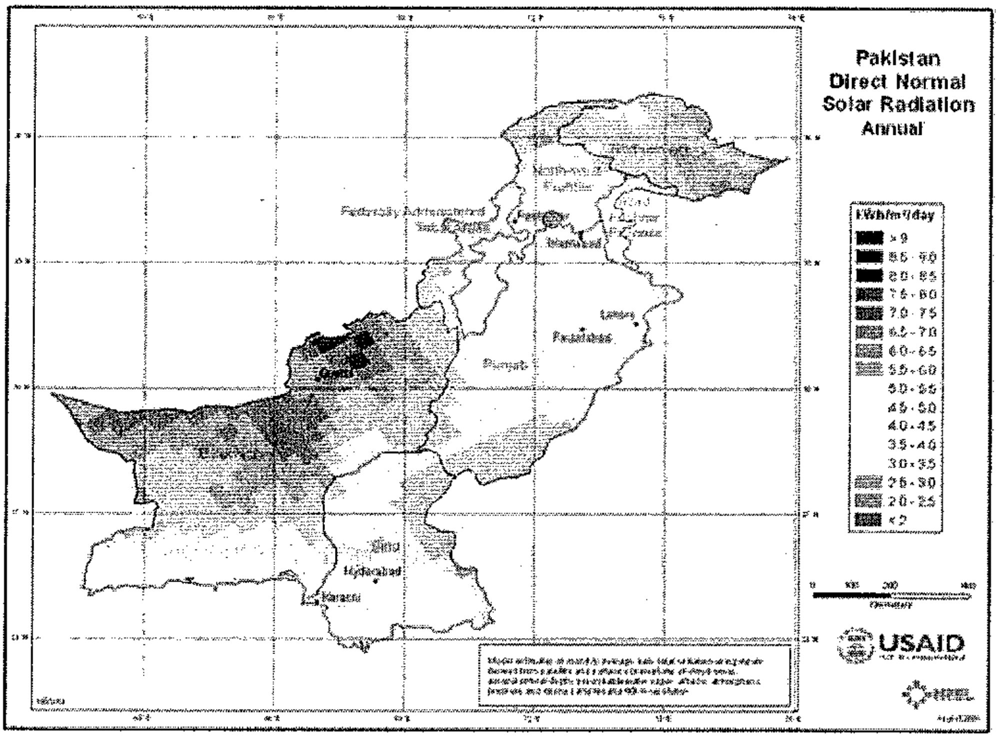


Figure 4.4: Solar map of Pakistan
Source: USAID/NREL

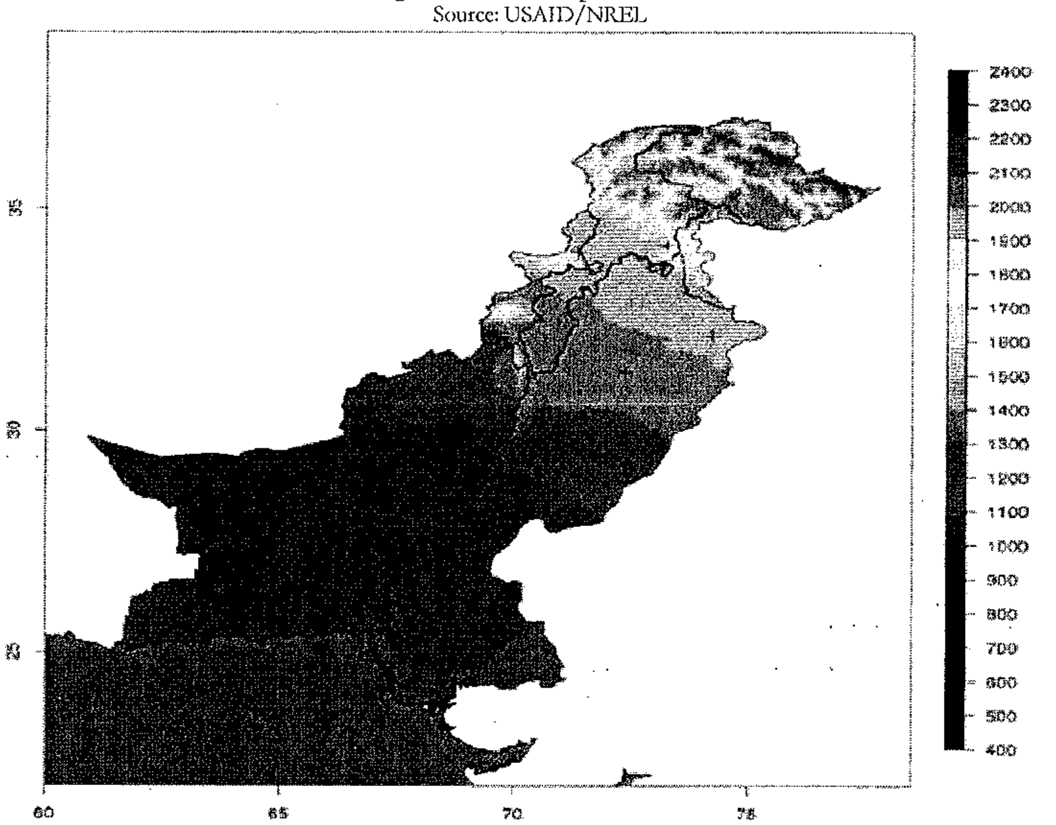


Figure 4.5: Multi-Year Mean (2000-2012) of annual Global Horizontal Irradiance (GHI) for Pakistan in kWh/m²
Source: Alternative Energy Development Board (AEDB)

4.3.2. Ambient Air Quality and Noise

The proposed project site is more than 5 Km towards the eastern side of the Indus highway, air quality is much within acceptable limits throughout the Project area. The paved roads, including the main access road from the northern side of the site, arriving from Indus highway crossing the town of Lachi. Localities of Mesan Khel and Mulghainare are far from project site. The area has smaller roads, which are not too wide, and are devoid of any heavy traffic, while dust on the road side suspends in air for a little while and settles quickly. The heavy traffic load is toward west of the site, because of heavy transport load on Indus highway. As indicated earlier, this main highway is over 5 km away from the site, therefore emissions due to vehicular movement is insignificant as studied at the proposed project site. Much of the dust in the area actually occurs due to aridity, limited vegetation cover, and a lot of barren/uncultivated land in the surrounding, and it is exacerbated by human activity. Considerable amount of Suspended Particulate Matter (SPM) may be generated when the vehicles move on unpaved shoulders and poorly maintained existing road.

Overall, the Project area is located in a sparsely populated area that has no industry. There are no major sources of air pollution in the vicinity, and although infrequent vehicular traffic on the dirt roads may produce dust emissions but its effect is fairly localized. Existing traffic movement is in the area low and hence traffic does not constitute a significant source of air quality deterioration in the microenvironment.

Sources of noise in the microenvironment are very limited and include merely the small scale vehicle movement. Due to its large distance from the Indus highway, and less traffic load in the nearby village roads, the noise levels were found in range of 45-50 dB(A). On the whole, the project site has got a good noise quality represented by serene living environment.

4.3.3. Topography

The site is located at the base of hills a few tens of meters from the southern boundary of the site. The uneven terrain in the south extends up to 370 meters to the center of the site. A pond approximately 0.12 hectares is located near the north-western boundary of the site with the presence of streams and smaller trailing water bodies running through the site. From the survey, it is concluded that these streams are now dry. The land is currently barren and uncultivated, with distributed and non-dense vegetation on the site although some evidence of animals grazing was found on the site. The site also contains unused and barren plots which are clearly demarcated through borders / trees.

Ridges, gullies, elevated hillocks and steep depressions are located in the south of the site. During site visit, the area in the centre west was found comparatively flat whereas rest of the site can only be utilised after significant grading.

The Kohat district is full of mountains, but none of them attain any great altitude. The Cherat, Nilab, Mirkhwali, Swanai Sar, Mirandai and Lawaghar ranges are all nearly of the same height. The only hill marked in the maps as more than 5,000 feet high is the Jalala Sir in the Cherat range (5,110 feet), but all these other ranges have peaks varying from 4,700 to 4,900 feet in height. As regards the hills along the border, the highest ranges in the Adam Khel country are of about the same height as the Cherat range. The Orakzai hills are considerably higher. Molaghar, a conspicuous hill in Tira, 12 miles northwest of Kohat, is 7,060 feet high. Mazeoghar and the adjoining peaks which overlook kachai are about 8,300 feet high. The Samana range, which lies just outside the district, rises north of Kahi to a height of 6,670 feet, and further from our border in the Zaimusht country reaches an altitude of over 9,000 feet. The Waziri hills to the west are much lower, the highest, Kafir Kot, being only 4,004 feet.

There are no major lakes in the district except one at Dhand near Shakardara, which is about a quarter of a mile long. The village tanks are for the most part insignificant in size. There is an almost entire absence of ponds and marshes. Owing to the generally high level of the district, height of the mountains above the level of the plains is very much less than their height above the sea.

Figure 4.5 depicts the topography of the project area.

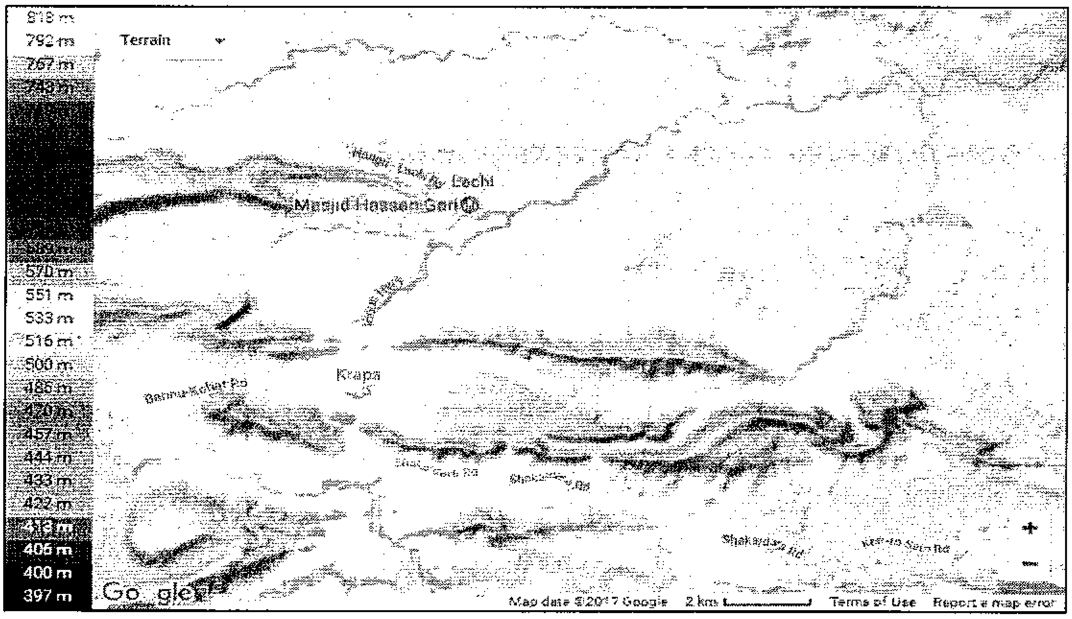


Figure 4.6: Topographic Map of the Area
Source: http://cn-au.topographic-map.com/

4.3.4. Soil

During site visit, the texture of the top layer of the soil was found to be gravely, silty clay with small rocks and light brown in color.

Soil structure, and other physical properties influence the germination and emergence of young seedlings, root penetration and growth into the soil, besides affecting the movement of water within the soil. The composition of soil air and the availability of plant nutrients influence plant growth.

Wasiullah and Bhatti. A. U (2007)[2], analysed the soils of District Kohat and District Bannu for their properties. Soil samples were collected from two depths i.e. 0-15 and 15-45 cm from 86 locations in Kohat.

[2] Physico-Chemical Properties of Soils of Kohat and Bannu Districts NWFP Pakistan, Journal Chem.Soc.Pak Volume. 29, No. 1, 2007

Sand content of the surface soil ranged from 1.20 to 70% with a mean value of 29.58% while it ranged from 1.20 to 80.80% in the subsoil with a mean value of 29.13%. Silt content of the surface soil varied from 11.20 to 73.20% with a mean value of 37.42% while subsoil samples ranged from 6.40 to 56.40% with a mean value of 33.58%. Clay content of the surface soil ranged from 11.60 to 59.60% with an average value of 33% while it ranged from 2.8 to 70.80% with a mean value of 37.30% in the subsoil. Though the coefficient of variation for silt and clay in both the depths was almost the same, it was quite lower than for sand content. Based on average as well as the minimum and maximum values, silt content was lower in the subsoil than the surface but vice versa for clay. Saturation percentage of the surface soil ranged from 25.15 to 71.76% with a mean value of 45.93%. In the subsoil, it ranged from 16.60 to 82.64% with a mean value of 50.10%. Besides such surveys and studies aiming to the fertility status of the local soils of Kohat, there are so many areas in District Kohat those are not suitable for crops, and there are certain areas where stone/pebble content is moderate to high. These sites are usually located along side the ridges. These sites are mostly barren, soil quality and depth is low, and is not suitable for any type of cropping/agriculture. Most of the soil in the proposed project area is the same type, with dry and scanty type of vegetation, no irrigation or water retention system is available, hence agriculture is only rain fed and not common in the area.

Bulk density of the surface soil ranged from 1.10 to 1.75 g cm^{-3} with a mean value of 1.37 g cm^{-3}. Variation in bulk density was very high with a coefficient of variation about 87%.

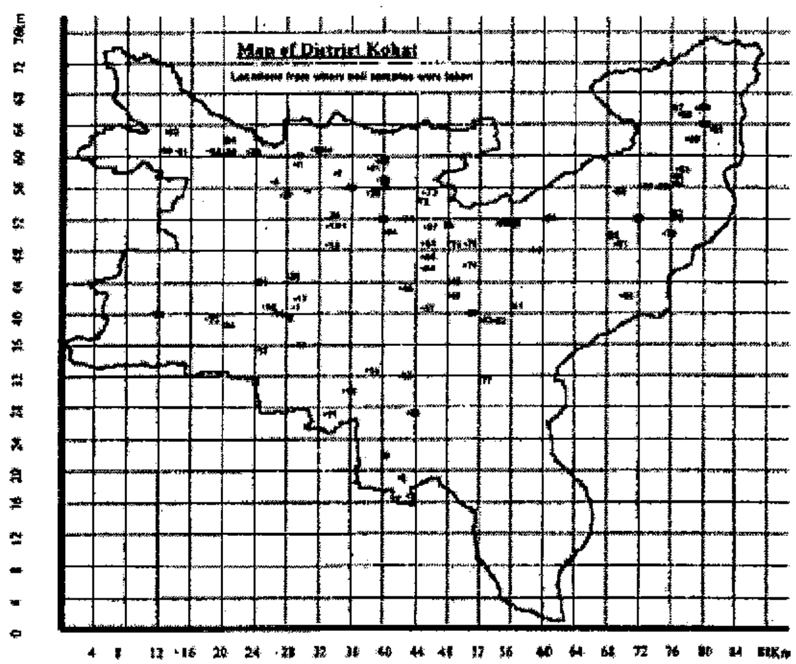


Figure 4.7: Soil sampling locations in Kohat district

Source: Physico-chemical Properties of Soils of Kohat by Wasiullah and Bhatti A.U. Journal of Chem.Soc.Pak. Vol. 29, No. 1, 2007

Findings of the phyisco-chemical analysis are summarized in the tables below;

Table 4.5: Descriptive statistics of soil physical properties of Kohat District

Property	Mean	Minimum	Maximum	C.V (%)
(0 – 15 cm depth)				
Sand (%)	29.58	1.20	70.00	65.11
Silt (%)	37.42	11.20	73.20	35.44
Clay (%)	33.00	11.60	59.60	37.30
Saturation percentage	45.93	25.15	71.76	26.04
Bulk Density (g cm^{-3})	1.37	1.10	1.75	86.83
(15 – 45 cm depth)				
Sand (%)	29.13	1.20	80.80	68.03
Silt (%)	33.58	6.40	56.40	36.96
Clay (%)	37.30	2.80	70.80	38.25
Saturation percentage	50.10	16.60	82.64	27.58

Source: Physico-chemical Properties of Soils of Kohat by Wasiullah and Bhatti A.U. Journal of Chem.Soc.Pak. Vol. 29, No. 1, 2007

Table 4.6: Descriptive statistics of soil chemical properties of Kohat District

Property	Mean	Minimum	Maximum	C.V (%)
(0 – 15 cm depth)				
pH	7.66	7.08	8.36	23.84
ECe (dS m^{-1})	3.06	1.09	17.76	69.27
SAR	1.56	0.00	6.68	85.42
Lime (%)	13.72	1.75	29.75	48.30
Organic Matter (%)	0.75	0.28	1.69	49.99
(15 – 45 cm depth)				
pH	7.57	7.20	8.05	18.89
ECe (dS m^{-1})	3.26	1.31	16.75	62.65
SAR	1.79	0.14	5.85	67.04
Lime (%)	15.09	2.50	37.50	50.97
Organic Matter (%)	0.68	0.17	1.45	43.76

Source: Physico-chemical Properties of Soils of Kohat by Wasiullah and Bhatti A.U. Journal of Chem.Soc.Pak. Vol. 29, No. 1, 2007

Soil pH of the surface soil ranged from 7.08 to 8.36 with a mean value of 7.66, while it ranged from 7.20 to 8.05 in the subsoil with a mean value of 7.57.

Electrical conductivity of the surface soil ranged from 1.09 to 17.76 dS m^{-1} with a mean value of 3.06 dS m^{-1}. In the subsoil, it ranged from 1.31 to 16.75 dS m^{-1} with an average of 3.26 dS m^{-1}.

Sodium Adsorption Ratio (SAR) of surface soil ranged from 0 to 6.68 with a mean value of 1.56 and the coefficient of variation being 85.42%. In the subsoil, it ranged from 0.14 to 5.85 with a mean value of 1.79 and C.V. 67.04%.

Lime content of the surface soil ranged from 1.75 to 29.75% with an average of 13.72% while it ranged from 2.5 to 37.50% with an average of 15.09% in subsoil.

Organic matter content of the surface soil ranged from 0.28 to 1.69% with a mean value of 0.75%. In case of subsoil, organic matter ranged from 0.17 to 1.45% with an average of 0.68%.

The paper concludes that the texture of soil in Kohat ranged from clay to sandy loam. All the soils of Kohat were alkaline in reaction and calcareous of different degree. Salinity problem existed in various areas of Kohat district ranging from 14 to 17% area in mainly central irrigated parts. No sodicity problem was observed. Organic matter of all the soils was low in eastern and western parts as compared to central parts of the district Kohat.

Soil moisture anomaly map shows the district Kohat in the range 100 – 200 mm of moisture anomaly.

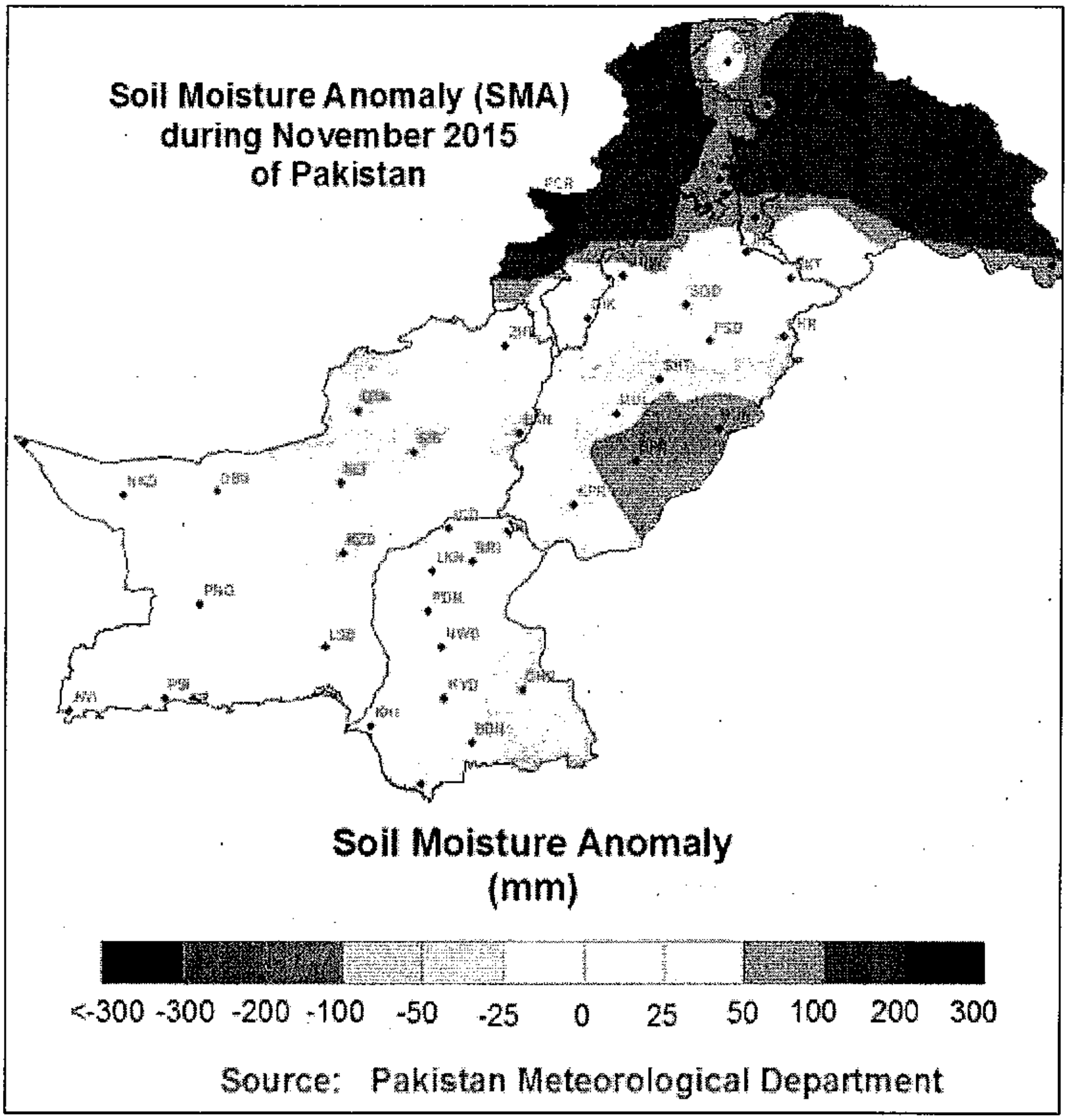


Figure 4.8: Soil Anomaly Map of Pakistan
Source: Pakistan Meteorological Department (PMD)

The classification of District Kohat including the project site as per AEZ is shown in the figure 4.8.

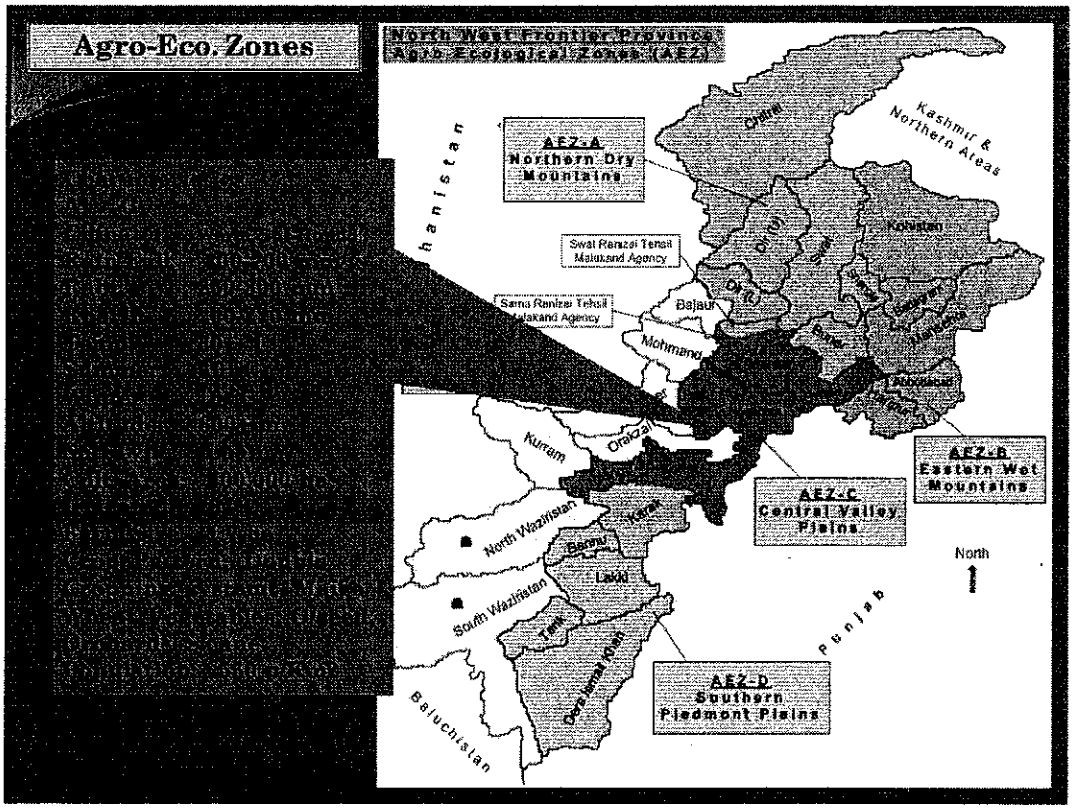


Figure 4.9: Land classification under AEZ

4.3.5. Geology and Tectonics

The Kohat basin is the most complex tectonic area of northern Pakistan. It is a tilted plateau with a moderate to steeper dips and asymmetrical structures formed by a large number of thrust/normal faults. It has been interpreted as formed by transgressional tectonics based on salt affected or basement involved thrust/reverse faulting (Paracha, 2001). The exposed stratigraphic sequence comprised of clastic, carbonate and evaporite strata ranging in age from Jurassic to Quaternary constitute a thickness in excess of 4 km. The earlier literature on the geology of Kohat and adjacent area is mainly focused on the salt deposits (Brunes,1832; Fleming,1853; Oldham and Thomas,1864. Later work on the stratigraphy and structure include that of Eames (1952) Rashid et. al, (1965) Khan (1967) Meissner et. al (1968; Meissner, et. al. (1974). Gardezi, et al., (1976) discussed the geology of the Darra Adam Khel , District Kohat with the observations on the facies changes and their tectonic implications. Tanoli, et. al. (1993) has done a detailed study of the Eocene sedimentary sequence in Kohat Basin.

The nomenclature of the stratigraphic units exposed in the area, adopted by the Stratigraphic Committee of Pakistan (Fatmi, 1973) are as follows.

Table 4.7: Stratigraphic units in the area

Age	Old Names	Present Names
Eocene	Kohat Limestone and Sirki Shales Kuldana Series/Lr. Chharat Series Shekhan Lst./Jatta Gypsum Green Shales/Kohat Saline Series	Kohat Formation Kuldana Formation/Mamikhel Clay Shekhan Lst/Jatta Gypsum Panoba Shale/Bahadur Khel Salt
Paleocene - Eocene	Tarkhobi Shales	Patala Formation
Paleocene	Tarkhobi Limestone Hangu Shale & Sst	Lockhart Limestone Hangu Formation

Source: PALEOGENE BIOSTRATIGRAPHY OF KOHAT AREA, NORTHERN PAKISTAN by Shahid J. Sameeni, Mohammed Haneef, et al. Geol. Bull. Punjab Univ. 44, 2009.

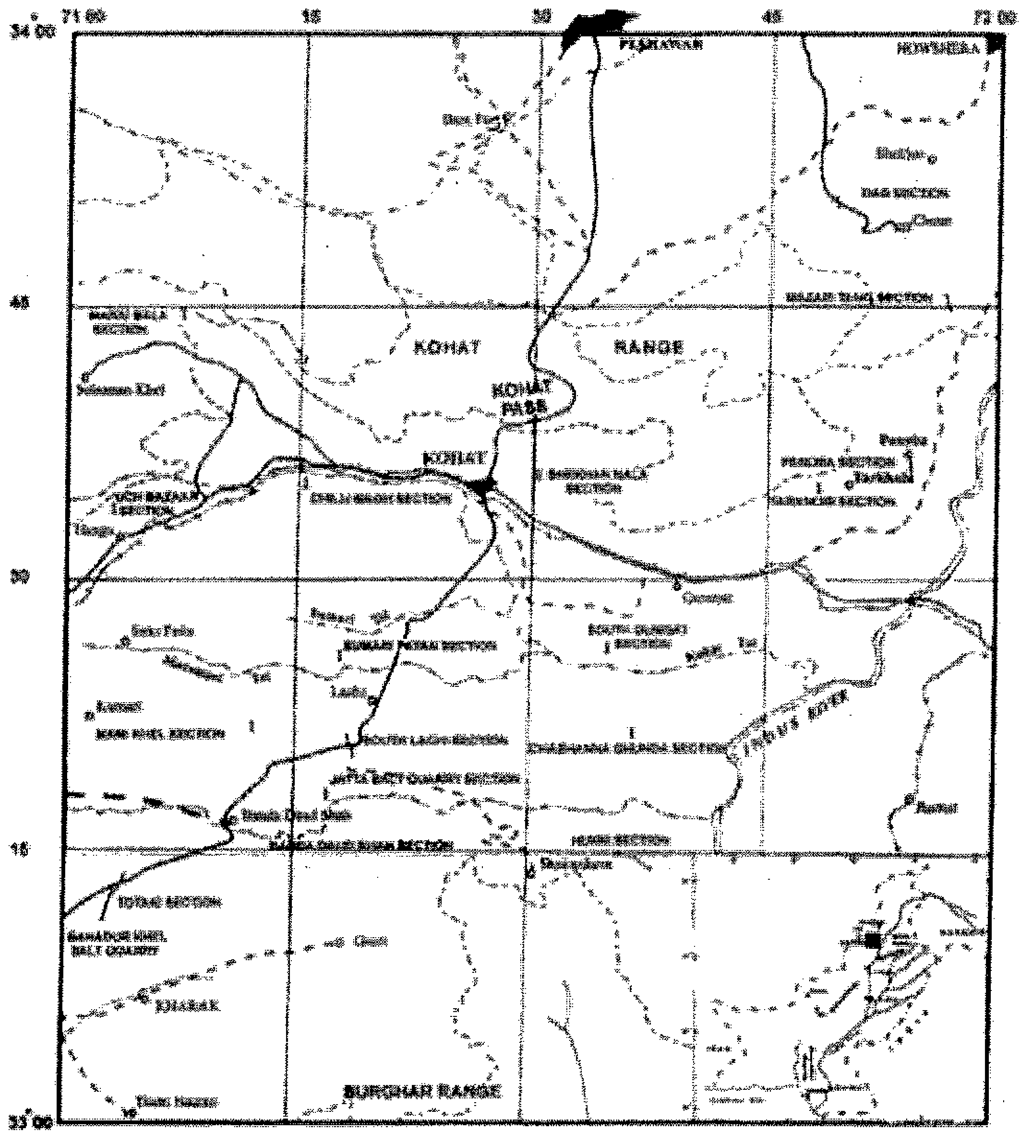


Figure 4.10: Location Map (after Meissner, et. al. (1974))

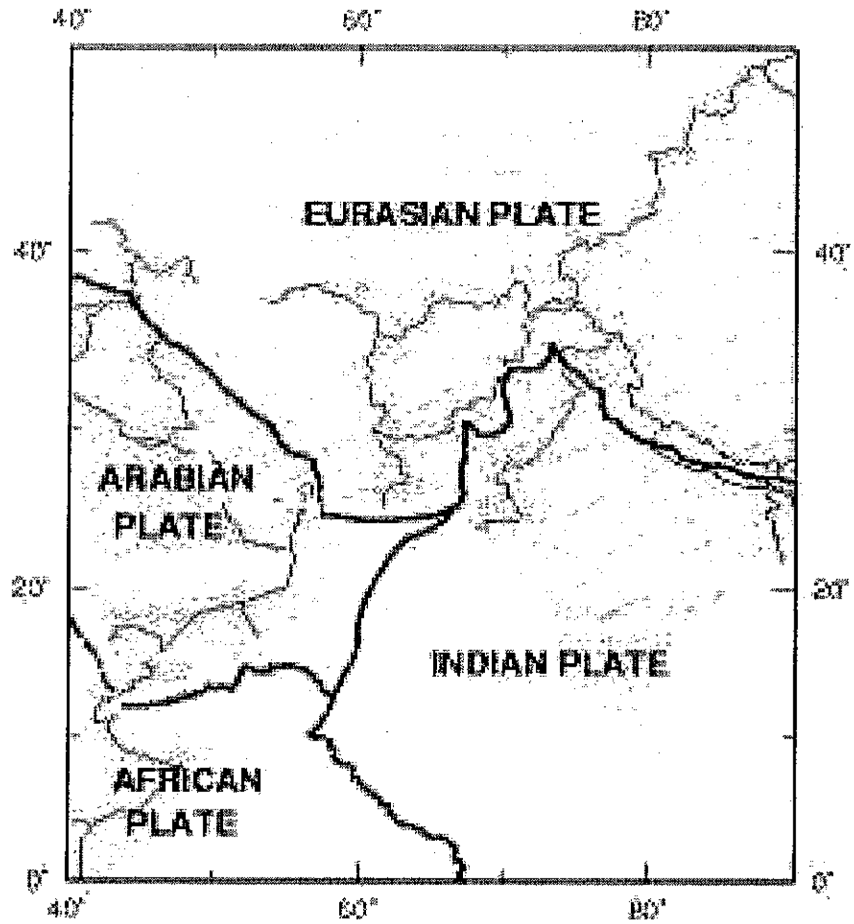


Figure 4.11: Tectonic Plates traversing Pakistan
Source: http://www.neduet.edu.pk/Civil/tp.html

4.3.6. Seismicity

Generally, earthquake proves to be the most devastating natural disaster, with a high mortality rate and widespread destruction. It is one of the most active and complicated themes for the Disaster Risk Management community. Pakistan is located in one of the seismically active region on earth, with active Himalayan ranges in the north, Hindu Kush mountain ranges in the Northwest and Suleiman Mountain ranges in the South West. High seismic hazards in Pakistan and adjacent Indian and Afghanistan regions are due to northward movement of the Indian tectonic plate at a rate of 31 mm/year, which is subducting beneath the Eurasian Continent. Earthquakes in Pakistan are often related with the Eastward trending regional thrust faults. Experts believe that the region is prone to more earthquakes in the future. As per the Seismic Zoning Map of Pakistan, District Kohat lies in zone 2B with Peak Ground Acceleration of 0.16 g to 0.24 g having no fault lines.

The seismicity record for 1973-1976 of this region unveils major earthquake risk vulnerability and identifies areas of potential seismic gap for impending major earthquake. The record shows that the devastating 1905 Kangra earthquake killing more than 19,000 people was located on this zone. The 1974 Pattan earthquake killing more than 5,000 people was also located on this crushed zone. A 5.2 magnitude earthquake that occurred near Rawalpindi in 1977 causing severe damage and loss of lives was also located near this zone.

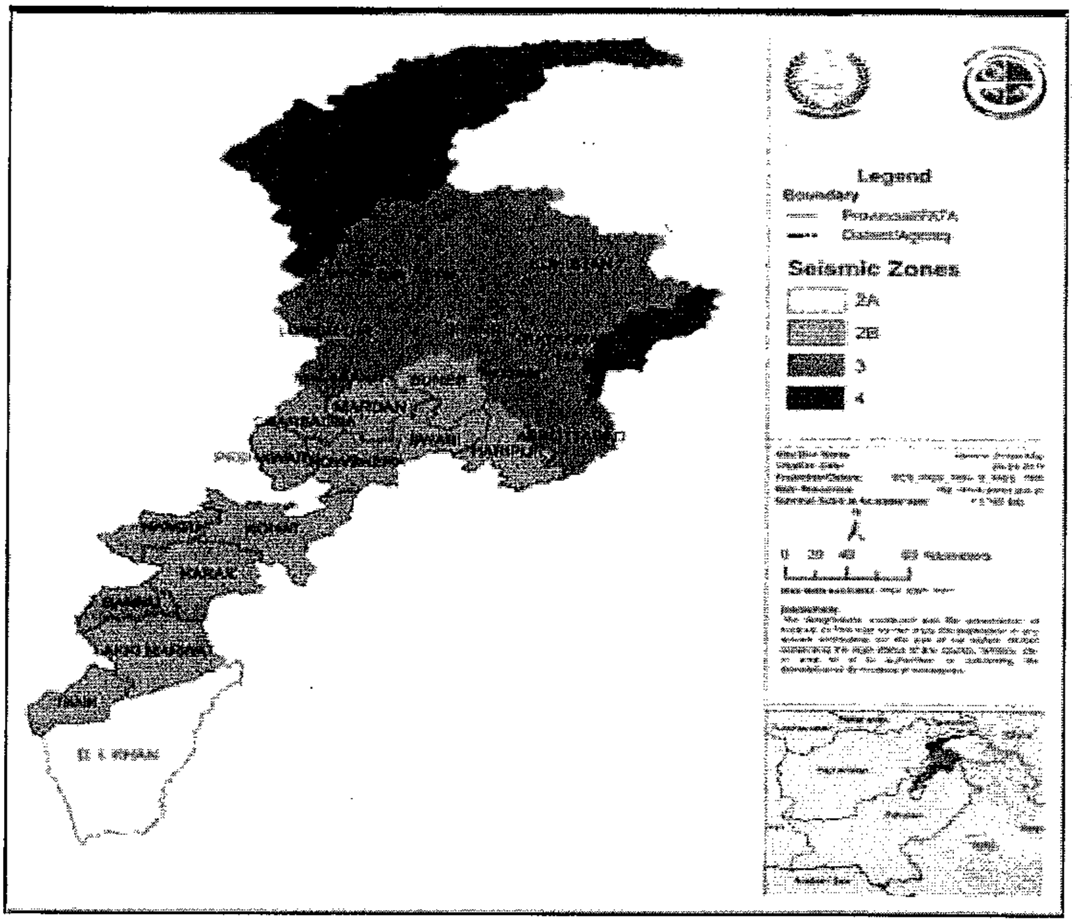


Figure 4.12: Seismicity Map of Khyber Pakhtunkhwa
Source: District Disaster Risk Management Plan Nowshera

4.4 Hydrology

4.4.1. Surface Water

There is no major surface water body in the immediate vicinity of the project area. No permanent rivers were visible at the site. The water channels were dry during the site visit. There is a stream called Lachi Toi from the Kohat Toi Tributary about 2.38 km northwards from the project site. Stream of Maramzai Algad, which originates from Lachi Toi, is at about 3 km from the project site, in north-western direction. Water access is made possible by the presence of small ponds located in close proximity to the northern and western boundaries of the site. A pond has been located within the site and could potentially meet all water requirements.

The major water body in the district is River Indus, which flows along the eastern boundary of the district. It exits the district in south into Attock District of Punjab and further flows into District Mianwali.

Indus River originates from the north side of the Himalayas at Kaillas Parbat in Tibet having altitude of 18000 feet. Traversing about 500 miles in NW direction, it is joined by Shyok River near Skardu (elevation 9000 feet). After about 100 miles in the same direction, it reaches Nanga Parbat and joined by the Gilgit River at an elevation of 5000 feet. Flowing about 200 miles further in SW direction, the river enters into the plains of the Punjab province at the Kalabagh (800 feet). The Kabul River, a major western flank tributary, joins with Indus near Attock. The Kunar which is also called Chitral River joins Indus below Warsak. About five miles below Attock, another stream Haro River drains into the Indus River. About seven miles upstream of Jinnah Barrage, another stream called Soan River joins with Indus.

The flows in the River Indus are perennial and provide the main freshwater resource for the area and the water is considered to be suitable for irrigation purposes. There are seasonal nullahs on both sides of the river which carry rainwater from the hills and other adjoining areas into the river during period of heavy rain. The water quality of Indus River and its tributaries is generally considered excellent for irrigation purposes. The total dissolved solids (TDS) range from 60 mg/l in the upper reaches to 375 mg/l in the lower reaches of the Indus, which are reasonable levels for irrigated agriculture and also as raw water for domestic use.

In the upper reaches of the Indus River, the Dissolved Oxygen (DO) content remains above 8.5 mg/l which is well above the acceptable levels of 4 mg/I. The Biochemical Oxygen Demand (BOD) downstream of Attock has been recorded as 2.9 mg/l. The major source of anthropogenic pollution in the river waters is the uncontrolled and untreated discharges from cites, settlements and industries, and water quality immediately downstream of major towns is usually well below the acceptable limits.

Kohat city is facilitated with two dams i.e. Tanda and Gandiali dams, which are good for fishing spot, hunting enthusiasts in Asia pacific because these dams contain great diversity of many fish species.

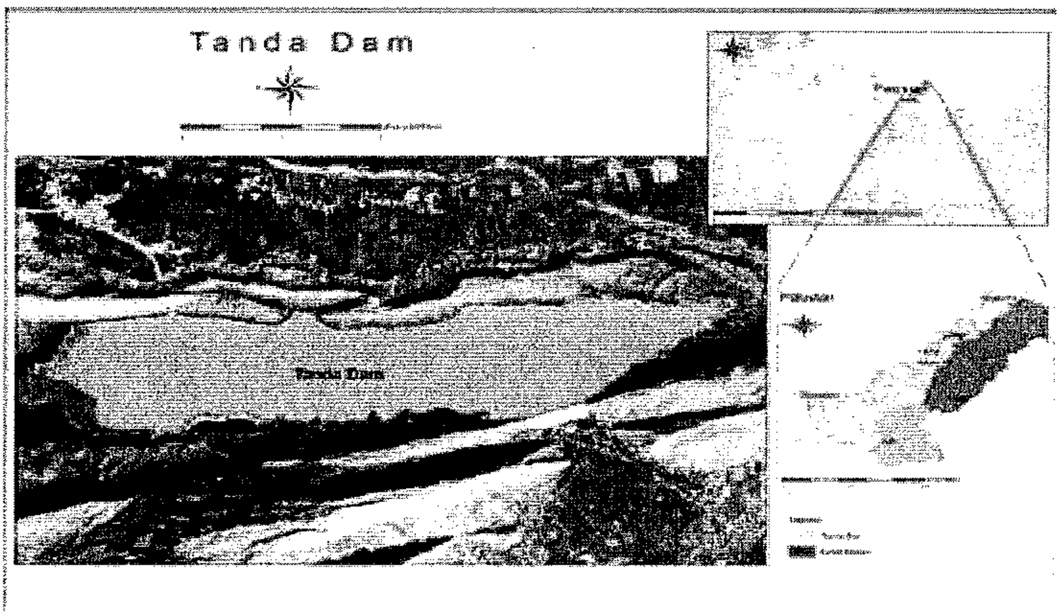


Figure 4.13: Location of Tanda Dam in District Kohat
Source: Zubia Masood, Afshan Majeed, et al. (2015)[3]

[3] Evaluationof Some Physiochemical Properties of Water, Soil and Sediments of the Dams of Kohat District, Khyber Pakhtunkhwa Province of Pakistan, with Special Reference to Their Impact on Fish Growth and Survival by Zubia Masood, Afshan Majeed, et al. American-Eurasian J. Agric & Environ. Sc, 15 (6): 1186-1191, 2015

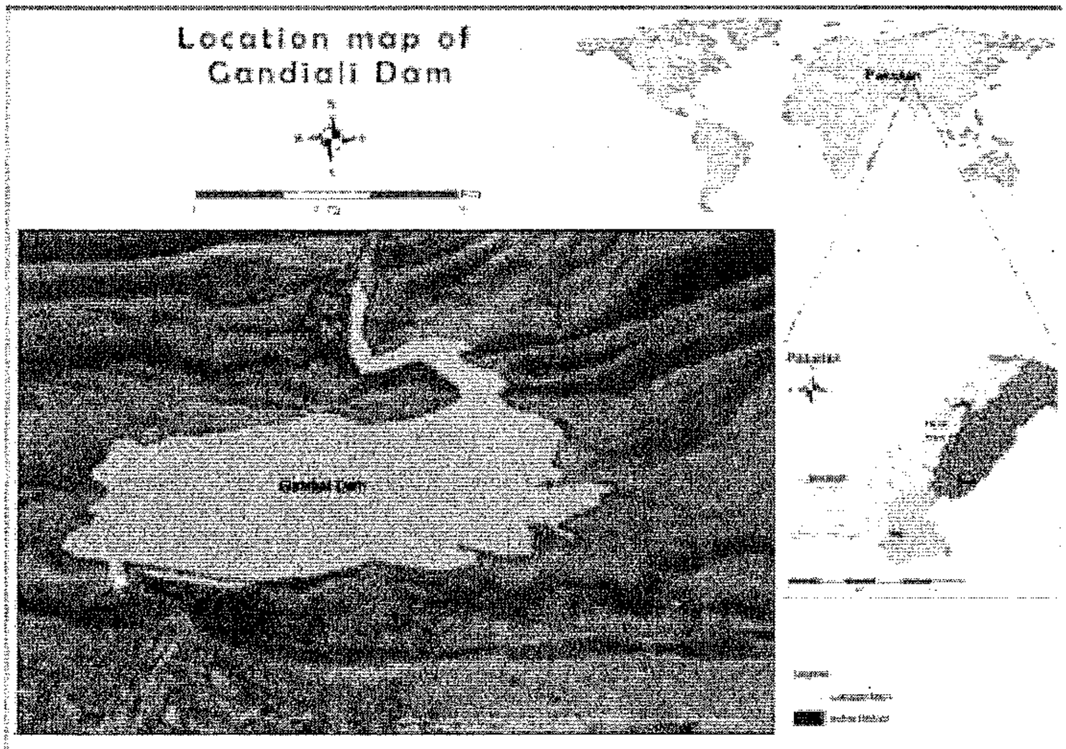


Figure 4.14: Location of Gandiali Dam in District Kohat
Source: Zubia Masood, Afshan Majeed, et al. (2015)[4]

A study by Zubia Masood, Afshan Majeed, et al. (2015) on the water quality of Tanda and Gandiali dams analyses the various physico-chemical parameters of the water resource and associated elements. Results are summarized below in tables;

Table 4.8: Physiochemical properties of water, soil and sediments from Gandiali Dam of Kohat district

Samples	pH	Conductance (µs/ml)	Temp (°C)	TDS (mg/50 ml)	Taste	Colour	Odor	Elasticity
Water	6.86	51.0	34.0	60.0	Tasteless	Pale	Odourless	Non-elastic
Soil	6.9	18.0	33.5	86.0	Sour	Reddish brown	Odourless	Elastic
Sediments	6.9	15.0	31.6	70.0	Sour	Black brown	pungent	Non-elastic

Source: Evaluationof Some Physiochemical Properties of Water, Soil and Sediments of the Dams of Kohat District, Khyber Pakhtunkhwa Province of Pakistan, with Special Reference to Their Impact on Fish Growth and Survival by Zubia Masood, Afshan Majeed, et al. American-Eurasian J. Agric & Environ. Sc, 15 (6): 1186-1191, 2015

[4] Evaluationof Some Physiochemical Properties of Water, Soil and Sediments of the Dams of Kohat District, Khyber Pakhtunkhwa Province of Pakistan, with Special Reference to Their Impact on Fish Growth and Survival by Zubia Masood, Afshan Majeed, et al. American-Eurasian J. Agric & Environ. Sc, 15 (6): 1186-1191, 2015

Table 4.9: Physiochemical properties of water, soil and sediments from Tanda Dam of Kohat district								
Samples	**pH**	**Conductance (µs/ml)**	**Temp (°C)**	**TDS (mg/50ml)**	**Taste**	**Colour**	**Odour**	**Elasticity**
Water	7.35	46.0	32.5	50.0	Salty	Pale	Pungent	Non-elastic
Soil	6.63	31.0	30.0	30.0	Sour	Brown	Pungent	Elastic
Sediments	6.87	31.0	32.5	29.0	Sour	Black brown	Pungent	Non-elastic
Source: ibid.								

4.4.2. Groundwater Hydrology

A Study was undertaken by Malik A. Badruddin (2004) to evaluate overexploitation of ground water resources in Lachi valley and its effects on ground water balance and quality during the year 2001-2002. Climate of the study area is semi-arid, which necessitates artificial irrigation to undertake agricultural pursuits. As no proper surface water exists, the only option remains into use ground water for irrigation and domestic purposes. In the past few years, low precipitation and reduction in up- stream flow caused the water table to drop at rate of0.06 to 1.6 m per year with average of 0.6m/year. The total recharge to the area amount to 0.550 cumecs, out of which 0.055 cumecs comes from Lachi-Toi and the remaining from precipitation. The total discharge from the area amounts to 0.796 cumecs out of which 0.740 cumecs were discharged by wells and the remaining by natural springs. The discharge from the area is two-third times more than the recharge to the area that imbalanced the aquifer and the ground water quality has deteriorated. Out of total thirty-two groundwater samples collected randomly from the study area, forty-six percent were found hazardous (mostly in the south-eastern part of the valley, close to the saline water stream), ten percent were marginal (mostly in the north-eastern part of the valley) and forty-four percent were safe (mostly in the western part of the valley).

During the site survey, and while visiting the local population/village, it was learnt that the ground water quality of the project area itself is fine, most of the tube well water and occasionally the subsoil water from the hand-pumps is drinkable. During the visit, it was learnt that in some places near the hills/ridges the water is not available, and hence the locals population has to carry the water from a distance of an average of 2 km. According to the local respondents, the average depth of subsoil water is 50 meters (150-200 feet). They also reported that the water carries some taste, and little turbidity and occasionally colour in some samples. Some of the respondents in interviews indicated that in the sandy areas the ground water quality is very good.

4.5 Ecological Environment

4.5.1 Wetlands

Tanda Dam is located at 33°35'N & 071°22'E, about 22 km from the project site. It spans 405 ha. It is a wetland of international importance, according to Ramsar Convention[5]. It is a small water-storage reservoir supporting irrigated agriculture and a small fishery. The site is a wintering area for

[5] Ramsar Sites Information Service (https://rsis.ramsar.org/ris/98)

Anatidae (ducks, geese, swans, etc.) and serves as a staging area for various waterbirds. Bird numbers seldom exceed 500 in mid-winter and 2,000 during migration periods.

Since the project site is located far from the protected site, the project activities will not affect the protected site and are confined to the microenvironment.

Figure 4.15: Ramsar Convention Designated Protected Wetland Area: Tanda Dam
Source: https://rsis.ramsar.org/ris/98

4.5.2 Flora

The project land is currently barren and uncultivated, with very little vegetation on the site. Most of the terrain is covered with wild bushes & shrubs with only a few small trees along the west boundary of the site. There is a pocket of vegetation that are mostly small trees and shrubs in the south-eastern region of the site alongside small patches of distributed shrubs and trees along the northern and north-western regions.

The district constitutes dry climatic region, having a variety of arid, semi-arid and sub humid types of climatic conditions and therefore represents different types of habitats and vegetation types, which can be seen in different parts of the macro environment. The overall biodiversity of this district is moderate to rich but confined to a few areas i.e. their distribution is seen as few patched vegetation areas.

The overall low vegetation cover at the project site is mainly based on the high average temperatures in summers and low precipitation throughout the year and also due to wood cutting/logging for fuel. Due to the heavy grazing and other related biotic factors there are certain edaphic variants, those related to dry climatic conditions, levity of top soil and soil erosion etc. have rendered *Zizyphus nummularia* and *Acacia spp* as dominant species while among herbs and Grasses the two important species surviving in current dry conditions are *Typha* surpantine grass, and *Poa spp* respectively which are the main species left in competition, largely because of overgrazing, and lack of any other palatable forage available for the domestic cattle.

Table 4.10: List of plant species and their Families found in Kohat Areas

Number	Species Name	Family Name
1.	*Justicia adhatoda*	Acanthaceae
2.	*Alternanthera pungence*	Amaranthaceae
3.	*Amaranthus viridis*	Amaranthaceae
4.	*Calatropis procera*	Asclepiadaceae
5.	*Caralluma tuberculata*	Asclepiadaceae
6.	*Carissa opaca*	Asclypiadaceae
7.	*Carthamus oxyacantha*	Asteraceae
8.	*Conyza buneriansis*	Asteraceae
9.	*Launaea procumbens*	Asteraceae
10.	*Conyza Canadensis*	Asteraceae
11.	*Xanthium stromonium*	Asteraceae
12.	*Artemisia scoparia*	Asteraceae
13.	*Buxus sempervirens*	Buxaceae
14.	*Opuntia spp.*	Cactaceae
15.	*Chenopodium album*	Chenopodiaceae
16.	*Ipomoea cornea*	Convolvulaeae
17.	*Citrulus colocynthis*	Cucurbitaceae
18.	*Cyperus arenarius*	Cyperaceae
19.	*Cyperus irio*	Cyperaceae
20.	*Cyperus rotundus*	Cyperaceae
21.	*Ephedra ciliate*	Ephedraceae
22.	*Ephedra gerardiana*	Ephedraceae
23.	*Euphorbia prostrate*	Euphorbiaceae
24.	*Ricinus communis*	Euphorbiaceae
25.	*Gymnosporea royleana*	Gymnosporeaceae
26.	*Lamium amplexicaule*	Lamiaceae
27.	*Cassia alata*	Leguminoseae
28.	*Acacia modesta*	Leguminoseae
29.	*Acacia nilotica*	Leguminoseae
30.	*Grewia optiva*	Leguminoseae
31.	*Grewia tenax*	Leguminoseae
32.	*Trifolium repens*	Leguminoseae
33.	*Mimosa rubicaulis*	Leguminoseae
34.	*Acacia Senegal*	Leguminoseae
35.	*Albizia lebbeck*	Leguminoseae
36.	*Prosopis cineraria*	Leguminoseae
37.	*Malvestrum coromendalianum*	Malvaceae
38.	*Ficus spp*	Moraceae
39.	*Olea cespidata*	Oleaceae
40.	*Nannorrhops ritchieana*	Palmae
41.	*Echinochloa crus galli*	Poaceae

Table 4.10: List of plant species and their Families found in Kohat Areas		
Number	Species Name	Family Name
42.	*Eragrostis atrovirens*	Poaceae
43.	*Panicum antidotale*	Poaceae
44.	*Leptochloa panicea*	Poaceae
45.	*Typha spp.*	Poaceae
46.	*Themeda anathera*	Poaceae
47.	*Digitaria decumbens*	Poaceae
48.	*Aristida funiculate*	Poaceae
49.	*Cynodon dactylon*	Poaceae
50.	*Desmostachya bipinnate*	Poaceae
51.	*Echinochloa fusca*	Poaceae
52.	*Phragmites karka*	Poaceae
53.	*Poa annua*	Poaceae
54.	*Saccharum sponteneum*	Poaceae
55.	*Polygonum plebium*	Polygonaceae
56.	*Platanus orientalis*	Platanaceae
57.	*Zizyphus jujube*	Rhamnaceae
58.	*Zizyphus nummularia*	Rhamnaceae
59.	*Rubus ellipticus*	Rosaceae
60.	*Rosa spp.*	Rosaceae
61.	*Salvadora oleoides*	Salvadoraceae
62.	*Dodonaea viscosa*	Sapindaceae
63.	*Verbascum Thapsus*	Scrophulariaceae
64.	*Bacopa monnieri*	Scrophulariaceae
65.	*Rhus cotinus*	Scrophulariaceae
66.	*Solanum surattense*	Solanaceae
67.	*Datura innoxia*	Solanaceae
68.	*Myrsine Africana*	Symplocaceae
69.	*Tamarix aphylla*	Tamaricaceae
70.	*Tamarix dioica*	Tamaricaceae
71.	*Tamarix galica*	Tamaricaceae
72.	*Peganum hermala*	Zygophyllaceae
73.	*Tribulis trrestris*	Zygophyllaceae
Source: EIA of Proposed Nashpa Development Project: Chanda, Mela and Nashpa Development and Production Leaseses by EMC Pakistan, July 2014		

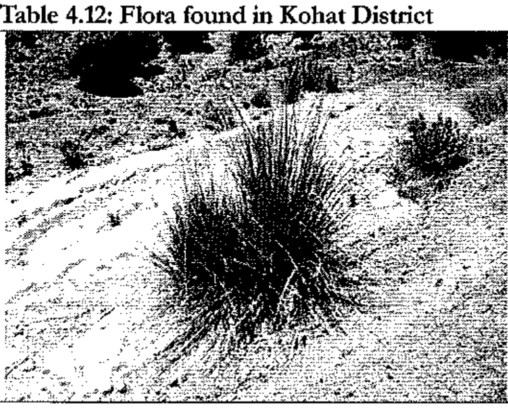
Table 4.11: Dominant vegetation of Kohat area (using Line Transect and Quadrate Method)				
S.No.	Plant Species	Kohat Area		
		Site1 Tanda Dam	Site 2 Shakardara	Site 3 Rehmanabad
Trees				
1	*Acacia modesta*	1.5	3.5	2.1
2	*Acacia nilotica*	2.1	2.6	3.4
3	*Ziziphus mauritiana*	1.3	1.9	0.4
4	*Prosopis cineraria*	2.4	3.8	3.2
5	*Grewia optiva*	0.3	0	1.5
6	*Olea caspidata*	0.2	0	0.7
7	*Ehretia aspara*	1.6	0	0.8
8	*Ziziphus jujube*	3.2	3	1.9
9	*Eucalyptus spp.*	2.6	0	0

Table 4.11: Dominant vegetation of Kohat area (using Line Transect and Quadrate Method)

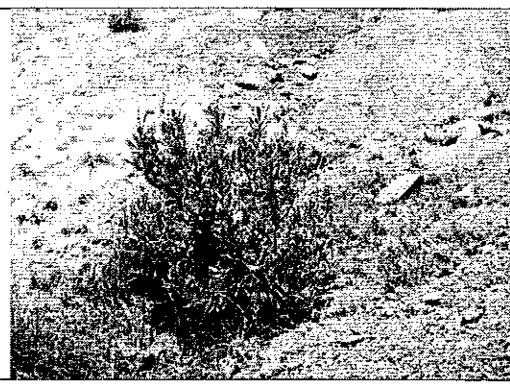
S.No.	Plant Species	Kohat Area		
		Site1 Tanda Dam	Site 2 Shakardara	Site 3 Rehmanabad
10	*Platanus orientalis*	1.7	0.2	0
	Total Tree Cover	16.9	15	14
Shrubs				
11	*Justicia adhatoda*	3.2	3.4	3.5
12	*Buxus sempervirens*	1.7	2.2	4.5
13	*Carissa opaca*	2.5	16	3.3
14	*Ricinus communis*	3.4	1.4	0.5
15	*Dodonaea viscose*	3.7	6.5	3.4
16	*Gymnosporea royleana*	2.4	1.4	6.1
17	*Jasminum sp.*	7.2	1.8	0.3
18	*Woodfordia fruticosa*	4.6	0.6	4.8
19	*Rubus ellipticus*	2.9	1.2	0
20	*Myrsine Africana*	0.3	2.8	3.4
	Total Shrub Cover	31.9	37.3	29.8
21	*Xanthium stromonium*	1.1	3.0	1.8
22	*Digitaria decumbens*	4.2	3.5	2.7
23	*Silybum marianum*	0.2	0.4	0.6
24	*Lamium amplexicaule*	1.9	0.0	0.5
25	*Trifolium repens*	1.2	0.4	0.0
26	*Heteropogon contortus*	2.6	2.4	1.0
27	*Calatropis procera*	3.0	2.9	1.9
28	*Mimosa rubicaulis*	3.5	1.2	2.4
29	*Polygonum plebium*	2.0	1.2	0.2
30	*Solanum surattense*	1.0	1.9	0.5
31	*Poa annua*	3.7	3.8	2.9
32	*Saccharum sponteneum*	0.9	1.8	1.2
33	*Artemisia scoparia*	0.5	0.0	2.1
34	*Ephedra gerardiana*	1:6	0.6	2.8
	Total Herb Cover	27.4	23.2	20.7
	Total Plant Cover	76.2	75.5	64.5

Source: Ecological survey conducted in Kohat by EMC Pakistan team in 2013

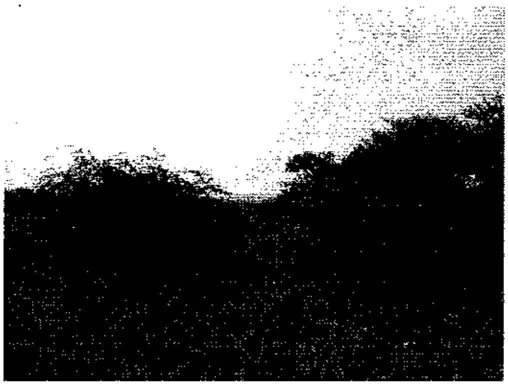
Table 4.12: Flora found in Kohat District



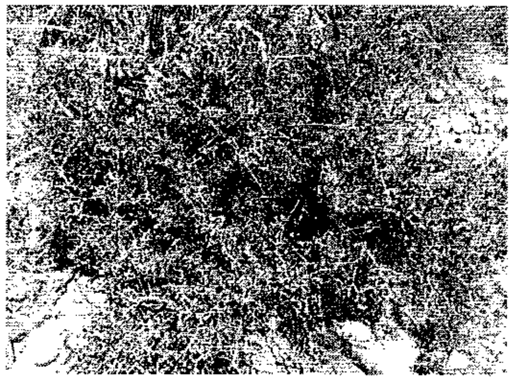
Saccharum Spontaneum



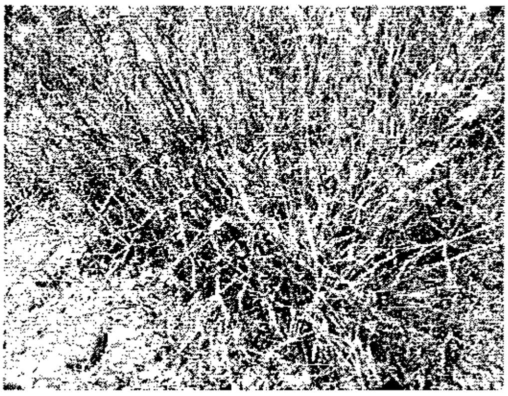
Rhazia stricta



Zizphus nummularia

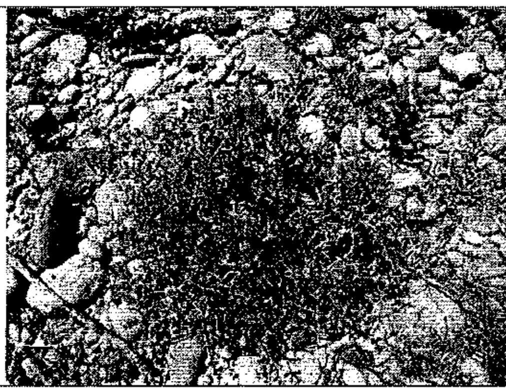


Indigofera oblongifolia



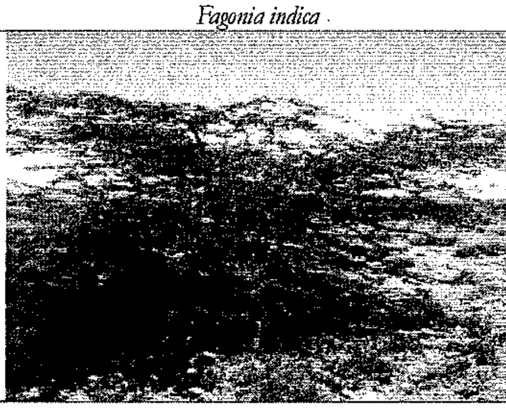
Lasurus sindicus

mix vegettaion Surpentine grass andAcacia

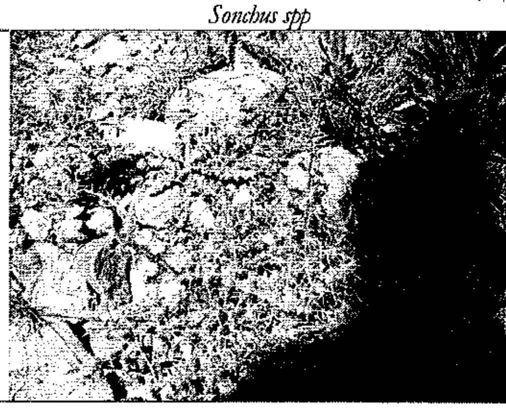


Fagonia indica

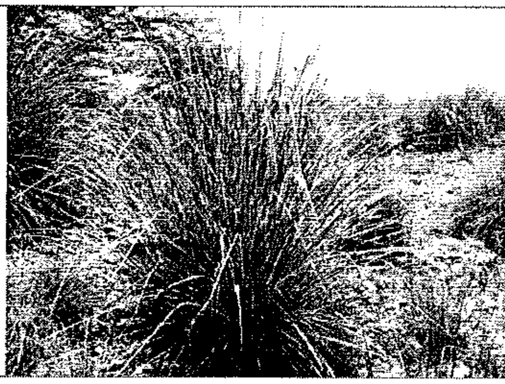
Sonchus spp



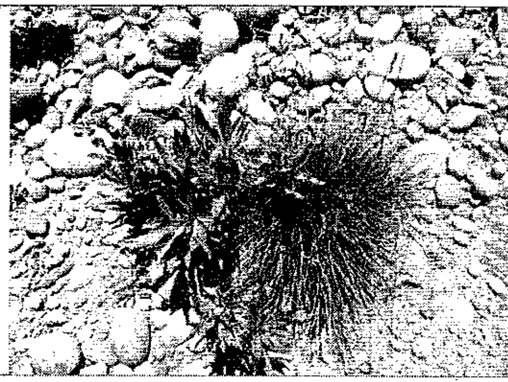
Prosopis juliflora



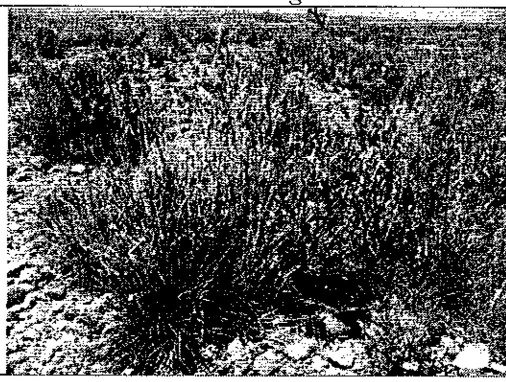
Echinops achintes



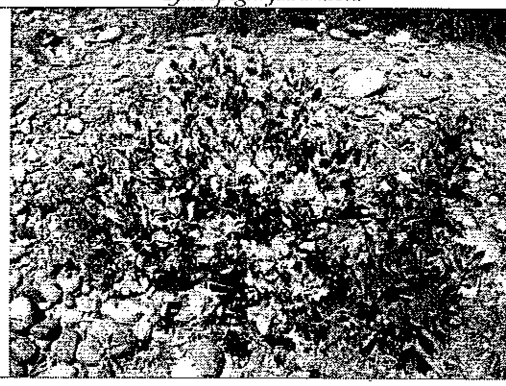
Saccharum bengalensis



Cymbopogon jawarncosa

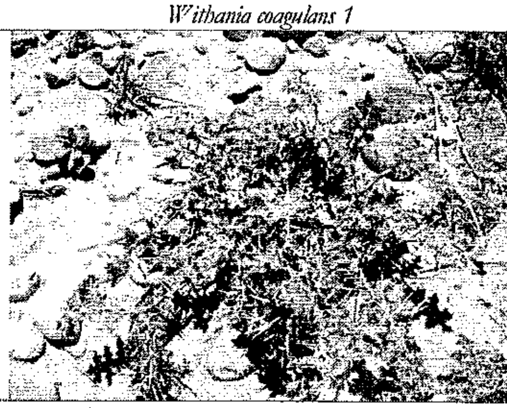


Lasiurus scindicus

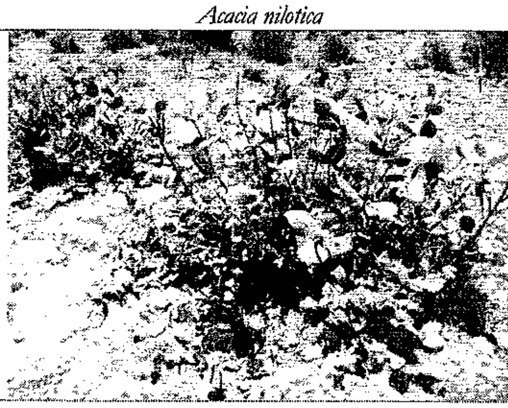


Withania coagulans 1

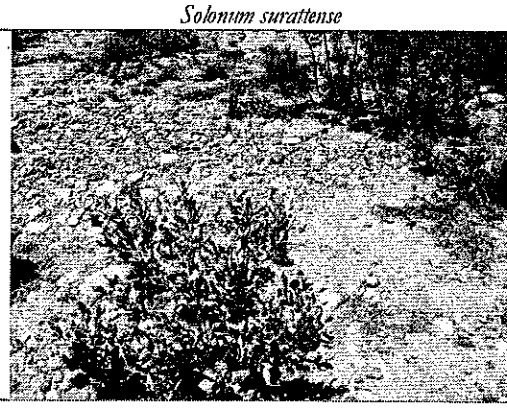
Acacia nilotica



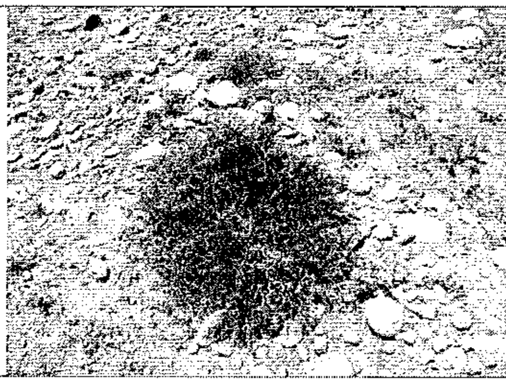
Solonum surattense



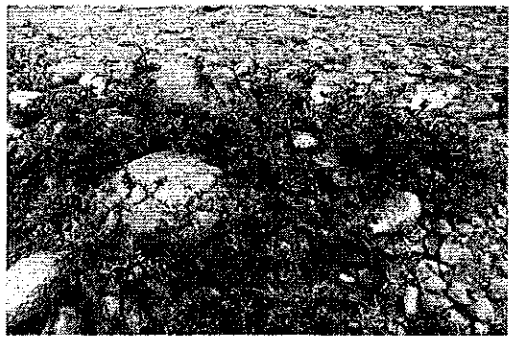
Calotropis procera



Withania coagulans 2

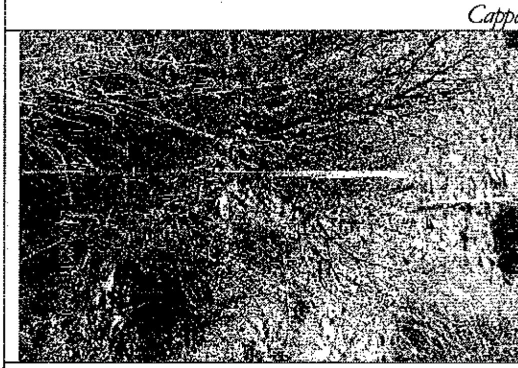
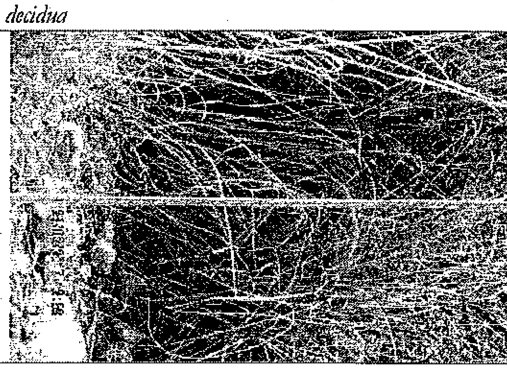



Zygophyllum simplex | *Convolvulus scindicus*

Capparis decidua | *Solanum surattense*

Capparis decidua

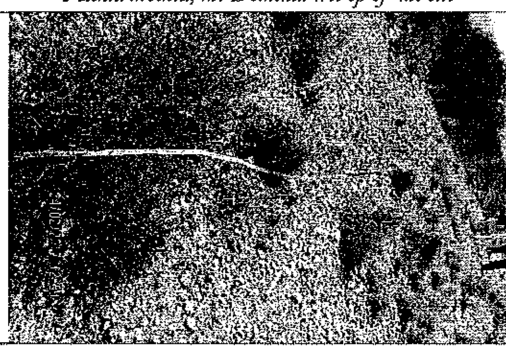



Vegetation sampling at the project site, Dominnat vegetation is clumped Grass

Dry Decidous vegetation around the project area

New sprouting in Acacia

Acacia modeta, the Dominat tree sp of the site



Vegetation sampling at the project site with scanty bushes and grass species

Ziziphus nummularia

Opuncia app

Source: Ecological Survey conducted by EMC Pakistan for the project on 24 feb 17.

4.5.3 Fauna

Owing to the scattered vegetation cover and scarcity of surface water bodies, there is limited availability of the habitats for the wild animals in the proposed project site. Therefore, the overall diversity of wildlife is also low in these areas, while the avian fauna though dominant among animal species include most of the seasonal visitors. Animal densities are high at locations where dense patches of vegetation cover exist. However near the proposed project site there is little existence of any such dense vegetation patch. Large part of land is barren hence the overall faunal diversity is negligible at the proposed project site. At locations, near water bodies and the ridges tot the eastern side, where land use change has occurred such as settlements/villages or for agriculture, animal density is noticeably reduced. Carnivorous species like foxes, wolf, jackal and other wild animals are not seen in because of their depleted habitat. Partridges, foxes, and wolf are reported from the surrounding areas, specially the mountains to the other side i.e. West of the Indus highway, where deep inside the mountains, Grey Wolf, Leopard, Chinkara, Urial and other deer species are present, this is also confirmed during interview with Mr Shabbir Bangash and staff in visit to the District Kohat local Wildlife and forest department that the natural habitats are shrinking in these areas, so the wild animals are not seen around areas of human intervention.

The animals seen during the survey conducted by EMC Pakistan included common animal species such as camel, horse donkeys, cattle, squirrels, reptiles including, lizards and toads. However there is little dependence of the local population over the proposed project site for the grazing of their livestock.

4.6 Local Villagers Perception about Project

Most of the local people were in favour of any type of developmental activity in the surrounding area of the said village. The village elders mentioned that the local community is very much traditional in cultural norms and most of the decisions about any developmental activity or project is endorsed by the community. The community's main issue is reported to be the lack of drinking water. And quality of the subsoil water. There is no piped supply or any other water supply system available in the area. The only source of the water is ground water, which is traditionally made available by the old dug wells. These dug wells are present in the deeper hilly adjoining areas among small valleys and the lowing areas of the watershed; their depth is about 150 to 200 feet based on the location. Besides the older dug-wells there is increasing need of the water access points with the growing population. Mostly this need is fulfilled by the bores and small tube wells but these wells are deeper and the ground water table is depleting and the average depth is more than 300 feet, and in certain cases is as deep as 400-450 feet. The water availability is the main issue and the price to access the water is also growing higher and higher. With increasing average depth of the water a number of issues are rising, from the change in depth the cost of well is increasing enormously which is beyond the access of the local poor community. Alongside the pricing of water is based on cost of the well and availability of the electricity or fuel cost as at some places generators are used.

The other informants among the village representatives assured that the local population will welcome and support any proposed project by the government and/or privet organization. These projects are considered by the local community as employment opportunity and they expect from the project some job opportunity, localized economic activity and may be some benefit to the community i.e. access to the portable drinking water and healthcare. Basic and utmost dire of the local population is need of the drinking water supply system or at least a water supply point accessible to all local population within the outer boundary of the project area.

The survey included interviews with the local General Councillor "Mr. M. Sajideen" Moiz Ali Jan, Represntative Local council, and Musalli Khan retd. Army person. Their point of view regarding water quality and scarcity was same. Also the local population indicated that the sewerage and waste water drainage is not appropriate in all of these local populations from Lachi to Mesam Khel, and Mulgheen.

4.7 Socio-Economic Environment

This section deals with the socio-economic characteristics of the areas associated with Solar Power Plant at Kohat. It provides with the details of existing social and demographical aspects of the project area.

4.7.1 District Kohat

District Kohat is located at the eastern belt of Khyber Pakhtunkhwa adjoining Punjab. It has an area of about 2,545 sq km. It is bounded by Kohat at its north, Orakazai Agency at northwest, Hangu District at southwest, District Karak at it south and Punjab provincial boundary at its east and southeast. Kohat city is the capital of the District.

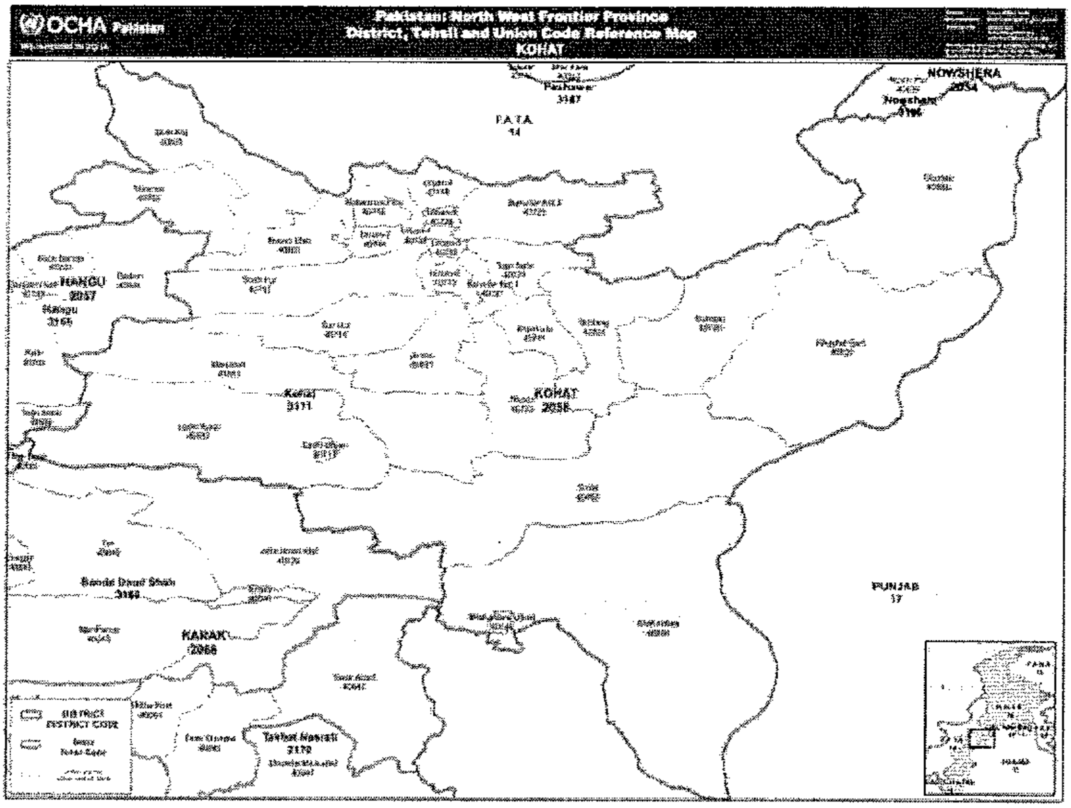


Figure 4.16: Map of Kohat
Source: OCHA Pakistan

4.7.2 History

Kohat was a part of Afghanistan between 16th to 18th centuries but in early part of 19th century it was taken over by the Sikh and by mid-century was annexed under British domain along with the rest of Punjab. Afridi, Khatak, Orakazai and Bangash are the three centuries old tribes inhabiting the District. The main language of the District is Pashto.

4.7.3 Population

According to Bureau of Statistics, Planning and Development Department, Government of Khyber Pakhtunkhwa report 2016, the population of Kohat District according to the 1998 census was 562,644 with the annual growth rate of 3.25%. The sex ratio was 101 males per hundred females. The estimated population for Kohat District for the year 2015-16 is 1.01 million and the estimated ratio of male to females is 1:0.9.

4.7.4 Administrative Setup

Like other Districts in the province, District Kohat is headed by District coordination officer (DCO) assisting the Divisional commissioner and is accountable to him. The DCO is appointed by the provincial government from the Federal or Provincial civil service. The DCO coordinates with Executive district officers (EDOs), who head each of the District offices including health[6].

[6] Health Facility Assessment – Khyber Pakhtunkhwa District Kohat by Technical Resource Facility (2012)

4.7.5 Water Availability

Presently the community of District Kohat is facing scarcity of drinking water in urban and rural localities, however the shortage is not as swear as in case of other districts. In most of the areas ground water of good quality has been reported by the community, however the quantity of water is insufficient in some areas. The issue got worst after the flood in year 2010; the major reasons for paucity of drinking water are enlisted here under:

- Damage of water sources and existing water supply networks;
- Increase in water demand, due to emergence of IDPs;
- Natural increase in population;
- Water rights for certain communities
- Effect on water tables in flood affected areas
- Contamination at water sources
- Land owner ship and administrative issues
- Less coverage of line departments due financial constraints

The above mentioned factors are of vital importance, while analyzing the data and proposing the interventions regarding water supply system in Kohat. It is important to note that the more than 50% of population is receiving water at door step, therefore a proper system of water supply network exists in the project area. Majority of the areas are under administrative control of PHED, therefore maintenance and operation is not directly related to community.

The most commonly used water sources in the project area are tube wells with proper distribution piped system. As reported 50.3% population is served by water distribution lines and second most used source is tube wells/boreholes i.e. 26.4%, then comes the category of public tap/standpipe, with 18.1%. Whereas, 6.5% population get water from protected dug wells. The population relying on unoperational water resource is only 0.3% of the surveyed population, who are forced to rely on unoperational piped water, into dwellings[7].

Table 4.13: Percentage Distribution of Household by Source of Drinking Water for Kohat

	Tap Water	Hand Pump	Motor Pump	Dug Well	Others	Total
Kohat	26	17	30	6	21	100
Urban	44	10	32	6	8	100
Rural	21	18	30	6	24	100

Source: Pakistan Social and Living Standards Measurement Survey (2014-15)

Map showing the district wise improved drinking water situation in Khyber Pakhtunkhwa province is given below.

[7] WASH Need Assessment for 6 District under Unicef – Intervention Report Kohat (2004)

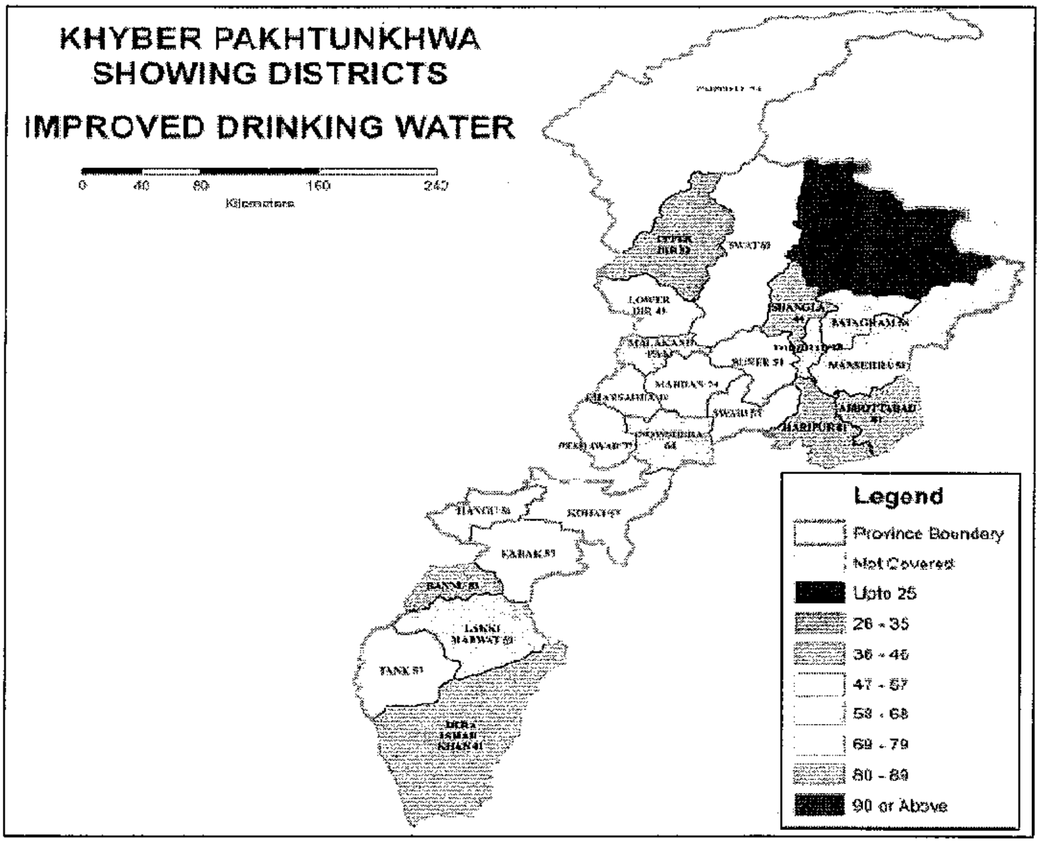


Figure 4.17: District Wise Improved Drinking Water Coverage for Khyber Pakhtunkhwa
Source: Pakistan Social and Living Standards Measurement Survey (2014-15)

4.7.6 Potable Water

As can be seen from the figure above, the amount of improved drinking water in Kohat District is 57%. The amount of potable water in the district must be enhanced as the improved drinking water percentage in Abbotabad, Bannu and Haripur districts is greater than that in Kohat District.

A study conducted by Hamid Iqbal, Muhammad Ishfaq, et al. (2013)[8] examines the Physico-chemical properties of water resources like Storage tank, Tube well and Tap water, collected at sampling points of Shakardara, Lachi and Kohat city in the district. Results are summarized in the figures and table below;

[8] Physico-Chemical Analysis of Drinking Water in District Kohat, Khyber Pakhtunkhwa, Pakistan by Hamid Iqbal, Muhammad Ishfaq, et al. International Journal of Basic Medical Sciences and Pharmacy, Vol. 3, No. 2, Dec 2013

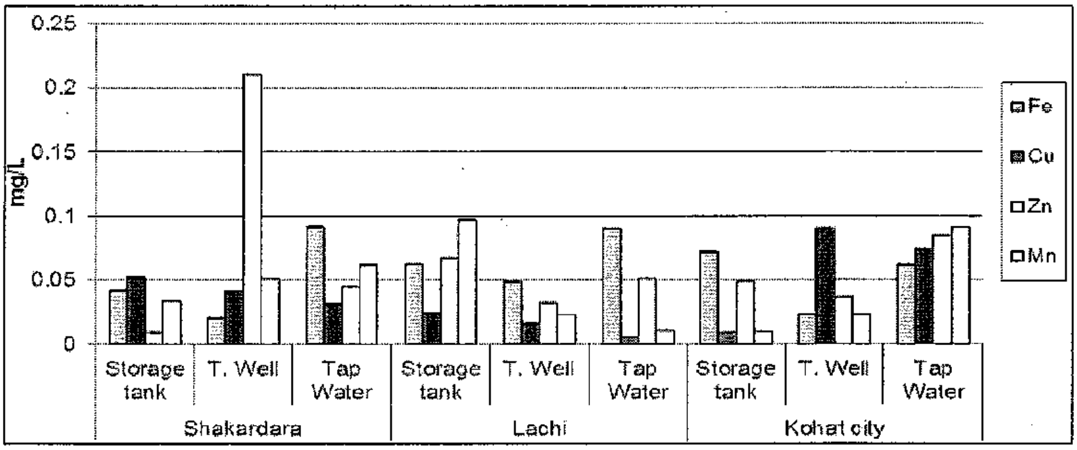


Figure 4.18: Level of essential elements in Kohat Water Samples

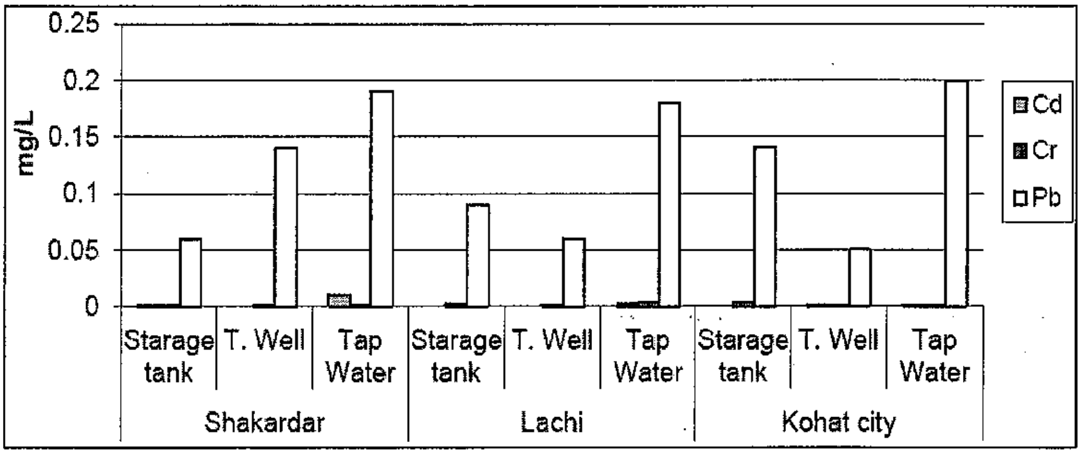


Figure 4.19: Level of toxic elements in Kohat Water Samples

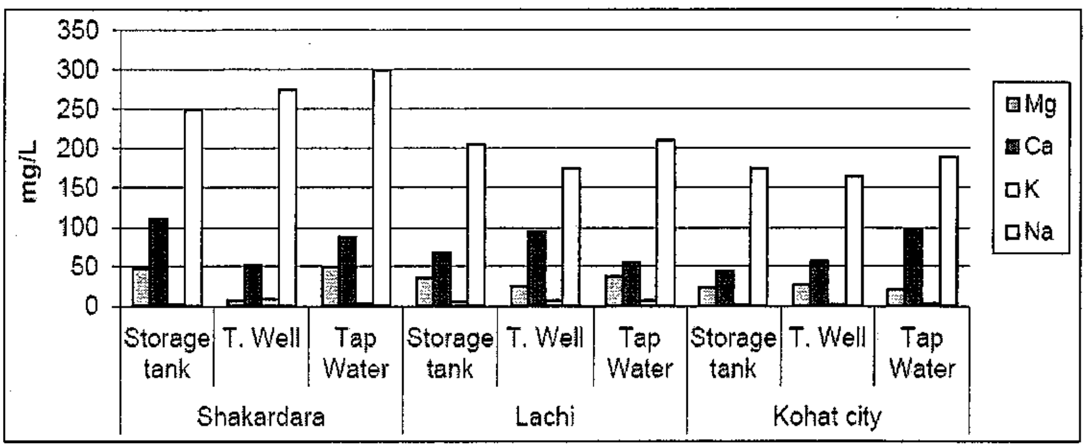


Figure 4.20: Level of mineral elements in Kohat Water Samples

Table 4.14: Various Physico-chemical parameters of water samples of Kohat				
Location	**Source**	**Temperature (°C)**	**pH**	**EC (µS/cm)**
Shakardara	Storage tank	25.8	8.4	760
	Tube well	26.3	8.3	970
	Tap water	28.6	8.5	2300
Lachi	Storage tank	26.5	8.2	546

Table 4.14: Various Physico-chemical parameters of water samples of Kohat				
Location	Source	Temperature (°C)	pH	EC (µS/cm)
	Tube well	26.9	8.1	595
	Tap water	27.1	7.9	885
Kohat City	Storage tank	24.2	8.0	345
	Tube well	24.0	8.3	385
	Tap water	24.4	8.2	490
Source: Physico-Chemical Analysis of Drinking Water in District Kohat, Khyber Pakhtunkhwa, Pakistan by Hamid Iqbal, Muhammad Ishfaq, et al. International Journal of Basic Medical Sciences and Pharmacy, Vol. 3, No. 2, Dec 2013				

4.7.7 Sanitary Waste Disposal

The majority of the residents of Kohat have fair latrine facilities and sanitary waste disposal is carried out. According to the Pakistan Social and Living Standards Measurement Survey (2014-15), 70% of the households in Kohat District have a flush toilet. Detailed statistics are given in the table below.

Table 4.15: Percentage Distribution of Household by Type of Toilet			
	Flush	Non Flush	No Toilet
Kohat	65	22	13
Urban	96	3	1
Rural	56	27	17
Source: Pakistan Social and Living Standards Measurement Survey (2014-15)			

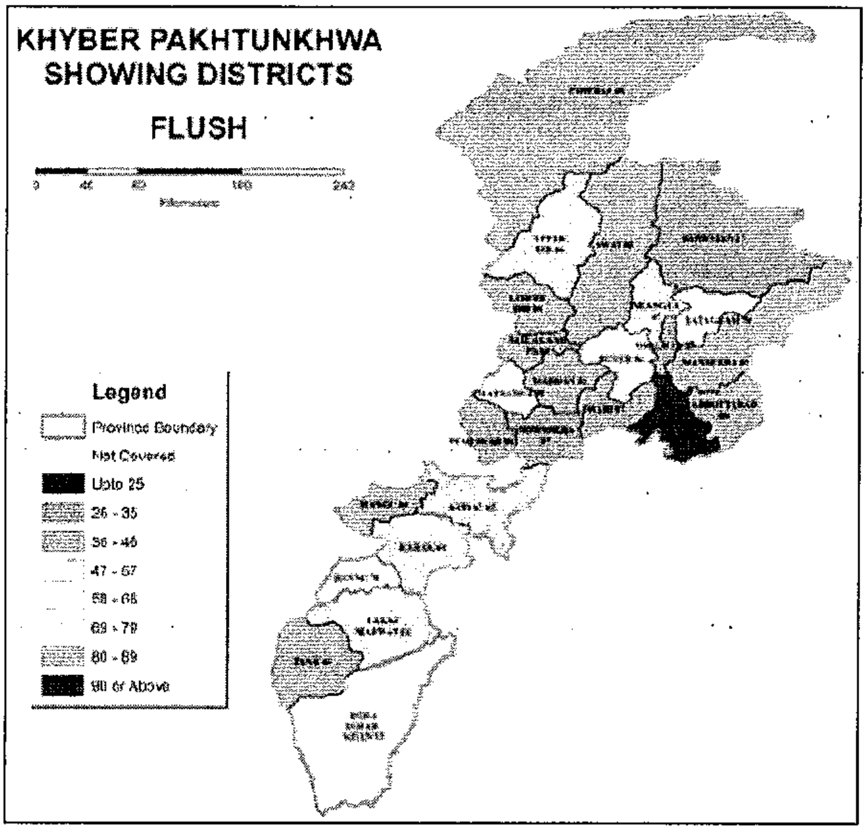


Figure 4.21: District Wise Distribution of Flush Toilet in Khyber Pakhtunkhwa
Source: Pakistan Social and Living Standards Measurement Survey (2014-15)

The map above shows the percentage of flush toilets in each district of Khyber Pakhtunkhwa. As can be seen from the map, Kohat District is among the districts with moderate percentage of flush toilets (65%) in the Khyber Pakhtunkhwa province.

4.7.8 Electricity

Total number of electricity connections in Kohat district is 109618, as of 2014-15. This include 106532 domestic/ commercial, 1218 industrial, 1758 irrigational and 85 bulk electricity connections. About 1042 villages across the district have been electrified. Total electricity consumption in the district is estimated to be 453.59 Million kilowatt hours (kWh).

4.7.9 Transport Infrastructure

District Kohat is linked by road and railway with other districts. Indus highway (N55) which is a 1,264 km long four lane national highway, connecting Karachi and Peshawar, passes through the district. Other major roads in the district are Rawalpindi-Jand-Kohat Road (N80), Bannu Road, Kohat-Hangu Road and Bannu-Kohat Road. Total length of roads in the district was 516.170 km, as of 2013-14. It includes 364.7 km of high type roads and 151.47 km of low type roads. Railway line exists to Rawalpindi however as of 2016, there were no regular train services to district Kohat.

4.7.10 Education Profile

Literacy situation in the Kohat district is summed up in the table below;

Table 4.16: Literacy rate in Kohat District (age 10 years and above)

Unit	Literacy Rate (1998 Census)	Literacy Rate (estimated 2014-15)
Male	65	74
Female	23.48	33
Total	44.06	52

Source: Important District-Wise Socio-Economic Indicators of KPK 2016, Bureau of Statistics, GoKPK

Profile of types of educational institutions, along with the respective enrolment and available teaching staff is summarized below;

Table 4.17: Profile of Educational Institutions in the Kohat District

Unit	Total Institutions	Enrolment			Teaching Staff
		Total	Male (%)	Female (%)	
Primary	657	103511	61	39	2371
Middle	81	6816	63	37	458
High	74	23758	66	34	932
Higher Secondary	17	11887	67	33	433
Degree Colleges	4	1347	55	45	83
Post Grad. Colleges	2	1205	18	82	144

Source: Important District-Wise Socio-Economic Indicators of KPK 2016, Bureau of Statistics, GoKPK

4.7.11 Health Profile

There are about 45 health institutions in the district, as of 2015. This includes 5 hospitals, 10 dispensaries, 5 Rural Health Centers (RHCs), 20 Basic Health Units (BHUs) and 2 Mother Child Health Centers (MCHC). Population per health institution is estimated to be 21,420. There are total 613 beds in the hospitals and dispensaries. Population per available bed is 1,916. There are 123 doctors and 102 nurses in the health institutions. There are 6 dental surgeons in the district.

Population served per doctor is estimated to be 7,837. Additionally, there are about 128 private medical practitioners in the district[9].

4.7.12 Industrial and Mining Sector

There are about 25 industrial units in Kohat, out of which, 21 units are in operation, as of 2014-15. There are about 4,785 people employed in these industrial units. Several minerals are also produced in the district. Their production as of 2014-15, is summarized below[10];

Table 4.18: Minerals Production in Kohat

S. No	Type of Minerals	Production (Tonnes)
1	Coal	60
2	Gypsum	76,551
3	Lime stone	2,088,954
4	Shale clay	450,074

Source: Important District-Wise Socio-Economic Indicators of KPK 2016, Bureau of Statistics, GoKPK

4.7.13 Agriculture and Livestock

Total cultivated area of Kohat is 90,000 hectares. About 18,280 hectares of land is irrigated. Cropped area is estimated to be 85,000 hectares and forest area comprises of 72,000 hectares. Land use intensity is 83.3% and the cropping intensity is 123.54%. There are total 1,082 tractors available for agriculture in the district.

Production statistics of various crops is given below;

Table 4.19: Agricultural Production in Kohat

S.No	Crop/Cultivation	Area (Hectares)	Production (000 Tonnes)
1	Wheat	37.58	70.23
2	Maize	40.05	56.87
3	Vegetables	0.13	2.53
5	Sugarcane	0.11	3.53
6	Fruits	1.10	8.69
7	Onion	0.01	0.04
8	Garlic	0.33	3.47

Source: Important District-Wise Socio-Economic Indicators of KPK 2016, Bureau of Statistics, GoKPK

Major livestock of the district are Cattle, Buffalos, Sheep, Goats and Asses.

4.7.14 Irrigation and Drainage Systems

The district is irrigated mainly by canals, tanks, tube wells, wells and left pump. Total canal irrigated area is 18,275 hectares. Area irrigated by government and private canals totals 7,643 hectares. Area irrigated by tube wells is 1,588 hectares while 1,508 hectares is irrigated by wells in the district. There were about 1,758 electricity connections given for the irrigation purpose in the district in 2012-13[11].

[9] Important District-Wise Socio-Economic Indicators of KPK 2016, Bureau of Statistics, GoKPK

[10] ibid.

[11] Development Statistics KPK 2016, Bureau of Statistics, GoKPK

4.7.15 Occupation

District Kohat is blessed with a hardworking community. According to 1998 census, 59,731 people were employed in the district. About 15,882 people were employed in agriculture, 5,807 in construction, 298 in utilities, 503 in financing, 2,127 in manufacturing, 5,085 in transport and 8,090 in whole sale. About 2,610 people were employed as clerks[12].

4.7.16 Poverty

According the Pakistan Poverty Survey, conducted in 2010-2011 under Benazir Income Support Program, Kohat is declared as a Poor district with 32.97% of its population lives below poverty line.

[12] ibid.

Chapter 5. Potential Environmental Impacts and Mitigation Measures

5.1 Introduction

The proposed project may have impact on the environment during construction & operation phases. During the construction phase, the impacts may be regarded as temporary or short-term; while long-term impacts may be observed during the operation stage. Spatially, the impacts have been assessed over the study area of 2 km radius from the project site.

Solar energy systems provide significant environmental benefits in comparison to the conventional energy sources, thus contributing to the sustainable development of human activities.

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

5.1.1 Methodology for Impact Assessment

Potential environmental impacts of the proposed 50 MW Solar PV Power Plant Project on different features of micro and macro-environment pertain to construction and operation and maintenance (O&M).

A systematic strategy was developed to provide an assessment of the likely impacts on the micro and macro environment of the project site. The strategy included:

- Identification of potential environmental impacts by conducting surveys;
- Assessment of the intensity and significance of potential impacts by obtaining expert opinion and carrying out environmental analysis;
- Defining mitigation measures to reduce impacts to as low as practicable;
- Predicting any residual impacts, including all long-term and short-term, direct and indirect, and beneficial and adverse impacts;
- Monitoring of residual impacts

NEQS were used for the verification of permissible levels of environmental parameters during project operation and environmental indicators were used for the classification of the site with respect to its pollution status, soil, and ecology including fauna, flora and wildlife, historical and archaeological sites.

The environmental aspects of the project were identified by situation analysis related to present land use, waste, noise and other forms of nuisance during construction at site, air pollution due to fugitive dust emission and operation of equipment during construction.

Site Visits have been carried out prior to proceeding with impact assessment and objective of carrying out site visits is:

- To assess environmental and social status of the project site. This will involve physical survey and visits to the site.

- To develop an understanding of the history of the site, the facility, and the surrounding properties to understand whether there might be historic contamination, or community issues.
- To check sensitivity of the site by checking any protected areas and cultural heritage sites.
- To check the socio-economic settings in and around the site and assess the impact of the project to them.
- To identify types of pollution sources, where and how to mitigate them.

Assessment of impact of different activities during construction, and operation of the proposed Solar Power plant has been undertaken. The entire screening procedure was designed in such a way to provide a complete assessment of the impacts on the macro-environment and microenvironment of the project.

5.2 Potential Impact Generation Activities

The construction and O&M phase of the proposed project comprises various activities each of which may have an impact on environmental parameters.

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

- Site Clearance
- Minor excavation and levelling
- Building and construction of Site Office and boundary walls (Civil works)
- Hauling of earth materials
- Generation of inter waste during construction
- Generation of Hazardous waste during O&M phase
- Welding of Frameworks
- Landscaping

Construction work will involve site clearance and bushes removal; masonry works for construction of site offices, minor excavation, concreting for the platforms of panels etc. All these activities attribute to minor dust pollution which will be localized to the site boundaries.

Mechanical erection work involves use of mechanical equipment for erection of Solar PV panels, erection of transformers, electrification/cabling and on-site fabrication work. These activities may generate some noise pollution. The electrical activities are less polluting in general. Potential Impacts and Mitigation Measures (for construction and O&M phase) are given in the following section.

5.3 Impacts due to Project Siting

5.3.1 Encroachment on Precious Ecology

Incursion into Protected Areas

Project area does not lie inside or adjacent to protected area or buffer zone of protected area. In addition, no special area for protecting biodiversity is found. No Ramsar sites are found within the study area.

Loss of Forests

No areas of primary forest are found within or adjacent to the proposed project site. There is some vegetation at the project site that will be removed during site clearance, and will be replanted in the ratio of 1:5 for the case of mature tree, and in the ratio of 1:3 for the case of small tree after completion of the project.

Impact on Fauna

No major faunal specie was found during the site visit. Few small holes of rodents and a few birds were spotted.

Incursion into Wetlands

No wetlands are found near the project area so no incursion is envisaged.

5.3.2 Encroachment on Historical/Cultural/Archaeological Sites

There is no archaeological site in the close vicinity of the project area.

5.3.3 Land Acquisition

The project site is already acquired by the proponent; the project therefore involves no land acquisition.

5.3.4 Temporary Construction Camps and Facilities including Batching Plants

Following measures will be adopted to mitigate the related impacts;

- Should be located at appropriate distance from settlements.
- Should not be located in environmentally sensitive areas.
- Should have adequate drainage and not be subject to flooding.
- Should not be within 100 m of any domestic or public water sources.

As construction activities will be mainly confined to the project site only for a short duration, hence the impact due to Temporary Construction Camps during construction and development phase is minor.

5.4 Impact during Construction Phase

The environmental impact during construction phase is localized and short term and of low magnitude.

Impact is primarily related to the civil works and some intensive impact due to erection of the equipment. The details of the activities and probable impact are brought out in table below:

Table 5.1: Identification of activities and probable Impacts (Construction Phase)

Construction Activities	*Environment Attribute*	*Probable Impacts*
Land Acquisition	Land	- No permanent impact on land use is expected
	Socio economics	- No impact due to rehabilitation and resettlement issue is expected as land has already been purchased and belongs to proponent.
Site clearing and Levelling (cutting, stripping, earth movement, compaction)	Air	- Fugitive dust emission - Air emissions from construction equipment and machinery
	Water	- Runoff from construction campsite
	Land	- Loss of top soil
	Ecology	- There will be some loss of vegetation at the project site
Transportation and storage of construction materials/equipment	Air	- Air emissions from vehicles - Fugitive dust emissions due to traffic movement
	Water	- Runoff from storage areas of construction material
	Public utilities	- Increased flow of traffic
Civil construction activities	Air	- Air emissions from construction machinery - Fugitive dust emission
	Water	- Runoff from construction areas
Mech. And Elec. Erection activities	Air	- Air emissions from machines/activities
Influx of labour	Socio economic	- Employment opportunities shall increase
	Land	- Change in land use pattern of the area
	Water	- Sanitary effluents from office and labour accommodation
Transportation and disposal of construction debris	Air	- Air emission from transport vehicles - Fugitive dust emissions due to movement of traffic - Spillage and fugitive emissions of debris materials
	Water	- Runoff from disposal areas
	Soil	- No conversion of land into waste land

5.4.1 Impact on Land Use

The land required for the proposed expansion project will be about 284 acres which is already acquired by the proponent. The construction activities attract few construction workers likely to be associated with construction of temporary campsite, having an effect on land use pattern of the areas surrounding the project. However, this impact is envisaged to be insignificant due to following reasons.

- Temporary labor campsite shall be situated in the areas already acquired for the project.
- It will be only a temporary change (restricted to construction period). After construction phase, the areas acquired by labor campsite shall be restored to its original contours.

The Project will generate employment opportunities for the local population in addition to indirect job opportunities created outside the project boundary. The Project will improve the basic infrastructure and the people of nearby villages will use these amenities. Proponent would like to give priority to the skilled, unskilled labor of the nearby villages. Overall, it is anticipated that there will be marginal impacts on the socio-economic conditions of the locality and the impact will be mostly positive.

5.4.2 Impact on Soil Cover

As the construction activities for the main plant units of project would be confined in the wasteland, the impact on soil will be minimal and confined. Only cutting and filling is required during site clearance. The construction activities result in loss of some vegetation (mainly shrubs). No adverse impact on soil in the surrounding area is anticipated. Completion of excavation and foundation work in limited time schedule would also reduce / minimize the chances of soil erosion. No impact on the soil will occur during construction activities.

5.4.3 Impact of Solid Waste

Solid waste during the construction phase consists primarily of scrapped building materials, excess concrete and cement, rejected components and materials, packing and shipping materials (pallets, crates, Styrofoam, plastics etc.) and human waste. During the construction, there will be generation of garbage, for which designated practices of solid waste disposal shall be followed as mentioned in Section 6 of EMP.

5.4.4 Air Emissions

As the proposed project is Solar PV Project, the impact during construction of it is expected to be minimal as a Greenfield Project.

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 civil works of site offices, hauling operations along with transportation activities. However, barricading of work area will prevent the dust due to construction activities going outside the project area.

The main source of gaseous emission during the construction phase is the running of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO_2, NOX, and particulate matter. The impact is reversible, marginal and temporary in nature and lasts during construction activity.

5.4.5 Impact

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

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

5.4.6 Impact on Water Environment

The construction personnel would be housed in campsite. The campsite would discharge considerable amount of domestic wastewater. Stagnant pools of water would increase breeding of mosquitoes and generally create insanitary conditions. Contractor will provide Soak pit with a depth of 2 meter to dispose liquid waste so that such waters do not form stagnant pools nor aggravate soil erosion. The main pollutants are organic components and microorganisms with the potential to cause contamination of water quality. To address potential impacts on water quality, disinfected latrines (e.g., through regular liming) will be used as main component of the sanitation system.

Construction processes include fabrication of concrete and related water usage. Wastewater from construction activities would mostly contain suspended impurities. The wastewater will be arrested before discharge, to prevent solids buildup in the existing canal. Thus, the construction site wastewaters would be led to sedimentation basins, allowing a hydraulic retention time of 1 ½ to 2 hours, where excess suspended solids would be settled out and relatively clear supernatant would be discharged. Generally, Surface run-off water is not there in dry months during construction. In addition, since the area is semi-arid, there will not be any considerable surface runoff as it shall be lost due to evaporative losses. However, during monsoon, surface run-off including effluents may cause load of suspended solids.

5.4.7 Ecological Impact

There is some vegetation at the project site which will need to be removed during site clearance. The impact of the construction activities would be primarily confined to the project site. The flora species removed during project construction will be replanted in the ratio of 1:5 in the case of mature tree, and 1:3 in the case of small tree after completion of the project.

5.4.8 Occupational Health and Safety

The construction of civil works such as construction of site office and lying of panels poses an inherent risk of injury to workers from accidents and hazardous working environments. To mitigate these potential impacts:

Prior to the commencement of civil works the EHS specialists will develop a construction phase Occupational Health and Safety Plan (OHSP). The OHSP should:

- identify and minimize, so far as reasonably practicable, the causes of potential hazards to workers, including communicable diseases such as HIV/AIDS and vector borne diseases;
- provide preventive and protective measures, including modification, substitution, or elimination of hazardous conditions, with particular attention to live power lines, working above water, high noise levels, and exposure to chemicals;
- provide measures for the management and appropriate disposal of hazardous wastes to ensure protection of the workforce and the prevention and control of releases and accidents;
- provide for the provision of appropriate fire extinguishers and fire response plans and appropriately trained first aid response staff;

- provide for the provision of appropriately stocked first-aid equipment and stations at both work sites including appropriately trained first-aid staff on site and provision of adequate transport facilities for moving injured persons to the nearest hospital;
- provide for the provision of appropriate personal protective equipment (PPE) to minimize risks, such as but not limited to appropriate (insulated if necessary) outerwear, boots and gloves; eye protectors; ear plugs safety helmets, etc.;
- provide training for workers, and establish appropriate incentives to use and comply with health and safety procedures and utilize PPE;
- include procedures for documenting and reporting occupational, accidents, diseases, and incidents; and
- include emergency prevention, preparedness, and response arrangements in place.

With the development of an effective OHSP, occupational health and safety risks can be minimized.

5.4.9 Heat Stress to Construction Worker

There will be a very likely impact of sunlight causing Heat stress to construction worker during summer season.

To mitigate the impact of heat stress the following measures are proposed:

- Provide cold refuge to the worker
- Provide plenty of drinking water
- Break the working in shifts

5.4.10 Improvement of Access Routes into Project Target Areas

The construction of access roads for motorized, non-motorized and paved walkways will improve the aesthetics of the project area. Since the construction of roads will be built to the required standards, incidents of emergency vehicles not being able to access areas of distress will be minimized. Depending on the extent of paving, soil erosion and dust in the areas will be reduced, hence reduction in respiratory diseases that are brought about by dust.

5.5 Impact during Operation and Maintenance (O&M)

During their normal operation PV systems emit no gaseous or liquid pollutants, and no radioactive substances.

Various activities of O&M phase and their probable impacts on various sectors of environment are presented in table below.

Table 5.2: Identification of activities and probable Impacts (O&M)

O&M Activities	Sector	Probable Impacts
Transportation	Air	- Air emissions from vehicles - Fugitive dust emissions due to traffic movement

Table 5.2: Identification of activities and probable Impacts (O&M)		
O&M Activities	**Sector**	**Probable Impacts**
	Water	- Effluents from oil storage areas and transformers
Water treatment of various uses	Water	- Generation of wastewater due to PV cleaning modules
Operation of transformers and switchyard	Water	- Generation of effluents containing oil
	Land	- Soil contamination due to spillage of transformer oils and PCBs

5.5.1 Impact on Land Use

The site, after completion of its development, would consist of built structure of solar panels, landscaped to give a pleasing outlook. Following the construction phase, the temporarily modified land use pattern, such as construction of temporary tents to accommodate some construction personnel will be totally removed during the operation stage. Land released from the construction activities would be put to economic and aesthetic use to hasten recovery from adverse impacts.

5.5.2 Impact on Soil Cover

In the case of CIS and CdTe modules, which include small quantities of toxic substances, there is a potential slight risk that a fire in an array might cause small amounts of these chemicals to be released into the environment (Various, 1996).

In large-scale central plants a release of these hazardous materials might occur as a result of abnormal plant operations and it could pose a small risk to public and occupational health. Thus there must be emergency preparedness and response in case of an accidental fire or exposure to heat. Emissions to soil and groundwater may occur due to inadequate storage of materials (OECD/IEA, 1998).

5.5.3 Oil, Fuel Spills, and Dangerous Goods

Transformer oil has a long life, typically more than 15 years depending on the level of load the transformer serves. Transformer oil spills are rare and can be avoided through routine maintenance and good practices. No significant impacts from oily residues such as transformer oil and lubricants are expected to occur during Project operation.

Nonetheless, to avoid inappropriate disposal of transformer oil or accidental releases of other chemicals, fuels and oils, the following mitigation measures will be adopted:

- All transformers will be equipped with spill containment berms in accordance with relevant national standards.
- A transformer maintenance schedule will be developed and transformer oils will be monitored on a regular basis.
- Chemicals and oils should be stored in secure designated areas with permanent impermeable bunds at distance of at least 100 m from any watercourse.

- Transformer oil will be supplied in drums from an imported source and tap tanks will be topped up as necessary at the above noted secure designated areas.
- Refueling of machinery, equipment and vehicles should be undertaken at distance of at least 100 m from any watercourse such as canal.
- Any major work including oil changing and engine maintenance with the potential for oil to be spilled will be done in designated areas at distance of at least 100 m from any watercourse and with containment to prevent any oil spills washing away.
- Transformer oil will be recycled if local facilities allow. Oil to be recycled should only be stored temporarily in designated areas.
- Contaminated residues and waste oily residues should be incinerated through Waste management contractor.
- An emergency spill response plan will be established and staff will be trained on spill response procedures.

5.5.4 Waste Management

To deal with risks associated with the storage, handling and disposal of hazardous materials such as transformer oils and Polychlorinated biphenyls (PCBs):

i. For new installations restrictions on the use of PCBs will be included as a requirement in the design and bidding contract documents.

ii. For replacement (upgrading) of existing transformers, transformer oil will be removed prior to transportation, tested and either reused or taken for recycling at designated recycling facilities, if available, or for disposal at designated waste disposal facilities if recycling is not available.

iii. All transformers will be equipped with suitably sized impervious spill containment berms made of precast and reinforced concrete in accordance with relevant national standards.

Soil from excavation for the transformer bases will be only a minor impact since the volume of soil excavated is a very small. Other construction wastes will also be minimal. Soil will be reused to the extent possible and appropriate soil and waste disposal will be a requirement in the design and bidding contract documents.

5.5.5 Use of Poly Chlorinated Biphenyls and Sulfur Hexafluoride

PCBs have historically been widely used as an insulating material in capacitors and transformers due to their high heat capacity, low flammability and low electrical conductivity. However, PCBs are non-biodegradable, toxic and have carcinogenic tendencies, and the United States Congress banned PCB production in 1979 and by the Stockholm Convention on Persistent Organic Pollutants in 2001.

To mitigate potential impacts with respect to PCBs and to comply with international commitments:

- Transformers using PCBs should be banned the purchase of, and no PCBs will be utilized in the Project.

- Proponent will obtain confirmations from suppliers at the time of bid offers that transformers will be free from the PCBs.

Sulfur hexafluoride (SF_6) is an inorganic, colorless, odorless, non-flammable widely used insulating gas. However, SF_6 is also a potent greenhouse gas (GHG), having a global warming potential of 23,900 times greater than CO_2 (100 year time horizon). To minimize potential releases of this GHG:

- Emission of SF_6 will be controlled by adopting good international practices for the use and handling of SF_6, including leak detection and repair, recycling of equipment, and training of employees on good practices.

5.5.6 Air and Noise Impact

The Solar PV energy is a clean energy and does not emit air pollutants and noise. Therefore, there will be no impact of air and noise during O&M phase.

5.5.7 Impact on Water Environment

Impact on Groundwater

No ground water due to plant operation will be drawn during operation phase for any purpose. So lowering of groundwater table will not be an issue. In addition, Rainwater Harvesting will be implemented at proposed plant to conserve storm water and help in recharge of ground water.

Impact on Surface Water

There shall be minimal discharge of wastewater from cleaning of Solar PV modules. The wastewater emanating from cleaning operations shall be recycled for plantation and greenbelt development around the plant. The rest of the wastewater will be deposited in rainwater harvesting pond.

Only sanitary waste from site office will be generated that will be routed to a septic tank before discharge.

5.5.8 Terrestrial Ecology

There is no sensitive ecological area / protected forest area such as national wildlife park, bird sanctuary crossing the proposed route alignment. The removal of herbaceous vegetation from the soil and loosening of the top soil generally causes soil erosion. However, such impacts would be primarily confined to the project site during initial periods of the construction phase and would be minimized through adoption of mitigation measures like paving and surface treatment and water sprinkling.

5.5.9 Clean Energy Generation

In response to international commitments as agreed to by the Pakistani government for the reduction of atmospheric greenhouse gas emissions, the proposed Kohat Solar project facility contributes to this goal. A mix of energy sources including wind, solar, hydro, wave and biogas form some of the identified areas of opportunity for energy capture in Pakistan.

In line with commitments to reduce greenhouse gas emissions, Pakistan's largest contributing sector, the energy sector, is taking steps to address this need. As a result, a transformation program is currently being employed to diversity to energy mix, to reduce a current dependency on fossil fuel derived electricity.

The proponent intends to see the contribution and feed-in of clean energy into the Pakistan Power national grid. It is through development of Kohat Solar Power (50 MW) plant that the proponent shall contribute to this goal.

5.6 Social Impact

5.6.1 Traffic Congestion

No overburden on the local transportation system is envisaged due to the proposed Project.

5.6.2 Labor Influence

<u>Construction Phase</u>

During construction activities, there will be an influx of labor from outside of local area. This will have an effect on social fabrics of the areas surrounding the project. However, this impact is envisaged to be insignificant due to the following reasons:

- Local population will be preferred for the skilled and unskilled jobs during construction and O&M.
- Temporary labor accommodations shall be situated in the areas already acquired for the project.
- It will be only a temporary change (restricted to construction period). After construction phase, the areas acquired by labor campsite shall be reverted back similar to pre-construction stage

Proponent has a Human Resources Policy, which specifies the terms of employment and working conditions and follows Pakistan Labor Law. All the employees will have access to the human resources policy and procedures.

Most of the construction labor will be on contractual basis. Separate labor accommodations shall be made within the plant premises for the construction labor. Therefore, conflict of the migrating labor with locals, will not take place during the construction phase. Regarding monitoring of diseases corresponding to labor influx, regular health status monitoring of labor will be carried out operated by the proponent.

5.6.3 Change in Socio-economic Condition

Employment: The project will generate employment opportunities for the local population. Even indirect job opportunities will be created outside the project boundary. Many people will find employment in service sector and marketing of day-to-day needs viz. poultry and other agricultural products. The project will improve the basic infrastructure and the people of nearby villages can also use these amenities.

Proponent is working for the employment and skills training for the locals through following steps.

- Provision in project contracts to provide priority in employment
- Training for skills up-gradation
- Efforts to employ educated unemployed youth
- Overall, there will be marginal impact on the socio-economic condition of the locality and the impact will be mostly positive.

Development of Infrastructure: The job opportunities in non-agricultural sector are likely to increase. The installation of the power plant is expected to further increase the prospects by bringing in direct and indirect employment opportunities.

As the project and consequent activities are expected to generate additional employment and income opportunities for the local population, market expansion supported by infrastructural development will foster economic growth in the area. Flow of reliable and adequate power from the proposed plant will not only enhance growth in the region, but will also bring about a change in energy consumption pattern by switching over from other sources of energy. This will ease off burden on the existing biomass.

Table 5.3: Impact Assessment and Mitigation Rating

Item of Impact	Magnitude of adverse impact	Mitigation Measures	Magnitude of residual impact
Pre-Construction (Siting) Phase			
Encroachment on Protected Site	D	- Project area does not lie inside or adjacent to protected area or buffer zone of protected area. Also no special area for protecting biodiversity is found. No Ramsar sites are found within study area. Also no gazette archeological sites are found near the project area.	D
Land Acquisition	D	- Project site has already been acquired by proponent.	D
Temporary Construction Camps and Facilities including Batching Plants	B-	- As construction activities will be mainly confined to the project site only for a short duration, hence the impact due to Temporary Construction Camps during construction and development phase is Minor.	D
Construction Phase			
Dust Emission	B-	- The contractor should keep their construction equipment proper condition to avoid the imperfect combustion. - To reduce the dust, periodical water spray should be taken. - All vehicles and machinery should be routinely checked and maintained and in good working order, and should be in compliance with NEQS. - If the residents and pedestrians complain about the dust and gas, the	C-

Table 5.3: Impact Assessment and Mitigation Rating

Item of Impact	Magnitude of adverse impact	Mitigation Measures	Magnitude of residual impact
		consultant of the supervision and contractors should reconsider the construction technique.	
Ecological	B-	- There is no major faunal specie in the area, hence no significant impact on fauna is expected. - There is some vegetation at the project site which will need to be removed during construction phase.	C-
Waste	B-	- Construction sites should be equipped with temporary refuse bins, and construction wastes should be collected on a daily basis and contained in a temporary designated waste storage area. - Designated waste storage areas should not be within 50 m radius of waterways. - At all construction sites chemicals and oils should be stored in secure designated areas with temporary impermeable bunds at distance of at least 100 m from any water course. - A Comprehensive Waste management Plan for Construction phase should be developed - The environmental surveys and analysis should be conducted and being part of EMP. - The consultant of supervision should monitor the waste disposal.	C-
Noise and vibrations	B-	- The proper work schedules should be considered not to concentrate the construction equipment at a certain point for long time. - The contractor should keep their construction equipment in proper condition. - Construction activities with high noise generation should be scheduled during daytime only. - If the local people complain about noise and vibration, the consultant of the supervision and the contractors should reconsider the construction technique.	D
Working conditions/ Occupational Health and Safety	B-	- The construction personnel should be provided with the necessary safety gears such as protective hardhat. - Construction Camps should be provided with appropriate sanitation	C-

Table 5.3: Impact Assessment and Mitigation Rating			
Item of Impact	**Magnitude of adverse impact**	**Mitigation Measures**	**Magnitude of residual impact**
		facilities, washing facilities, temporary toilets, and waste containers. - Pests and rodents should be controlled through good housekeeping and maintenance and the use of screens on openings of structures intended for occupancy or food service. Traps should be used if necessary. - First-aid kits should be prepared within the construction site office. - Common people should be restricted to enter the construction site strictly.	
Improvement of Access Routes into Project Target Areas	A+	No mitigation measures required.	A+
Operation Phase			
Electrocution and Induced Currents	A-	- Warning signs will be posted wherever required. - Substations/transformers will be fenced with gates, locks and security personnel. - Conducting objects (e.g. fences or other metallic structures) installed near power lines will be grounded to prevent shock.	C-
Oils, Fuel Spills and Dangerous Goods	B-	- All transformers will be equipped with spill containment berms in accordance with relevant national standards. - A transformer maintenance schedule will be developed and transformer oils will be monitored on a regular basis. - Chemicals and oils should be stored in secure designated areas with permanent impermeable bunds at distance of at least 100 m from any watercourse.	D
Use of Poly Chlorinated Biphenyls and Sulfur hexafluoride	C-	- Transformers using PCBs should be banned the purchase of, and no PCBs will be utilized in the Project. - Proponent will obtain confirmations from suppliers at the time of bid offers that transformers will be free from the PCBs. - Emission of SF_6 will be controlled by adopting good international practices for the use and handling of SF_6, including leak detection and repair, recycling of equipment, and training of employees on good practices.	P
Operation and Maintenance	B-	- The work safety plan shall be established including mitigation measures on soft aspects (safety training, etc.) and hard aspect (provide	D

Table 5.3: Impact Assessment and Mitigation Rating			
Item of Impact	**Magnitude of adverse impact**	**Mitigation Measures**	**Magnitude of residual impact**
		workers with appropriate protective equipment, etc.).	
Clean Energy Generation	A+	No mitigation measures required	A+
Social Impact			
Employment	A+	- The project will generate employment opportunities for the local population. Even indirect job opportunities will be created outside the project boundary.	A+

Rating Category
A+: *Significant positive effect is expected.*
A-: *Significant negative effect is expected*
B+: *Certain positive effect is expected.*
B-: *Certain negative effect is expected.*
C: *Effect is unknown (as of preparatory survey phase).*
D: *No effect is expected.*

Chapter 6. Environmental Management Plan

6.1 Introduction

This chapter outlines the Environmental Management and Monitoring Plan (EMP) and defines EMP for the proposed 50 MW Solar PV Power Plant at Lachi, District Kohat, KPK. This EMP is intended to cover the institutional arrangements required for the implementation of the plan along with mitigation related to the environmental issue of the proposed project activity identified in the previous section.

An Environmental Management Plan (EMP) is a management tool that helps ensure that all reasonable avoidable adverse impacts of a project's pre-construction, construction, operation and decommissioning phases are either mitigated or at best prevented. The main purpose of this EMP will assist in ensuring continual improvement of environmental performance, reduction of negative impacts and enhancement of positive effects during all the stages of this project.

6.2 Objectives of EMP

This EMP provides the delivery mechanism to address the adverse environmental impacts of the proposed project during its implementation, to enhance project benefits, and to introduce standards of good practices to be adopted during all project stages. The primary objectives of the EMP are to:

- Facilitate the implementation of the mitigation measures identified in this report;
- Define the responsibilities of the project proponent, contractors and environmental issues among them;
- Define a monitoring mechanism and identify monitoring parameters in order to ensure complete implementation and effectiveness of identified mitigation measures; and
- Provide a mechanism for taking timely action in the face of unanticipated environmental or social situations.
- Required equipment and human resources for environmental monitoring and meeting contingency plan objectives are in place and personnel are trained to meet accidents and emergencies

This EMP provides the delivery mechanism to address the adverse environmental impacts of the proposed project during its implementation, to enhance project benefits, and to introduce standards of good practices to be adopted during all project stages.

6.3 Scope of EMP

This Environmental Management Plan has provided detailed strategy to be implemented for achieving improved environmental performance in the following areas:

- Environmental Management
- Water Usages and Disposal
- Recycling and Waste Management

- Pollution Prevention/Environmental Risk Assessment
- Energy Management
- Transport
- Community Awareness

6.4 Components of EMP

The EMP consists of the following components:

- Legislation and Guidelines
- Organizational Structure and Responsibilities
- Mitigation Plan
- Environmental Monitoring Plan
- Emergency Response and Contingency Plan
- Communication and Documentation
- Change Management

6.5 Legislation and Guidelines

The 50 MW Solar Power Project will ensure that the key project management officials and staff and all its assigned and associated consultants and contractors are aware of these legislations and guidelines prior to the start of the project activities.

IEE Regulation: The project will be conducted in conformance with IEE regulation and relevant international conventions and that guidance is sought from national and international guidelines. An independent monitoring consultant will be appointed for the project.

NEQS Requirements: The NEQS for industrial gaseous emissions, Motor Vehicle Emissions and Noise levels, and Industrial and Municipal effluents will be followed throughout the project activities and operation.

IFC Guidelines: The IFC guidelines will be followed in all such cases where National guidelines have not been proposed. The project designers need to know applicable bank requirements and the environmental implications of their design choices.

6.6 Organizational Roles and Responsibilities

Proponent shall have its own Environmental Management System EMS to ensure the implementation of EMP and Health and Safety Issues during construction and maintenance.

Its Project Manager will assume the environmental management responsibilities and his team members during construction and operations phase to:

- Coordinate with relevant government departments

- Identify and report changes in activities and services that may create new environmental aspects
- Collect and coordinate information regarding environmental aspects, and maintain records related to environmental aspects and their impacts
- Ensure construction work is carried out in an environmentally sound manner by the Contractor by incorporating environmental compliance by appropriate provision in the construction contract

EPC Contractor and their Sub-Contractor will ensure compliance with the environmental management plan by way of training of construction crews in all aspects of implementation of EMP.

6.7 EHS Plan

Will be provided by EPC Contractor.

6.8 EHS Committee

EPC contractor will establish an EHS committee for the Project as the authority department which settles for safety, occupational health and environment business during the course of project duration period. EHS committee will strive to accomplish project objectives, applicable rules and regulations of Pakistan, WB and IFC.

EHS committee is composed of EPC contractor project manager, EHS Chief, EHS Assistant, chief principals of all subcontractors and specialized departments. Project manager serves as the chairman of EHS responsibilities for specific positions are described in the following subsections.

The EHS organizational framework is given below:

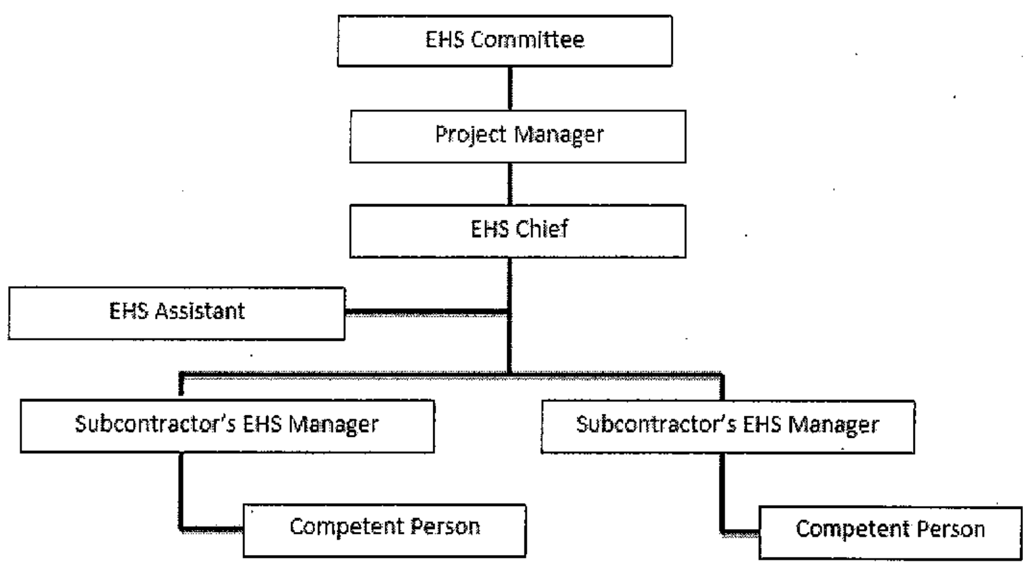


Figure 6.1. EHS Organogram

6.9 Environmental Management Process

This EMP has been designed within the framework of requirement under Khyber Pakhtunkhwa Environmental Protection Act 2014 on environmental aspects.

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

- Environmental Management Plan
- Rainwater Harvesting
- Clean Development Mechanism
- Occupational Health and Safety
- Labor Working Conditions
- Construction Labor Management
- Environmental Action and Monitoring Plan
- Community Development Plan
- Disaster Management Plan

This EMP table has been prepared and shown in Table 6.1 considering life cycle approach of the project that proponent will own and operate.

6.9.1 Roles and Responsibilities

Project Manager

- Ensure adequate and suitable resources are allocated to the project to enable the project to be completed, designating qualified persons to cooperate with business unit of the project while complying fully with the requirements of this EHS Plan, and all applicable regulatory requirements.
- Ensure that any subcontractors have received a copy of this EHS plan before they submit a work plan at the jobsite.
- Coordinate all EHS activities with owners and other subcontractor on the project site.
- Issue a work stoppage directive where conditions exist which are Immediately Dangerous to Life or Health (IDLH) or damaging to the environment.
- Support or participate in the investigation of all accidents and reportable occurrences

EHS Chief

- The EHS Chief will have overall responsibility for the environmental performance of the project and will ensure that all operations comply with Environmental Policy and all relevant regulatory requirements.
- Ensuring implementation of this project EHS plan and compliance with rules and regulations of the Project to all personnel of contractor(s)/subcontractor(s) on site.

- Support or participate in the investigation of all accidents and reportable occurrences in order to identify the root causes and take corrective and preventive actions aimed at preventing the occurrence of similar events.
- Ensure adequate facilities, procedures and trained personnel are available for all foreseeable emergencies.
- Where applicable, ensure periodical EHS Inspections are conducted and keep document.
- Attend Owner/Contractor/Subcontractor's weekly EHS meetings, arrange EHS work of next week.
- Conduct site internal Audits and Assessment among subcontractors, in accordance with the contract and environment management plan.
- Be responsible for the safety and health of EPC staff, and provide necessary training and personal protective equipment to them

EHS Assistant

- Draft the Site EHS plan and assist the EHS Chief in implementing the Site EHS Plan.
- Ensure implementation of the provisions of the project, including training, development and revision of procedures, and periodic auditing of program compliance.
- Attend Owner / Contractor / Subcontractor's weekly EHS meetings, arrange EHS work of next week, complete memo of meeting for later reference.
- Conduct, or assist with conducting accident investigations, analyzing causes, and formulating recommendations for corrective/preventative actions.
- Liaise with owner, contractor and Subcontractors, health medical services, local fire and police departments, and local regulatory agencies on EHS related matters.
- Verify that all the EHS defects related to subcontractors are rectified and completed according to the owners' requirement.
- Verify that EPC and each contractor/subcontractor is providing adequate and proper record keeping as required by regulatory agencies and maintaining documentation of EHS training, EHS audits and inspections and occupational safety and health monitoring activities.
- Maintain record keeping for the project and as required by owner and regulatory agencies.
- Conduct site internal Audits and Assessment among subcontractors, in accordance with the contract and environment management plan.

EHS Manager of Subcontractors

- The subcontractor's EHS Manager will be responsible for the effective implementation of the mitigation measures during the project by assigning a competent person supervising the execution of this plan.

- Ensuring and documenting adequate environmental training to all personnel. Issuing high-risk job instructors, ensuring safety and occupational health of employees, visitors, contractors / subcontractors and other person's entry into the jobsite.
- Supervising execution of financial plan for the normal performance of preventive and corrective activities to be planned in the organization.
- Review qualification and training of workers who have access to high-risk areas.
- Furnish transportation, housing, food, clothing, tools, supplies, furniture, first-aid organization, ambulance services and other necessary facilities to its personnel in order to perform this Contract.
- Keep sufficient first-aid facilities and ambulance services available for its personnel, its Subcontractors' personnel, visitors and other persons at the Site.
- Prohibit or halt the work in which they warn imminent risk of accidents.
- Organize, implement and maintain an Emergency Response Plan and Organization to ensure a full and proper performance to safeguard their employees and property in case of emergency.
- Conduct frequent and regular scheduled safety inspections of construction activities to monitor compliance with applicable rules and regulations and EHS plan.
- Attend Owner / Contractor / Subcontractor's weekly EHS meetings, and analyze and summarize EHS business of last week, arrange EHS work of next week, complete memo of meeting for later reference.
- Conduct, or assist with conducting accident investigations, analyzing causes, and formulating recommendations for corrective/preventative actions.
- Verify and provide adequate and proper record keeping as required by regulatory agencies and maintaining documentation of EHS training, and inspections and occupational safety and health monitoring activities

Competent Person of Subcontractor

- Report to EHS manager unsafe acts/conditions observed on the project site for prompt corrective action to eliminate the unsafe act/condition.
- Ensure all work on site only proceeds when required Job Safety Analysis/Risk assessments have been completed, and reviewed by EHS Chief and communicated to those who can be impacted by the hazards identified.
- Ensure all personnel wear all required personal protective equipment for the environment they are in and the tasks they are performing.
- Attend Owner/Contractor/Subcontractor's weekly EHS meetings, and analyze and summarize EHS business of last week, arrange EHS work of next week.
- Attend accident investigations, analyzing causes, and formulating recommendations for corrective/preventative actions.

- Inform workers about risk factors arising in the execution of their work and EHS rules to follow to prevent the occurrence of work accidents or occupational diseases.
- Maintain a system for recording and reporting of accidents, incidents and occupational diseases and the results of risk assessments and proposed control measures, which have access record to EHS manager.
- Set up necessary risk factors identifying signs or banners at the site

6.10 Environmentally Sound and Safe Working Procedures

Contractors, sub-contractors and contract workers will be made aware of environmental aspects and Emergency Response Plan prior to commencing the work. Prior to leaving the site contractors, sub-contractors and contract workers will ensure that their work area is in safe position. On emergency call they will report in assembly area. Written procedures or standards will be prepared for all activities, where the absence of such procedures and standards could result in not following HSE policy, the law or the contract.

Safe Working Procedures will be based on the following four aspects of job safety:

Safe Place: Work site will be designed and controls set up to ensure that working environment provides no significant risk to personnel, property and the environment.

Safe Equipment: All equipment for any job, including tools, machinery and protective equipment will be specified and/or designed to ensure that it poses no significant risk to personnel, property or the environment. All equipment will comply with legislative standards for conformity and test.

Safe Procedure: Procedures will be designed for all aspects of the job to facilitate safe use of equipment at the work site to complete tasks with no significant risk to personnel, property or the environment. Design of procedure will be based on systematic analysis of the tasks involved (Job Safety Analysis), identification of associated hazards and elimination of control of those hazards. Procedures should allow for work in ideal conditions as well as under aggravating conditions e.g. adverse weather.

Trained Personnel: Suitable job-specific, safety skills and supervision training will be provided to personnel involved in construction and operation activities so that they are able to use the procedure and equipment at the worksite with no significant risk to personnel, property and environment.

Safe Working Procedures will be available to contractors and sub-contractors, who will adopt the relevant labor laws of the country.

6.11 Identification of Environmentally Safe Aspects

EMS will identify Environmental aspects at the initiation of activities at the site with regard to:

- Emissions of fugitive dust and gaseous pollutants from vehicles and equipment,
- Discharges of liquid effluent including oily waste and seepage to land, and water
- Disposal of excavated material and solid waste to land, water and air

- Hazardous waste disposal
- Health and Safety
- Emergency releases

6.12 Environmental Assessment of Safe Procedures

After identifying the environmental aspects, the related impacts will be assessed and the significance of each issue will be evaluated. Following aspects will be identified for evaluating the impacts:

- Parts of microenvironment impacted
- Parts of macro-environment impacted
- Whether the impact is beneficial or damaging
- Severity of impact
- Frequency or likelihood of impact
- Existing mitigation measures
- Adequacy of mitigation measures
- Concerns of stakeholders/interested parties
- Regulatory requirements and their compliance

6.13 Impact Rating

Impact rating will be assessed for each identified aspect to determine the significance as small, medium and high intensity or non-significant.

6.13.1 Pre-construction Phase

Following are likely to be the main activities at pre-construction phase:

- Photographs of the project area will be taken for recording current status of environment to compare with alterations introduced by the Project
- Monitoring disturbance or alterations in the natural drainage, if any
- Use of horns will be avoided
- Soaking pits for waste water from campsites will be constructed and hazardous waste from these pits will be treated during rehabilitation and restoration phase
- Leakages and drips from operating vehicles and equipment will be attended to immediately; vehicles with leaks will be restrained from operation at the site. All vehicles will carry fire extinguishers.

6.13.2 Environmental Aspects of Construction Activity

Construction activities for establishment of Solar Power Plant Project would likely include the following main elements:

- Location of campsite and field construction office
- Land clearance
- Construction of foundations and transformer pads
- Installation of electrical collection system – underground and some overhead lines
- Assembly and installation of panels
- Construction and installation of substations.
- Plant commissioning and energizing

The above activities would likely entail the following issues that may have impact on the environment and require adoption of mitigation measures during the implementation phase:

- Heavy weight and/or long trucks haulage, Surface sealing
- Topsoil removal, Compressing of topsoil
- Fuel storage
- Concrete production
- Waste disposal
- Dust emission
- Construction related noise
- General conditions of construction site (visual)
- Disturbance of fauna, including reptiles
- Emergency response
- Site rehabilitation.

6.13.3 Potential Impact of Construction Activity and Mitigation Measures

Construction at the proposed site of Solar Power Plant would not involve extensive land preparation and the likely impact will be minor and not significant on the microenvironment that has currently insignificant land use.

- Site preparation activities would include clearing, excavation, earth and fill movement; transportation of equipment to the site. The said activities will lead to soil erosion resulting from removal of topsoil at the site, but to improvement of its quality. The fugitive dust emission would be extensive because of aridity of the soil. Dust emission due to other materials of construction will be controlled through appropriate measures to reduce the level of impact to minor significance.
- Temporary disturbance to the landscape will be limited to the microenvironment during construction at site, installation of electrical collection system, including underground and overhead lines; and construction and installation of substations.

- Electrical trenching and other site works will hardly be perceptible to the residents of villages in the neighborhood at distances of over 1 km from the site. At completion of the project, the panels, access tracks and associated equipment occupying about 1% of the site area, will meaningfully add value to the wasteland.
- Diesel and other petroleum products used for the operation of construction machinery and transportation equipment would cause air pollution besides causing soil pollution through oil spills. The impact from such activity would be of minor significance and would be controlled by good housekeeping practices.
- Water required for numerous construction activities would not be of such order as to result in any significant impact on other beneficial water uses or its reduced availability for functions of villages inside Project land. Conservation practices would nevertheless be adopted during the entire course of construction.

Table 6.1: Environmental Management Plan

Impacts	Proposed Mitigation Measures	Location	Scheduling	Institutional Responsibility	
				Implementation	Supervision
Construction Phase					
Noise: Trucks and construction machines	- Maintain construction machines in good conditions to avoid excessive noises generated. - Uses of heavy machineries are not allowed during late hours. - If necessary, instruct contractors to install temporary noise barrier at the project area that is close to the communities before starting the construction	- At Site - At Site - At Site	Construction Period	EPC Contractor	IMC
Air Quality: Particulate Matters (PM), Exhausted gases	- Remove earth from trucks, wheels before leaving the project site. - Truck hauling construction materials are required to cover its container unit to prevent spillage. - Maintain construction machines in good condition to prevent incomplete combustion.	- Site exit and public roads nearby - At Site	Construction Period	EPC Contractor	IMC
Ecological: Flora and Fauna	- The plant species removed from the project site will be replanted in the ratio 1:5 in the case of mature tree, and in the ratio 1:3 in the case of small tree after project completion	- At Site	Construction Period	EPC Contractor	IMC
Occupational Health and Safety	- Construction workers shall be trained in relevant working area prior to execute work. - Construction workers shall be provided and equipped with personal protection equipment (PPE) related to particular work. - Particular work shall be strictly followed work permit scheme, i.e. hot work, confined space, etc.	- At Site	Construction Period	EPC Contractor	IMC
Transportation	- Use of vehicles shall be strictly conformed to traffic rules (loading speed, etc.). - Designate officers to take care of safety and traffic at the entrance/exit of every project site.	- Public Roads	Construction Period	EPC Contractor	IMC
Socio-economic Conditions	- Creation of community relations to promote good relationship with the community, provide project information/status and look after and receive complaints and query during project construction and provide immediate and appropriate action. - Comply with core labor standards (CLS) and national labor laws.	- Within the project site and communities around the site	Construction Period	Community Relations Office (During Construction) Contractor	IMC

Table 6.1: Environmental Management Plan

Impacts	Proposed Mitigation Measures	Location	Scheduling	Institutional Responsibility	
				Implementation	Supervision
		- At Site			
Operation Phase					
Water quality and flood protection	- Provide a retention pond with a capacity enough to hold run-off water 3 hours within each project site. - Clear water may be discharged to natural water when necessary, but not to boost severity of flooding outside if any.	- At Site	During Operation	Proponent	Concerned Authority
Hazardous waste	- Hazardous waste such as used lube oil / transformer oil and containment rags shall be treated or discarded through approved waste contractor	- At Site	During Operation	Approved waste contractor	Concerned Authority
Socio-economic Condition	- Creation of community relations team to promote good relationship with the community and look after and receive complaints/queries and provide immediate and appropriate action. - Comply with national labor laws.	- Within the project site and communities around the site - At Site	Constriction Period Operation Period	Community Relations Office (During Construction) Proponent	
Decommissioning Phase					
Expired PV Panels	- Contact certified recycling agency to collect the expired PV panels for recycling - Follow related laws on mobilizing industrial waste	- At Site	When PV Panels get expired	Proponent	Concerned Authority

6.14 EMP during Construction and Operation

The Project activities will be executed in phased manner, Pre-construction Phase, Construction Phase and O&M Phase. The major activities to be undertaken are described below.

6.14.1 Construction Phase

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

Construction/Labor Camp Management

- The labor camp construction, upkeep and maintenance at the 50 MW Solar PV project site is under the scope of the contractor.
- Construction Camp Development Plan has to be formulated to control degradation of the surrounding landscape due to the location of the proposed construction camp. Although, it is the responsibility of EPC contractor to implement, Proponent shall ensure that it is strictly followed.
- Sufficient supply of potable water will be provided at camps and working sites. If the drinking water is obtained from the intermittent public water supply then storage tanks will be provided. All water supply storage may be at least 15 m away from the toilets or drains. It is the responsibility of EPC contractor to fulfil the water requirement during construction period. Proponent will ensure that water will be supplied through water tanker from nearby area, where sufficient water is available.
- Adequate sanitation facility, Septic tank, will be provided.
- Health check-up will be conducted. The construction contractor may provide these activities.
- At every Camp first aid facility will be provided. Suitable transport will be provided to take injured or ill person to the nearest hospital.
- Adequate supply of fuel in the form of kerosene or LPG will be provided to construction labors to avoid felling of trees for cooking and other household activities.
- All the construction workers will be provided with proper training to handle potential occupational hazards and on safety and health, which include the following:
  - Environmental Awareness program
  - Medical surveillance
  - Engineering controls, work practices and protective equipment
  - Handling of raw and processed material

- Emergency response

Table 6.2: Environmental Mitigation Measures During Construction Phase			
Mitigation Measures	**Purpose**	**Failure Consequence**	**Responsible Organization**
Water Sprinkling	Control of fugitive dust during construction and transportation activity	Increment in ambient SPM concentration	- Contractor - Proponent - Environment Consultant
Transportation of construction material in covered trucks	Control of fugitive dust	Increase in dust emission	- Proponent - Environment Consultant
Regular maintenance of transport vehicle and provision of acoustic cover on construction machinery	Control Noise	Increase the noise level of surrounding area	- Contractor - Proponent
Provision of environmentally safe camping area for laborers	To provide a clean and healthy living condition for laborers	Unhealthy living condition and spread of disease	- Contractor - Proponent

6.15 Operation Phase

During operation phase of the proposed project pollution impacts are minimum. However, in order to limit within predicted impact levels and to further mitigate the impacts wherever possible on individual environment components, the following mitigation measures shown in Table 6.3 are recommended.

Table 6.3: Environmental Mitigation Measures During Operation Phase		
Possible Impact	**Mitigation during planning and design**	**Mitigation during operation**
Air Impact	Incorporate consultant and engineers advice	No Air Pollution
Soil Quality Degradation	Consider strategies to avoid soil quality degradation	Periodic Monitoring of soil quality at project site
Occupational Health Hazard	Occupational Health and Safety Plan should be compiled	Periodic health check-up
Safety workers	Necessary safety equipment for workers (e.g. PPE) should be arranged prior to start of project	Workers would be provided with hand gloves, earmuffs, safety boots, safety goggles, helmets etc. Workers should be trained to follow safety working practices

6.16 Waste Management Plan

This Waste Management Plan identifies the wastes that are likely to be generated during the construction and operation of the proposed Plant and documents cradle to grave waste management practices to be employed for their collection, storage, treatment and/or disposal. Specifically, the waste covered by this WMP includes the following sources:

- Construction and commissioning of plant and the associated facilities

- Operation of plant and the associated facilities throughout the project life cycle.
- Temporary accommodation during construction phase for the workers.
- Other operations like equipment maintenance, site preparation etc.
- Operation and maintenance of infrastructures during both construction and operation phase.

WMP is intended to serve as a guideline for the project proponent & the contractor(s) to manage wastes effectively during construction and operation phase. The contractor(s) should prepare their own WMP in compliance with this WMP and implement the same during the construction phase.

The WMP describes how wastes will be managed during the construction and operation phase of the project and how the project will:

- Minimize the potential to cause harm to human health and the environment.
- Comply with KPK Environmental Protection Act.
- Reduce operational costs and any potential liabilities which may arise from waste handling operations

This plan also ensures that every waste stream and solid waste materials from the main plant site and the associated facilities will be managed effectively.

Solid and Hazardous Waste Management

The mitigation measures with respect to waste treatment, storage, handling and disposal during both phases of the project have been discussed below:

Construction Phase

- A waste inventory of various waste generated will be prepared and periodically updated.
- The excavated material generated will be reused for site filling and levelling operation to the maximum extent possible.
- The 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.
- Food waste and recyclables viz. paper, plastic, glass etc. will be properly segregated and stored in designated waste bins/containers. The recyclables will be periodically sold to local recyclers while food waste will be disposed through waste handling agency.
- Hazardous waste viz. waste oil etc. will be collected and stored in paved and bunded area and subsequently disposed/incinerated via waste contractor. Necessary manifest for the same will be maintained.

Operational Phase

- Hazardous waste viz. transformer oil and wires and cables generated during maintenance activity will be collected and stored in paved and bundled area and subsequently disposed/incinerated via waste contractor. Necessary manifest for the same will be maintained.

6.17 Road Safety and Traffic Management Plan

The plan encompasses the addresses of community safety related impacts that may arise from the increased vehicular traffic due to movement of equipment/machineries and vehicles along the site access and approach roads particularly during construction phase. The plan will be regularly reviewed and as vehicle movement requirements are identified in detail

During Construction Phase

The following mitigation measures will be implemented during this phase:

- Project vehicular movement will be restricted to defined access routes.
- Proper signage will be displayed at important traffic junctions along the vehicular access routes to be used by construction phase traffic. The signage will serve to prevent any diversion from designated routes and ensure proper speed limits are maintained near residential areas.
- Any road diversions and closures will be informed in advance to the project vehicles accessing the above route. Usage of horns by project vehicles will be restricted near sensitive receptors viz. schools, settlements etc.
- Traffic flows will be timed wherever practicable during period of increased commuter movement in the day.
- Temporary parking facilities should be provided within the work areas and the construction sites to avoid road congestion.
- Vehicular movement to be controlled near sensitive locations viz. schools, colleges, hospitals identified along designated vehicular transportation routes
- Routine maintenance of project vehicles will be ensured to prevent any abnormal emissions and high noise generation
- Adequate training on traffic and road safety operations will be imparted to the drivers of project vehicles. Road safety awareness programs will be organized in coordination with local authorities to sensitize target groups viz. schoolchildren, commuters on traffic safety rules and signage.

During Operational Phase

Since limited vehicular movement is anticipated during operational phase considering only the daily movement of project personnel, any impacts arising from the same can be effectively addressed through implementation of mitigation measures as discussed during the construction phase.

6.18 Electrocution

The areas prone to electrocution are transformer area, switchyard area and high-tension transmission lines and towers. There should be no green belt in switchyard side. The growth of grasses and bushes should be controlled in switchyard and transformer area. Sagging in high-tension wires may also take place due to high ambient temperature, dust storm or poor coupling at HT tower. This should be regularly checked to prevent any possibility of electrocution to vehicles passing on road. Person attending for faults any of the above areas should be trained and should wear electrical resistant shoes, gloves and helmet with cotton clothes.

6.19 House Keeping

Better housekeeping can improve the working conditions. The following measures are recommended:

- Regular cleaning
- Avoiding accumulation and dumping of wastes and damaged equipment and items anywhere inside the plant affecting aesthetics and increasing risk of fire and other hazards.
- Keeping ventilation systems of premises in good working condition to avoid ingress of dust inside the pressurized room.
- Keeping air conditioning plants in good running conditions for control/instrumentation rooms.
- Regular watering of kaccha roads by spraying water during construction as well as operation and maintenance to avoid dust generation from vehicle movement.
- Maintaining hygienic conditions in areas like canteens, near drinking water sources and toilets.
- Developing a positive outlook in the employees for improving the working place, both in plant and office or laboratory clean and well maintained.

6.20 Safety and Emergency Plan

Safety of both men and material during construction and operation stages are of concern to industries. Keeping in view the safety requirements during construction and operation and maintenance phases, a safety policy will be formulated for the present Solar PV project. Separate safety rules should be prepared for each type of occupation / processes involved in the project in consultation with manufacturer / supplier of equipment and materials and regular safety inspection should be ensured of all buildings, equipment, work places and operations by a competent person.

6.20.1 Safety Organization

Organization already has a Safety Department headed by Senior Manager and having qualified and experienced supporting staff. The responsibilities of Safety Department include identification of the hazardous conditions and unsafe acts of workers and advise on corrective action, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of Safety Rules/Statutory provisions Safety Department has prepared.

6.20.2 Safety Awareness among Workers/Employees

Training programs in safety and accident prevention should be organized at all levels of employees with a view to familiarize them with the general safety rules, safety procedures in various operational activities and to update their knowledge in safety and accident prevention, industrial hygiene and emergency equipment. These training programs should be conducted periodically in a planned manner to refresh their knowledge.

6.20.3 First Aid Training

First aid training programs should also be conducted for all employees with the help of qualified medical and para-medical staff. This program may be conducted in batches. The program should include basic first-aid techniques and should be repeated periodically to refresh knowledge.

6.21 Environmental Monitoring Program

Regular monitoring of critical environmental parameters is of immense importance to assess the status of environment during plant operation. The monitored data can serve as an indicator for any change in environmental quality due to operation of the plant with respect to baseline environmental conditions, so that suitable mitigation steps could be taken in time to safeguard the environment. Monitoring indicators have been developed for each of the activity considering the mitigation measures proposed. Indicators have been developed for ascertaining the environmental quality and the performance of the EMP implementation through Environmental Quality Indicators (EQI's) and Environmental Performance Indicators (EPI's) respectively which focus not only on quantifying or indexing activity-environment interactions that may potentially impact the environment but at the same time also help in comparing different components of environmental quality against previously established baseline values.

Project EMS will establish its own unit to:

- Coordinate with other units
- Follow the monitoring frequency of selected parameters as per the monitoring plan given in the following table.
- Record all non-conformities observed and report them along with actions to Project Manager for further action.
- Report any impact anticipated along with recommendations for further action.

Monitoring results would be documented, analyzed and reported internally to Head - HSE. Monitoring requirements (including monitoring frequency) have been presented in the following table;

A. Environmental Performance Monitoring

Table 6.5: Proposed Monitoring Requirements for the Proposed Project

Environmental Performance Indicator (EPI)	Monitoring Parameter	Location	Period and Frequency
Construction Phase			
Air emissions from vehicle and machineries	- CO_2, HC based on emission factors - % of vehicles possessing valid certification	- Exhaust	Quarterly during construction phase

Table 6.5: Proposed Monitoring Requirements for the Proposed Project			
Environmental Performance Indicator (EPI)	**Monitoring Parameter**	**Location**	**Period and Frequency**
Dust generated from site clearance/leveling	- Visual observation of dust generation	- Site and approach road	Daily during site preparation
Noise emissions from vehicles and machineries	- Noise pressure level in dB(A) - Compliance with NEQS noise limits. - Check for valid certificates of type approval and also valid certificates for conformity of production for equipment particularly digging sets	- Near noise sources (5m)	Quarterly during site preparation
Sourcing of water	- Volume of water sourced and consumed	- Sourcing and usage areas	Daily during construction phase
Ecology	- Cutting of trees	- At Site	Monthly during construction phase
Fugitive emissions from handling and storage of raw materials	- Visual observation	- Material stockpile	Daily during construction phase
Community health and safety	- Complaints registered by the local communities - No. of accidents	- Grievance records - Safety records	Monthly during construction phase
Occupational health and safety	- Health surveillance of workers - Sanitation status of labor camps and canteen - Potable nature of drinking water viz. coliform, pH, TSS, Residual chlorine - Usage of proper PPEs - Safety performance indicators viz. LTIs. Near misses fatalities etc.	- Medical records - Labor camp maintenance records - Drinking water storage tanks - Construction site	Monthly during construction phase
Disposal of sewage	- Visual observation of leaks, overflows etc. - Odor	- Septic tank and soak pits	Daily during construction phase
Domestic waste generation, storage,	- Quantity of water generated and recycled	- Waste generation areas viz.	Weekly during construction phase

Table 6.5: Proposed Monitoring Requirements for the Proposed Project			
Environmental Performance Indicator (EPI)	**Monitoring Parameter**	**Location**	**Period and Frequency**
handling and disposal	- Visual observation of waste segregation and storage conditions viz. usage of labeled and covered bins, insect repellents etc. - Awareness level of onsite workers	canteen, labor camps etc. - Workers involved in waste handling and storage	
Hazardous chemicals and waste storage, handling and disposal	- Visual observation of chemical storage conditions viz. presence of spill kits, drip trays, fire extinguisher, display of MSDS etc. - Quantity of waste oil and other hazardous waste generated and recycled to registered recyclers - Awareness level of onsite workers	- Hazardous waste storage areas - Workers involved in waste handling and storage	Weekly during construction phase
Operational Phase			
Fugitive emissions	- Visual observation of dust generated - Water sprinkling details viz. frequency and quantity.	- Maintenance records	Weekly during operational phase
Noise generated from operation	- Noise pressure level in dB(A) - Maintenance parameter check with respect to equipment noise attenuation and control	- Near noise sources (5m) - Noise generating equipment	Weekly during operational phase
Water sourcing and consumption	- Volume of water sources and consumed	- Water usage areas	Daily during operational phase
Community health and safety	- Complaints registered by the local community - No. of accidents	- Grievance records - Safety records	Monthly during operational phase
Occupational health and safety	- Health surveillance of workers - Sanitation status of onsite office building and canteen - Potable nature of drinking water - Usage of proper PPEs - Safety performance indicators	- Medical records - Office building maintenance records - Drinking water storage tank - Operational sites	Monthly during operational phase

B. Environmental Quality Monitoring

Environmental Quality Indicator (EQI)	Monitoring Parameter	Location	Period and Frequency
Construction Phase			
Ambient Noise quality	Measurement of Noise pressure level in dB(A)	Nearest receptor, villages, schools, ecological habitat	Monthly during construction phase
Ground water quality	Depth of ground water table	Drainage channel	Quarterly during construction phase
Operational Phase			
Ambient Noise quality	Measurement of Noise pressure level in dB(A)	Nearest receptor	Monthly during operational phase

Chapter 7. Conclusion

This Initial Environmental Examination (IEE) study was carried out to assess the environmental and socioeconomic impact during the design, installation and operational phase of 50 MW_p PV Solar Power Plant in Lachi Tehsil, District Kohat, KPK. The assessment was carried out according to the requirements of KPK Environmental Protection Act and all applicable national and international standards.

The baseline environmental and socioeconomic information was collected from a variety of sources, including reports of previous studies, published literature, and field survey (primary information). The information collected was used to develop baseline conditions of project area with respect to the natural, socioeconomic, and cultural environments likely to be affected by the project.

The proposed project activities were reviewed, and an assessment made of the potential impact of these activities on the area's natural, socioeconomic, and cultural environments is also described in this report. Where appropriate, mitigation measures were recommended to keep the adverse environmental impact within acceptable limits.

It is therefore concluded that if the field activities, including the implementation of all mitigation measures, are carried out in line with recommendations suggested in the report, the impacts from project's construction and operations will not be adverse so as to deteriorate the environmental quality of the project area and a more detailed report will not be required in the form of an EIA. Additionally careful implementation of the EMP will ensure that environmental impacts are managed and minimized and the project proponent meets all statutory requirements.

There are two essential recommendations that need to be followed to ensure that the environmental impacts of the project are successfully mitigated. The Proponent Siddiqsons Kohat Solar Limited shall ensure that:

- All mitigation, compensation and enhancement measures proposed in this IEE report are implemented in full, as described in the document;
- The Environmental Management and Monitoring Plan is implemented in letter and spirit.

Screening of potential impact suggests that the Construction & O&M of 50 MW Solar PV Power Plant will, on adoption of the suggested mitigation measures, be an environmentally acceptable proposition and will provide clean and renewable energy.

It is recommended that the IEE be approved with the condition that recommendations given in the IEE and NOC will be duly followed by the proponent.