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

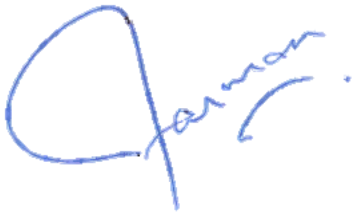
Subject: <u>Application for Generation License upto 6.5 MW</u>

I, Farman Ahmed Khan Lodhi, Chief Executive Officer, being the duly authorized representative of **SOLIS DELTA ENERGY (PRIVATE) LIMITED** by virtue of BOARD RESOLUTION dated 8th July, 2019, hereby apply to National Electric Power Regulatory Authority for the grant of a Generation License to SOLIS DELTA ENERGY (PRIVATE) LIMITED pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

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

A PAY ORDER in the sum of Rupees 177,688 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.

Date: 13th -September-2019



Farman Ahmed Khan Lodhi
Chief Executive Officer

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

SOLIS
DELTA ENERGY

EXTRACT OF THE BOARD OF DIRECTORS RESOLUTION OF SOLIS DELTA ENERGY (PVT.) LTD HELD ON JULY 08, 2019

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

"RESOLVED THAT filing of an application with National Electric Power Regulatory Authority for obtaining generation license for setting up 6.5 MW Solar power generation projects by Solis Delta Energy (Private) Limited (a company incorporated under the laws of Pakistan with its registered office located at 3rd Floor, Horizon Vista, Block-4, Scheme 5, Clifton, Karachi, Pakistan (the **Company**) be and is hereby approved along with all submission of required documents, filings, applicable fees and completion of all necessary formalities".

"**FURTHER RESOLVED THAT** in respect of submitting an application for the generation license (including any modifications thereto) to National Electric Power Regulatory Authority, **MR. FARMAN AHMED KHAN LODHI, CEO** be and is hereby singly 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 along with all 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

(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. Farman Ahmed Khan Lodhi, the Chief Executive Officer of the Company, 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 by him."

Certified True Copy

Abdullah Khawar
Director

Dated: July 08, 2019

A058059

SECP

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

[Under section 16 of the Companies Act, 2017 (XIX of 2017)]

Corporate Universal Identification No. **0135091**

I hereby certify that **SOLIS DELTA ENERGY (PRIVATE) LIMITED** is this day incorporated under the Companies Act, 2017 (XIX of 2017) and that the company is **limited by shares.**

Given under my hand at **Karachi** this **Eleventh** day of **June, Two Thousand** and **Nineteen**

Incorporation fee Rs. **1,000/=**

(Muhammad Naeem Khan)
Additional Registrar/Incharge CRO

Asst 11/6/19

FREE OF COST COPY

THE COMPANIES ACT, 2017

(Company Limited by Shares)

MEMORANDUM OF ASSOCIATION

OF

SOLIS DELTA ENERGY (PRIVATE) LIMITED

1) The name of the Company is "**SOLIS DELTA ENERGY (PRIVATE) LIMITED**".

2) The Registered Office of the company shall be situated in the province of Sindh.

3) (i) The principal line of business of the company shall be to carry on all or any of the businesses of generating, supplying, converting, transforming, distributing, purchasing, dealing in, importing and exporting all forms of electricity and energy (solar, wind, thermal, hydel and/or biomass) and products or services associated therewith including provision of energy related equipment as vendor/supplier for use of electricity or right to use such equipment and to perform all other acts which are necessary or incidental to the business of electricity generation and supply and to locate, setup, develop, design, own, establish, construct, equip, operate, use, manage, and maintain power plants anywhere in Pakistan or elsewhere, subject to approval of NEPRA wherever, required.

(ii) Except for the businesses mentioned in sub-clause (iii) hereunder, the company may engage in all the lawful businesses and shall be authorized to take all necessary steps and actions in connection therewith and ancillary thereto.

(iii) Notwithstanding anything contained in the foregoing sub-clauses of this clause nothing contained herein shall be construed as empowering the Company to undertake or indulge, directly or indirectly in the business of a Banking Company, Non-banking Finance Company (Mutual Fund, Leasing, Investment Company, Investment Advisor, Real Estate Investment Trust management company, Housing Finance Company, Venture Capital Company, Discounting Services, Microfinance or Microcredit business), Insurance Business, *Modaraba* management company, Stock Brokerage business, forex, real estate business, managing agency, business of providing the services of security guards or any other business restricted under any law for the time being in force or as may be specified by the Commission.

(iv) It is hereby undertaken that the company shall not:

(a) engage in any of the business mentioned in sub-clause (iii) above or any unlawful operation;

(b) launch multi-level marketing (MLM), Pyramid and Ponzi Schemes, or other related activities/businesses or any lottery business;

(c) engage in any of the permissible business unless the requisite approval, permission, consent or license is obtained from competent authority as may be required under any law for the time being in force.

4) The liability of the members is limited.

5) The Authorized Capital of the Company is Rs. 100,000 (Rupees One Hundred Thousand only) divided into 10,000 (Ten Thousand) ordinary shares of Rs. 10 (Rupees Ten only) each.

We, the several persons whose names and addresses are subscribed, 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 set opposite our respective names:-

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	National ity (ies) with any former National ity	Occupation	Usual residential address in full or the registered/principal office address for a subscriber other than natural person	Number of shares taken by each subscriber (in figures and words)	Signatures
MR. ABDUL BASIT TOLA	42301-1106437-9	Mr. Abdul Razzak Tola	Pakistan	Business Executive	Plot # 508, Flat # G-1, Muhammad Residency, Shikarpur Colony, Jamshed Quarters, Karachi	10 (Ten Shares only)	
MR. MUHAMMAD ABDULLAH KHAWAR	42201-4937427-1	Mr. Khawar	Pakistan	Business Executive	House No. C-11, Block H, North Nazimabad Karachi	10 (Ten Shares only)	
MR. FARMAN AHMED KHAN LODHI	42101-7436364-3	Mr. Munib Ahmed Khan Lodhi	Pakistan	Business Executive	House No. 164/II, Street No. 18, Khayaban-e-Qasim, Phase VIII, DHA, Karachi	10 (Ten Shares only)	
SOLIS ENERGY SOLUTIONS (PRIVATE) LIMITED **REPRESENTED BY:** MR. FARMAN AHMED KHAN LODHI	0114993 42101-7436364-3	Mr. Munib Ahmed Khan Lodhi	Pakistan Pakistan	Business Executive	3rd Floor, Horizon Vista, Block 045, Clifton, Karachi House No. 164/II, Street No. 18, Khayaban-e-Qasim, Phase VIII, DHA, Karachi	3000 (Three Thousand Shares Only)	
			Total number of shares taken (in figures and words)			3030 (Three Thousand Thirty Shares only)	

Dated: June 03, 2019

Witness to above signatures:

Signature	
Full Name (in Block Letters)	
Father's/ Husband's name	
Nationality	
Occupation	
NIC No.	
Usual residential address	

THE COMPANIES ACT, 2017

(Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF

SOLIS DELTA ENERGY (PRIVATE) LIMITED

PRELIMINARY

1. (1) In these regulations-
   a. "section" means section of the Act;
   b. "the Act" means the Companies Act, 2017; and
   c. "the seal" means the common seal or official seal of the company as the case may be.

   (2) Unless the context otherwise requires, words or expressions contained in these regulations shall have the same meaning as in this Act; and words importing the singular shall include the plural, and *vice versa*, and words importing the masculine gender shall include feminine, and words importing persons shall include bodies corporate.

BUSINESS

2. The directors shall have regard to the restrictions on the commencement of business imposed by section 19 if, and so far as, those restrictions are binding upon the company.

SHARES

3. In case of shares in the physical form, every person whose name is entered as a member in the register of members shall, without payment, be entitled to receive, within thirty days after allotment or within fifteen days of the application for registration of transfer, a certificate under the seal specifying the share or shares held by him and the amount paid up thereon:

   Provided that if the shares are in book entry form or in case of conversion of physical shares and other transferable securities into book-entry form, the company shall, within ten days after an application is made for the registration of the transfer of any shares or other securities to a central depository, register such transfer in the name of the central depository.

4. The company shall not be bound to issue more than one certificate in respect of a share or shares in the physical form, held jointly by several persons and delivery of a certificate for a share to one of several joint holders shall be sufficient delivery to all.

5. If a share certificate in physical form is defaced, lost or destroyed, it may be renewed on payment of such fee, if any, not exceeding one hundred rupees, and on such terms, if any, as to evidence and indemnity and payment of expenses incurred by the company in investigating title as the directors think fit.

6. Except to the extent and in the manner allowed by section 86, no part of the funds of the company shall be employed in the purchase of, or in loans upon the security of, the company's shares.

TRANSFER AND TRANSMISSION OF SHARES

7. The instrument of transfer of any share in physical form in the company shall be executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the register of members in respect thereof.

8. Shares in physical form in the company shall be transferred in the following form, or in any usual or common form which the directors shall approve: -

Form for Transfer of Shares
(First Schedule to the Companies Act, 2017)

I..... s/o .....r/o..... (Hereinafter called "the transferor") in consideration of the sum of rupees ..... paid to me by..... S/o .....r/o..... (hereinafter called "the transferee"), do hereby transfer to the said transferee.....the share (or shares) with distinctive numbers from .....to.....inclusive, in the SOLIS DELTA ENERGY (PRIVATE) LIMITED, to hold unto the said transferee, his executors, administrators and assigns, subject to the several conditions on which I held the same at the time of the execution hereof, and I, the said transferee, do hereby agree to take the said share (or shares) subject to the conditions aforesaid. As witness our hands this.....day of....., 20.....

Signature.....
Transferor
Full Name, Father's / Husband's Name
CNIC Number (in case of foreigner, Passport Number)
Nationality
Occupation and usual Residential Address

Signature.....
Transferee
Full Name, Father's / Husband's Name
CNIC Number (in case of foreigner, Passport Number)
Nationality
Occupation and usual Residential Address
Cell number
Landline number, if any
Email address

Witness 1:
Signature.....date.....
Name, CNIC Number and Full Address

Witness 2:
Signature.....date.....
Name, CNIC Number and Full Address

Bank Account Details of Transferee for Payment of Cash Dividend
(Mandatory in case of a listed company or optional for any other company)

It is requested that all my cash dividend amounts declared by the company, may be credited into the following bank account:

Tile of Bank Account	
Bank Account Number	
Bank's Name	
Branch Name and Address	

It is stated that the above mentioned information is correct and that I will intimate the changes in the above-mentioned information to the company and the concerned Share Registrar as soon as these occur.

.....
Signature of the Transferee(s)

9. (1) Subject to the restrictions contained in regulation 11 and 12, the directors shall not refuse to transfer any share unless the transfer deed is defective or invalid. The directors may also suspend the registration of transfers during the ten days immediately preceding a general meeting or prior to the determination of entitlement or rights of the shareholders by giving seven days' previous notice in the manner provided in the Act. The directors may, in case of shares in physical form, decline to recognise any instrument of transfer unless—

   a) A fee not exceeding fifty rupees as may be determined by the directors is paid to the company in respect thereof; and

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

   (2) If the directors refuse to register a transfer of shares, they shall within fifteen days after the date on which the transfer deed was lodged with the company send to the transferee and the transferor notice of the refusal indicating the defect or invalidity to the transferee, who shall, after removal of such defect or invalidity be entitled to re-lodge the transfer deed with the company.

   Provided that, where the transferee is a central depository, the refusal shall be conveyed within five days from the date on which the instrument of transfer was lodged and the company shall notify the defect or invalidity to the transferee who shall, after the removal of such defect or invalidity, be entitled to re-lodge the transfer deed with the company.

TRANSMISSION OF SHARES

10. The executors, administrators, heirs, or nominees, as the case may be, of a deceased sole holder of a share shall be the only persons recognised by the company to deal with the share in accordance with the law. In the case of a share registered in the names of two or more holders, the survivors or survivor, or the executors or administrators of the deceased survivor, shall be the only persons recognised by the company to deal with the share in accordance with the law.

11. The shares or other securities of a deceased member shall be transferred on application duly supported by succession certificate or by lawful award, as the case may be, in favour of the successors to the extent of their interests and their names shall be entered to the register of members.

12. A person may on acquiring interest in a company as member, represented by shares, at any time after acquisition of such interest deposit with the company a nomination conferring on a person, being the relatives of the member, namely, a spouse, father, mother, brother, sister and son or daughter, the right to protect the interest of the legal heirs in the shares of the deceased in the event of his death, as a trustee and to facilitate the transfer of shares to the legal heirs of the deceased subject to succession to be determined under the Islamic law of inheritance and in case of non-Muslim members, as per their respective law.

13. The person nominated under regulation 13 shall, after the death of the member, be deemed as a member of the company till the shares are transferred to the legal heirs and if the deceased was a director of the company, not being a listed company, the nominee shall also act as director of the company to protect the interest of the legal heirs.

14. A person to be deemed as a member under regulation 12, 13 and 14 to a share by reason of the death or insolvency of the holder shall be entitled to the same dividends and other advantages to which he would be entitled if he were the registered holder of the share and exercise any right conferred by membership in relation to meetings of the company.

ALTERATION OF CAPITAL

15. The company may, by special resolution-
    (a) increase its authorized capital by such amount as it thinks expedient;
    (b) consolidate and divide the whole or any part of its share capital into shares of larger amount than its existing shares;
    (c) sub-divide its shares, or any of them, into shares of smaller amount than is fixed by the memorandum;
    (d) Cancel shares which, at the date of the passing of the resolution in that behalf, have not been taken or agreed to be taken by any person, and diminish the amount of its share capital by the amount of the share so cancelled.

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

17. The new shares shall be subject to the same provisions with reference to transfer, transmission and otherwise as the shares in the original share capital.

18. The company may, by special resolution-

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

    b. sub-divide its existing shares or any of them into shares of smaller amount than is fixed by the memorandum of association, subject, nevertheless, to the provisions of section 85;

    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.

19. The company may, by special resolution, reduce its share capital in any manner and with, and subject to confirmation by the Court and any incident authorised and consent required, by law.

GENERAL MEETINGS

20. The statutory general meeting of the company shall be held within the period required by section 131.

21. A general meeting, to be called annual general meeting, shall be held, in accordance with the provisions of section 132, within sixteen months from the date of incorporation of the company and thereafter once at least in every year within a period of **one hundred and twenty days** following the close of its financial year.

22. All general meetings of a company other than the statutory meeting or an annual general meeting mentioned in sections 131 and 132 respectively shall be called extraordinary general meetings.

23. The directors may, whenever they think fit, call an extraordinary general meeting, and extraordinary general meetings shall also be called on such requisition, or in default, may be called by such requisitionists, as provided by section 133. 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.

24. The company may provide video-link facility to its members for attending general meeting at places other than the town in which general meeting is taking place after considering the geographical dispersal of its members.

NOTICE AND PROCEEDINGS OF GENERAL MEETINGS

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

26. All the business transacted at a general meeting shall be deemed special other than the business stated in sub-section (2) of section 134 namely; the consideration of financial statements and the reports of the board and auditors, the declaration of any dividend, the election and appointment of directors in place of those retiring and the appointment of the auditors and fixing of their remuneration.

27. No business shall be transacted at any general meeting unless a quorum of members is present at that time when the meeting proceeds to business. The quorum of the general meeting shall be two members present personally, or through video-link who represent not less than twenty-five percent of the total voting power, either of their own account or as proxies.

28. If within half an hour from the time appointed for the meeting a quorum is not present, the meeting, if called upon the requisition of members, shall be dissolved; in any other case, it shall stand adjourned to the same day in the next week at the same time and place, and, if at the adjourned meeting a quorum is not present within half an hour from the time appointed for the meeting, the members present, being not less than two, shall be a quorum.

29. The chairman of the board of directors, if any, shall preside as chairman at every general meeting of the company, but if there is no such chairman, or if at any meeting he is not present within fifteen minutes after the time appointed for the meeting, or is unwilling to act as chairman, any one of the directors present may be elected to be chairman, and if none of the directors is present, or willing to act as chairman, the members present shall choose one of their number to be chairman.

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

31. (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. Unless a poll is so demanded, a declaration by the chairman 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 of the proceedings of the company shall be conclusive evidence of the fact, without proof of the number or proportion of the votes recorded in favour of, or against, that resolution.

    (2) At any general meeting, the company shall transact such businesses as may be notified by the Commission, only through postal ballot.

32. A poll may be demanded only in accordance with the provisions of section 143.

33. If a poll is duly demanded, it shall be taken in accordance with the manner laid down in sections 144 and 145 and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded.

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

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

36. Except for the businesses specified under sub-section (2) of section 134 to be conducted in the annual general meeting, the members may pass a resolution (ordinary or special) by circulation signed by all the members for the time being entitled to receive notice of a meeting. The resolution by circulation shall be deemed to be passed on the date of signing by the last of the signatory member to such resolution.

VOTES OF MEMBERS

37. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands every member present in person shall have one vote except for election of directors in which case the provisions of section 159 shall apply. On a poll every member shall have voting rights as laid down in section 134.

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

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

40. On a poll votes may be given either personally or through video-link, by proxy or through postal ballot:

    Provided that nobody corporate shall vote by proxy as long as a resolution of its directors in accordance with the provisions of section 138 is in force.

41. (1) The instrument appointing a proxy shall be in writing under the hand of the appointer or of his attorney duly authorised in writing.

    (2) The instrument appointing a proxy and the power-of-attorney or other authority (if any) under which it is signed, or a notarially certified copy of that power or authority, shall be deposited at the registered office of the company 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.

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

INSTRUMENT OF PROXY

SOLIS DELTA ENERGY (PRIVATE) LIMITED

"I ..... s/o ..... r/o .....being a member of the SOLIS DELTA ENERGY (PRIVATE) LIMITED, hereby appoint ..... r/o .....as my proxy to attend and vote on my behalf at the (statutory, annual, extraordinary, as the case may be) general meeting of the company to be held on the.....day of....., 20..... and at any adjournment thereof."

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

DIRECTORS

44. The following subscribers of the memorandum of association shall be the first directors of the company, so, however, that the number of directors shall not in any case be less than that specified in section 154 and they shall hold office until the election of directors in the first annual general meeting:

i.	MR. ABDUL BASIT TOLA
ii.	MR. MUHAMMAD ABDULLAH KHAWAR
iii.	MR. FARMAN AHMED KHAN LODHI

45. The remuneration of the directors shall from time to time be determined by the company in general meeting subject to the provisions of the Act.

46. Save as provided in section 153, no person shall be appointed as a director unless he is a member of the company.

POWERS AND DUTIES OF DIRECTORS

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

48. The directors shall appoint a chief executive in accordance with the provisions of sections 186 and 187.

49. The amount for the time being remaining undischarged of moneys borrowed or raised by the directors for the purposes of the company (otherwise than by the issue of share capital) shall not at any time,

without the sanction of the company in general meeting, exceed the issued share capital of the company.

50. The directors shall duly comply with the provisions of the Act, or any statutory modification thereof for the time being in force, and in particular with the provisions in regard to the registration of the particulars of mortgages, charges and pledge affecting the property of the company or created by it, to the keeping of a register of the directors, and to the sending to the registrar of an annual list of members, and a summary of particulars relating thereto and notice of any consolidation or increase of share capital, or sub-division of shares, and copies of special resolutions and a copy of the register of directors and notifications of any changes therein.

MINUTE BOOKS

51. The directors shall cause records to be kept and minutes to be made in book or books with regard to-
    (a) all resolutions and proceedings of general meeting(s) and the meeting(s) of directors and Committee(s) of directors, and every member present at any general meeting and every director present at any meeting of directors or Committee of directors shall put his signature in a book to be kept for that purpose;
    (b) recording the names of the persons present at each meeting of the directors and of any committee of the directors, and the general meeting; and
    (c) all orders made by the directors and Committee(s) of directors:

    Provided that all records related to proceedings through video-link shall be maintained in accordance with the relevant regulations specified by the Commission which shall be appropriately rendered into writing as part of the minute books according to the said regulations.

THE SEAL

52. The directors shall provide for the safe custody of the seal and the seal shall not be affixed to any instrument except by the authority of a resolution of the board of directors or by a committee of directors authorized in that behalf by the directors and in the presence of at least two directors and of the secretary or such other person as the directors may appoint for the purpose; and those two directors and secretary or other person as aforesaid shall sign every instrument to which the seal of the company is so affixed in their presence.

DISQUALIFICATION OF DIRECTORS

53. No person shall become the director of a company if he suffers from any of the disabilities or disqualifications mentioned in section 153 or disqualified or debarred from holding such office under any of the provisions of the Act as the case may be and, if already a director, shall cease to hold such office from the date he so becomes disqualified or disabled:

    Provided, however, that no director shall vacate his office by reason only of his being a member of any company which has entered into contracts with, or done any work for, the company of which he is director, but such director shall not vote in respect of any such contract or work, and if he does so vote, his vote shall not be counted.

PROCEEDINGS OF DIRECTORS

54. The directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings, as they think fit. A director may, and the secretary on the requisition of a director shall, at any time, summon a meeting of directors. Notice sent to a director through email whether such director is in Pakistan or outside Pakistan shall be a valid notice.

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

56. At least one-third (1/3rd) of the total number of directors or two (2) directors whichever is higher, for the time being of the company, present personally or through video-link, shall constitute a quorum.

57. Save as otherwise expressly provided in the Act, every question at meetings of the board shall be determined by a majority of votes of the directors present in person or through video-link, each director having one vote. In case of an equality of votes or tie, the chairman shall have a casting vote in addition to his original vote as a director.

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

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

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

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

61. A copy of the draft minutes of meeting of the board of directors shall be furnished to every director within seven working days of the date of meeting.

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

FILLING OF VACANCIES

63. At the first annual general meeting of the company, all the directors shall stand retired from office, and directors shall be elected in their place in accordance with section 159 for a term of three years.

64. A retiring director shall be eligible for re-election.

65. The directors shall comply with the provisions of sections 154 to 159 and sections 161, 162 and 167 relating to the election of directors and matters ancillary thereto.

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

67. The company may remove a director but only in accordance with the provisions of the Act.

DIVIDENDS AND RESERVE

68. The company in general meeting may declare dividends but no dividend shall exceed the amount recommended by the directors.

69. The directors may from time to time pay to the members such interim dividends as appear to the directors to be justified by the profits of the company.

70. Any dividend may be paid by a company either in cash or in kind only out of its profits.

71. Dividend shall not be paid out of unrealized gain on investment property credited to profit and loss account.

72. Subject to the rights of persons (if any) entitled to shares with special rights as to dividends, all dividends shall be declared and paid according to the amounts paid on the shares.

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

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

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

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

(2) Any dividend declared by the company shall be paid to its registered shareholders or to their order. The dividend payable in cash may be paid by cheque or warrant or in any electronic mode to the shareholders entitled to the payment of the dividend, as per their direction.

76. The dividend shall be paid within the period laid down under the Act.

ACCOUNTS

77. The directors shall cause to be kept proper books of account as required under section 220.

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

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

80. The directors shall as required by sections 223 and 226 cause to be prepared and to be laid before the company in general meeting the financial statements duly audited and reports as are referred to in those sections.

81. The financial statements and other reports referred to in regulation 81 shall be made out in every year and laid before the company in the annual general meeting in accordance with sections 132 and 223.

82. A copy of the financial statements and reports of directors and auditors shall, at least twenty-one days preceding the meeting, be sent to the persons entitled to receive notices of general meetings in the manner in which notices are to be given hereunder.

83. The directors shall in all respect comply with the provisions of sections 220 to 227.

84. Auditors shall be appointed and their duties regulated in accordance with sections 246 to 249.

NOTICES

85. (1) A notice may be given by the company to any member to his registered address or if he has no registered address in Pakistan to the address, if any, supplied by him to the company for the giving of notices to him against an acknowledgement or by post or courier service or through electronic means or in any other manner as may be specified by the Commission.

(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 will be delivered in the ordinary course of post.

86. 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.

87. A notice may be given by the company to the person entitled to a share in consequence of the death or insolvency of a member in the manner provided under regulation 86 addressed to them by name, or by the title or representatives of the deceased, or assignees of the insolvent, or by any like description, at the address, supplied for the purpose by the person claiming to be so entitled.

88. Notice of every general meeting shall be given in the manner hereinbefore authorised to (a) every member of the company and also to (b) every person entitled to a share in consequence of the death or insolvency of a member, who but for his death or insolvency would be entitled to receive notice of the meeting, and (c) to the auditors of the company for the time being and every person who is entitled to receive notice of general meetings.

WINDING UP

89. (1) In the case of members' voluntary winding up, with the sanction of a special resolution of the company, and, in the case of creditors' voluntary winding up, of a meeting of the creditors, the liquidator shall exercise any of the powers given by sub-section (1) of section 337 of the Act to a liquidator in a winding up by the Court including *inter-alia* divide amongst the members, in specie or kind, the whole or any part of the assets of the company, whether they consist of property of the same kind or not.

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

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

DISPUTE RESOLUTION

90. 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.

INDEMNITY

91. Every officer or agent for the time being of the company may be indemnified out of the assets of the company against any liability incurred by him in defending any proceedings, whether civil or criminal, arising out of his dealings in relation to the affairs of the company, except those brought by the company against him, in which judgment is given in his favour or in which he is acquitted, or in connection with any application under section 492 in which relief is granted to him by the Court.

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

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	National ity (ies) with any former National ity	Occupation	Usual residential address in full or the registered/principal office address for a subscriber other than natural person	Number of shares taken by each subscriber (in figures and words)	Signatures
MR. ABDUL BASIT TOLA	42301-1106437-9	Mr. Abdul Razzak Tola	Pakistan	Business Executive	Plot # 508, Flat # G-1, Muhammad Residency, Shikarpur Colony, Jamshed Quarters, Karachi	10 (Ten Shares only)	
MR. MUHAMMAD ABDULLAH KHAWAR	42201-4937427-1	Mr. Khawar	Pakistan	Business Executive	House No. C-11, Block H, North Nazimabad Karachi	10 (Ten Shares only)	
MR. FARMAN AHMED KHAN LODHI	42101-7436364-3	Mr. Munib Ahmed Khan Lodhi	Pakistan	Business Executive	House No. 164/II, Street No. 18, Khayaban-e-Qasim, Phase VIII, DHA, Karachi	10 (Ten Shares only)	
SOLIS ENERGY SOLUTIONS (PRIVATE) LIMITED **REPRESENTED BY:** MR. FARMAN AHMED KHAN LODHI	0114993 42101-7436364-3	 Mr. Munib Ahmed Khan Lodhi	Pakistan Pakistan	 Business Executive	3rd Floor, Horizon Vista, Block 045, Clifton, Karachi House No. 164/II, Street No. 18, Khayaban-e-Qasim, Phase VIII, DHA, Karachi	3000 (Three Thousand Shares Only)	
			Total number of shares taken (in figures and words)			3030 (Three Thousand Thirty Shares only)	

Dated: June 03, 2019

Witness to above signatures:

Signature	
Full Name (in Block Letters)	
Father's/ Husband's name	
Nationality	
Occupation	
NIC No.	
Usual residential address	

3(5)(a)(ii) Certified Copies of Memorandum and Articles of Association

(Certified by SECP)

SOLIS

ENERGY SOLUTIONS

Accessible, Affordable Solar Energy

What is Solis?

Fossil Fuel has traditionally been the largest source for generating electricity, gradually though we have seen its adverse effects harm our environment and the need for more affordable energy has been dictating energy policies for some years now. The methods of old are simply unacceptable today, they produce expensive energy, and they pollute our environment. The world is moving fast to clean and green energy and Solar Power is one of the most attractive options available to us with potentially unlimited capabilities.

Solis's core focus is to leverage that unlimited potential and provide reliable solutions and dependable customer support which can help drive down the cost of energy you pay for today through a pragmatic and feasible solar powered system.

But how do you do that in a manner that doesn't hinder your activities or operations? Solis can help supplement the energy you pay for today by enabling you to effectively generate your own, which means you consume less billable power.

Our Pay as You Go mechanism ensures that you can significantly reduce your energy footprint which ultimately results in more savings for you!

Financial Support Model

Solis's primary business value is the promise of affordable Solar Power. And being committed to our promise, we have partnered with Bank to offer various leasing options that allow our customers to easily avail the benefits that Solis has to offer.

OPTION A
Direct Consumer Financing through Bank*

- Flexible Tenure, 1-3 Years
- Minimum Up Front from as low as 20%
- Affordable Monthly Payments

OPTION B
Leasing of Equipment*

- Flexible Tenure
- Minimum Up Front Down Payment
- Affordable Monthly Rentals

** Subject to approval*

Our Offerings

INDUSTRIAL/COMMERCIAL SYSTEMS

One of Solis's key targets is the facilitation of the commercial and industrial sectors, this is derived on the basis of 2 key objectives;

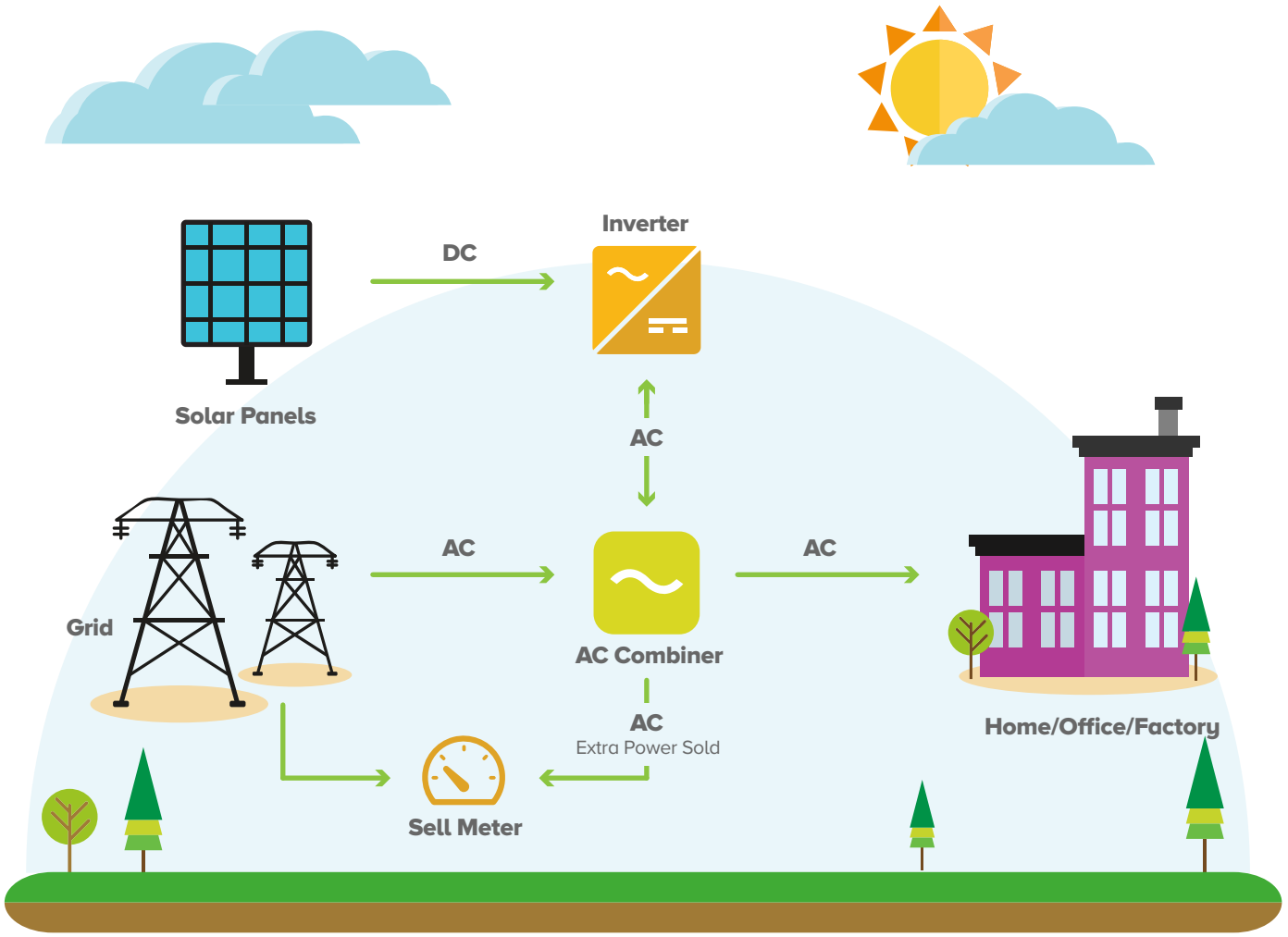
The commercial sector is extremely vital due to its status as a driving force behind the local economy. Solis aims to provide an affordable clean and green environment friendly source of power to this sector which will result in a tremendously reduced carbon footprint as well as significant savings in energy cost to the consumer too.

The industrial sector is the main powerhouse behind the nation's growth, due its tremendous size and as a result significantly larger energy requirements, standard solutions aren't cut out for doing the job. This is why Solis provides bespoke large scale grid-tied solutions to suit your needs.

Types of Solutions

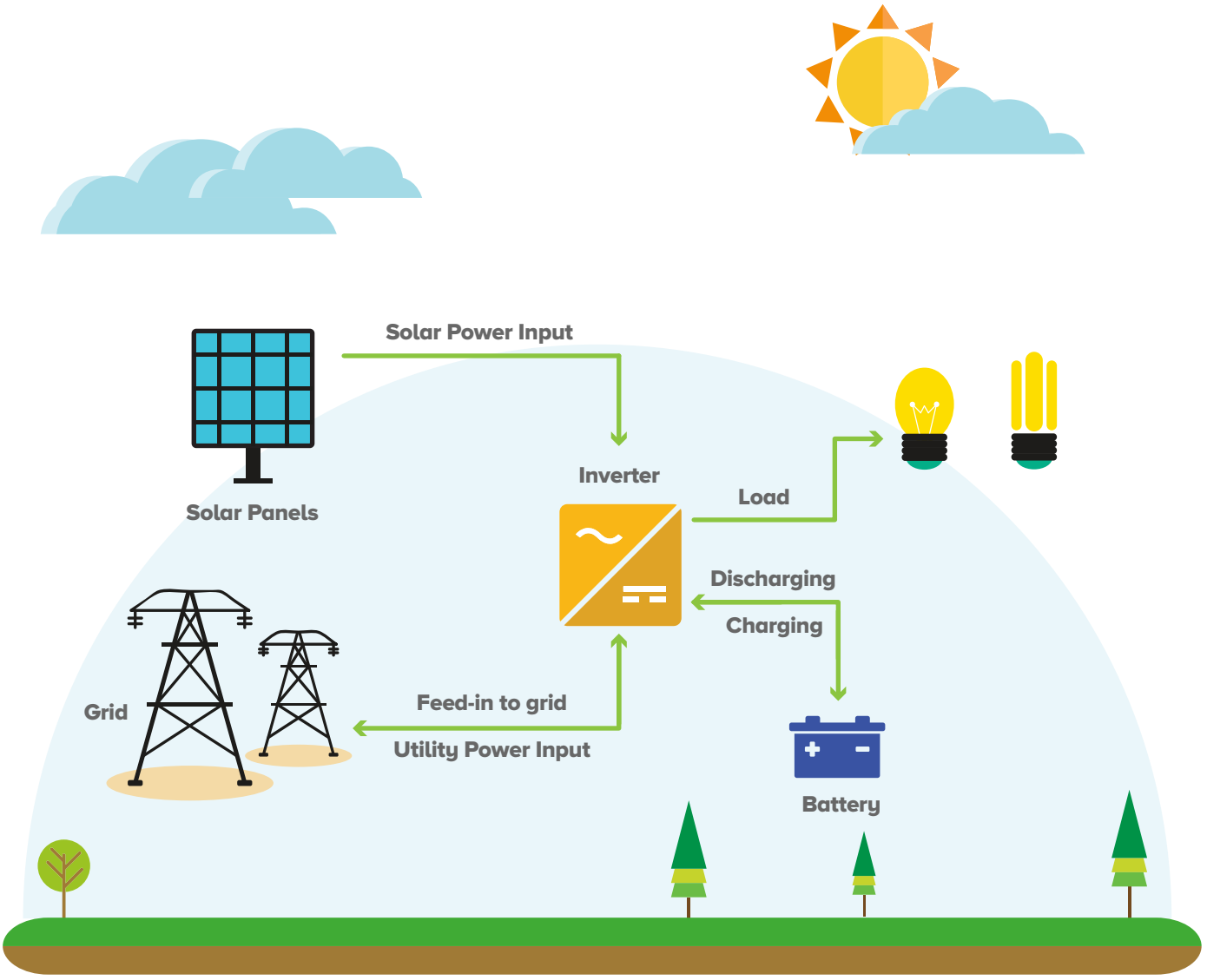
ON-GRID SOLAR SYSTEM

An On-Grid solution is connected to the public electricity grid, this means that any excess energy produced by the system is fed to the grid and now with the inclusion of 'Net-Metering', a consumer can receive compensation for the excess electricity they generate.



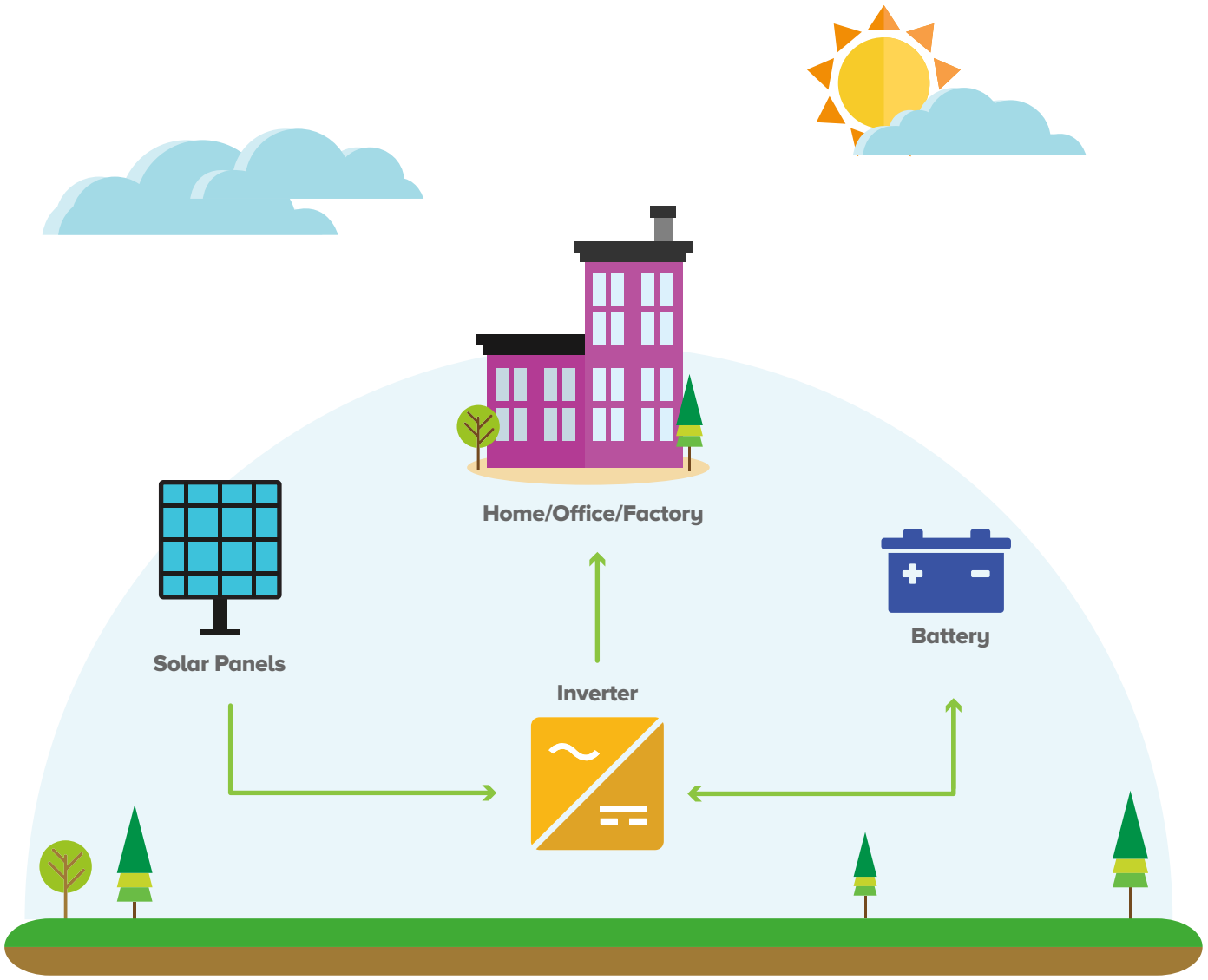
HYBRID SOLAR SYSTEM

A hybrid solution combines the best of both worlds and allows you to generate your own electricity and also reap the benefits of Net Metering along with sustained backup and battery support. Since it is connected to the public grid it is less expensive than a completely off-grid solution.



OFF-GRID SOLAR SYSTEM

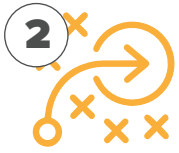
An Off-Grid solution is completely isolated from the public electricity grid and comes with its own Battery Backup to ensure supply long after the Sun is gone. Usually this is an option for customers who are isolated or have no access to the electricity grid. For details contact Solis's product team.



Our Process

We Exercise Due Diligence to determine your Needs!

Each customer is different, we understand this all too well which is why our experts make on-site visits, technically analyze, plan and take all considerations into account as they deliberate on a system that meets your needs.



Our experts install your solution as per the Best Industry Practices!

Using some of the best equipment available in PV Technology today and having capable personnel to handle the process, we install the equipment as per the proposed design and ensure its lasting and optimum performance.

Assured Commitment to Quality and Dedicated Customer Support

Our commitment to you doesn't end with installation of the system, rather we build and maintain the trust of our customers by ensuring that our support team stay in touch to make module integrity certain on a timely basis. Swift and satisfactory resolution of customer queries is the top priority of our support team.

CONTACT US

For more details of our products and offerings feel free to get in touch with us at one of our two offices

KARACHI

Solis Energy Solutions Pvt.
Ltd. C-18, Block 4 Clifton,
Karachi – Pakistan.

Telephone: +92 (21) 3587 6531
Fax: +92 (21) 3587 6621

LAHORE

Solis Energy Solutions Pvt. Ltd.
2nd Floor, Plaza 3, Block XX,
Ph. III, D.H.A
Lahore – Pakistan.

Telephone: +92 (42) 3569 3855
Fax: +92 (21) 3587 6621

QUETTA

Solis Energy Solutions Pvt.
Ltd. Showrooms 1-3, Plot 5,
Main Airport Road,
Gul Muhammad Saeedan,
Quetta – Pakistan.

Telephone: +92(81) 230 1714

www.solis-energy.com

For any direct queries or feedback feel free to write to us at info@solis-energy.com

Purchase and Seller Brief

PROJECT BRIEF AND PURPOSE OF THE PROJECT

POWER SELLER – SOLIS DELTA ENERGY PRIVATE LIMITED

Solis Delta Energy Pvt Ltd, a company registered and existing under the laws of Pakistan having its registered office at 3rd Floor, Horizon Vista, Block 4, Scheme 05, Clifton Karachi, Pakistan (the "**Seller**"). The Seller desires to develop, design, construct, own and operate the Solar PV plants (the **"Plants"**) of 6.5 MWp aggregate to be installed at the following locations.

DISCO	Location	Plant size	District	Province
GEPCO	Sialkot Cantonment	1 MWp	Sialkot	Punjab
	Gujranwala Cantonment	3 MWp	Gujranwala	Punjab
	Kharian Cantonment	2.5 MWp	Kharian	Punjab

The Seller intends to sell all the Energy generated by the Solar PV Plant to **Military Engineer Services (MES)** (**"**the **Purchaser**") for the period of 25 years.

POWER PURCHASER – MILLITARY ENGINEERING SERVICES

MES (Military Engineer Services), an organization represented by DGW&CE (Army) or its designated officer of Military Engineer Services, working under the umbrella of Armed Forces of Pakistan and existing under the laws of Pakistan, having its registered head office at GHQ Rawalpindi **(**the "**Purchaser**").

The Purchaser shall provide land on Rent to the Seller for the construction, operation and maintenance of a Grid Connected Solar PV Plants of 6.5 MWp aggregate for the period of 25 years.

The Seller shall invest, design, construct, install, own, operate, and maintain the Plant located at the land provided on rent by the Purchaser to the Seller for duration of the Power Purchase Agreement and the Purchaser shall purchase all of the power generated or available by the Plant from the Seller under the agreed terms and conditions and the Puchaser will provide facilitation to the Seller in early achievement of Commerical Operation Date.

PROJECT RATIONAL

GHQ-Military Engineering Services (MES) intends to install a Grid-Tie Solar PV Power Plant at different locations in their premises, by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load. The Military Engineering Services - GHQ wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, GHQ has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

Solis Delta Energy is found to be very much suitable among different EPC contractors technically as well as financially, therefore GHQ has awarded the project to Solis Delta Energy.

TECHNOLOGY

- Solar PV Grid tie system with all necessary protection, instrumentation, monitoring, control and synchronizing with Grid.
- Solar based Power Generation System, civil structures and Auxiliaries
- 400 V LV cable for inverter output. 11 KV MV cable used for interconnection with existing VCB and control wires.
- 330 Wp PV Modules of Tier 1 Manufacturer with 17.0% efficiency.
- Grid-Tie smart inverter with all necessary protections.
- Dual string DC combiner box to isolate the DC part when required.
- LV Panel containing Energy Meter, AC Breakers and necessary indications.
- All the electrical installations and wiring for the PV System in accordance with the codes and standard.

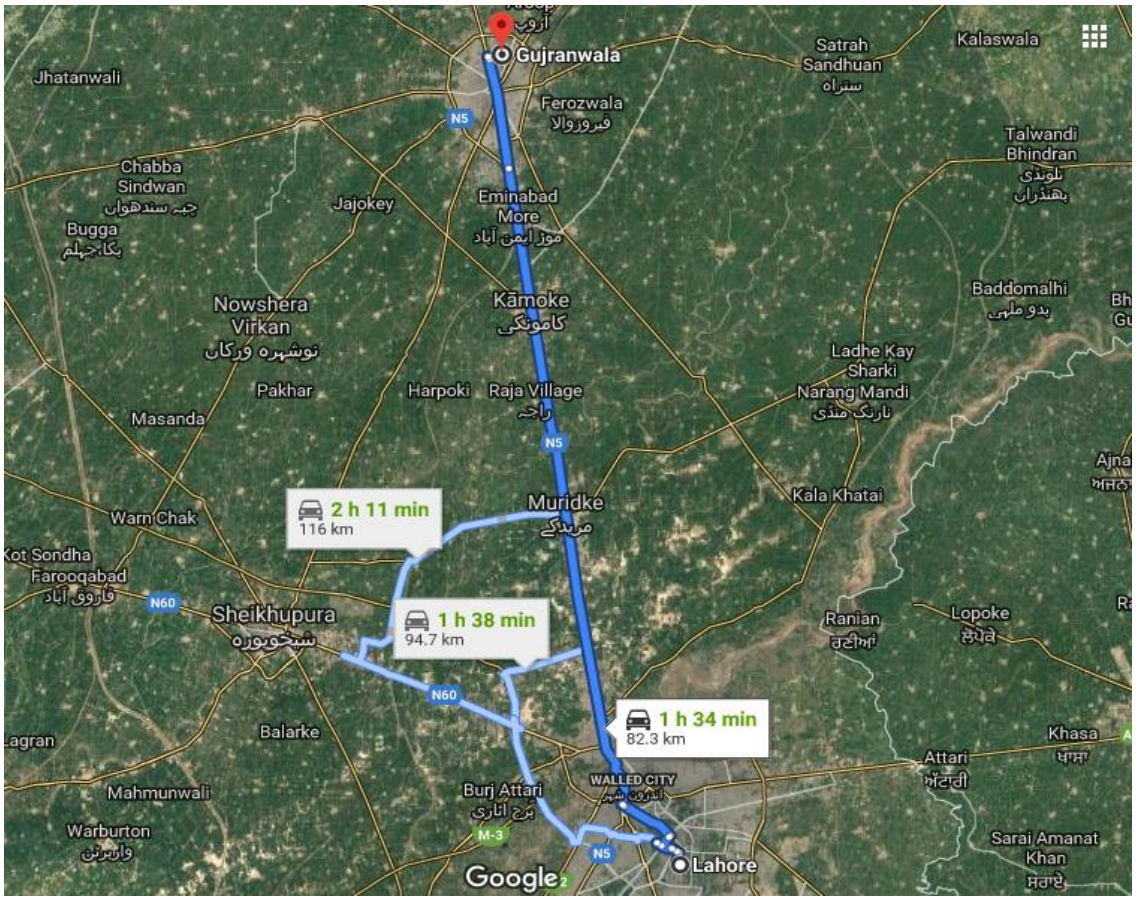
PROJECT LOCATIONS

Site Name	Capacity	Location	Geographical Coordinates
Gujranwala	3 MW	90 KM from Lahore, Punjab.	32.24^0N, 74.09^0E
Sialkot	1 MW	Sialkot Cantt	32.53^0N, 74.56^0E
Kharian	2.5 MW	170 KM from Lahore, Punjab.	32.16^0N, 73.41^0E

Gujranwala

3 MWp Solar PV On-Grid system is to be installed at the allocated space in cantonment area of Gujranwala. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

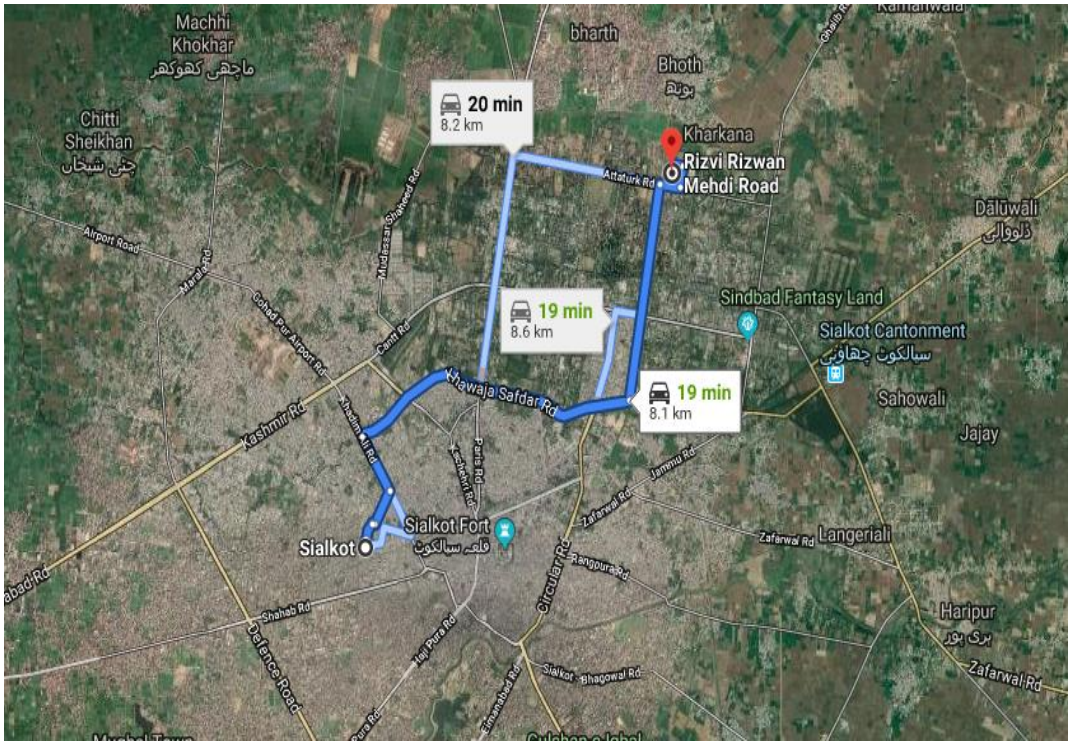
ROUTE MAP: LAHORE TO SITE



Sialkot

1 MWp Solar PV On-Grid system is to be installed at the allocated space in Sialkot Cantt. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

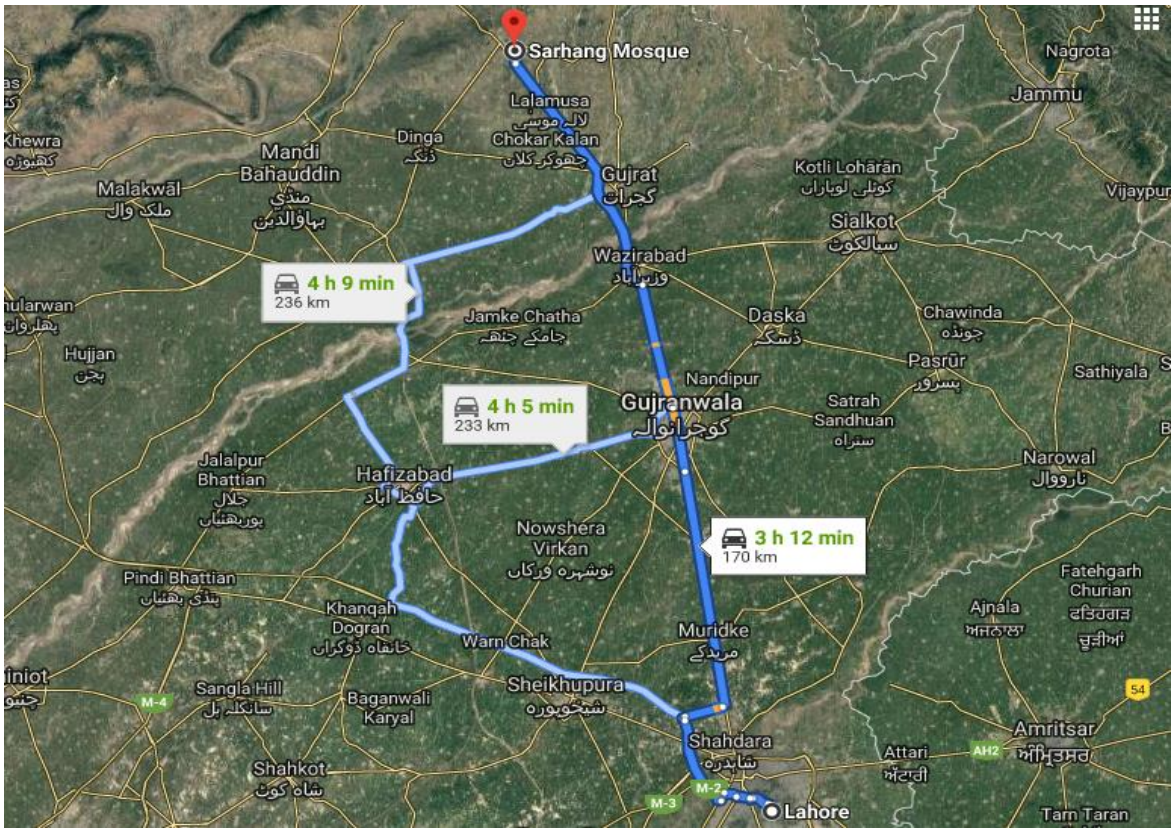
ROUTE MAP: SIALKOT CITY TO SITE



Kharian

2.5 MWp Solar PV On-Grid system is to be installed at the allocated space in cantonment area of Kharian. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

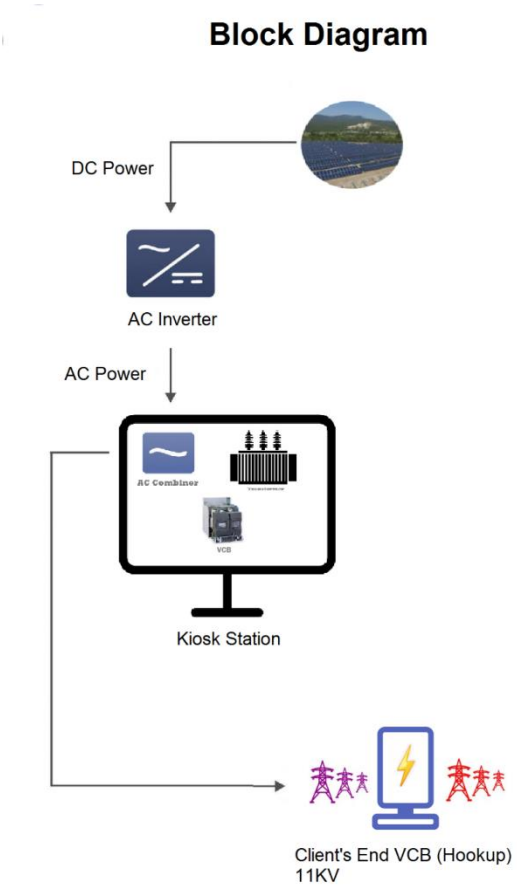
MAP: LAHORE TO SITE



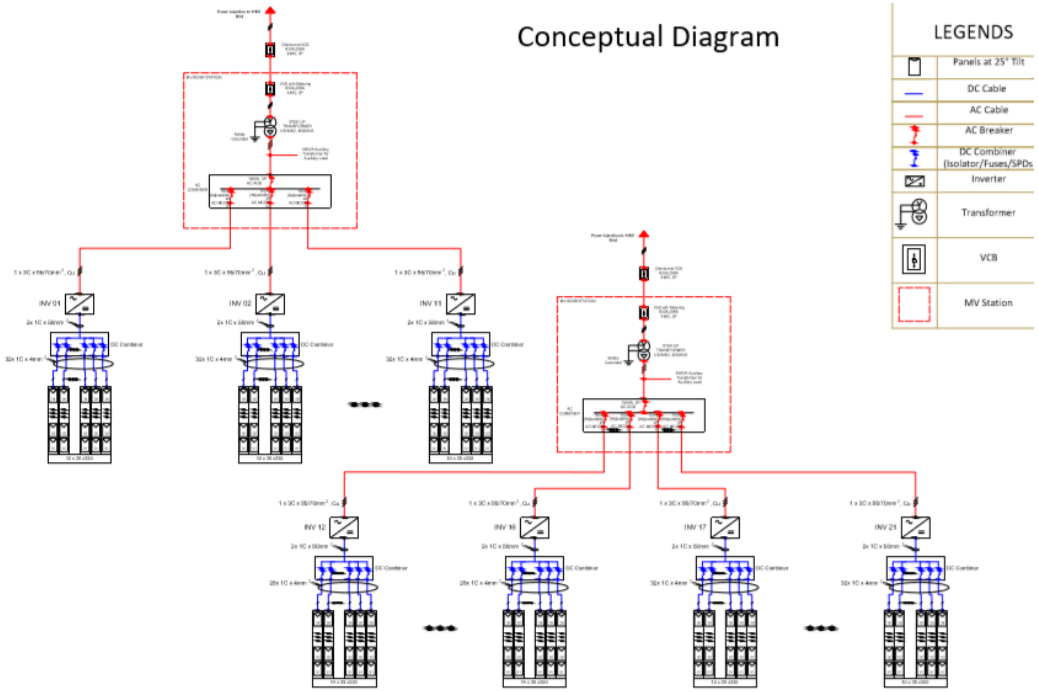
TECHNOLOGY USED

S.No.	Parameters	
1	Technology	Grid Tie, Solar PV Power Plant
2	System Size	6.5 MWp
3	Solar Modules	Polycrystalline Solar PV Module
4	Inverter	On-Grid String Inverter, SMA

BLOCK DIAGRAM



CONCEPTUAL DESIGN



3(5)(g)(a) Type, Technology, Model, Technical Details and Design

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITY

DESIGN DETAILS – SIALKOT CANTT - 1 MW

- Polycrystalline 330 Wp Solar Modules with efficiency 17.0% are used in the design
- 125 kVA grid connected solar inverters, 600 V three phase, 98.9% have been considered
- System will be synchronized with 11 KV Grid.
- DC/AC Ratio of 1.119 for inverters has been considered.
- Maximum AC output of the system is assumed to be 900 KVA
- Output of the system is based on the instantaneous irradiation value of Solar Energy

BILL OF MATERIALS

S.No.	Items	Description	Quantity
Sialkot Cantt – 1 MW			
1	PV Modules	330 Wp, Polycrystalline, Tier 1 Manufactured	3052
2	Inverters	Grid-Tie Solar Inverters 150 kVA 3 phase	6

ENERGY GENERATION

S.No.	Efficiency Parameters	
Sialkot Cantt – 1 MW		
1	Capacity Utilization Factor	16.66%
2	Energy Generation Units	1.47 Million kWh

DESIGN DETAILS – GUJRANWALA CANTT - 3 MW

- Polycrystalline 330 Wp Solar Modules with efficiency 17.0% are used in the design
- 150 kVA grid connected solar inverters, 600 V three phase, 98.9% have been considered
- System will be synchronized with 11 KV Grid.
- DC/AC Ratio of 1.112 for inverters has been considered.
- Maximum AC output of the system is assumed to be 2.7 MVA
- Output of the system is based on the instantaneous irradiation value of Solar Energy

BILL OF MATERIALS

S.No.	Items	Description	Quantity
Gujranwala – 3 MW			
1	PV Modules	330 Wp, Polycrystalline, Tier 1 Manufactured	9100
2	Inverters	Grid-Tie Solar Inverters 150 kVA 3 phase	18

ENERGY GENERATION

S.No.	Efficiency Parameters	
Gujranwala – 3 MW		
1	Capacity Utilization Factor	16.70%
2	Energy Generation Units	4.39 Million kWh

DESIGN DETAILS –KHARIAN CANTT – 2.5 MW

- Polycrystalline 330 Wp Solar Modules with efficiency 17.0% are used in the design
- 150 kVA grid connected solar inverters, 600 V three phase, 98.9% have been considered
- System will be synchronized with 11 KV Grid.
- DC/AC Ratio of 1.113 for inverters has been considered.
- Maximum AC output of the system is assumed to be 2.25 MVA
- Output of the system is based on the instantaneous irradiation value of Solar Energy

BILL OF MATERIALS

S.No.	Items	Description	Quantity
Kharian Cantt – 2.5 MW			
1	PV Modules	330 Wp, Polycrystalline, Tier 1 Manufactured	7588
2	Inverters	Grid-Tie Solar Inverters 150 kVA 3 phase	15

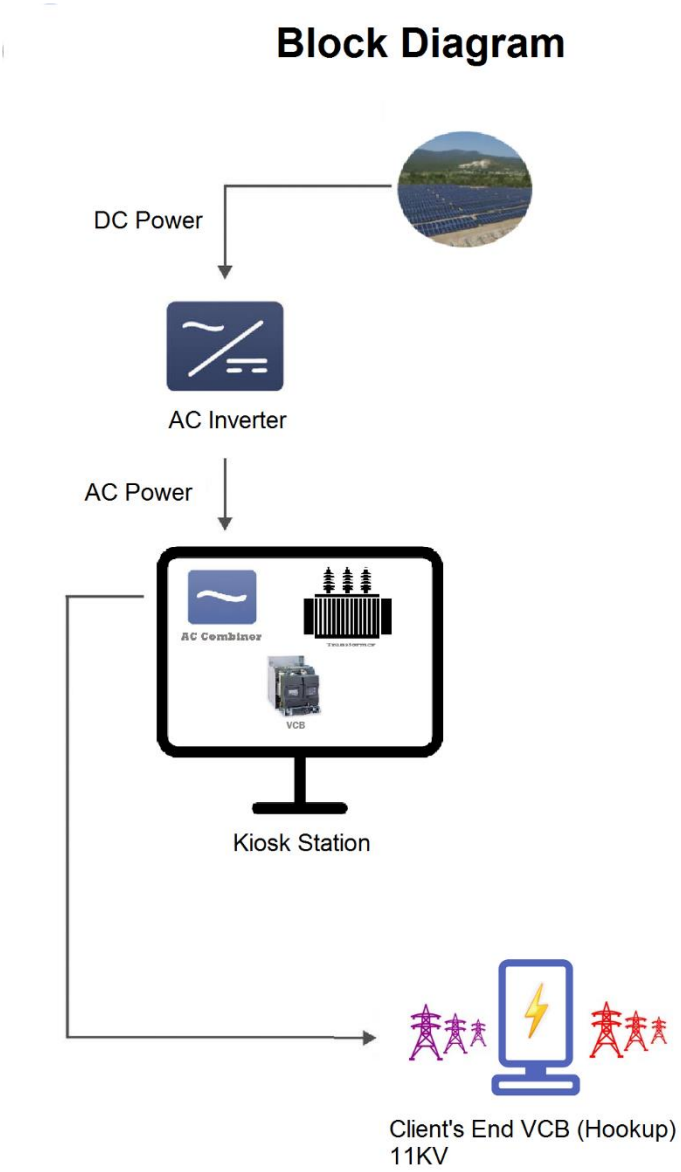
ENERGY GENERATION

S.No.	Efficiency Parameters	
Kharian Cantt – 2.5 MW		
1	Capacity Utilization Factor	16.68%
2	Energy Generation Units	3.66 Million kWh

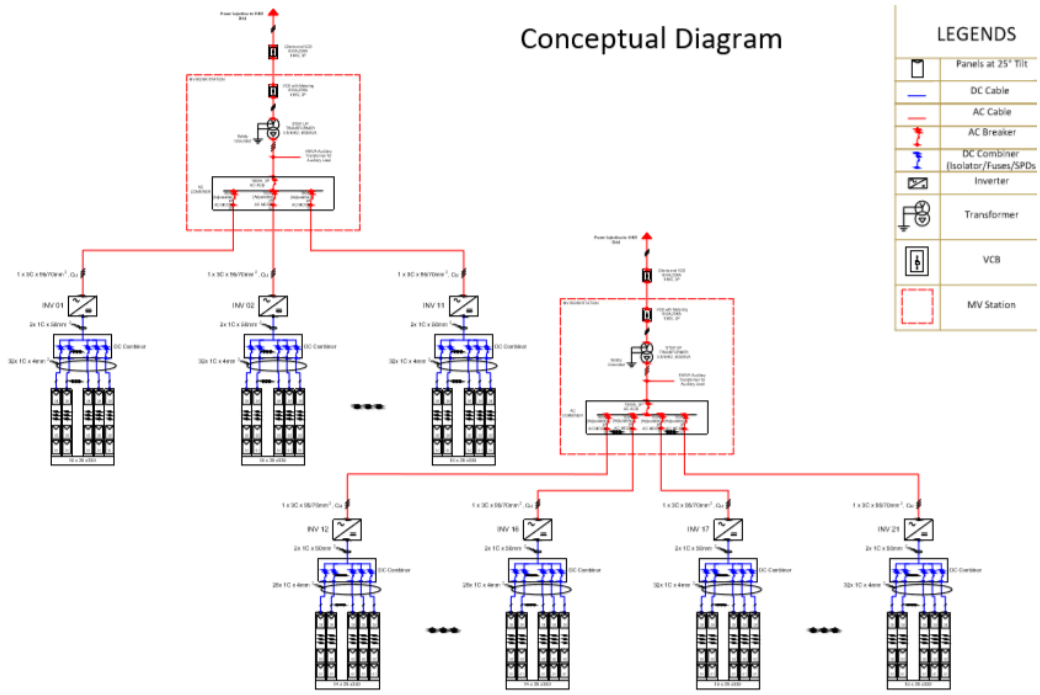
TECHNOLOGY USED

S.No.	Parameters	
1.	**Technology**	**Grid Tie, Solar PV Power Plant**
2.	System Size – Sialkot	1 MWp
3.	System Size - Gujranwala	3 MWp
4.	System Size -Kharian Cantt	2.5 MWp
5.	**Total System Size**	**6.5 MWp**
6.	**Solar Modules**	**Polycrystalline Solar PV Module**
7.	**Inverter**	**On-Grid String Inverter, SMA**

BLOCK DIAGRAM

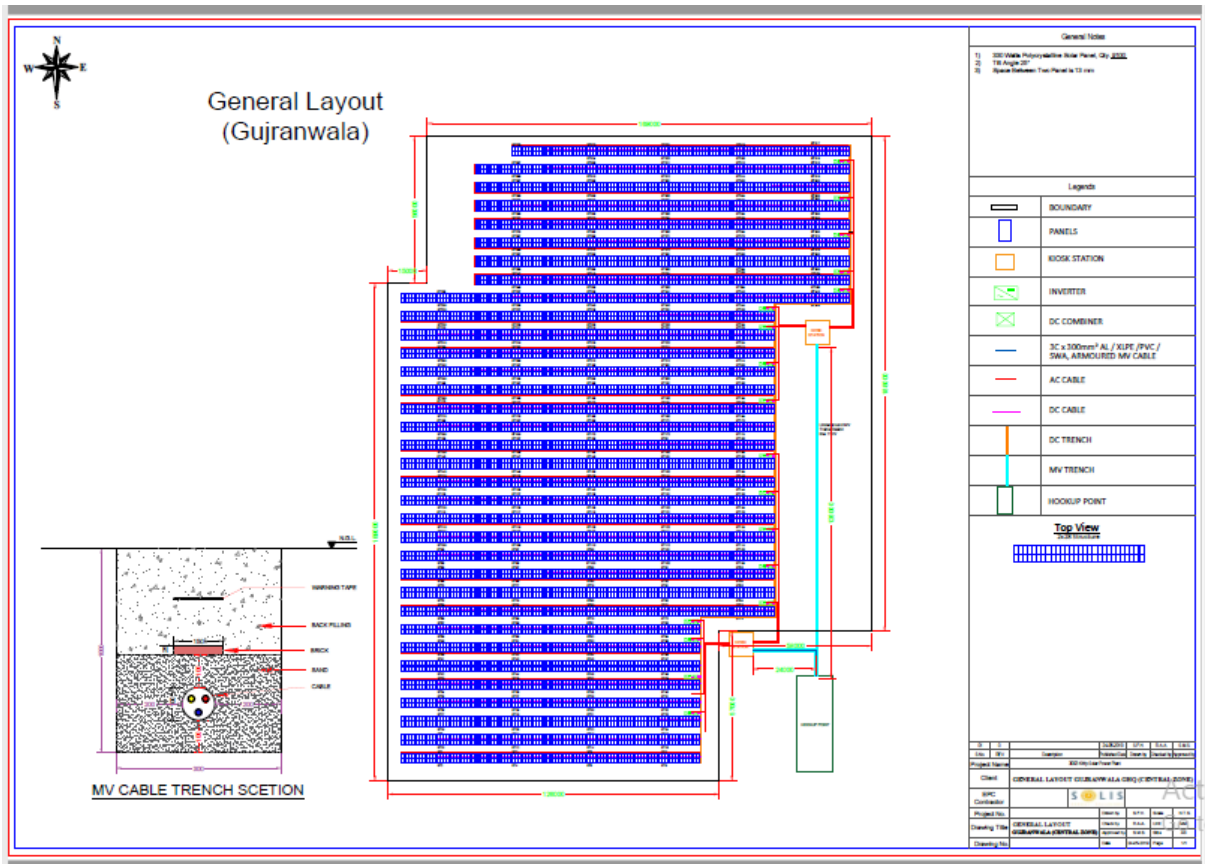


CONCEPTUAL DESIGN

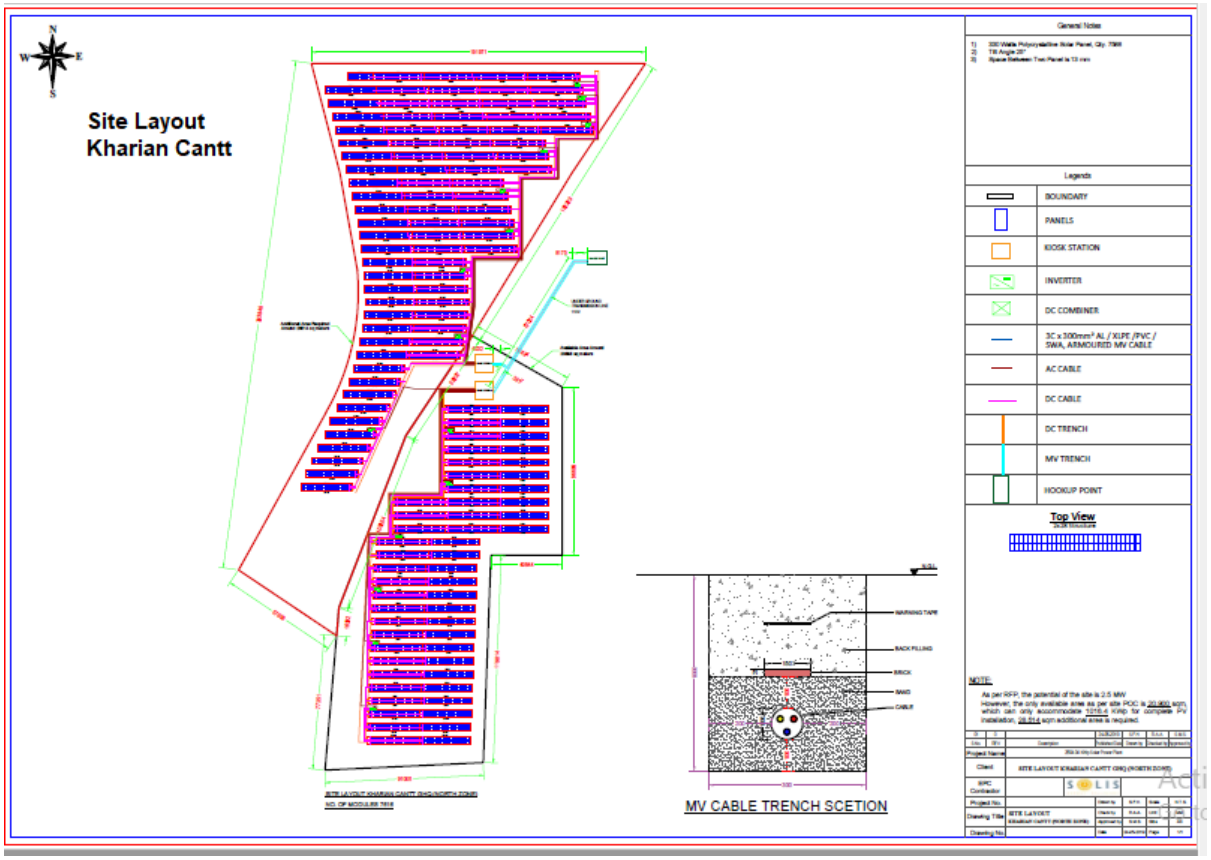


Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

SITE LAYOUTS



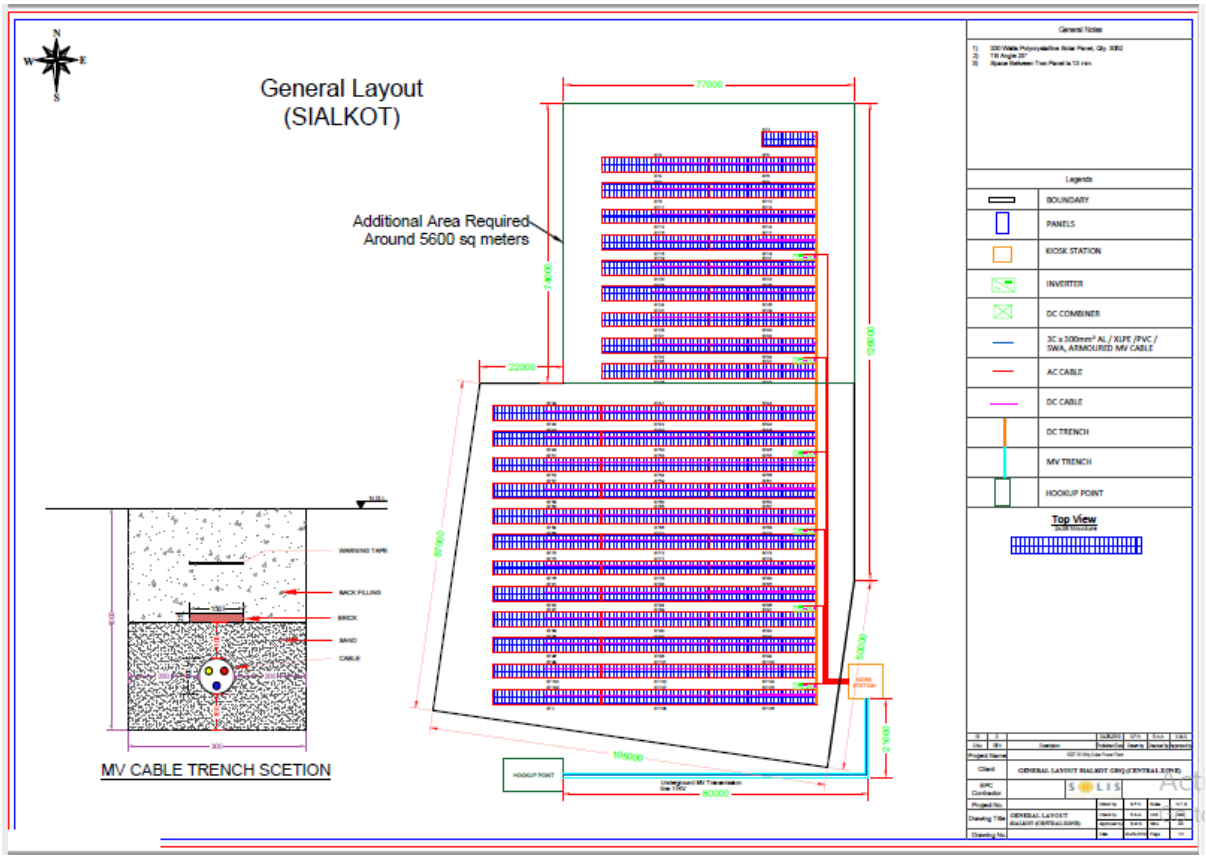
Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com



Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan

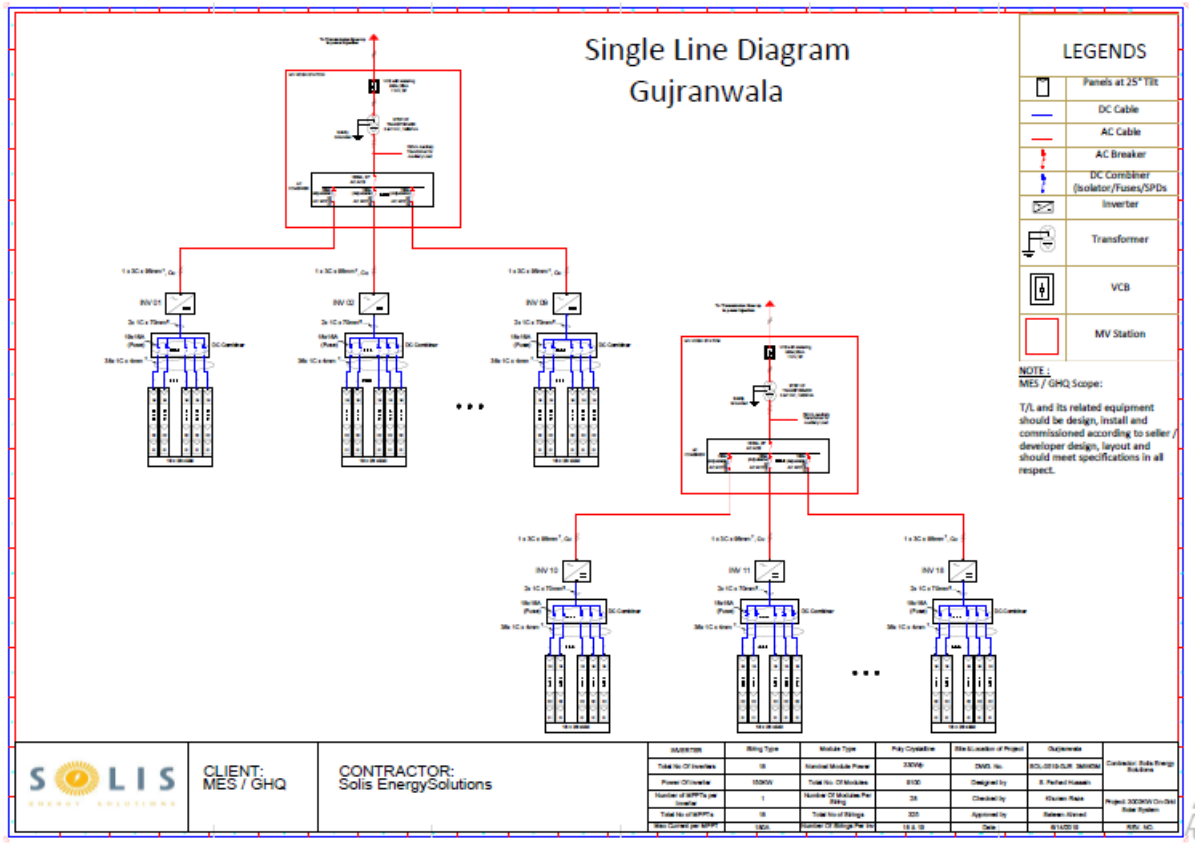
T +92(21)3529 4301-6
F +92(21)35294311

www.solis-energy.com

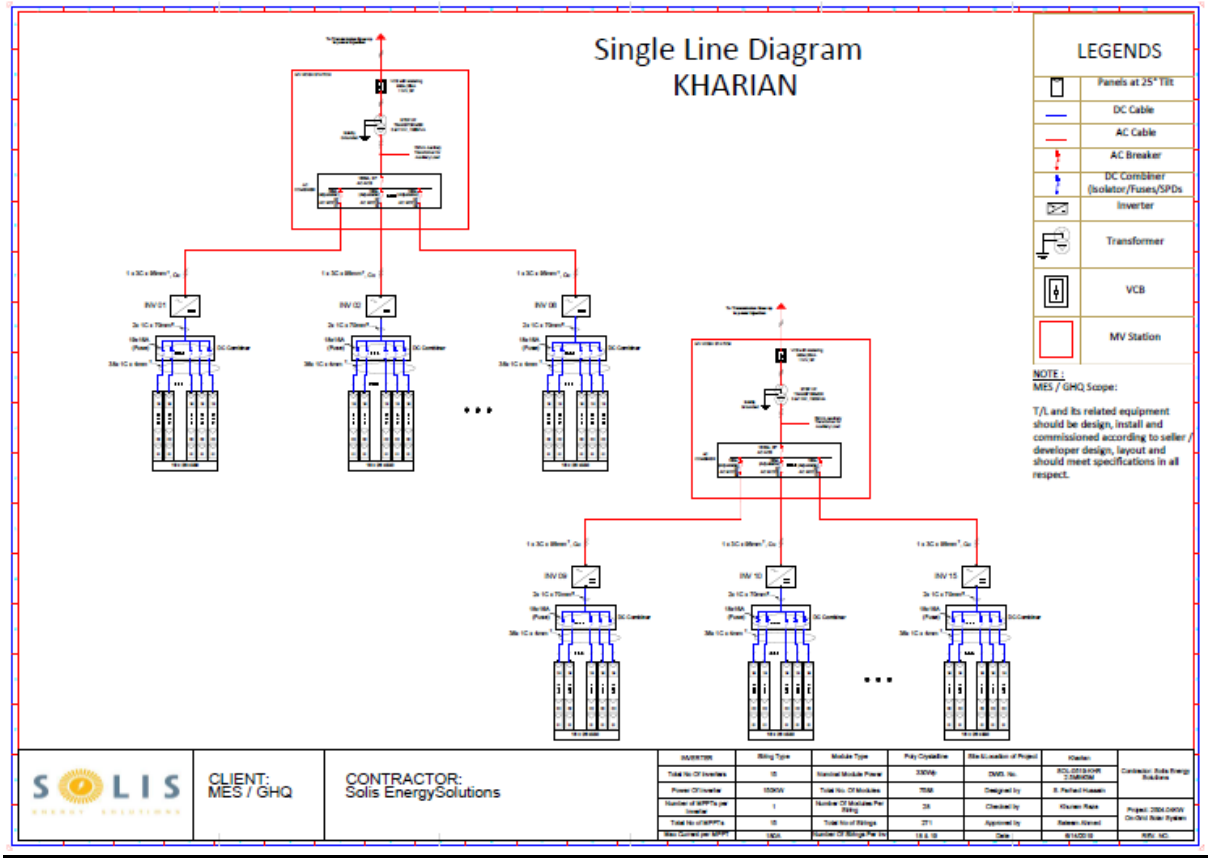


SINGLE LINE DIAGRAM

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com



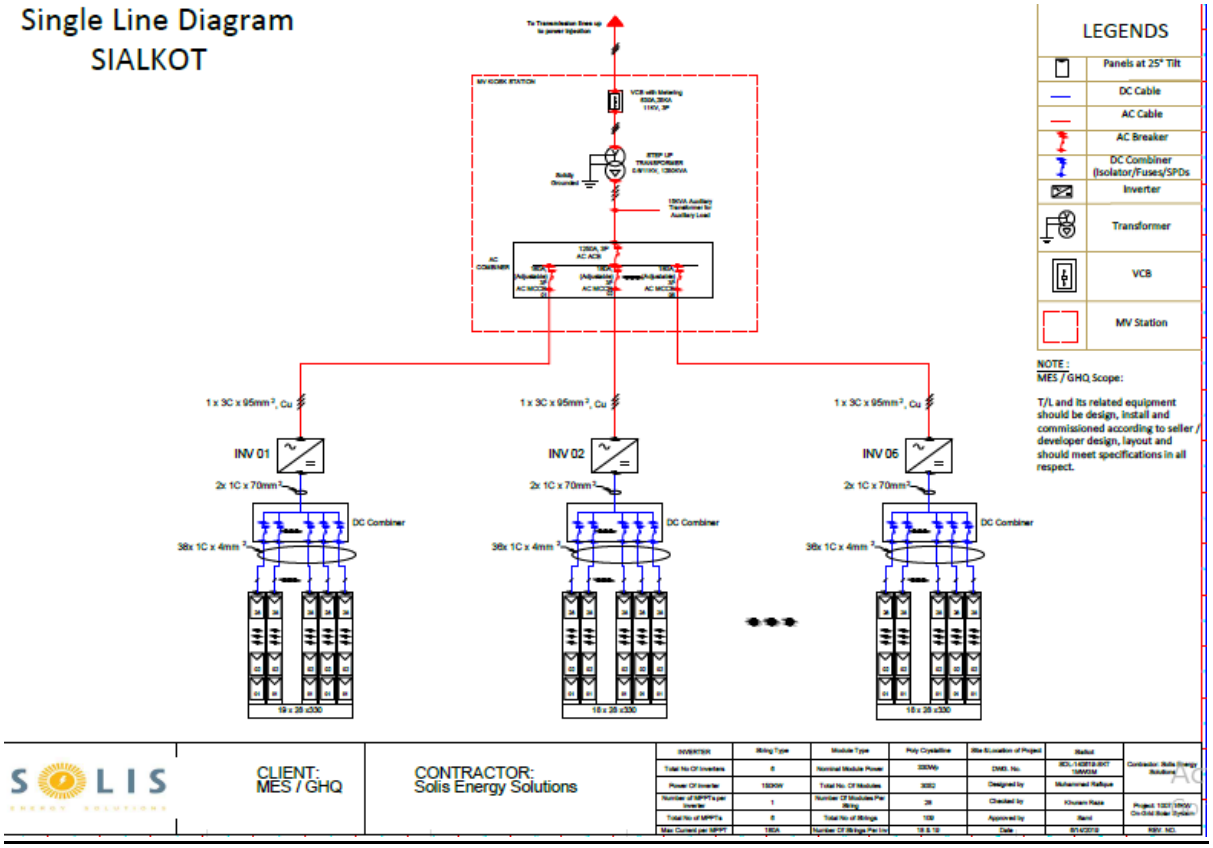
Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com



Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

SOLIS
DELTA ENERGY

Single Line Diagram
SIALKOT



Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan

T +92(21)3529 4301-6
F +92(21)35294311

www.solis-energy.com

ANNEXURE -15

3(5)(h) Feasibility Report

FEASIBILITY REPORT
GUJRANWALA 3 MWp SOLAR PV PLANT

Introduction

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

- Introduction to Solar
- Solar Potential in Pakistan
- Project Overview
- Site Overview
- Conceptual Design
- Environmental Benefits
- Socio Economic Benefits
- Technical Summary

Executive Summary

3 MWp Solar PV On-Grid system is to be installed at the allocated space in cantonment area of Gujranwala. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

Introduction to Solar

Solar is one of the natural sources for the generation of electricity, either directly using photovoltaic or indirectly using concentrated solar power.

While generating electricity directly using photovoltaic, the used technologies include On-Grid System, Off-Grid System and Hybrid system (both on-grid and off-grid). As the cost of solar electricity has reduced, many grid-connected solar PV system has been built. Solar PV is rapidly becoming an inexpensive, low-carbon technology to harness renewable energy from sun. The most important factor influencing the generation is the solar irradiance, which changes throughout the day and it is affected by the land's latitude and climate conditions.

Solar Potential in Pakistan

Pakistan's per capita electricity consumption is comparatively lower than other countries in a similar development stage. The consumption of electricity mostly depends on Human Development Index (HDI), and the current trend of rising incomes and energy supplies, falling poverty levels. This creates a healthy demand for additional power generation.

Even with the projected surplus in power generation capacity by 2020, there will still be sufficient economic feasibility for small and medium-sized (50-100 MW) renewable energy-based power projects in Pakistan. The viability of these projects will be further enhanced by the continued decline in technology prices and the emphasis by the government on indigenous energy resources that also help the country meet its environmental objectives and reduce carbon emissions.

Project Overview

GHQ-Military Engineering Services (MES) intends to install a Grid-Tie Solar PV Power Plant at different location in their premises, by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load. 3 MWp Solar PV Plant has been designed for Gujranwala which will get synchronize with the conventional 11 KV Grid already present at the site. The site is located at Gujranwala Cantonment area in the province of Punjab.

The summary of site which is very much feasible for the installation of Solar PV plant is as follow:

Site Name	Capacity	Location	Geographical Coordinates
Gujranwala Cantt	3 MW	90 KM from Lahore, Punjab.	32.24^0N, 74.09^0E

Project Rationale

The Military Engineering Services - GHQ wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, GHQ has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

Solis Delta Energy is found to be very much suitable among different EPC contractors technically as well as financially, therefore GHQ has awarded the project to Solis Delta Energy.

Technology

- Solar PV Grid tie system with all necessary protection, instrumentation, monitoring, control and synchronizing with Grid.
- Solar based Power Generation System, civil structures and Auxiliaries
- MV & LV cable for interconnection of the system with 11 KV switchgear. Board and control wires for the necessary communication and control system.
- 330 Wp PV Modules of Tier 1 Manufacturer with 17.0% efficiency.
- 150 kVA Grid-Tie smart inverter with all necessary protections.

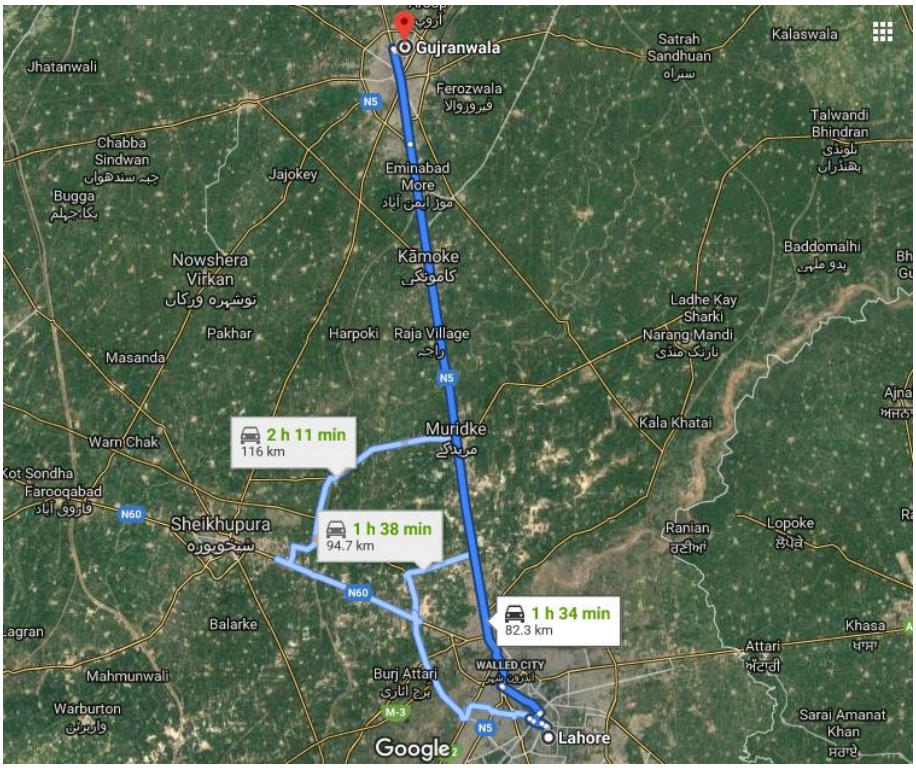
- DC Combiner Box having 20 inputs with complete DC protections.
- Kiosk station containing LV cabinet (comprising of Energy Analyzer, AC Breakers and complete protections), Step-up Transformer (0.6/11kV) and Auxiliary Transformer.
- All the electrical installations and wiring for the PV System in accordance with the codes and standard.

Project Location

Site Overview

Site for the project covers an area of 10 acres and is located 90 km from Lahore. The Geographical coordinates of the site are 32.24^0N and 74.09^0E. The area can be approached by Road using National Highway or GT Road.

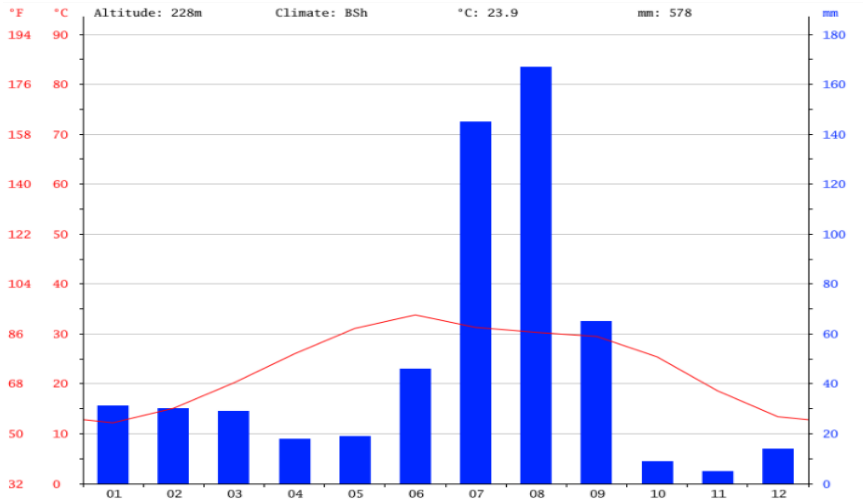
ROUTE MAP: LAHORE TO SITE



Climate and Weather in Gujranwala

The average temperature in Gujranwala is 24 ^{0}C. In a year, the average rainfall is 578 mm/year.

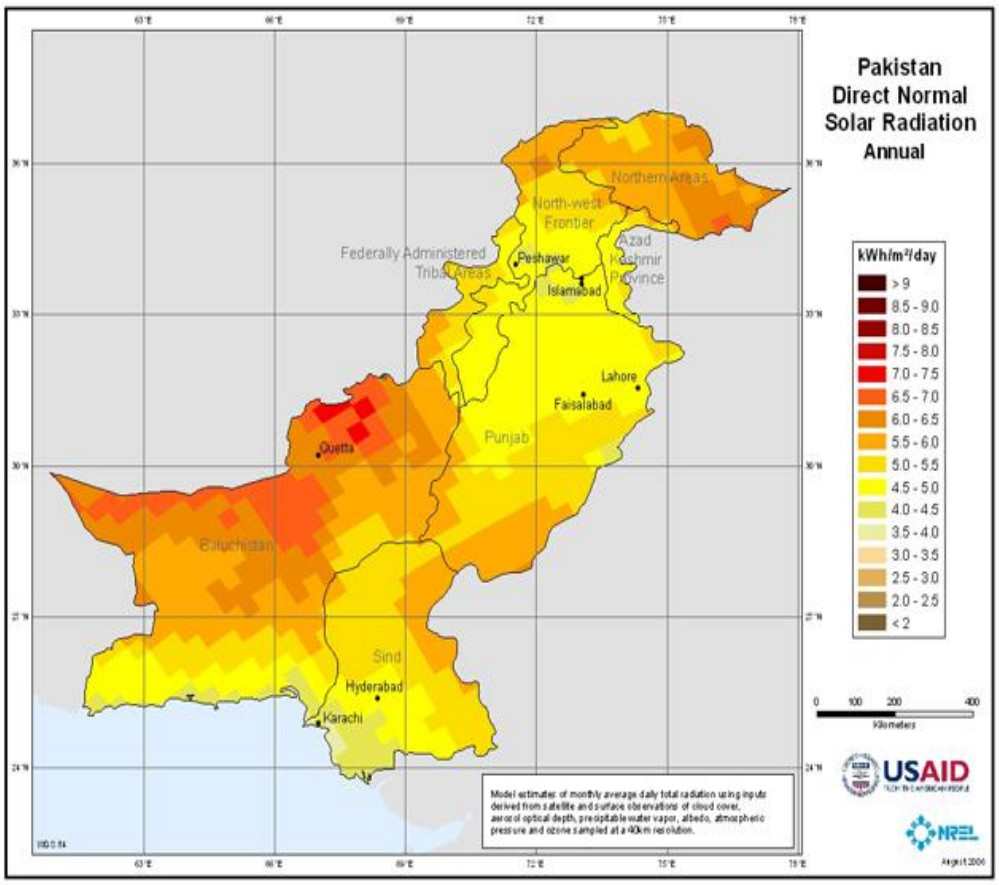
The graph below shows the average climate and weather of Gujranwala.



The Global Horizontal Irradiance (GHI)-kWh/sq.m data for the site based on meteonorm 7.1 data is shown below

	Gujranwala Site
Jan	85.8
Feb	104.7
Mar	147.4
Apr	164.0
May	187.9
Jun	187.4
Jul	169.1
Aug	165.0
Sep	157.9
Oct	129.3
Nov	97.4
Dec	83.8
Total	**1679.8**

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4, Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com



O & M Costs

The project also includes 24/7 O&M of the complete PV plant including all its relevant system and equipment. This cost will include the following items inclusive of all importation and local charges, duties, taxes, etc.

- Provision of all manpower as duly approved by the company.
- Provision of all consumable material and parts.
- Provision of all routine and preventive maintenance parts.
- Periodic cleaning of PV modules.
- Timely update of inverter's firmware (if necessary).
- Periodic maintenance of Electrical distribution board parts.
- Corrective maintenance of inverter or electrical panels in case of any fault.
- Periodic and corrective maintenance of transformers and its related equipment.

Feasibility & Financing

The project at Gujranwala Cantt up to 3 MW will cost approximately **PKR 276,607,554.**

Gujranwala Cantt up to 3 MW	
Project Cost	**PKR**
EPC	273,479,458
Insurance During Construction	395,522
CAPEX	**273,874,980**
Financing Fee	553,211
Interest During Construction	2,179,362
PROJECT COST	**276,607,554**
Equity	**55,323,106**
Debt	**221,284,447**

Socio-Economic and Environmental Benefits

There are many different benefits which can be achieved from Solar Energy. Some of them are discussed below.

Upgrading power grids to integrate renewables also contributes to broader value creation, while operation and maintenance of renewable energy facilities creates long-term jobs for plant monitoring, equipment inspections and repair services. With the emergence of a local renewable energy industry, numerous opportunities for domestic value creation arise along all segments of the value chain.

The ever-increasing cost of fuel and power has become a big issue for many under-developed and developing countries. The socio-economic condition of people living in these areas is not as per the normal standard. Hence, it becomes imperative to provide these people with cheap power and energy. The governments in these areas look for options, like solar energy, to initiate a better and proper distribution of power. This has also helped these people to grow and develop themselves so that they can erase the economic inequality in the country.

The benefits of solar energy are ever increasing with different technologies coming up. The research and development of various solar plants will surely create a sense of equality among different economic groups in the world.

Conceptual Design

Generation Voltage

The Solar PV System will be generating the electricity at 11 KV and it will be synchronized on the same voltage level.

Power Factor & Frequency

Gujranwala 3 MW Solar PV system is using Grid-Tie inverters of 150 KVA each to convert DC power of solar panels to Alternating Power. The Power Factor is adjustable from 0 overexcited to 0 underexcited and the rated Power Factor at nominal power is 1. The range of frequency of the inverter is 44-55 Hz and nominal frequency of generation is 50 Hz.

Metering and Protection

The energy which will be generated by Solar System will be locked in the inverters and a separate CT meters will be installed at the site, by which the instantaneous power, daily energy, monthly energy and total energy can be measured.

The inverters with the following protections will be installed at the site.

- DC current reverse connection protection
- AC short circuit protection
- Leakage current protection
- Grid monitoring
- DC fuse and over current protection
- Anti-PID function
- Overvoltage protection

Technical Summary

- Polycrystalline 330 Wp Solar Modules with efficiency 17.0% are used in the design
- 150 kVA grid connected solar inverters, 600 V three phase, 98.9% have been considered
- System will be synchronized with 11 KV Grid.
- DC/AC Ratio of 1.112 for inverters has been considered.
- Maximum AC output of the system is assumed to be 2.7 MVA
- Output of the system is based on the instantaneous irradiation value of Solar Energy

BILL OF MATERIALS

S.No.	Items	Description	Quantity
Gujranwala – 3 MW			
1	PV Modules	330 Wp, Polycrystalline, Tier 1 Manufactured	9100
2	Inverters	Grid-Tie Solar Inverters 150 kVA 3 phase	18

ENERGY GENERATION

S.No.	Efficiency Parameters	
Gujranwala – 3 MW		
1	Capacity Utilization Factor	16.70%
2	Energy Generation Units	4.39 Million kWh

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

FEASIBILITY REPORT
KHARIAN 2.5 MWp SOLAR PV PLANT

Introduction

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

- Introduction to Solar
- Solar Potential in Pakistan
- Project Overview
- Site Overview
- Conceptual Design
- Environmental Benefits
- Socio Economic Benefits
- Technical Summary

Executive Summary

2.5 MWp Solar PV On-Grid system is to be installed at the allocated space in cantonment area of Kharian. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

Introduction to Solar

Solar is one of the natural sources for the generation of electricity, either directly using photovoltaic or indirectly using concentrated solar power.

While generating electricity directly using photovoltaic, the used technologies include On-Grid System, Off-Grid System and Hybrid system (both on-grid and off-grid). As the cost of solar electricity has reduced, many grid-connected solar PV system has been built. Solar PV is rapidly becoming an inexpensive, low-carbon technology to harness renewable energy from sun. The most important factor influencing the generation is the solar irradiance, which changes throughout the day and it is affected by the land's latitude and climate conditions.

Solar Potential in Pakistan

Pakistan's per capita electricity consumption is comparatively lower than other countries in a similar development stage. The consumption of electricity mostly depends on Human Development Index (HDI), and the current trend of rising incomes and energy supplies, falling poverty levels. This creates a healthy demand for additional power generation.

Even with the projected surplus in power generation capacity by 2020, there will still be sufficient economic feasibility for small and medium-sized (50-100 MW) renewable energy based power projects in Pakistan. The viability of these projects will be further enhanced by the continued decline in technology prices and the emphasis by the government on indigenous energy resources that also help the country meet its environmental objectives and reduce carbon emissions.

Project Overview

GHQ-Military Engineering Services (MES) intends to install a Grid-Tie Solar PV Power Plant at different location in their premises, by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load. 2.5 MWp Solar PV Plant has been designed for Kharian which will get synchronize with the conventional 11 KV Grid already present at the site. The site is located at Kharian Cantonment area in the province of Punjab.

The summary of site which is very much feasible for the installation of Solar PV plant is as follow:

Site Name	Capacity	Location	Geographical Coordinates
Kharian Cantt	2.5 MW	170 KM from Lahore, Punjab.	32.16^0N, 73.41^0E

Project Rationale

The Military Engineering Services - GHQ wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, GHQ has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

Solis Delta Energy is found to be very much suitable among different EPC contractors technically as well as financially, therefore GHQ has awarded the project to Solis Delta Energy.

Technology

- Solar PV Grid tie system with all necessary protection, instrumentation, monitoring, control and synchronizing with Grid.
- Solar based Power Generation System, civil structures and Auxiliaries
- MV & LV cable for interconnection of the system with 11 KV switchgear. Board and control wires for the necessary communication and control system.
- 330 Wp PV Modules of Tier 1 Manufacturer with 17.0% efficiency.
- 150 kVA Grid-Tie smart inverter with all necessary protections.

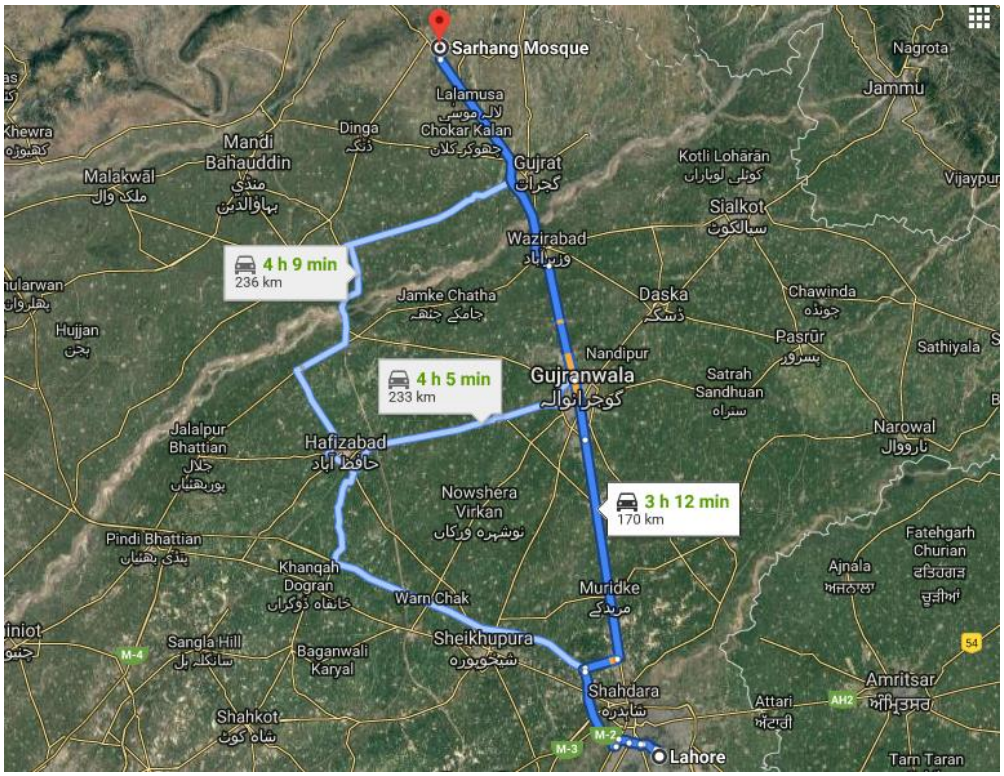
- DC Combiner Box having 20 inputs with complete DC protections.
- Kiosk station containing LV cabinet (comprising of Energy Analyzer, AC Breakers and complete protections), Step-up Transformer (0.6/11kV) and Auxiliary Transformer.
- All the electrical installations and wiring for the PV System in accordance with the codes and standard.

Project Location

Site Overview

Site for the project covers an area of 5 acres and is located 170 km from Punjab. The Geographical coordinates of the site are 32.16^0N and 73.41^0E. The area can be approached by Road using National Highway or GT Road.

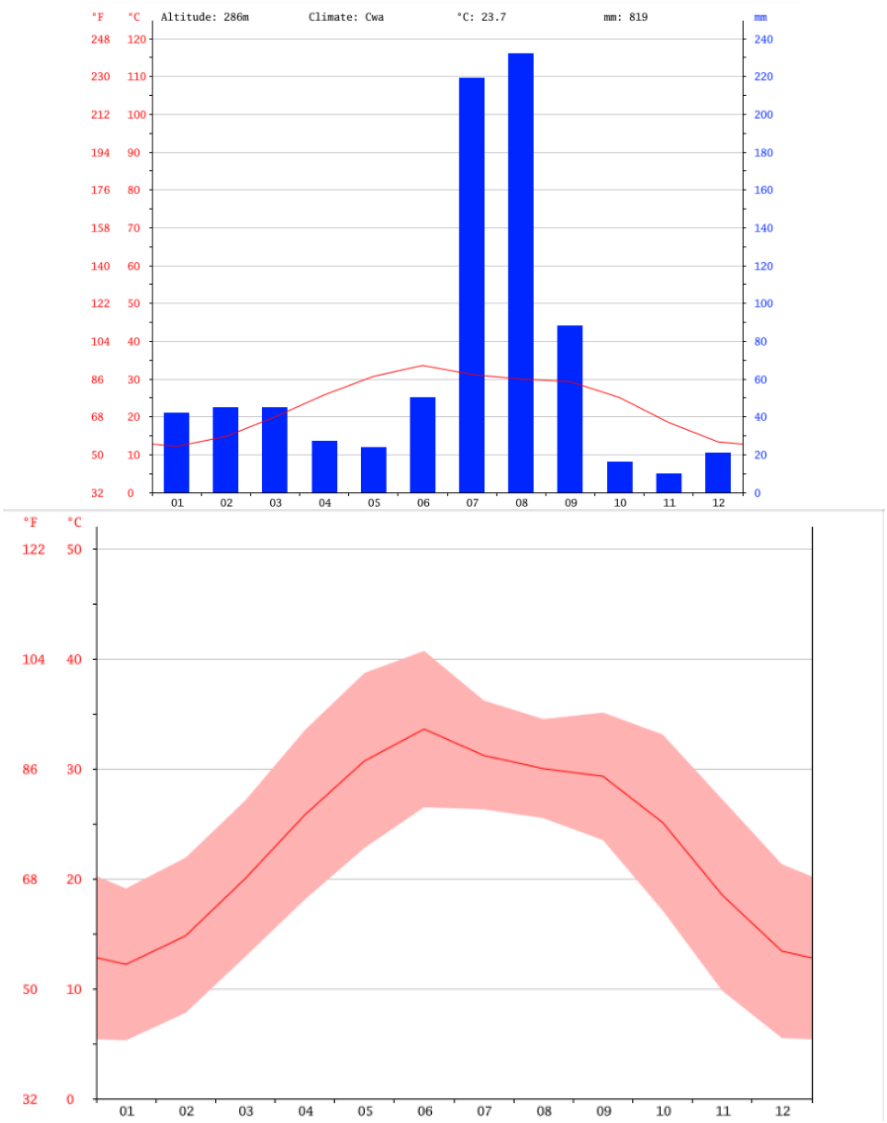
ROUTE MAP: LAHORE TO SITE



Climate and Weather in Kharian

The average temperature in Kharian is 23.7 ^{0}C. In a year, the average rainfall is 819 mm/year.

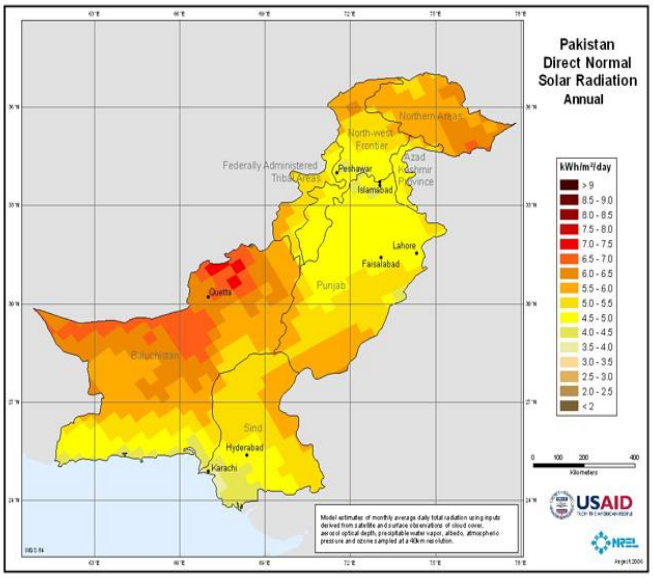
The graph below shows the average climate and weather of Kharian.



The Global Horizontal Irradiance (GHI)-kWh/sq.m data for the site based on meteonorm 7.1 data is shown below

	Kharian Site
Jan	83.9
Feb	93.5
Mar	143.7
Apr	163.7
May	190.6
Jun	184.1
Jul	174.1
Aug	164.0
Sep	158.5

Oct	138.2
Nov	104.2
Dec	83.4
Total	**1681.8**



O & M Costs

The project also includes 24/7 O&M of the complete PV plant including all its relevant system and equipment. This cost will include the following items inclusive of all importation and local charges, duties, taxes, etc.

- Provision of all manpower as duly approved by the company.
- Provision of all consumable material and parts.
- Provision of all routine and preventive maintenance parts.
- Periodic cleaning of PV modules.
- Timely update of inverter's firmware (if necessary).
- Periodic maintenance of Electrical distribution board parts.
- Corrective maintenance of inverter or electrical panels in case of any fault.
- Periodic and corrective maintenance of transformers and its related equipment.

Feasibility & Financing

The project at Kharian Cantt up to 2.5 MW will cost approximately **PKR 230,506,295.**

Kharian Cantt up to 2.5 MW	
Project Cost	**PKR**
EPC	227,899,548
Insurance During Construction	329,602

CAPEX	**228,229,150**
Financing Fee	461,009
Interest During Construction	1,816,135
PROJECT COST	**230,506,295**
Equity	**46,102,589**
Debt	**184,403,706**

Socio-Economic and Environmental Benefits

There are many different benefits which can be achieved from Solar Energy. Some of them are discussed below.

Upgrading power grids to integrate renewables also contributes to broader value creation, while operation and maintenance of renewable energy facilities creates long-term jobs for plant monitoring, equipment inspections and repair services. With the emergence of a local renewable energy industry, numerous opportunities for domestic value creation arise along all segments of the value chain.

The ever increasing cost of fuel and power has become a big issue for many under-developed and developing countries. The socio-economic condition of people living in these areas is not as per the normal standard. Hence, it becomes imperative to provide these people with cheap power and energy. The governments in these areas look for options, like solar energy, to initiate a better and proper distribution of power. This has also helped these people to grow and develop themselves so that they can erase the economic inequality in the country.

The benefits of solar energy are ever increasing with different technologies coming up. The research and development of various solar plants will surely create a sense of equality among different economic groups in the world.

Conceptual Design

Generation Voltage

The Solar PV System will be generating the electricity at 11 KV and it will be synchronized on the same voltage level.

Power Factor & Frequency

Kharian 2.5 MW Solar PV system is using Grid-Tie inverters of 150 KVA each to convert DC power of solar panels to Alternating Power. The Power Factor is adjustable from 0 overexcited to 0 underexcited and the rated Power Factor at nominal power is 1. The range of frequency of the inverter is 44-55 Hz and nominal frequency of generation is 50 Hz.

Metering and Protection

The energy which will be generated by Solar System will be locked in the inverters and a

separate CT meters will be installed at the site, by which the instantaneous power, daily energy, monthly energy and total energy can be measured.
The inverters with the following protections will be installed at the site.

- DC current reverse connection protection
- AC short circuit protection
- Leakage current protection
- Grid monitoring
- DC fuse and over current protection
- Anti-PID function
- Overvoltage protection

Technical Summary

- Polycrystalline 330 Wp Solar Modules with efficiency 17.0% are used in the design
- 150 kVA grid connected solar inverters, 600 V three phase, 98.9% have been considered
- System will be synchronized with 11 KV Grid.
- DC/AC Ratio of 1.113 for inverters has been considered.
- Maximum AC output of the system is assumed to be 2.25 MVA
- Output of the system is based on the instantaneous irradiation value of Solar Energy

BILL OF MATERIALS

S.No.	Items	Description	Quantity
Kharian Cantt – 2.5 MW			
1	PV Modules	330 Wp, Polycrystalline, Tier 1 Manufactured	7588
2	Inverters	Grid-Tie Solar Inverters 150 kVA 3 phase	15

ENERGY GENERATION

S.No.	Efficiency Parameters	
Kharian Cantt – 2.5 MW		
1	Capacity Utilization Factor	16.68%
2	Energy Generation Units	3.66 Million kWh

FEASIBILITY REPORT
SIALKOT CANTT 1 MWp SOLAR PV PLANT

Introduction

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

- Introduction to Solar
- Solar Potential in Pakistan
- Project Overview
- Site Overview
- Conceptual Design
- Environmental Benefits
- Socio Economic Benefits
- Technical Summary

Executive Summary

1 MWp Solar PV On-Grid system is to be installed at the allocated space in Sialkot Cantt. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

Introduction to Solar

Solar is one of the natural sources for the generation of electricity, either directly using photovoltaic or indirectly using concentrated solar power.

While generating electricity directly using photovoltaic, the used technologies include On-Grid System, Off-Grid System and Hybrid system (both on-grid and off-grid). As the cost of solar electricity has reduced, many grid-connected solar PV system has been built. Solar PV is rapidly becoming an inexpensive, low-carbon technology to harness renewable energy from sun. The most important factor influencing the generation is the solar irradiance, which changes throughout the day and it is affected by the land's latitude and climate conditions.

Solar Potential in Pakistan

Pakistan's per capita electricity consumption is comparatively lower than other countries in a similar development stage. The consumption of electricity mostly depends on Human Development Index (HDI), and the current trend of rising incomes and energy supplies, falling poverty levels. This creates a healthy demand for additional power generation.

Even with the projected surplus in power generation capacity by 2020, there will still be sufficient economic feasibility for small and medium-sized (50-100 MW) renewable energy based power projects in Pakistan. The viability of these projects will be further enhanced by the continued decline in technology prices and the emphasis by the government on indigenous energy resources that also help the country meet its environmental objectives and reduce carbon emissions.

Project Overview

GHQ-Military Engineering Services (MES) intends to install a Grid-Tie Solar PV Power Plant at different location in their premises, by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load. 1 MWp Solar PV Plant has been designed for Sialkot which will get synchronize with the conventional 11 KV Grid already present at the site. The site is located at Sialkot Cantt in the province of Punjab.

The summary of site which is very much feasible for the installation of Solar PV plant is as follow:

Site Name	Capacity	Location	Geographical Coordinates
Sialkot Cantt	1 MW	Sialkot Cantt	32.53^{0}N, 74.56^{0}E

Project Rationale

The Military Engineering Services - GHQ wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, GHQ has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

Solis Delta Energy is found to be very much suitable among different EPC contractors technically as well as financially, therefore GHQ has awarded the project to Solis Delat Energy.

Technology

- Solar PV Grid tie system with all necessary protection, instrumentation, monitoring, control and synchronizing with Grid.
- Solar based Power Generation System, civil structures and Auxiliaries
- MV & LV cable for interconnection of the system with 11 KV switchgear. Board and control wires for the necessary communication and control system.
- 330 Wp PV Modules of Tier 1 Manufacturer with 17.0% efficiency.
- 150 kVA Grid-Tie smart inverter with all necessary protections.
- DC Combiner Box having 20 inputs with complete DC protections.

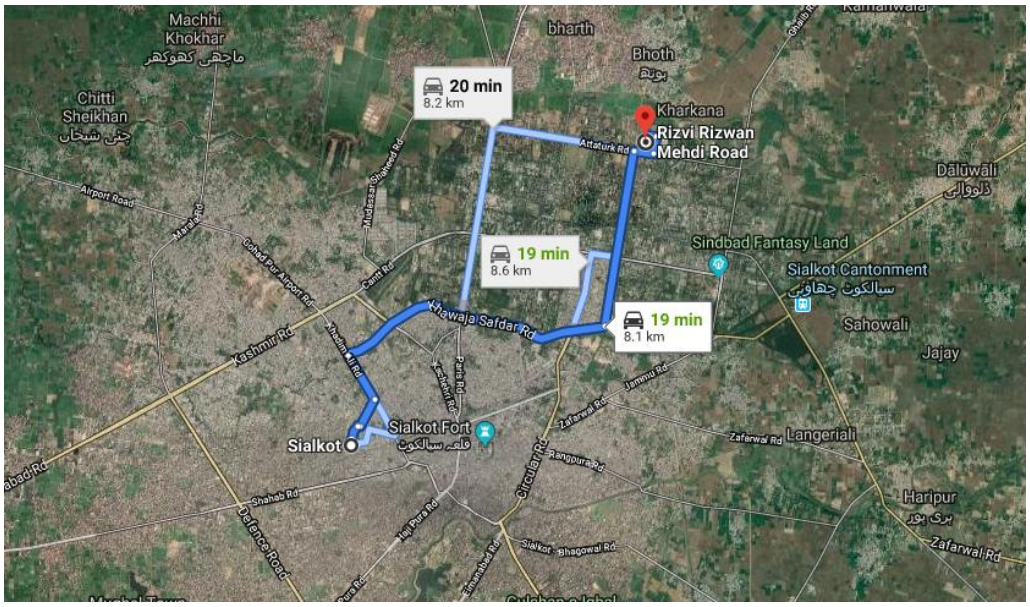
- Kiosk station containing LV cabinet (comprising of Energy Analyzer, AC Breakers and complete protections), Step-up Transformer (0.6/11kV) and Auxiliary Transformer.
- All the electrical installations and wiring for the PV System in accordance with the codes and standard.

Project Location

Site Overview

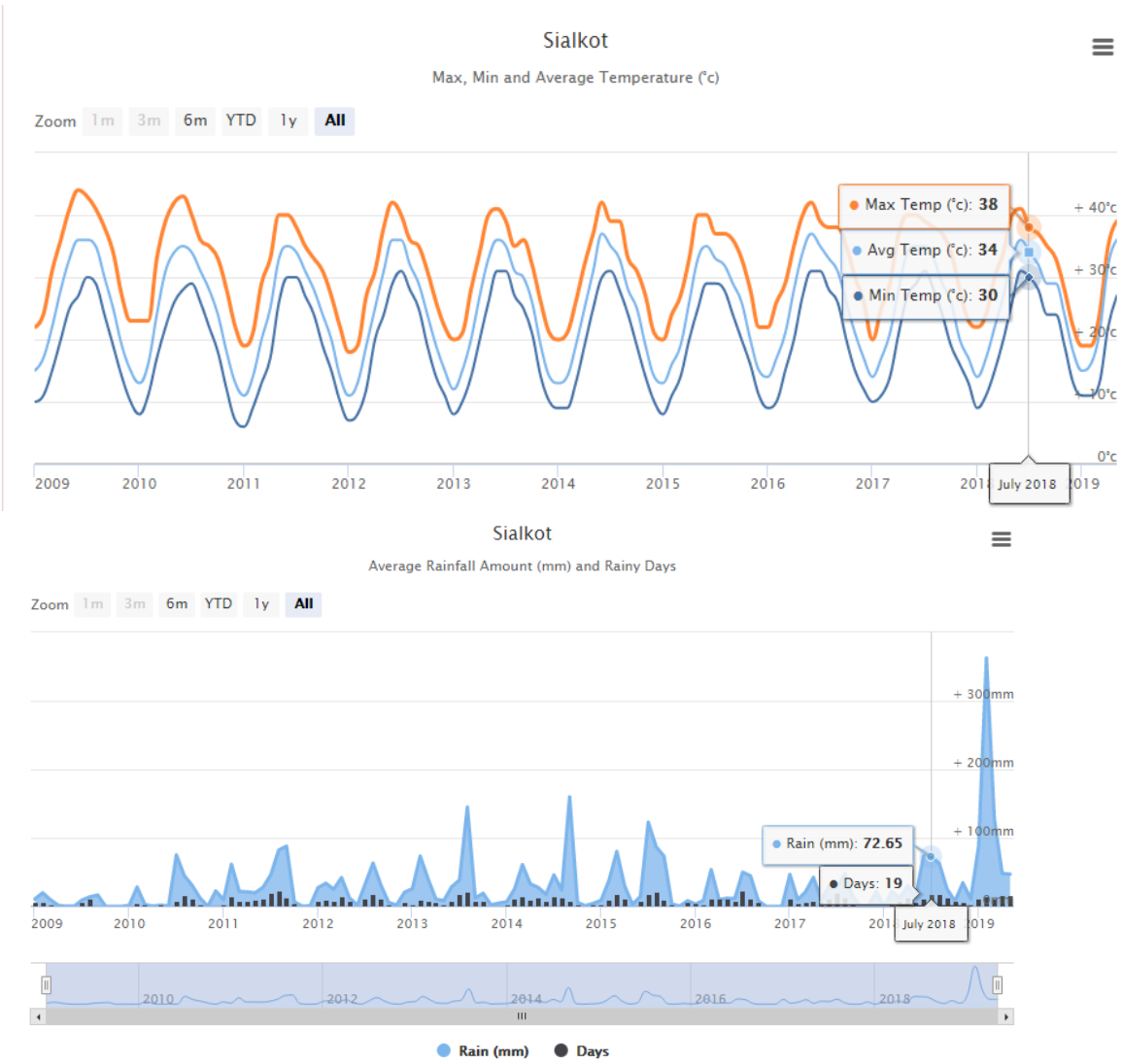
Site for the project covers an area of 2.22 acres and is located at Sialkot Cantt. The Geographical coordinates of the site are 32.53^0N and 74.56^0E.

ROUTE MAP: SIALKOT CITY TO SITE



Climate and Weather in Sialkot

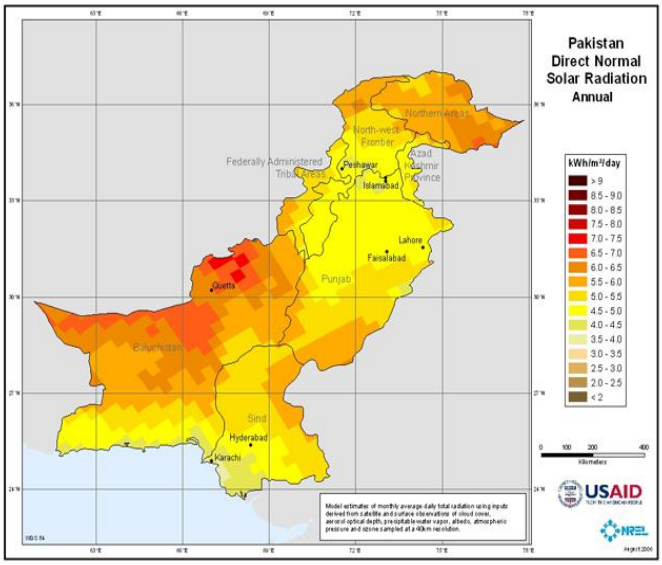
The average temperature in Lahore is 34 ^{0}C. In a year, the average rainfall is 72 mm/year. The graph below shows the average climate and weather of Sialkot.



The Global Horizontal Irradiance (GHI)-kWh/sq.m data for the site based on meteonorm 7.1 data is shown below

	Sialkot Cantt Site
Jan	83.9
Feb	96.6
Mar	143.3
Apr	161.9
May	190.1
Jun	184.6
Jul	169.4
Aug	160.8
Sep	158.7
Oct	136.4

Nov	102.6
Dec	82.6
Total	**1671.1**



O & M Costs

The project also includes 24/7 O&M of the complete PV plant including all its relevant system and equipment. This cost will include the following items inclusive of all importation and local charges, duties, taxes, etc.

- Provision of all manpower as duly approved by the company.
- Provision of all consumable material and parts.
- Provision of all routine and preventive maintenance parts.
- Periodic cleaning of PV modules.
- Timely update of inverter's firmware (if necessary).
- Periodic maintenance of Electrical distribution board parts.
- Corrective maintenance of inverter or electrical panels in case of any fault.
- Periodic and corrective maintenance of transformers and its related equipment.

Feasibility & Financing

The project at Sialkot Cantt up to 1 MW will cost approximately **PKR 92,202,518.**

Sialkot Cantt up to 1 MW	
Project Cost	**PKR**
EPC	91,159,819
Insurance During Construction	131,841
CAPEX	**91,291,660**
Financing Fee	184,404

Interest During Construction	726,454
PROJECT COST	**92,202,518**
Equity	**18,441,035**
Debt	**73,761,482**

Socio-Economic and Environmental Benefits

There are many different benefits which can be achieved from Solar Energy. Some of them are discussed below.

Upgrading power grids to integrate renewables also contributes to broader value creation, while operation and maintenance of renewable energy facilities creates long-term jobs for plant monitoring, equipment inspections and repair services. With the emergence of a local renewable energy industry, numerous opportunities for domestic value creation arise along all segments of the value chain.

The ever-increasing cost of fuel and power has become a big issue for many under-developed and developing countries. The socio-economic condition of people living in these areas is not as per the normal standard. Hence, it becomes imperative to provide these people with cheap power and energy. The governments in these areas look for options, like solar energy, to initiate a better and proper distribution of power. This has also helped these people to grow and develop themselves so that they can erase the economic inequality in the country.

The benefits of solar energy are ever increasing with different technologies coming up. The research and development of various solar plants will surely create a sense of equality among different economic groups in the world.

Conceptual Design

Generation Voltage

The Solar PV System will be generating the electricity at 11 KV and it will be synchronized on the same voltage level.

Power Factor & Frequency

Sialkot Cantt 1 MW Solar PV system is using Grid-Tie inverters of 150 KVA each to convert DC power of solar panels to Alternating Power. The Power Factor is adjustable from 0 leading to 0 lagging and the rated Power Factor at nominal power is 1. The range of frequency of the inverter is 44-55 Hz and nominal frequency of generation is 50 Hz.

Metering and Protection

The energy which will be generated by Solar System will be locked in the inverters and a separate CT meters will be installed at the site, by which the instantaneous power, daily energy, monthly energy and total energy can be measured.

The inverters with the following protections will be installed at the site.

- DC current reverse connection protection
- AC short circuit protection
- Leakage current protection
- Grid monitoring
- DC fuse and over current protection
- Anti-PID function
- Overvoltage protection

Technical Summary

- Polycrystalline 330 Wp Solar Modules with efficiency 17.0% are used in the design
- 125 kVA grid connected solar inverters, 600 V three phase, 98.9% have been considered
- System will be synchronized with 11 KV Grid.
- DC/AC Ratio of 1.119 for inverters has been considered.
- Maximum AC output of the system is assumed to be 900 KVA
- Output of the system is based on the instantaneous irradiation value of Solar Energy

BILL OF MATERIALS

S.No.	Items	Description	Quantity
Sialkot Cantt – 1 MW			
1	PV Modules	330 Wp, Polycrystalline, Tier 1 Manufactured	3052
2	Inverters	Grid-Tie Solar Inverters 150 kVA 3 phase	6

ENERGY GENERATION

S.No.	Efficiency Parameters	
Sialkot Cantt – 1 MW		
1	Capacity Utilization Factor	16.66%
2	Energy Generation Units	1.47 Million kWh

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

3(5)(i) Prospectus

Company Prospectus

Company Background

Company provides an end to end solution to acquire, deploy, operate and maintain Solar Energy Solutions in collaboration with leading Tier 1 OEM's when it comes to Solar System Equipment. The Company provides a solutions which are carefully crafted for each customer and caters to a variety of industries and domains be it Commercial, Residential, Industrial, Small, Medium or Large Scale.

The Company's mission is to drive down the cost of energy as compared to today's cost. This is to be achieved by making available to the general masses of Pakistan a pragmatic and feasible solar powered solution.

Accordingly, the Company has decided to apply for a generation license for its proposed project with GHQ-MES.

Projects have been delivered for a variety of customers, including The City School, ZMTL, At-Tahur etc. with the largest being a 2 MW installation for The City School. The Company is providing customers with clean energy and minimizing their energy price risk.

The foundation of Company lies on 2 staunch principles which are, to provide affordable, sustainable Solar Technology to the household-residential as well as commercial-industrial complex, by ensuring access to the general masses, guarantee a significant reduction in operational energy costs to our customers.

The Company has focussed on Supply Chain Management and Engineering Collaborations to bring in efficiencies, which have ultimately benefitted customers. The Company is now directing all focus to the high-growth areas in solar energy space. Solar Energy Solutions help provide energy security and minimize energy costs for businesses.

Project Overview

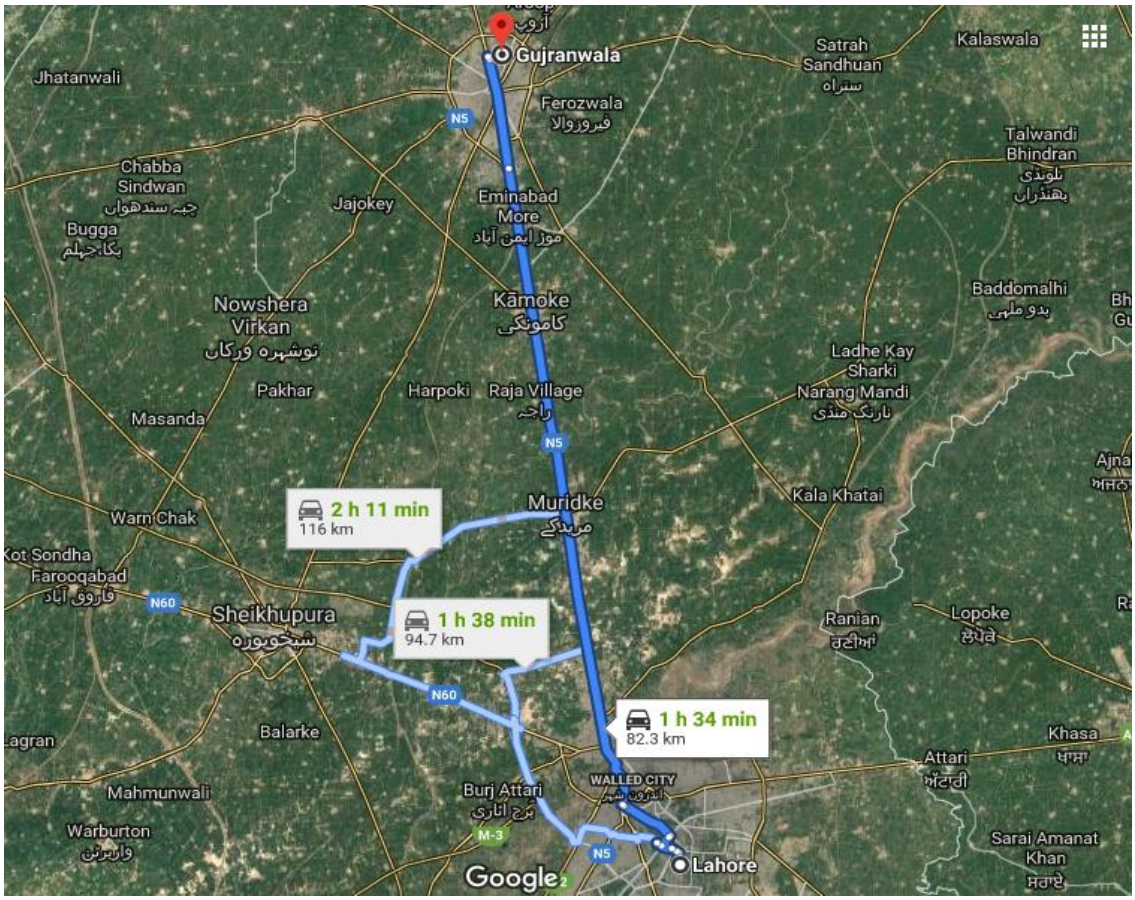
GHQ is the Head Quarter Of Pakistan Army; A disciplined fighting force in consonance with national ideals and aspirations. The armed forces have established a number of organisations for running industrial and commercial enterprises along with remarkable infrastructure development. “Arms for peace” is a vital link in the ideological chain of Pakistan Army inculcating the military men a spirit to promote peace throughout the world. Training and development has always been a significant factor for Pakistan Army preparing officers to perform their onerous duties with responsibility and honour. GHQ has different locations which are very much feasible for the installation of Solar PV Plant.

Site Name	Capacity	Location	Geographical Coordinates
Gujranwala	3 MW	90 KM from Lahore, Punjab.	32.24^0N, 74.09^0E
Sialkot	1 MW	Sialkot Cantt	32.53^0N, 74.56^0E
Kharian	2.5 MW	170 KM from Lahore, Punjab.	32.16^0N, 73.41^0E

Gujranwala

3 MWp Solar PV On-Grid system is to be installed at the allocated space in cantonment area of Gujranwala. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

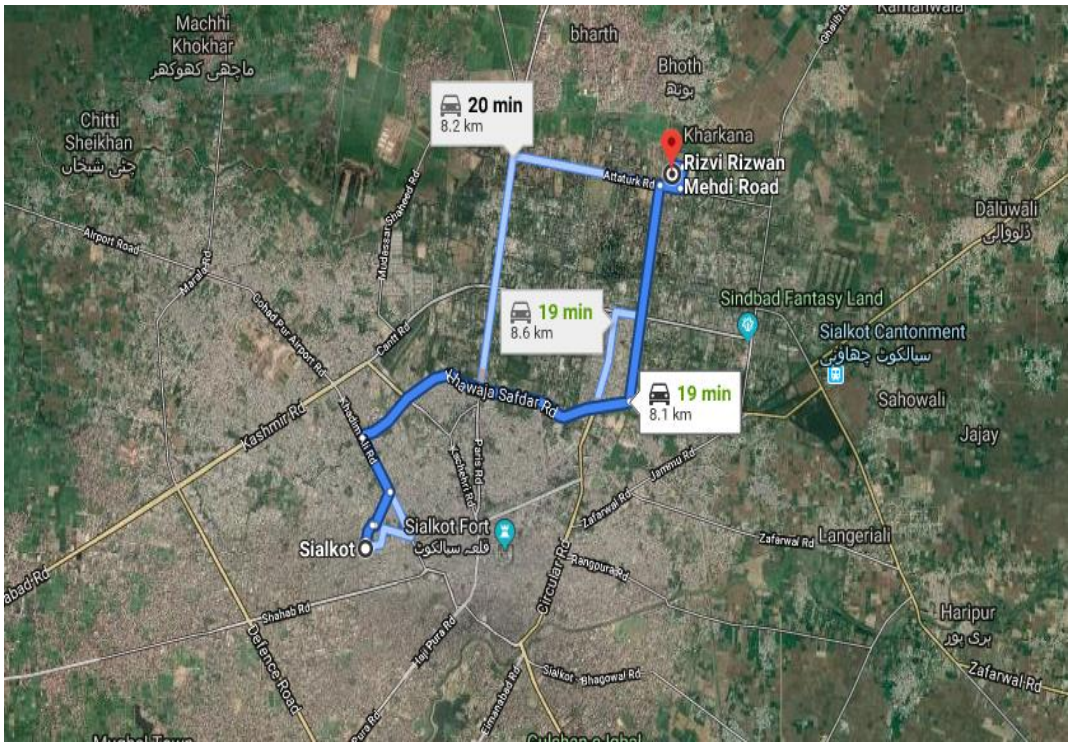
ROUTE MAP: LAHORE TO SITE



Sialkot

1 MWp Solar PV On-Grid system is to be installed at the allocated space in Sialkot Cantt. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

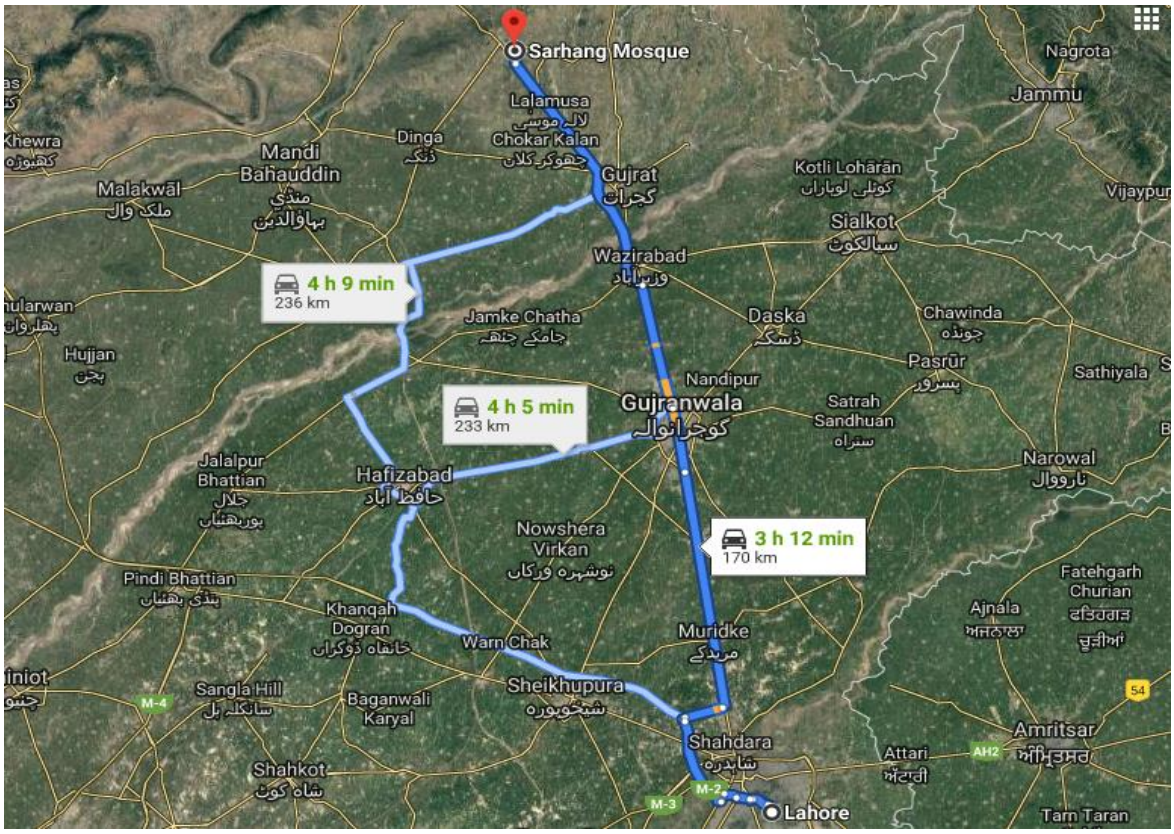
ROUTE MAP: SIALKOT CITY TO SITE



Kharian

2.5 MWp Solar PV On-Grid system is to be installed at the allocated space in cantonment area of Kharian. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

ROUTE MAP: LAHORE TO SITE



Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan

T +92(21)3529 4301-6
F +92(21)35294311

www.solis-energy.com

Project Rationale

GHQ-Military Engineering Services (MES) intends to install a Grid-Tie Solar PV Power Plant at different locations in their premises, by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load. The Military Engineering Services - GHQ wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, GHQ has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

Solis Delta Energy is found to be very much suitable among different EPC contractors technically as well as financially, therefore GHQ has awarded the project to Solis Delta Energy.

Technology

- Solar PV Grid tie system with all necessary protection, instrumentation, monitoring, control and synchronizing with Grid.
- Solar based Power Generation System, civil structures and Auxiliaries
- 400 V LV cable for inverter output. 11 KV MV cable used for interconnection with existing VCB and control wires.
- 330 Wp PV Modules of Tier 1 Manufacturer with 17.0% efficiency.
- Grid-Tie smart inverter with all necessary protections.
- Dual string DC combiner box to isolate the DC part when required.
- LV Panel containing Energy Meter, AC Breakers and necessary indications.
- All the electrical installations and wiring for the PV System in accordance with the codes and standard.

Project Location

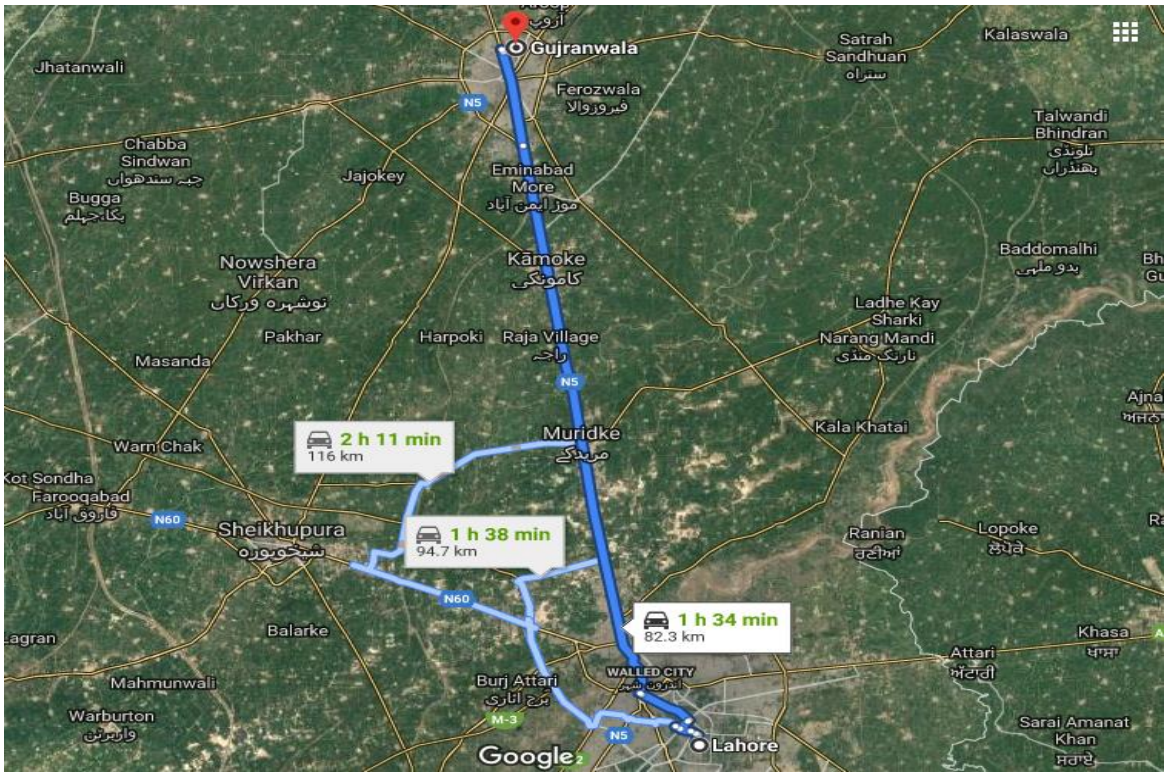
GHQ has different locations, which are very much feasible for the installation of Solar PV System.

Site Name	Capacity	Location	Geographical Coordinates
Gujranwala	3 MW	90 KM from Lahore, Punjab.	32.24^0N, 74.09^0E
Sialkot	1 MW	Sialkot Cantt	32.53^0N, 74.56^0E
Kharian	2.5 MW	170 KM from Lahore, Punjab.	32.16^0N, 73.41^0E

Gujranwala

Site for the project covers an area of 10 acres and is located 90 km from Lahore. The Geographical coordinates of the site are 32.24^0N and 74.09^0E. The area can be approached by Road using National Highway or GT Road.

ROUTE MAP: LAHORE TO SITE



Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan

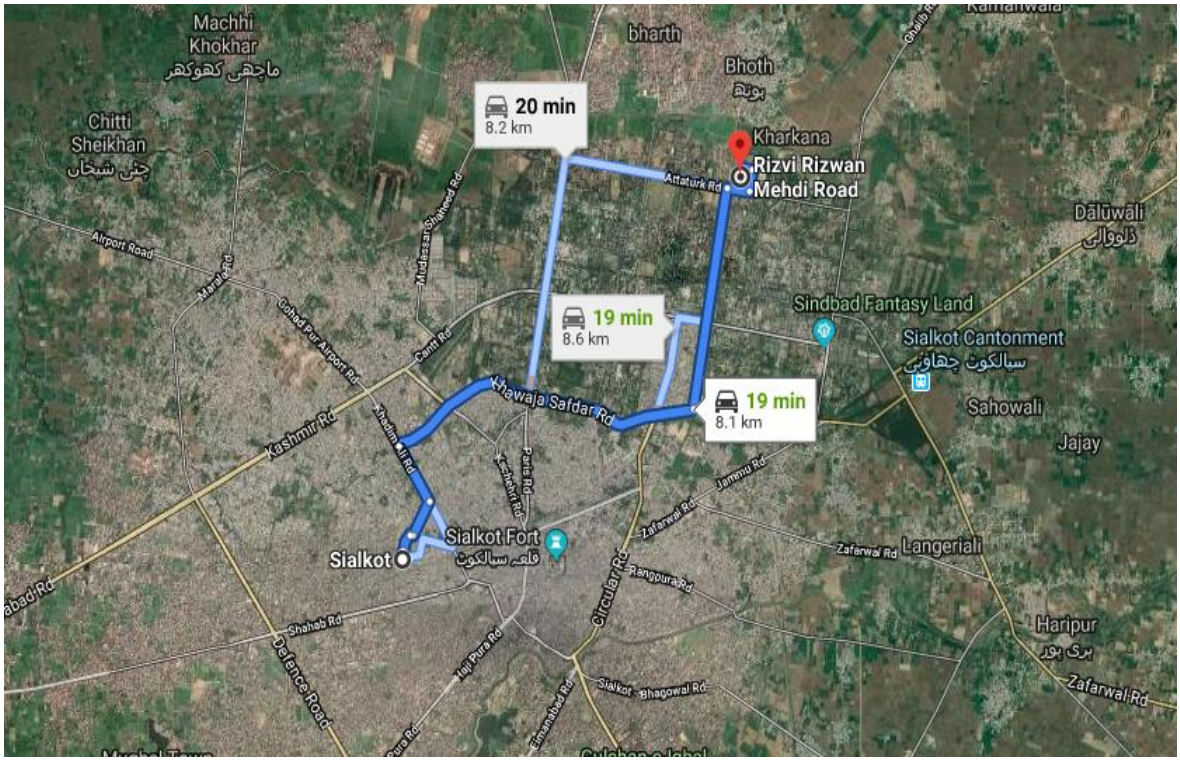
T +92(21)3529 4301-6
F +92(21)35294311

www.solis-energy.com

Sialkot

Site for the project covers an area of 2.22 acres and is located at Sialkot Cantt. The Geographical coordinates of the site are 32.53^0N and 74.56^0E.

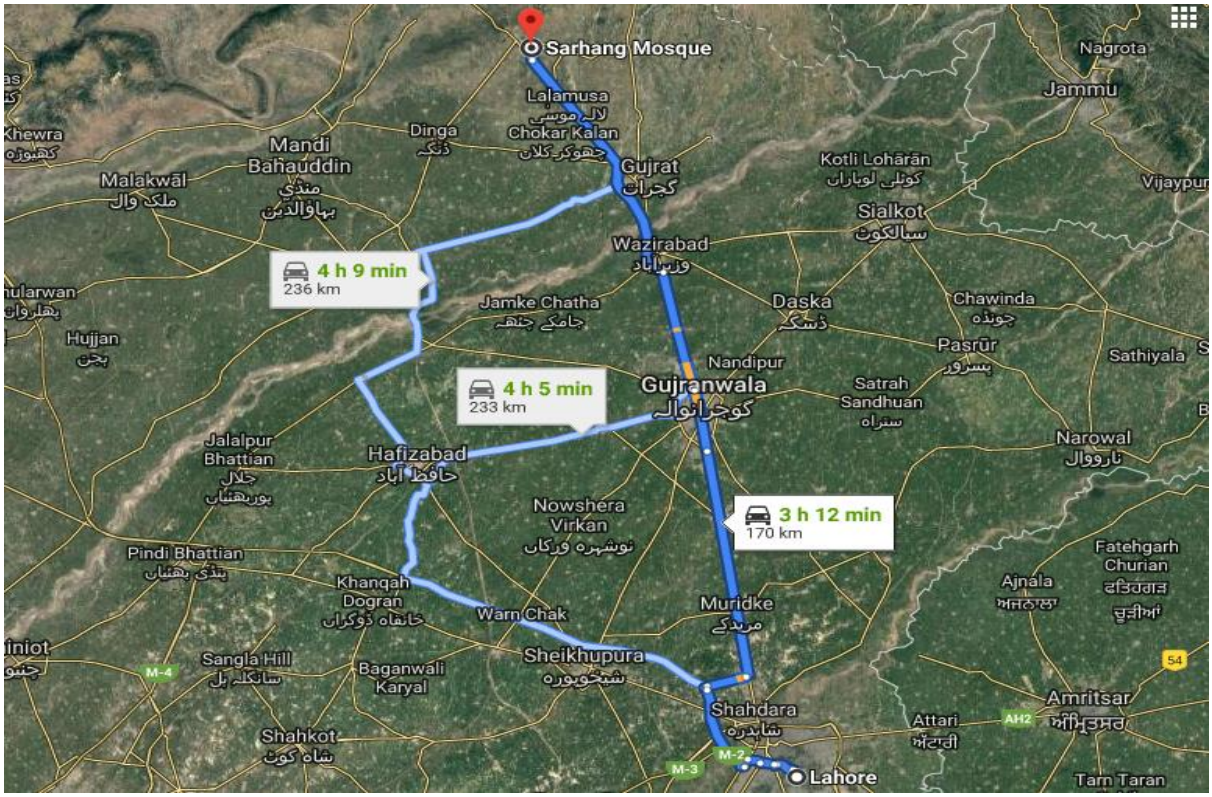
ROUTE MAP: SIALKOT CITY TO SITE



Kharian

Site for the project covers an area of 5 acres and is located 170 km from Punjab. The Geographical coordinates of the site are 32.16^0N and 73.41^0E. The area can be approached by Road using National Highway or GT Road.

ROUTE MAP: LAHORE TO SITE



Operations & Maintenance Cost

The project also includes 24/7 O&M of the complete PV plant including all its relevant system and equipment. This cost will include the following items inclusive of all importation and local charges, duties, taxes, etc.

- Provision of all manpower as duly approved by the company.
- Provision of all consumable material and parts.
- Provision of all routine and preventive maintenance parts.
- Periodic cleaning of PV modules.
- Timely update of inverter's firmware (if necessary).
- Periodic maintenance of Electrical distribution board parts.
- Corrective maintenance of inverter or electrical panels in case of any fault.

Environmental Assessment

Effective environmental planning and management depends on reliably predicting the project's effects on resources. The basis for the prediction is the knowledge of the proposed project of local resources with which it is expected to interact, and how similar projects elsewhere have affected the environment. Adverse effects that cannot be mitigated become residual and must be acceptable for the project to go forward.

Environmental and social impact attributable to the Project can broadly be classified into those taking place before construction and those occurring during operation. Some of the impacts can be anticipated and avoided through appropriate provisions in the project design. Some can be mitigated by careful implementation of the Project while some other can be adjusted with by appropriately following the operational manual and an affective collaboration with communities.

ANNEXURE – 16

SCHEDULE- III

Location Maps, Site Maps, Land

LOCATION MAP AND SITE MAP

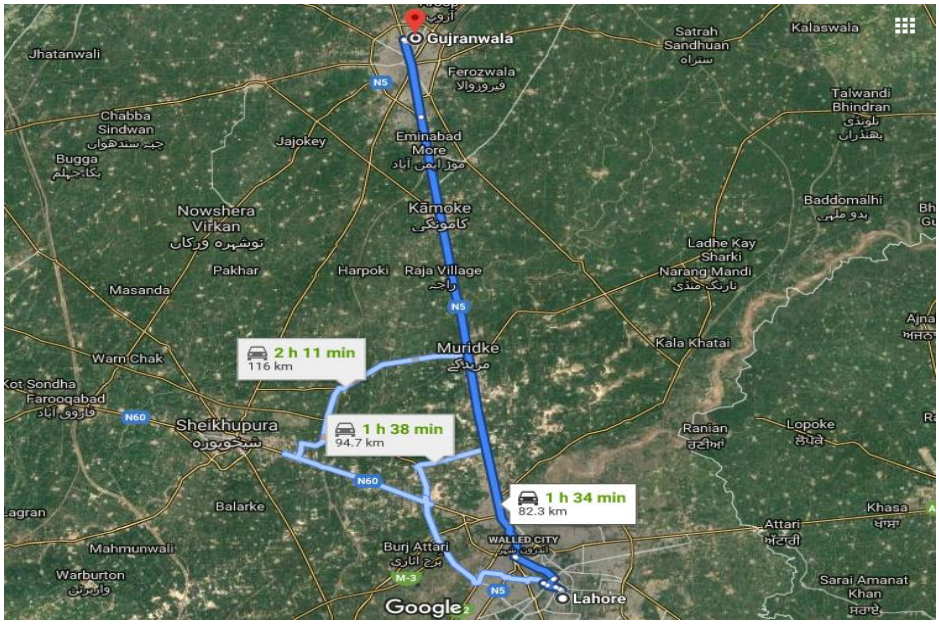
GHQ has different locations which are very much feasible for the installation of Solar PV Plant.

Site Name	Capacity	Location	Geographical Coordinates
Gujranwala	3 MW	90 KM from Lahore, Punjab.	32.24^0N, 74.09^0E
Sialkot	1 MW	Sialkot Cantt	32.53^0N, 74.56^0E
Kharian	2.5 MW	170 KM from Lahore, Punjab.	32.16^0N, 73.41^0E

Gujranwala

Site for the project covers an area of 10 acres and is located 90 km from Lahore. The Geographical coordinates of the site are 32.24^0N and 74.09^0E. The area can be approached by Road using National Highway or GT Road.

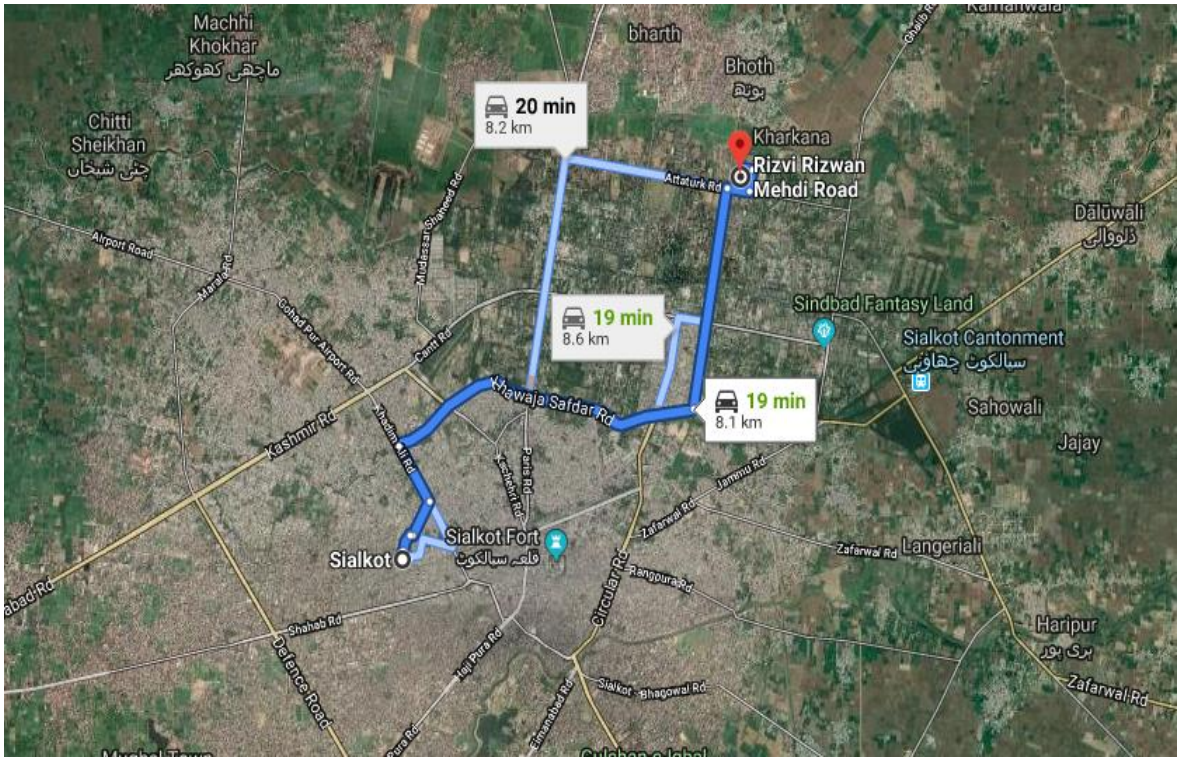
ROUTE MAP: LAHORE TO SITE



Sialkot

Site for the project covers an area of 2.22 acres and is located at Sialkot Cantt. The Geographical coordinates of the site are 32.53^{0}N and 74.56^{0}E.

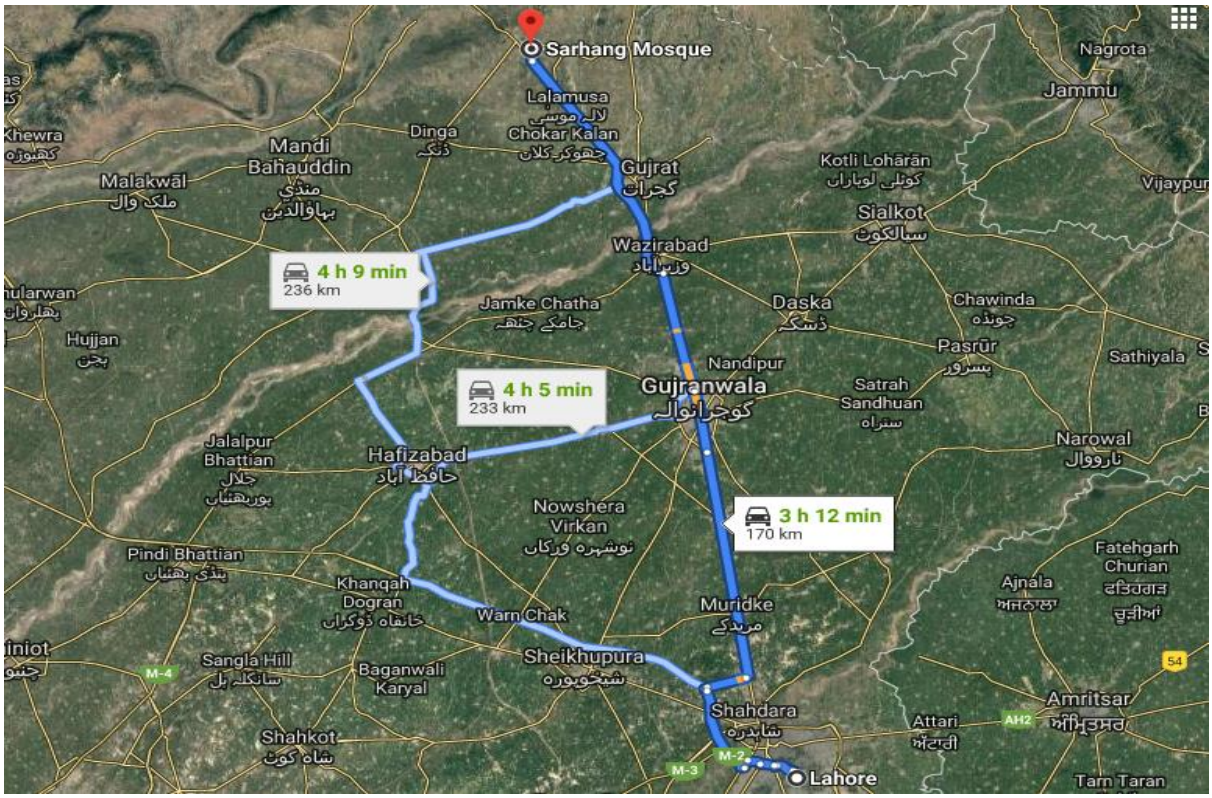
ROUTE MAP: SIALKOT CITY TO SITE



Kharian

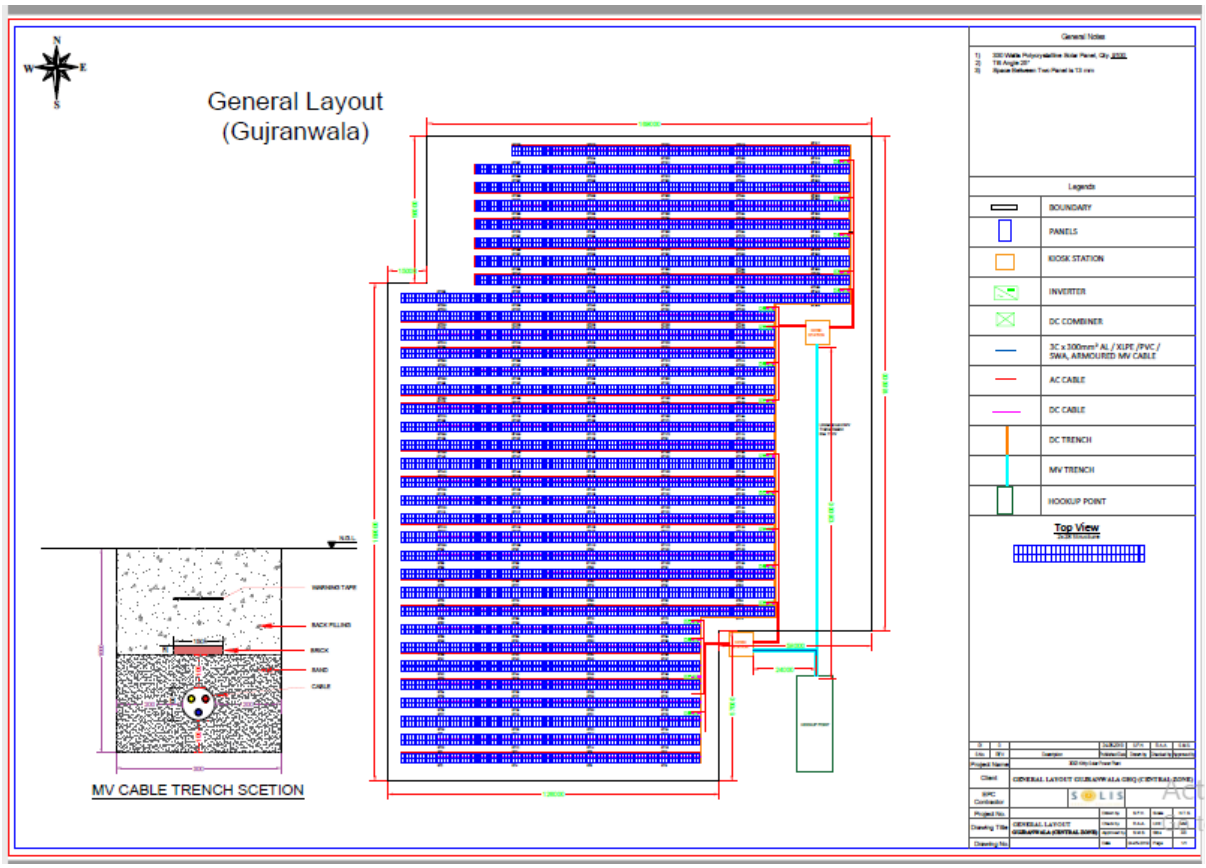
Site for the project covers an area of 5 acres and is located 170 km from Punjab. The Geographical coordinates of the site are 32.16^{0}N and 73.41^{0}E. The area can be approached by Road using National Highway or GT Road.

ROUTE MAP: LAHORE TO SITE

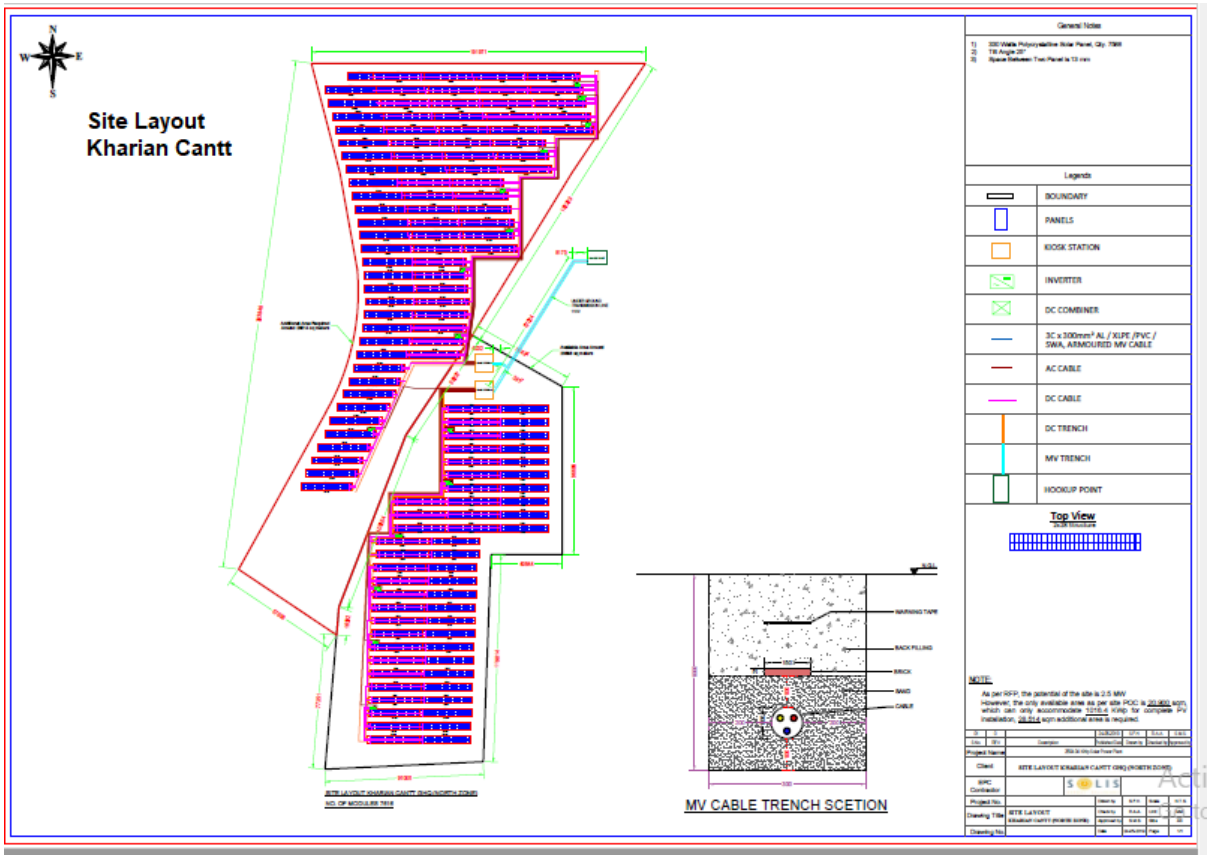


Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4, Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

SITE LAYOUTS



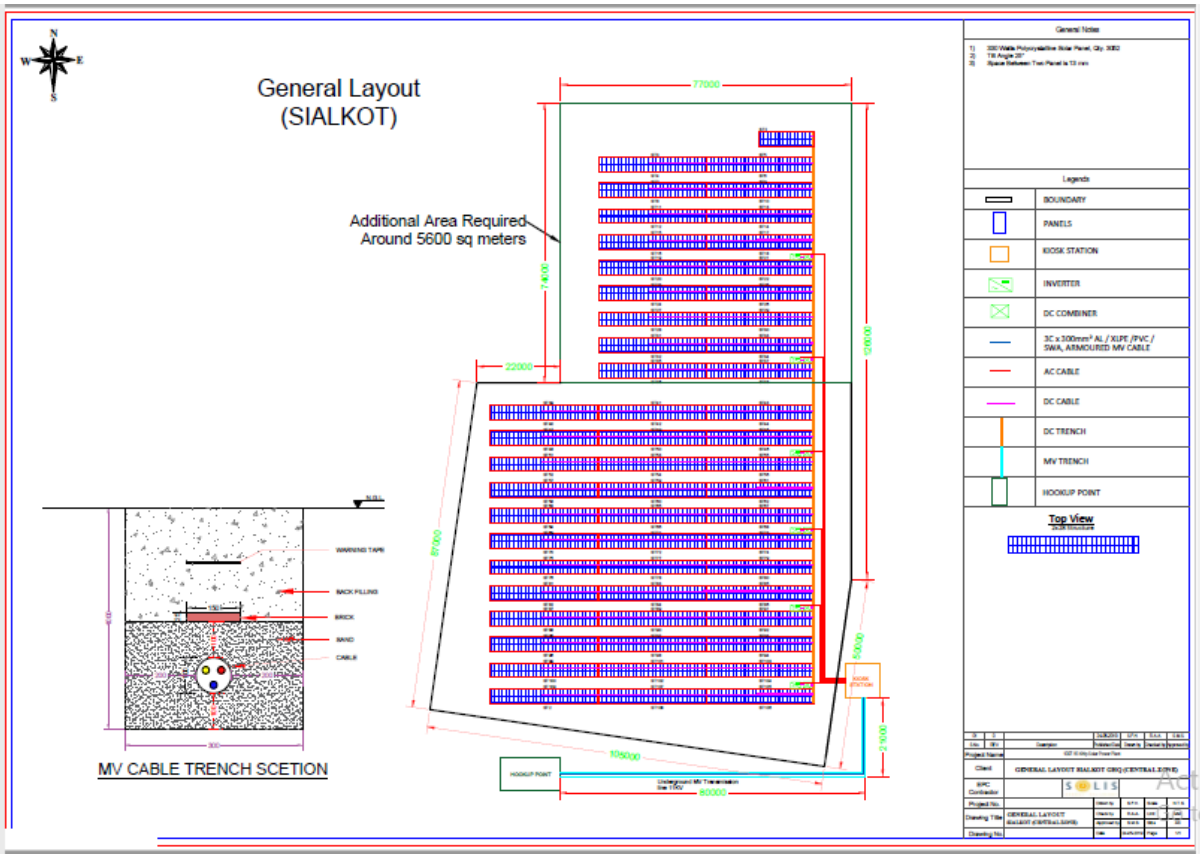
Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com



Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan

T +92(21)3529 4301-6
F +92(21)35294311

www.solis-energy.com



Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan

T +92(21)3529 4301-6
F +92(21)35294311

www.solis-energy.com

Interconnection with National Grid

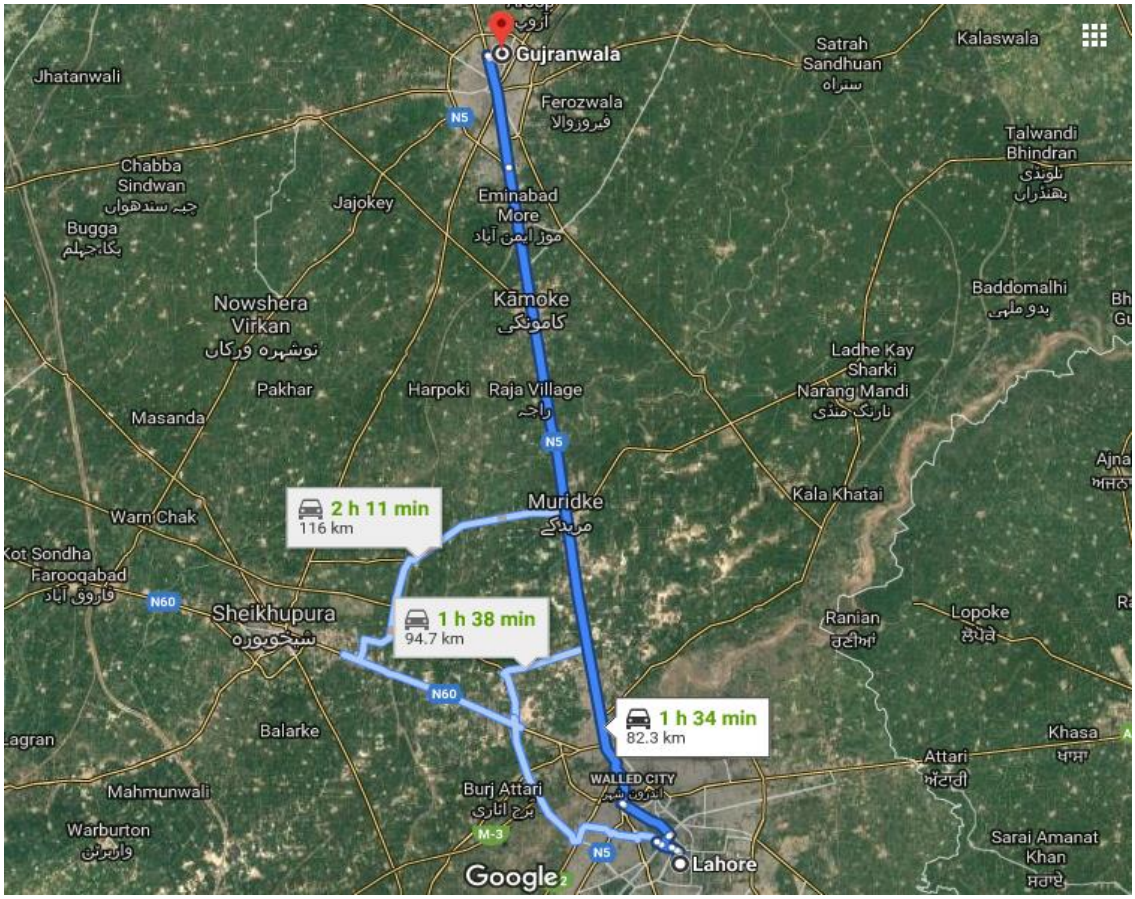
Not Applicable. Since, this plant is not connected to the national grid.

INFRASTRUCTURE

Gujranwala

3 MWp Solar PV On-Grid system is to be installed at the allocated space in cantonment area of Gujranwala. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

ROUTE MAP: LAHORE TO SITE

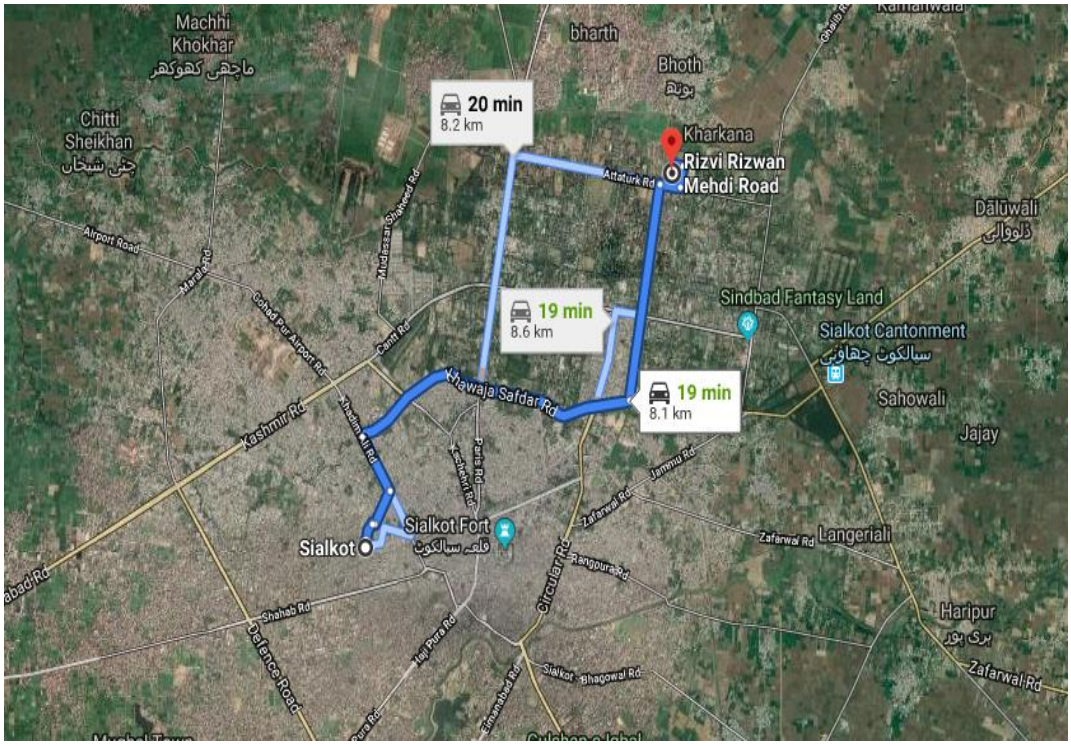


Sialkot

1 MWp Solar PV On-Grid system is to be installed at the allocated space in Sialkot Cantt. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from

solar to the grid.

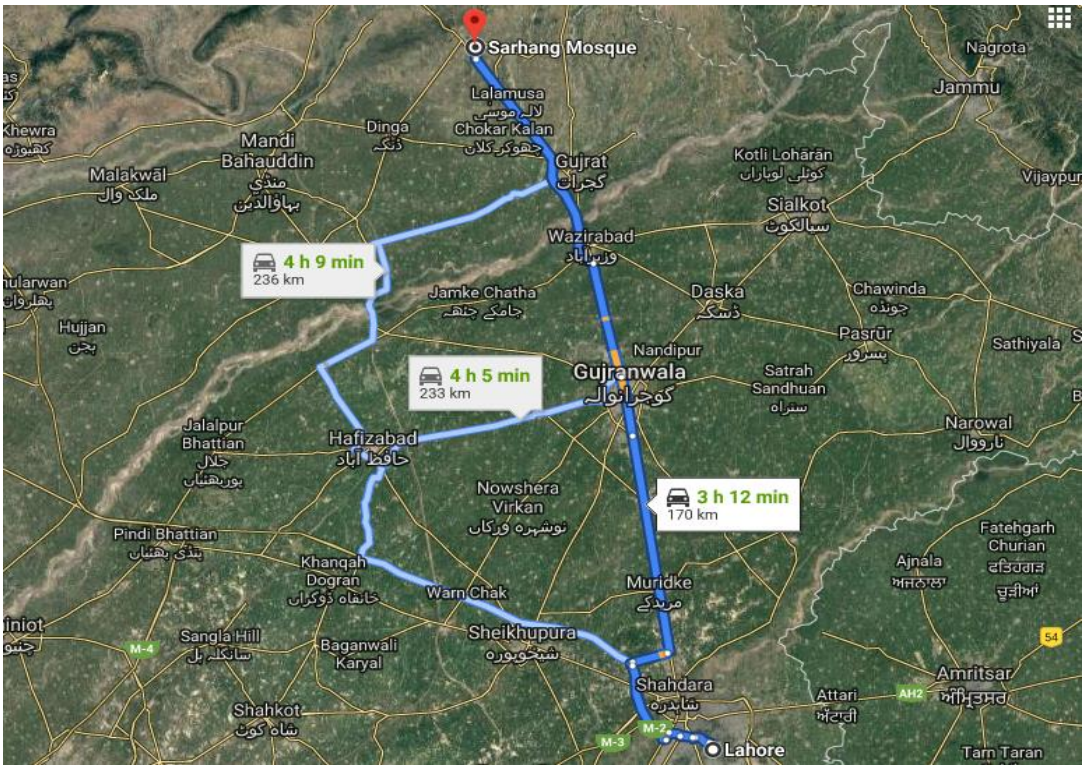
ROUTE MAP: SIALKOT CITY TO SITE



Kharian

2.5 MWp Solar PV On-Grid system is to be installed at the allocated space in cantonment area of Kharian. The designing of the system is done by considering total available area, minimum and maximum operating load and synchronizing voltage. Main objective of installing solar plant is to minimize the electricity utilization from the grid and revert the extra generated units from solar to the grid.

ROUTE MAP: LAHORE TO SITE



Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan

T +92(21)3529 4301-6
F +92(21)35294311

www.solis-energy.com

Project cost, information regarding sources and amounts of equity, debt.

Feasibility & Financing:

The project at Gujranwala Cantt up to 3 MW will cost approximately **PKR 276,607,554.**

Gujranwala Cantt up to 3 MW	
Project Cost	**PKR**
EPC	273,479,458
Insurance During Construction	395,522
CAPEX	**273,874,980**
Financing Fee	553,211
Interest During Construction	2,179,362
PROJECT COST	**276,607,554**
Equity	**55,323,106**
Debt	**221,284,447**

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

The project at Kharian Cantt up to 2.5 MW will cost approximately **PKR 230,506,295.**

Kharian Cantt up to 2.5 MW	
Project Cost	**PKR**
EPC	227,899,548
Insurance During Construction	329,602
CAPEX	**228,229,150**
Financing Fee	461,009
Interest During Construction	1,816,135
PROJECT COST	**230,506,295**
Equity	**46,102,589**
Debt	**184,403,706**

The project at Sialkot Cantt up to 1 MW will cost approximately **PKR 92,202,518.**

Sialkot Cantt up to 1 MW	
Project Cost	**PKR**
EPC	91,159,819
Insurance During Construction	131,841
CAPEX	**91,291,660**
Financing Fee	184,404
Interest During Construction	726,454
PROJECT COST	**92,202,518**
Equity	**18,441,035**
Debt	**73,761,482**

The total project will cost approximately **PKR 599,316,366**

Project Cost	**PKR**
EPC	592,538,825
Insurance During Construction	856,965
CAPEX	**593,395,790**
Financing Fee	1,198,624
Interest During Construction	4,721,952
PROJECT COST	**599,316,366**
Equity	**119,866,730**
Debt	**479,449,636**

PROJECT COMMENCEMENT AND COMPLETION:

The project completion time would be 6 months, covering all the sites of the project. The expected Commercial Operation Date (COD) is 26th February 2020.

Major activities of the project involve, Detailed Engineering Design, Procurement of local and Imported Equipment, and Construction involving Civil, Mechanical and Electrical Works.

S#.	Milestone	Timeline
1.	Detailed Design	Jun, 2019
2.	Equipment's Procurement	Jun, 2019 – Dec, 2019
3.	Project Construction	Aug, 2019 – Feb, 2020
4.	Commissioning	Feb, 2020
5.	Testing	Feb, 2020

ENVIRONMENTAL REPORT OF GUJRANWALA

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

GHQ-Military Engineering Services (MES) is interested to install Solar PV Panels on the Ground Mounted structure with capacity of 3.0 MW (500kW) in Gujranwala Cantt. Around 9128 polycrystalline (Tier 1 Manufactured) PV panels will be installed with power rated of 330 Wp and the capacity factor is approximately 16.7%. the total energy generation will around 4.41 Million kWh.

The Military Engineering Services (MES)- GHQ wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, GHQ has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 PROJECT BACKGROUND AND JUSTIFICATION

The project sponsor is GHQ-Military Engineering Services (MES). The sponsors of the company will be interested to install the solar PV plant to generate electricity. GHQ-Military Engineering Services (MES) intends to install a Grid-Tie Solar PV Power Plant at different location in their premises, by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load of 3.0 MW Solar PV Plant has been designed for Gujranwala Cantt which will get synchronize with the conventional 11 KV Grid already present at the site. The site is located at Gujranwala Cantt in the province of Punjab.

1.2 Description of the Project

The project company will be installed 3.0 MW of Solar PV plant in Gujranwala Cantt to produce electricity. The total area of the project is around 10.12 acres for the installation of PV panels. The project area is already a developed area and the solar PV panels will be installed with Ground Mounted structure in Gujranwala Cantt.

1.3 Project Location

The proposed project site lies between 32°14'23.00"N & 74° 5'28.00"E, located in Gujranwala Cantt, Gujranwala, Punjab. It is around 15.5 kilometers away from Gujranwala City. The land area of project site is 10.12 acres located near Cantt Road, Gujranwala Cantt. The project land is owned by the project company for the installation of 3.0 MW Solar PV plant**.** The location of site can be viewed in **Figure 1.1** and overview of the project site is shown in **Figure 1.2.**

Figure 1.1: Location of Project Site

Figure 1.2: Overview of Project Site (Picture-1)

Figure 1.3: Overview of Project Site (Picture-2)

CHAPTER 2

SOLAR ENERGY IN PAKISTAN

2 PROSPECTS OF SOLAR ENERGY IN PAKISTAN

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

To summarize, the sun shines for 250-300 days per years in Pakistan with an average sun shine hour of 8-9 per day. This gives huge amount of energy to be used for electricity generation by solar thermal power plants. A quick potential of solar energy in Pakistan can be obtained from the map of solar energy resource released by World Bank Group from 1999 to 2016 as shown in **Figure 2.1.**

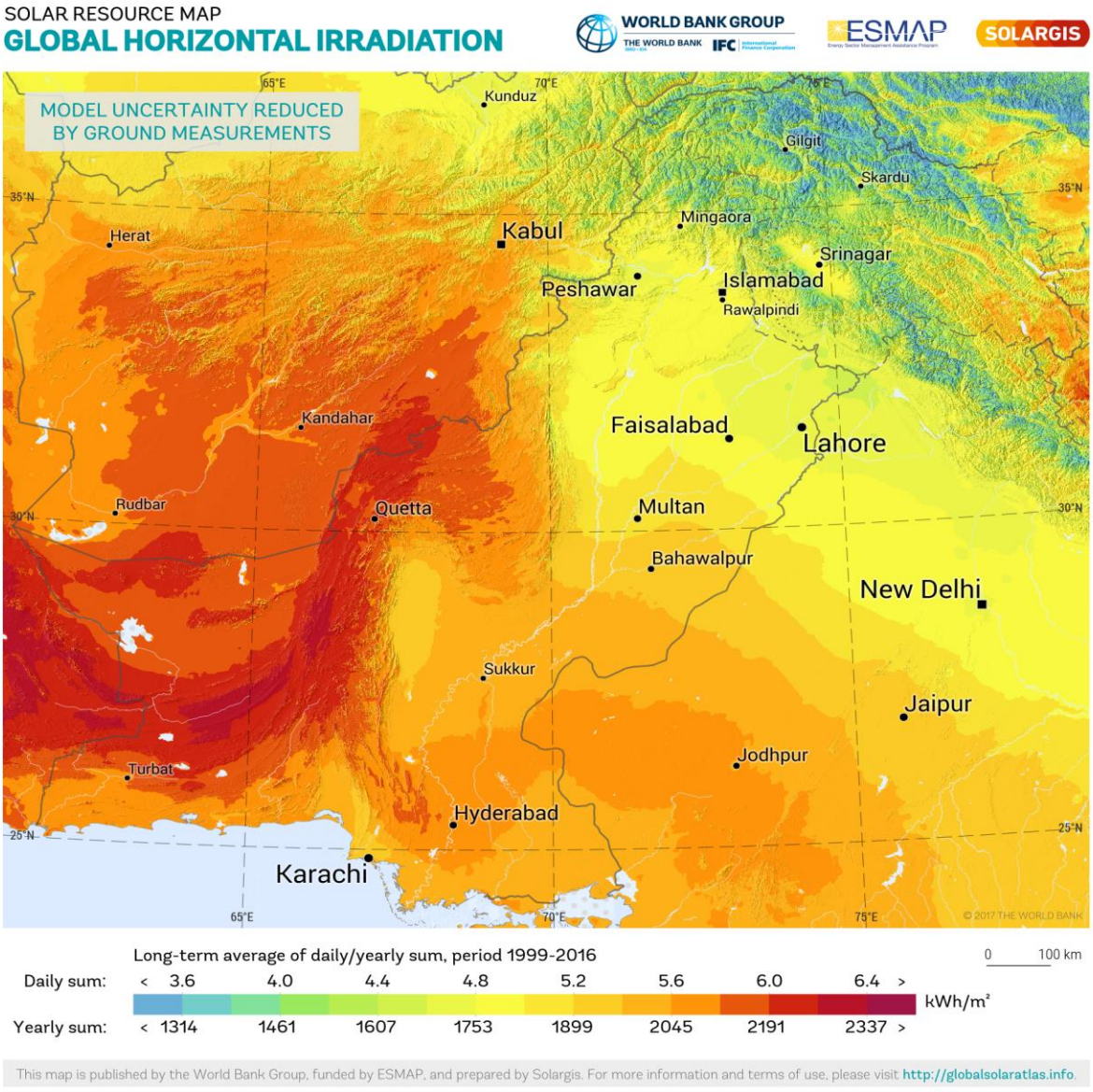


Figure 2.1: Solar Resource Potential Map of Pakistan

2.1 Road Access to the Project Site

The Project site is easily accessible throughout the year. Distance from Gujranwala City to the Lahore is approx. 107 kms. One way from Lahore to Gujranwala city, goes from Jail road towards Tollinton Market road which turn towards the Lahore-Kasur Road then move towards the link ferozepur road which turns left towards the National Highway N-5 road which turns right towards the Main Blvd Gulshan-e-Ravi road, after that it touches the Hakeem Muhammad

Ajmal Khan road then touched the Lahore Islamabad motorway M-2 then move towards the Lahore Bypass which touched the National Highway N-5 then take right towards the Gujranwala city. The distance from Lahore to project site as shown in **Figure 2.2**.

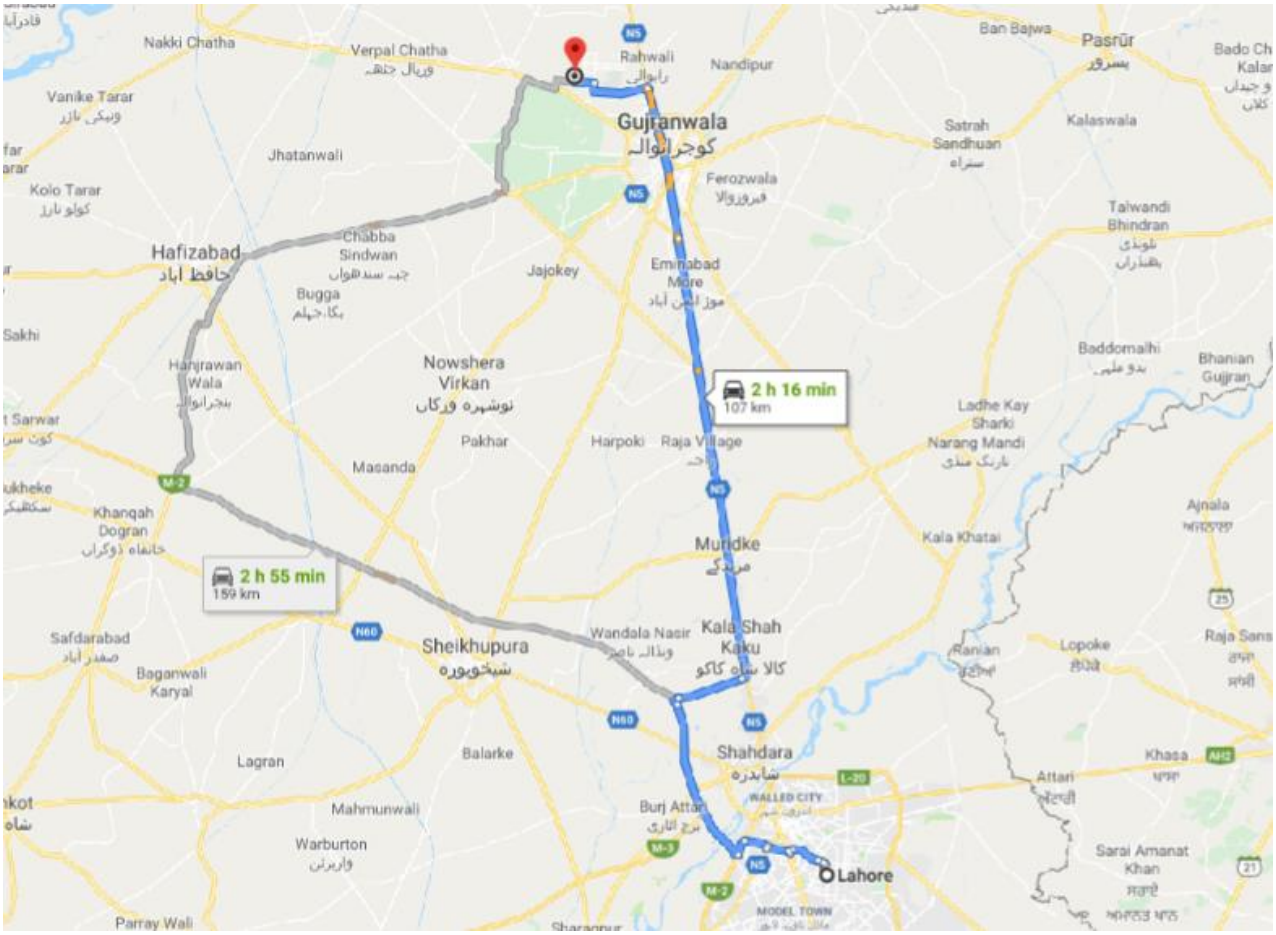


Figure 2.2: Distance from Lahore to the Project Site

From Gujranwala city to project site reached Khalid Bin Waleed Road then move towards the Sialkot Bypass Road and further move towards the National Highway N-5 Grand Trunk road which is then move towards the Cantt road which is around 15.5 km from the city as shown in **Figure 2.3** and Arial distance from city to the project site is shown in **Figure 2.4.**

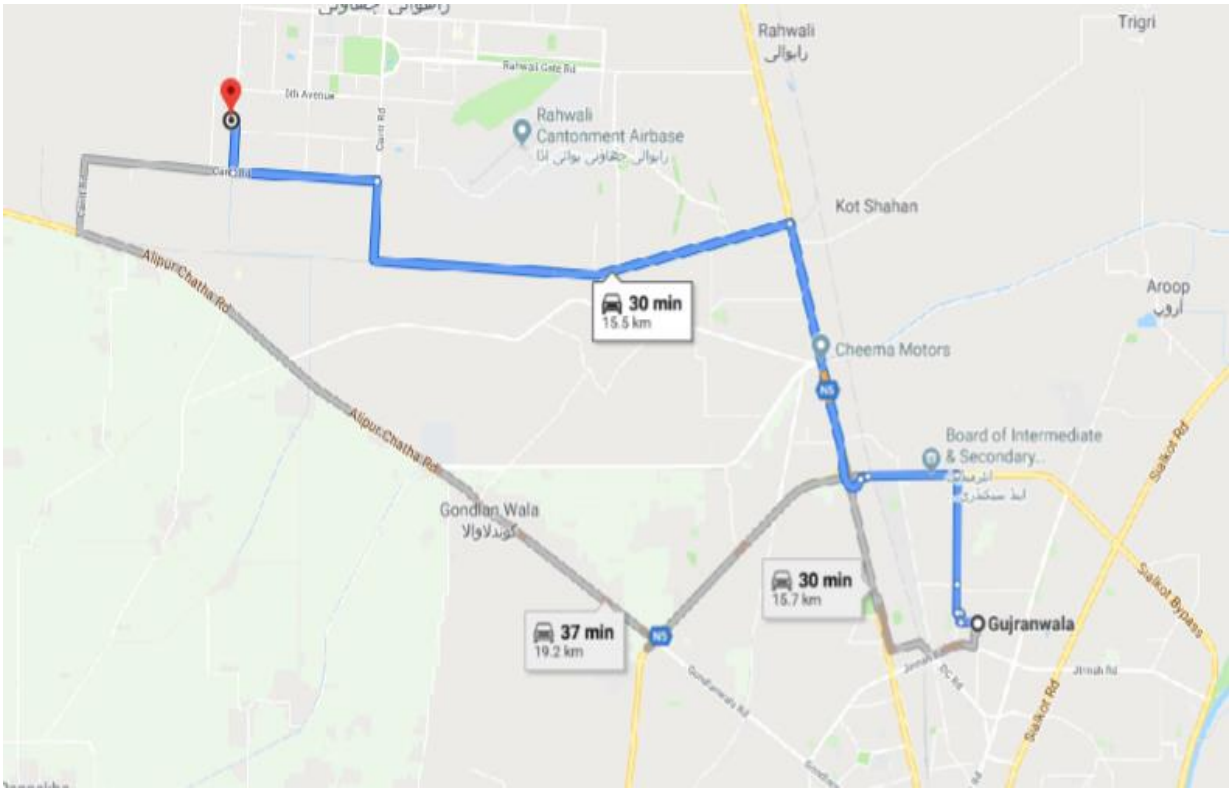


Figure 2.3: Orientation of Project Site from Gujranwala City

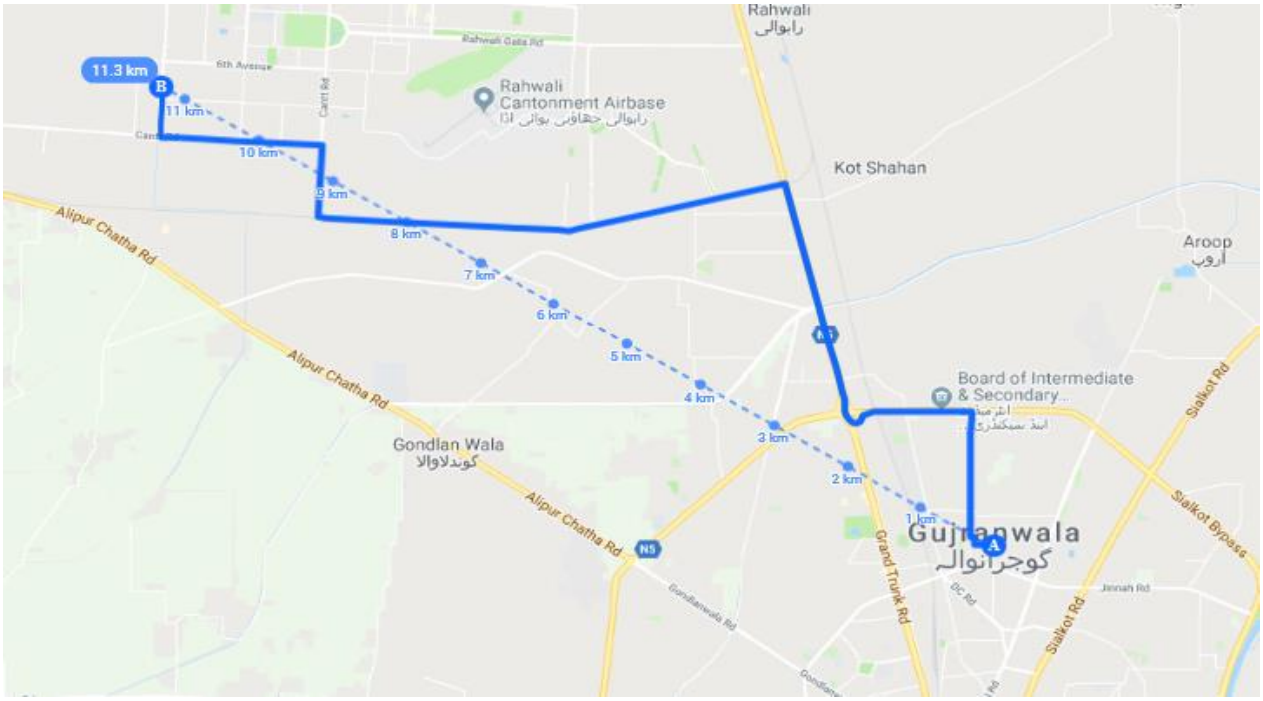


Figure 2.4: Orientation of Project Site from Gujranwala City (Arial Distance)

The planned movement from Port Qasim to the site will be through the National and Super highways. The major section of the track from Karachi to the site is a multi-lane road, having a relatively flat terrain.

CHAPTER 3

BASELINE CONDITIONS

3 Baseline Conditions

The Baseline condition includes the different parameters which covers under this study are topography, climatic conditions, hydrology, biological conditions, socio-economic environment and seismic hazards.

3.1 Topography

Gujranwala lies between 32° 9'16.12"N and 74°11'3.18"E. The district lies in between two main cities, in North is the Gujrat and in South, there are Sheikhupura and Lahore. The Chenab River forms the Northern boundary of the district. Beyond the river, it is bounded by Gujrat and Mandi Bahauddin districts, on the East by Sialkot district, on the South by Sheikhupura district and on the West by Hafizabad district. Gujranwala district spreads over an area of 3,622 square kilometers comprising of following seven Towns

Gujranwala is a city in Punjab, Pakistan, that is located north of the nearby provincial capital of Lahore. The city is Pakistan's 7th most-populous metropolitan area, and its 5th most populous city proper. Founded in the 18th century, Gujranwala is a relatively modern town compared to the many nearby millennia-old cities of northern Punjab. The city served as the capital of the Sukerchakia Misl state between 1763 and 1799, and is the birthplace of the founder of the Sikh Empire, Maharaja Ranjit Singh.

Topographically speaking, the soil is alluvial and fertile. It is a flat strip of land running roughly east to west. Gujranwala sits at the heart of the so-called Rechna Doab - a strip of land between the Chenab in the north, and Ravi River in the south. Gujranwala is also part of the Majha - a historical region of northern Punjab. The city was built upon the plains of Punjab, and the surrounding region is unbroken plain devoid of topographical diversity.
Topographically the area used to be a fairly plain with the ground surface sloping gently from NE to SW. It is also a plain of Alluvial material and scattered rocks at deeper depth. The area is underlain by Pleistocene deposits to a depth of several thousand meters. The first 200 meters

of these deposits consist of approximately 70% silty sand interspersed with limited clay layers. The strata are generally heterogeneous with little vertical or lateral continuity.

Sialkot and Gujrat lie to its north. Gujrat connects Gujranwala with Bhimber, Azad Kashmir, and Sialkot connects it with Jammu. About 160 kilometers (99 mi) southwest is Faisalabad. To its west are Hafizabad and Pindi Bhattian, which connect Gujranwala to Jhang, Chiniot and Sargodha. Gujranwala city is situated at an average elevation of 222 to 227 meters above mean sea level. Topographic map of Gujranwala derived from satellite mapping through GIS software is shown in **Figure 3.1.**

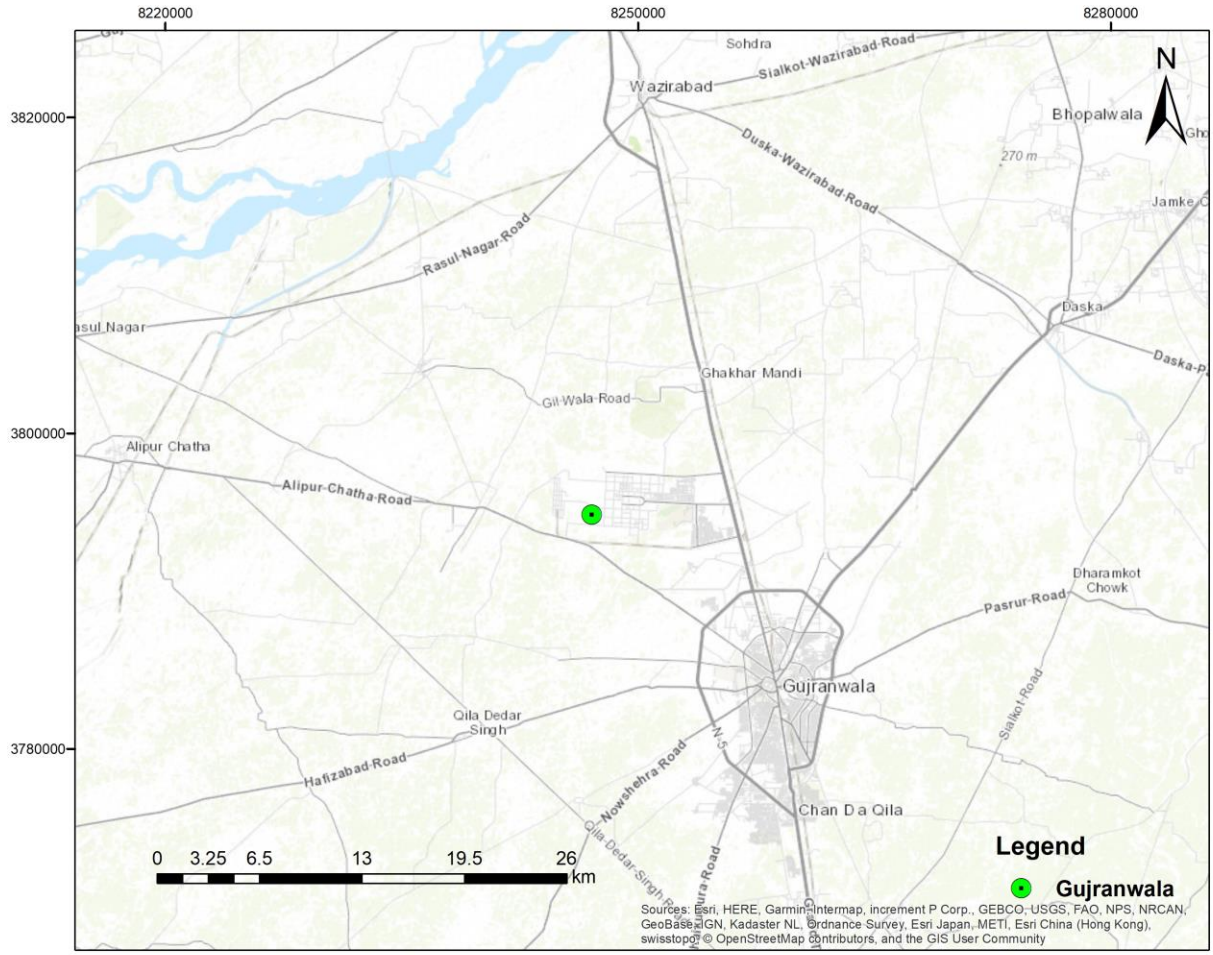


Figure 3.1: Topographic Map of Project Area

3.2 Climatic Conditions

3.2.1 Temperature & Rainfall

The weather conditions of Gujranwala vary from different conditions like; seasonal variations, weather pattern shifts, monsoon season, summer season etc. The climate of the district is hot and dry during summer and moderately cold in winter. The summer season starts from April and ends up in the month of September. June is the hottest month with maximum and minimum temperatures of 40ºC and 27ºC, respectively. Relief is only provided by occasional dust storms. The winter season begins in November and lasts till March. January is the coldest month. The maximum and minimum temperatures during this month are 19ºC and 5ºC, respectively. The sky is frequently overcast during winter with meagre rainfall. The monsoons set in July and continue till September. The eastern part of the district receives more rain.

Pakistan is also facing the change in its climatic conditions, especially in the temperature which seems to be risen considerably. Climate has intrinsic variability and has been changing in past decades, even, before we started measuring the climate parameters. But the uniqueness of this issue in modern world is that human activities are now playing significant role in causing the climate to change. This is evident from the recent rise in carbon dioxide (CO_2) concentration in the atmosphere and in response the rise of global temperatures on land and ocean's surface. Gujranwala does have a rainy season from the end of June until September, and it certainly rains more during this period of time than during the rest of the year but the rain is fairly less even so and January to March in winters as well.

Gujranwala has 7-8 hours of sunshine daily on average. As there will be no rise in temperature due to reflections of the panels on the atmosphere because the panels are lined with anti-reflection coating (ARC) on the surface which help to reduce the reflection of the panels to almost zero. Adopted measures during rain and sandstorm are to generate or produce electricity is to be reduced. The detailed temperature data are given in **Table 3.1** taken from metronome 7.7 and graphical presentation in given in **Figure 3.2.**

Table 3.1: Temperature Statistics for Gujranwala in 2018

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Temperature(˚C)	11.1	15.1	20.8	26.4	32	31.6	30.6	30	27.9	24.7	18	13

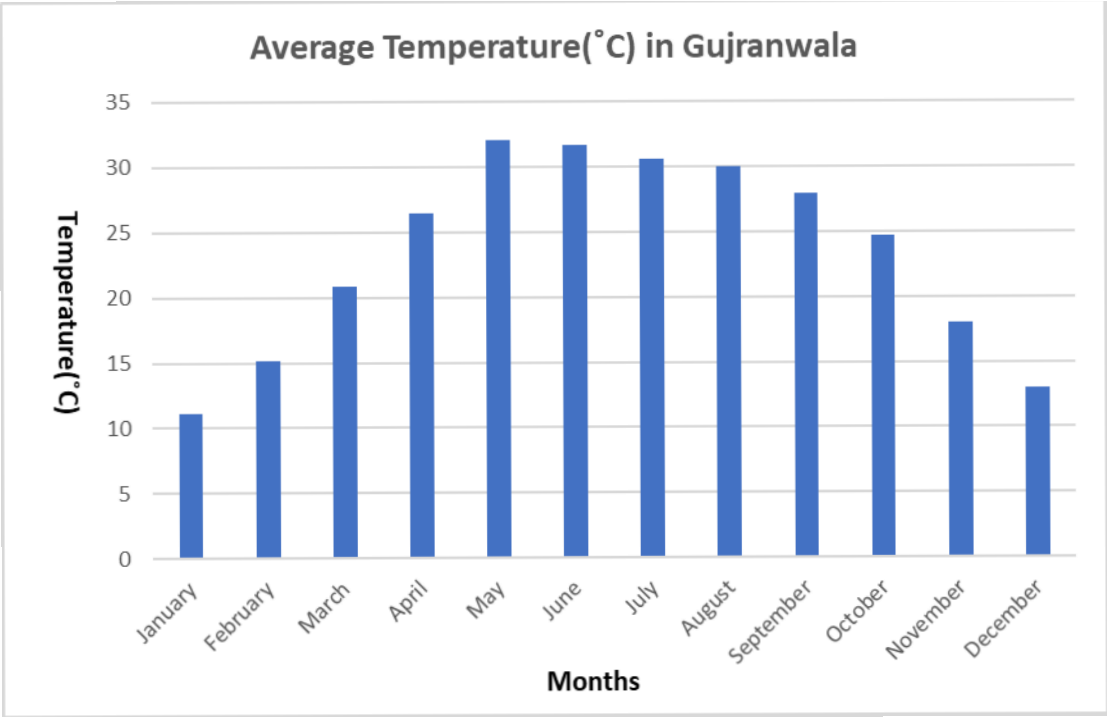


Figure 3.2: Graphical representation of Temperature

The detailed average annual rainfall data are given in **Table 3.2** and graphical presentation in given in **Figure 3.3.**

Table 3.2: Rainfall Statistics for Gujranwala District in 2018

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Precipation (mm)	1.31	18.52	7.59	21.39	11.21	54.02	39.25	24.04	11.43	0.4	11.9	14.6
Days	1	3	7	14	4	7	20	16	7	3	5	3

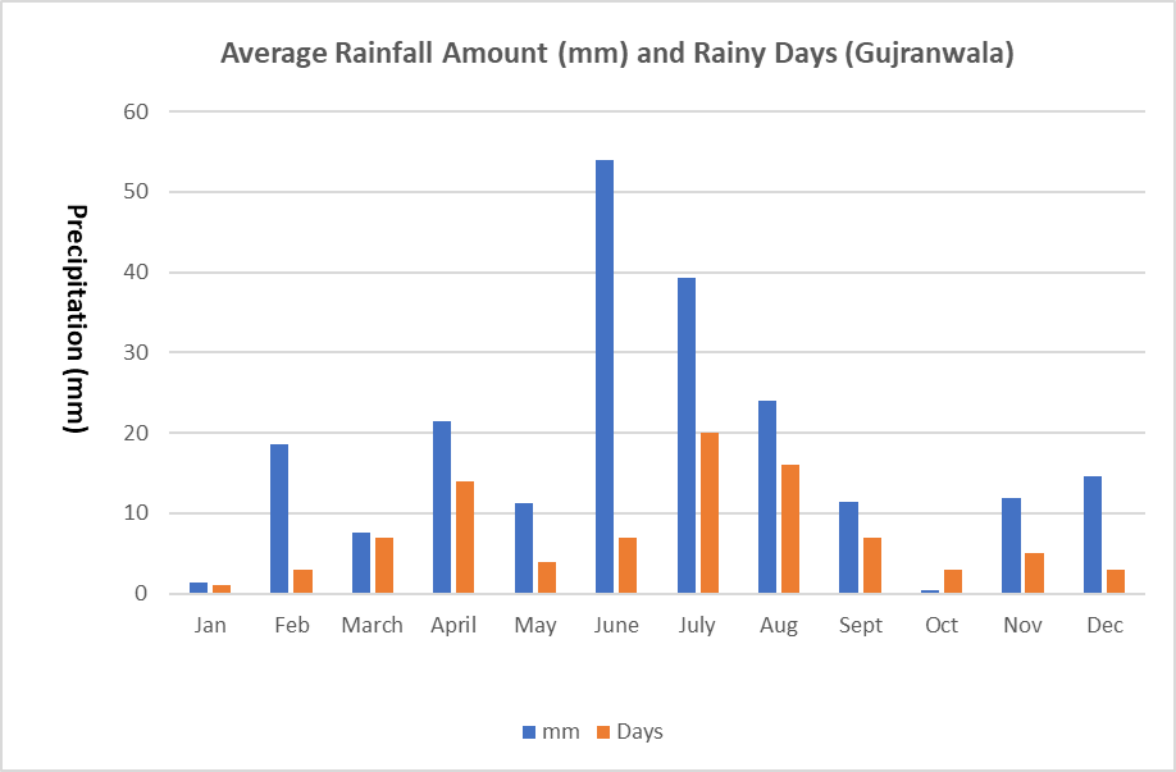


Figure 3.3: Graphical representation of Average Rainfall

Maximum and Minimum Temperature Regime Map of Pakistan is shown in **Figure 3.4**, **Figure 3.5** & **Figure 3.6.**

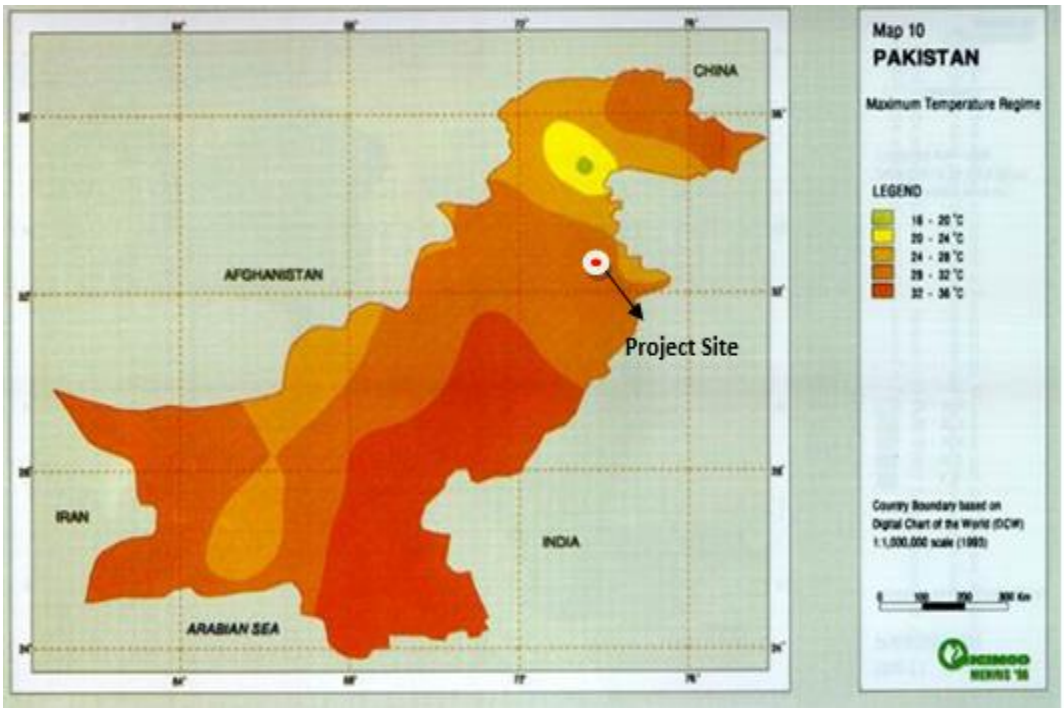


Figure 3.4: Maximum Temperature Regime Map of Pakistan

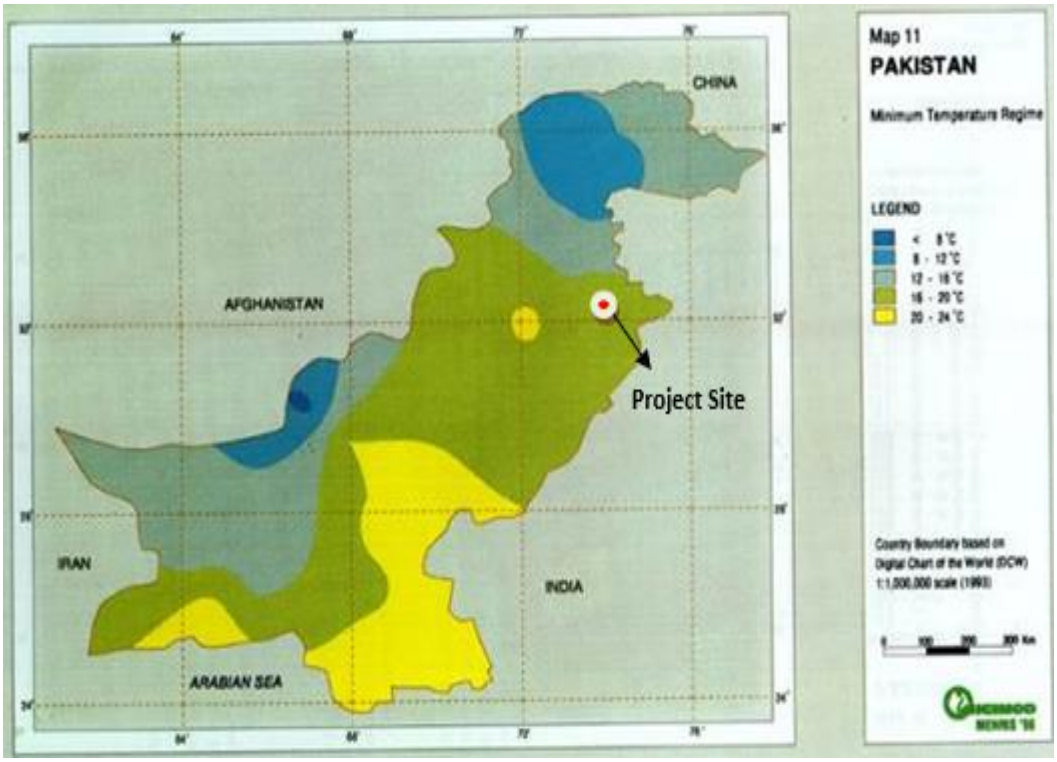


Figure 3.5: Minimum Temperature Regime Map of Pakistan

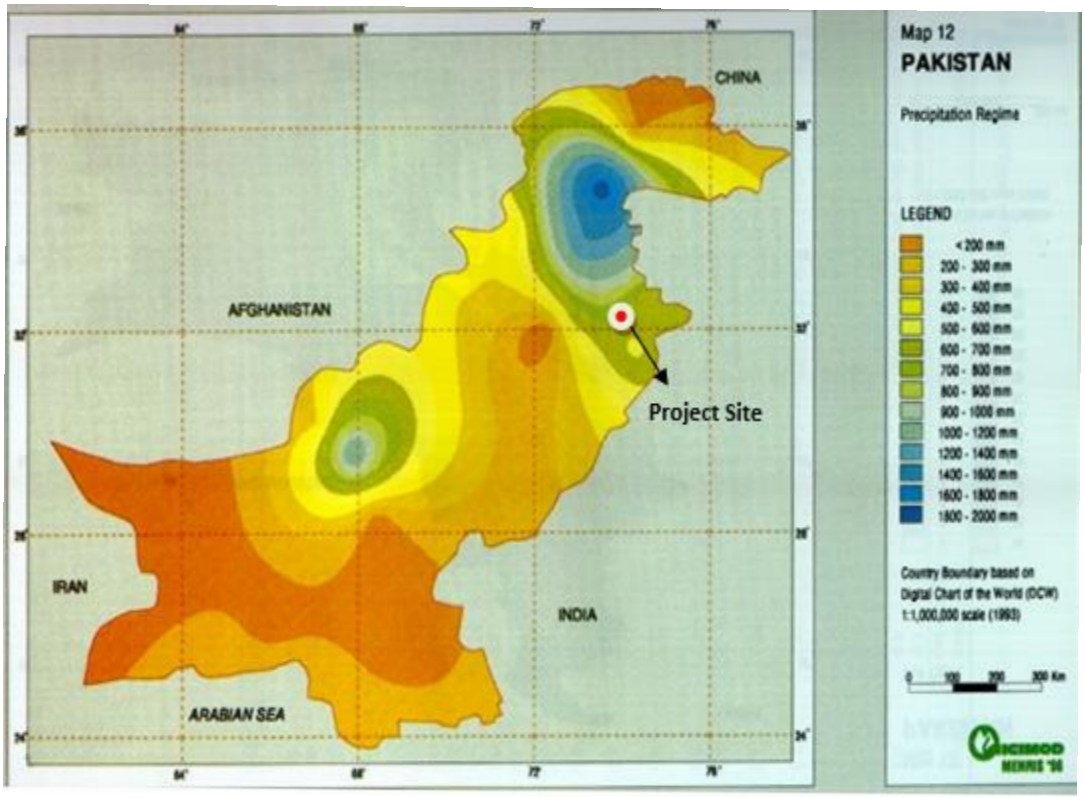


Figure 3.6: Precipitation Map of Pakistan

3.2.2 Wind Speed

The wind speed of any location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. Gujranwala become plain and flat region due to which the gusts and more chances of dust storms occur. Monsoons create steady strong winds on the Tibetan Plateau from December to April, but calm winds from June to October.

In Gujranwala, the windiest month is May and June, followed by April and July. May average wind speed of around 2.49m/s is considered “a light breeze.” Maximum sustained winds (the highest speed for the day lasting more than a few moments) are at their highest in June where average top sustained speeds reach 2.5m/s. The average wind speed on yearly basis are given below in **Figure 3.7**.

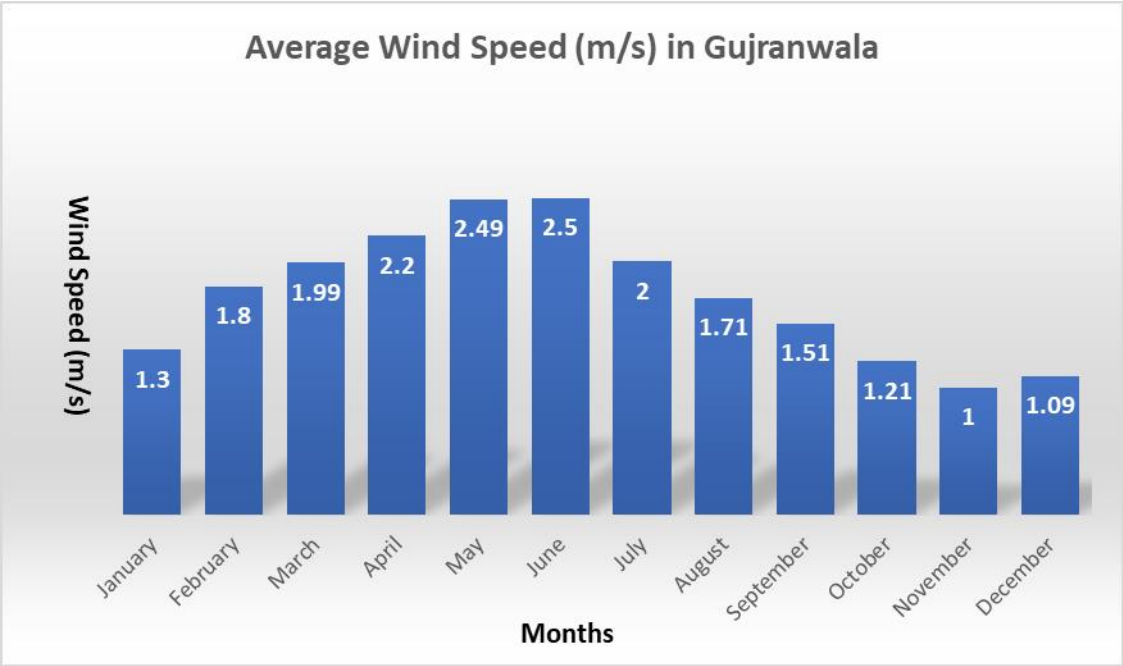


Figure 3.7: Graphical representation of average wind speed in Gujranwala

3.2.3 Relative Humidity

Gujranwala experiences extreme seasonal variation in the perceived humidity. Gujranwala has a hot and semi-arid region; the humidity is high. They have some humid months, and dry months in the opposite season. The least humid month is April & May and the most humid month is August (74%). Average annual humidity is given in **Figure 3.8.**

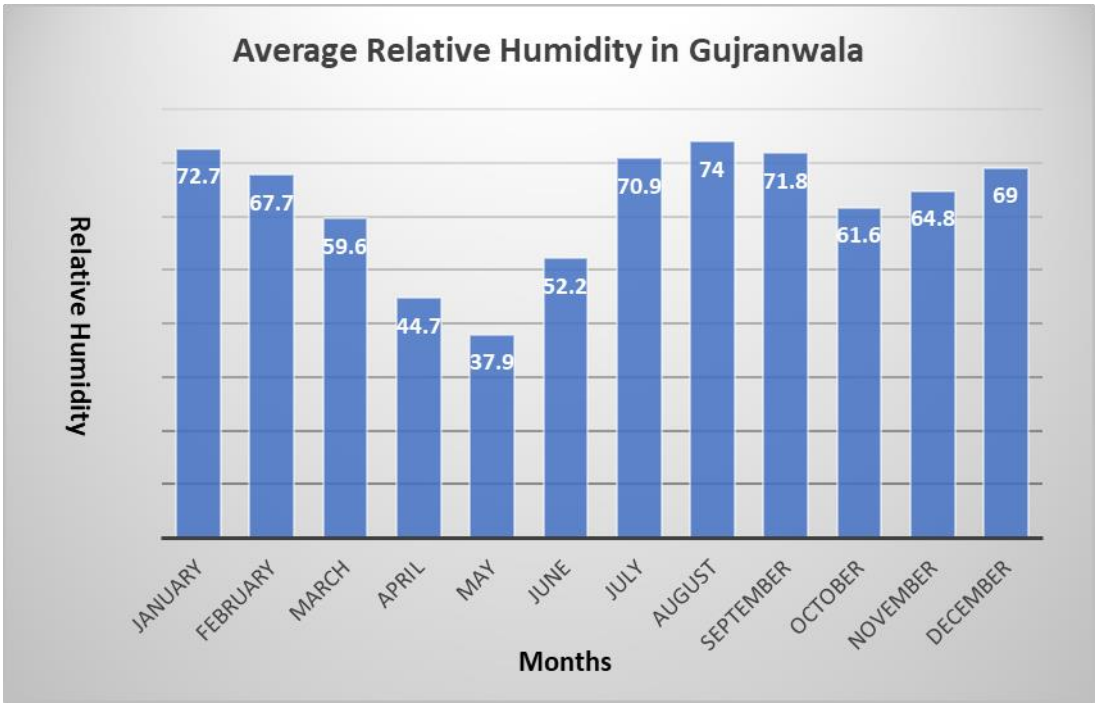


Figure 3.8: Graphical representation of average relative humidity in Gujranwala

3.3 Hydrology

Change in land use, land cover and economic activities affect the climate change in cities and around the cities. There are various causes which are responsible for urban/rural temperature variation like change in the physical physiognomies of the area (thermal capacity, albedo, heat conductivity), like reinstatement of vegetation by concrete and asphalt, change in the rate of evapotranspiration, change in the radioactive fluctuations due to complex geometry of high-rise buildings and streets and anthropogenic heat expulsions.

The hydrogeology of aquifers at different locations in Gujranwala city has been discussed for groundwater recharge, confined aquifers available at various locations have been taken into consideration. The water in unconfined aquifers is mostly less or unavailable and contaminated due to infiltration of toxic elements from the ground surface into the aquifers and mixing of sewage by the possible leakage of underground sewer system. The confined aquifers are available at different locations in Gujranwala at an average depth of about 270 ft with an average saturated thickness of 240 ft.

The total 21 water supply schemes are installed in three tehsils of the district. Tehsil-wise distribution of the schemes, shows that the maximum (10) and the minimum (03) number of water supply schemes are in Wazirabad and Nowshehra Virkan tehsils, respectively. The functional water supply schemes in the district are using water from groundwater sources only. The wells as source of water appear to be more prominent. The status of functional water supply schemes in the district, three (14%) are non-functional which are temporarily closed. In relation to population size, it appears that on account of the temporarily closed water supply schemes, nearly 26 percent of the total served population is being affected as facing non-availability of water. On the overall basis of the presently functioning water supply schemes, the information on frequency distribution of these schemes in relation to that of population served (under various population ranges), which results; (i) nearly, 28 percent of the schemes serve 9 percent of the population ranging between 1001-2500 persons, (ii) about (28%) of the schemes serve (12%) within the range 2501-5000 persons and (iii) only 28 percent of the water supply schemes serve a bigger proportion of population (63%), consisting of more than 10,000 persons, which reflects the higher size of the water supply schemes. The total 86% of schemes supply water is unsafe for drinking purposes due to biological contamination.

Main Components of the existing system include tube wells, overhead reservoir and distribution network. The maintenance level of pumping machinery is not so reasonable. Privately installed hand pumps / power pumps have been installed. Evidently, during post irrigation phase, the water table has been raised, thereby improving the sub soil water quality.

3.4 Seismic Hazards

According to Seismic Zoning map of Pakistan, Gujranwala falls in Zone 2A which is minor to moderate damage area. There is no earthquake recorded in the history of region above Richter scale 4.5. Also, no damage to the infrastructure and human settlement is reported in the area. Map is shown in **Figure 3.9.**

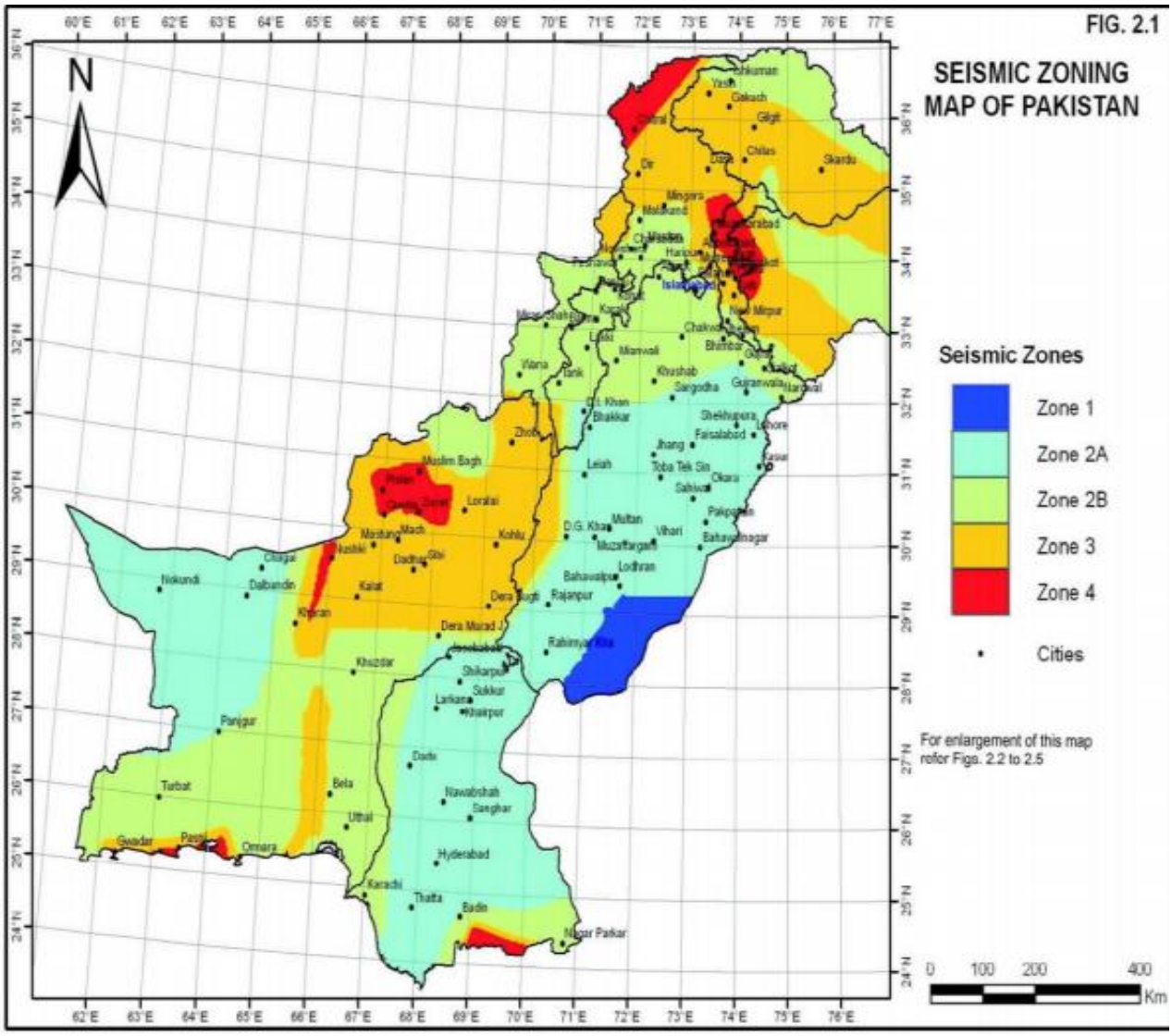


Figure 3.9: Seismic Map of Pakistan

3.5 Socio-Economic Conditions

The population of the Gujranwala city was approximately 1.67 million in 2013. It is the fourth-most populous city of Pakistan having the status of a district with the following towns under its administration of Khiali Shahpur, Aroop, Nandipoor, Qila Didar Singh, Wazirabad, Kamoke and Nowshera Virkan. The city of Gujranwala is divided into 64 Union Councils. For the city's strategic location on both sides of the Grand Trunk Road (GT Road), economic activity has understandably been easier both in the form of industrialization and agricultural produce. On the industrial front the city manufactures ceramics, fans, electrical switchgears, engineering

tools and textile products like sweaters, hosiery products etc. Major agricultural produce of Gujranwala includes: wheat, rice, sugarcane and melons.

According to the Punjab Development Statistics 2013, adult literacy rate (15+ years of age) is 56 in Punjab whereas it is 68 in Gujranwala. 1981 and 1998 housing censuses claimed that there were 306,000 and 449,000 household units respectively in Gujranwala district. According to the 1998 census, population of Gujranwala was 1,927,000, (Punjab Development Statistics) and the estimated population as on 30 June 2013 is 4,592,000. According to 1998 census, population density was 359 persons per square km at Punjab level whereas it was 993 in Gujranwala.

Gujranwala is a vibrant economic city of Punjab with tangible contribution in agriculture and industrial sector. According to a survey conducted by the State Bank of Pakistan (2008), Gujranwala is one of the major wheat producers in the Punjab. The average yield of wheat in the district is 31.57 maunds per acre. In addition to wheat, Gujranwala district is largest producer of rice in Punjab province, the average yield of rice is 34.41 maunds of rice per acre. When it comes to the industrial sector, Gujranwala is one of the important commercial and industrial nerve centers of Pakistan. According to the Federation of Pakistan Chambers of Commerce and Industry (FPCCI) in Gujranwala there are almost 15,000 units operating as cottage industries whereas 6000 units are working as small and medium scale industries. Quality ceramic products are also one of the most important sectors in Gujranwala. The major products are: electric fans, domestic utensils/appliances, and various types of electrical/industrial machinery. Gujranwala is known for electronics, machinery and equipment, and textiles. According to Statistical Pocket Book 2011, there were 2548 registered factories in Gujranwala Division out of which 1056 were in Gujranwala. However, if we set the threshold those factories employing 100 or more workers, then there were 136 in Gujranwala division out of which 37 were in Gujranwala. Furthermore, the city has dry port for the export of local product. The importance of road cannot be overemphasized when it comes to economic growth and it is worth mentioning that the district has metalled road-length of 1413KM.

3.6 Ecology

The common species in such plantations are Poplar (Populus alba), Eucalyptus, Keekar (Acacia arabica), mulberry (Morus alba) and Jamun (Syzygium cumini). Ever since the irrigation canal system was developed, cotton, rice, sugarcane and wheat have been the main crops.
Gujranwala District is also famous for its fruit production, which includes mango, guava, banana, oranges and water-melons.

Due to extensive cultivations, high population and human activities, there is little wildlife in the project area. However, the local population as well as the Wildlife Department have reported some fauna.

Common mammals in the area are wild-bore, hyaena (Hyaena striata), Red Indian foxes (Vulpes bengalensis), porcupines and jackals (Canis aureus). Until a few years ago the wolf (Canis palfies) was also found in riverine forests, but the species has almost become extinct due to loss of forests. The commonly found birds of the area are hawk (Accipiter badius cenchroides), kite (Milvus migrans govinda), parrot (Paleornis torquata), partridge (Fvancolinus pondoceraianus mecrranesis) and common crow (Corvidae splendens). A large variety of waterfowls and migratory birds also visit the region because of wetlands associated with barrages along the river systems of the area. Reptiles are aalso present in the region due to hot and humid climate of the region, some population of reptiles have also been reported. Reptilian and amphibian fauna are not well documented. However, local people have reported that snakes and lizards are common in the region. Wild-bores are reported to be inflicting serious crop damages, mainly to sugarcane and potato crops. Some degree of illegal hunting, poaching and trapping has been reported in this region.

As for the birds, there is no impact on the birds due to the solar panels; the panels that are used in the project are lined with anti-reflection coting which helps to reduce the reflection of the panels to almost zero. When the Solar PV panels will be installed on the ground mounted structure, there is a minor disturbance of flora and fauna due to execution of this project. Some small shrubs will be removed during construction of the project.

CHAPTER 4

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4 Potential Environmental Impacts and Mitigation Measures

The project may have environmental impact during construction and operation phase of the project. During construction phase, the impacts may be temporary and short term while long term impacts may be observed during the operational phase of the project. The project has positive impacts overall by providing a competitive, pollution free and cost effective. It may also meet the increasing demand of power and reduce the gap between demand and supply of power.

The construction and operation phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. The impacts of the project are envisaged during the design and planning, during pre-construction phase, construction phase.

4.1 Impact on Air Quality

As the proposed project is Solar PV project, the impact during construction of project is expected to be minimal as a Greenfield Project plant. 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 through the movement of vehicles (transportation activities). Minor excavation and back filling are required because the PV panels will install on vacant land. The main source of gaseous emission during the construction phase is movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO2, NOX, and particulate matter. The impact is reversible, marginal and temporary in nature.

4.2 Impact on Noise Quality

The major noise generating sources during the construction phase are vehicular traffic, construction equipment like; generators, compressors, vibrators etc. The operation of this equipment will generate noise ranging between 75 – 90 dB (A). As noise generated during

construction phase of the project is low and within the Limits of NEQ's. As there is no human settlements and villages near the project vicinity or buffer zone so overall, the impact of generated noise on the environment during construction period is insignificant, reversible and localized in nature.

4.3 Impact on Water Use and Quality

The construction personnel would be housed in temporary settlements or settlements provided by the project sponsors. These settlements would discharge considerable amount of domestic wastewater. Stagnant pools of water would increase breeding of mosquitoes and generally create insanitary conditions. 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 washroom (e.g., through regular liming) will be used as main component of the sanitation system. As the PV panels will be installed on flat land which is semi-agriculture land so minor use of water during construction phase of the project and overall no impact on water use and its quality.

4.4 Impact on Groundwater Contamination

There is no harm to the ground water due to construction of PV project because panels will be installed on the Ground but require little excavation to fix the structure and the project site is already developed in premises of Cantt area. There is no impact on the Ground water.

Ground water due to plant operation will be drawn during operation phase for any purpose. There shall be minimal discharge of wastewater from cleaning of Solar PV modules. The wastewater emanating from cleaning operations shall be recycled or used for plantation around the plant. For 01 MW, one vehicle of water is required for the cleaning and duration of the cleaning for 1.0 MW is required approximately 01 or 02 days. For 3.0 MW, approximately 45000 liters of water is required for washing of panels, only 04 to 05 days require for the cleaning of panels and on monthly basis and the process will be done on monthly basis.

During the operation & maintenance period, natural underground water can be used for cleaning the modules with manual washing. The water for cleaning the module doesn't include any chemical agents, so the untreated underground water will be used for cleaning. Based on our project circumstances, modules shall be cleaned once in every month. The water supply

system will be installed along the solar panel array and will be used by the cleaning staff to use the tap water for manual cleaning.

4.5 Impact on Land Use

The mobilization of construction equipment and construction materials will require space for storage and parking of construction vehicles and equipment, construction material storage yards, disposal sites, and labor camps for human resource to avoid environmental impact and public inconvenience. The total land available for the Project is 10.12 acres. At the Project site, there has been an absence of the following since the past few decades:

- Any major agricultural activity on the land (A small chunk of Agriculture land is also present)
- Any field, wetland or protected area.

Overall, there will be minor impact on the land use. There is minor excavation require for the piling and adjust the mounting structure and a small chunk of land is required for the space of storage of equipment, construction material and waste handling which have a no or minor impact and will be temporary only in construction phase.

4.6 Impact on Biological Environment

The project area is already developed and there is no harm to the biological environment for the installation of PV plant. There will be no or minor impact on flora and fauna of the project vicinity. Thus, the site development works would not lead to any significant loss of important species or ecosystems. Only few plants and small chunk of agriculture land will be damage during clearing of land. After installation, afforestation will be done in the vicinity of project area.

4.7 Impact on Solid Waste

Solid waste during the construction phase consists primarily of 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.

Solid waste disposal will be done as follows;

- A waste inventory of various waste generated will be prepared and periodically updated.
- The excavated material generated will be reused for site filling and leveling 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 stored in designated waste bins/containers. The recyclables will be periodically sold to local recyclers while food waste will be disposed through proper waste handling mechanism.
- Hazardous waste viz. waste oil etc will be collected and stored in paved and bounded area and subsequently sold to authorized recyclers.

The complete details of scrap metal details will be given as; scrap metal waste generated from erection of structures and related construction activities will be collected and stored separately in a stack yard and sold to local recyclers as per to manage the solid waste handling team. A separate yard area will be allocated for storing the waste material as per the required industrial practice. Also, approved contractor will be hired for the recycling of waste appropriately during construction phase. Waste handling agency will be hired at the start of project construction to manage the waste generating during the construction and operational phase of the plant and the practices used for handling the waste disposal to manage proper waste management through different mechanisms like, make a proper dumping site for the disposal of waste, handling of waste. The wastes which are recyclable are sold to the external contractors and the non-hazardous waste will be dumped through municipal waste collection system and services. The solid waste will be dumped away from the project site and where nearby no settlements or any other affected environment is present. It may the proper dumping site that is used for local municipality. Although the PV cells will not be disposed but sent back under as warranty is for 25 years. There are some solid wastes in the project site, including the packing material for the equipment, like the wooden pallets and carton boxes. Solid waste management plan will be followed third party EPA certified contractor will be hired for disposal of solid waste (No Impact).

CHAPTER 5

INSTITUTIONAL REQUIREMENT AND ENVIONMENTAL MONITORING PLAN

5 Institutional Requirement and Environmental Monitoring Plan

During the construction and operation of PV Project, the project company will comply all the rules and regulations of EPA and the standard industrial practices as well as NEQs standards. Implement the environmental mitigation and monitoring plan during construction of the project. Environmental Management and Monitoring Plan provides the mechanism to address the adverse environmental as well as social impacts of the proposed project during its execution, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works.

5.1 Preconstruction Phase

During pre-construction phase of the project, a field survey was conducted by the team to identify the potential impacts and address into the monitoring plan to mitigate their affects to the project and the surrounding environment. Define the roles and responsibilities for those who involved in the implementation of the EMP during construction. Also define the implementation mechanism for the mitigation measures identified during the present study.

5.2 Construction Phase

During construction phase of the project, a solid waste will be handled properly as per the standard industrial practices and dumped into the proper waste disposal sites which are already identified. Provide safety trainings to the workers who works during the construction phase. Provide instructions to project personnel and contractors regarding procedures for protecting the environment and minimizing environmental impact during construction of the project.

5.3 Operational Phase

During operational phase, the environment and social impact will be minimum as there is no dust and any gaseous emission from the plant. Only the waste water that used for the cleaning mechanism of PV panels will be generated and will be handled properly as per the standards. Also provide trainings and awareness sessions rising on the environmental and social issues related to power transmission projects to the project. Ensure the legal compliance properly during O & M phase of the project.

CHAPTER 6

FINDINGS AND RECOMMENDATIONS

6 Findings and Recommendations

The Project will be the replacement of conventional power generation with renewable energy. Solar energy will replace fossil fuel powered generation, and therefore reduce suspended particulate matter and greenhouse gas emissions into the atmosphere. The project is cost effectively and environmental impacts are likely to be minimum in result from the proposed Power project. Careful mitigation and monitoring, specific selection criteria and review/assessment procedures have been specified to ensure that minimal impacts will take place. The detailed design would ensure inclusion of any such environmental impacts that could not be specified or identified at this stage are taken into account and mitigated where necessary. Those impacts can be reduced through the use of mitigation measures such as correction in work practices at the construction sites, or through the careful selection of sites and access routes. As proposed land is already the developed land and PV panels will be installed on the Ground mounted structure and there is no or minimum harm to the natural environment or any biological habitat.

Based on the environmental and social assessment and survey conducted for the Project, the potential adverse environmental impacts can be mitigated to an acceptable level by adequate implementation of the mitigation measures identified during visit. Adequate provisions are being made in the Project to cover the environmental mitigation and monitoring requirements, and their associated costs.

ENVIRONMENTAL REPORT OF KHARIAN

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

GHQ-Military Engineering Services (MES) is interested to install Solar PV Panels on the Ground Mounted structure with capacity of 2.5 MW (500kW) in Kharian Cantt. Around 7616 polycrystalline (Tier 1 Manufactured) PV panels will be installed with power rated of 330 Wp and the capacity factor is approximately 16.66%. the total energy generation will around 3.67 Million kWh.

The Military Engineering Services (MES)- GHQ wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, GHQ has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 PROJECT BACKGROUND AND JUSTIFICATION

The project sponsor is GHQ-Military Engineering Services (MES). The sponsors of the company will be interested to install the solar PV plant to generate electricity. GHQ-Military Engineering Services (MES) intends to install a Grid-Tie Solar PV Power Plant at different location in their premises, by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load of 2.5 MW Solar PV Plant has been designed for Kharian Cantt which will get synchronize with the conventional 11 KV Grid already present at the site. The site is located at Kharian Cantt in the province of Punjab.

1.2 Description of the Project

The project company will be installed 2.5 MW of Solar PV plant in Kharian Cantt to produce electricity. The total area of the project is around 12.19 acres for the installation of PV panels. The project area is already a developed area and the solar PV panels will be installed with Ground Mounted structure in Kharian Cantt.

1.3 Project Location

The proposed project site lies between 32°48'6.00"N & 73°53'45.00"E, located in Kharian Cantt, Kharian, Punjab. It is around 3.4 kilometers away from Kkharian City. The land area of project site is 12.19 acres located near Kharian Jalalpur Jattan Road, Kharian Cantt. The project land is owned by the project company for the installation of 2.5 MW Solar PV plant**.** The location of site can be viewed in **Figure 1.1** and overview of the project site is shown in **Figure 1.2.**

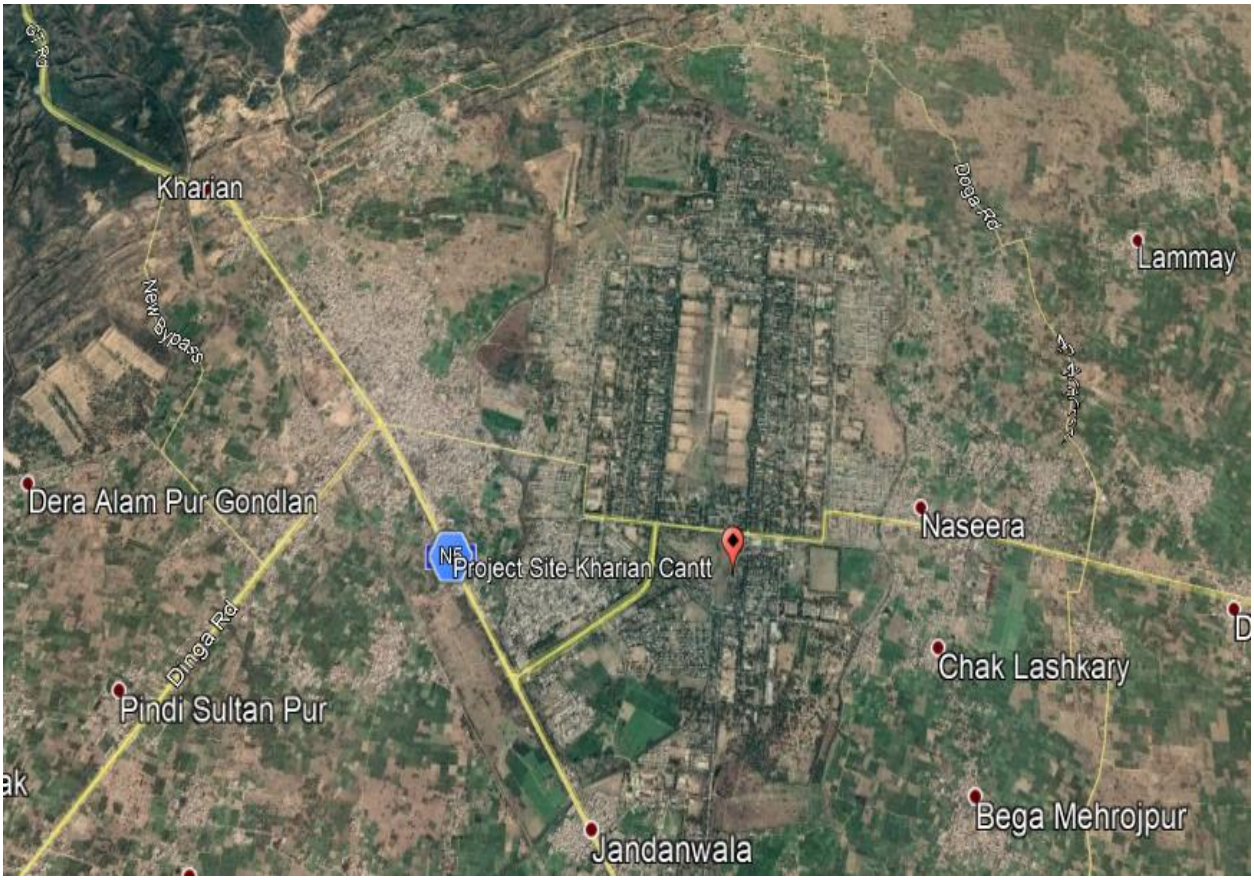


Figure 1.1: Location of Project Site

Figure 1.2: Overview of Project Site (Picture-1)

Figure 1.3: Overview of Project Site (Picture-2)

CHAPTER 2

SOLAR ENERGY IN PAKISTAN

2 PROSPECTS OF SOLAR ENERGY IN PAKISTAN

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

To summarize, the sun shines for 250-300 days per years in Pakistan with an average sun shine hour of 8-9 per day. This gives huge amount of energy to be used for electricity generation by solar thermal power plants. A quick potential of solar energy in Pakistan can be obtained from the map of solar energy resource released by World Bank Group from 1999 to 2016 as shown in **Figure 2.1.**

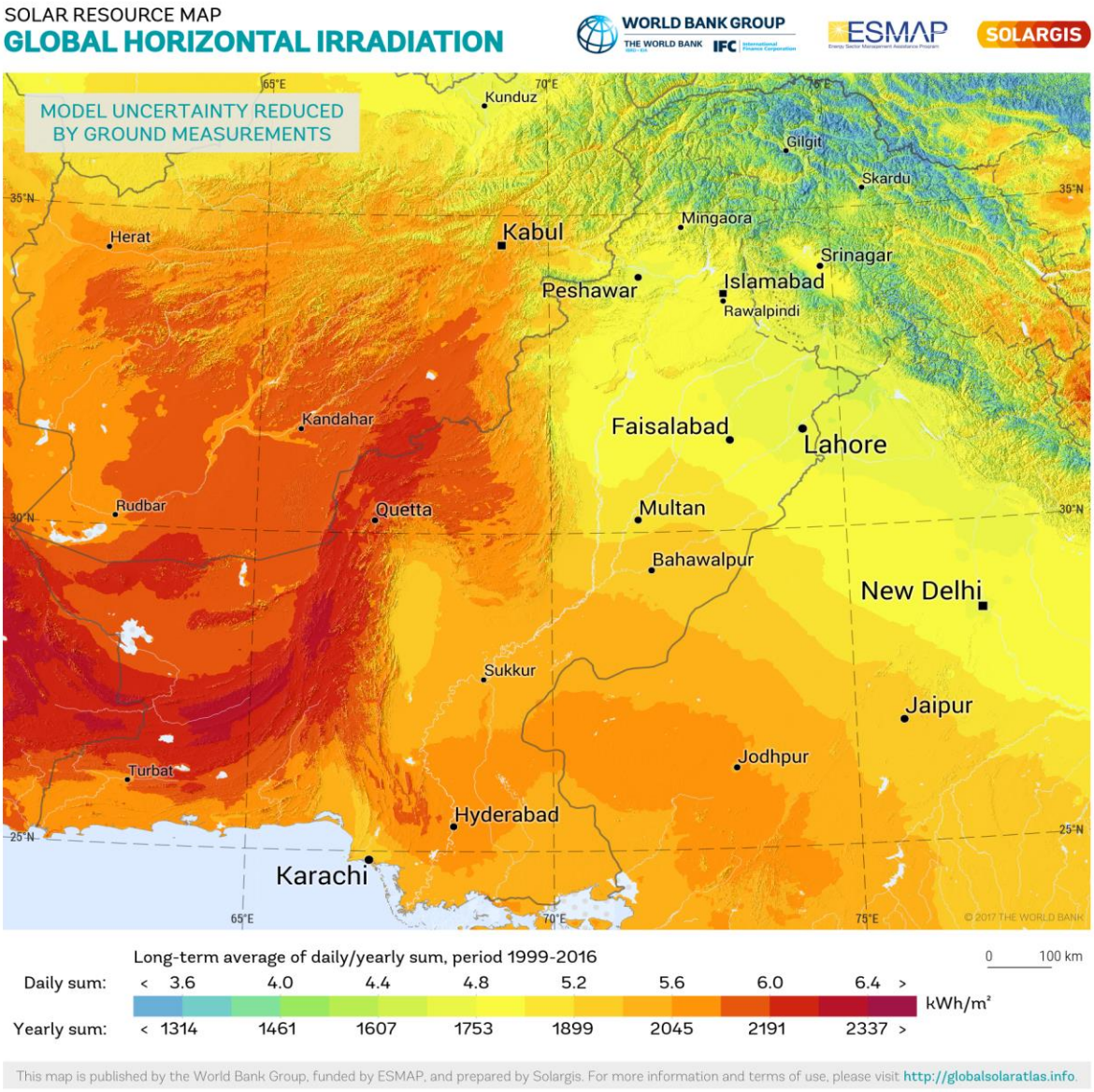


Figure 2.1: Solar Resource Potential Map of Pakistan

2.1 Road Access to the Project Site

The Project site is easily accessible throughout the year. Distance from Kharian City to the Lahore is approx. 172 kms. One way from Lahore to Kharian city, goes from College road towards Jail road and move towards Tollinton Market road which turn towards the Lahore-Kasur Road then move towards the link ferozepur road which turns left towards the National Highway N-5 road which turns right towards the Main Blvd Gulshan-e-Ravi road, after that take left towards the Hakeem Muhammad Ajmal Khan road then touched the Lahore Islamabad

motorway M-2 through Babu Sabu Interchange then move towards the Lahore Bypass which touched the National Highway N-5 then take left towards the Wazirabad Bypass (N-5) then crossing Chenab River. After this, crossing Gujrat Bypass and National Highway (N-5). From N-5, taking right toward the Cantt road. The distance from Lahore to project site as shown in **Figure 2.2**.

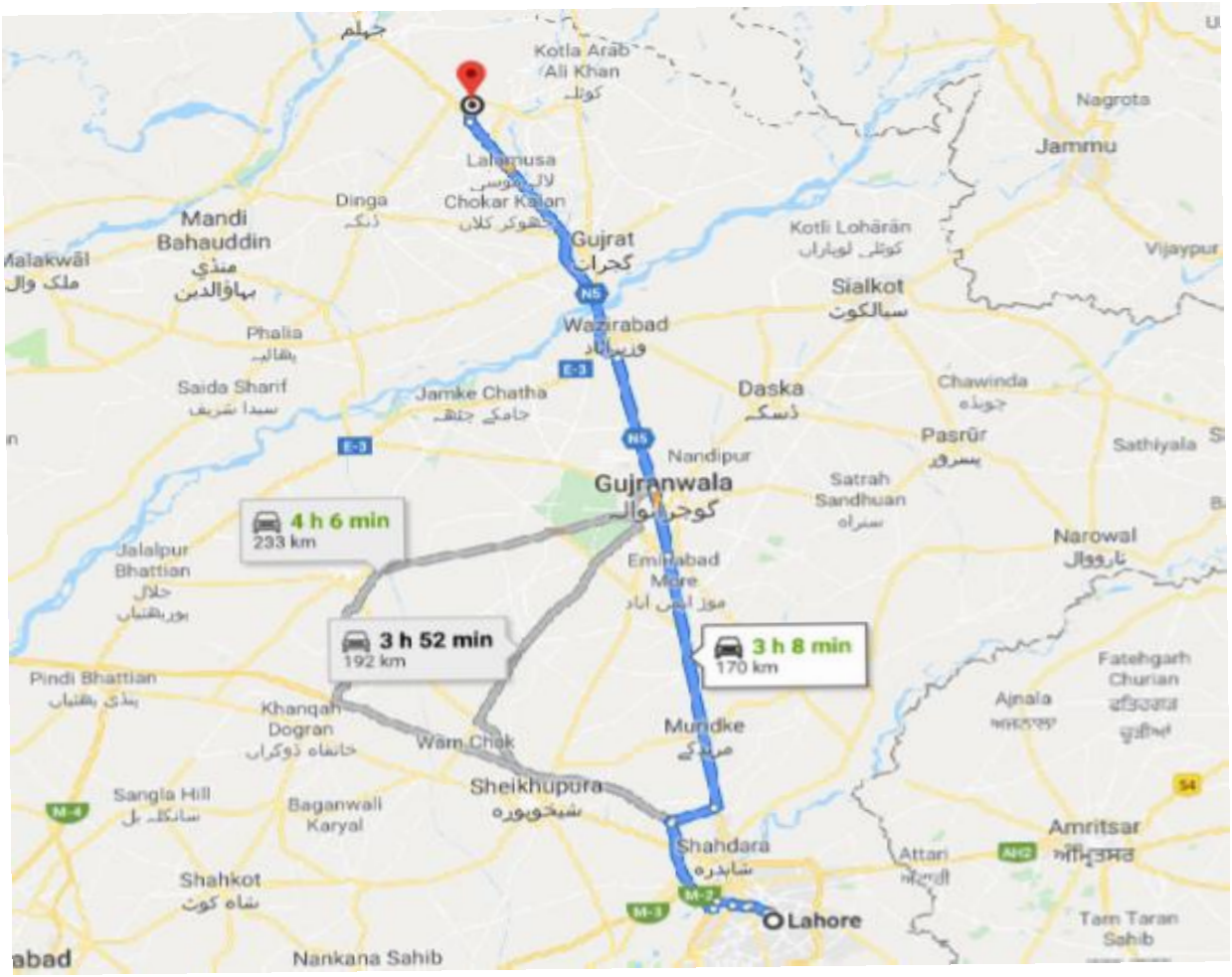


Figure 2.2: Distance from Lahore to the Project Site

From Kharian city to project site, it reaches through Guliana road towards the Kharian Jalalpur Jattan Road and also from Quaid-e-Azam road towards the project which is then move towards the Cantt road which is around 3.4 km from the city as shown in **Figure 2.3** and Arial distance from city to the project site is shown in **Figure 2.4.**

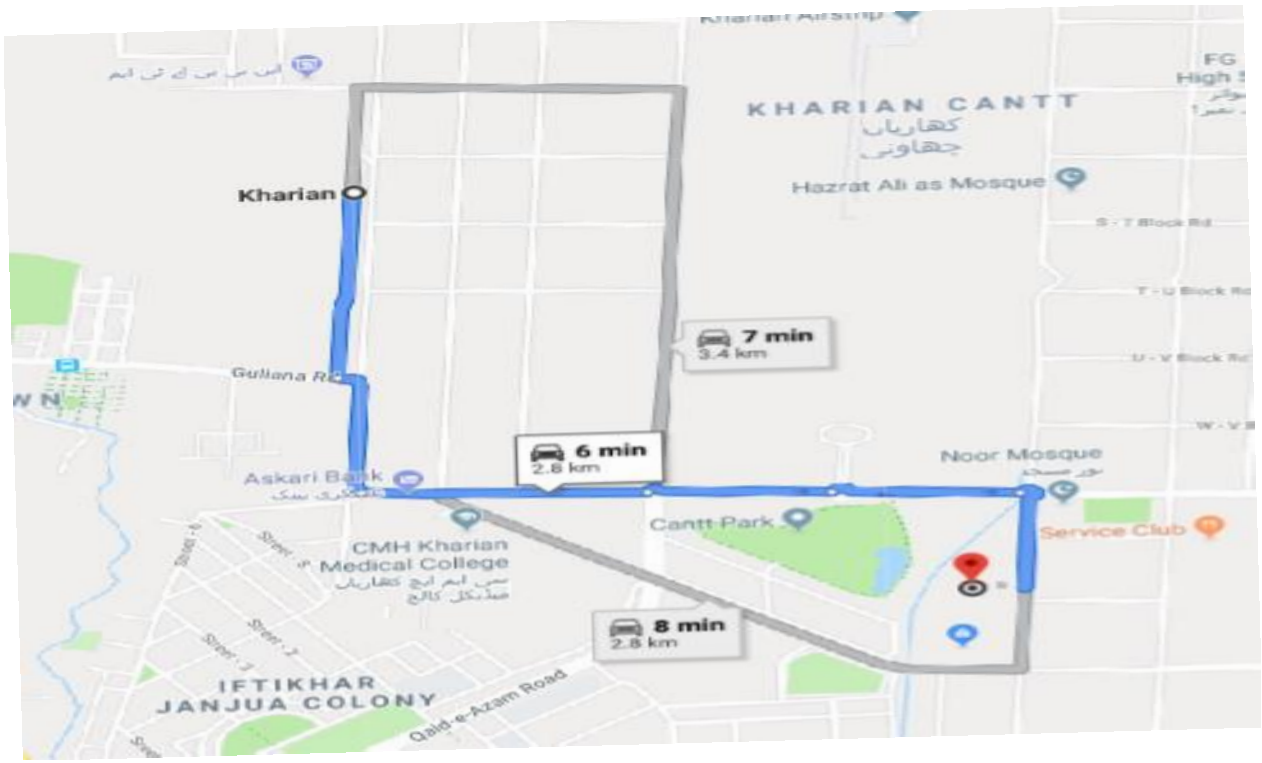


Figure 2.3: Orientation of Project Site from Kharian City

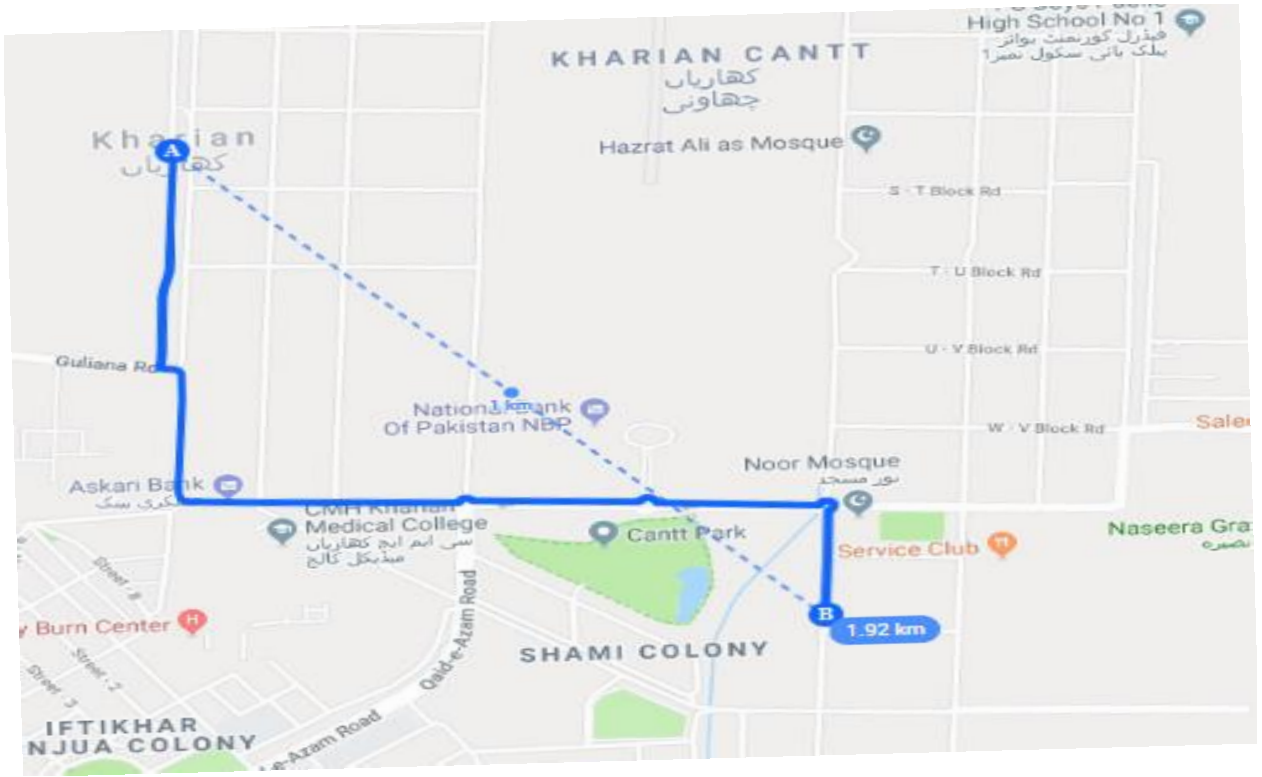


Figure 2.4: Orientation of Project Site from Kharian City (Arial Distance)

The planned movement from Port Qasim to the site will be through the National and Super highways. The major section of the track from Karachi to the site is a multi-lane road, having a relatively flat terrain.

CHAPTER 3

BASELINE CONDITIONS

3 Baseline Conditions

The Baseline condition includes the different parameters which covers under this study are topography, climatic conditions, hydrology, biological conditions, socio-economic environment and seismic hazards.

3.1 Topography

Kharian lies between 32°48'6.00"N and 73°53'45.00"E. Kharian is a tehsil located in Gujrat District, Punjab, Pakistan. The land lies between the rivers of Chenab and Jhelum and in the North the foothills of the mountains of Kashmir. Gujrat District is an ancient district located in between two famous rivers, the Jhelum and Chenab. It is bounded on the northeast by Mirpur, on the northwest by the River Jhelum which separates it from Jhelum District, on the east and southeast by the Chenab River, separating it from the districts of Gujranwala and Sialkot, and on the West by Mandi Bahauddin. District Gujrat is spread over an area of 3,192 square kilometres, and it includes historic villages and towns such as Kathala chenab, Barnali, Jalalpur Jattan, Chakdina, Karnana, Kunjah, Sehna, Bhagwal and Lalamusa. The district is administratively subdivided into four tehsils, these are Gujrat, Kharian, Sarai Alamgir and Jalalpur Tattan.

Topographically speaking, Gujrat District lies in the end of Chaj Doab. It has a good fertile land with dark brown clay. The City area is mostly flat. The area of Gujrat city is part of the Punjab plains. This part of plain where the City stands has been formed by piedmont deposits of hill torrents of Bhimber and Nullah Shah Jahangir, which originate in Jammu hills. The geology of greater part of the area is simple along Grand Trunk Road (Lahore Section) and Sargodha road. The water of Nullah Bhimber and Nullah Shah Jahangir mixed with Chenab River, spread out and the deposits of silt convert the land into hard clay. There is no canal irrigation system in whole area.

Kharian city is situated at an average elevation of 270 to 305 meters above mean sea level. Topographic map of Kharian derived from satellite mapping through GIS software is shown in **Figure 3.1.**

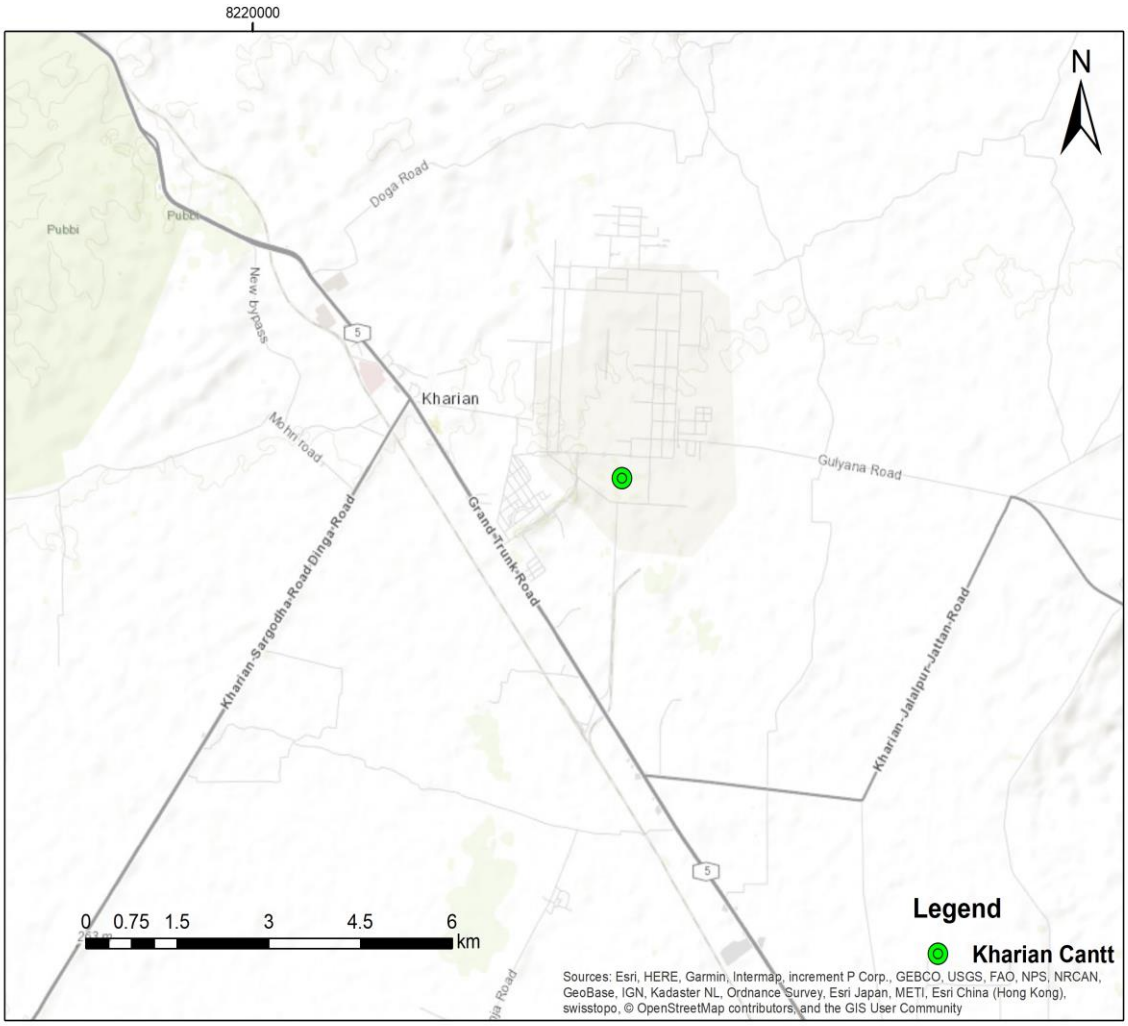


Figure 3.1: Topographic Map of Project Area

3.2 Climatic Conditions

3.2.1 Temperature & Rainfall

Pakistan is also facing the change in its climatic conditions, especially in the temperature which seems to be risen considerably. Climate has intrinsic variability and has been changing in past few decades, even, before we started measuring the climate parameters. The uniqueness of

this issue in modern world is that human activities are now playing significant role in causing the climate to change. This is evident from the recent rise in carbon dioxide (CO2) concentration in the atmosphere and in response the rise of global temperatures on land and ocean's surface. Kharian does have a rainy season from the end of June until September, and it certainly rains more during this period of time than during the rest of the year but the rain is fairly less even so and February to April in winters as well.

The weather conditions of Kharian vary from different conditions like; seasonal variations, weather pattern shifts, monsoon season, summer season etc. The climate of also the whole district is moderate and during summer and moderately cold in winter. The summer season starts from April and ends up in the month of October. June is the hottest month with maximum and minimum temperatures of 45ºC and 25ºC, respectively. The winter season begins in November and lasts till March. January is the coldest month. The maximum and minimum temperatures during this month are 10ºC and 4ºC, respectively. The sky is frequently overcast during winter with insufficient rainfall. The monsoons set in June and continue till September. The average rainfall on the Kashmir border is over 1000 mm, at Kharian it is 750 mm, at Gujrat 670 mm, and at Dinga 500 mm.

Kharian has 7-8 hours of sunshine daily on average. As there will be no rise in temperature due to reflections of the panels on the atmosphere because the panels are lined with anti-reflection coating (ARC) on the surface which help to reduce the reflection of the panels to almost zero. Adopted measures during rain and dust storm are to generate or produce electricity is to be reduced. The detailed temperature data are given in **Table 3.1** taken from metronome 7.7 and graphical presentation in given in **Figure 3.2.**

Table 3.1: Temperature Statistics for Kharian in 2018

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Temperature(˚C)	10.8	14.3	20	25.3	30.9	31.4	30.5	29.6	27.4	23.7	17.1	12.4

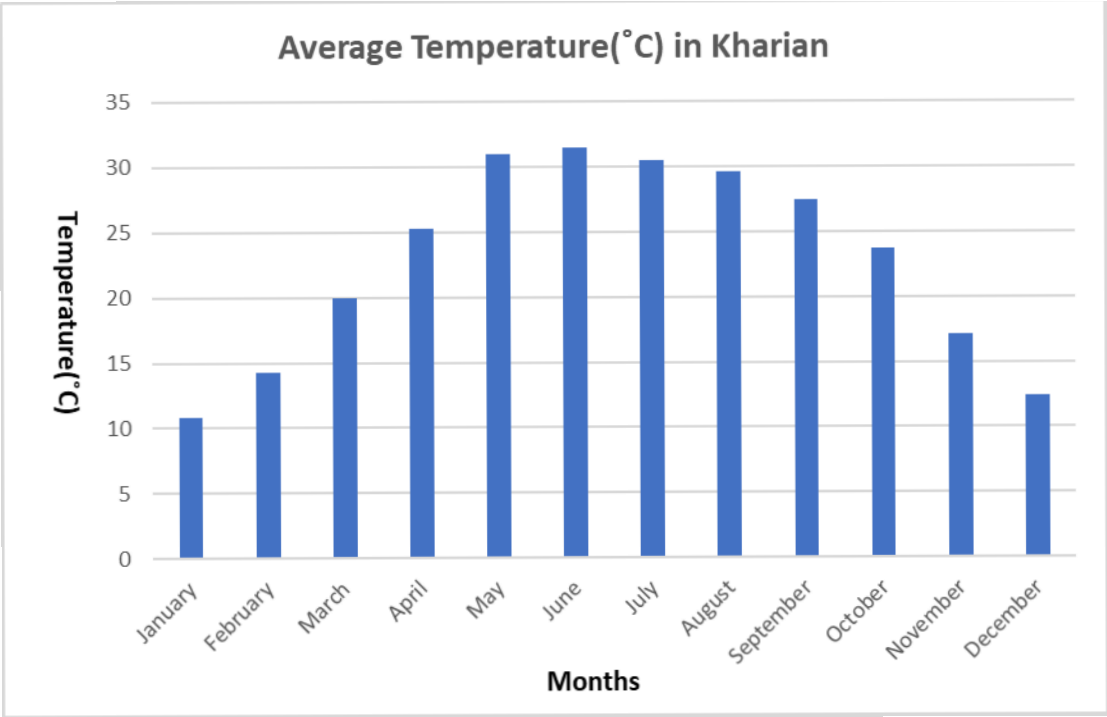


Figure 3.2: Graphical representation of Temperature

The detailed average annual rainfall data are given in **Table 3.2** and graphical presentation in given in **Figure 3.3.**

Table 3.2: Rainfall Statistics for Kharian in 2018

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Precipation (mm)	0.05	22.23	11.05	31.08	11.4	43.78	37.45	38.62	10.22	2.2	25.4	11.7
Days	1	4	8	14	6	9	14	18	3	3	6	4

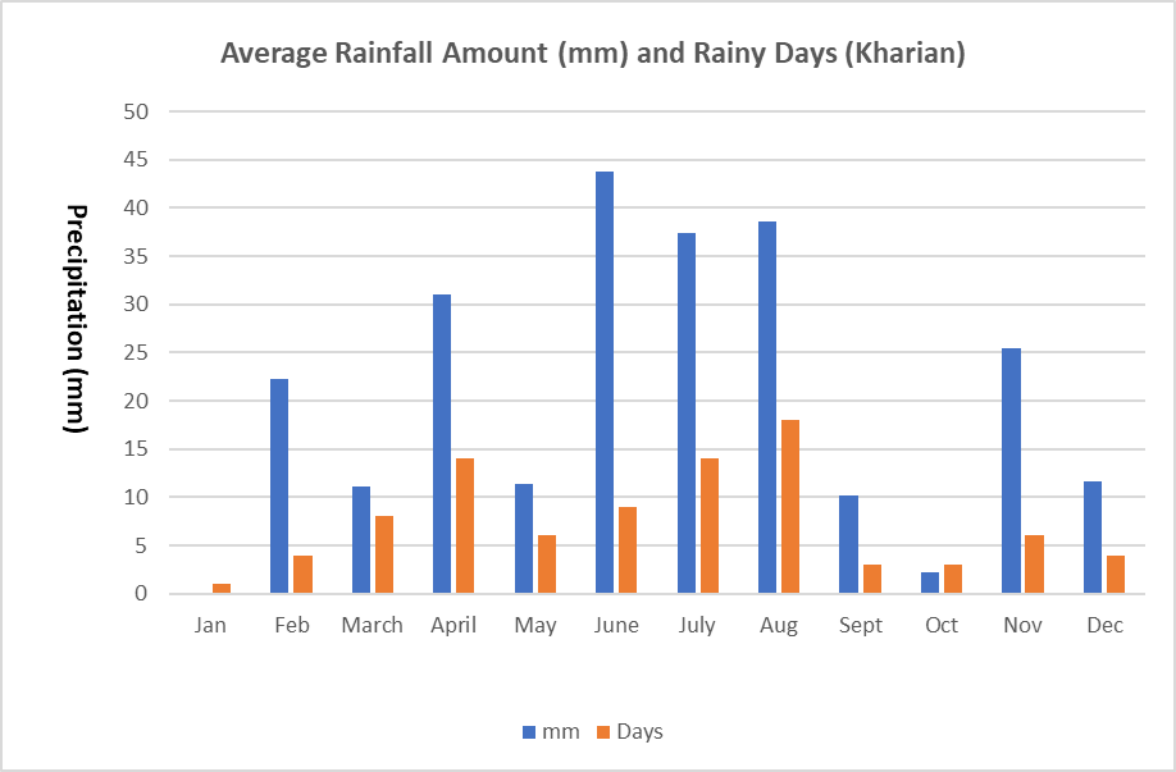


Figure 3.3: Graphical representation of Average Rainfall

Maximum and Minimum Temperature Regime Map of Pakistan is shown in **Figure 3.4**, **Figure 3.5** & **Figure 3.6.**

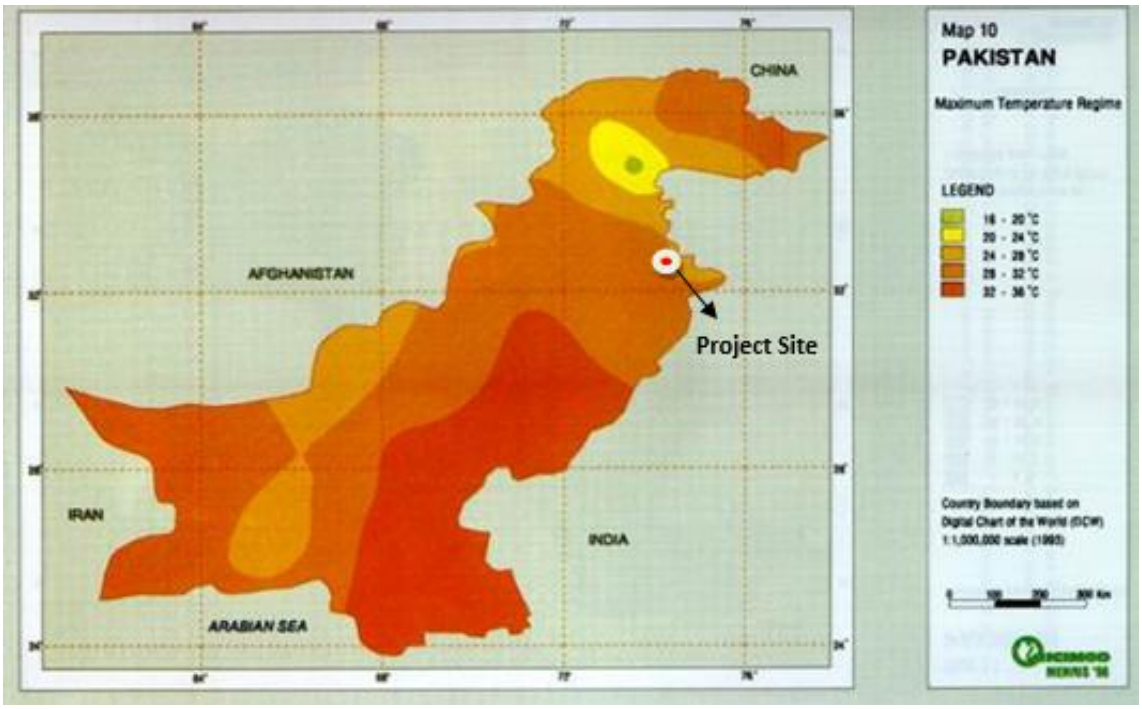


Figure 3.4: Maximum Temperature Regime Map of Pakistan

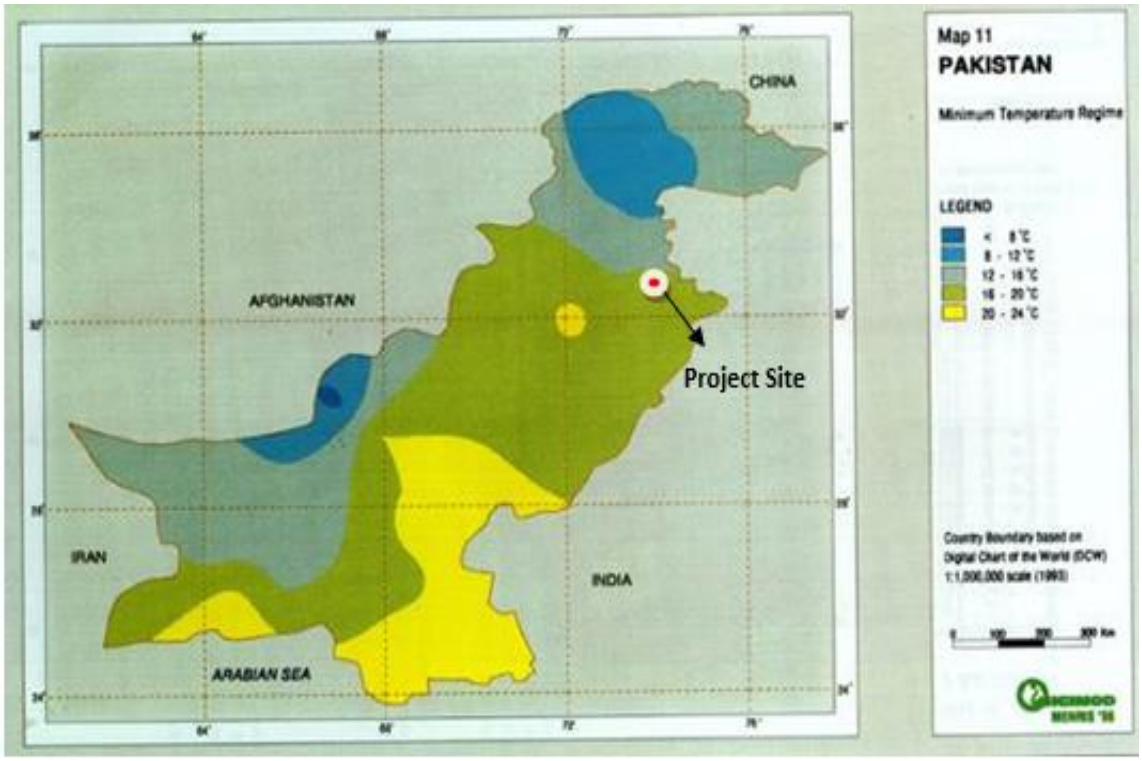


Figure 3.5: Minimum Temperature Regime Map of Pakistan

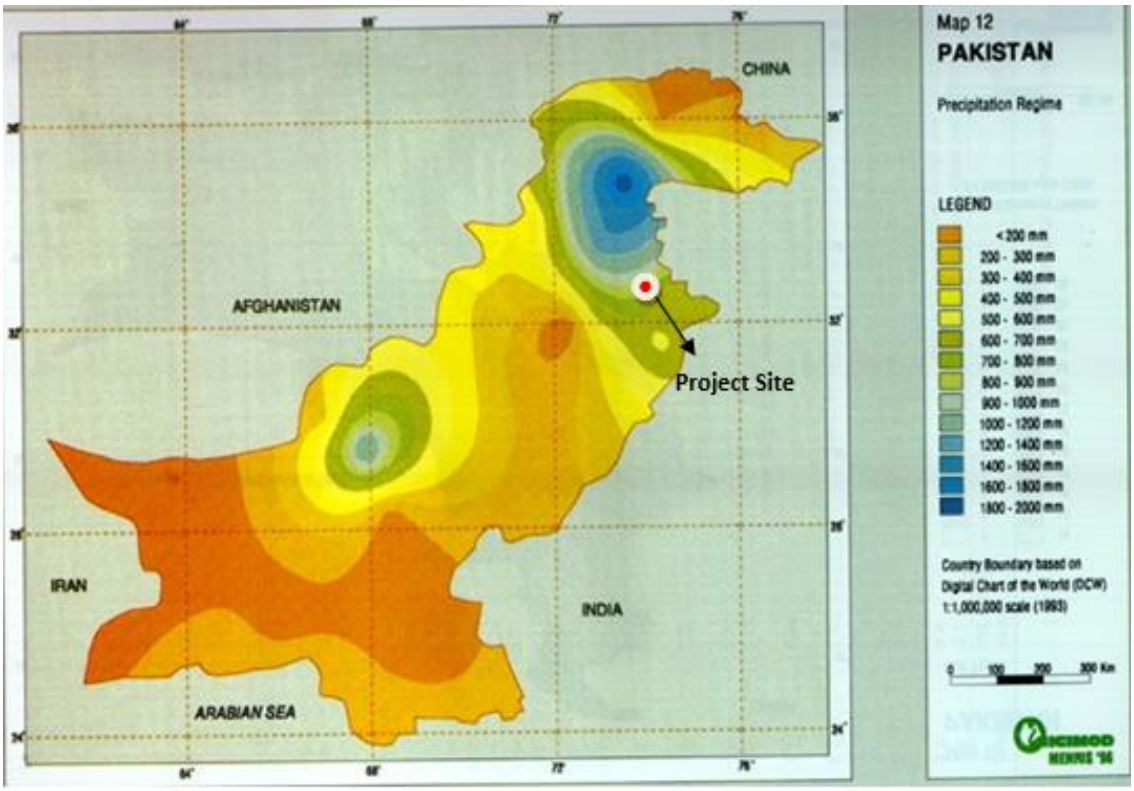


Figure 3.6: Precipitation Map of Pakistan

3.2.2 Wind Speed

The wind speed of any location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. Kharian become plain and flat region due to which the there is more chances of dust storms occur.

In Kharian, the windiest month is May and June, followed by April and July. May average wind speed of around 3.49m/s is considered “a light breeze.” Maximum sustained winds (the highest speed for the day lasting more than a few moments) are at their highest in June where average top sustained speeds reach 3.6m/s. The average wind speed on yearly basis are given below in **Figure 3.7**.

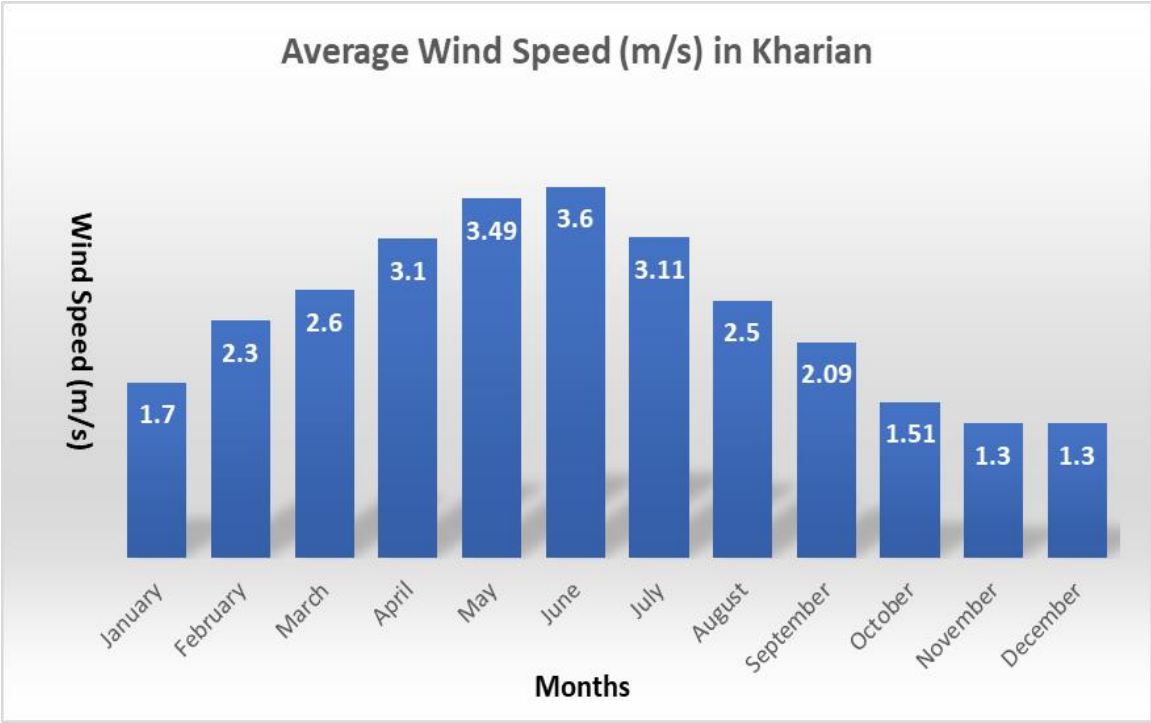


Figure 3.7: Graphical representation of average wind speed in Kharian

3.2.3 Relative Humidity

Kharian experiences extreme seasonal variation in the perceived humidity. They has a hot and semi-arid region; the humidity is high. They have some humid months, and dry months in the opposite season. The least humid month is April & May and the most humid month is August (74.2%). Average annual humidity is given in **Figure 3.8.**

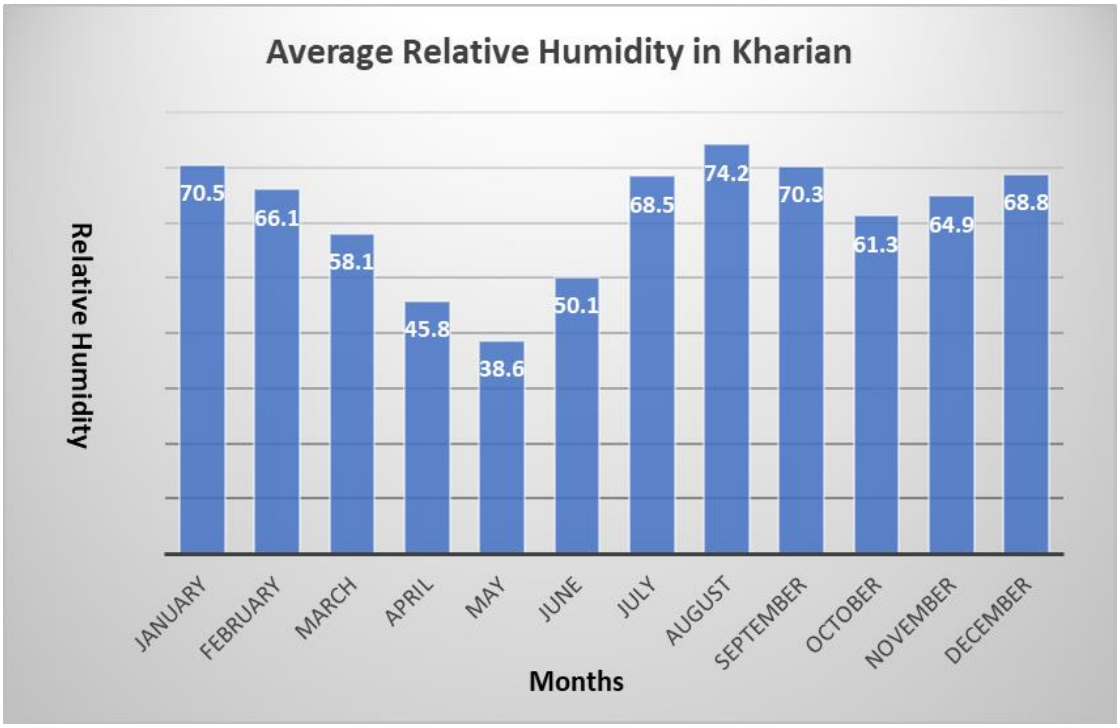


Figure 3.8: Graphical representation of average relative humidity in Kharian

3.3 Hydrology

District Gujrat is situated on the bank of the Chenab River, 134 km North of Lahore and 150 km South from Islamabad. The main Peshawar-Karachi Railway line passes through the city, connecting it directly to Jhelum, Gujranwala, Mandi Bahauddin and Sargodha. Gujrat is also well connected to Lahore via bus service. Other nearby towns include Sialkot and Bhimber-Azad Kashmir. Gujrat airport does not host any commercial flights, and residents must travel to Lahore or Sialkot for domestic and international flights.

The water table varies from 50‟ to 100‟. The quality of drinking water is fit for human consumption. It is estimated that the water supply network covers 75% of the town and serves 70% of the total population. Presently, the water distribution system is only working on an intermittent pumping method and with no storage facility. This is due to the lack of coordination and planning when extending the distribution system beyond its hydraulic capacity to provide a 24-hour service. Currently, the water supply runs for approximately 16 hours on average.

The overall Gujrat district has total of 126 water supply schemes in the district, 34 (27%) are non-functional. Of those non-functional schemes, 91 percent are temporarily closed while the remaining (9%) appear to be permanently closed. By tehsils, it becomes evident that in relative

terms, on the basis of non-functional schemes, the temporarily closed schemes vary largely (75 to 100%). Similarly, the permanently closed schemes range up to 25%. In relation to population size, it appears that on account of the temporarily closed water supply schemes, nearly 39% of the total served population is being affected and facing no availability of water. The reason reflects the disputes within the community mostly on collection of O&M funds and non-payment of electricity bills due to non-availability of funds, which are broadly, accounted for financial constraints that have caused the temporarily closure of 18 water supply schemes with their higher numbers (6 to 7) in Kharian and Gujrat tehsils. The other reason identified relate to the mechanical and electrical problems. The third reason is the breakage in the water conveyance and distribution system including missing and damaged links between the source and mainline of water, uncompleted/inadequate various water pipe fittings causing leaks etc.

The functional water supply schemes in the district are using water from groundwater sources only. The wells as source of water appear to be more prominent. The main Components of the existing system include tube wells, overhead reservoir and distribution network. The maintenance level of pumping machinery is not so reasonable. Privately installed hand pumps / power pumps have been installed.

3.4 Seismic Hazards

According to Seismic Zoning map of Pakistan, Kharian falls in Zone 2B which is moderate to severe damage area. There is no earthquake recorded in the history of region above Richter scale 5.0. Also, no damage to the infrastructure and human settlement is reported in the area. Map is shown in **Figure 3.9.**

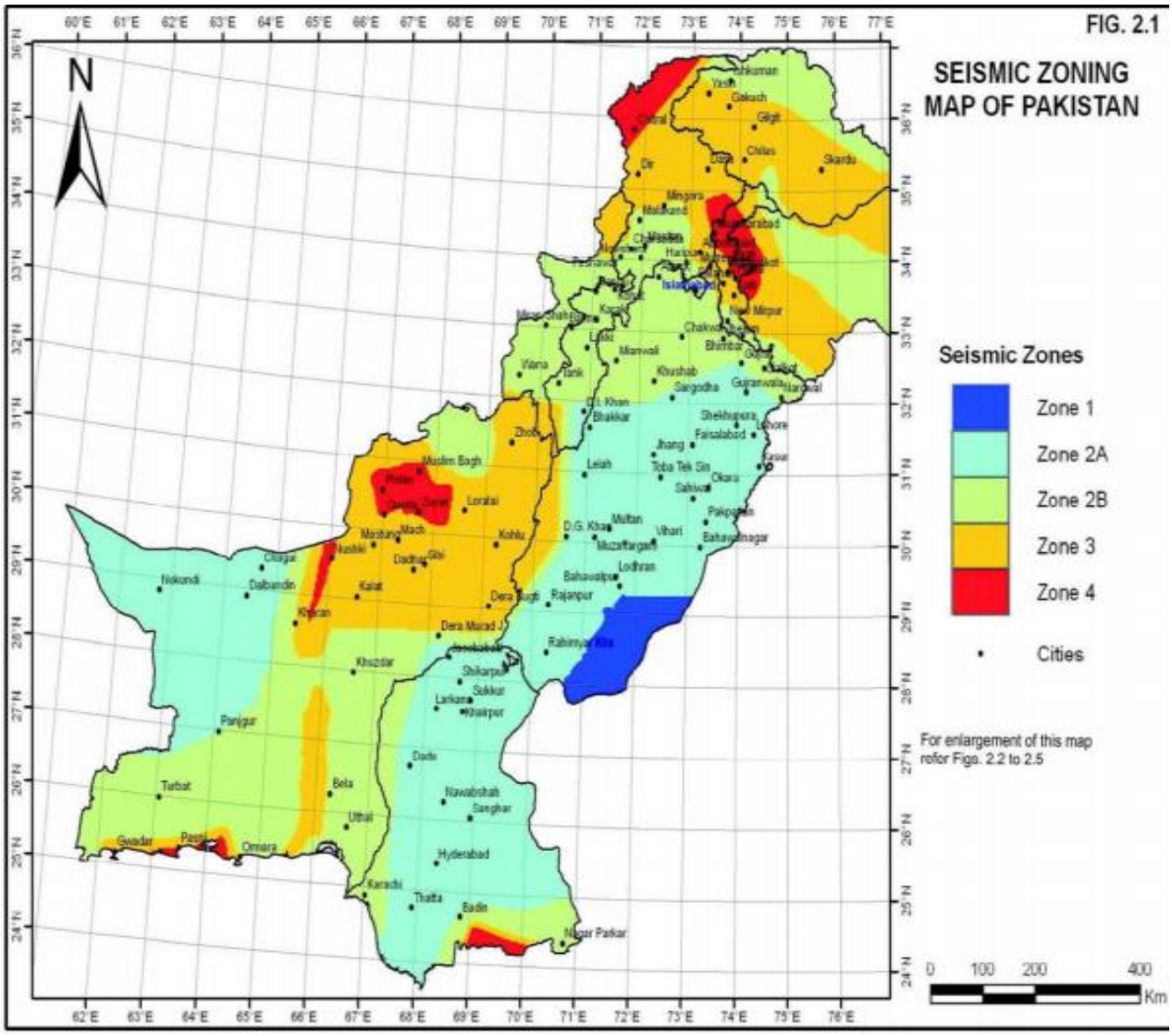


Figure 3.9: Seismic Map of Pakistan

3.5 Socio-Economic Conditions

District Gujrat is spread over an area of 3,192 square kilometers and comprises of the four tehsils of: Gujrat, Kharian, Sarai Alamgir and Jalalpur Jattan Area and Population. According to 1998 Population and Housing Census, total population of Gujrat district is 20,48,000 persons out of which 10,26,000 are males and 10,22,000 are females. Density of population in the district is 642 persons per square Kilometers. Percentage break-up of the Rural and Urban population is 72.3% and 27.7% respectively. The Cantonment was built in the late 1950s with

US support. The population of the cantonment is 90,462, and the population of the parent city Kharian is around 30,000.

Gujrat is well established and developed district of Punjab Pakistan. Its literacy rate is very high as compare to other regions of Pakistan. It has a leading name in many industrial and agricultural products. The people of Gujrat are well educated, highly skilled and brave. So, they are successful in every field. District Gujrat has a total of 1,475 government schools at primary and secondary level. Out of these public schools, 60 percent (889 schools) are for girls. According to the latest available data, 323,058 students are enrolled in the public schools while 10,581 teachers are working in these schools.

Gujrat is also known in the world for its clay with which Gujratis produce quality pottery since ages. Apart from agriculture and clay the city is well known due to its furniture manufacturing skills. Gujratis have mastered the skills of conditioning the wood and producing world class furniture having immaculate finish. Over last few decades Gujrat has also attained a name in export of electric fans. Gujrat has a unique status throughout the Punjab due to some of its manufacturing capabilities and productions. There are about 1,059 cottage level and small/medium/large scale industrial units operating in the district. Jalalpur is a large town of Gujrat, where several small and large textile industrial units have been established. There are many other industrial units and factories engaged in manufacturing of electrical goods (Fan), Electric Motors, Earthen Utensils, Shoes, Rubber Tyre Tube, Sanitary Ware, Rice Cleaning Mills and Furniture. The high-quality furniture made here have been used in National and Provincial Assemblies. The story of emergence of electric fan manufacturing industry in Pakistan is one of those heroic efforts made by a few enterprising individuals who. Starting with nothing in early 1940s struggled against all odds and turned this concern into a most efficient industry in Pakistan. This is an industry on which all Pakistanis can rightly be proud of. It does not owe its success to any foreign collaboration or any from the Government, but only to its own people whose constant research for maintaining good quality and devising new methods and techniques of production have now resulted in a product which we can rightfully claim as among the best in the world. There are now over five hundred fan manufacturing units operating in Gujrat, Gujranwala , Lahore and a few other cities. Except for a few, the rest falls into the category of cottage industry. These small units from the real backbone of this industry. They provide employment to a large number of people and all put together account of more than 90 percent of the domestic market. The agriculture of this region is dependent upon rains and tube wells. The major crops of the area in rabbi and Kharif seasons are wheat, Rice, Sugarcane, pulses and Oil seeds.

In 1998 of the total employed persons, 36% had elementary occupations followed by 29.4% skilled agricultural and fishery workers, service workers, shop and market sales workers, representing 11.6%, craft and related trade workers representing 7.2%. In rural areas people

having elementary occupations were again in majority, followed by skilled agriculture and fishery workers and service workers, shop and market sales workers representing 40.1%, 37.4% and 7.2% respectively. The highest percentage in urban area is of elementary occupation; followed by service workers, shop and market sales workers having 33.7% and 20.8% respectively. In 1998 majority of employed persons were working in construction industries, followed by agriculture, forestry, hunting and fishing industries and community, social and personal services industries, representing 30.8, 29.5 and 12.6 percent respectively.

The Government Health institutions has provided health services to 61,573 patients are attended with different categories diseases. As per the type wise diseases Diarrhoea/Dysentery in >5 yrs, 15,339 patient, Acute Flaccid Paralysis, 6 patient, Worm Infestations, 8,153 patient Peptic Ulcer Diseases, 21,137 patient, Cirrhosis of Liver 16873 patients, Nephritis / Nephrosis patient 65 patients visited Government health institutions.

Also, according to 2017 census the population of the district has reached to 2,756,110 of which 1,335,339 are males and 1,420,628 are females. This census shows that 1,928,714 persons live in rural while 827,396 live in urban areas. It is further reported that there are 143 transgenders.

The predominant language of the district is Punjabi, which according to the 1998 census is the first language of 98% of the population, while Urdu accounts for 1.1%.

3.6 Ecology

The fauna and flora of the area include: Kikar, Dhreak, Toot, Shisham, Kau and Poplar trees, and wild animals are rarely found in this area. However, jackal, wolf and fox are found in some part of the area. The district is also famous for fruits like; Citrus, Guava, Mango, Jaman and Banana are also grown in minor quantities in the district. The major crops of the area in rabbi and Kharif seasons are wheat, Rice, Sugarcane, pulses and Oil seeds.

Medicinal plants play a key role in traditional health care system for human and animals. Most of allopathic drugs also comprise extracts taken from medicinal plants. Among these specimens, twelve species of butterflies were identified which belong to eight generas, four subfamilies and three families. The Pieridae family includes 78.44 %, family Nymphalidae includes 8.18 % and family Danaidae includes 13.36 % species. The family Pieridae is represented by six species that are Anapheis aurota, Pieris canidia, Pieris brassicae, Catopsilia florella, Catopsilia pyranthe and Eurema hecabe. The family Nymphalidae is represented by four species that are Junonia orithya, Junonia almana, Vanessa carduiand Ergolis merione. Whereas the family Danaidae is represented by two species that are Danaus chryssipus and Danaus genutia. The maximum population (74 numbers) of Pieris canidia was recorded throughout the season; whereas, Danaus genuttia and Vanessa cardui was least populated (01

numbers). The population of Pieris brassicae was moderate in the seasons that might be due to the host availability and preference. This is the first record of systematics and diversity of butterflies from Gujrat district of Province Punjab, Pakistan.

Due to extensive cultivations, high population and human activities, there is little wildlife in the project area. However, the local population as well as the Wildlife Department have reported some fauna. As for the birds, there is no impact on the birds due to the solar panels; the panels that are used in the project are lined with anti-reflection coting which helps to reduce the reflection of the panels to almost zero. When the Solar PV panels will be installed on the ground mounted structure, there is a minor disturbance of flora and fauna due to execution of this project. Some small shrubs and tree will be removed during construction of the project. After construction of the project, a new plant will be planted in the project premises.

CHAPTER 4

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4 Potential Environmental Impacts and Mitigation Measures

The project may have environmental impact during construction and operation phase of the project. During construction phase, the impacts may be temporary and short term while long term impacts may be observed during the operational phase of the project. The project has positive impacts overall by providing a competitive, pollution free and cost effective. It may also meet the increasing demand of power and reduce the gap between demand and supply of power.

The construction and operation phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. The impacts of the project are envisaged during the design and planning, during pre-construction phase, construction phase.

4.1 Impact on Air Quality

As the proposed project is Solar PV project, the impact during construction of project is expected to be minimal as a Greenfield Project plant. 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 through the movement of vehicles (transportation activities). Minor excavation and back filling are required because the PV panels will install on vacant land. The main source of gaseous emission during the construction phase is movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO2, NOX, and particulate matter. The impact is reversible, marginal and temporary in nature.

4.2 Impact on Noise Quality

The major noise generating sources during the construction phase are vehicular traffic, construction equipment like; generators, compressors, vibrators etc. The operation of this

equipment will generate noise ranging between 75 – 90 dB (A). As noise generated during construction phase of the project is low and within the Limits of NEQ's. As there is no human settlements and villages near the project vicinity or buffer zone so overall, the impact of generated noise on the environment during construction period is insignificant, reversible and localized in nature.

4.3 Impact on Water Use and Quality

The construction personnel would be housed in temporary settlements or settlements provided by the project sponsors. These settlements would discharge considerable amount of domestic wastewater. Stagnant pools of water would increase breeding of mosquitoes and generally create insanitary conditions. 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 washroom (e.g., through regular liming) will be used as main component of the sanitation system. As the PV panels will be installed on flat land which is semi-agriculture land so minor use of water during construction phase of the project and overall no impact on water use and its quality.

4.4 Impact on Groundwater Contamination

There is no harm to the ground water due to construction of PV project because panels will be installed on the Ground but require little excavation to fix the structure and the project site is already developed in premises of Cantt area. There is no impact on the Ground water.

Ground water due to plant operation will be drawn during operation phase for any purpose. There shall be minimal discharge of wastewater from cleaning of Solar PV modules. The wastewater emanating from cleaning operations shall be recycled or used for plantation around the plant. For 01 MW, one vehicle of water is required for the cleaning and duration of the cleaning for 1.0 MW is required approximately 01 or 02 days. For 2.5 MW, approximately 37,500 liters of water is required for washing of panels, only 03 to 04 days require for the cleaning of panels and on monthly basis and the process will be done on monthly basis.

During the operation & maintenance period, natural underground water can be used for cleaning the modules with manual washing. The water for cleaning the module doesn't include any chemical agents, so the untreated underground water will be used for cleaning. Based on our project circumstances, modules shall be cleaned once in every month. The water supply

system will be installed along the solar panel array and will be used by the cleaning staff to use the tap water for manual cleaning.

4.5 Impact on Land Use

The mobilization of construction equipment and construction materials will require space for storage and parking of construction vehicles and equipment, construction material storage yards, disposal sites, and labor camps for human resource to avoid environmental impact and public inconvenience. The total land available for the Project is 12.19 acres. At the Project site, there has been an absence of the following since the past few decades:

- Any major agricultural activity on the land (A small chunk of Agriculture land is also present)
- Any field, wetland or protected area.

Overall, there will be minor impact on the land use. There is minor excavation require for the piling and adjust the mounting structure and a small chunk of land is required for the space of storage of equipment, construction material and waste handling which have a no or minor impact and will be temporary only in construction phase.

4.6 Impact on Biological Environment

The project area is already developed and there is no harm to the biological environment for the installation of PV plant. There will be no or minor impact on flora and fauna of the project vicinity. Thus, the site development works would not lead to any significant loss of important species or ecosystems. Only few plants and small chunk of agriculture land will be damage during clearing of land. After installation, afforestation will be done in the vicinity of project area.

4.7 Impact on Solid Waste

Solid waste during the construction phase consists primarily of 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.

Solid waste disposal will be done as follows;

- A waste inventory of various waste generated will be prepared and periodically updated.
- The excavated material generated will be reused for site filling and leveling 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 stored in designated waste bins/containers. The recyclables will be periodically sold to local recyclers while food waste will be disposed through proper waste handling mechanism.
- Hazardous waste viz. waste oil etc will be collected and stored in paved and bounded area and subsequently sold to authorized recyclers.

The complete details of scrap metal details will be given as; scrap metal waste generated from erection of structures and related construction activities will be collected and stored separately in a stack yard and sold to local recyclers as per to manage the solid waste handling team. A separate yard area will be allocated for storing the waste material as per the required industrial practice. Also, approved contractor will be hired for the recycling of waste appropriately during construction phase. Waste handling agency will be hired at the start of project construction to manage the waste generating during the construction and operational phase of the plant and the practices used for handling the waste disposal to manage proper waste management through different mechanisms like, make a proper dumping site for the disposal of waste, handling of waste. The wastes which are recyclable are sold to the external contractors and the non-hazardous waste will be dumped through municipal waste collection system and services. The solid waste will be dumped away from the project site and where nearby no settlements or any other affected environment is present. It may the proper dumping site that is used for local municipality. Although the PV cells will not be disposed but sent back under as warranty is for 25 years. There are some solid wastes in the project site, including the packing material for the equipment, like the wooden pallets and carton boxes. Solid waste management plan will be followed third party EPA certified contractor will be hired for disposal of solid waste (No Impact).

CHAPTER 5

INSTITUTIONAL REQUIREMENT AND ENVIONMENTAL MONITORING PLAN

5 Institutional Requirement and Environmental Monitoring Plan

During the construction and operation of PV Project, the project company will comply all the rules and regulations of EPA and the standard industrial practices as well as NEQs standards. Implement the environmental mitigation and monitoring plan during construction of the project. Environmental Management and Monitoring Plan provides the mechanism to address the adverse environmental as well as social impacts of the proposed project during its execution, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works.

5.1 Preconstruction Phase

During pre-construction phase of the project, a field survey was conducted by the team to identify the potential impacts and address into the monitoring plan to mitigate their affects to the project and the surrounding environment. Define the roles and responsibilities for those who involved in the implementation of the EMP during construction. Also define the implementation mechanism for the mitigation measures identified during the present study.

5.2 Construction Phase

During construction phase of the project, a solid waste will be handled properly as per the standard industrial practices and dumped into the proper waste disposal sites which are already identified. Provide safety trainings to the workers who works during the construction phase. Provide instructions to project personnel and contractors regarding procedures for protecting the environment and minimizing environmental impact during construction of the project.

5.3 Operational Phase

During operational phase, the environment and social impact will be minimum as there is no dust and any gaseous emission from the plant. Only the waste water that used for the cleaning mechanism of PV panels will be generated and will be handled properly as per the standards. Also provide trainings and awareness sessions rising on the environmental and social issues related to power transmission projects to the project. Ensure the legal compliance properly during O & M phase of the project.

CHAPTER 6

FINDINGS AND RECOMMENDATIONS

6 Findings and Recommendations

The Project will be the replacement of conventional power generation with renewable energy. Solar energy will replace fossil fuel powered generation, and therefore reduce suspended particulate matter and greenhouse gas emissions into the atmosphere. The project is cost effectively and environmental impacts are likely to be minimum in result from the proposed Power project. Careful mitigation and monitoring, specific selection criteria and review/assessment procedures have been specified to ensure that minimal impacts will take place. The detailed design would ensure inclusion of any such environmental impacts that could not be specified or identified at this stage are taken into account and mitigated where necessary. Those impacts can be reduced through the use of mitigation measures such as correction in work practices at the construction sites, or through the careful selection of sites and access routes. As proposed land is already the developed land and PV panels will be installed on the Ground mounted structure and there is no or minimum harm to the natural environment or any biological habitat.

Based on the environmental and social assessment and survey conducted for the Project, the potential adverse environmental impacts can be mitigated to an acceptable level by adequate implementation of the mitigation measures identified during visit. Adequate provisions are being made in the Project to cover the environmental mitigation and monitoring requirements, and their associated costs.

ENVIRONMENTAL REPORT OF SIALKOT CANTT

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

GHQ-Military Engineering Services (MES) is interested to install Solar PV Panels on the Ground Mounted structure with capacity of 01 MW in Sialkot Cantt. Around 3080 polycrystalline (Tier 1 Manufactured) PV panels will be installed with power rated of 330 Wp and the capacity factor is approximately 16.69%. the total energy generation will around 1.48 Million kWh.

The Military Engineering Services (MES)- GHQ wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, GHQ has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 PROJECT BACKGROUND AND JUSTIFICATION

The project sponsor is GHQ-Military Engineering Services (MES). The sponsors of the company will be interested to install the solar PV plant to generate electricity. GHQ-Military Engineering Services (MES) intends to install a Grid-Tie Solar PV Power Plant at different location in their premises, by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load of 01 MW Solar PV Plant has been designed for Sialkot Cantt which will get synchronize with the conventional 11 KV Grid already present at the site. The site is located at Sialkot Cantt in the province of Punjab.

1.2 Description of the Project

The project company will be installed 01 MW of Solar PV plant in Sialkot Cantt to produce electricity. The total area of the project is around 3.79 acres for the installation of PV panels. The project area is already a developed area and the solar PV panels will be installed with Ground Mounted structure in Sialkot Cantt.

1.3 Project Location

The proposed project site lies between 32°31'49.44"N & 74°33'51.12"E, located in Sialkot Cantt, Sialkot, Punjab. It is around 8.2 kilometers away from Sialkot City. The land area of project site is 3.79 acres located near Ataturk road, Sialkot Cantt. The project land is owned by the project company for the installation of 2.2 MW Solar PV plant**.** The location of site can be viewed in **Figure 1.1** and overview of the project site is shown in **Figure 1.2.**

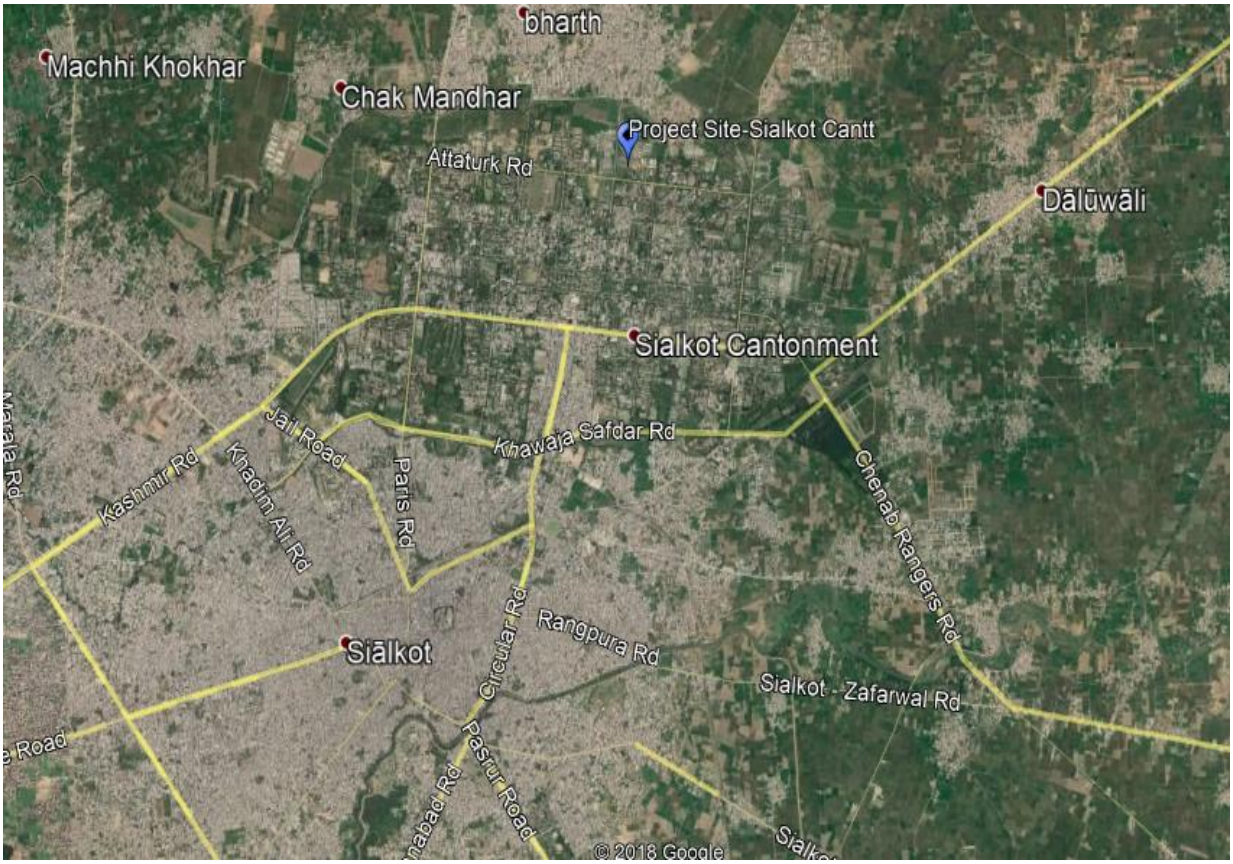


Figure 1.1: Location of Project Site

Figure 1.2: Overview of Project Site (Picture-1)

Figure 1.3: Overview of Project Site (Picture-2)

CHAPTER 2

SOLAR ENERGY IN PAKISTAN

2 PROSPECTS OF SOLAR ENERGY IN PAKISTAN

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

To summarize, the sun shines for 250-300 days per years in Pakistan with an average sun shine hour of 8-9 per day. This gives huge amount of energy to be used for electricity generation by solar thermal power plants. A quick potential of solar energy in Pakistan can be obtained from the map of solar energy resource released by World Bank Group from 1999 to 2016 as shown in **Figure 2.1.**

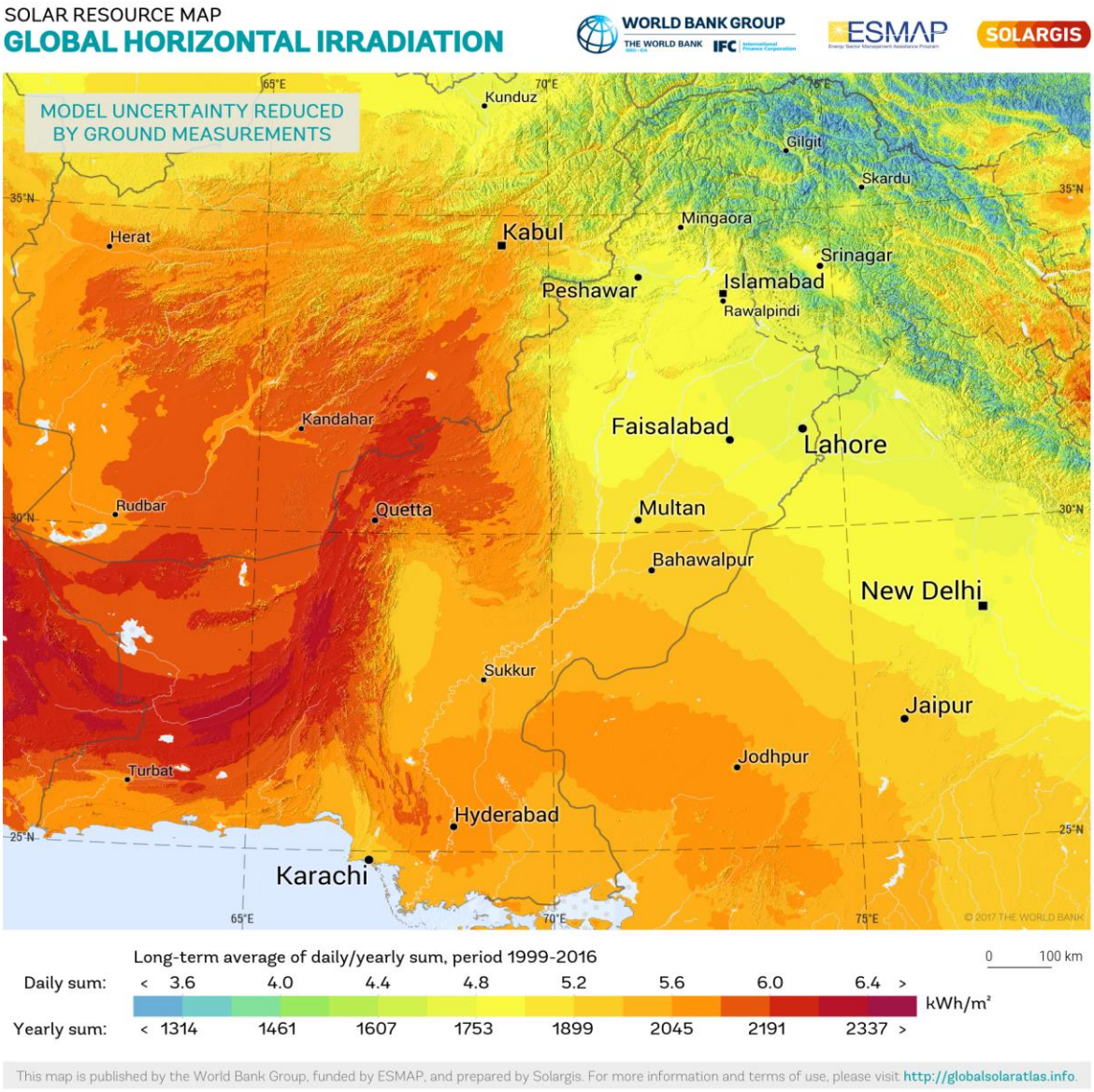


Figure 2.1: Solar Resource Potential Map of Pakistan

2.1 Road Access to the Project Site

The Project site is easily accessible throughout the year. Distance from Sialkot City to the Lahore is approx. 139 kms. One way from Lahore to Sialkot city, goes from Gurumangut road to the college road then Jail road and move towards Tollinton Market road which turn towards the Lahore-Kasur Road then move towards the link Ferozepur road which turns left towards the National Highway N-5 road which turns right towards the Main Blvd Gulshan-e-Ravi road, after that take left towards the Hakeem Muhammad Ajmal Khan road then touched the Lahore

Islamabad motorway M-2 through Babu Sabu Interchange then move towards the Lahore Bypass which touched the National Highway N-5 then take right towards the Sialkot Bypass which touches the Sialkot road and Gurjanwala road. After this take left from circular road which joined the Sialkot road and Daska road then take right towards the Haji pura road that touches the Church road. From Aalam Chowk, it merges with the Khadim ali road towards the Capital road then take left towards the street 5 and also its touches from Mubarik pura road to the city. The distance from Lahore to project site as shown in **Figure 2.2**.

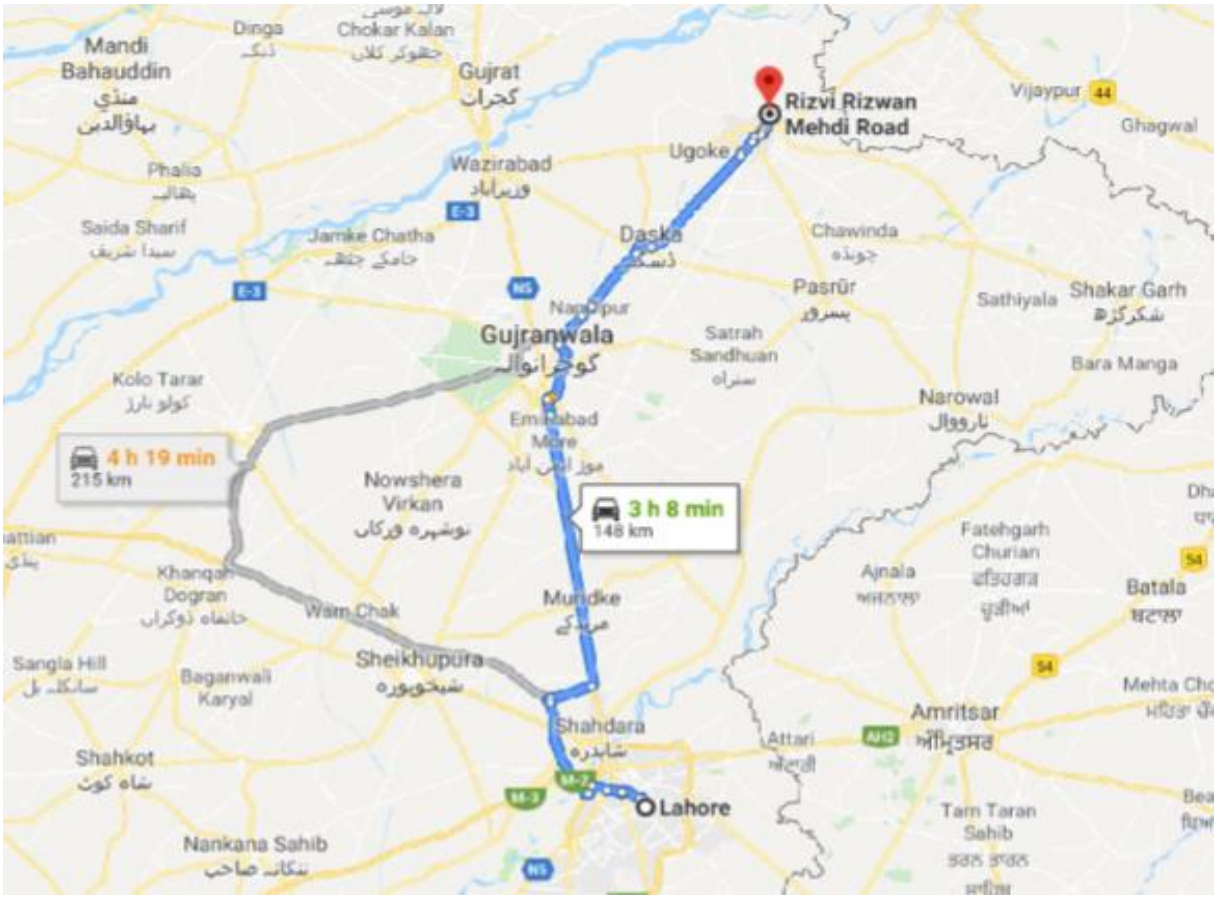


Figure 2.2: Distance from Lahore to the Project Site

From Sialkot city to project site, it reaches through Abdullah street towards the Capital road then take left from capital road towards the Sajjad Cheema road, after this it touched to Khadim Ali road. After Khadim ali road then turn right towards the Khawaja Safdar road. After this it touched to Mahmood Ghaznavi road then turn right towards the Ataturk road which is around 8.2 km from the city as shown in **Figure 2.3** and Arial distance from city to the project site is shown in **Figure 2.4.**

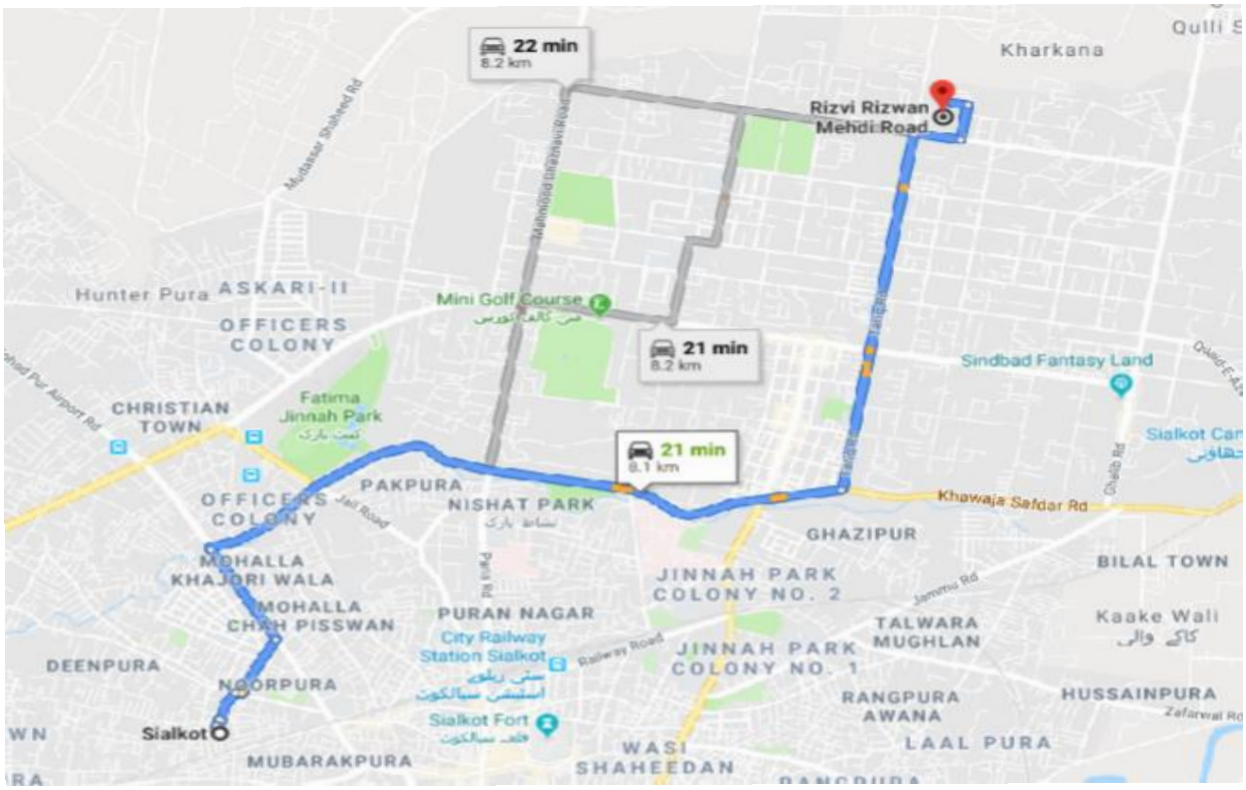


Figure 2.3: Orientation of Project Site from Sialkot City

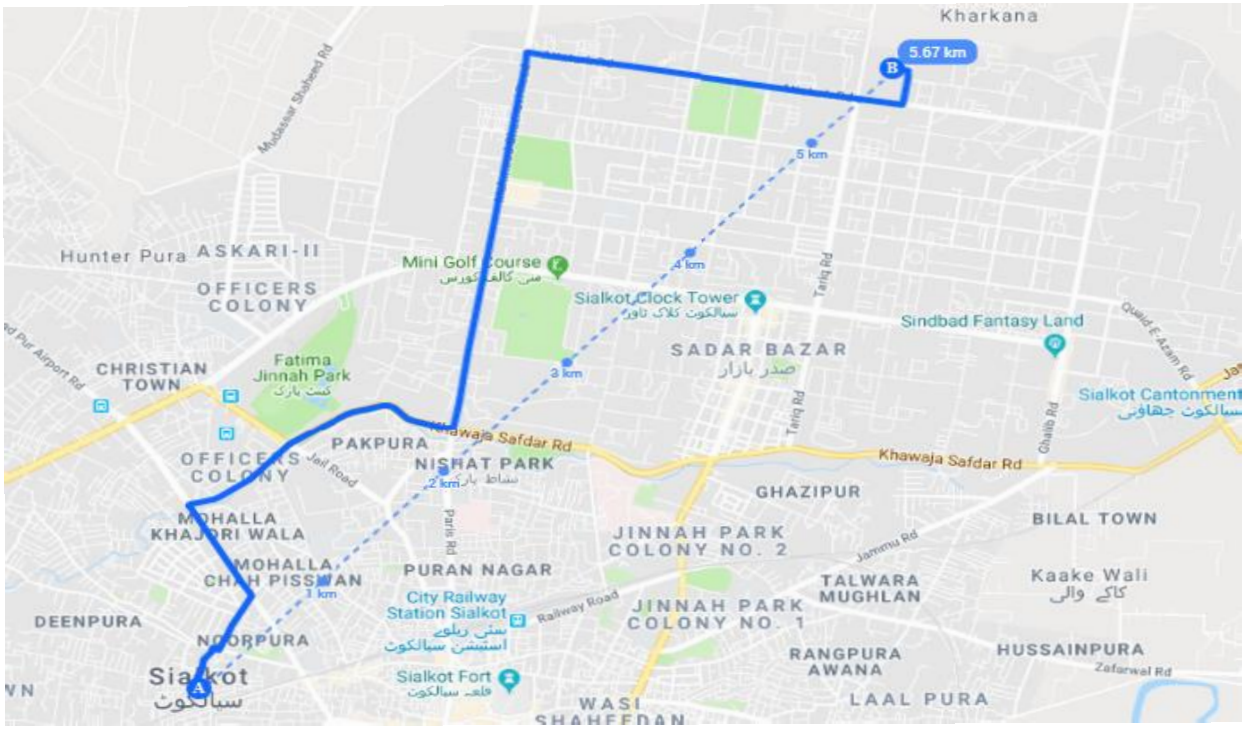


Figure 2.4: Orientation of Project Site from Sialkot City (Arial Distance)

The planned movement from Port Qasim to the site will be through the National and Super highways. The major section of the track from Karachi to the site is a multi-lane road, having a relatively flat terrain.

CHAPTER 3

BASELINE CONDITIONS

3 Baseline Conditions

The Baseline condition includes the different parameters which covers under this study are topography, climatic conditions, hydrology, biological conditions, socio-economic environment and seismic hazards.

3.1 Topography

Sialkot lies between 32°29'33.02"N and 74°31'51.78"E. Sialkot is a city in Punjab, Pakistan. Sialkot is Pakistan's 13th largest city and located 9 km from Ghuinke, and is located in north-east Punjab. Along with the nearby cities of Gujranwala and Gujrat, Sialkot forms part of the so-called Golden Triangle of industrial cities with export-oriented economies. It is the third-richest city in Pakistan. The Sialkot cantonment was established in 1852.

Topographically speaking, Sialkot is situated in the Upper Rachna Doab, which is bounded by the Ravi and Chenab rivers. The general slope of the land within the Doab is to the south-west and the area is an active flood plain, although storm flows and hence flooding have been greatly reduced by irrigation and power generation works carried out on the Indian side of the border. The historic center of Sialkot is located between two seasonal watercourses, the Bhaid Nullah and the Aik Nullah. It occupies land that is elevated up to about 10 meters above the surrounding areas. Apart from the central area, the city is generally flat. Overall, there is an east to west fall, from around 253 meters in the east to about 245 meters in the west, an average fall of about 1 in 1000.

Geologically, the area is underlain by Pleistocene deposits to a depth of several thousand meters. The first 200 meters of these deposits consist of approximately 70% silty sand interspersed with limited clay layers. The strata are generally heterogeneous with little vertical or lateral continuity. This suggests that aquifers at different depths are interconnected.

Sialkot city is situated at an average elevation of 250 to 357 meters above mean sea level. Topographic map of Sialkot derived from satellite mapping through GIS software is shown in **Figure 3.1.**

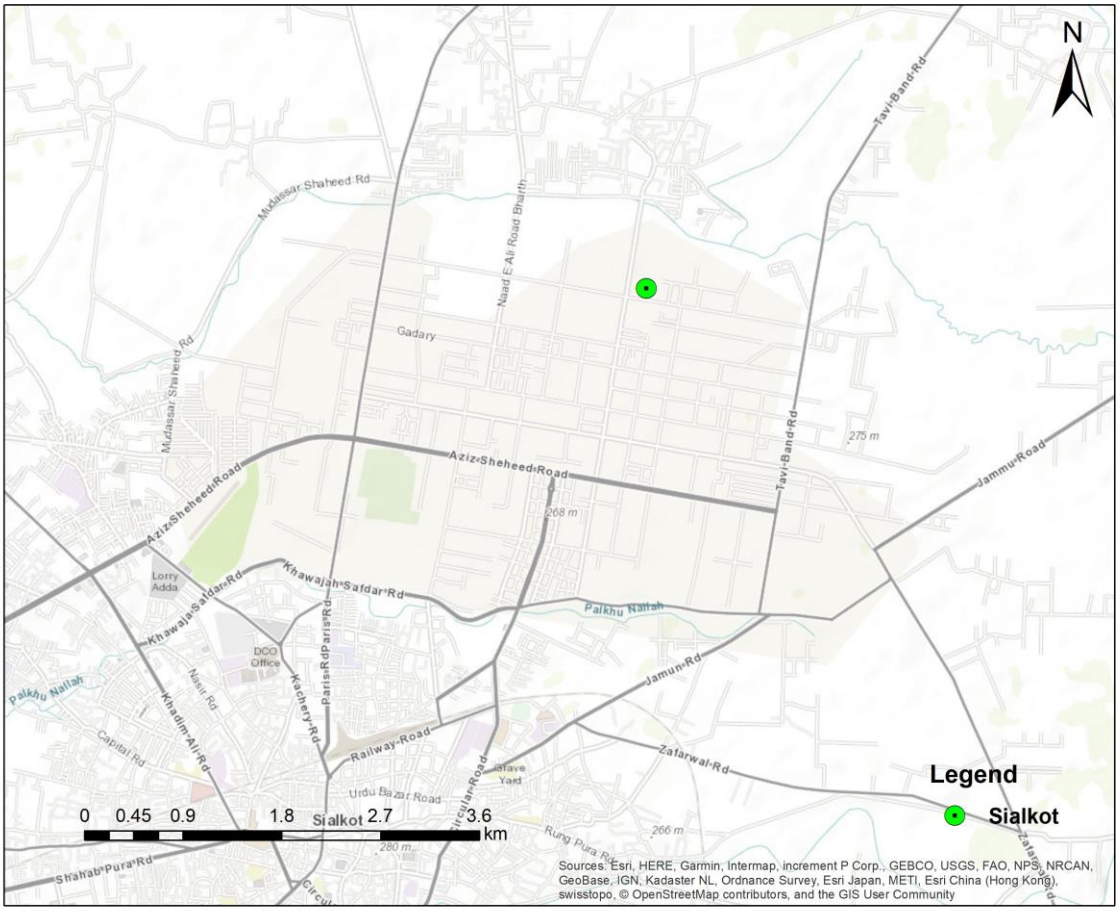


Figure 3.1: Topographic Map of Project Area

3.2 Climatic Conditions

3.2.1 Temperature & Rainfall

Global temperatures have recorded unprecedented increases. The length and timing of seasons are changing. The frequency and severity of floods and cyclones accompanied by rising sea levels are increasing. In short, climate change has become one of the most important challenges of this century for policy-makers, industry, and civil society. It is now an overarching development parameter, which affects most sectors in all countries.

As Pakistan is also facing the change in its climatic conditions, especially in the temperature which seems to be risen considerably. Climate has intrinsic variability and has been changing in past few decades, even, before we started measuring the climate parameters. The uniqueness of this issue in modern world is that human activities are now playing significant role in causing

the climate to change. This is evident from the recent rise in carbon dioxide (CO2) concentration in the atmosphere and in response the rise of global temperatures on land and ocean's surface. Sialkot experiences significant seasonal variations in temperature with the average monthly temperature varying from 11.6 ºC in January to 32.2 ºC in June.

Sialkot is hot and humid during the summer and cold during the winter. June and July are the hottest months. The maximum temperature during winter may drop to −2 °C (28 °F). The land is generally plain and fertile. Post-monsoon season from mid-September to mid-November remains hot during the daytime, but nights are cooler with low humidity. In the winter from mid-November to March, days are mild to warm, with occasionally heavy rainfalls occurring. Temperatures in winter may drop to 0 °C or 32 °F, but maximum are very rarely less than 15 °C or 59 °F. The monsoon season starts from the month of June and ends up in the month of August. The average annual rainfall is about 1000 mm.

Sialkot has 7-8 hours of sunshine daily on average. As there will be no rise in temperature due to reflections of the panels on the atmosphere because the panels are lined with anti-reflection coating (ARC) on the surface which help to reduce the reflection of the panels to almost zero. Adopted measures during rain and dust storm are to generate or produce electricity is to be reduced. The detailed temperature data are given in **Table 3.1** taken from metronome 7.7 and graphical presentation in given in **Figure 3.2.**

Table 3.1: Temperature Statistics for Sialkot Cantt in 2018

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Temperature(˚C)	10.9	14.9	20.5	26.2	31.8	31.5	30.5	29.9	27.7	24.7	18	12.8

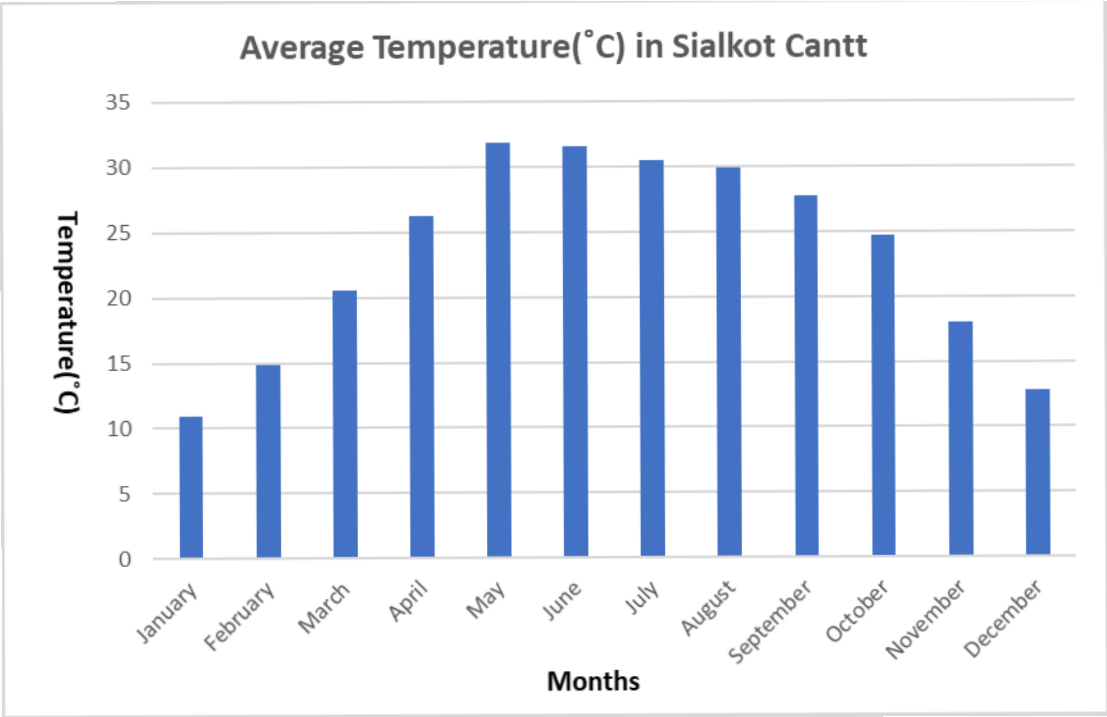


Figure 3.2: Graphical representation of Temperature

The detailed average annual rainfall data are given in **Table 3.2** and graphical presentation in given in **Figure 3.3.**

Table 3.2: Rainfall Statistics for Sialkot in 2018

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Precipation (mm)	0.05	22.23	11.05	31.8	11.4	43.78	37.45	38.62	10.22	2.2	25.4	11.7
Days	1	4	8	14	6	9	14	18	3	3	6	4

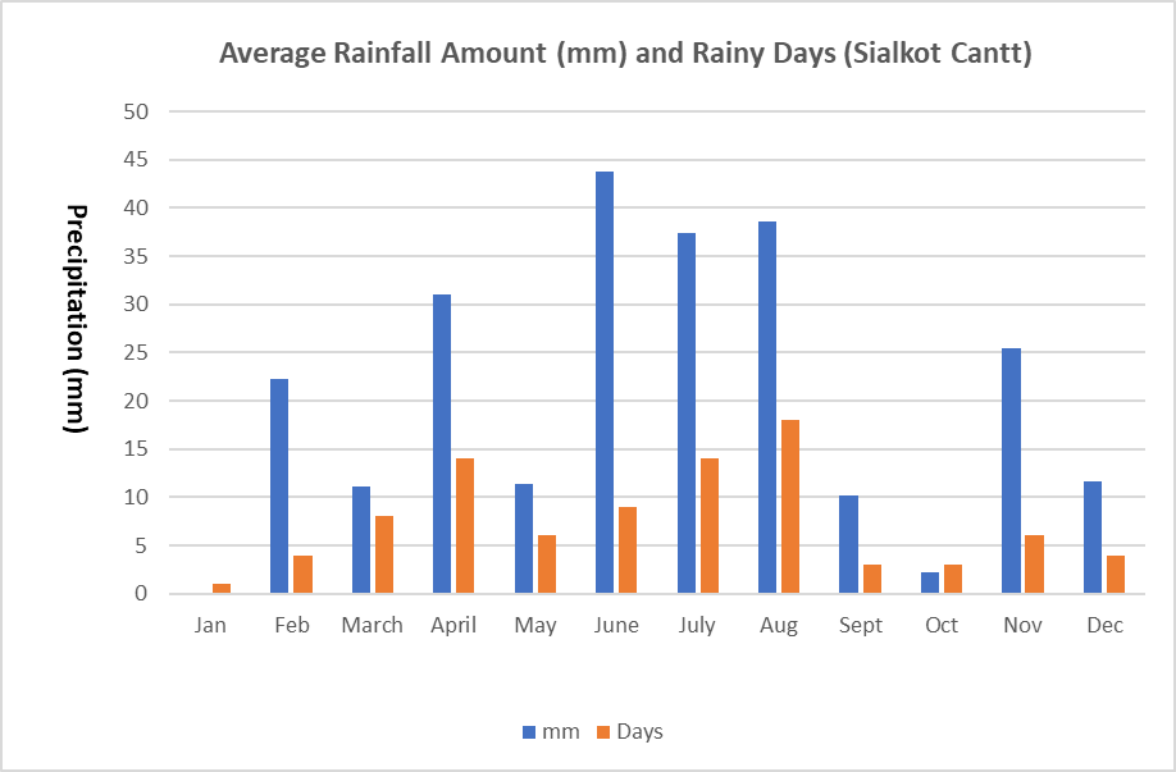


Figure 3.3: Graphical representation of Average Rainfall

Maximum and Minimum Temperature Regime Map of Pakistan is shown in **Figure 3.4**, **Figure 3.5** & **Figure 3.6.**

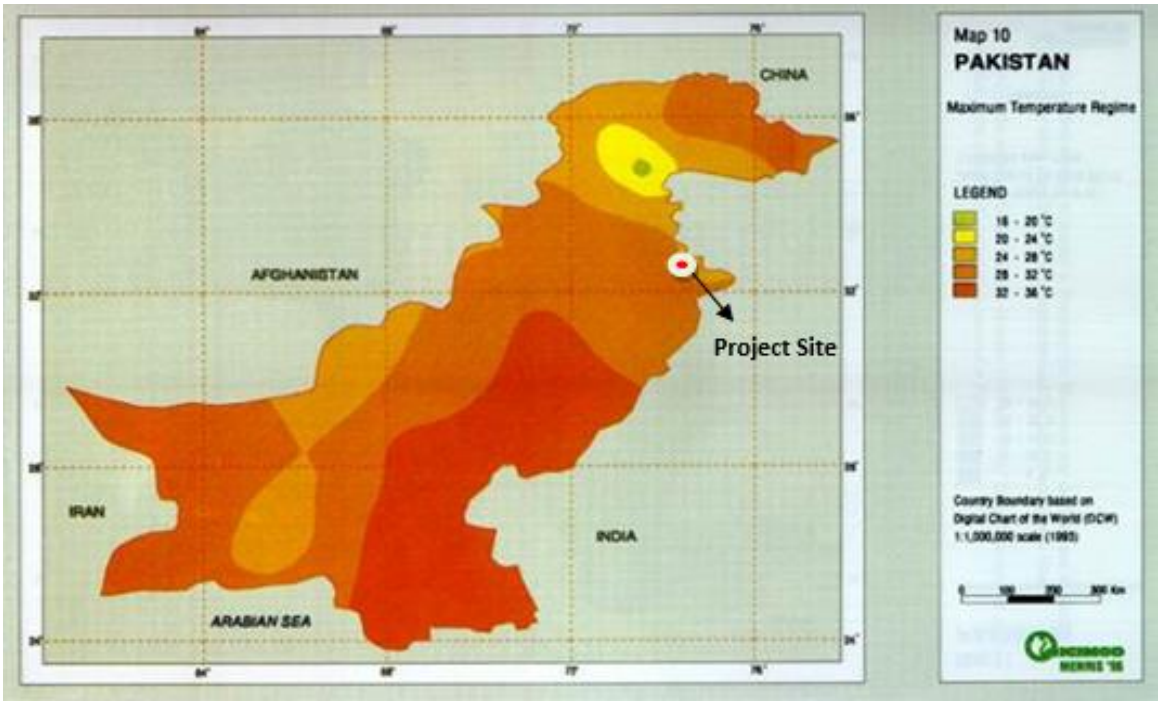


Figure 3.4: Maximum Temperature Regime Map of Pakistan

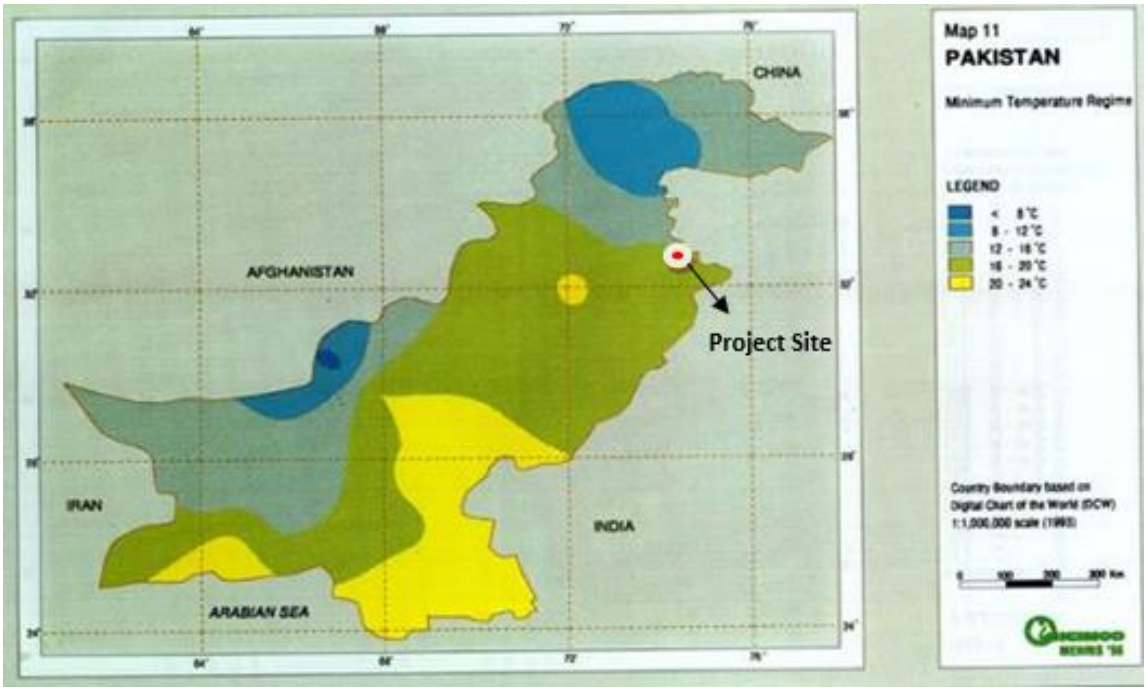


Figure 3.5: Minimum Temperature Regime Map of Pakistan

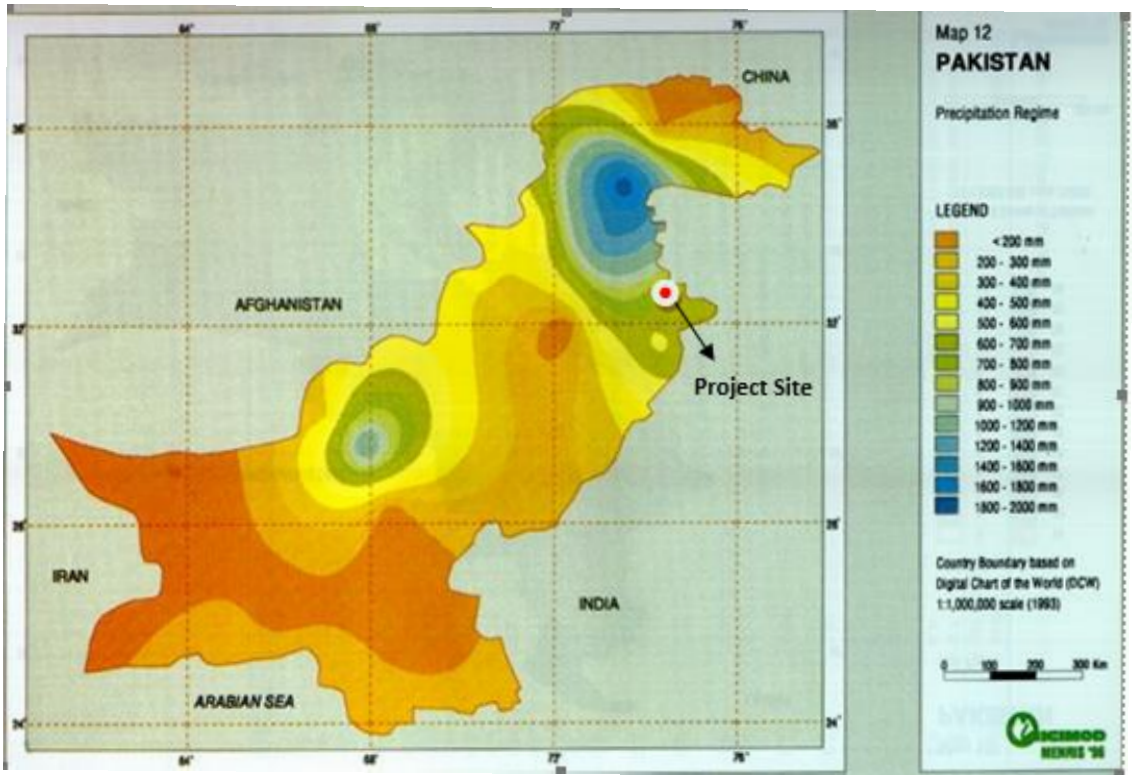


Figure 3.6: Precipitation Map of Pakistan

3.2.2 Wind Speed

The wind speed of any location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. Sialkot become plain and flat region due to which the there is more chances of dust storms and gusty winds occur.

In Sialkot, the windiest month is May and June, followed by April and July. May average wind speed of around 2.4m/s is considered “a light breeze.” Maximum sustained winds (the highest speed for the day lasting more than a few moments) are at their highest in June where average top sustained speeds reach 2.4m/s. The average wind speed on yearly basis are given below in **Figure 3.7**.

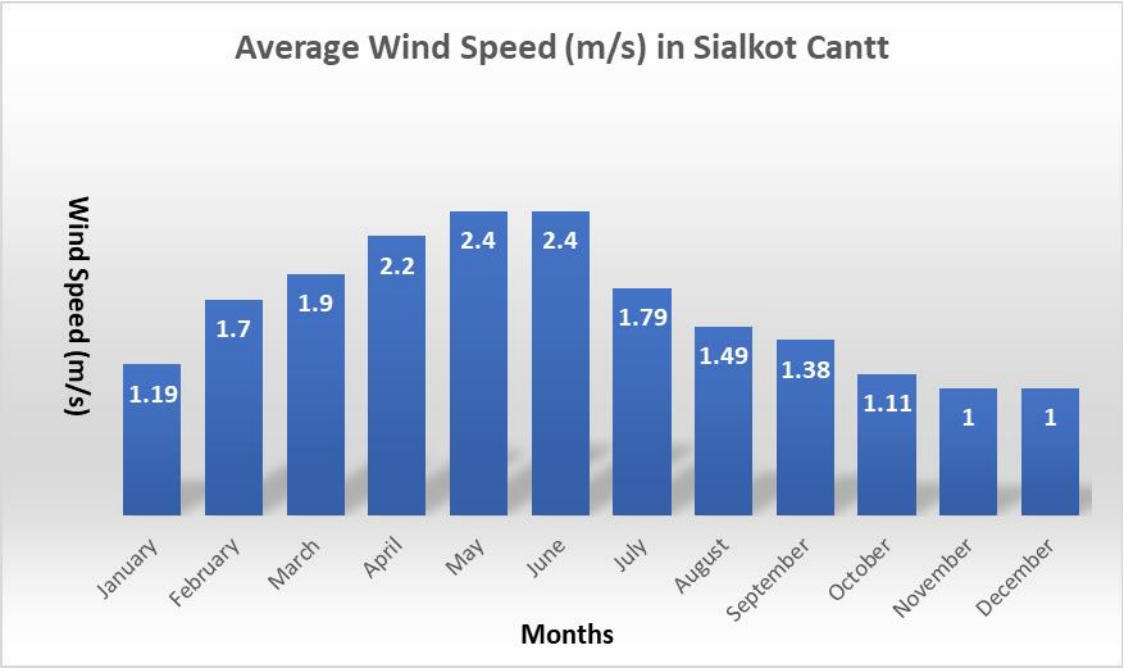


Figure 3.7: Graphical representation of average wind speed in Sialkot

3.2.3 Relative Humidity

Sialkot experiences extreme seasonal variation in the perceived humidity. Sialkot is hot and humid region; the humidity is high. They have some humid months, and dry months in the opposite season. The least humid month is April & May and the most humid month is August and January (74.3%& 74.4%). Average annual humidity is given in **Figure 3.8.**

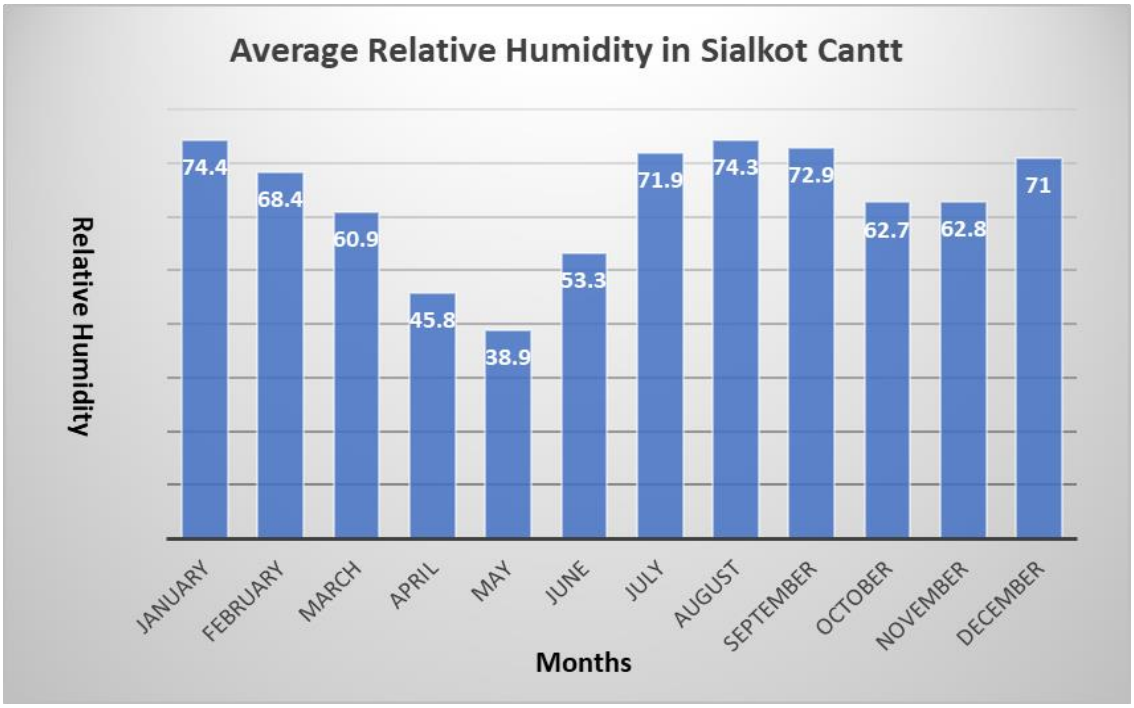


Figure 3.8: Graphical representation of average relative humidity in Sialkot

3.3 Hydrology

Sialkot is situated in the Upper Rechna Doab, which is bounded by the Ravi and Chenab rivers. The Chenab River flows to the northwest of Sialkot, and the Marala-Ravi Link Canals flow to the west. It sits over abundant shallow and deep groundwater aquifers which are used by both the city water supply system and inhabitants with wells for their water supplies.

The maximum daily rainfall was reported on 26th July 2012 because of cloud burst and the rainfall reported for Sialkot Cantt. was 128mm and that for Sialkot Air Port was 76mm (PMD, 2012). This kind of event causes urban flooding. Urban flooding, which occurs during monsoon is due to increased inflows in Nullah Aik, Nullah, Bhaid and Nullah Palkhu and due to inadequate storm and sewer system within city which causes storm overflows in various areas of the city. Sialkot District faces the onslaught of flood causing devastation and disruption of normal life activity during the peak flood season. Sialkot city is threatened by the flood in Aik, Bhaid and Palkhu Nullahs. Due to the twin onslaught of Nullahs, aggravated with intensive rains.

The Cantonment has its own water supply system which, like that in Sialkot City, is supplied from tube wells. Verbal information provided by the Cantonment is that there are about 5,500 connections. Assuming an average household size of 7, the population served will be about

38,500 or 47.5% of the Cantonment population. These figures are lower than might be expected but might be explained by the fact that many properties in the Cantonment have private tube wells.

The piped water system in Sialkot is supplied by tube wells, from which water is pumped directly into supply. The aquifer is recharged from the Chenab River, which is located some 20 km north-west of the center of Sialkot and from the water channels and bodies within the city. The water channels were originally seasonal water courses but now carry wastewater from the city throughout the year. Local water bodies are heavily polluted. The available information suggests that the depth to the water table is typically 10 – 15 meters and that shallow groundwater is polluted with industrial and domestic waste. Water drawn from more than 150 meters (500ft) depth is generally considered to be safe although it is not clear. The TMA is supplied by 72 tube wells, located at intervals throughout the town. A further 25 tube wells have been installed by PHED, of which about 8 are ready to be commissioned. However, the TMA has not yet accepted these tube wells because they believe that the pumps and control panels are sub-standard. Most tube wells are nominally rated at 1.5 cusecs (42.5 l/sec or 153m3 /hr). TMA staff say that water is provided for 12 hours per day, with continuous supply in Model Town and perhaps some other high-income areas. Overall the water supply situation within the old municipal limits is fairly good. However, frequent power cuts mean that it is likely that actual supply periods are rather less than those claimed by the TMA. The Cantonment is supplied by 15 tube wells, with rated discharges ranging from 0.5 cusecs to 2 cusecs and a total rated discharge of 21.5 cusecs. The average rated discharge is thus 1.43 cusecs per tube well. In addition, one 1 cusec tube well is not functioning because of bore failure and two 1.5 cusec tube wells have yet to be commissioned. The Cantonment Board says that the tube wells are normally operated for 8 hours per day.

Tube well depths vary from about 350 feet (106 meters) to 600 feet (183 meters). Sialkot TMA is working to replace the shallower tube wells on the basis that groundwater at depths less than about 500 feet (152 meters) is polluted with municipal and industrial wastes. In 2006, about 34 tube wells were identified for replacement. Since then 20 new tube wells have been sunk by the PHED, suggesting that around 15 remain to be deepened and or replaced. Energy costs, mainly for pump operation, account for 75% of the operational budget for water supply. It is not possible to isolate tube well power costs within the municipal budget but calculations suggest that current power expenditure should be of the order of Rs40 million per year, which is in broad agreement with the power bills received by the TMA.

There is one main network covering most of the city and four smaller independent networks on the western side. These zones cover Model Town, Industrial Estate, Kashmir Road, including China Chowk, and an area on either side of Roras Road. The Model Town network currently has about 720 connections and is served by three tube wells. It provides a continuous (24/7) supply

and approximate calculations suggest that it is capable of producing up to 160 gallons per person per day over 3 times the PHED norm. Factors such as load shedding mean that actual production is likely to be less but still in excess of the PHED norm. There is no accurate record of the Cantonment distribution system. However, the available information suggests that the system is decentralized with two isolated systems in the east and north of the Cantonment area.

3.4 Seismic Hazards

According to Seismic Zoning map of Pakistan, Sialkot falls in Zone 2B which is moderate to severe damage area. There is no earthquake recorded in the history of region above Richter scale 5.0. Also, no damage to the infrastructure and human settlement is reported in the area. Map is shown in **Figure 3.9.**

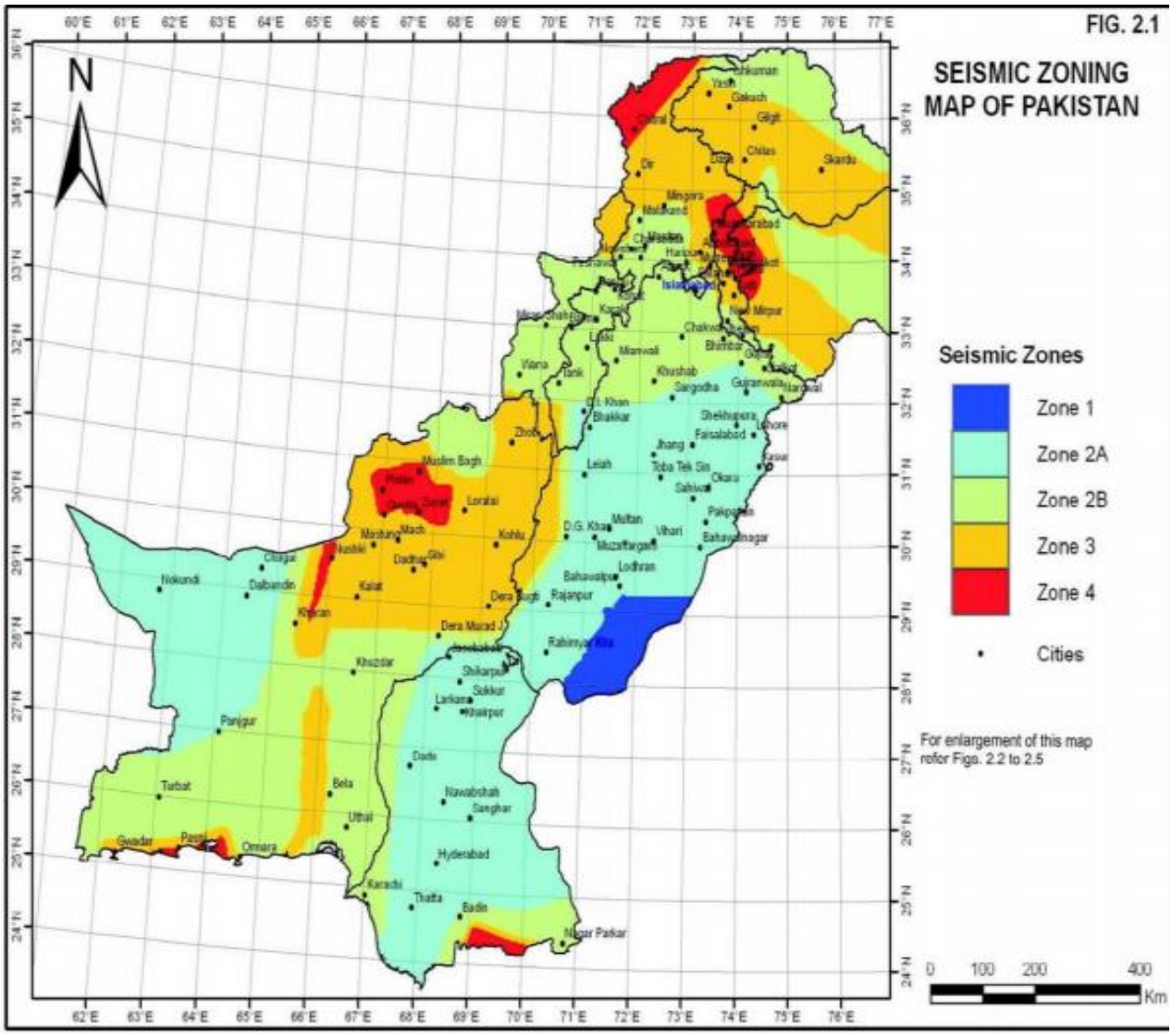


Figure 3.9: Seismic Map of Pakistan

3.5 Socio-Economic Conditions

The district is administratively divided into the following four tehsils (subdivisions), which contain a total of 122 Union Councils. Sialkot's current population is about 809,871, of which about 81,600 live in the Cantonment area. The estimated growth rate of the urban agglomeration, 3.42% per annum, will result in a total population of around 1.10 million in 2020. Currently the population of Sialkot is around 3,893,672. Sialkot district is spread over an area of 3,016 square kilometers.

Sialkot is an important economic hub and a totally export-oriented city of the country and is the only export-oriented city in Pakistan where 99 percent of items produced are exported to various parts of the globe. Through export, Sialkot-based small and medium industries are earning foreign exchange amounting to over 1.30 billion dollars yearly and strengthening the national exchequer. With their business acumen, the local exporters have excelled in foreign trade but they have paid special attention to fulfilling their social responsibility. Attaining exceptional achievements in business, the corporate sector is fully vigilant to its responsibilities towards social sector and has played significant role in this regard on 'self-help basis', which has become now the culture of Sialkot. Sialkot-made footballs, field hockey sticks, cricket gear and boxing gloves are used in international games including the Olympics and World Cups. Surgical instruments and sports goods industries are among the oldest industries which have been playing tremendous role not only in strengthening the national economy but also in providing employment opportunities for thousands of industrial workers.

Most of the developed countries are importing surgical instruments from Sialkot and everyday hundreds of surgeries were performed around the world by surgeons using the instruments made in Sialkot. Thus, Sialkot-made instruments have been playing a silent but significant role in healing wounds and fighting diseases world-wide. There is great need of a 'separate business strategy' for Sialkot, keeping in view its unique export culture and craftsmanship, enabling it to play significant role in earning lot of foreign exchange for the country. Despite several internal problems, like power crisis and law and order situation, the local exporters and manufacturers have been fulfilling their international commitments to keep the national economic wheel in full motion and compete in global market. The industrial needs for bringing radical changes in the industrial sector of the city, underscored the need of formulation of a separate business plan for Sialkot for enhancing productivity and bringing innovation in products to cope with the challenges of international markets. The trends of industrial technology and production line has totally been changed world-wide but due to lack of funds and government support the industrial sector is lagging behind and without the support and co-operation of the government the tracking of the local industrial sector on modern lines is impossible.

Sialkot first became a center for sporting goods manufacturing during the colonial era. Enterprises were initially established for the recreation of British troops stationed along the North West Frontier. Nearby timber reserves served to initially attract the industry to Sialkot. The city's Muslim craftsmen generally manufactured the goods, while Sikh and Hindu merchants of the Sindhi Bania, Arora, and Punjabi Khatri castes acted like middle men to bring goods to market. Sialkot now produces a wide array of sporting goods, including footballs and hockey sticks. Sialkot is also noted for its leather goods. Leather for footballs is sourced from nearby farms, while Sialkot's leather workers craft some of Germany's most prized leather lederhosen trousers.

Sialkot is wealthy relative to other cities in South Asia, with an estimated 2014 per capita income of $2800 (nominal). The city has been noted by The Economist for its entrepreneurial spirit, and productive business climate that have made Sialkot an example of a small Pakistani city that has emerged as a "world-class manufacturing hub." The relatively small city exported approximately $2 billion worth of goods in 2015, or about 10% of Pakistan's total exports. Sialkot is also home to the Sialkot International Airport – Pakistan's first privately owned public airport

Sialkot has a fairly well-developed educational infrastructure that comprises a sub campus of University of Management and Technology, Lahore, a sub campus of University of Gujrat, Gujrat, a sub-campus of the Fatima Jinnah Women University, a sub-campus of the Virtual University of Pakistan, 8 Degree Colleges for Women, 5 Degree Colleges for Men, 2 Cadet Colleges, 6 Commerce Colleges, one Law College, one Medical College, one Homeopathic Medical College, one Nursing School, one Para-Medical School, one Poly-Technic Institute, with numerous Inter Colleges, Higher Secondary Schools and over 250 High Schools. The Convent of Jesus and Mary, Sialkot was established in 1856. It was the first Catholic mission school in Punjab and the second of its kind in British India. Other eminent private-sector schools include the American School, the City School, the Beaconhouse School and Zaka Public School and College GulBahar. The Murray College, Sialkot was established in 1889 as the Scotch Mission College by the Scottish missionaries belonging to the Church of Scotland Mission. It is one of the oldest educational institutions in Pakistan offering education up to the post-graduate level.

3.6 Ecology

The flora of Sialkot is very sparse. Fifty-one species after twenty-seven families were recorded by studding forty quadrats in different sites of Sialkot. This major community, Cynodon dactylon -Solanum nigrum was named so because of greatest presence of these species in the area and was further divided into two sub- communities namely Cynodon dactylon-Convolvulus arvensis and Parthenium hysterophorus -Amaranthus viridis. The most important species Cynodon dactylon exhibited good frequency value of 45 % and Convolvulus arvensis 35 %. The dominant species of this community were Parthenium hysterophorus and Amaranthus viridis. This community was located on the Pasrur to Gujranwala road. Both species were growing frequently on disturbed habitats such as road side, trampled and over grazed patches of land, crop fields and waste lands etc. Similar ecological amplitude and microclimatic conditions requirements made these species to grow together. Low rate of regeneration and overexploitation of economically and medicinally important plants has considerably reduced

their number in this district. Sialkot is basically an agricultural district. Mostly it is full of greenery. The most important crops and fruit of district Sialkot are wheat, rice, citrus and guava. About 2.17 % of the total area of the district is under human forest plantation of trees of economic importance like Shisham, Keeker, Mulberry that are used in construction and making sports goods and furniture. Other introduced species are Mesquite an invasive species and Safeda Sheesham Bohar and Bakain are also seen in and around the urban areas. The district Sialkot is the host of a variety of flora. The indigenous tress is Lasoora, Bairy, Siris, Keeker, Phali, Khajoor, Toot and Paper Mulberry These are commonly found along the edges of agricultural fields.

Pakistani wetlands host a large number of resident as well as migratory birds. Bajwat is the most distinctive part of district Sialkot in terms of fauna and flora. Bajwat, the northern part of Sialkot district, covers an area of 19452 hectares. The area is a wetland of international importance due to the presence of Marala Headworks, Munawar Tawi, Jammu Tawi, many nullahs, ponds and marshy areas. Wild animals are rarely found in this area. However, jackal, wolf and fox are found in some part of the area.

As for the birds, there is no impact on the birds due to the solar panels; the panels that are used in the project are lined with anti-reflection coting which helps to reduce the reflection of the panels to almost zero. When the Solar PV panels will be installed on the ground mounted structure, there is a minor disturbance of flora and fauna due to execution of this project. Some small shrubs and tree will be removed during construction of the project. After construction of the project, a new tree will be planted in the project premises.

CHAPTER 4

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4 Potential Environmental Impacts and Mitigation Measures

The project may have environmental impact during construction and operation phase of the project. During construction phase, the impacts may be temporary and short term while long term impacts may be observed during the operational phase of the project. The project has positive impacts overall by providing a competitive, pollution free and cost effective. It may also meet the increasing demand of power and reduce the gap between demand and supply of power.

The construction and operation phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. The impacts of the project are envisaged during the design and planning, during pre-construction phase, construction phase.

4.1 Impact on Air Quality

As the proposed project is Solar PV project, the impact during construction of project is expected to be minimal as a Greenfield Project plant. 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 through the movement of vehicles (transportation activities). Minor excavation and back filling are required because the PV panels will install on vacant land. The main source of gaseous emission during the construction phase is movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO2, NOX, and particulate matter. The impact is reversible, marginal and temporary in nature.

4.2 Impact on Noise Quality

The major noise generating sources during the construction phase are vehicular traffic, construction equipment like; generators, compressors, vibrators etc. The operation of this equipment will generate noise ranging between 75 – 90 dB (A). As noise generated during

construction phase of the project is low and within the Limits of NEQ's. As there is no human settlements and villages near the project vicinity or buffer zone so overall, the impact of generated noise on the environment during construction period is insignificant, reversible and localized in nature.

4.3 Impact on Water Use and Quality

The construction personnel would be housed in temporary settlements or settlements provided by the project sponsors. These settlements would discharge considerable amount of domestic wastewater. Stagnant pools of water would increase breeding of mosquitoes and generally create insanitary conditions. 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 washroom (e.g., through regular liming) will be used as main component of the sanitation system. As the PV panels will be installed on flat land which is barren land so minor use of water during construction phase of the project and overall no impact on water use and its quality.

4.4 Impact on Groundwater Contamination

There is no harm to the ground water due to construction of PV project because panels will be installed on the Ground but require little excavation to fix the structure and the project site is already developed in premises of Cantt area. There is no impact on the Ground water.

Ground water due to plant operation will be drawn during operation phase for any purpose. There shall be minimal discharge of wastewater from cleaning of Solar PV modules. The wastewater emanating from cleaning operations shall be recycled or used for plantation around the plant. For 01 MW, one vehicle of water is required for the cleaning and duration of the cleaning for 1.0 MW is required approximately 01 or 02 days. For 01 MW, approximately 15000 liters of water is required for washing of panels, only 02 days require for the cleaning of panels and on monthly basis and the process will be done on monthly basis.

During the operation & maintenance period, natural underground water can be used for cleaning the modules with manual washing. The water for cleaning the module doesn't include any chemical agents, so the untreated underground water will be used for cleaning. Based on our project circumstances, modules shall be cleaned once in every month. The water supply

system will be installed along the solar panel array and will be used by the cleaning staff to use the tap water for manual cleaning.

4.5 Impact on Land Use

The mobilization of construction equipment and construction materials will require space for storage and parking of construction vehicles and equipment, construction material storage yards, disposal sites, and labor camps for human resource to avoid environmental impact and public inconvenience. The total land available for the Project is 3.79 acres. At the Project site, there has been an absence of the following since the past few decades:

- Any major agricultural activity on the land
- Any field, wetland or protected area.

Overall, there will be minor impact on the land use. There is minor excavation require for the piling and adjust the mounting structure and a small chunk of land is required for the space of storage of equipment, construction material and waste handling which have a no or minor impact and will be temporary only in construction phase.

4.6 Impact on Biological Environment

The project area is already developed and there is no harm to the biological environment for the installation of PV plant. There will be no or minor impact on flora and fauna of the project vicinity. Thus, the site development works would not lead to any significant loss of important species or ecosystems. Only few plants will be damage during clearing of land. After installation, afforestation will be done in the vicinity of project area.

4.7 Impact on Solid Waste

Solid waste during the construction phase consists primarily of 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.

Solid waste disposal will be done as follows;

- A waste inventory of various waste generated will be prepared and periodically updated.
- The excavated material generated will be reused for site filling and leveling 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 stored in designated waste bins/containers. The recyclables will be periodically sold to local recyclers while food waste will be disposed through proper waste handling mechanism.
- Hazardous waste viz. waste oil etc will be collected and stored in paved and bounded area and subsequently sold to authorized recyclers.

The complete details of scrap metal details will be given as; scrap metal waste generated from erection of structures and related construction activities will be collected and stored separately in a stack yard and sold to local recyclers as per to manage the solid waste handling team. A separate yard area will be allocated for storing the waste material as per the required industrial practice. Also, approved contractor will be hired for the recycling of waste appropriately during construction phase. Waste handling agency will be hired at the start of project construction to manage the waste generating during the construction and operational phase of the plant and the practices used for handling the waste disposal to manage proper waste management through different mechanisms like, make a proper dumping site for the disposal of waste, handling of waste. The wastes which are recyclable are sold to the external contractors and the non-hazardous waste will be dumped through municipal waste collection system and services. The solid waste will be dumped away from the project site and where nearby no settlements or any other affected environment is present. It may the proper dumping site that is used for local municipality. Although the PV cells will not be disposed but sent back under as warranty is for 25 years. There are some solid wastes in the project site, including the packing material for the equipment, like the wooden pallets and carton boxes. Solid waste management plan will be followed third party EPA certified contractor will be hired for disposal of solid waste (No Impact).

CHAPTER 5

INSTITUTIONAL REQUIREMENT AND ENVIONMENTAL MONITORING PLAN

5 Institutional Requirement and Environmental Monitoring Plan

During the construction and operation of PV Project, the project company will comply all the rules and regulations of EPA and the standard industrial practices as well as NEQs standards. Implement the environmental mitigation and monitoring plan during construction of the project. Environmental Management and Monitoring Plan provides the mechanism to address the adverse environmental as well as social impacts of the proposed project during its execution, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works.

5.1 Preconstruction Phase

During pre-construction phase of the project, a field survey was conducted by the team to identify the potential impacts and address into the monitoring plan to mitigate their affects to the project and the surrounding environment. Define the roles and responsibilities for those who involved in the implementation of the EMP during construction. Also define the implementation mechanism for the mitigation measures identified during the present study.

5.2 Construction Phase

During construction phase of the project, a solid waste will be handled properly as per the standard industrial practices and dumped into the proper waste disposal sites which are already identified. Provide safety trainings to the workers who works during the construction phase. Provide instructions to project personnel and contractors regarding procedures for protecting the environment and minimizing environmental impact during construction of the project.

5.3 Operational Phase

During operational phase, the environment and social impact will be minimum as there is no dust and any gaseous emission from the plant. Only the waste water that used for the cleaning mechanism of PV panels will be generated and will be handled properly as per the standards. Also provide trainings and awareness sessions rising on the environmental and social issues related to power transmission projects to the project. Ensure the legal compliance properly during O & M phase of the project.

CHAPTER 6

FINDINGS AND RECOMMENDATIONS

6 Findings and Recommendations

The Project will be the replacement of conventional power generation with renewable energy. Solar energy will replace fossil fuel powered generation, and therefore reduce suspended particulate matter and greenhouse gas emissions into the atmosphere. The project is cost effectively and environmental impacts are likely to be minimum in result from the proposed Power project. Careful mitigation and monitoring, specific selection criteria and review/assessment procedures have been specified to ensure that minimal impacts will take place. The detailed design would ensure inclusion of any such environmental impacts that could not be specified or identified at this stage are taken into account and mitigated where necessary. Those impacts can be reduced through the use of mitigation measures such as correction in work practices at the construction sites, or through the careful selection of sites and access routes. As proposed land is already the developed land and PV panels will be installed on the Ground mounted structure and there is no or minimum harm to the natural environment or any biological habitat.

Based on the environmental and social assessment and survey conducted for the Project, the potential adverse environmental impacts can be mitigated to an acceptable level by adequate implementation of the mitigation measures identified during visit. Adequate provisions are being made in the Project to cover the environmental mitigation and monitoring requirements, and their associated costs.

Safety and Emergency Plans

SAFETY AND EMERGENCY PLAN

EMERGENCY RESPONSE PLAN (ERP)

PURPOSE

To describe responsibilities in preparation for, response to and recovery from any reasonably foreseeable incident.

PRIORITIES

Secure the Health and Safety of all personnel involved Minimize any impact on the environment. Minimize any impact on property and assets.

ROLES AND RESPONSIBILITIES

EMERGENCY RESPONSE TEAM LEADER

The person is responsible to manage the execution of emergency response. The main responsibilities include

- Lead the team in case of emergency.
- Ensuring that appropriate emergency response teams are defined and prepared for the various emergency response in different cases.
- Notification to Project Manager of any emergency incident. Emergency should be notify via radio, telephone or messenger.

SITE ENGINEER

Site Engineer is responsible for ensuring at site that provisions are in place for emergency response, including:

- Assembly Points
- Arrangements for conducting head count
- Identification & Mobilization of Fire Team
- Setting up drills and exercise
- Procurement of firefighting equipment

In the event of any emergency, following actions shall be taken by Site Engineer (HSE).

- Analyse the situation and issue direction to the concerned parties and to the Fire Team.
- To make sure that the emergency situation is properly communicated to ERT leader.
- Analyse the intensity of the incident and raise the requirement of any additional equipment if necessary.

- Communicate with site supervisor for withdrawing any permits and for mobilization of any plant and equipment necessary for dealing with emergency.

FIRE TEAM

Fire Team will be responsible for:

- Practice the emergency plan exercise on periodic basis.
- Select a member of their team as a leader who will report to Site Engineer (HSE).
- Take part in different training activities.

An electrician shall be included in the fire team who will be responsible for electrical isolation of areas as necessary.

There shall be a periodic check and routine maintenance of firefighting appliances. There will be a sufficient redundancy of appliances to get utilized in case of emergency.

GENERAL CONSIDERATIONS

Emergency drills shall be arranged after a periodic intervals. The Site Engineer (HSE) shall be responsible for identifying any remedial actions required.

Communication is a critical factor while dealing with emergency. In case of emergency observed by any person, the emergency alarm will be raise on priority and the assembly point shall be clearly indicated. List of all emergency contacts will be displayed at site. A person will notify about the emergency to the site Engineer as well as on emergency numbers.

Activate the emergency alarm to evacuate the area safely and make sure that all persons leave the site safely. Assign someone to advise security to open the main gate of facility for emergency vehicles.

System Studies

Short Circuit Study/Load Flow Studies are being prepared by the Consultants. We will submit the same to the Authority once completed.

Plant Characteristics

Generation Voltage
The Solar PV System will be generating the electricity at 11 KV and it will be synchronized on the same voltage level.

Power Factor & Frequency
Gujranwala 3 MW Solar PV system is using Grid-Tie inverters of 150 KVA each to convert DC power of solar panels to Alternating Power. The Power Factor is adjustable from 0 overexcited to 0 underexcited and the rated Power Factor at nominal power is 1. The range of frequency of the inverter is 44-55 Hz and nominal frequency of generation is 50 Hz.

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

Plant Characteristics

Generation Voltage

The Solar PV System will be generating the electricity at 11 KV and it will be synchronized on the same voltage level.

Power Factor & Frequency

Kharian 2.5 MW Solar PV system is using Grid-Tie inverters of 150 KVA each to convert DC power of solar panels to Alternating Power. The Power Factor is adjustable from 0 overexcited to 0 underexcited and the rated Power Factor at nominal power is 1. The range of frequency of the inverter is 44-55 Hz and nominal frequency of generation is 50 Hz.

Plant Characteristics

Generation Voltage

The Solar PV System will be generating the electricity at 11 KV and it will be synchronized on the same voltage level.

Power Factor & Frequency

Sialkot Cantt 1 MW Solar PV system is using Grid-Tie inverters of 150 KVA each to convert DC power of solar panels to Alternating Power. The Power Factor is adjustable from 0 leading to 0 lagging and the rated Power Factor at nominal power is 1. The range of frequency of the inverter is 44-55 Hz and nominal frequency of generation is 50 Hz.

Metering and Protection

The energy which will be generated by Solar System will be locked in the inverters and a separate CT meters will be installed at the site, by which the instantaneous power, daily energy, monthly energy and total energy can be measured.

The inverters with the following protections will be installed at the site.

- DC current reverse connection protection
- AC short circuit protection
- Leakage current protection
- Grid monitoring
- DC fuse and over current protection
- Anti-PID function
- Overvoltage protection

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com

Training and Development

The most important things to cover in Training & Development include orientation, site induction according to HSE instructions and other professional and management training.

INITIAL HSE ORIENTATION PROGRAM

After completion of successful HSE orientation, a person will be permitted to enter the site. The Site Engineer HSE will be responsible for the initial orientation which will cover the general HSE rules and regulations for working on site including use of PPEs, first aid, incident reporting, emergency response (alarm system, escape route, assembly point) and possible hazards at the site.

This orientation will be also for the workers of sub-contractors working at the site. Site Engineer HSE will be responsible to keep a record of all the workers.

MANAGEMENT EMPLOYEES TRAINING PROGRAM

The management employees training program will be conducted during to make sure that all management employees are trained.

Site HSE Engineer will conduct HSE trainings for all staff based on training plan.

TASK SPECIFIC TRAINING PROGRAM

If required, an additional training program shall also be arranged for staff and workers in order to give technical knowledge of solar PV system.

Efficiency Parameters

Calculation of PR

PV power plant efficiency can be judged per its performance ratio, expressed as a percentage. This ratio compares a plant's actual energy production to its theoretical energy-generating potential and describes how efficient a PV power plant is in converting sunlight incident on the PV array into AC energy delivered to the utility grid. AS per IEC definition, Performance

Ratio is defined as:

$$Performance\ Ratio = \frac{Z1}{Z2} \div \frac{Z3}{Z4}$$

Where,

Z1 = Accumulated electricity generated during testing period (KWh)

Z2 - Total system installed capacity (KWs)

Z3 - Accumulated irradiation during testing period (Wh/m^2)

1A - Intensity of irradiance under STC condition = $1000W/m^2$

Calculation of CUF

Capacity Utilization Factor of the plant is calculated using this formula:

$$Capacity\ Utilization\ Factor = \frac{Specific\ Production\ KWh/KWp}{24 \times 365} \times 100$$

Solis Delta Energy (Pvt.) Ltd
3rd Floor, Horizon Vista, Block-4,
Clifton Karachi-Pakistan
T +92(21)3529 4301-6
F +92(21)35294311
www.solis-energy.com