BEFORE THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

(NEPRA)

ORIGINAL

APPLICATION FOR GENERATION LICENSE

PURSUANT TO THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY LICENSING (APPLICATION AND MODIFICATION PROCEDURE) REGULATIONS, 1999 READ WITH THE PROVISIONS OF THE REGULATION OF THE GENERATION, TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER ACT, 1997 AND THE RULES AND REGULATIONS MADE THEREUNDER

AND

THE FEDRAL GOVERNMENT'S POLICY OF RENEWABLE ENERGY AND POWER GENERATION 2006

AND

THE PUNJAB GOVERNMENT'S POLICY FOR RENEWABLE ENERGY AND POWER GENERATION 2006-9

ON BEHALF OF

CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD

(THE PROJECT COMPANY)

RE: 50MW SOLAR PHOTOVOLTAIC (PV) POWER GENERATION FACILITY AT QUAID-E-AZAM SOLAR PARK LAL SUHANARA, BHAWALPUR, CHOLISTAN, PUNJAB

(THE PROJECT)

Dated May 18, 2020

Address: Office 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad 44000, Pakistan. Tel: +92-51-2870422-3, Fax: +92-51-2870424, Email: info@weltkonnect.com, www.weltkonnect.com

CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD

Harnessing the Energy of the Sun

No: CWCSPP/NEPRA/RGL/2020-01 Date: - 18th May 2020

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

Subject: - **APPLICATION OF CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD FOR GRANT OF GENERATION LICENSE IN RESPECT OF 50 MW SOLAR POWER PLANT BEING DEVELOPED IN DISTRICT BAHAWALPUR QUAID-E-AZAM SOLAR PARK (QASP).**

Dear Sir,

1. I, Engineer Habil Ahmed Khan, Director Operations, being the duly authorized representative of CTGI-WK Cholistan Solar Power Project Pvt. Ltd (The Project Company), hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to the Company pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

2. 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.

3. A Pay Order from Askari Bank Ltd having No. 30802082 dated 09th March 2020, in the sum of Rupees, Three Hundred Seventy Thousand Six Hundred Eighty Eight Only (Rs.370,688/-) being the non-refundable license application fee calculated in accordance with Schedule TT to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Eng. Habil Ahmed Khan
Director Operations

Pakistan Office 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad 44000, Pakistan. Tel: +92-51-2870422-3, Fax: +92-51-2870424, Email: info@ctgiwkcspp.com, www.ctgiwkcspp.com

1 EXECUTIVE SUMMARY OF THE PROJECT

Project Company	CTGI-WK Cholistan Solar Power Project (Pvt) Ltd
LOI	Letter of interest dated 09-06-2011 (bearing reference number PPDB/1201/127/2011) issued by PPDB.
Main Sponsor	• China Three Gorges • Welt Konnect Pvt Ltd
Current Shareholder	CTGI-WK Cholistan Solar Power Project (Pvt) Ltd
Project Capacity	50MW
Project Location	Quaid-E-Azam Solar Park, Lal Suhanara, Bhawalpur, Cholistan, Punjab
Land Area	250 Acres
Concession Period	25 year from Commercial Operation date (COD)
Auxiliary Consumption	300KW
Project Basis	Build Own Operate Transfer (BOOT)
Energy Purchaser	Central Power Purchase Agency (Guarantee) Limited (CPPA-G)
PV Module	Mono Crystalline PV Modules
Inverter Output	5000KW
Capacity Factor	20.50%
Construction Period	08 Months
EPC Contractor	HDEC Engineering (Pvt.) Limited / POWERCHINA International Group Limited
Annual Energy Generation	87.943GWh
Project Cost	USD 35,916,642
EPC Cost	USD 30.706196 Million
Debt to Equity Ratio	80:20
Financing	86% Foreign Debt 14% Local Debt
Return on Equity	15%

Exchange rate	165/-
Levelized tariff	4.9330 US Cents/Kwh
Financial Advisor	RSM Avais Hyder Liaquat Nauman Contact Person: Mr. Jamil Akhtar

(i) review, execute, submit and deliver the Generation License Application (including any review petitions and any motions for leave for review) and any related documentation required by NATIONAL POWER REGULATORY AUTHORITY for the grant of generation License, including any contracts, documents, power of attorney, affidavits, statements letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature what so ever;

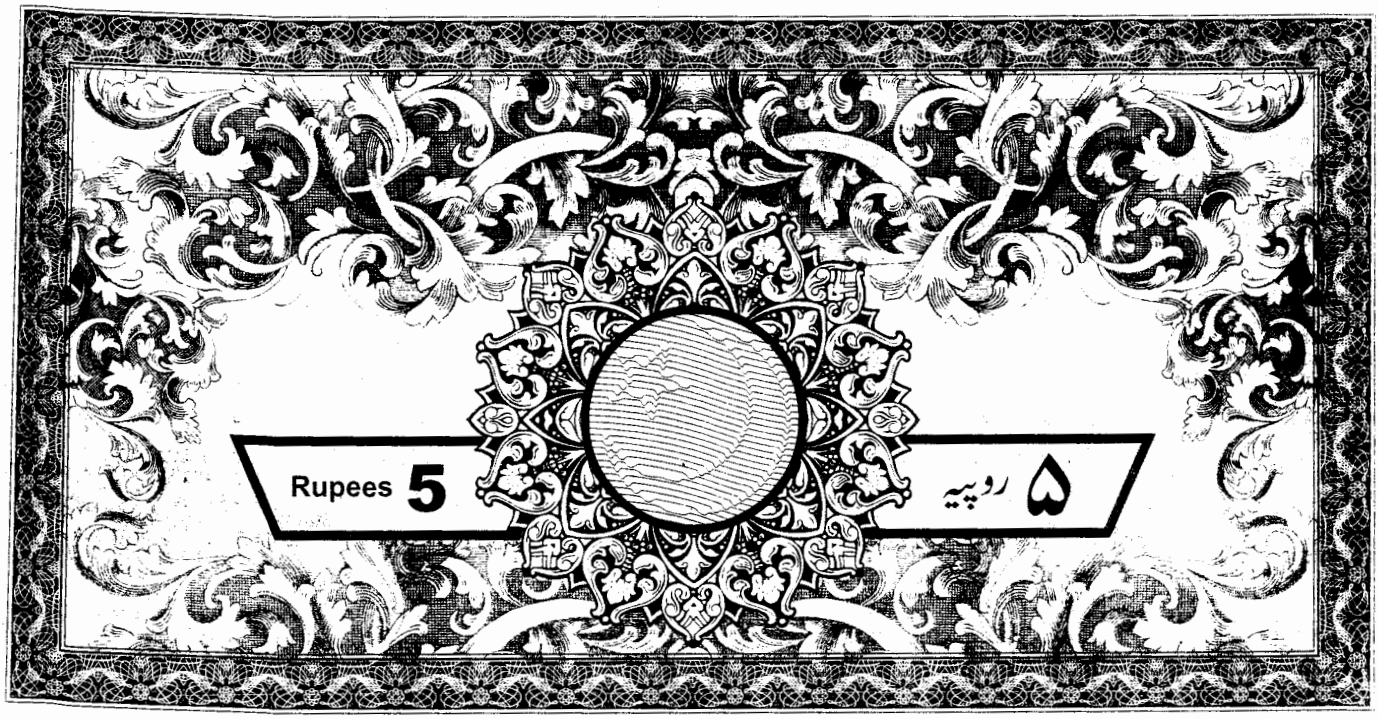
(ii) represent the Company in all negotiations, representations, presentations, hearings, conferences and meetings of any nature what so ever with any entity (including in no manner limited to NATIONAL POWER REGULATORY AUTHORITY and private parties, companies, partnerships, individuals governmental and/or semi-governmental authorities and / or any other entity of any nature whatsoever);

For & behalf of
CTGI-WK Cholistan Solar Power Project (Pvt) Ltd

Fiaz Ahmad
(Chairman)

CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD. ISLAMABAD

A336841



BEFORE THE

NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

AFFIDAVIT

AFFIDAVIT of Engr. Habil Ahmed Khan, Authorized Representative of CTGI-WK Cholistan Solar Power Project (Pvt) Ltd

I, the above named Deponent, do hereby solemnly affirm and declare that: -

1. I am the authorized representative of CTGI-WK Cholistan Solar Power Project (Pvt) Ltd.

2. The contents of the accompanying application for grant of Generation License of the 50 MW Solar Power Plant at Quaid-E-Azam Solar park, Lal Suhanara, Bahawalpur, Punjab being developed under Letter of Intent (LOI) No: PPDB/1210/127/2011 Dated 09-06-2011 issued by Punjab Power Development Board (PPDB), including all supporting documents are true and correct to the best of my knowledge and belief, and nothing material or relevant thereto has been concealed or withheld therefrom.

3. I also affirm that all further documentation and information to be provided by me in connection with the aforesaid Generation License shall be true and correct to the best of my knowledge and belief.

B002175

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

SECP

CERTIFICATE OF INCORPORATION ON CHANGE OF NAME

[Under section 40 of the Companies Ordinance, 1984 (XLVII of 1984)]

Corporate Universal Identification No. 0078366

I hereby certify that pursuant to the provisions of section 39 of the Companies Ordinance, 1984 (XLVII of 1984) the name of **CTG SOLAR POWER BAHAWALPUR (PRIVATE) LIMITED** has been changed to **CTGI WK CHOLISTAN SOLAR POWER PROJECT (PRIVATE) LIMITED** and that the said company has been duly incorporated as a company limited by **Shares** under the provisions of the said Ordinance.

This change is subject to the condition that for period of one year from the date of issue of this certificate, the company shall continue to mention its former name alongwith its new name on the outside of every office or place in which its business is carried on and in every document or notice referred to in clauses (a) and (c) of section 143.

Given under my hand at Islamabad this 16th day of April, two thousand and Fifteen.

(Shaukat Hussain)
Additional Registrar of Companies
Islamabad

CERTIFIED TO BE TRUE COPY

Additional Joint Registrar
Company Registration Office Islamabad

Fee Rs.

Islamabad 21

No. ADI 12140
Dated 15/4/15

THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

OF

CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT.) LIMITED

I. The name of the Company is "**CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT.) LIMITED**".

II. The Registered Office of the Company will be situated in Islamabad Capital Territory.

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

1. To carry on all or any of the businesses of generating of solar power, steam turbine generating plant, gas turbine generating plant and purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply Subject to approval from concerned authorities i.e. NEPRA, Ministry of Water and Power.

2. To locate, establish, construct, equip, operate, use, manage and maintain thermal power plants and coal fired power plants, power grid station, transforming, switching, conversion, and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops, dispensing machines for pre-payment cards and other devices, showrooms, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities Subject to approval from concerned authorities i.e. NEPRA, Ministry of Water and Power.

3. To locate, establish, construct, equip, operate, use, manage and maintain hydal power plants and all other acts required for establish, maintaining and running such plants, like building of dams and all the allied acts necessary for our objectives Subject to approval from concerned authorities i.e. NEPRA, Ministry of Water and Power.

4. To locate, establish, construct, equip, operate, use, manage and maintain hydal power plants run on alternate energy resources e.g. sunlight, wind, sugarcane and any other new way of producing electricity and all acts necessary for achieving these ends, which include but are not limited to research, trainings, experiments, joint ventures etc Subject to approval from concerned authorities i.e. NEPRA, Ministry of Water and Power.

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

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

7. To carry on the business of general order suppliers including Government, Semi-Government Agencies, Armed Forces, Army, Military or Defense and commission agents, indenters, traders and as general merchants, wholesalers, retailers, dealers, distributors, stockiest agents, sub-agents in any goods or products or within the scope of the object of the Company and subject to any permission required under the law.

8. To apply for, tender, offer and accept purchase or acquire any contracts and concessions for or in relation to the projection execution, carrying out improvements, management, administration or control of works and conveniences and undertake, execute, carry out, dispose of or otherwise turn to account the same.

9. To carry on in or outside Pakistan the business of manufacturers, importers, exporters, indenters, transporters, dealers in all articles and commodities akin to or

connected with any of the business of the Company capable of being conveniently carried on or necessary for the promotion of the objects herein contained, as permissible, under law.

10. To establish and manage branches, zonal, divisional and sub offices and to appoint representatives of the company or its allied associated concerns anywhere in Pakistan or in foreign countries.

11. To go in for, buy or otherwise acquire and use any patent design, copyright, licenses, concession, convenience, innovation, invention, trade marks, or process, rights, or privileges, plants, tools or machinery and the like in Pakistan or elsewhere, which may for the time being appear to be useful or valuable for adding to the efficiency or productivity of the Company's work or business, as permissible under the law.

12. To carry out joint venture agreements with other companies or countries within the scope of the objects of the Company.

13. To import, export, invent, design, develop, produce, manufacture, assemble, test, install, maintain, renovate, refurbish, recondition, utilize operate, manage, acquire, sell, hire out, supply and otherwise deal in plant, equipment and apparatus for the business of the company.

14. To do the business of importing, exporting, simple & heavy machinery, technology uses for the company's business and any other business.

15. To provide for the benefit of other persons consultancy, advisory, training and management services , including but not limited to IT, Finance and Telecom Sectors; concerning or connected with anything that the company does in the exercise of its power or has power to do, or in which the company has gained or developed expertise in the course of its business, and to provide training and educational courses, documentation and material for employees of the company and for other persons in matters which in the opinion of the company and for other persons in matter are connected with, of concern or are of benefit to, the business and activates of the company or which utilize the company's communications systems or services.

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

17. To grant pensions, allowances, gratuities and bonuses to employees of the Company or any of them or the dependants of all or any of the employees and to subscribe to any labor, industrial, charitable or other institutions, clubs, societies and funds.

18. To create any Reserve fund, sinking fund, Insurance fund or any special or other funds whether for depreciation or for repairing, improving, extending or maintaining any of the property of the Company or for redemption of debentures/ventures or redeemable preference shares or for other purpose or purposes conducive to the interest of the Company.

19. To apply for and obtain necessary consents, permissions and licences from any government, state, local and other authorities for enabling the Company to carry on any of its objects into effect as and when required by law.

20. To distribute all or any of the property of the company among the members in specie or kind but so that no distribution amounting to a reduction in capital is made without sanction of the court where requisite.

21. To do all or any of the above acts and all such acts as are incidental or may be thought conducive to the attainment of the above objects or any of them, and as agents, contractors, trustees or otherwise and either alone or in conjunction with others with the intention that the objects set forth in each of the several paragraphs of this memorandum shall be in no way limited or restricted by reference to or by inference in terms of any other paragraph of this memorandum.

22. It is undertaken that the Company shall not by advertisement, pamphlets or through other means, offer for sale or take advance money for the further sale of plots, houses, flats etc., to the general public or individuals.

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

24. It is Declared that notwithstanding anything contained in the forgoing object clauses of this Memorandum of Association nothing contained therein shall be construed as empowering the Company to undertake or to indulge in business of banking company, leasing , investment, managing agency, insurance business ,any of the NBFC business, multi-level marketing (MLM), Pyrmid and Ponzi Scheme, commodity, Future contract or share trading business locally or internationally, directly or indirectly as restricted under the law or any unlawful operation.

We the several persons, whose names and addresses are subscribed below are desirous of being formed into a Company in pursuance of the Memorandum of Association and we respectively agree to take the number of shares in the capital of the Company set opposite to 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	Nationality with any former Nationality	Occupation	Residential Address in full	Number of shares taken by each subscriber	Signatures
FIAZ AHMAD	61101-1916032-5	Hakim Jan	Pakistani	Business	MARGALLA ROAD, HOUSE NO. 60, SECTOR F-8/2 ISLAMABAD	80	
HABIL AHMAD KHAN	61101-9543551-1	Irshad Ahmad Khan	Pakistani	Business	HOUSE NO. 324, STREET NO. 49, BLOCK G-10/3 ISLAMABAD	20	
			Total number of shares to be taken			100	

Dated: the 12th day of Jan 2012

Witness to Above Signatures.

National Institutional Facilitation Technologies Pvt. Ltd.

5th Floor, AWT Plaza I.I. Chundrigar Road, Karachi, Pakistan

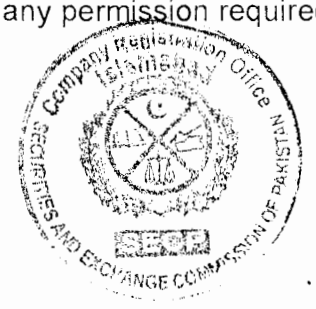
COMPANY REGISTRATION OFFICE Dispatch No..... Islamabad

CERTIFIED TO BE TRUE COPY

Additional Joint Registrar
Company Registration Office Islamabad
03-03-2020

IV. The liability of the Members is Limited.

v. The Authorize Share Capital of the Company is Rs. 200,000/- (Rupees Two Hundred Thousands only) divided into 2,000 ordinary shares of Rs.100/-(Rupees Hundred only) each with powers to the company from time to time to increase and reduce its capital subject to any permission required under the law.



THE COMPANIES ORDINANCE, 1984
(COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT.) LIMITED

1. **CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT.) LIMITED** is established as a private Company with limited liability in accordance with and subject to the provisions of the Companies Ordinance, 1984 and accordingly the following provisions shall have effect, namely:

   (a) The numbers of the members for the time being of the Company (exclusive of persons who are for the time being in the employment of the Company), is not to exceed to fifty but when two or more persons hold one or more shares in the company jointly they shall, for the purpose of this paragraph, be treated as a single member;

   (b) Any invitation to the public to subscribe for any shares or debentures or debenture stock of the Company is hereby prohibited.

   (c) The right to transfer shares of the Company shall be restricted in manner hereinafter appearing.

2. The regulations contained in Table "A" in the First Schedule to The Companies Ordinance, 1984 shall apply to the Company, subject to the articles hereinafter provided.

INTERPRETATION

3. In these Articles unless there is something in the subject or context inconsistent therewith:

   (i) "The Company" means the above named Company.

   (ii) "The Ordinance" means the Companies Ordinance, 1984, or any statutory modification or re-enactment thereof for time being in force in Pakistan;

   (iii) "The Directors" means the Directors for the time being of the Company or the Directors assembled at a Board;

   (iv) "Month" means a calendar month;

   (v) "The Office" means the Registered Office for the time being of the Company;

   (vi) "The Seal" in relation to a Company means the common Seal of the Company.

   (vii) "Writing" shall include printing and lithography and any other mode or modes representing or reproducing words in a visible form.

(viii) Words importing the singular number only shall include the plural number and vice versa;

(ix) Words importing the masculine gender only shall include the feminine gender;

(x) Words importing persons shall include corporations.

(xi) Subject as aforesaid any words or expressions defined in the Ordinance; shall except where the subject or context forbids bear the same meaning in these Articles.

CAPITAL

4. The Authorized capital of the Company is Rs. 200,000/- (Rupees Two Hundred Thousands Only) divided into 2,000 ordinary shares of Rs.100 each with powers to increase, consolidate, subdivide, reduce or otherwise reorganize the capital of the Company in accordance with the provisions of the Companies Ordinance, 1984.

5. The shares shall be under the control of the Directors who may allot or otherwise dispose off the same to such persons, firms or corporation on such terms and conditions and at such times, as they may deem fit.

6. Transfer of shares shall not be made or registered without the previous sanctions of the Directors if registration of shares is refused, the Directors shall within one month from the date when instrument of transfer was lodged send notice of refusal to the transferee and the transferor.

7. An instrument of share transfer must be accompanied by the certificate of shares sought to be transferred thereby.

GENERAL MEETINGS

8. An annual General meeting, of the Company shall be held within eighteen months from the date of it's incorporation and thereafter once at least in every calendar year within four months following the close of its financial year at such time and place as the Directors may determine, provided however, that no greater interval than fifteen months shall be allowed to elapse between two general meetings.

9. The above mentioned meeting shall be called Annual General Meetings. All other general meetings shall be called extraordinary general meeting.

PROCEEDINGS AT GENERAL MEETING

10. At least Twenty-One days' notice of any General Meeting specifying the place, day and the hour of meeting and, in case of special business, the general nature of such business shall be given to members in manner hereinafter mentioned or in such other manner as may from time to time be prescribed by the Company in General Meeting. The accidental omission to give any such notice to or the non-receipt of any such notice by any member shall not invalidate the proceedings at any General Meeting or any resolution passed thereat.

11. The business of an Annual General Meeting shall be to receive and consider the profit and loss account, the balance sheet and the reports of the directors and auditors, to declare

dividends, to elect the directors and to appoint and fix the remuneration of, the auditors, and to transact any other business which under these presents ought to be transacted at an Annual General Meeting and all business transacted at an Extraordinary General Meeting shall be deemed special.

12. Two members present in person who represent not less than twenty five percent of the total voting power either of their own account or as proxies shall constitute quorum for a General Meeting.

13. No business shall be transacted at any General meeting unless the requisite quorum shall be present at the commencement of business.

14. At every General Meeting the Chairman appointed b y the Directors as the Chairman of the Meeting shall take the Chair, but if there be no such chairman or he be not presents within fifteen minutes after the time appointed for the meeting or is unwilling to act as Chairman, the members present shall choose a Director as Chairman and if none of the Directors be present, or willing to act as Chairman, the members present shall choose from one of their members, to be Chairman of the Meeting.

15. If within half an hour from the time appointed for the holding of a General Meeting the requisite quorum be not present, the meeting, if convened on the requisition of or by members, shall be dissolved and in every other case, it shall stand adjourned to the same day in the next week at the same hour and place, and, if at such adjourned meeting the requisite quorum be not present within half an hour from the time appointed for the meeting, two members present in person shall constitute a quorum and may transact the business for which the meeting was called.

16. The Chairman with the consent of the meeting may adjourn any General Meeting from time to time and from place to place but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place and which might have been transacted at that meeting.

17. Every question submitted to any General Meeting shall be decided in the first instance by a show of hands and in the case of equality of votes the Chairman shall, both on a show of hands and at the poll have a casting vote in addition to the vote or votes to which he may be entitled as a member.

VOTES OF MEMBERS

18. Upon a show of hands every member holding ordinary shares present in person or by proxy or attorney or in case of corporation under section 162 of the Ordinance shall have one vote except for election of Directors in which case, the provisions of section 178 of the Ordinance shall apply and upon a poll every member present in person or by proxy or attorney or by representative under section 162 of the Ordinance shall have votes proportionate to the paid up value of the shares carrying voting rights held by such member.

19. (a) Votes may be given, either personally or by proxy or attorney or representative subject to the provisions of the Ordinance

(b) No person shall be appointed a proxy who is not a member of the Company and qualified to vote save that a corporation or an organization being a member of

the Company may appoint as its representative any person whether a member of the Company or not. An attorney of a member need not himself be a member.

20. The instrument appointing a proxy, and every power of attorney or other authority (if any) under which it assigned, or a notarially certified copy of that power of authority shall be deposited a the registered office of the Company, not less than 48 hours before the time for holding the meeting. Otherwise the instrument of proxy shall not be treated as valid.

DIRECTORS

21. The number of directors shall not be less than two nor more than nine.

22. The persons hereinafter named shall be the first directors and they shall hold the office upto the First Annual General Meeting.

    (1) FIAZ AHMAD
    (2) HABIL AHMAD KHAN

23. A Director may, with the approval of the directors, by notice in writing under his hand appoint any person to be an alternate director during his absence of not less than four months from Pakistan, and such appointment shall have effect and such appointee, whilst he holds office as an alternate director, shall be entitled to notice of meeting of directors, and to attend and vote thereat accordingly, but he shall ipso facto vacate office if and when the appointer returns to Pakistan or vacates office as Director, or removers the appointee from office by notice in writing under his hand.

24. The Directors shall subject to clause 21 hereof fix the number of Directors to comprise the Board of Directors at least 35 days before the convening of General Meeting at which election of directors is to take place.

25. The directors shall have power to fill a casual vacant but so that the total number of directors shall not at nay time exceed the maximum number fixed in clause 24 hereof. But any Director appointed in a casual vacancy shall hold office only for the remainder of the term of the director in whose place he is appointed and shall then be eligible for re-election.

26. A Director must be a member of the Company except where the director is a nominee of a corporation or an organization, which is a member of the Company.

27. The remuneration of every director shall be such sum not exceeding Rs 500/- for every meeting of the Board attended by him, as may from time to time be fixed by the Board.

28. If any Director being willing is called upon to perform extra services (which expression shall include work done by a Director as a member of any committee formed by the Directors), or to make any special exertion in going or residing abroad, or otherwise for any of the purposes of the Company, the directors may remunerate such director as may be determined by the Directors.

29. The continuing directors may act not withstanding any vacancy in their body, but so that if the number falls below the minimum fixed above, the Directors shall not except in emergencies or for the purposes of filling vacancies act so long as the number remains below the minimum.

ELECTION OF DIRECTORS

30. At the first annual general meeting of the Company, the whole of the directors shall retire from office

31. A director shall hold office for a period of three years, unless he earlier resigns, becomes disqualified from being a Director or otherwise ceases to hold office.

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

33. The company at the annual general meeting at which a director retires in manner aforesaid may fill up the vacated office by electing a person thereto as provided in the Ordinance.

MANAGING DIRECTOR

34.

(a) The directors shall within fifteen days of the incorporation of the Company appoint any individual to be the Chief Executive, hereinafter called the Managing Director. of the company, to hold office till the holding of the first annual general meeting, unless the earlier resigns or otherwise ceases to hold office.

(b) within fourteen days of election of Directors under the preceding Articles or the office of Chief Executive falling vacant, as the case may be as prescribed by section 199 of the Companies Ordinance, 1984, the directors shall appoint any individual, including an elected director, to be the Managing Director of the Company for a period not exceeding three years on such terms and conditions as the Directors deem fit.

(c) On the expiry of the term of his office, the Managing Director shall be eligible for reappointment.

35. The directors of a company by resolution passed by not less than three fourth of the total number of directors for the time being, or the company by a special resolution may remove the managing director before the expiry of his term of office notwithstanding anything contained in the articles or in any agreement between the company and the managing director.

36. The remuneration of Managing Director shall from time to time be fixed by the Directors and may be by way of fixed salary or by any other mode.

37. The directors may from time to time entrust to and confer upon the Managing Director for the time being such of powers as they may think fit and may confer such powers for such time and to be exercised for such objects and purposes and upon such terms and condition s and with such restrictions as they think expedient and may from time to time revoke, withdraw alter or vary all or any of such powers.

PROCEEDINGS OF DIRECTORS

38. The directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings and proceedings, as they think fit, and may determine the quorum necessary for the transactions of the business. Until otherwise determined two Directors shall be a quorum.

39. A director may, at any time, convene a meeting of directors. A Director who is at any time not in Pakistan shall not during such time be entitled to notice of any such meeting.

40. Questions arising at any meeting shall be decided by a majority of votes, and in case of an equality of votes, the Chairman shall have a second or casting vote.

41. The directors may elect as chairman of their meetings and determine the period for which he is to hold office; and unless otherwise determined, the chairman shall be elected annually. 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 shall choose one of their numbers to be chairman of the meeting.

42. A meeting of directors for the time being at which a quorum is present shall be competent to exercise all or any of the authorities, powers and discretions by or under the Articles of the Company for the time being vested in or exercisable by the directors generally.

43. 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 and may from time to time revoke such delegation. Any committee so formed shall in the exercise of the powers delegated, conform to any restrictions that may from time to time be imposed upon it by the Directors.

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

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

46. A resolution in writing signed by all the directors for the time being present in Pakistan, shall be valid and effectual as if it had been passed at a meeting of the directors duly called and constituted.

MINUTES

47. (a) The directors shall cause a fair and accurate summary of the minutes of all proceedings of general meetings and meetings of its directors and committee of directors, along with the names of those participating in such meetings, to be entered in properly maintained books.

(b) Any such minutes of any general meeting, or of any meeting of the directors or of any committee of the directors if purporting to be signed by the Chairman of such meeting, or by the chairman of the next succeeding meeting shall be receivable as prima facie evidence of the matter stated in such minutes.

POWERS OF DIRECTORS

48. The management of the business of the company shall be vested in the directors, and the directors may exercise all such powers and do all such acts and things as the company is by its articles of association or otherwise authorized to exercise and do and are not hereby or by statute directed or required to be exercised or done by the Company in general meeting, but subject nevertheless to the provisions of the Companies Ordinance, 1984 or to any of these presents and regulations being not inconsistent with the aforesaid provisions, as may from time to time be prescribed by the company in general meeting provided that no regulations made by the company in general meeting shall invalidate any prior act of the directors which would have been valid if such regulation had not been made.

BORROWING POWERS

49. The Directors may from time to time raise or borrow any sums of money for and on behalf the company from the members or other persons, Companies, firms or banks or they may themselves advance money to the company on such terms as may be approved by the directors.

50. The directors may raise and secure payment of such sum or sums of money in such manner and upon such terms and conditions in all respects as they think fit, and in particular by the issue of debentures or bonds or by mortgage or charge of all or any part of the property of the company.

THE SEAL

51. The directors shall provide for the safe custody of the seal and the seal shall never be used except by the authority of the Directors or a committee of directors previously given and in the presence of two directors who shall sign every instrument to which the seal is affixed.

ACCOUNTS

52. The directors shall cause true accounts to be kept in such form as they may decide for sums of money received and expended by the company and the mattes in respect of which such receipt and expenditure take place and of all sales and purchases of goods by the company and of the assets, credits and liabilities of the Company.

53. The books of account shall be kept at the registered office of the company or at such other place or places as the directors think fit.

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

AUDIT

55. Once at least in every year the accounts of the Company shall be examined and the fairness of profit and loss account and balance sheet ascertained by one or more auditor or auditors.

56. The first auditor of the company shall be appointed by the directors.

NOTICES

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

(b) 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 unless the contrary is proved, to have been effected at the time at which the letters would be delivered in the ordinary course of post.

58. Each holder of registered share whose registered place of address is not in Pakistan may from time to time notify in writing to the Company an address in Pakistan which shall be deemed his registered place or address within the meaning of the last preceding clause.

WINDING UP

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

INDEMNITY

60. Every director, manager, auditor, secretary, chief accountant and other officer or servant of the company shall be indemnified by the company against, and it shall be the duty of the directors out of the funds of the company to pay all costs, losses and expenses which any such officer or servant may incur or become liable to by reason of any contract entered into or thing done by him as such officer or servant or in any way in the discharge of his duties and the amount for which such indemnity is provided shall immediately attach as a lien on the property of the Company and have priority as between the members over all other claims.

No director, auditor or other officer of the company shall be liable for the acts, receipts, neglect or default of any other director or officer or for joining in any receipt or other act for conformity or for any loss or expenses happening to the company through the insufficiency or deficiency of title to any property acquired by order of the directors for or on behalf of the company or for the insufficiency or deficiency of any security in or upon which any of the money of the company shall be invested or for any loss or damage arising from bankruptcy, insolvency of any person with whom any moneys, securities or effects shall be deposited or for any loss occasioned by any error of judgment or oversight on his part or for any other damage or misfortune whatever which shall happen in the execution of the duties of his office or in relation thereto unless the same happens through his own dishonesty.

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

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential Address in full	Number of shares taken by each subscriber	Signatures
FIAZ AHMAD	61101-1916032-5	Hakim Jan	Pakistani	Business	MARGALLA ROAD, HOUSE NO. 60, SECTOR F-8/2 ISLAMABAD	80	
HABIL AHMAD KHAN	61101-9543551-1	Irshad Ahmad Khan	Pakistani	Business	HOUSE NO. 324, STREET NO. 49, BLOCK G-10/3 ISLAMABAD	20	
			Total number of shares to be taken			100	

Dated: the 12th day of Jan 2012.

Witness to Above Signatures.

National Institutional Facilitation Technologies Pvt. Ltd.

5th Floor, AWT Plaza I.I. Chundrigar Road, Karachi, Pakistan

CERTIFIED TO BE TRUE COPY

Additional Joint Registrar
Company Registration Office Islamabad
03-03-2020

COMPANY REGISTRATION OFFICE
Dispatch No.....
Islamabad

NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

Licensing (Generation) Rules

EXTRAORDINARY

PUBLISHED BY AUTHORITY

ISLAMABAD, SATURDAY, APRIL 22, 2000

PART II

Statutory Notifications (S.R.O.)

GOVERNMENT OF PAKISTAN

NOTIFICATION

Islamabad the 17th April, 2000

S.R.O. 221(I)/2000.

SECTION – B

SCHEDULE-I

The Location, Size, Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facility/Solar Farm of the Licensee are described in this Schedule.

Plant/Solar Farm Location

Image 1- Lal Suhanara Quaid-E-Azam Solar Park Location

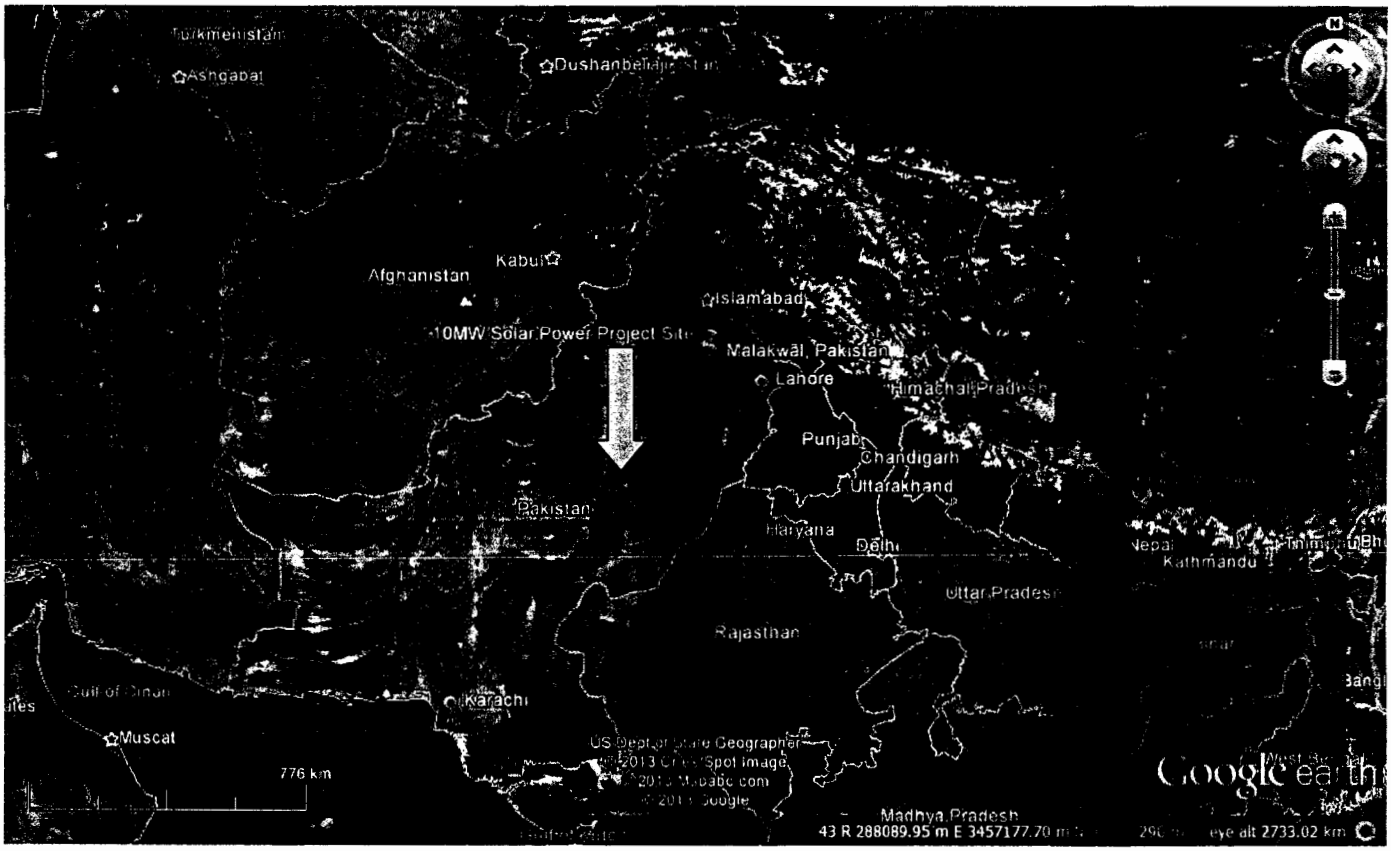
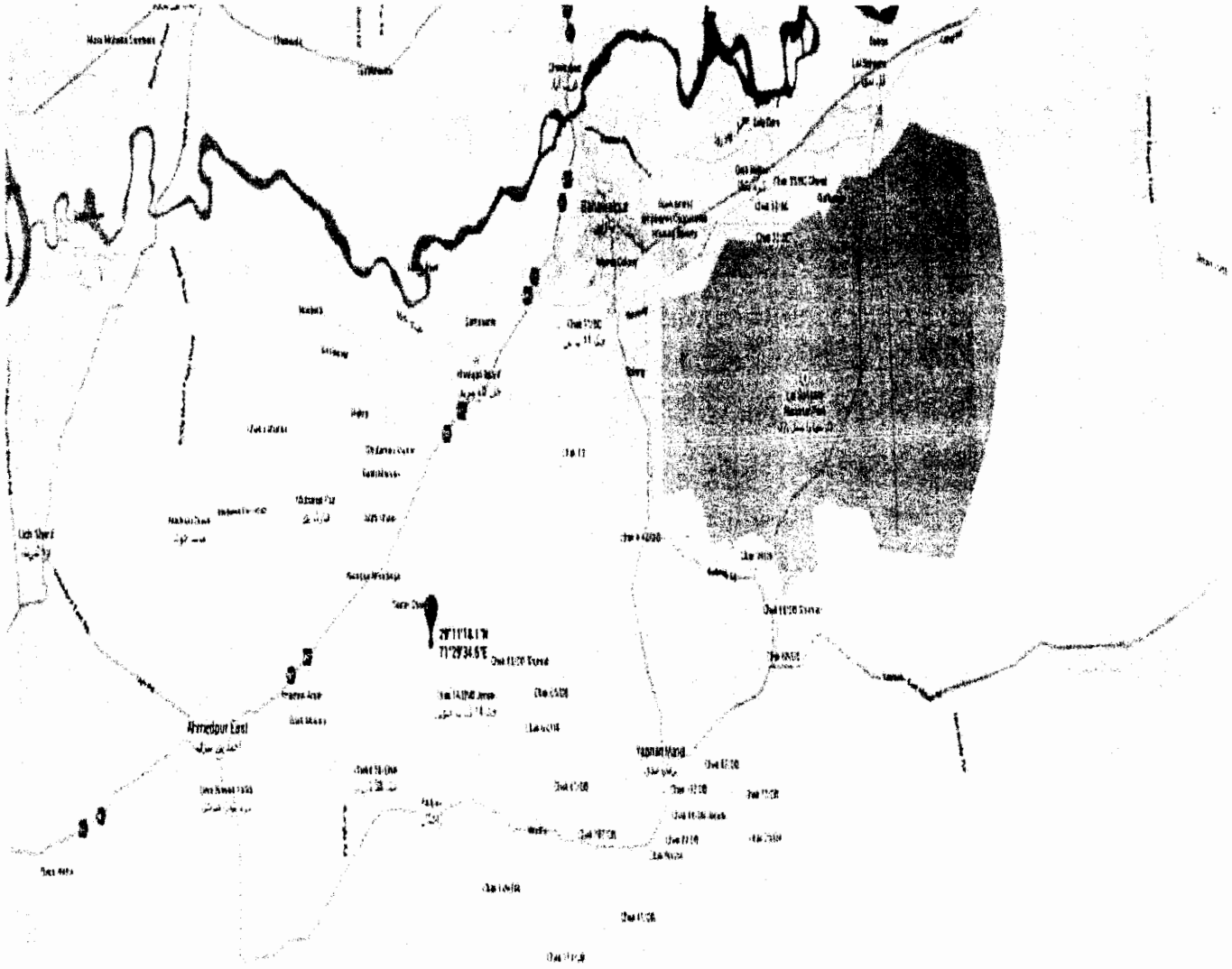
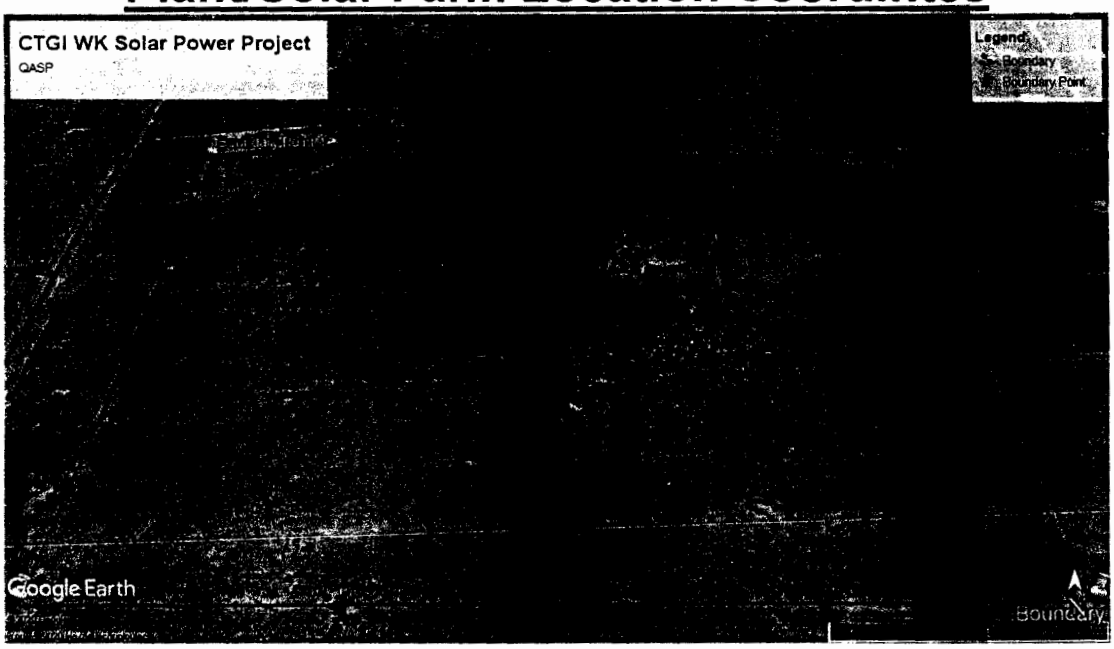


Image 2 – Site location



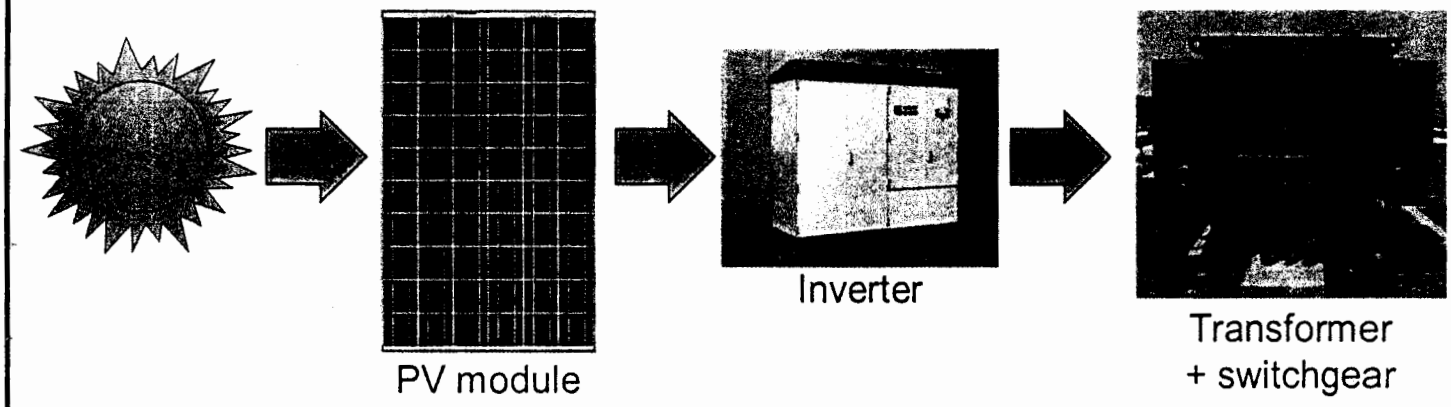
Satellite Map of Project Site

Plant/Solar Farm Location Coordintes



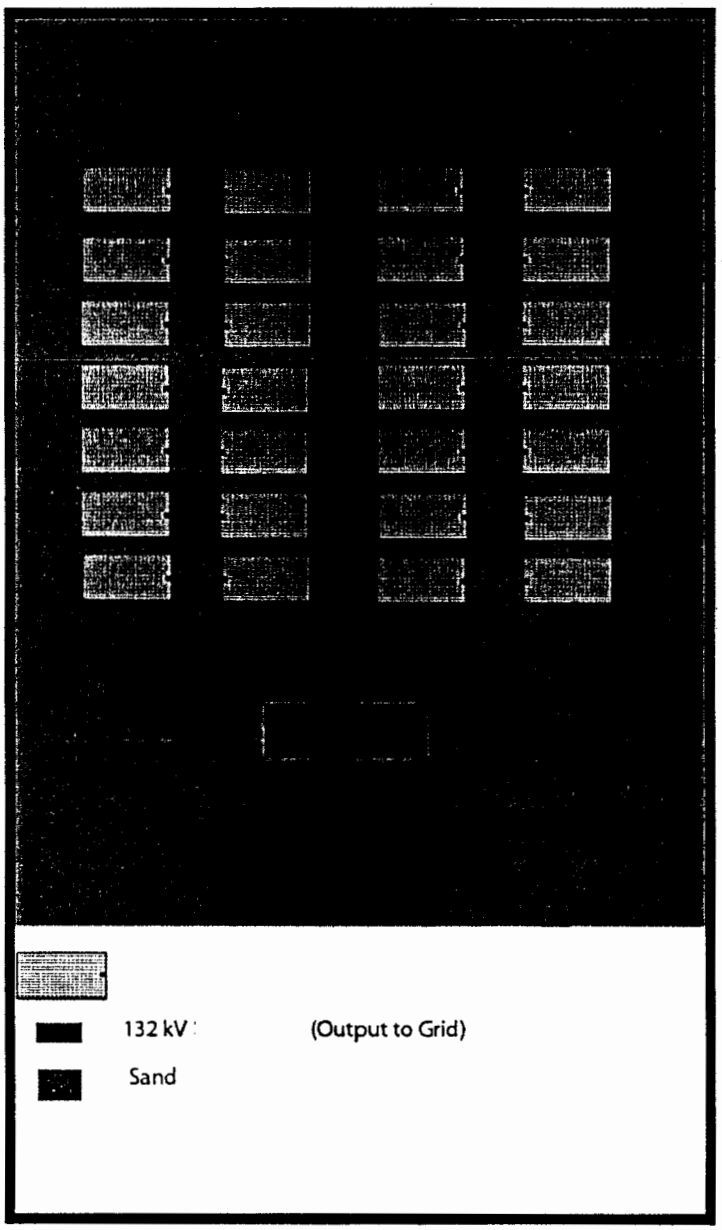
Longitude [E]			Latitude [N]		
Deg.	Min.	Sec.	Deg.	Min	Sec.
071°	48'	14.6400"	29°	19′	05.1000"
071°	48'	59.3400"	29°	19′	05.1000"
071°	48'	14.6400"	29°	18'	37.6800"
071°	48'	59.3400"	29°	18'	37.6800"

Process Flow Diagram

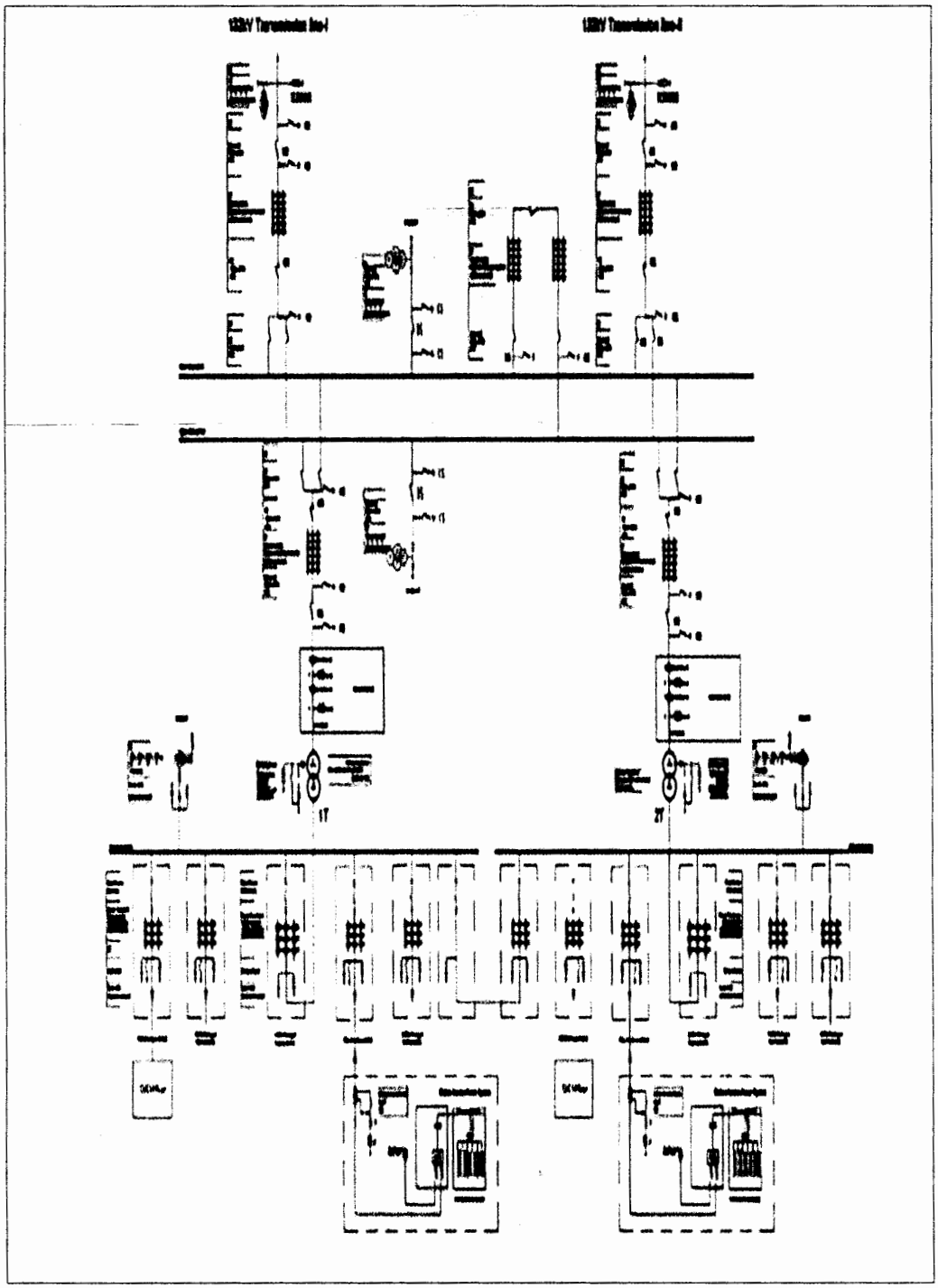


Actual drawings pertaining to Solar Farm (SF)

1. Plant Layout



2. Layout Diagram



INTERCONNECTION ARRANGEMENT FOR DISPERSAL OF POWER FROM THE GENERATION FACILITY/SOLAR FARM

1. The Government of Pakistan (GoP) plans to develop 1000 MW Quaid-e-Azam Solar park at Lal Suhanra as a major step towards development of solar generation in Pakistan. M/s Welt Konnect intends contribute to this plan by setting up 50 MW solar PV power plant in Quaid-e-Azam solar park. CTGI-WK Cholistan Solar Power Project Pvt Ltd hired the services of Planning Power Department of NTDC to carry out grid interconnection study in order to propose interconnection scheme for evacuation of power from 50 MW CTGI-WK Cholistan Solar Power Project to the system network.

2. The draft final report of the grid interconnection study shows the results of extensive system studies including load flow, short circuit, transient stability and power quality studies have been presented pertaining to the interconnection of CTGI-WK Cholistan Solar Power Project. The adequacy of the proposed interconnection scheme regarding performance of 50 MW CTGI-WK Cholistan Solar Power Project and of the system network in its vicinity has been evaluated in the light of Grid Code.

3. For the grid interconnection study, NTDC has used the latest system network model data & transmission expansion plans of NTDC and MEPCO, whereas, M/s Welt Konnect has provided the data of its power plant on data request from NTDC.

4. The load flow analysis has been carried out for operating scenarios of summer 2015 and 2016 with the induction of 50 MW Welt Konnect solar PV power plant and the results of load flow studies have been presented in this report. It has been found that the power from 50 MW Welt Konnect solar power plant can reliably be evacuated to the system under normal and N-1 contingency conditions.

5. The proposed interconnection scheme for evacuation of power from 50MW CTGI-WK Cholistan Solar Power Project is given as under:

"A 132 kV double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra single circuit line at the 132 kV switchyard of 50 MW CTGI-WK Cholistan Solar Power Project ."

6. Short circuit studies have been carried out with proposed Interconnection option to compute the maximum three phase and single phase short circuit levels after the induction of 50 MW CTGI-WK Cholistan Solar Power Project. It is found that the proposed solar generation has no adverse impact on the existing network in its vicinity and the short circuit currents remain within the installed switchgear ratings at the existing substations. On the other hand, the standard switchgear of the short circuit rating of 40 kA would be sufficient at 132kV switchyard of the CTGI-WK Cholistan Solar Power Project.

7. Transient stability analysis with the proposed interconnection scheme for 50 MW CTGI-WK Cholistan Solar Power Project has been carried out using the NEPRA Grid Code Criteria. The stability of the solar PV plant and the power system has been checked with application of faults at the 132 kV switchyard of 50 MW CTGI-WK Cholistan Solar Power Project and at the substations in the vicinity of the plant. It has been found that 50 MW CTGI-WK Cholistan Solar Power Project and the surrounding power system network remain stable with no adverse effects after subjected to faults as per Grid Code requirement.

The LVRT requirements for 50 MW CTGI-WK Cholistan Solar Power Project are also met as mentioned in Grid Code Addendum for solar power plants (under approval by NEPRA).

8. The issues of power quality with the induction of the 50 MW CTGI-WK Cholistan Solar Power Project have also been studied. The study results indicate that the power quality parameters including flicker and voltage unbalance, remain within the permissible limits as mentioned in relevant IEC standard.

9. On the basis of the results of the detailed system studies, it has been concluded that the proposed interconnection scheme has no technical constraints in evacuation of power from 50 MW CTGI-WK Cholistan Solar Power Project to the system network..

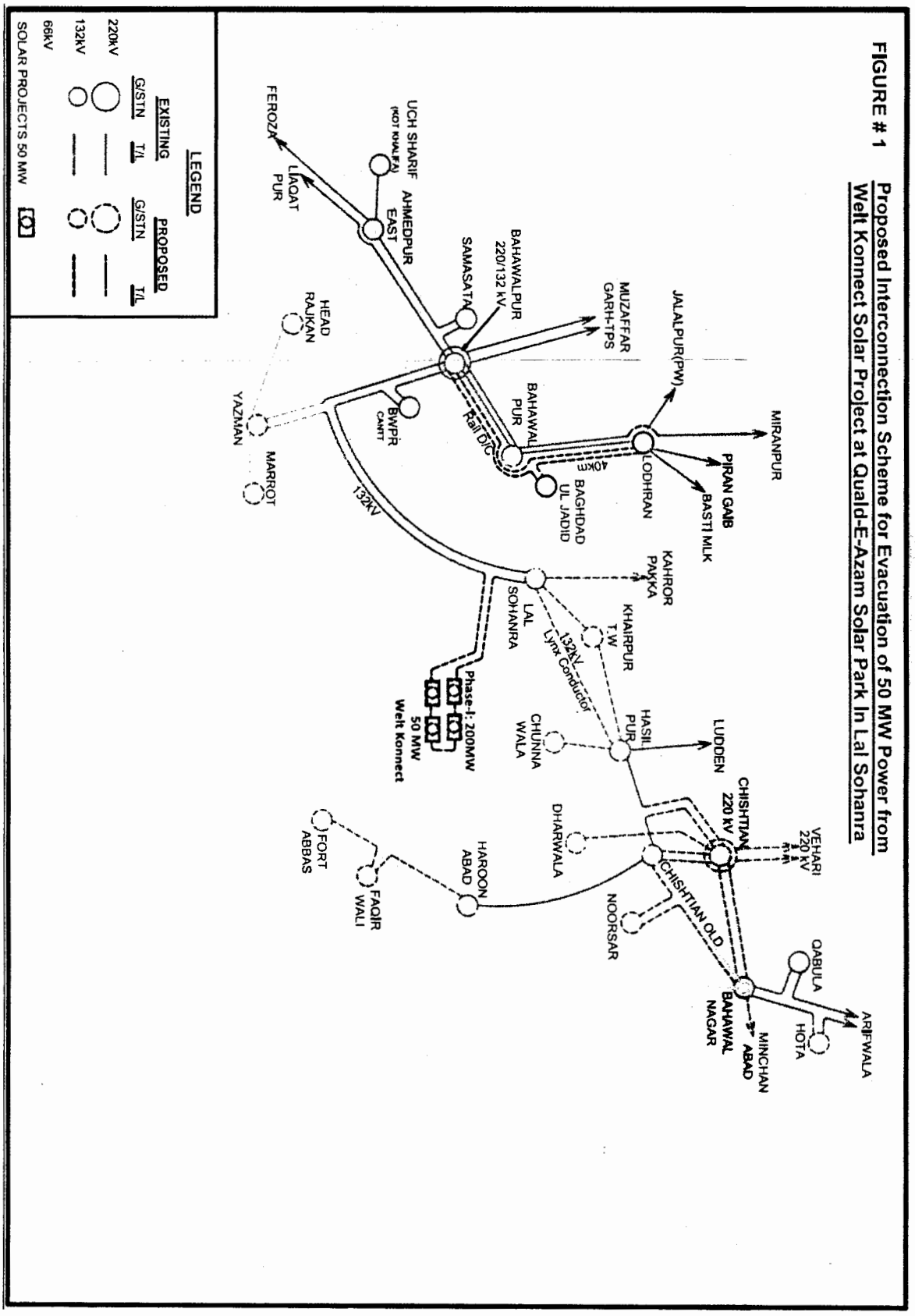


FIGURE # 1 Proposed Interconnection Scheme for Evacuation of 50 MW Power from Welt Konnect Solar Project at Quald-E-Azam Solar Park In Lal Sohanra

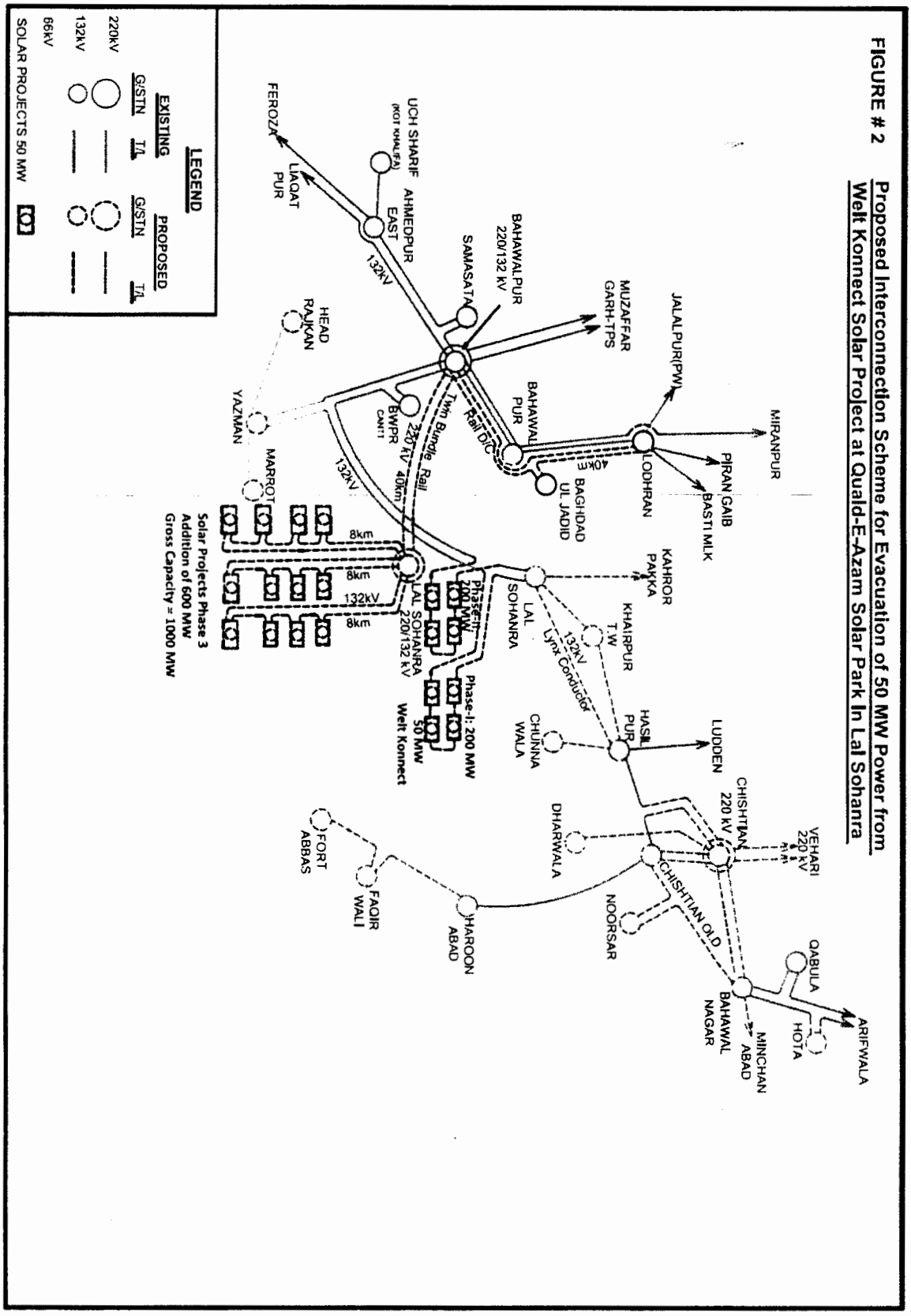


FIGURE # 2 Proposed Interconnection Scheme for Evacuation of 50 MW Power from Welt Konnect Solar Project at Quald-E-Azam Solar Park In Lal Sohanra

If there is any change in the final dispersal arrangement, the same will be communicated to NEPRA in due course.

Detail of Generation Facility/ Solar Farm

The Project details are as provided below:

1.	Total PV Installed Capacity of Generation facility	50 MWp
2.	Average sun hour availability /day (Irradiation on Inclined surface)	6.0 Hrs
3.	Days per Year	365
4.	PV Plant Annual Generation Capacity	87.97 GWH
5.	Generation per Year if Plant operational 24/7	438.161 GWH
6.	Net Capacity Factor	20.02%

The project technology chosen is single axis tracking system with Mono crystalline solar PV and string inverters. The project will be the first smart PV project in Pakistan and expected to provide one of the best efficiencies in the region. Single axis tracking technology was preferred over fixed tilt after performing a cost benefit analysis showing more efficient utilization of the plant, it shall significantly help in capacity building of such plants in the region. The expected operations and maintenance costs for a tracking project in the region were found to be lower than the advantage in the overall cost of energy. The technical details of the power plant are provided below:

General Information

1.	Name of Licensee	CTGI-WK Cholistan Solar Power Project (Pvt) Ltd, duly registered with the SECP under Section 40 of the Companies Ordinance 1984 (XLVII of 1984) with Corporate Universal Identification No. 0078366
2.	Registered / Business Office	Office 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad 44000, Pakistan. Tel: +92-51-2870422-3, Fax: +92-51-2870424, Email: info@weltkonnect.com, www.weltkonnect.com
3.	Plants Location	Quaid-e-Azam, Solar Park, Lal Suhanara, Bahawalpur, Punjab
4.	Type of Generation Facility	Solar Photovoltaic (PV)

Solar Power Generation Technology & Capacity

1.	Type of Technology	Mono Crystalline Photovoltaic (PV) Cell
2.	System Type	Grid Connected (Independent Power Producer)
3.	Installed Capacity of Solar Farm (MW)	50.00814MWp DC

Technical Details of Equipment (At each site)

1.	Type of Module	Si-Mono LR4-72HPH-445M-new
2.	Manufacturer	Longi Solar
3.	Type of Cell	Mono Crystalline
4.	Dimension of each Module	1.052 x 2.131m^2
5.	Module Area	2.44m^2
6.	No of Panel/ Modules	112,364
7.	Total Land Area Used	250 Acres/ 1,011,715m2
8.	Panel's Frame	Aluminum
9.	Weight of One Module	20.2 kg
10.	Module Output Warranty	445 Wp/ 25 years Warranty
		25 years Guarantee for depreciation not more than 0.7 %
11.	Number of Solar Cells in each module	2*72
12.	Efficiency of Module	19.8 %
13.	Maximum Power (Pmax)	445Wp
14.	Voltage @ (Pmax)	43.4 V
15.	Current @ (Pmax)	9.91 A
16.	Open circuit Voltage (VOC)	53.7V
17.	Short circuit Current (Isc)	10.36 A
A.	**PV Array**	
1.	Number of PV Module in Series	28 Module
2.	Number of Strings in Parallel	4013 strings
3.	Total No. of Modules	112,364
B.	**PV Capacity**	
1.	Total Power DC	50.00814MWp DC
2.	Total Power AC	40.625 MWac
C.	**Inverters**	
1.	Capacity of Inverter (MW)	3.125 MWac

2.	Manufacturer		Sungrow
3.	Inverter Model		SG3125HV-30
4.	Rated Input Voltage		875V
5.	Input operating Voltage Range (Vmax)		1300V
6.	Number of Inverters		13
7.	Total Power		40625 KW AC
8.	Efficiency		98.6% (Euro: 98.4%; CEC:98.5%)
9.	Max. Allowable Input voltage		1300 V DC
10.	Max. Current		2400 A
11.	Output electrical system		3 Phase, 3 Wire
12.	Rated AC output Voltage		875-1300V AC (+-10%)
13.	Rated Frequency		50 Hz/ 60 Hz
14.	Power Control		MPP Tracker
15.	Modes of Operation of Inverter		On-Grid
16.	Power Factor of Inverter (Leading & Lagging)		Adjustable 0.9 Leading ..... 0.9 Lagging (0.9 Induction to 0.9 Capacitance)
17.	Environmental Enclosures	Operating temperature range	-25 to 62oC
		Relative Humidity	15 to 95%
		Audible Noise	<61 dB (A)
		Operating Elevation	<2000m
		Warranty Period	5 years
18.	Grid Operation Protection	(a)	DC Circuit Breakers
		(b)	AC Circuit Breakers
		(c)	DC Over Voltage Protection
		(d)	Lightening Protection Level III

		(e)	Grid Monitoring
		(f)	Insulation Monitoring
		(g)	Anti-Islanding
D.	**Medium Voltage (Isolating)Transformer**		
1.	Rating /Inverter Transformer Capacity (MVA)		3.125 MVA * 13
2.	Type of Transformer		Low to Medium Voltage
3.	Input Voltage		800-1500KV
4.	Output Voltage		33KV-132KV (Adjustable)
5.	Purpose of Transformer		Step Up Voltage Transformer, Galvanic Isolation and Elimination of DC Current Injection.
6.	Efficiency		98.8%
7.	No. of Taps of Inverter Transformer		± 2*2.5%%
8.	Positive, Negative & Zero Sequence impedances of inverter Transformer on its own MVA Vector Group		6250kVA; Dy11y11; 15kV; 360V- Positive-, negative-sequence impedance: 5,94% - Zero-sequence impedance: infinite
9.	X/R Ratio of Inverter Transformer		6
10.	No. of Collecter Systems		7
11.	Collector System Length (Section Wise)		925 m
12.	Collector System R, X, B in p.u on 100 MVA Base		R: 0.0185 X: 0.0453 B: 0.0322
13.	Plant Reactive Compensation Device Type		n/a
14.	Compensation Device Rating/ Size		n/a
15.	Compensation Device MVAR Range (Leading and Lagging)		n/a
E.	**Station Transformer**		
1.	Station Transformer Capacity (MVA)		8

2.	Voltage Level of Station Transformer		Voltage adjustment range:±132KV×10% 8 step=8×1.25%
F.	**Junction Boxes installed and fixed on main steel structure in Array Yard**		
1.	Number of J/Box Units		13
2.	Input circuits in each box		1
3.	Max. input current for each circuit		2400A
4.	Max. input Voltage		800-2000 V
5.	Power of each box		3.125 MW
6.	Protection Level		IP 54
7.	Over current Protection		Fuse
8.	Output Switch		125A, 1000V disconnector
9.	Surge Protection		1000V, Type II
10.	Purpose of Junction Box	(a)	To combine groups of strings into Sub-Arrays that will be wired into the Inverter
		(b)	To provide Isolation of Sub Arrays
		(c)	In case of fault provide arrangement for disconnection of each of the Sub-Arrays or Strings.
		(d)	To ensure safety of the electric works in the Solar Module Arrays
		(e)	Protection from back flow of short circuit current through use of semi-diodes.
G.	**Data Collecting System**		
1.	Weather Data	(i)	data collected for Direct Solar Radiation (W/sqm) using two Li-COR Pyranometers installed with the NRG Symphonies Plu3 Data Logger at the site
		(ii)	data collected for Temperature (0C) using NRG 110s Sensor attached to the Solar Resource Assessment Equipment
		(iii)	data collected for Rain in mm/Sqm using NRG Nova Lynx Rain Sensor attached to the Solar Resource Assessment Equipment

		(iv)	data collected for Wind Speed (ms-1) using NRG Wind Speed Sensor attached to the Solar Resource Assessment Equipment
		(v)	data collected for Wind Direction (deg) using NRG 200P Wind Vane Sensor attached to the Solar Resource Assessment Equipment
2.	System Data	(i)	DC input voltage (V), Current (A) of each module, string, sub array, Invertor
		(ii)	Total Sub Array Power Generated and Inverter Power
		(iii)	AC output voltage (V) and current (A) of each inverter (Phase, total)
		(iv)	AC Output power (kW) and Energy (kwh) of each inverter
		(v)	Frequency (Hz)
		(vi)	Power Factor (PF)
		(vii)	Temperature inside inverter station
H.	**Outdoor Cubicle Control Room**		
1.	Data record	Data Logging using softwares and hardware will be provided contractor	
2.	Control Room System	Computerized Data Monitoring and communication systems using latest Satellite Technology	
3.	Control Room System Detail	Interfacing, Hardware and Software, suitable for such Multi-MW systems	
I.	**Mounting Structure**		
1.	Structure	Steel pile foundations	
2.	Tilt of Array Frame	29°	
3.	Array Specification	Designed and Certified for Wind Speed and Seismic Requirements	
4.	Tracking System	Tracking system with backtracking	
5.	No of Tracker	1292	
6.	Tracking Space	6 m	
7.	Collector Width	2.11 m	
J.	**Foundation Pillars**		

1.	No. of Foundations	32,720
2.	Foundation Structure	Reinforced Concrete

The Project will supply 87,984MWh of energy to the Multan Electric Power Company Limited (MEPCO). As the Project uses a renewable source of energy (the sun), it will displace 66,821 metric tons of carbon every year. This is equivalent to the carbon sequestered by 63,253 acres of forests in one year or 7,518,920 gallons of petrol consumed.

Project Economics & Key Factor:

Project Cost, Information Regarding Sources and Amounts of Equity, Debt:

Description	**Key Terms**
Project Cost	35,916,642 USD
Debt: Equity	80: 20
Amount of Debt	28,733,314 USD
Amount of Equity	7,183,328 USD
Source of Equity	CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD
Source of Debt	Industrial and Commercial Bank of China (ICBC)

Appendix 01

PQ Diagram

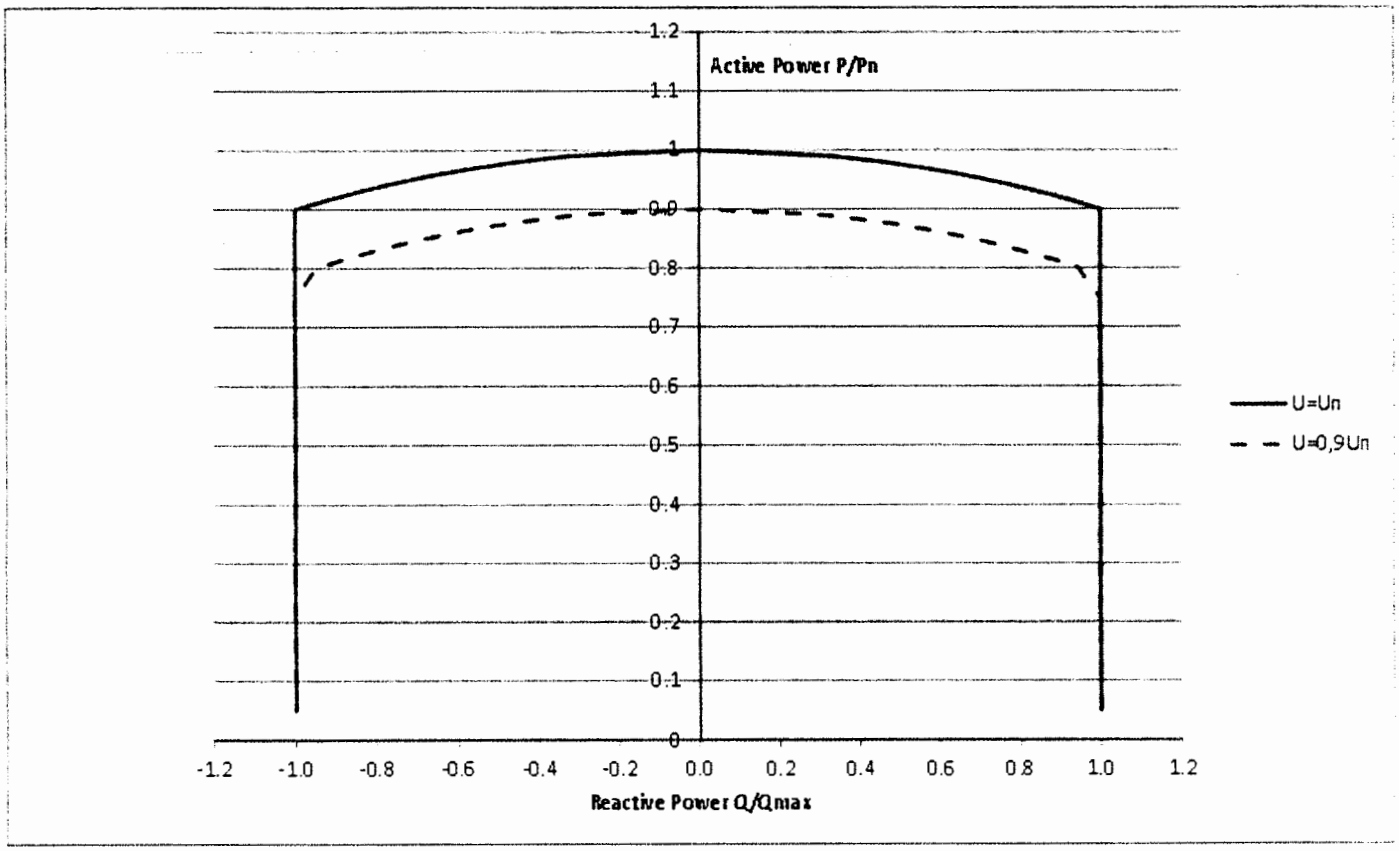


Figure A01.1 showing PQ Diagram

Appendix 02

Plant Layout

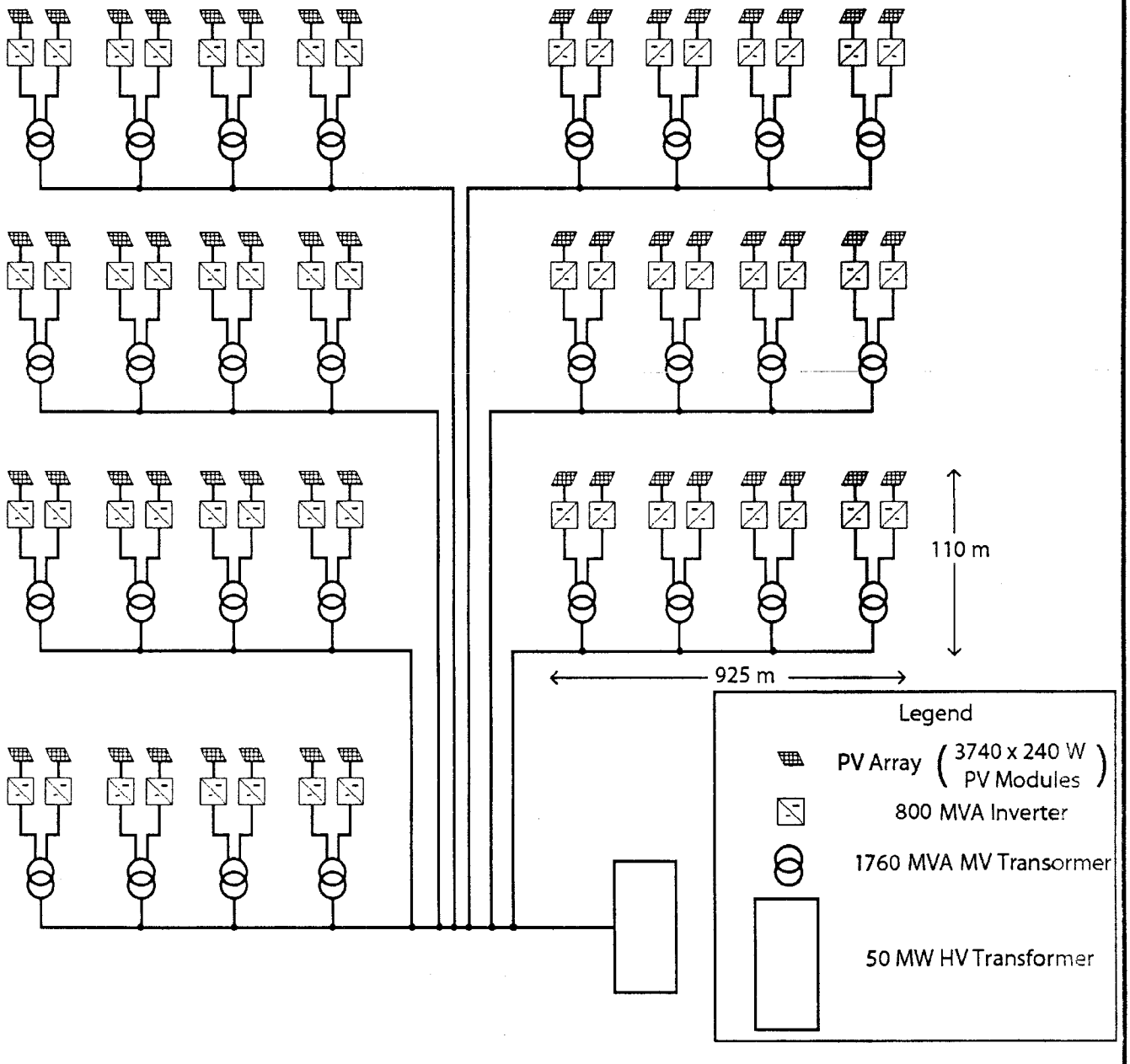
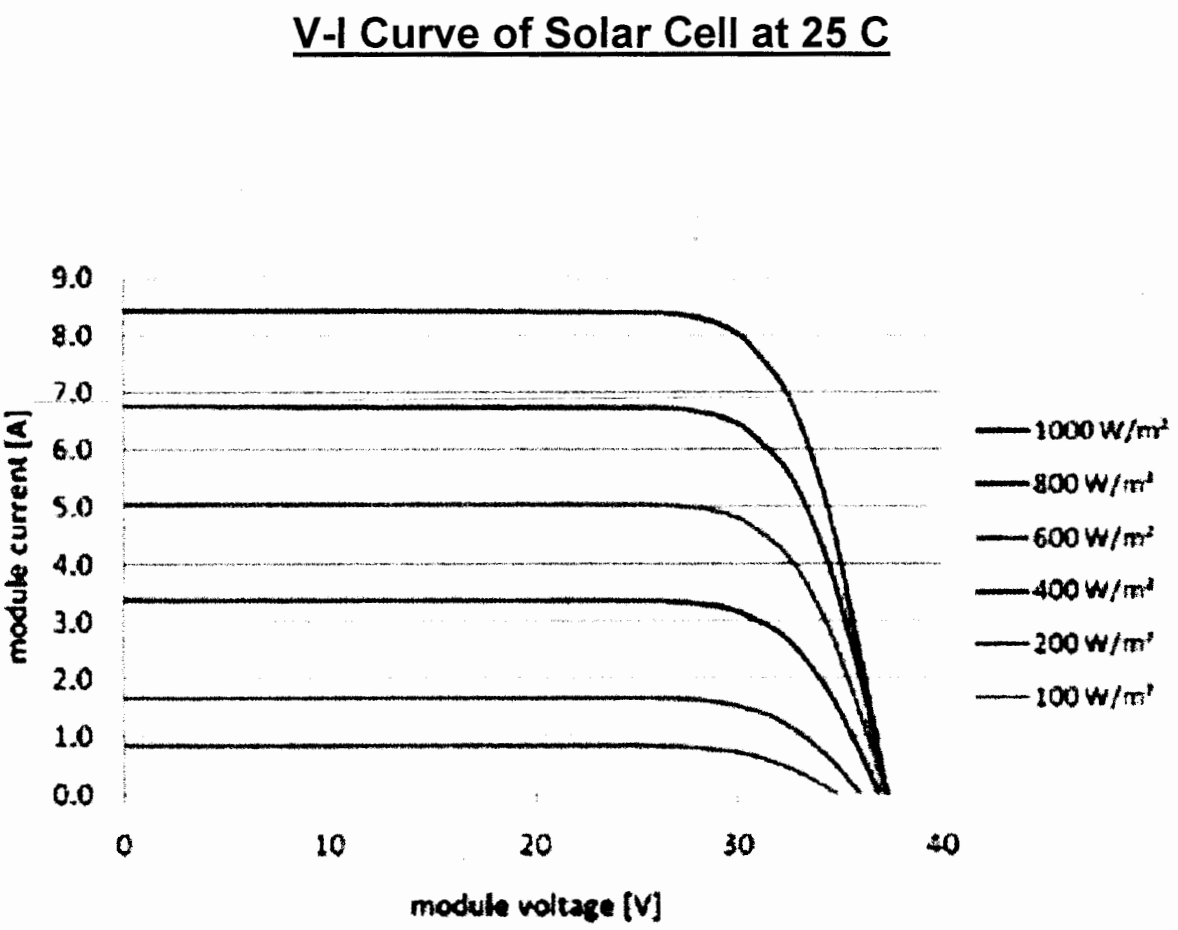


Figure A02.1: Plant layout showing collector systems

Appendix 03

Plant Layout



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NOTIFICATION

Islamabad the 17th April, 2000

S.R.O. 221(I)/2000.

SECTION - C

SCHEDULE-II

The Total Installed Gross ISO Capacity of the Generation Facility / Solar Plant (MW), Total Annual Full Load (Hours), Average Sun Availability, Total Gross Generation of the Generation Facility/Solar Farm (in kWh), Annual Energy Generation (30 year equivalent Net AEP) kWh and Net Capacity Factor of the Generation Facility /Solar Farm of Licensee is given in this Schedule.

		Site Overall
1.	Total PV Installed Capacity of Generation Facility	50.2656 MWp DC (40.28 MW AC Inverter Output)
2.	Average sun hour availability /day (Irradiation on inclined surface)	5.23 Hrs
3.	Days per year	365
4.	PV Plant generating capacity annually (As Per Simulation)	87,943 MWh
5.	Expected total generation in 30 years life span	2,638,290 MWh
6.	Generation per year from plant keeping 24 hrs working	50.2656 x 24 x 365 = 440,326.656 MWhdc
7.	Net Capacity Factor	20.02%

Note

All the above figures are indicative as provided by the Licensee. The Net energy available to the National Transmission Dispatch Company (NTDC) for dispatch will be determined through procedures contained in the Energy Purchase Agreement.

SECTION - E

REQUISITE APPROVALS

Approval of Feasibility Study by concerned agency

Approval of interconnection study by the concerned Agency

Approval of the Environmental Study of the Project by the concerned agency

No. PPDB/ 802 /2014

PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT
1st Floor, Central Design Building,
Irrigation Secretariat, Old Anarkali, Lahore
(Ph: 042-99212794 Fax: 042-99212796)

Date 4/7 /2014

To,

1. **Chief Executive Officer**, NTDC, WAPDA House, Lahore.
2. **Chief Executive Officer**, AEDB, H # 3, Street # 8, Sector F-8/3, Islamabad.
3. **Chief Executive Officer,** MEPCO, Headquarter Khanewal Road, Multan.
4. **Director General PCRET**, PCRET, House No.25, H-9, Islamabad.

Subject: - **MINUTES OF 4th PANEL OF EXPERTS (POEs) MEETING OF M/S. CWE & WK JV FOR DEVELOPMENT OF 50-MW SOLAR PV POWER PROJECT IN CHOLISTAN, PUNJAB**

The subject meeting was convened on 30.06.2014 in the Committee Room of Punjab Power Development Board, Irrigation Secretariat, Lahore. The approved minutes of said meeting are being enclosed for your kind information please.

MANAGING DIRECTOR
Punjab Power Development Board (PPDB)

Encl. As stated above

C.C:

i) P.S. to Addl. Chief Secretary (Energy), Govt. of the Punjab, 8th Floor, EFU Building, Jail Road, Lahore.

ii) P.S. to Managing Director, Punjab Power Development Board (PPDB)

iii) M/s. CWE & WK (Pvt.) Ltd. Suit 8, Ground Floor, Evacuee Trust Complex, Sector F-5/1, Islamabad. Fax: 051-2870424

Figure E 1.1 Feasibility Study Approval by Panel of Experts

PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT

Subject: MINUTES OF 4th PANEL OF EXPERTS (POES) MEETING OF M/S. CWE & WK JV FOR DEVELOPMENT OF 50 MW SOLAR PV POWER PROJECT IN CHOLISTAN PUNJAB

The meeting of Panel of Experts of PPDB for M/s. CWE & WK was arranged on 30.06.2014 at 11:00 hrs. under the Chairmanship of Managing Director, PPDB in the Committee Room of Energy Department. The following were the participants of the meeting:

PRESENT:

SR. #	NAME	DESIGNATION	DEPARTMENT / ORGANIZATION
1.	Mrs. Samya Awais	Managing Director	Punjab Power Development Board
2.	Mr. Anwer Aziz Khan	Deputy Director	PCRET, Islamabad
3.	Mr. Shehzad Butt	Deputy Manager	CPPA, NTDC
4.	Mr. Navid H. Bukhari	Director	AEDB, Islamabad
5.	Mr. Arshad Dharala	Additional Manager	MEPCO, Multan
6.	Mr. S.Shahid Ali Bokhari	Deputy Director	MEPCO, Multan
7.	Mr. Jahangir Bhutta	Manager Finance	MEPCO, Multan

ON INVITATION:

SR. #	NAME	DESIGNATION	DEPARTMENT / ORGANIZATION
8.	Mr. Habil Ahmed Khan	Director Operations	M/s. CWE & WK
9.	Ch. Sajjad Ahmad	Project Manager	M/s. CWE & WK
10.	Mr. Omer Ifitkhar	Project Manager	MR Consultant

IN ATTENDANCE:

SR. #	NAME	DESIGNATION	DEPARTMENT / ORGANIZATION
11.	Mr. Salman Azad	Manager Renewable Energy	Punjab Power Development Board
12.	Mr. Abdul Rauf	Manager Finance	Punjab Power Development Board

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Figure E 1.2 Feasibility Study Approval by Panel of Experts

PROCEEDINGS:

The Meeting started with the welcome from the Chair. The Manager Project Renewable Energy gave briefing about the 3rd POE meeting of the project. The Managing Director PPDB requested the CWE & WK representative for presentation to the Panel of Experts (POE) on the revised Feasibility Study as required in article 4.2 para-5 i & 5.2 of the Punjab Power Policy, 2006 (revised 2009).

Representing CWE & WK group Mr. Habil Ahmad Khan gave presentation about the revised feasibility study of the Project.

Item #	Description of Agenda Item	Recommendations of the Meeting
1.	**Backdrop** The revised Feasibility Study was reviewed by POE in the 3rd meeting convened on 29.05.2014. In this meeting POE members suggested improvement / amendments in the volume 2 of the Feasibility Study Report. The MOM of the meeting issued on 10.06.2014. The amended volume of 2 of the Feasibility Study submitted to PPDB on 11.06.2014. The detail of each volume given as; Volume 1 & 2 (revised Main report) Volume 3 & 4 (revised Geo Tech study & Topography survey) Volume 5 (revised IEE from EPA Department & EIA Studies) Volume 6 (CDM 9.1.2012) Volume 7 (Interconnection study approved by NTDC)	
2.	In the light of MOM of 3rd POE meeting, the POE members deliberated and reviewed the revised Feasibility Study The financial expert from MEPCO observed that in economic calculation, loan term is 12 years plus one year grace period at LIBOR plus margin of 5.25% and adjusted biannually. Responding this observation Mr. Hanif informed that they expressed the terms of Chinese financial institution, however, it will be according to NEPRA guideline It was also noted that M/s. CWE & WK JV has used "Meteonorm" for energy yield calculation of the Solar Power Project in the Feasibility. However no authentication	After detail discussion and deliberation all POE members appreciated the efforts made by M/s CWE&WK Joint Venture to carry out the detailed Feasibility study for the project having: • Environmental Approval of the project given by EPA Punjab • Interconnection Study Approved by NTDC

Figure E 1.3 Feasibility Study Approval by Panel of Experts

	certification attached in the Feasibility Study. Mr. Habil Khan on behalf of the Sponsor replied that they had a Memorandum of Understanding (MoU) with GIZ for conducting the Feasibility Study. M/s CWE&WK has installed solar resource assessment equipment manufactured by NRG with data logger at site, since 2011 and two years actual solar site data is used for solar resource assessment in this study report. It was further explained that they also used NASA data and PV Sys for energy yield calculation of the solar power plant. Furthermore, as per advice of GIZ Pakistan, M/s. CWE & WK paid to Meteonorm for use of data and their verification for energy yield calculation.	It was advised by the POE members that the Sponsor shall provide yield verification information of "Meteonorm" and shall be considered part of this Feasibility Study report It was resolved unanimously that based on the information placed before the POE the Feasibility Study of the 50 MW Solar Power Plant Project stands approved

The meeting ended with vote of thanks from and to the Chair.

Figure E 1.4 Feasibility Study Approval by Panel of Experts

NATIONAL TRANSMISSION & DESPATCH CO. LTD

Chief Operating Officer /
General Manager (CPPA) NTDCL

No.COO/GM/CPPA/CE-II/MT-IV/WKPL/2534-39 Dated: 21-4-02.2014

M/s Welt Konnect (Pvt) Limited,
Suit 8, Ground Floor, Evacuee Trust Complex,
F-5/1,
Islamabad.

Subject: **Interconnection Study Report for Power Dispersal of 50 MW PV Solar Project by M/s Welt Konnect (Pvt) Limited**

Enclosed please find herewith a copy of the Grid Interconnection Study (draft final report) for power dispersal of 50 MW Solar PV Plant by M/s Welt Konnect in Quaid-e-Azam Solar Park prepared by General Manager Planning Power NTDCL for further necessary action at your end please.

The attached report contains scope of work, load flow studies, short circuit studies, transient stability studies and power quality studies of the proposed interconnection scheme for subject solar PV power plant.

DA/As above

(Engr. Javaid Naseeb Malik)
General Manager (CPPA) NTDC

CC:

i. Additional Secretary, Energy Department, Government of Punjab, Lahore.
ii. Managing Director, Punjab Power Development Board, Irrigation and Power Department, 1st Floor Central Design Building, Irrigation Secretariat, Old Anarkali, Lahore.
iii. Chief Executive Officer, Alternative Energy Development Board (AEDB), AEDB Head Officer, 2nd Floor, OPF Building G-5/2, Islamabad.
iv. The General Manager Planning (Power) NTDC, 5th Floor, PIA Tower, Edgerton Road, Lahore.
v. A to COO/GM (CPPA), 229-WAPDA House, Lahore.
• Master File

GM(CPPA)	229–WAPDA House, Lahore, Pakistan.	TEL:+ 42 99203515, Fax:+92 42 99201179	gmcppa@ntdc.com.pk
CE-II(CPPA)	6th Floor, PIA Tower, Egerton Road, Lahore.	TEL:+ 42 99201489, Fax:+92 42 99201488	ce2cppa@gmail.com

Figure E 2.1 Interconnection Study Approval by National Transmission Dispatch Company (NTDC)

ENVIRONMENT PROTECTION DEPARTMENT
Government of the Punjab
National Hockey Stadium, Ferozpur Road, Lahore.

NO. DD (EIA)/EPA/E-362(IEE) /2012/0104
Dated: 15/04/2014

To,

Mr. Faiz Ahmad,
Managing Director,
M/s Welt Knnect Pvt. Limited,
Suit No. 08, Ground Floor, Evacuee Trust Complex,
F-5/1, Islamabad.

Subject: **ENVIRONMENTAL APPROVAL**

(Under Section 12 of the PEP Act, 1997 (amended in 2012) read with IEE/EIA Regulations, 2000)

Reference: Energy Department letter No. PPDB/1201/127/2011, dated: 09.06.2011 & letter No.SO(C)(ED)4-5/2012, dated: 13.02.2014

1. Description of Project: Development of 50-MW Solar Photovoltaic Power Project.

2. Location of Project: The Project site is located in Sqr No. 1, 2, 3, 4, 5, 6, 7, 8, 9 & 10 of Main Block 35 I of Quaid-e-Azam Solar Park in Lal Sohanra, Cholistan, District Bahawalpur.

3. Date of receiving of case 25.02.2014

4. After review of the Initial Environmental Examination (IEE) Report, SIR by DOE and other relevant record, the Environmental Protection Agency, Punjab accord approval for construction phase of the above-mentioned project to safeguard the environmental issues subject to the following conditions:

i. The proponent shall ensure compliance of National Environmental Quality Standards (NEQS).
ii. Mitigation measures suggested in the IEE Report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area.
iii. Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on monthly basis.
iv. Hazard of soil erosion will be minimized with proper provision for resurfacing of exposed areas.
v. Camping sites shall be located at suitable distance away from any settlement to avoid disturbance to the local people. Sewage generated from camping sites shall be treated in septic tanks and soak pits.
vi. The area around the project site shall be kept clean.
vii. The proponent shall dispose of solid and electronic waste in a proper scientific way in consultation with TMA/District Government
viii. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.
ix. The proponent shall plant 5000 indigenous species of trees around the project area on available space within six months in the area and shall do proper landscaping after completion of the project.
x. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.
xi. The proponent shall care about noise issues during construction and operation stage of the project.
xii. The objections/complaints of the locals/stakeholders (if any) shall be redressed on priority basis.

Figure E 3.1 Environmental Study Approval by Environmental Protection Agency (EPA) Punjab

xiii. The proponent shall provide compensation to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the relevant rates and that are agreed upon. There under all conflicting issues regarding compensation, etc. should be settled amicably by the competent authority before the start of the project activities.

xiv. The proponent shall obtain NOC / clearance from all other concerned departments before commencement of work.

xv. The proponent shall appoint Environmental Manager having qualification of M.Sc. Environmental Sciences or equivalent qualification recognized by the competent authority/ forum for the project and shall convey his name along with his complete Mailing Address and Phone Numbers.

5. The Proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.

6. The Proponent shall be liable for compliance of Regulations 13, 14, 17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

7. This approval is accorded only for the construction phase of the project. The proponent will obtain approval for operational phase of the project in accordance with regulation 13(2)(b) and Regulation 18 of the IEE/EIA Regulations, 2000.

8 Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.

9 This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under regulation 16 of IEE / EIA Regulations, 2000.

10. This approval can be withdrawn at anytime without any prior notice if deem necessary in the public / national interest.

(AMEN HANIF)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab
Ph: # 042-99232228.

NO. & DATE EVEN.

A copy is forwarded for information to:

1. The District Officers (Environment), Bahawalpur w.r.t. his letter No. 854/EIA/DO/EPA/BWP dated 29.03.2014. He is requested to ensure compliance of the above-mentioned conditions under intimation to this office.

(AMEN HANIF)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab

Figure E 3.2 Environmental Study Approval by Environmental Protection Agency (EPA) Punjab

Prospectus

1. Brief Introduction of the Applicant

China Three Gorges (CTG) being a large international clean energy company, houses main businesses of construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, initially starting with water conservancy & power projects, has now expanded its scope of business into Power Production through Wind, Solar and Nuclear Energy. Their vision is to be the World's largest clean energy group specializing in large-scale hydropower project development, management and operations; while also proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The Total assets of the Group stand around 41,316 million USD, with a revenue generation of 3,787 million USD, 99.47% from sales of electricity, and 1,418 million USD net profit.

Whereas China Three Gorges International Corp. (CTGI) is a new overseas-investment subsidiary company of CTG, which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CTGI has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CTGI is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include Sonda Jehrruk Coal Mine & Power Generation, 1100 MW Kohala Hydropower Project, 720 MW Karot Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

Whereas Welt Konnect (Pvt) Ltd (WK) is an independent, SAP managed, Project Development Company, conducting development activities in Power Generation, Transmission and Distribution Planning, Renewable Energy (RE), Energy Efficiency (EE), Environment (Env) and overall Power Projects Development.

Welt Konnect (Pvt) Ltd (WK) is an engineering, turn-key planning and Project development, company working on a number of Projects in Distribution, Transmission, Network and Generation Power Projects internationally. WK is an authorized licensee of several cutting edge engineering tools such as WindPro 3.2, PVSYST 6.0, and the largest number of latest PSSE V.34.3.1 in the Private Sector of Pakistan including advanced premium modules such as Oculus Rift and DVRM, with a certified engineering team trained by Siemens UAE. Furthermore the professional team of WK is well versed with the constitution, policies, rules and regulations governing the Generation, Transmission and Distribution Networks in various jurisdictions.

2. SALIENT FEATURES OF THE PLANT

Project Company	CTGI-WK Cholistan Solar Power Project (Pvt) Ltd
LOI	Letter of interest dated 09-06-2011 (bearing reference number PPDB/1201/127/2011) issued by PPDB.
Main Sponsor	• China Three Gorges International Corporation • Welt Konnect Pvt Ltd
Current Shareholder	CTGI-WK Cholistan Solar Power Project (Pvt) Ltd
Project Capacity	50MW
Project Location	Quaid-E-Azam Solar Park, Lal Suhanara, Bhawalpur, Cholistan, Punjab
Land Area	250 Acres
Concession Period	25 year from Commercial Operation date (COD)
Auxiliary Consumption	300KW
Project Basis	Build Own Operate Transfer (BOOT)
Energy Purchaser	Central Power Purchase Agency (Guarantee) Limited (CPPA-G)
PV Module	Mono Crystalline PV Modules
Inverter Output	5000KW
Capacity Factor	20.02%
Construction Period	08 Months
EPC Contractor	HDEC Engineering (Pvt.) Limited / POWERCHINA International Group Limited
Annual Energy Generation	87.943GWh
Project Cost	USD 35,916,642
EPC Cost	USD 30.706196 Million
Debt to Equity Ratio	80:20

Financing	86% Foreign Debt 14% Local Debt
Return on Equity	15%
Exchange rate	165/-
Levelized tariff	**4.9330 US Cents/Kwh**
Financial Advisor	RSM Avais Hyder Liaquat Nauman Contact Person: Mr. Jamil Akhtar
Project Documentation	• Generation License: Refer to Annexure F • Implementation Agreement: To be Negotiated and finalized • GOP Guarantee: To Be negotiated and finalized • Land for project: Please see Annexure E • Energy Purchase Agreement: To be negotiated and finalized • Security Document: To be negotiated and finalized • Construction • on Contract: Please see Annexure G • Supply Contract: Please see Annexure G • O&M Agreement: Attached with EPC • Insurance: To be negotiated and finalized
Relevant Policies	• PPDB Generation Policy. • Policy of Development of Renewable energy for power generation 2006; and • Alternative and renewable energy policy, 2011. (The aforesaid policies shall collectively be referred to as the "Policies")

3. PROPOSED INVESTMENT

Based on a project cost of USD 35,916,642 the project will be funded on the basis of a debt to equity ratio of 80:20. The proposed capital structure of the project is outlined below:

Description	Key Terms
Local Debt	4,168,357 USD
Foreign Debt	24,564,957 USD
Project Cost	35,916,642 USD
Debt: Equity Ratio	80:20

4. SOCIAL & ENVIRONMENTAL IMPACT OF THE PLANT.

Social Impacts

There will be reduction of poverty in an economically depressed region with very little industry and high unemployment as jobs are created during installation as well as operation for both unskilled and skilled workers. The skill sets of locals will be improved through training and capacity building for employment in the project contributing to technical advancement.

Projects like these provide us with the two major solutions to support problems which form the foundation of social and economic issues; Employment and cheap power for comfort. Through projects of this scale and nature, direct benefits to the community and economy are that of:

- Immediate employment
- Cheap energy and comfort

Some indirect and important benefits are:

- A Creation of a local market and/or of a local industry for Solar products and services,
- Security of energy supply
- Employment Opportunities, Creation of education facilities (need of skilled personnel)

Environmental Impacts Mitigation

The requirements set by the Government of Pakistan and the Provincial Government of Punjab on different aspects of environment have been reviewed in detail. Apart from the primary requirements of IEE, EIA and NEQS there are multiple legislations and laws that need to be considered for any power generation projects in Pakistan. For renewable energy projects, these laws and legislations belong to 14 various sectors.

Solar projects are out of the scope of noise sector, as opposed to those of wind power projects.

Renewable Energy Projects do not have relevance to the sectors or concerns of Toxic or hazardous substances, Air Quality, Marine and Fisheries (except for any wind power projects undertaken which is off-shore), mineral Development and Public health and safety.

PV Power and Biogas projects do need to consider all laws set by sectors of livestock and solid wastes.

Important issues with the Solar PV Project and other similar projects in the region have to pay serious attention to the selection site for power generation to cater to the environmental standards as set by sectors like forest conservation, Parks and Wildlife conservation, cultural environment, Environmental protection, Land use and water quality and resources.

Considering the size of this project, primary focus was kept on the laws and legislations of land use set by the Provincial Government of Punjab, meaning the Land acquisition Act 1984, Soil Reclamation Act 1964 and The Punjab Development of Damaged Areas Act 1952. Damaged areas have been defined as any area that is declared damaged by the government through notification.

The Project Site is not used for agriculture farming due to very arid climate and undulating topography. Neither is livestock grazing an option due to the limiting weather conditions of the Land There is scarcity of drinking water both for humans and scarce livestock. As a result, livestock production is less than its potential.

Groundwater is never the less available less than 20 meters below the surface however in some locations it is too saline to drink. The main method of keeping animals in areas further away from this hyper-arid region is a free availability of forage and monsoon rains which leave water stored in the pools dug in past by their owners.

Main soil types of Cholistan desert are sand dunes (44%), sandy soils (37%), loamy soils (2%) and saline-sodic clayey soils (17%).

The 50 MW Cholistan Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under the schedule II classified by Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. The project has also been planned to fulfill all requirements of Clean Development

2014

First 50 MW Solar PV Power Project Cholistan Feasibility Study Report

Volume 1 (Updated) Main Report - Part 1

By

CEEG Solar Energy Research Institute Co, Ltd (CEEG SI) & MR Consultants

For

CWE Investment Corporation

Joint Venture

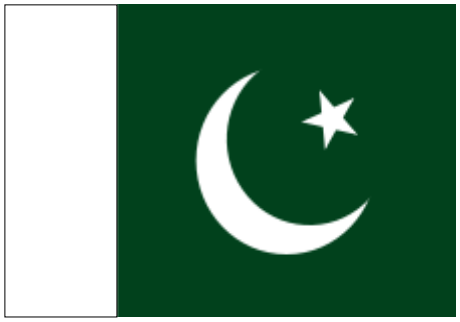
Welt Konnect (Pvt) Ltd

04/10/2014

CEEG 中电电气 China Electric Equipment Group & MR

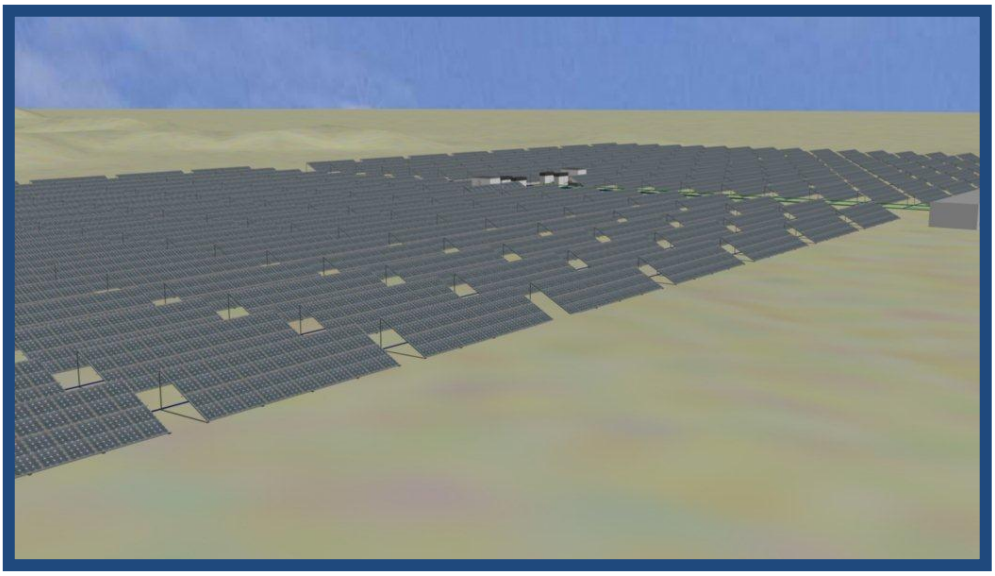
中水电国际投资有限公司 CWE INVESTMENT CORPORATION

WK WELT KONNECT Driving You Into The Future



Feasibility Study Report
First 50 MW Solar PV Power Project
In Cholistan, Punjab, Pakistan

April, 2014



Volume 1 (Updated)
Main Report - Part 1

JOINT VENTURE

CHINA WATER AND ELECTRIC INVESTMENT CORPORATION

&

WELT KONNECT (PVT) LTD

中水电国际投资有限公司
CWE INVESTMENT CORPORATION

TRANS TECH GROUP

WELT KONNECT
Driving You Into The Future

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LIST OF ABBREVIATIONS

AC	Alternate Current
AEDB	Alternative Energy Development Board
Approx.	Approximately
ASL	Associated Surveyors (Pvt)Ltd
BM	Build Margin
BOO	Build Own and Operate
BOR	Board of Revenue
Bwp	Bahawalpur
CAA	Civil Aviation Authority
CCGT	Combined Cycle Gas Turbine
CDA	Cholistan Development Authority
CDM	Clean Development Mechanism
CDMA	Code division multiple access
CERs	Certified Emission Reductions
CEEG	China Electric Equipment Group
CEEG SI	CEEG Solar Energy Research Institute Co, Ltd
CM	Combined Margin

CMA	Certified Management Accountant
CNG	Compressed natural Gas
CO2	Carbon dioxide
COD	Commercial Operational Date
CoP	Conference of the Parties
CPPA	Central Power Purchasing Agency
CPV	Concentrator photovoltaic
CTG	China Three Gorges
CTGC	China Three Gorges Corporation
CTGI	China Three Gorges International Corp.
CTGPC	China Three Gorges Project Company
CWE	China Water and Electric Corporation
CWEIC	China Water and Electric Investment Corporation
CYP	China Yangtze Power Co. Ltd
DC	Direct Current
deg	Degree
DG	Diesel Generator
DGPs	Dual Global Positioning System

DISCOs	Distribution Companies
DNA	Designated National Authority
DOE	Designated Operational Entity
DSSC	Dye-Sensitized Solar Cells
EE	Energy Efficiency
EF_y	Baseline Emission Factor
EIA	Environmental Impact Analysis
EMC	Electromagnetic Compatibility
EMP	Environment Plan
EPA	Energy Purchase Agreement
EPC	Engineering Procurement Construction
EPIA	European Photovoltaic Industry Association
EU	European Union
FDI	Foreign Direct Investment
FSR	Feasibility Study Report
GDP	Gross Domestic Product
GENCOs	Generation Companies
GHG	Green Gas

GIS	Geographic Information System
GoP	Government of Pakistan
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GTZ/GIZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HCA	Host Country Approval
HFCs	Hydro Fluorocarbons
HOMER	Hybrid Optimization Model for Electric Renewables
HSE	Health Safety and Environment
HSHD	Hard Surface High Duty
Hz	Hertz
IA	Implementation Agreement
IDC	Interest During Construction
IEA	International Energy Agency
IEE	Initial Environmental Examination
IEEE	Institute of Electrical and Electronic Engineers
IFC	International Finance Cooperation
IPPs	Independent Power Producers

IRR	Internal Rate of Return
JEDI	Jobs and Economic Development Impact
JI	Joint Implementation
JRC	European Joint Research Centre
Km	Kilometer
KV	Kilovolt
KW	Kilowatt
LIBOR	London Interbank Offered Rate
LNG	Liquefied Natural Gas
LNG	Liquefied Natural Gas
LOI	Letter of Intent
LOS	Letter of Support
LPG	Liquefied Petroleum Gas
LUC	Local Control Unit
m^2	Meter Square
m^3/h	Meter cube per hour
MEPCO	Multan Electric Power Company
mm	Millimeters

mmcft	Million Cubic Feet
MoU	Memorandum of Understanding
MTDF	Medium Term Development Framework
MVA	Million Volt-Ampere
MW	Megawatt
N_2O	Nitrous Oxide
NAPWD	Northern Area Public Works Department
NASA	National Aeronautics and Space Administration
NCS	National Conservation Strategy
NEC	National Energy Conservation
NEPRA	National Electricity Power Regulatory Authority
NEQs	National Environmental Quality Standards
NGOs	Non-Government Organizations
NOCs	No Objection Certificate
NOCT	Nominal Operating Cell Temperature
NREL	National Renewable Energy Laboratories
NTDC	National Transmission and Dispatch Company
O & M	Operation & Management

OECD	Organization for Economic Cooperation and Development
OEMs	Original Equipment Manufacturer
OHL	Overhead Lines
OLTC	On-Load Tap Changer
OM	Operating Margin
OPV	Organic photovoltaic
OSHA	Occupational Safety and Health Administration
PAEC	Pakistan Atomic Energy Commission
PAEC	Pakistan Atomic Energy Commission
PCM	Pulse Code Modulation
PCRET	Pakistan Council of Renewable Energy and technology
PDD	Project Design Document
PEPA	Pakistan Environment Protection Act
PINs	Project Idea Note
PLC	Programmable Logic Control
PMD	Pakistan Meteorological Department
POE	Panel of Experts
PPDB	Punjab Power Development Board

PPIB	Private Power Infrastructure Board
PV	Photo Voltaic
PVC	Poly Vinyl Carbonate
QC	Quality Control
R & D	Research and Development
RE	Renewable Energy
RE2	Renewable Resources (Pvt) Ltd
RFP	Request for Proposal
RFQ	Request for Quotation
RMP	Risk Management of Project
ROC	Return on Capital
ROE	Return on Equity
RQD	Rock Quality Designation
SECP	Security Exchange of Pakistan
SHYDO	Sarhad Hydro Development Organization
SOP	Standard Operating Procedure
SPT	Standard Penetration Test
SRA	Solar Resource Assessment

SRO	Statutory Regulatory Order
TGP	Three Gorges Project
TOE	Tons Oil Equivalent
tsf	Tones/square foot
TTG	Trans Tech Group
TTP	Trans Tech Pakistan
UNFCCC	United Nations Framework Convention on Climate Change
UPS	Uninterruptible Power Supply
USA	United States of America
WAPDA	Water & Power Development Authority
WK	Welt Konnect (Pvt) Ltd
WMO	World Metrological Organization

ACKNOWLEDGMENTS

The management of CWE Investment Corporation a fully owned subsidiary of China Three Gorges International Corporation & Welt Konnect (Pvt) Ltd comprising the Joint Venture would like to express their gratitude to the support and cooperation extended by the Government of Punjab in the development activities of the project.

We are also thankful to the dedicated team of the Punjab Power Development Board (PPDB) for the generous support throughout all stages of project development.

We hope for and look forward to the continued cooperation of all relevant Government Organizations, Bodies and officials for further advancement in implementing the Project and pioneering the way for Solar Photo Voltaic in Pakistan.

DISCLAIMERS

This document is intended for use by the Stake Holders and relevant Government Authorities for understanding and effective decision making regarding this Project.

The Company and the sponsors are and will not be responsible for any decision made by the intended or unintended users for any other purpose except in relation to this project.

The Company and the Sponsors are and will also not be responsible for any decision made by any other person or party not being an intended user of this document whether related to this project or not without consent of the Company or Sponsors in this regard.

Further, this is not intended to be a business or operational plan for the project.

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HEAD OFFICE IN CHINA

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DOCUMENT INFORMATION

Purpose and Scope:

The purpose of this report is to provide information required for the relevant agencies to make informed decision regarding the implementation and execution of this project.

This document presents the technical, financial and commercial viability of this project within Pakistan's economic and regulatory framework.

STRUCTURE OF THE DOCUMENT:

The Feasibility Study has been divided into 2 main parts/volumes followed by supporting Volumes 3 to 7 composed of essential studies:

- Volume 1: is composed of the Executive Summary, Introduction and Overview of the Project along with the relevant regulatory framework and policies. Where as
- Volume 2: contains the Technical and Financial Studies: including Engineering Drawings and Plant 3D layout.
- Volume 3: is composed of the Geo-Technical Study Topographic Survey.
- Volume 4: is the Geo-Technical Investigation Report.
- Volume 5: is a compiled Environmental Study.
- Volume 6: contains all documents relevant to the Clean Development Mechanism of the UNFCCC.
- Volume 7: Grid Interconnection Study has been conducted and approved by National Transmission Dispatch Company (NTDC).

Each Volume is further sub-divided into chapters for ease of reviewing and understanding the project. Information in the document is supplemented by Annexures attached at the end of each volume.

1 Executive Summary Of the Project

China Three Gorges (CTG) being a large international clean energy company, houses main businesses of including construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, initially starting with water conservancy & power projects, has now expanded its scope of business into Power Production through Wind, Solar and Nuclear Energy. Their vision is to be the World's largest clean energy group specializing in large-scale hydropower project development, management and operations; while also proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The Total assets of the Group stand around 41,316 million USD, with a revenue generation of 3,787 million USD, 99.47% from sales of electricity, and 1,418 million USD net profits.

Whereas China Water and Electric Investment Corp. (CTGI) *is a new overseas-investment subsidiary company of CTG,* which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CWE Investment Corporation (CWEIC) has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CWEIC is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include Sonda Jehrruk Coal Mine & Power Generation, 1100 MW Kohala Hydropower Project, 720 MW Karot Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

Whereas Welt Konnect (Pvt) Ltd (a subsidiary of the Transtech Group) is a Power Projects Developing company working in Pakistan. Its niche in the Energy Sector lies in the provision of Renewable Energy Engineering solutions particularly for Wind & Solar Power Projects as Independent Power Producers (IPP's) under the Clean Development Mechanism of the UNFCCC. These integrated solutions and systems are designed, simulated and tested by its team of experts and engineers' using the most advanced software's and tools the industry has to offer at this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in the ever growing and critical field of Renewable Energy.

In Accordance with their development strategies respectively, in 2009 after consultation with the Esteemed Punjab Government Welt Konnect (Pvt) Ltd (WK)

and China Three Gorges (CTG), planned to invest in the development & construction of Pakistan's first 50 MW Solar PV Power Farm in Cholistan in collaboration as a Joint Venture. For development of which consequently two MOU's were signed with the Punjab Government (**Annexure 1**: MoU between WK, CWE and The Punjab Government) in the presence of the Honorable Chief Minister Mr. Shahbaz Sharif, dated June 5th 2010 and later November 6th 2010 after having chalked out a way forward. An MOU was also signed with GTZ for support on developing the project under the Clean Development Mechanism of the UNFCCC (**Annexure 2**: MoU between WK and GTZ)

Teams were then immediately deployed to initiate work on the feasibility analysis of the project, and at the same time to search for a suitable site. With the help of the Punjab Government, 4 sites were short listed and identified in Cholistan, towards Southern Punjab with presence of the required minimum infrastructure, high irradiation levels and solar potential. After due scrutiny and deliberation by Experts over the sites; the 500 Acres strip of land located in (Chuk.No: 314 A Block No: 3, 4, 23, 24) approximately 3 to 4 Km away from the Marot Grid Station and about 50 km from Bahawalpur, the nearest urban city, was selected and finalized. The location enjoys a flat terrain with innocuous sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself a technically and logistically feasible location for the setup of a large solar power station.

However the process of selection & due allocation was delayed considerably due to the unfortunate flooding and ensuing humanitarian disaster in Pakistan during that period.

In parallel, a viable financial and economic model was developed for the project. Various financial institutions and carbon funding agencies were identified and engaged for the purpose. On the other hand search for suitable Solar PV equipment suppliers was initiated, with a special emphasis on quality of the products. Various technologies for Solar PV were considered, and the matter has been addressed in the feasibility study.

The project pre-feasibility study was completed by mid-2011. Subsequently after submission of the Pre-Qualification Documents, to the Punjab Power Development Board (PPDB) along with the Pre-Feasibility Report, Project Proposal, the required Bank Guarantees of 50'000.USD (fifty thousand) (**Annexure 4**: Bank guarantee) and the requisite fees, the Joint Venture (JV) successfully obtained an LOI (Letter of Intent) (**Annexure 3**: LOI) from the Board duly signed and accepted by both parties on 27-08-2011, along with Government Approvals and Support.

The JV also filed for and received confirmation/Allocation Letter (**Annexure 5**: Allocation Letter issued by PPDB to the Joint Venture on 09th June 2011) from PPDB for the 500 Acres Project Site on 11-01-2012, after formulation of the requisite policy and procedure by PPDB for such sanctioning of land for Solar Power Projects. Under this framework a 5000 Acre piece of land was handed over by Cholistan Development Authority (CDA) to the Board of Revenue (BOR) which in turn placed it under the control of PPDB for allocation to deserving companies for development of such projects.

Immediately after the Selected Site with coordinates 29 10N (Latitude), 72 25 E (Longitude) which is approximately 4 KM away from the Grid Station was handed over to the JV, competent teams of Engineers & Specialists were deployed for conducting the Topographic Survey, Soil Testing and layout design activities, amongst other studies, which were successfully completed and compiled in the Feasibility Study Report, which was then submitted to PPDB with the stipulated time period for review by the Panel of Experts (POE).

Whereas the Complete Feasibility Study Report for the subject 50MW Solar PV Power Project was approved by the Panel of Experts (POE) of PPDB in its second meeting and notified vide Letter No. PPDB/05/2013, Dated 01/01/2013, Subject: Approval of 50MW Solar Power Project in Marot Cholistan Punjab (**Annexure 6:** feasibility study report approval by the panel of experts (POE) of PPDB notified vide letter no. ppdb/05/2013, dated 01/01/2013).

However due to the change and relocation of the Project Site to the Quaid- E-Azam Solar Park (QASP) at Lal Suhanara, Bahwalpur, to facilitate and make viable the Grid Interconnection of the subject project, the Feasibility Study Report (FSR) including all studies which had been conducted for development of the 50MW Solar PV Power Project on the previous project site of Marot Cholistan Desert Punjab, have now been re-conducted and updated to reflect such change and acquire all project related Approvals again.

The project site under the Vision of the Chief Minister of Punjab Mr. Shahbaz Sharif, has been shifted to the new location of the Quad-E-Azam Solar Park (QASP) near to Lal Sohanra, Cholistan, Bahawalpur which in total comprises dedicated land of 6,500 acres for the purposes of establishing Solar Power Generation Stations of approximately 1000 MW's.

The New Project Site allocated to the Joint Venture comprising Welt Konnect Pvt Ltd & CWEI is composed of 250 Acres piece of land as allocated by the Energy Department of the Government of Punjab, through its Letter No.S.O(C)(ED)4-5 2014, Dated: 13th February 2014, Subject: Allocation/Earmarking of Land for 50MW Solar Project in QA Solar Park Bahawalpur (**Annexure 7:** new project site allocation letter

No.s.o(c)(ed)4-5 2014, dated: 13th February 2014). The Project is composed of Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354.

The updated studies reveal no environmental hazards related to the Project. The minor adjustments required during construction phase have been addressed and mitigation plan provided in Volume 5 Environmental Studies of the FSR. There are no settlements within 05-08 Km of the Project Site, which further supports the Project in this location.

Both the updated Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) were submitted to the competent authority of EPA Punjab for consideration, with all its concerns raised vide Letter No. DD (EIA)/EPA/F-362(IEE)/2013, dated 10/03/2014, answered in the documents which after its due diligence issued a No Objection Certificate (NOC)/Environmental Approval vide Letter No. DD(EIA)/EPA/F-362(IEE)/2012/0104/681, Dated 15/04/2014, Subject: Environmental Approval.

The Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) of the proposed project were conducted in accordance with the stipulations of Pakistan's environmental laws and the environmental guidelines of the International Finance Corporation (IFC).

Whereas NTDC which was hired in May 2012 to carry out the Grid Interconnection Study in order to propose the interconnection scheme for evacuation of power from the 50 MW Welt Konnect solar PV power plant to the system network, by the Joint Venture comprising Welt Konnect (Pvt) Ltd and CWEI through their Letter dated 9th May 2012, Subject: Interconnection study for 50 MW photovoltaic solar PV project in Cholistan, containing the Bank Draft No. DD 1875227 dated 04th May 2012 amounting to Rs. 1,500,000/- payable to General Manager (Services Division) NTDC, WAPDA on account of Interconnection studies for dispersal of power from the 50 MW generation project to the national grid, **(Annexure 8:** grid interconnection study correspondence with NTDC), after relocation of the Project to the QASP completed and submitted the draft final report of the grid interconnection study attached to its letter No. COO/GM/CPPA/CE-II/MT-IV/WKPL/2534-39, Dated 21st April 2014, Subject: Interconnection Study Report for Power Dispersal of 50MW PV Solar Project by M/s. Welt Konnect (Pvt) Ltd **(Annexure 8:** grid interconnection study correspondence with NTDC).

The results of extensive studies including load flow, short circuit, transient stability and power quality studies have been presented in the interconnection study of the subject 50 MW solar PV power plant. Whereas the adequacy of the proposed interconnection scheme regarding performance of 50 MW Welt Konnect power

plant and of the system network in its vicinity has been evaluated by NTDC in light of the Grid Code.

For the grid interconnection study, NTDC used the latest system network model data & transmission expansion plans of NTDC and MEPCO, whereas M/s Welt Konnect provided the data of its power plant on data request from NTDC.

In addition the project has been developed under the Clean Development Mechanism (CDM) of the UNFCCC under the Kyoto Protocol. After successfully making and submitting the Project Idea Note (PINs) to the Designated National Authority (DNA), registration with the UNFCCC via Prior Consideration Form and issuance of a Letter Of Intent (LOI) from the DNA for further development of the Project Design Documents (PDD's), the PDD's were made and submitted to the DNA followed by the issuance of the final Host Country Approval (HCA) by the DNA, we are now in the phase of obtaining validation by the Designated Operational Entity (DOE) and issuance of CER's by the Executive Board of UNFCCC.

The Joint Venture is now submitting the final Updated Feasibility Study for approval by the Panel of Experts (POE) of the Punjab Power Development Board (PPDB). After sanctioning of which competent companies in the field of Solar Photovoltaic's will be selected through a Short Listing Criteria based on Experience, Financial And Technical Competencies of such firms in development & construction of Power Projects and Project Management, which shall be advertised in the News Papers & other relevant media. Consequently the Request for Proposal (RFP) shall be circulated and shared amongst the qualifying companies for finalization of the Engineering Procurement & Construction (EPC) Contract after which a petition for Generation License and a petition for tariff would simultaneously be filed with the National Electric Power Regulatory Authority (NEPRA) directly for the second stage tariff as per the directives of the Economic Coordination Committee (ECC) for Solar and Wind Power Projects and allowed under the NEPRA regulations, before issuance of the LOS (Letter Of support) by AEDB. This is intended to save time and cut through avoidable red tape in the development of Independent Power Producers in Pakistan.

The Joint Venture has also completed substantial work on the financial modeling for the project. The JV believes that keeping in view the recent improvement and trend in the viability of the technology, possibility of fast track implementation and current energy crises, this project is of paramount importance for Pakistan and will prove to be a pioneer in the Solar PV industry, paving the way for future progress in this ever growing field and at the same time provide a viable profitable investment opportunity to all stake holders of the country.

2 Introduction

As a large international clean energy company, China Three Gorges main businesses include: construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, starting with water conservancy projects, has now expanded the scope of its business into power generation through wind, solar and nuclear energy.

With the vision of being the World's largest clean energy group specializing in large-scale hydropower development, project management and operations; proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The company was founded in 1993 upon approval of the State Council with the mission of implementing the Three Gorges Project and developing hydropower resources in the upper Yangtze.

The China Three Gorges Project has a Total installed capacity amounting to *22,250MW*, with Expected annual average power generation accounts up to *100 TWH*. The Three Gorges Project (TGP) ranks the *biggest* one in terms of installed capacity. TGP electricity is unceasingly transmitted as far as *1,000 Km* to Central China Grid, East China Grid, South China Grid, and Chongqing-Sichuan Grid

The Total assets of the Group are 41,316 million USD, with revenue of 3,787million USD, 99.47% from sales of electricity, 1,418 million USD net profits.

Whereas China Water and Electric Investment Corp. (CWEIC) *is a new overseas-investment subsidiary company of CTG,* which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CWEIC has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CTGI is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include Sonda Jehrruk Coal Mine & Power Generation, 1100 MW Kohala Hydropower Project, 720 MW Karot

Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

Whereas the Trans Tech Group of Companies is a multipurpose engineering concern and actively engaged in various Civil Engineering, Railway, Telecommunication and Renewable Energy Projects in Pakistan since 1991. TTP is committed to professional excellence and is playing its due role in the national progress and development of Pakistan.

Trans Tech Group incorporates technical, ecological and economical optimization in its solutions and ensures an efficient and effective implementation of its projects. The man power resource pool of TTP consists of managers, engineers, planners, computer professionals, economists, support staff and skilled technicians.

The Group has been working in Pakistan for the past 25 years and has targeted a number of projects including but not limited to the Infrastructure Sector: namely Construction of Roads, Bridges and Motorways, and The Power Sector; including Hydro Projects, Coal Power Projects, and Wind Energy Projects, and is currently working with its valuable foreign partners in implementing large scale projects.

Whereas Welt Konnect Pvt. Ltd ("WK" or the "client") a subsidiary of the Transtech Group is a duly established company under the laws of Pakistan specializing in Power Project Development. Its niche in the Alternative Energy sector lies in the provision of Renewable Energy Engineering particularly Wind & Solar Projects as Independent Power Producers (IPP's), various commercial applications & CDM projects. These integrated systems are designed, simulated and tested by its team of experts and engineers' using the most advanced software's and tools the industry has to offer at this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in this ever growing field of Renewable Energy.

Jointly both valuable partners are developing the strategic 120MW Taunsa Hydro Power Project, the First 50MW Solar PV Power Project and Coal Mining & Power generation projects amongst other projects of national importance.

Whereas MR Consultants ("MR" or "the Consultant") is an international consulting company that offers engineering consultancy services in the fields of energy, hydropower and transport since 1990.

Whereas CEEG SI (CEEG Solar Energy Research Institute Co., Ltd.) is comprehensive new energy system supplier with international advanced level which is founded by CEEG Group for wide application of worldwide solar & other new energy technology and great advancement for worldwide energy revolution. CEEG SI has a research team with abundant technical strength and work experience leaded by Zhizhang Liu who is the chief scientist on new energy application and Doctor Jianhua Zhao who keeps the world record (25%) in laboratory photoelectric conversion efficiency of P - type silicon solar cell.

CEEG SI provides a complete set of system solutions of 9 new energy application areas, and gives the service about system research, design, consultation and construction which mainly focuses on photovoltaic system and also contains new energy relevant products (incl. photo-thermal, wind power generation, water conservancy, ground source heat pumps, biomass energy, and tidal energy). As earlier domestic system supplier who has paid great efforts to R&D and market promotion, CEEG SI undertakes and finish multiple project both national key technologies research and development program of china and international collaboration programs one after another.

CEEG SI has undertaken the first BIPV on-grid project in 4 provinces in China successfully, and it is the international training centre for solar application in developing country assigned by ministry of science and technology (MOST), the new energy workstation for Post doctor student in Jiangsu province, the managing unit for engineering center of module preparation and control system in Jiangsu province. CEEG SI has better popularity and influence both at home and abroad, and especially it gains more achievements in research and application of solar energy photovoltaic generating system.

After due diligence the Joint Venture awarded CEEG SI & MR Consultants the task to provide technical consultancy Services for conducting the Feasibility Study Report (FSR) in accordance with the requirements of the Letter of Intent (LOI) issued by Punjab Power Development Board (PPDB) under the 2006-2009 Punjab Power Policy

coupled with an energy yield assessment for the PV Plant of 50MW, located in the region of Bahawalpur in the province of Punjab Pakistan. This report describes the results of the Feasibility Study performed for the 50MW PV Plant on the site (29° 17.650' N, 71° 49.196' E). The study also investigated solar power technology options that were appropriate for a large scale solar power facility in the Quaid-E-Azam Solar Park, Punjab and the economic viability of such a solar power facility

The plant consists of a rammed fixed mounted system with an installed module capacity of **50266 kWp** using Multi and Mono-crystalline Q-Cells module QC-C05 and 56 SMA Sunny Central inverters SMA SC 800 CP with a total AC capacity of 49,280 kVA.

The Project Layout has been designed to utilize 28 of "1.6 MW Inverter" combined units of two SMA 800 CP Series Inverters (Actual power output at test conditions is 1.76 MW for each unit) which are further connected to 28 SMA Low to Medium range voltage transformers at approximately 360V AC, one for each 1.6 MW unit respectively giving an output between 11 to 20KV range, leading finally to the switch gear or transformer from medium to high voltage range for connection to the Grid Station at 132KV . Each unit of 1.6 MW will consist of 7480 panels, 2 inverters and 1 transformer.

A string concept is being used with 22 modules connected to a string, and 17 strings connected on a Bus leading to the SMA Inverters connection in parallel with a total of 10 such connections. The total number of PV modules used in this arrangement would be 3470 units per 1.6 MW with a total of approximately 28 such units for the complete 50 MW setup.

The FSR also includes an introduction to the Country's Power Sector followed by an Analysis of the legal framework for ease of understanding the procedures and development steps to be taken ahead.

2.1 Purpose of Study

The scope of services stipulated for the FSR includes the following:

- Due Diligence of existing works and steps already taken by the JV.
- Analysis of Legal Framework and current scenario of the Power Sector of the country.
- International Market Analysis and case studies.
- Project Analysis
- Information about the site, Collection and Review of solar irradiation and climatic data of the site and comment on the adequacy and reliability of the data and make any corrections necessary;
- Evaluation of the site with respect to operations;
- Review the overall shading situation (horizon) and the detailed shading analysis of the nearby situated objects as well as the internal shading between the PV modules in function of fix mounted PV elements;
- Generation of climate relevant datasets from the installed solar resource measurement tower with NRG Symphonie Plus3 Data Logger and GSM iPack at site; along with the most advanced relevant programs including National Renewable Energy Laboratory's (NREL) of the USA's Department of Energy (DOE) Software Hybrid Optimization Model for Electric Renewables (HOMER), Maui Solar Corporation of California's Software Solar Studio Design Pro; International Climate Generator, Sun-Plot 3-D, ModuLab, etc. This data on irradiation, wind and temperature, is compared to other sources and long-term statistical data available from National Aeronautics and Space Administration (NASA) Meteorological Department, assessment and explanation of the differences;
- Simulation of the yearly energy production of the PV plant using up to date simulation software such as the National Renewable Energy Laboratory's (NREL) of the USA's Department of Energy (DOE) Software Hybrid Optimization Model for Electric Renewables (HOMER), PV SYST, VIPER, Maui Solar Corporation of California Software, Solar Studio Design Pro including; Solar PV Pro-G Version 6.0, International Climate Generator, Sun-Plot 3-D, ModuLab, PV Module Wizard, Sandia IV Tracer, (irradiation, wind and temperature) considering irradiation,

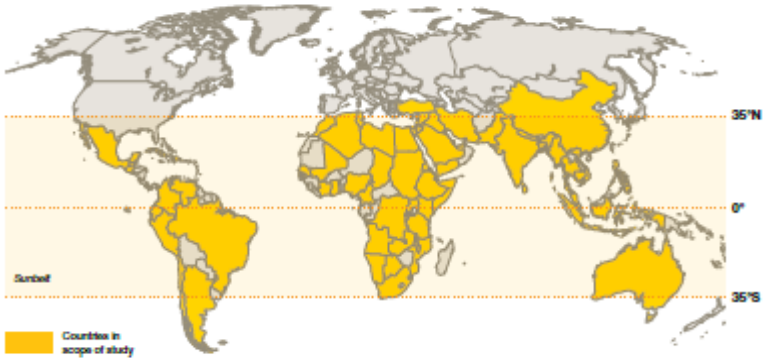
climatic conditions, shading situation, inverter failures, used PV technology and inverter type, external cabling and grid connection losses.

- Determination of expected losses, performance ratio (PR) and long-term performance taking into account module degradation;
- Uncertainty analysis of the simulation and the PV plant energy production assessment;
- Probability analysis of variances above the determined uncertainties concerning the amount of energy produced;
- If necessary, suggestions for improvement of the layout in order to improve the yield, the accuracy or mitigate the risks;
- Statement on the durability of the main equipment (modules, inverters and mounting structure)
- Description of technical equipment and Plant layout studies.
- Economic & Financial Analysis in concurrence with the prevailing industry regulations, standards and the National Electric Power Regulatory Authorities (NEPRA) policy regarding tariff determination
- Efficient Operation & maintenance studies with efficient Project management throughout
- Ecological lifecycle calculations & Ecological footprint, Environment Studies including IEE and EIA
- Socio-economic effects
- Geo-Technical Studies including Topographic Survey and Soil Testing
- Complete Clean Development Mechanism activities including development of PIN's, PDD's, Prior Consideration Form, and Evalutation Matrix

2.2 Background of Study

In view of the accelerated development of new markets for large scale solar power generation around the World and specifically in the so called "Sun-Belt" countries, of which Pakistan happens to be a very prominent member with very high irradiation levels; the JV aims at the identification and development of such large scale Solar PV Power Projects through collaboration with the concerned relevant boards and bodies through a structured approach and vision.

The "sunbelt" region is described as the region between 35N to 35S, encompassing 148 countries globally including Pakistan, as can be seen in Figure 2.2.1:



	Sunbelt countries in scope	All countries in Sunbelt	World
# countries (2008)	66	148	201
Population (2008)	5.0 billion	5.3 billion	6.7 billion
GDP (2008)	15.7 trillion	16.4 trillion	60.0 trillion
Electricity consumption (2007)	6,800 TWh	7,000 TWh	17,900 TWh

Source: World Bank, IMF, A.T. Kearney analysis

Figure 2.2.1: Sun Belt Countries Analysis

With Photovoltaic (PV) development booming globally the time seems just right for investment in the sector. More than 7,000 MW was added to the global generation base in 2009 alone; expanding the cumulated installed base well over 22 GW. Since then, there have been years of vigorous growth of the world-wide PV market, even during times of financial and economic crisis. Revisiting 2011 and now the early part of 2012 we see further growth and emphasis on the sector in emerging markets by Governments and the Private Sector alike. The volume of new grid-connected PV capacities world-wide rose from 16.6 GW in 2010 to 27.7 GW in 2011. Almost 21 GW of this growth can be accounted in Europe.

This somewhat paradoxically shows that the growth so far has mainly been driven by countries outside the world's Sunbelt; whereas by taking the initiative and focusing on the Sunbelt Countries, the growth of PV could be exponentially accelerated by tapping in to this huge natural resource. This phenomenon of unbalanced growth is further explained by the figure below:

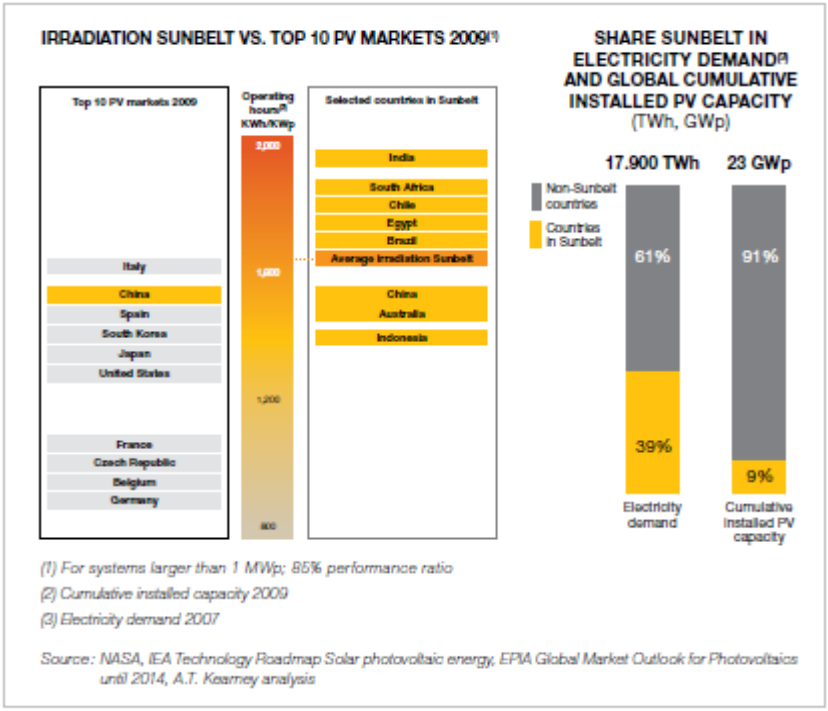


Figure 2.2.2: Comparison of Solar Irradiation, Share in Electricity Demand and Cumulative installed PV Capacity

It can clearly been seen that out of the top 10 PV markets of the world most are not as favorable in terms of PV potential but still have shown tremendous growth even through an era where skepticism over the affordability of the Solar Resource was high and financial crises had plagued several major global economies. It is further shown in Figure 2.2.2 that out of the total worldwide electricity demand of 17'900 TWh, 39% lies in the Sunbelt region whereas Cumulative Installed PV Capacity of the Sunbelt region is only 9% compared to 91% in non-Sunbelt countries. This shows the colossal latent opportunity for growth and investments in the PV sector in these areas.

Investing and tapping this huge naturally abundant resource would bring enormous benefits to the Sunbelt countries as summarized in Figure 2.2.3. The electricity grid may be decentralized, line losses reduced, and generation may be where it is needed rather than where it is available as is the case with other technologies and resources. PV can further contribute significantly to cover the dynamically increasing electricity demand of these growing economies in the shortest possible time, by

harnessing low-carbon, free energy solar resource therefore decreasing dependencies on (imported) fossil fuels (one of the major reasons for trade deficits of most of these economies), reducing pressures on water use and improving the carbon balance.

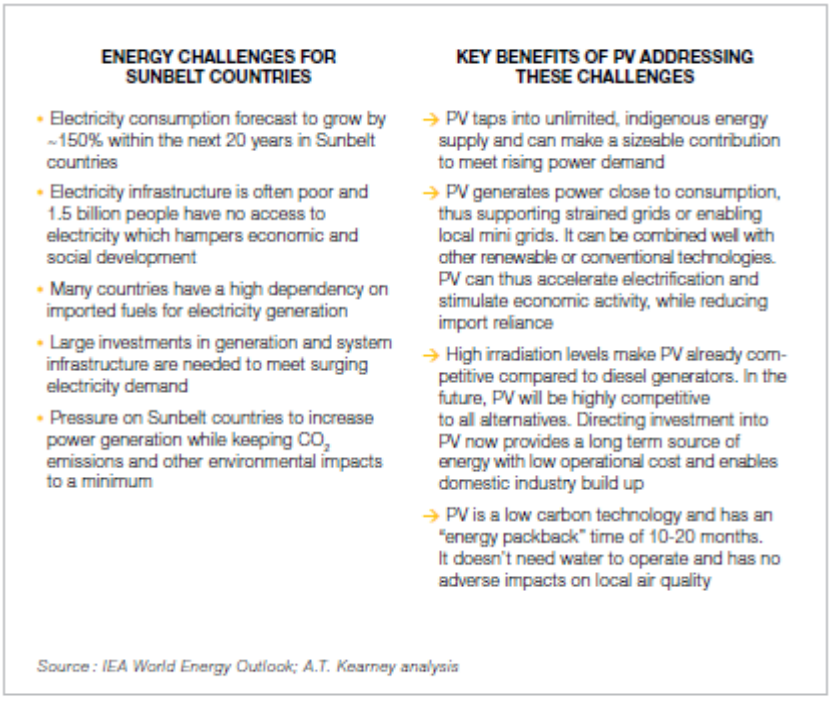


Figure 2.2.3: Benefits of PV for Sunbelt Countries

Amongst the Sunbelt countries we see Pakistan as a member with one of the highest PV Resource Potential with high average irradiation levels of almost 5.8 KWh/m^2 across the country but rather low installed capacity so far for a number of reasons effecting the region in the recent past; which include socio-political, financial and technical reasons coupled with the humanitarian disasters ensuing the country every couple of years.

However the opportunity for progress is immense, courtesy of the correct & appropriate environment which has now been developed through Government Support and Policy Emphasis on renewable energy, in face of the acute power shortage of almost 5000 to 6000 MW annually. The capacity for understanding the sector has also been on a constant rise which has further contributed to the sectors growth in Pakistan. Figure 2.2.4 shows how the country has been positioned in the past amongst other Sunbelt members.

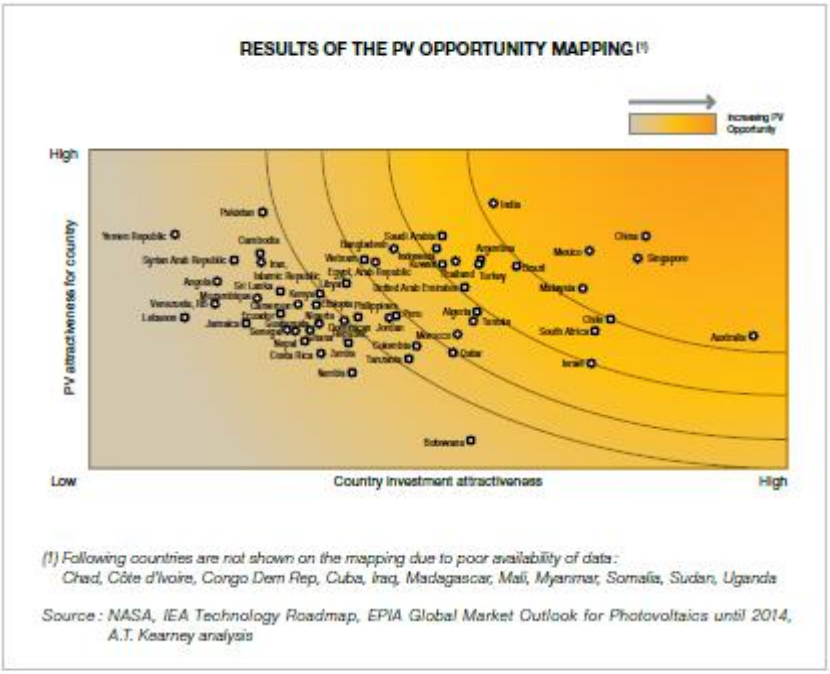
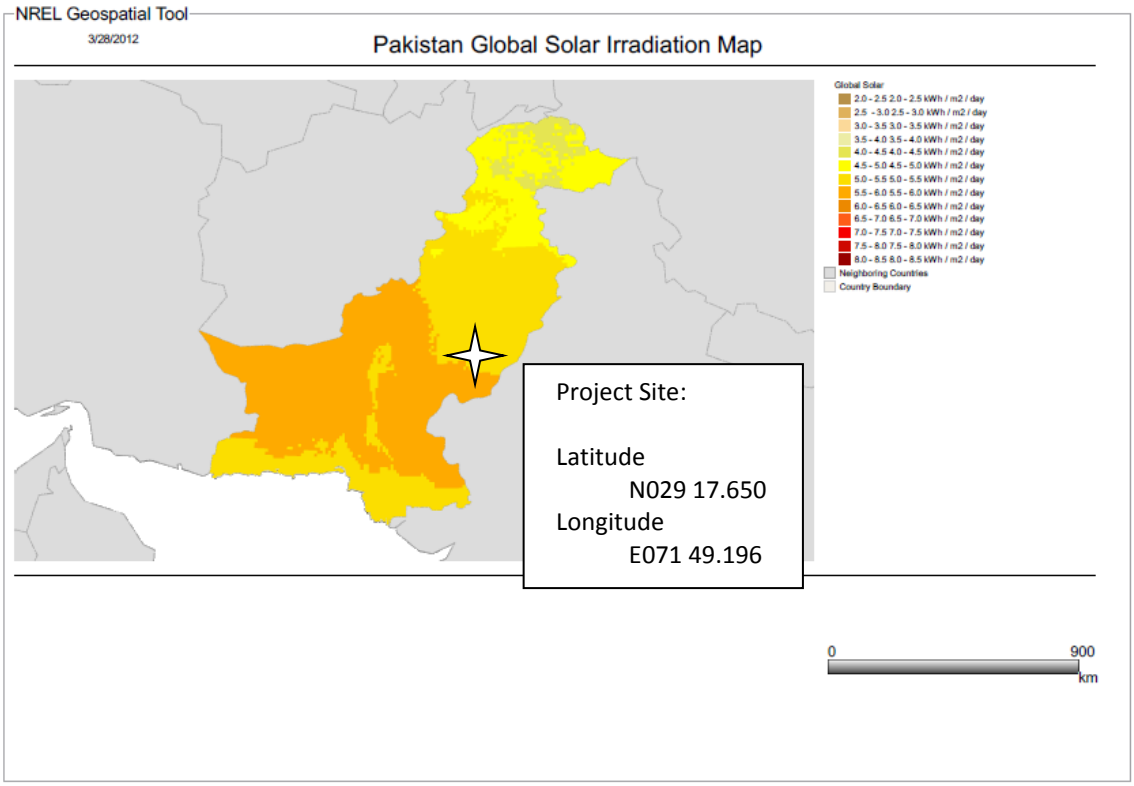


Figure 2.2.4: PV Opportunity Attractiveness for Sunbelt Countries

Located on the western stretch of the South Asian Continent, Islamic Republic of Pakistan is largely under the influence of tropical desert climate with high global irradiation levels. Solar energy has excellent potential in most areas of Pakistan that receive high levels of solar radiation throughout the year. Every day, the country receives an average of about 19 Mega Joules per square meter of solar energy



Map 2.2.1: Pakistan Global Solar Irradiation Map

Pakistan covers 796,095 square kilometers of land between latitudes 24° and 36°north and longitudes 61° and 76° east. At present, it faces serious energy problems: majority of its electricity generation comes from hydropower, which becomes less productive during the driest, hottest months of the year and cannot keep pace with the sharp rise in energy demand.

The relative shortage of conventional energy resources in Pakistan, when coupled with the hiking energy prices worldwide, leads to a tension in the power supply of the country, it has become a top agenda of Pakistan government to find alternative energies, including solar power.

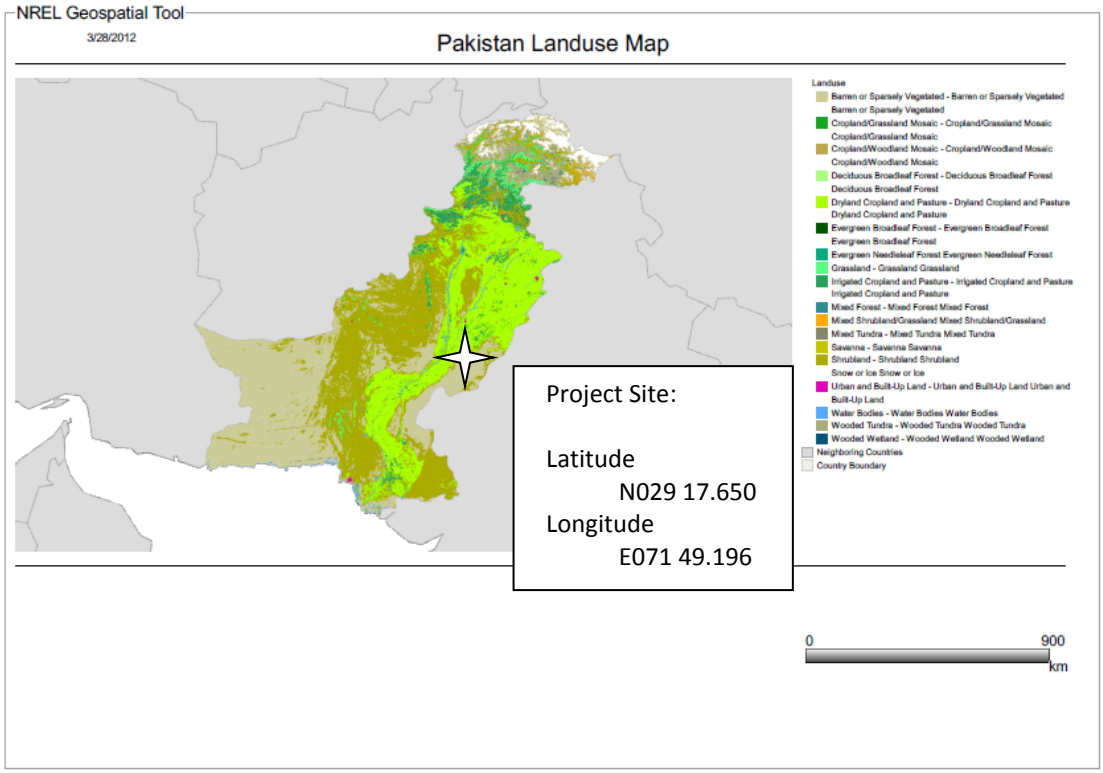
Also, about 70 per cent of the population lives in some 50,000 villages dispersed around the country. Many of these villages are far from the main transmission lines of the national grid and, because of their relatively small populations; it is usually not economically viable to connect these villages to the grid, however decentralized or networks could be developed on Solar Energy to power these areas, which provides an opportunity for micro-grid applications as well.

Government of Pakistan has formulated a policy to standardize and encourage the participation of private sector in the development and application of renewable energies. A Federal Government organization called Alternative Energy

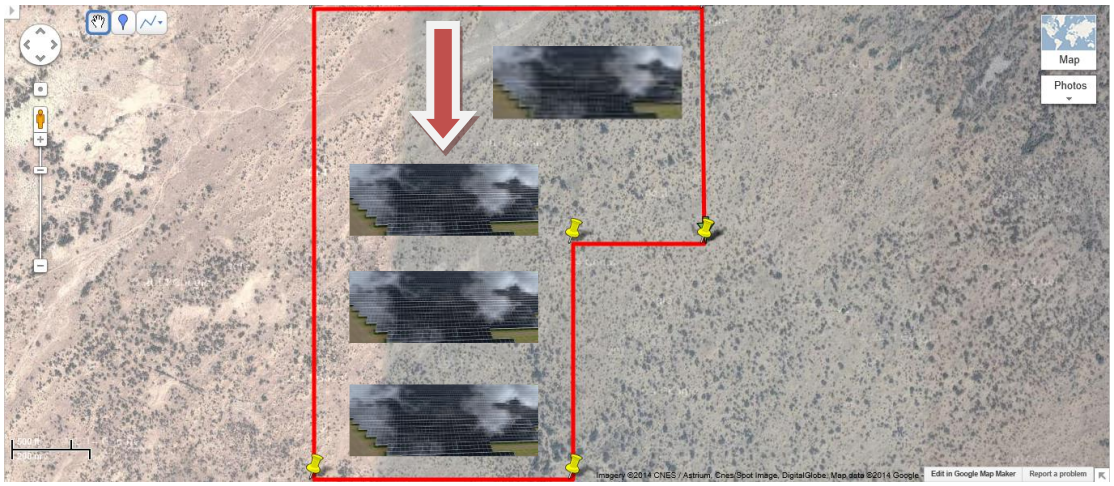
Development Board (AEDB) and respective Provincial Power Boards including the competent and highly esteemed Punjab Power Development Board (PPDB) have been established to facilitate the implementation of renewable energy projects. PPDB has been given a mandate, requisite resources and target to facilitate development of a number of Solar PV Power projects in Cholistan Desert, Bahawalpur District, Punjab Province.

Since the 18th Amendment to the Constitution of Pakistan, and the Powers vested to Provinces under article 157 Point 2(a) to 2(d), the Provincial bodies such as PPDB are now working actively and aggressively to ensure fast track development of Power Projects in their particular domains.

Keeping the above in view the Joint Venture comprising China Three Gorges International Corp. (CTGI) a new overseas-investment subsidiary company of CTG, which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power and Welt Konnect (Pvt) Ltd (a subsidiary of the Transtech Group) which is a Power Projects Developing company working in Pakistan jointly therefore have now opted to invest in the Solar PV Power Project of 50 MW installed capacity. The current Project Site is located within the Quaid-E-Azam Solar Park, at Lal Suhanara, Bahawalpur, Punjab and is composed of 250 Acres of land comprising Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354, about 18 km from Bahawalpur City Center, the nearest urban center. The locality enjoys a flat terrain, scarce plant cover, rich solar radiation, and availability of large area suitable for project expansion, accessibility and proximity to medium voltage transmission network, thus rendering itself an appropriate location for large Solar PV power stations.



Map 2.2.2: Project Site Coordinates



Map 2.2.3: Project Site comprising Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354 Lal Suhanra, Bahawalpur, Punjab

Both CTGI and Welt Konnect (Pvt) Ltd have been following closely the Solar Power sector of Pakistan since 2005, and in 2009 registered as a member of PPDB and in the same year obtained a preliminary qualification for solar power development. Consequently CTGI and Welt Konnect (Pvt) Ltd jointly began development of the 50 MW Solar PV project in Cholistan Desert, with an intention to further enhance and

develop a total of 200MW with support of the Punjab Government, in light and spirit of the MOU signed in the presence of the Honorable Chief Minister Mr. Shahbaz Sharif, dated June 5th 2010 and later November 6th 2010, provided in **Annexure 1:** MoU between WK, CWE and the Punjab Government on 06th Nov 2010".

The project was conceived in 2009 and by April 2010, the pre-feasibility study for the project was completed.

A MoU between Welt Konnect and the Punjab Government was signed on the 5th of June, 2010. At the same time a MoU was signed with GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) for facilitation in incorporation of the Carbon Development Mechanism for the project, and to provide assistance in other technical aspects of the project provided in **Appendix 2:** MoU between WK and GIZ on 16th June 2010"

PPDB also issued a letter of interest for said 50 MW Solar PV Power developments (LOI) to the consortium in 2011 (given in **Annexure 3:** LOI issues by PPDB to CTGI and WK on 09th June 2011); and in January 2012, PPDB allocated the project site of 500 Acres.

To stimulate this development, the government has passed a number of Fiscal Incentives for the Promotion of Renewable Energy which provides tax and customs duties exemptions for projects based on renewable energies.

The 50 MW Solar PV Power project benefits include avoided fossil fuel costs and emissions reductions from the displaced conventional power generation, and the economic analysis based on the guaranteed 17% Internal Rate of Return demonstrates that the project is beneficial to the investors and project developers. The Levelized cost of Energy comes out to be about **18.4568** cents per KWh.

PV Mono Crystalline Cells have been selected as the preferred technology as the prices of various cell types have been converging and the use of slightly cheaper thin film technologies such as amorphous Silicon (a-Si) or Cadmium Telluride with a-Si would be requiring about 80% more land and at lower efficiency and hence off setting whatever cost benefit which was to be gained in the past. The Summary of the design layout is provided below in Figure 2.2.5.

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Grid-Connected System: Main results

Project : **Cholistan 19-sep**
Simulation variant : **19-Sep Nasa**

Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	tilt	29°	azimuth	0°
PV modules	Model	SW 240 Mono	Pnom	240 Wp
PV Array	Nb. of modules	209440	Pnom total	**50266 kWp**
Inverter	Model	Sunny Central 800CP	Pnom	880 kW ac
Inverter pack	Nb. of units	56.0	Pnom total	**49280 kW ac**
User's needs	Unlimited load (grid)			

Figure 2.2.5: Plant Design Summary

2.3 Project overview

The Project Site is located near the Cholistan Desert, District Bhawalnagar, with nearest city of Bahawalpur; with is one of the oldest cities of the region with a very rich historical heritage. The direct distance between the Project Site and Main Bahawalpur City is about 17.5km. Detailed information on the Cholistan Desert and Bahawalpur City can be found in **Annexure 9:** General Site information, however relevant and concise information is provided below.

You will also find in **Annexure 10:** Report on Cholistan visit for Solar Power Project Site Selection; the Executive Summary Report on the Site Selection in Cholistan with a list of short listed sites with a few pictures.

Whereas in **Annexure 11** you will find the survey report for selection of land in the Quaid-E-Azam Solar Park.

Cholistan Desert sprawls thirty kilometers from Bahawalpur, Punjab, Pakistan and covers an area of 26,300 km². It adjoins the Thar Desert extending over to Sindh and into India.

The word Cholistan is derived from the Turkish word Chol, which means Desert. Cholistan thus means Land of the Desert. The people of Cholistan lead a semi-nomadic life, moving from one place to another in search of water and fodder for their animals. The dry bed of the Hakra River runs through the area, along which many settlements of the Indus Valley Civilization have been found.

The Desert also has an Annual Jeep Rally, known as Cholistan Desert Jeep Rally. It is the biggest motor sports event in Pakistan

Bahawalpur located in Punjab, is the twelfth largest city in Pakistan. The city was once the capital of the former princely state of Bahawalpur. The city was home to various Nawabs (rulers) and counted as part of the Rajputana states (now Rajasthan, India). The city is known for its famous palaces such as the Noor Mahal, Sadiq Ghar Palace, and Darbar Mahal, as well as the ancient fort of Derawar in the Cholistan Desert bordering India. The city is located near the historical and ancient cities of Uch and Harappa, which were once a stronghold of the Delhi Sultanate and Indus Valley Civilization. The city is home to one of the few natural safari parks in Pakistan, Lal Suhanra National Park.

In 2007, the city's population was recorded to have risen to 798,509 from 403,408 in 1998. Punjabi and Saraiki are the major languages of local people, while Urdu is well

understood and English is the official languages used in various educational and government institutions. Bahawalpur is located south of the Sutlej River and lies in the Cholistan region near the Thar Desert. It is situated 90 km from Multan, 420 km from Lahore, and 270 km from Faisalabad.

The main crops for which Bahawalpur is recognized are cotton, sugarcane, wheat, sunflower seeds, rape/mustard seed and rice. Bahawalpur mangoes, citrus, dates and guavas are some of the fruits exported out of the country. Vegetables include onions, tomatoes, cauliflower, potatoes and carrots. Being an expanding industrial city, the government has revolutionized and liberalized various markets, allowing the caustic soda, cotton ginning and pressing, flour mills, fruit juices, general engineering, iron and steel re-rolling mills, looms, oil mills, poultry feed, sugar, textile spinning, textile weaving, vegetable ghee and cooking oil industries to flourish.

Geography and climate: The city, which lies just south of the Sutlej River, is the site of the Adamwahan Empress Bridge, the only railway bridge over the Sutlej in Pakistan. It is situated 90 km from Multan, 420 km from Lahore, 122 km from Burewala, 90 km from Vehari, 270 km from Faisalabad and about 700 km from the national capital, Islamabad. The west region of the city is called the Sindh. It is a fertile alluvial tract in the Sutlej River valley that is irrigated by floodwaters, planted with groves of date palm trees, and thickly populated forests. The chief crops are wheat, gram, cotton, sugarcane, and dates. Mango Sheep and cattle are raised for export of wool and hides. East of Bahawalpur is the Pat, or Bar, a tract of land considerably higher than the adjoining valley. It is chiefly desert irrigated by the Sutlej inundation canals and yields crops of wheat, cotton, and sugarcane. Farther east, the Cholistan, is a barren desert tract, bounded on the north and west by the Hakra depression with mound ruins of old settlements along its high banks; it is still inhabited by nomads.

The climate is mainly hot and dry. In the summer the temperature reaches the high forties (Celsius) during the day and the nights are slightly cooler. Since the city is located in a desert environment there is little rainfall. Weather conditions reach extremes in both summer and winter. The average temperature in summer is 33 °C (91 °F) and 18 °C (64 °F) in winter. The average rainfall is 20 to 25 mm annually. (Kindly note all readings mentioned above are averages)

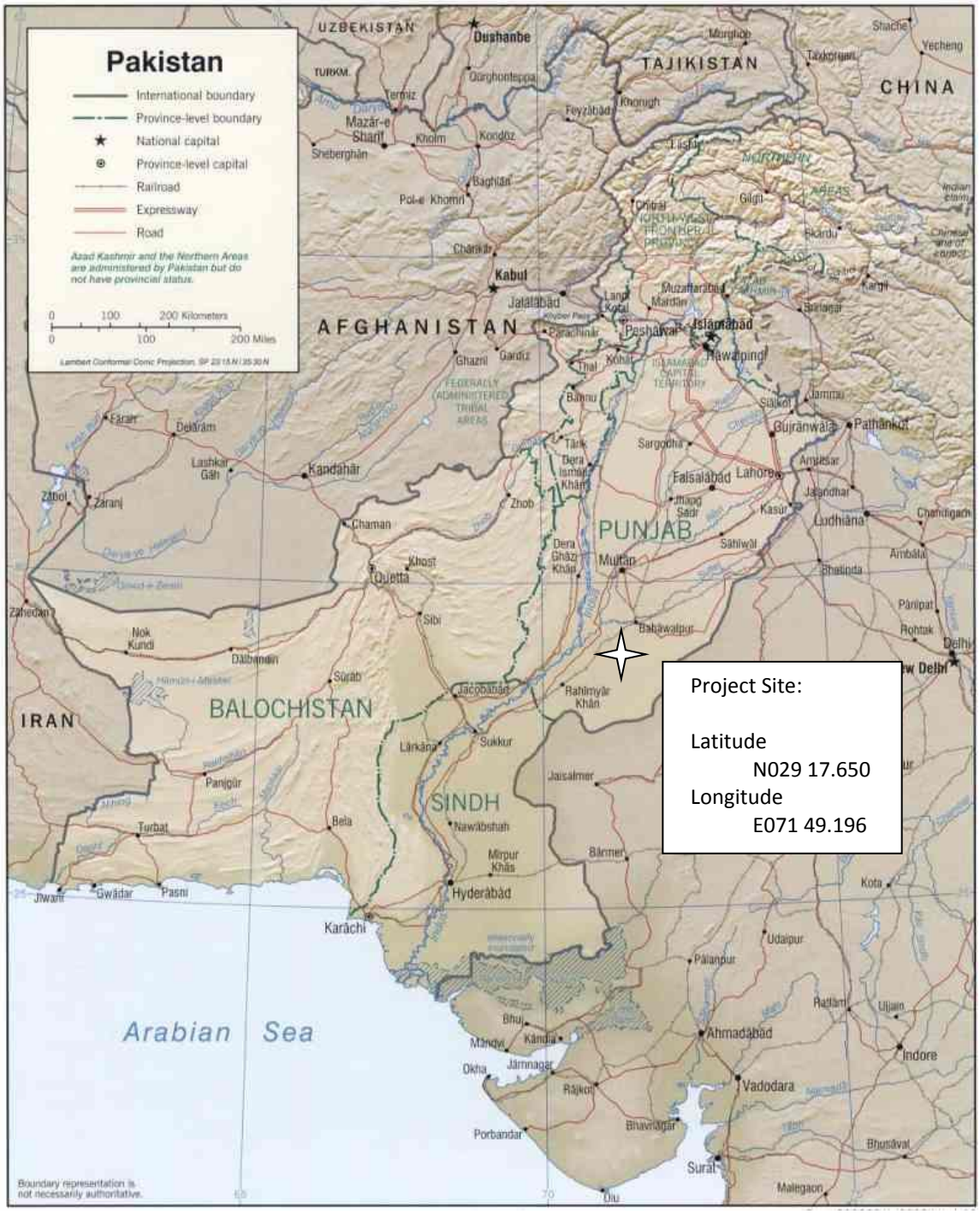
Demographics: Bahawalpur is one of the largest districts of Pakistan covering an area of 24,830 km^2. It has peculiar demographic, topographic and geographical characteristics. The district is situated almost in the center of the country at an elevation of 152 meters from the sea levels. The population of Bahawalpur district increased from 1.453 million in 1981 to 2.411 million in 1998, showing a growth rate of 3.88% per year and population density has increased from 59 in 1981 to 97 in

1998. The majority of Bahawalpur's residents speak Punjabi and Saraiki, while Urdu, and English are common languages used in various educational and government institutions

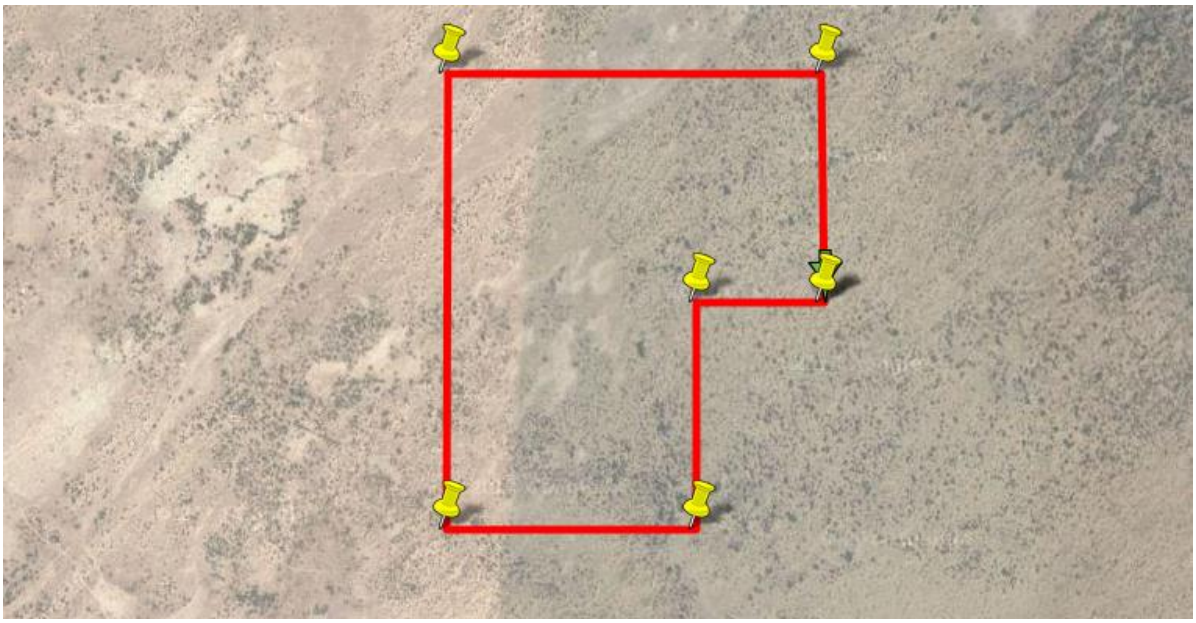
Transport: Bahawalpur is well connected with various cities in Pakistan. The city has its own airport built by the Dubai Civil Aviation Department and the CAA. Bahawalpur Airport links the city with various Pakistani cities such as Dera Ghazi Khan, Islamabad, Karachi and Lahore with the national flag carrier, Pakistan International Airlines. The airline has launched international flights to Dubai, and plans to introduce more international destinations. There are daily trains and bus services from Multan, Lahore, Sukkur and Karachi to Bahawalpur, taxicabs and rickshaws are plentiful in the city. Cars are also available for hire in the city.

The distance between Project Site and the border between Pakistan and India is between 100 to 150Km. The Project covers an area of **250 Acres which is equivalent to 1.01171 Square Kilometers**. The latitudes and longitudes are provided in a table below. The altitude is 150m above sea level. The monsoon from the Indian Ocean, which is stable in its direction and high in its quality, brings rich wind energy resource to the Site.

The installed capacity of the Project is planned to be 50 MW. The geographical location of the project is shown in Map 2.3.1



Map 2.3.1: Regional Map showing Project Site in District Bhawalpur, Punjab



Map 2.3.2: Satellite Map of Project Site

50 MW Project Coordinates

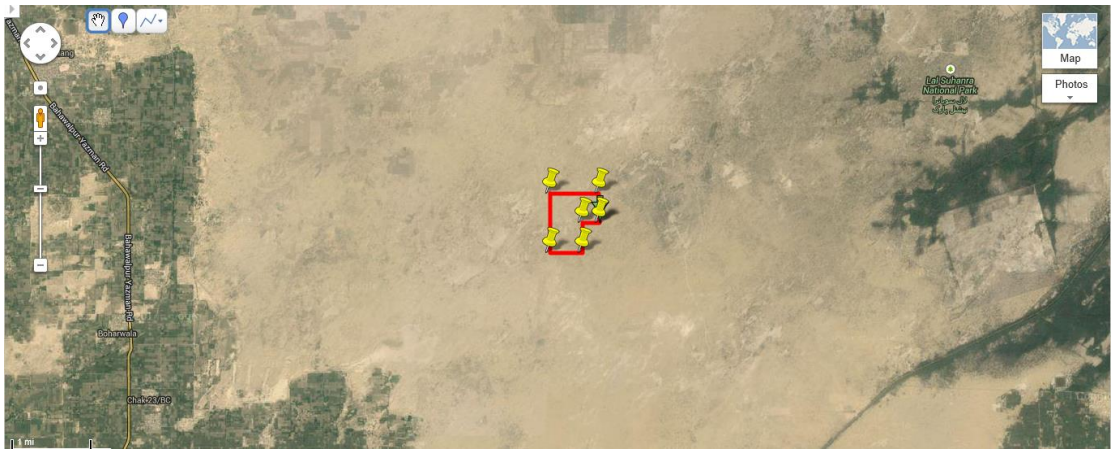
Node	Longitude (East)	Latitude (North)
1	71 49.196	29 17.650
2	71 49.817	29 17.650
3	71 49.196	29 16.998
4	71 49.817	29 17.324
5	71 49.608	29 17.324
6	71 49.608	29 16.998

Table 2.3.1: Geographical Coordinates of Project Site

The electric grid selected for connection with the PV power plant is the Marot Grid Station due to a number of factors. Connection to this grid station is most feasible as per initial surveys and research. The grid station has the required capacity (and is going up-gradation) for receiving and distributing maximum load from the PV Power station. Operators at grid station have also demonstrated their confidence in being able to forecast required information.

The grid station falls under the Multan Electric Power Company's (MEPCO) authority with which an initial round of meetings has already been conducted. The geographical details of the grid station are mentioned below:

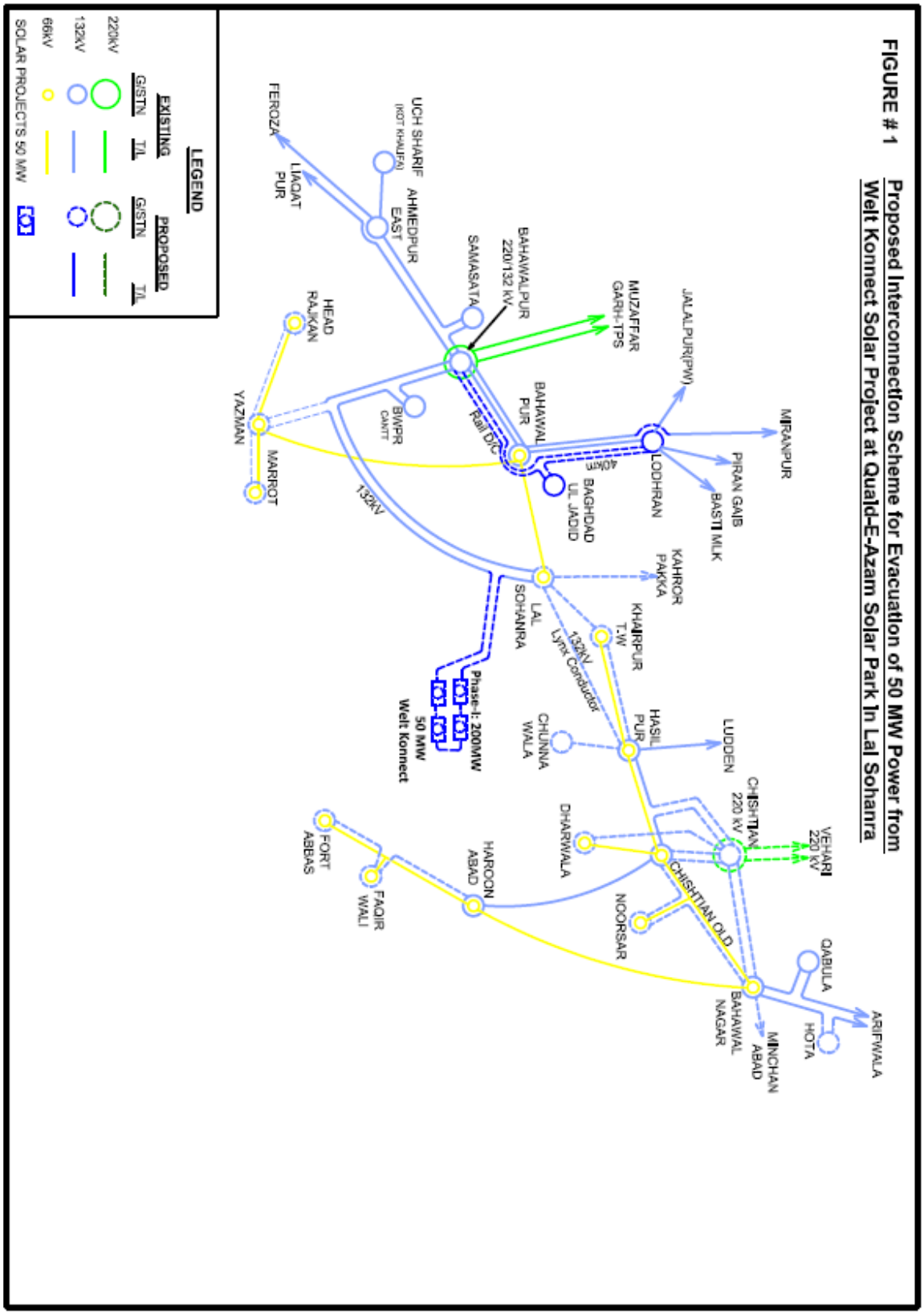
Latitude:	N029 17.650
Longitude:	E071 49.196
Distance (from site):	3.2 to 4.5 Km



Map 2.3.3: Satellite Map of Project Site showing Grid Station

The Project shall have an installed capacity of 50.26 MW. There shall be a substation of 132KV, which shall dispatch electricity to MEPCO Grid through their station at Marot, which is to the North of the Site which would be between 3.2 to 4.5 Km's from the Power Station depending on where the switch gear is finally positioned on the project site.

The Project Site is connected to Bahawalpur through good quality metal road capable of handling high loads and Bahawalpur is connected to all major cities of the country via network of Roads and Highways, providing a good facility for transportation of equipment.



Map 2.3.4: Map showing the Proposed Interconnection Scheme with the National Grid

2.3.1 Project Size

The Project will install 209,440 Solar PV Modules of 240 Wp each, totaling 50.26MWp approx., covering an area of almost 1000 Meters square (250 acres), as shown below in Figure 2.3.1.1

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Grid-Connected System: Main results				
Project :	**Cholistan 19-sep**			
Simulation variant :	**19-Sep Nasa**			
Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	tilt	29°	azimuth	0°
PV modules	Model	SW 240 Mono	Pnom	240 Wp
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Inverter	Model	Sunny Central 800CP	Pnom	880 kW ac
Inverter pack	Nb. of units	56.0	Pnom total	**49280 kW ac**
User's needs	Unlimited load (grid)			

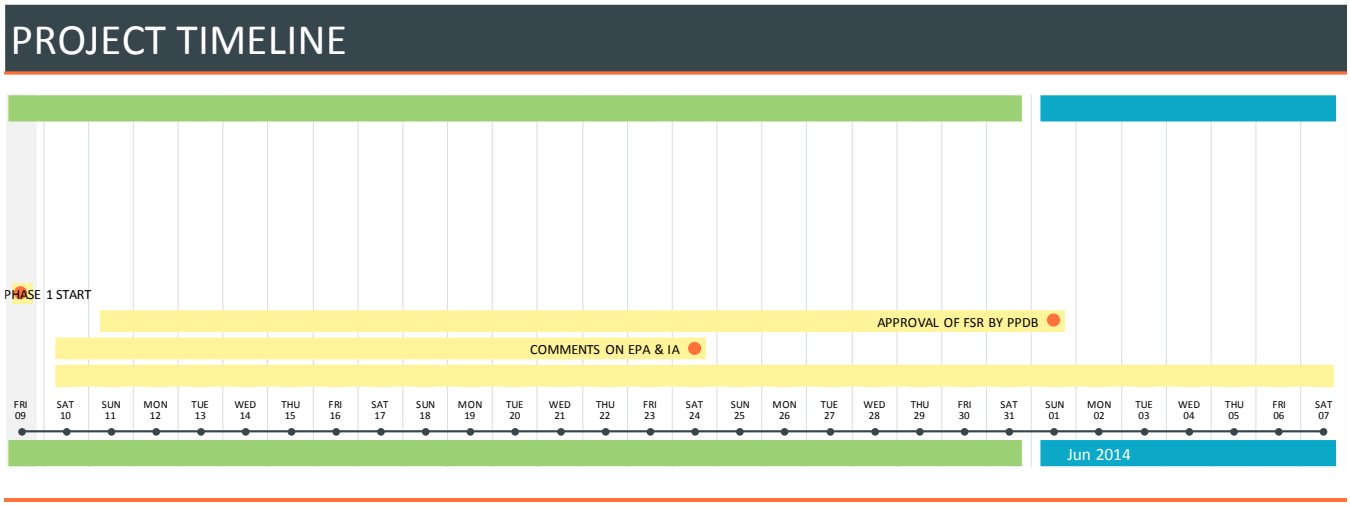
Figure 2.3.1.1: Plant Design Summary

2.3.2 Project Status and Calendar

The project has successfully achieved a number of milestones as outlined in the Executive Summary and Background of the Study provided above, and now the Comprehensive Feasibility Study Report is being submitted from here onwards for approval of feasibility and all its parts from the concerned stakeholders / Panel of Experts of the Punjab Power Development Board (PPDB). In parallel, the Project shall also pursue and continue work on determination of tariff and signing of EPA/ IA.

All factors have been taken into account during the preparation of this Feasibility Study including the Project Site Location, natural resources, environment and construction of this Solar Power farm along with the local government's plans for social and economic development as well as requirements for the exploitation and use of Solar Power by the Federal and Provincial Governments of Pakistan.

The following time line in Fig. 2.3.2.1 has been estimated till the Commercial Operation Date (COD) of the project which includes all major milestones and activities which need to be undertaken.



ENTER START DATE: 5/9/2014

ACTIVITY	START	END	NOTES
Phase 1 Start	5/9/2014		
Approval of FSR by PPDB	5/11/2014	6/1/2014	(Phase 1) Duration of 3 weeks
Comments on EPA & IA	5/10/2014	5/24/2014	(Phase 1) Duration of 2 weeks
Finalization of RFP	5/10/2014	7/5/2014	(Phase 1) Duration of 8 weeks
Selection of EPC	7/6/2014	8/31/2014	(Phase 1) Duration of 8 weeks
Phase 1 End	9/1/2014		
Phase 2 Start	09/02/2014	09/02/2014	
Obtain Generation License	09/09/2014	09/23/2014	(Phase 2) Duration of 2 weeks
Obtain Tariff	09/10/2014	11/05/2014	(Phase 2) Duration of 8 weeks
Signing of EPA	11/06/2014	11/27/2014	(Phase 2) Duration of 6 weeks
Signing of IA	11/28/2014	01/09/2015	(Phase 2) Duration of 6 weeks
Phase 2 End	01/10/2015	01/10/2015	
Phase 3 start	01/11/2015	01/11/2015	
Achieve COD	01/12/2015	10/19/2015	(Phase 3) Duration 40 Weeks or 10 Months
Phase 3 End	10/20/2015	10/20/2015	

Table 2.3.2.1 Project Planned Milestones

2.3.3 Geological Conditions

The site selected lies in the vicinity of the Cholistan desert and has been selected due to favorable conditions for a Solar PV Power plant in regards to the available infrastructure, microclimate effects, risks of natural hazards, geographical advantages, presence of distribution network for power and Geological conditions. The site map and coordinates of the site have been shown in **Figure 2.3.3.1** and **Figure 2.3.3.2** respectively.

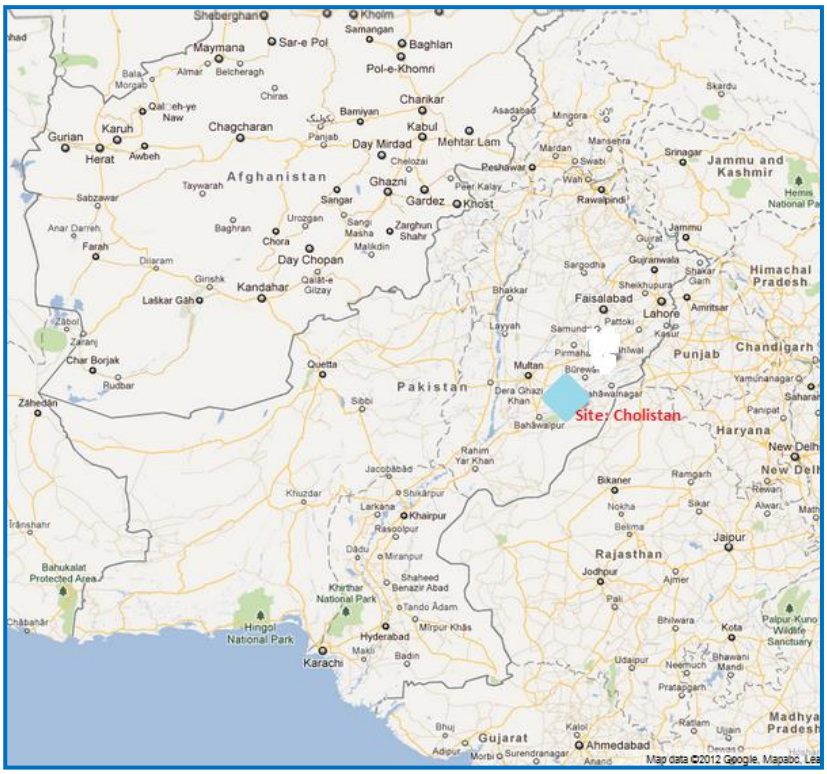


Figure 2.3.3.1: WK Project Site Overview

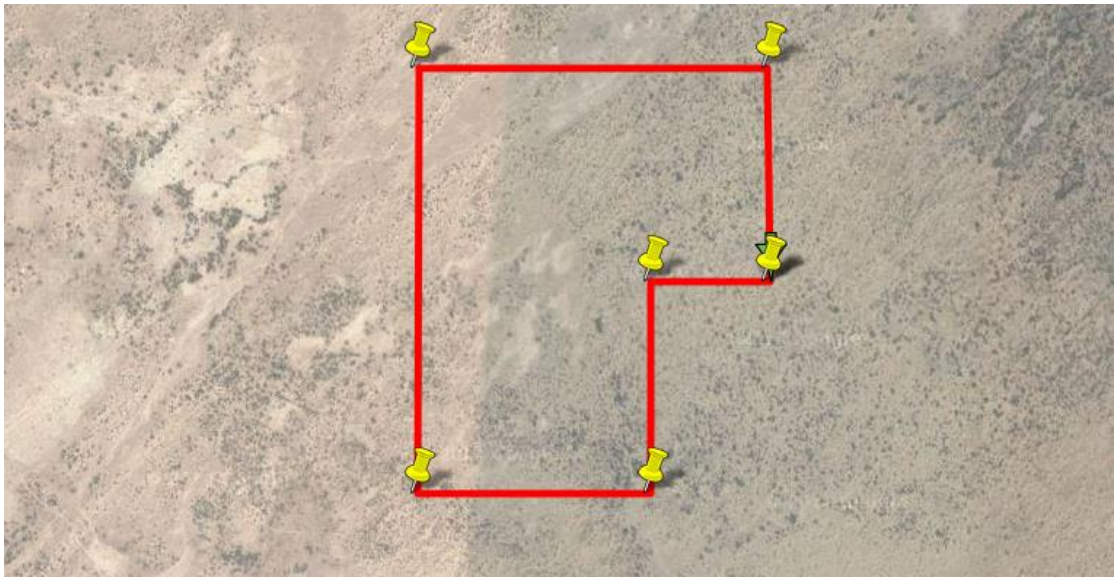


Figure 2.3.3.2: WK Project Site Coordinates

The Project Site encompasses an area of 250 Acres (Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354 in the Quad-E-Azam Solar Park at Lal Suhanra, Bahawalpur, Punjab) which is approximately 2 to 3 Km away from the nearest Grid Station and

about 17.5 km from Bahawalpur (the nearest urban city). The location enjoys a flat terrain with sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself an appropriate location for the setup of a large solar power station

The subsurface stratum at the site consists of sandy silty clay and similar results were found to the maximum explored depth of 5m (16.4ft). Geological (Solid Earth) characteristics of the site are also affected by the microclimate factors of the area. Bahawalpur and nearby area are characterized by low and sporadic rain. Therefore aridity is the most striking feature of the Bahawalpur with wet and dry years occurring in clusters. Bahawalpur is one of the hottest regions of Pakistan.

Bahawalpur has very low propensity towards natural disasters or similar risks. Till date the nearest area to Bahawalpur which has faced the effects of a flood is Bahawalpur and only once in our history. Cholistan and nearby areas for a significant radius are not prone to earth quakes (as per past records). Similar studies support the selection of the site as a safe geographical location for operations of a solar power project. **Figure 2.3.3.3** and **Figure 2.3.3.4** show hazard maps of Pakistan.

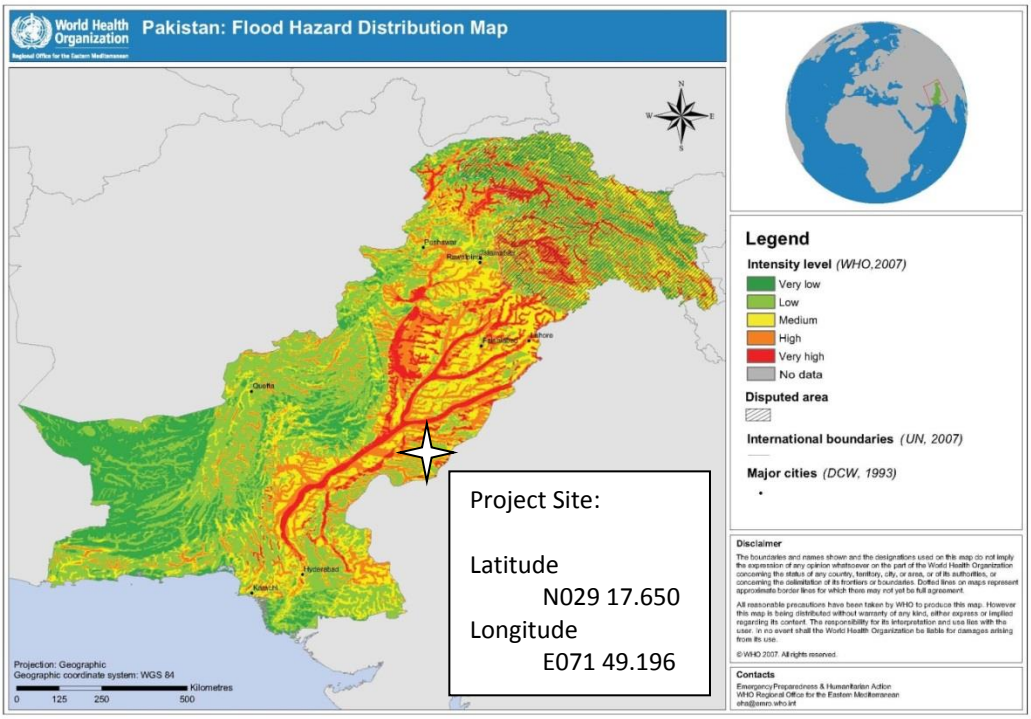


Figure 2.3.3.3: Shows the Flood hazard map of Pakistan

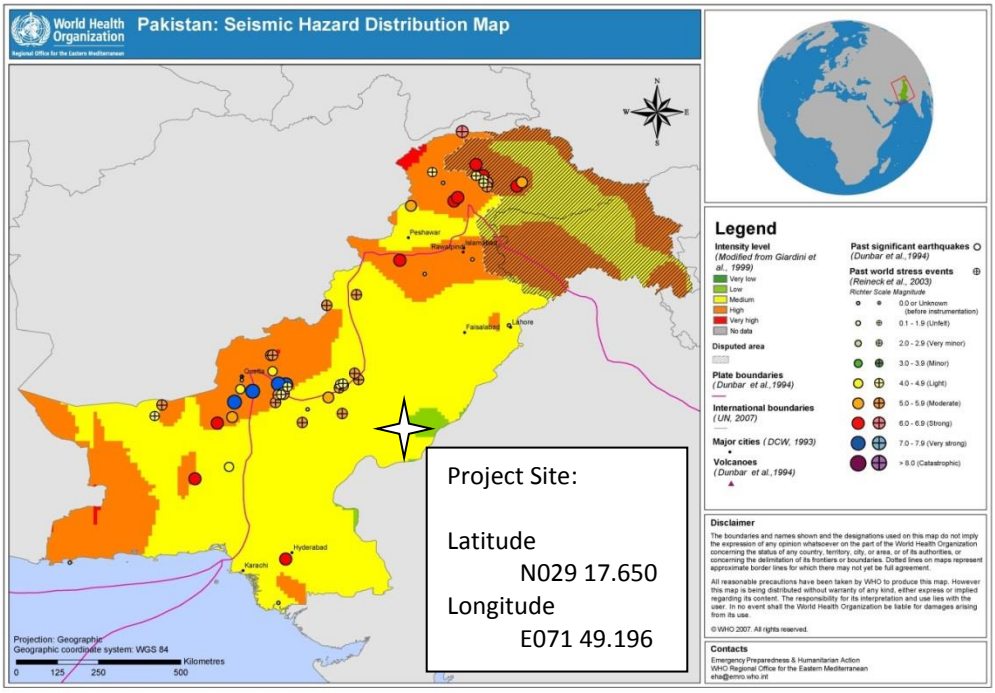


Figure 2.3.3.4: Shows the Natural Hazard map of Pakistan

The site is facilitated with a very favorable level of water table, less tan 20m below ground level. The project team would drill bores to gain access to this water table and its supply. Simultaneously for initial work scope, there are existing wells within approachable distance which are being used by local habitants for their livestock.

The land acquired by the Joint Venture consists primarily of flat ground and sand dunes. Construction of the solar farm will be focused on the flat areas. Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading.

2.3.4 Solar Resource Assessment

The SRA equipment installed at site has been manufactured by NRG, Vermont with Data Logger Model # 4941 (**Fig. 10.3.5** NRG Data Logger Installed and Connected). The Solar Resource Assessment System; NRG Systems SymphoniePLUS3™ data logger, iPackGPS communications modules (GSM, CDMA, and Satellite), SDR software, meteorological tower components, and reliable sensors from NRG Systems is designed for the professional solar PV developer looking for quick and repeatable deployment, easy and autonomous off grid operation, and bankable data. The system is comprised of proven products including the NRG Systems Symphonie*PLUS*3™ data logger, iPackGPS communications modules (GSM, CDMA,

and Satellite), SDR software, meteorological tower components, and reliable sensors. NRG Systems resource assessment equipment is currently used on all continents and across 145 countries.

The complete region of Pakistan falls in the "sunbelt" region of the globe. The rise in interest of international PV industry in the region is due to its geographical location on the whole and the natural advantages as compared to other regions. As per NREL solar resource maps (**Fig 10.1.1** Solar resource map for Pakistan), average solar irradiation in Pakistan varies from 3.5 – 7 kWh/m2 per day while Germany witnesses a variation of 2.5 – 3.2 kWh/m2.

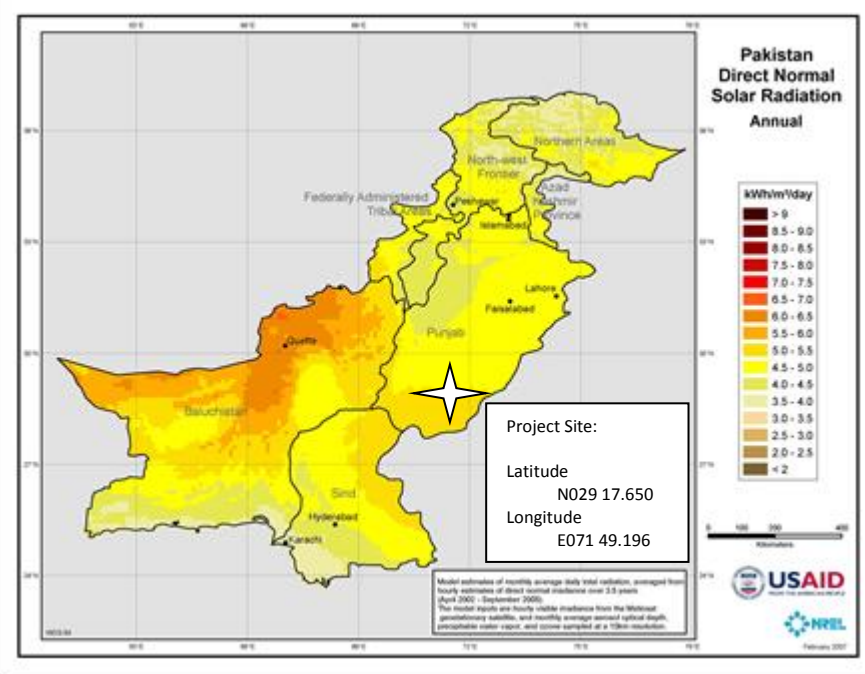


Figure 2.3.4.1: Solar Radiation Map of Pakistan

As can be clearly seen from Fig 2.3.4.1, the greatest amount of solar radiation after parts of Balochistan is in the southern part of Punjab. The daily radiation levels at the project site vary between 4.6 – 7.00 kWh/m^2/day and average at 5.53 kWh/m^2/day.

2.3.5 Solar Power Plant Equipment and Energy Yield Estimate

PV Modules

The modules used in the Feasibility Study have been selected after stringent analysis of technologies in the market. The product to be used is SW 240 Mono which is a

240 W solar panel manufactured by Solar World. The technology used in these panels is Mono-Crystalline silicone. It has the following specifications:

	STC*	NOTC**
P_{max}	240Wp	175.4 Wp
V_{mpp}	30.6 V	27.9 V
I_{mpp}	7.87 A	6.30 A

Table 2.3.5.1: Specifications of PV Modules

* Test conditions according to UL1703
** Performance at 800 W/m^2, NOCT (Nominal Operating Cell Temperature)

The total number of modules used is 209,440 units creating nominal power of 50.26 MW.

Inverters

The basic function of inverters is to convert DC electricity generated by the PV array into AC electricity. The inverter selected is the SC 800-CP model manufactured at SMA Solar Technology. The power rating of these inverters is at 800W at 50 °C and 880W at 25 °C. The specification of the inverter is as follows:

	Input (DC)	Output (AC)
P_{max}	898 kW	898 kW
Voltage Range @ 50 °C	583 V – 820 V (620V Rated)	324 V – 396 V (360V Rated)
I_{max}	1400 A	1411 A

Table 2.3.5.2: Specifications of Inverter

The modules are to be connected to the inverters in a sub-array concept. A string consists of 22 panels. 17 of these strings constitute a single connection. 10 such connections are connected to a single inverter. Therefore the total number of strings connected to an inverter is 170. The total number of inverters utilized is 56 units. The inverters are planted in close vicinity of the PV array

Transformers

A medium voltage transformer is used to step-up the voltage from 360V to 11 kV. The transformer used is the TSC 1000SC model also manufactured by SMA Solar Technology. The specifications are as follows:

	Medium-Voltage	Low-Voltage
P_{rated}	1760 kVA	
Voltage Range @ 50 °C	10 kV – 33 kV (20 kV Rated)	360 V
I_{max}	46.2 A	2 x 1283 A

Table 2.3.5.3: Specifications of Transformer

2 inverters could be connected to a single transformer. A total of 28 such transformers would be planted in close vicinity to the inverters. The transformers used in this layout are supplied by the manufacturers of the inverters thus allowing for optimum performance.

The output lines carry medium voltage electricity to specially constructed switchgear which steps up the voltage from 11 kV to 132 kV and feeds the electricity to the gridline. It has an input range from 10 kV to 33kV. The specifications are as follows:

Model: SFZ9-60000/11/132 STEP UP TRANSFORMER
Input Voltage: 11 kV
Output Voltage: 132 kV
Capacity: 60000 kVA

Computer generated simulations of the layout showed that the annual system production is 76,037 MWh/yr at an average of 208.8 MWh/day.

All the equipment complies with international standards set by the IEC. The equipment also comes with certificates that guarantee performance at temperature extremes varying from -10 °C to 50 °C and under sand dust conditions.

2.3.6 Design of Electrical Engineering

The Project has an Installed capacity of 50.26 MW, with 209,440 solar modules installed. The module to be used for power generation is the “SW240 Mono Model” which is a 240 W solar panel manufactured by Solar World, using Mono-crystalline silicon. The output lines carry medium voltage electricity to specially constructed

switchgear which steps up the voltage from 11 kV to 132 kV and feeds the electricity to the gridline.

Electrical designing of the plant has been done in view of recommendations and best practices of running Solar Power PV plants in the world. To prevent the design and installation issues discussed in research reports, system engineers have ensured that all components such as over current devices, fuses, and disconnect switches are dc rated. Metallic enclosures, junction boxes, disconnect switches, and equipment used in the entire solar power system, which could be accidentally energized are required to be grounded. NEC Articles 690, 250, and 720 describe specific grounding requirements. Equipment grounding conductors similar to regular wires are required to provide 25 percent extra ground current-carrying capacity and are sized by multiplying the calculated ground current value by 125 percent. The conductors must also be oversized for voltage drops as defined in NEC Article 250.122(B).

The modules are to be connected to the inverters in a sub-array concept. A string consists of 22 panels. 17 of these strings constitute a single connection. 10 such connections are connected to a single inverter. Therefore the total number of strings connected to an inverter is 170. The total number of inverters utilized is 56 units. The inverters are planted in close vicinity of the PV array.

A medium voltage transformer is used to step-up the voltage from 360V to 11 kV. 2 inverters could be connected to a single transformer. A total of 28 such transformers would be planted in close vicinity to the inverters. The transformers used in this layout are supplied by the manufacturers of the inverters thus allowing for optimum performance. The output lines carry medium voltage electricity to specially constructed switchgear which steps up the voltage from 11 kV to 132 kV and feeds the electricity to the gridline. Computer generated simulations of the layout showed that the annual system production is 76,037 MWh/yr at an average of 208 MWh/day.

2.3.7 Design of Civil Works

Prior to any construction activity, the site must be cleared of all debris and surface vegetation if any. The leveling and grading can be carried out by normal earth moving machine. It is recommended that immediately after excavation for construction of foundation or other substructures, the excavation bottoms and slopes are cleared of all debris, proof rolled and covered by a 5 cm thick blinding concrete layer. The onsite material is generally classified as SANDY SILTY CLAY (CL-ML) group of Unified Soil Classification System. Select fill material should consist only of inorganic material and shall have 5-20% passing the No. 200 sieve. Fill material should pass 100% the 50 mm sieve. Besides, that portion of material

passing sieve No. 40 should not have liquid limit more than 35 and plasticity index of not more than 12. Atterberg limits are not required for select fill material with less than 15% passing sieve No. 200. Select fill material shall have a carbonate content of less than 25% by weight.

The main construction activities of the Project are the foundations of the 132kV substation and the mountings for the PV modules. Detailed topographic analyses of the project site were conducted after which a structural design of the mountings was developed. Details of these designs have been provided in **Section 12**. The units have been designed to ensure easy site installations.

The inverters and medium voltage transformers provided by SMA are housed in compact and weatherproof enclosures ready for immediate outdoor set-up in close vicinity to the PV arrays.

In order to be safe, the load carrying strata must be competent to sustain the imposed loading without undergoing shear failure, and at the same time settlements of the foundations must not exceed the tolerable limits. Therefore, the load carrying characteristics of the strata must be evaluated keeping in view these two considerations. As per the information provided by the consultant, a foundation for solar panel is to be constructed at the site. Based on the type of structure, envisaged loading, type of subsurface strata and engineering analysis carried out, shallow foundation could be adopted for the intended structure. For the intended structure we recommend adopting isolated/strip footings with an allowable bearing pressure of 150 kN/m^2 (1.50tsf). Depth of foundations have been taken as 1.0m (3.28ft) below the existing investigated level which was already excavated up to 5ft from existing ground level.

2.3.8 Fire Fighting Management

In general, small-size solar power system wiring projects, such as residential installations commonly undertaken by licensed electricians and contractors who are not trained in life safety installation procedures; do not represent a major concern. However, large installations where solar power produced by photovoltaic arrays generates several hundred volts of dc power require exceptional design and installation measures.

A complete SOP for the firefighting management will be prepared duping the Procurement and construction phases, in light of the guidelines given by OEMs and the structuring of the Power Plant. The decision is based on a brief introduction to "Fire Fighting Management in Solar Power Systems, by The Fire Protection Research Foundation"

Certain basic safety precautions should be taken into account by all fire fighters on the fire ground. Determining the presence of a PV system is the key to preventing fire ground injuries. The following six points of safe operation are offered for fire fighters:

- Daytime = Danger;
- Nighttime = No Hazard
- Inform the IC that a PV system is present
- Securing the main electrical does not shut down the PV modules
- At night apparatus-mounted scene lighting does not produce enough light to generate an electrical hazard in the PV system
- Cover all PV modules with 100 percent light-blocking materials to stop electrical generation
- Do not break, remove, or walk on PV modules, and stay away from modules, components, and conduit

A photovoltaic array will always generate electricity when the sun shines. These units do not turn “off” like conventional electrical equipment. Fire fighters on the fire ground should always treat all wiring and components as energized. Breaking or compromising a photovoltaic module is extremely dangerous and could immediately release all the electrical energy in the system.

Without light, photovoltaic panels do not generate electricity, and thus nighttime operations provide an inherent level of safety. Emergency scene lighting during a nighttime fire ground operation, such as from a mobile lighting plant unit, are not bright enough for the photovoltaic system to generate a dangerous level of electricity. Light from a full moon, which is reflected light, also will not energize the photovoltaic cells. However, lightning is bright enough to create a temporary surge of electrical current.

In summary, there are several fundamental points of consideration for fire fighters and incident commanders when handling any building fire equipped with a solar power system:

- Identify the existence of a solar power system
- locate rooftop panels
- clarify electrical disconnects
- obtain system information
- Identify the type of solar power system
- Solar Thermal System
- Photovoltaic System
- Isolate and shutdown as much of the system as possible

- Lock-out and tag-out all electrical disconnects
- Isolate the photovoltaic system at the inverter using reliable methods
- Work around all solar power system components

2.3.9 Construction Management

Installation and construction of Solar PV Power Stations require many specific considerations:

- Orientation and setting of the modules to take full advantage of sun as generators of energy
- Selection, delivery and handling of fragile, state-of-the-art components
- Expertise and qualifications of system installers such as roofers, electricians and glaziers.

Prior to and during construction activities, all contractors will be required to follow three main principles:

- Conduct systematic site inspections and prepare site plans with clients
- Project managers should be skilled at specifying, receiving and safely installing valuable materials
- Ensure that all personnel engaged in construction and installation are well qualified and trained

Civil works team is required to follow certain site specific guidelines. To avoid possible attack of deleterious salts on cement, we recommend the use of Type-I cement in underground structures including foundations. To minimize corrosion potential the concrete mix should be designed using a water cement ratio not greater than 0.45. Admixtures may be required to provide workability. Concrete shall be densified using vibrators and a cover of 75mm should be provided over all reinforcing steel embedded in foundations concrete. A layer of bitumen coating should be applied to the exterior of all the foundation and other concrete coming in contact with soil.

For construction activities of the project, during the planning phase primary focus is kept on the laws and legislations of land use set by the Provincial Government of Punjab, meaning the Land acquisition Act 1984, Soil Reclamation Act 1964 and The Punjab Development of Damaged Areas Act 1952; so that all activities are carried out in a manner which do not hinder the decommissioning procedures of the project or repairing the damaged areas.

Main soil types of Bahawalpur desert are sand dunes (44%), sandy soils (37%), loamy soils (2%) and saline-sodic clayey soils (17%). The 50 MW Solar PV Power project is

exempted from all requirements of IEE and EIA as it falls under schedule II classified by the Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. However both studies were conducted and submitted to EPA Punjab which after its due diligence has issued a No Objection Certificate (NOC) to the Project. The site will be restored to the original landscape in the later phase of construction.

2.3.10 O & M Management

After the completion of its construction, the Project shall be jointly managed with the 132 kV Substation. A joint management organization will be established with the principle of requiring "few on-duty staff". After the electrical equipment and machinery have entered their stable operation mode; the solar farm and substation shall be managed with "no on-call staff and few on-guard staff'.

OEMs for Solar panels are responsible for providing the generic maintenance plans for solar panels which include cleaning. The maintenance manuals would be prepared for the utility plant. The joint management between Welt Konnect, CTGI and EPC Contractor will be required to further determine the suitable cleaning requirements for the panel. This would be done by sharing complete site information (dust, dirt, pollen and/or pollution in the site environment; the frequency of rain or snow) with the OEMs for Solar panel, and ask them for site specific cleaning plans and details for the solar panels.

Operation and maintenance team members and their qualification requirements will be dependent on the requirements presented by OEMs for equipment and components, requirements identified by EPC Contractors, Welt Konnect and China Three Gorges International Cooperation. Team structure would be dependent on the nature of approach taken towards the responsibility of O&M.

Welt Konnect, CWEIC & the EPC Contractor will jointly draft procedure and decision protocols regarding the presence of skilled engineers and technicians on site to operate the plan or control through utility from remote location. The systems of Patrol Inspection, operation guardianship, maintenance and overhaul will be established for the daily maintenance of production equipment, instruments and apparatus. These SOPs would be in-line with all requirements of International Standards of Safety, Management, Quality and Human resource management.

2.3.11 Environmental Management

A separate environment study has been carried out. Please refer to Volume 5. There are no significant hazards. The minor adjustments required during construction

phase have been addressed and mitigation plan provided. There are no settlements within 05-08 Km of the Project Site, which further supports the Project in this location. As mentioned above, the 50 MW Cholistan Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under the schedule II classified by Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. However both studies were conducted and submitted to EPA Punjab which after its due diligence has issued a No Objection Certificate (NOC) to the Project.

2.3.12 Health and Safety

During the construction and operation of the Project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personal safety of workers.

HSE personnel will be required to draft emergency shutdown procedures for the plant in collaboration with the maintenance and project department during the detailed design phase of the Project. These would include all procedures in case of fire, lightning, flood, other natural disasters, etc. The procedures would be based on the guidelines from OSHA Standards (29 CFR 1910). Further standards and guidelines will be reviewed and adopted based on the recommendations of different stake holders.

A safety and health supervision department will be established on the site, which is to be in charge of the education, training and management of safety and health related issues after the project is put into operation. There will be safety personnel in the production section, and a part-time worker for the routine safety and health work.

The systems of patrol inspection, operation guardianship, maintenance and over-haul will be established for the daily maintenance of production equipment, instruments and apparatus. The safety and health supervision department will provide appropriate inspection equipment, as well as necessary public education service for production safety.

A comprehensive safety system will be established during the preparation phase, and carefully implemented during the construction process. The systems of work sheet, operation sheet shift relief, patrol inspection, operation guardianship, maintenance and over-haul will be strictly implemented, The Safety Regulation of the wind farm will also be seriously observed to preclude accidents such as fall, fire, or electric shock.

2.3.13 CDM Aspect

Thorough work has been done to develop the Project under the Clean Development Mechanism of the UNFCCC. The Project is a power generation project with renewable resource and zero emission. When put into operation, the project can provide power supply to the southern Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. It can deliver good environmental and social benefits. It is also consistent with the spirit of the Kyoto Protocol and qualifies for the application of CDM projects', NEPRA is allowing almost the same return on equity (RoE) to the thermal and the renewable energy projects. The Sponsors of the Project require CERs to bring the RoE at a level where they can invest in renewable energy projects in Pakistan in future as well. If the project is approved and registered as a CDM project, CERs can provide slightly extra financial resource for the project it encouraging project sponsors and lenders. Besides providing minutely more favorable conditions for the project financing, it will improve competitiveness of the project, and reduce investment risk during the project implementation process.

Refer to Volume 6 for detailed studies for the Project under the Clean Development Mechanism – Project Idea Note (PIN's), Letter of Intent (LOI) by the Designated National Authority (DNA) Project Design Document (PDD's), PDD Evaluation Matrix, the Prior Consideration Form and the Host Country Approval (HCA) by the DNA of Pakistan.

1	**Location of the Solar Farm**		
1.1	Elevation	m	135
1.2	Longitude (East)		71" 49"19.6"
1.3	Latitude (North)		29" 17" 65.0"
2	Solar resource		
2.1	Annual Average Horizontal Radiation	kWh/m2/day	5.53
3	Major Equipment		
3.1	PV Modules		
(1)	Quantity	Ea	209,440
(2)	Technology		Mono Silicone
(3)	No. of cells	Ea/panel	60
(4)	Impp	A	30.6
(5)	Vmpp	V	7.87

(6)	Rated Power	Wp	240
3.2	Inverters		
(1)	Quantity	Ea	56
(2)	Pmax	Wp	880
(3)	Input Voltage	V	673
(4)	Input Imax	A	1338
(5)	Output Voltage	V	363
(6)	Output Imax	A	1400
3.3	Medium Transformers		
(1)	Quantity	Ea	28
(2)	Pmax	Wp	1760
(3)	Input Voltage	V	363
(4)	Input Imax	A	2 X 1400
(5)	Output Voltage	kV	11
(6)	Output Imax	A	46.2
3.4	High Voltage Transformer		
(1)	Quantity	Ea	1
(2)	Capacity	kVA	60000
(3)	Input Voltage	kV	11
(4)	Output Voltage	kV	132
(5)	Frequency	Hz	50
(6)	Phase	Ea	3
4	Civil Engineering		
4.1	PV Module Mountings	Simple truss structures for immediate installation at site	
4.2	Foundation for High Voltage Substation		
5	Construction		
5.1	Construction Period	month	9
6	Production Analysis		
	Annual Benchmark Energy Yield	GWh/yr	76.03
7	Budgetary Estimates		
7.1	EPC Cost	Min US $	89.63
7.2	Total Project Cost	Min US $	99.216062
7.3	O&M Cost for Year 01 – 02	Min US $	2.044
7.4	O&M Cost for Year 03 – 05	Min US $	2.044
7.5	O&M Cost for Year 06 – 20	Min US $	2.044

8	Referenced Levelized Tariff		-
8.1	Levelized Tariff	US Cents / KWh	18.4568

Figure 2.3.13.1: Project Technical and Financial Summary

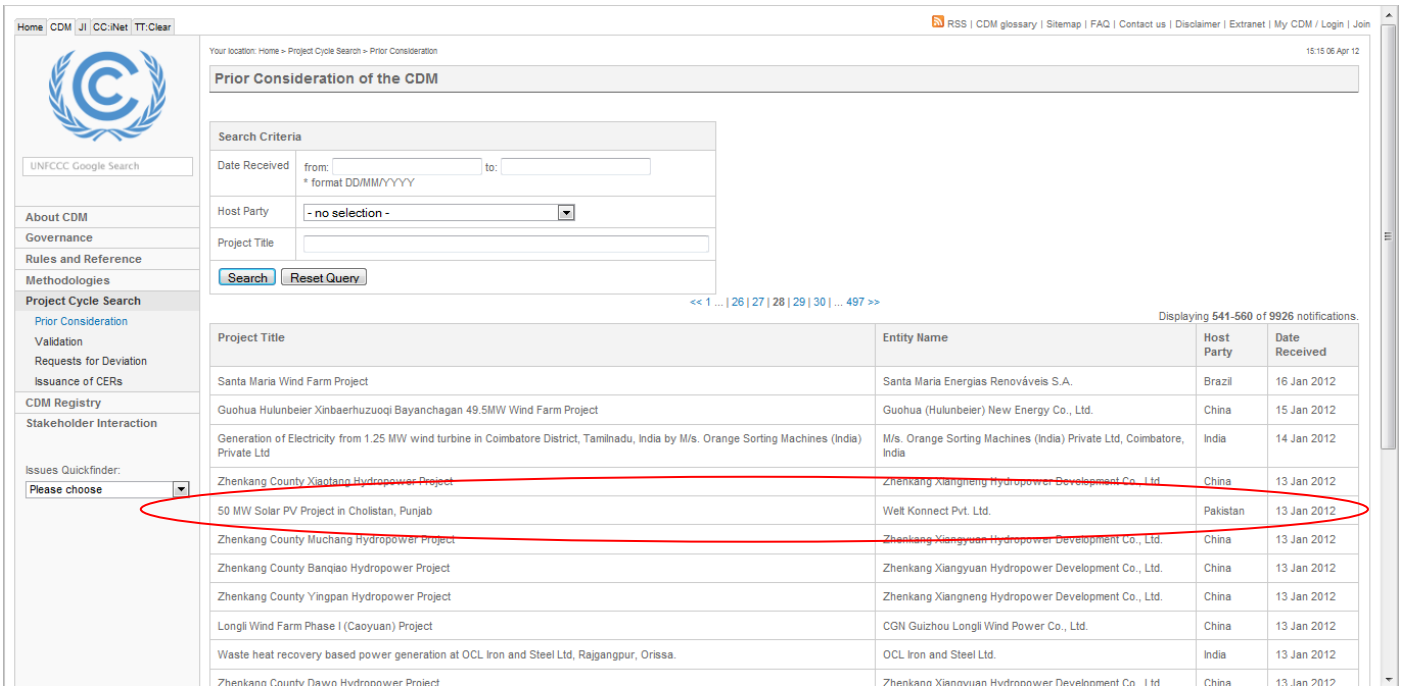


Figure 2.3.13.2: Listing on UNFCCC Website Snapshot

2.4 Rational for Solar power

Pakistan's major electricity sources are thermal and hydro generation, meeting approximately 70% and 28% (respectively) of the country's annual electricity demand. The primary thermal generation fuels employed are furnace oil and gas. While both are produced domestically, demand already outstrips supply by a considerable amount. Oil import is a significant burden on the national exchequer and the increasing import bill continues to exert further pressure on the foreign exchange reserves.

Import of gas could be seen as a viable option to overcome the depleting domestic reserves but gas import has significant issues, mainly the need for substantial capital investment in infrastructure, security difficulties and physical terrain concerns. Moreover, it would increase Pakistan's reliance on imported fuels with associated foreign exchange effects. This must be considered in the context of rising fuel costs for gas and oil-based fuels as a result of uncertainty over future supply.

Alternatives to further fuel imports for electricity generation are the use of domestic coal, co-generation from hydro-electric or other renewable sources, such as Solar Power. These options will assist in reducing Pakistan’s reliance on imported oil, and consequent vulnerability to changes on global oil prices which will in turn have a positive effect on the current trade deficit and inflating import bill. As with gas, securing future supplies of coal and hydro-electric power would rely on significant spending on infrastructure. Pakistan has domestic reserves of coal. However, coal currently makes up a very small proportion of total generation, largely the result of most of the reserves being located in one area, the Thar Desert. Exploiting the reserves would require huge and costly upfront investment in local infrastructure (including provision of water supplies), development of mines, housing and related infrastructure, and investment in transmission lines before power plant development could commence. Hydroelectric power already supplies almost 30% of electricity, and numerous sites for future investment exist but due to their locations, this would also require significant investment in transmission to meet the expected power needs. Moreover, there are varying political stands on hydro-electric power options.

Looking at how the country's future electricity needs might be met in a way that supports the environmental objectives of the Government of Pakistan, Solar Generation has the potential of being a strong contributor. The development of Solar Power generation projects could reduce dependence on fuels for thermal power generation, increase diversity in Pakistan's electricity generation mix, and reduce greenhouse gas (GHG) emissions avoiding thermal power generation. Also

the per kWh tariff for Solar Power projects are now comparatively less than that of furnace oil tariff; particularly the rental power projects.

In addition Solar PV Power Projects have the benefit of supplying electricity in a decentralized manner to areas "where it is required", as the resource is not constrained by geographic locations', Solar Power can be generated in almost all parts of the country which enjoy high Irradiation levels of almost 5.8Kwh/m2 on average.

2.5 Country overview

Pakistan is located on the western stretch of South Asian Subcontinent with Arabian Sea in the south, China in the north, India on the east, Afghanistan and Iran on the west It covers an area of 796,000 km^2 and has a coastal line of 980km. Almost 3/5th of Pakistan's total area is mountains and hills, deserts spreading along the southern coastal areas, and plateau pastures and fertile agricultural land stretching north. The Indus River, which originates from China, traverses 2300km from north to south into the Arabian Sea.

Pakistan has a tropical climate. It is hot and dry in most of its areas, with relatively high average annual temperature. The southern coastal areas have an average yearly temperature of 26°C. Most areas show temperatures higher than 40°C around noon in June and July. Some parts of Sindh and Baluchistan even have temperatures higher than 50°C. The yearly precipitation in Pakistan is less than 250 mm; with 1/4th of Pakistan having annual rainfall less than 120 mm. Pakistan is under great influence of monsoon from Indian Ocean, which brings both precious rain and abundant wind energy resources.

2.6 Industry overview

2.6.1 INTRODUCTION

The series of years of vigorous growth of the world-wide PV market, even during times of financial and economic crisis, has continued in 2011. The volume of new grid-connected PV capacities world-wide rose from 16.6 GW in 2010 to 27.7 GW in 2011. Almost 21 GW of this growth can be accounted in Europe.

2.6.2 MARKET REPORT 2011

The global PV market in 2011: 27.7 GW of new plants connected to the grid

Globally, PV systems connected to the grid rose from 16.6 GW in 2010 to 27.7 GW in 2011. The number of markets reaching more than 1 GW of additional capacity during 2011 rose from 3 to 6. In 2010 the top 3 markets were Germany, Italy and the Czech Republic; in 2011 Italy leads the ranks and Germany, China, the USA, France and Japan follow, each with over 1 GW of new capacity.

The European share in the global PV arena still remains predominant with more than 75% of all new capacity in 2011. The 2 biggest markets, Italy and Germany, account for nearly 60% of global market growth during last year.

Increasing the PV momentum by adding additional markets of important growth can be considered the single most important achievement on the continued growth track of world-wide PV development. And yet, many of the cited markets, in particular China, the USA and Japan, but also Australia and India, have addressed only a very small part of their enormous potential; several countries from large sunbelt regions like Africa, the Middle East, Asia and South America are on the brink of starting their development.

Total installed PV capacity world-wide reached over 67.4 GW at the end of 2011. PV is now, after hydro and wind power, the third most important renewable energy in terms of globally installed capacity. The growth rate of PV during 2011 reached almost 70%, an outstanding level among all renewable technologies. The total energy output of the world's PV capacity run over a calendar year is equal to some 80 billion kWh. This energy volume is sufficient to cover the annual power supply needs of over 20 million households in the world.

In Europe, over 50 GW of PV systems were installed at the end of 2011. With growing contributions from Southern European countries, the average load factor of

this capacity is increasing and will produce some 60 billion kWh on an annual basis, enough energy to supply over 15 million European households.

2011 also highlighted a peculiar feature of fast growing markets: the final numbers on grid connected capacities are communicated in several markets only around March. On the back of very strong growth contributions during the last quarter of the previous year, they then need to be revised upwards. In addition, specific regulation in Italy and France created strong installation growth in 2010; however the grid connection was to be counted only in 2011. Although this effect is not new, it reached between 3 and 5 GW of installations made in 2010 with grid connection taking place in 2011.

The following table 2.6.2.1 shows the top 15 markets world-wide, both in terms of newly connected capacity during 2011 and cumulative installed capacity at the end of the year. European countries are marked in orange.

	Country	2011 Newly connected capacity (MW)	2011 Cumulative installed capacity (MW)
1	Italy	9,000	12,500
2	Germany	7,500	24,700
3	China	2,000	2,900
4	USA	1,600	4,200
5	France	1,500	2,500
6	Japan	1,100	4,700
7	Australia	700	1,200
8	United Kingdom	700	750
9	Belgium	550	1,500
10	Spain	400	4,200
11	Greece	350	550
	Slovakia	350	500
13	Canada	300	500
	India	300	450
15	Ukraine	140	140
	Rest of the World	1,160	6,060
	Total	**27,650**	**67,350**

Table 2.6.2.1: Top 15 Markets

The market share of the world's top 10 markets is highlighted in Chart 2.6.2.1. These top 10 markets make up over 90% of the entire PV growth world-wide.

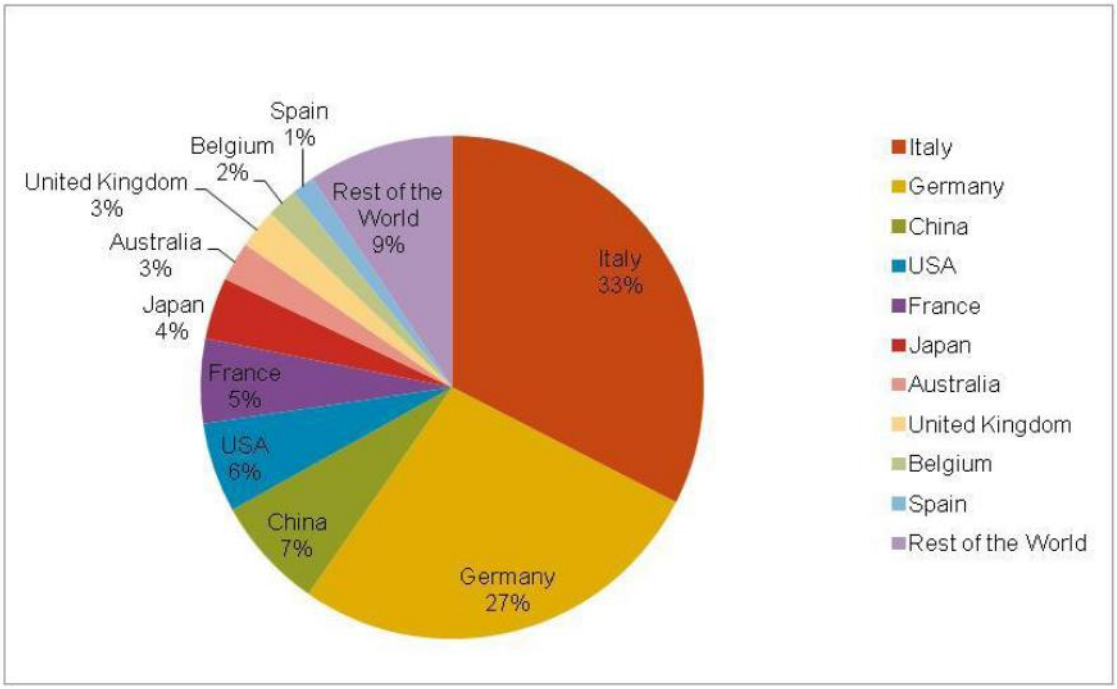


Chart 2.6.2.1: Top 10 markets

Figure 2.6.2.1 reveals the evolution of global cumulative PV capacity since the year 2000 and also indicates the market growth contributions from Europe (orange) and from all other markets (yellow).

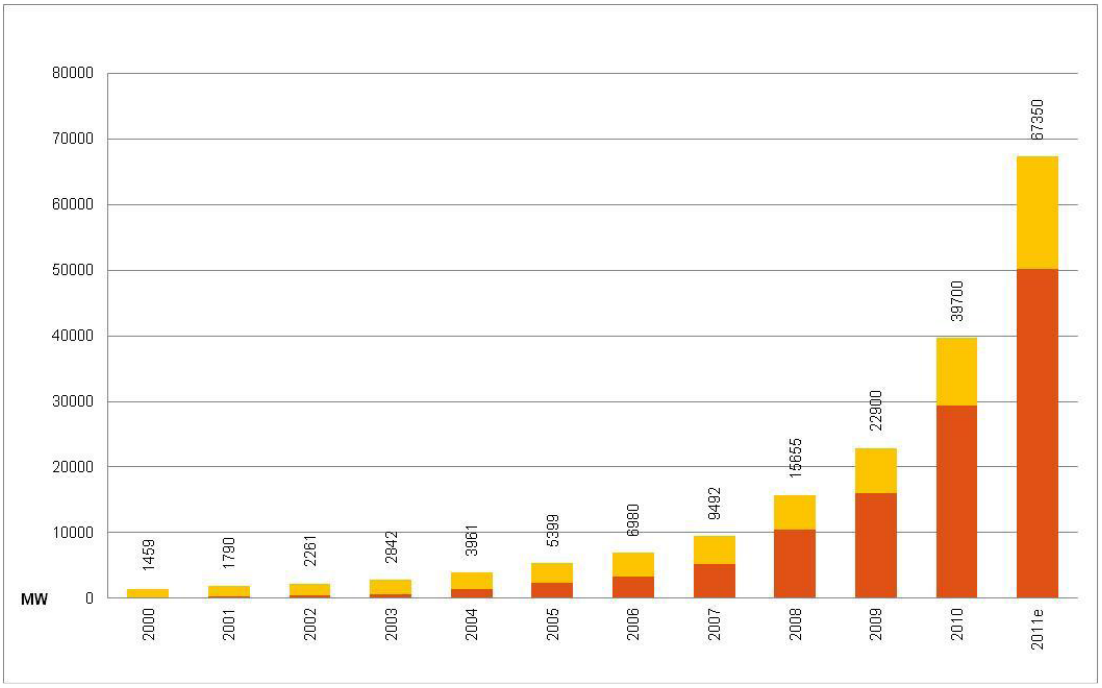


Figure 2.6.2.1: Evolution of Global PV Capacity

European markets: GW markets" and an all-time record for Italy

With almost 21 GW of grid connected PV installations in 2011 Europe has increased its cumulative capacity base by over 50%. This impressive figure is mainly driven by 3 markets: Italy, Germany and France.

Italy became for the first time the top PV market with 9 GW of newly connected systems in 2011 (compared to 2.3 GW in 2010). A substantial portion of these new connections were part of a rush of installations that took place at the end of 2010. The reason for this unusual concentration was the adoption of a decree allowing for systems installed by the end of 2010 but connected by mid-2011 to benefit from the more advantageous 2010 Feed-in Tariffs (FiT). This decree, known under the umbrella name "Salva Alcoa", allowed 3.5 GW of installations to benefit from these exceptional conditions.

At the beginning of 2011, Italy's 3rd *Conto Energia* registered 1.5 GW of newly connected systems. The 4th *Conto Energia* entered into force at the beginning of June 2011, and despite its stricter conditions and reduced FiT, it allowed for the connection of almost 4 GW in only 7 months.

As for **Germany**, a very strong last quarter propelled total 2011 market growth to 7.5 GW. 2011 started slowly with harsh weather conditions and small capacity additions due to lower FiT. From March, installations started to rise and reached up

to some 600 MW in the months of June and July. Unlike the previous year there was no reduction of the FiT in July.

France saw 1.5 GW of new systems connected last year, mainly a result of installations done in 2010. Only less than 10% of this capacity was installed during 2011. The new legal framework allows systems of up to 100 kW only to benefit from a remunerative FiT level, whilst larger projects had to wait until the summer to apply for several types of call-for-tender schemes. The new support framework aims to limit the annual market size to 500 MW.

The extremely long grid connection process in France can take up to 18 months. The important FiT cuts and long grid connection lead times explain why new installations were at a poor level during 2011, whilst grid connections reached a record high of 1.5 GW in 2011.

The **UK** also delivered a surprising development during 2011, reaching unprecedented growth of some 700 MW. In April 2010 a new FiT scheme was introduced and immediately followed by enthusiastic market development. The reaction was so positive that after only a few months several stakeholders sought to curtail this rapid growth. This was confirmed in January 2011 with the introduction of a "fast track review" which led to a strong reduction of all FiT for PV systems over 50 kW. This led to a rush of projects seeking grid connection before the deadline. The awaited FiT cut was followed by another intervention announced at the end of October 2011 affecting smaller PV systems, leading to another massive rally for grid connection in 2011.

Other key markets in Europe were **Belgium** (550 MW), **Spain** (400 MW), **Slovakia** (350 MW) and **Greece** (350 MW). In Belgium the Flemish market boomed again in 2011 despite reduced support schemes while the Walloon market reached 100 MW, highly concentrated in the residential sector. Spain has not made particular progress since the halt of the market at the end of 2008. Slovakia drastically reduced its support to PV in mid-July, stopping the market after a rapid growth in the first 2 quarters of the year. Finally, the Greek market progressed in particular in the residential segment where some 60 MW were connected last year.

The **Czech Republic**, after 2 hectic years that saw PV installations reach 2 GW has disappeared from the PV map; with less than 10 MW of new PV installations as a result of strong opposition from major stakeholders.

Some other EU countries are progressing with yet limited capacities, with Austria reaching 100 MW and Bulgaria some 80 MW during 2011.

PV markets outside Europe: China ahead, several markets growing importantly

Outside Europe, **China** will probably rank first in 2011, with at least 2 GW of new PV systems installed and connected. The market was pushed thanks to the deployment of FiT at provincial level. Rapid growth was also seen in the **USA**, with at least 1.6 GW of newly connected systems. This is nearly double the 2010 market figures.
Behind those 2 leaders, **Japan** is expected to have connected over 1 GW of PV systems in 2011 benefiting from the revised FiT scheme. In Asia-Pacific, the performance of **Australia** was impressive, with some 700 MW of new installations in 2011. **India** installed over 300 MW during last year.

Sizeable contributions came also from 3 other markets in different parts of the world: 300 MW from **Canada**, 140 MW from **Ukraine** (2 large plants) and 130 MW from **Israel**. In 2010, 80% of global PV system connections were counted in Europe; in 2011, Europe's share declined to 75%.

2.6.3 MARKET SUSTAINABILITY: AN INDUSTRY AT THE CROSSROADS

2011 saw prices going down rapidly due to increased economies of scale, production efficiency and – in particular – a strong supply overhang compared to demand.

The PV industry is at a crossroads. Whilst European markets have always outpaced home production, this will presumably no longer be the case in the years to come. At the same time, massive capacity build-up concentrated in Asia has not yet led to a sustainable growth momentum in local markets and is far from being in tune with its enormous production power.

There may be at least 3 hints with regard to the future direction of the PV industry. Firstly, large producer countries will need to activate their home markets, placing a larger share of their production locally. Secondly, with enormous potentials still untapped in almost all continents, new markets will have to be opened up to drive PV development in the coming decade just as Europe accounted for it during the last decade. Finally, the principles of open markets and fair competition should be recalled and will certainly require more attention in the future.

EPIA will follow these guidelines and lobby for an ever-growing share of PV power to be fed and integrated into our energy systems. Prompt release of reliable market data is an elementary tool to better respond to all challenges our industry will face in the months and years to come.

Summary table	2010		2011	
	EU	World	EU	World
Newly connected PV systems (GW)	13,3	16,6	20,9	27,7
Year on Year growth	N/A	N/A	57%	67%
EU share in the World	80%		75%	
Cumulative installed capacity (GW)	29,4	39,7	50,3	67,4
Year on Year growth	N/A	N/A	71%	70%
EU share in the World	74%		75%	
% electricity demand	1,15%	0,25%	2%	0,5%

2.7 Project team

2.7.1 The Project Company

A special purpose Limited Liability Company (LLC) shall be incorporated in accordance with the laws and policies of Pakistan for development, construction and operation of the Project as an Independent Power Producer (IPP).

2.7.2 The Main Sponsor: China Three Gorges International Corporation & CWE Investment Corportation

www.ctg.cn

As a large international clean energy company, China Three Gorges (CTG) has main businesses including: construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, initially starting with water conservancy & power projects, has now expanded its scope of business into Power Production through Wind, Solar and Nuclear Energy, with the vision of being the World's largest clean energy group specializing in large-scale hydropower project development, management and operations; while also proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The Total assets of the Group stand around 41,316 million USD, with a revenue generation of 3,787 million USD, 99.47% from sales of electricity, and 1,418 million USD net profits.

Whereas CWE Investment Corp. (CWEIC) *is a new overseas-investment subsidiary company of CTG,* which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CWEIC has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CWEIC is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include Sonda Jehrruk Coal Mine & Power Generation, 1100 MW Kohala Hydropower Project, 720 MW Karot Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

CTG has 11 wholly-owned and majority-stake subsidiaries. As a public company, China Yangtze Power Co. Ltd (CYP) is the primary subsidiary of CTG in charge of electricity generation and management. CYP has 26 generation sets that have been launched into operation in Gezhouba Power Station and TGP. China Three Gorges New Energy Co., Ltd mainly specializes in on-land wind power developments. Yangtze New Energy Development Co., Ltd mainly specializes in development of wind power on the eastern coast of China. Inner Mongolia Hohhot Pumped Storage Power Station Co., Ltd mainly engages in the construction and operation of Hohhot Pumped Storage Power Station. China International Water & Electric Corporation is CTG platform for international cooperation. Yangtze Three Gorges Technological & Economic Development Co., Ltd. mainly engages in project management, counseling and supervision work. Three Gorges Financial Co., Ltd. is a non-banking financial institution that provides services exclusively to CTGPC and its affiliates. Yangtze Three Gorges Investment Development Co., Ltd. mainly specializes in investments and management. Three Gorges Tourism Development Co., Ltd mainly specializes in tourism development and hotels management. Yichang Three Gorges Engineering Duoneng Company mainly specializes in asset disposal. Yangtze Three Gorges Land General Electric Co., Ltd. mainly specializes in developing total solutions of control equipment.

2.7.2.1 Main International Projects of CTG

CTGPC manages the construction and operation of the Three Gorges Project. The construction of the Three Gorges Project was officially launched on December 14, 1994, followed by successful river closure on November 8, 1997. The project's initial water storage, navigation and power generation targets were fulfilled in 2003. In 2009, except for the ship lift, whose construction was postponed with Central Government's approval, all construction tasks set in the initial design were completed on schedule, and the project passed the final inspection before water storage reached the 175-meter level. This particular year marked the project's transition from construction to operation, ushering in the delivery of comprehensive benefits in flood and drought control, power generation, navigation, and water supply.

The Central Government has authorized CTGPC to develop the hydroelectric resources in the mainstream and tributaries of the upper reaches of the Yangtze River and to build four massive hydropower plants at Xiluodu, Xiangjiaba, Wudongde, and Baihetan. The construction of the hydropower plants at Xiluodu and Xiangjiaba began in 2005 and 2006, respectively; these projects are expected to become operational in 2013 and 2012, respectively. Pre-construction surveys and designs are currently underway for the two hydropower plants at Wudongde and

Baihetan. The four hydropower plants will have a combined total installed capacity of 385 MW and will produce 175.3 TWh of electricity per year

2.7.2.2 Major Projects completed by CTG in Pakistan

Chances are very bright for the development of alternative energy resources/projects in the country. Many Chinese companies have already offered their assistance in this regard. China has also offered to start construction of 50 MW wind power project in Jhampir (Sindh) and which will be completed in 2012. Furthermore it has also planned to install 2000 MW wind power. China has also planned to invest in the 300 MW solar power projects in Pakistan.

Hydro-power Projects in Pakistan are passing through a severe energy crisis. Pakistan badly needs construction of big and small hydro-projects in the country to overcome the persisting energy shortage. The projects of hydropower i.e. Kohala Hydro Power (1100 MW), Bhunji (7100 MW), Bhasha, Dashu in Upper Indus Valley, and other Hydro Power projects in lower Indus valley were thoroughly discussed most recently with the Chinese representatives of public-private sector. China Three Gorges Project Corporation (CTGPC) signed an agreement with a private Pakistani firm, Associate Technologies (Private) Limited to invest $1.2 billion in 720 MW Karot Hydropower Project. The Karot project would be completed in four years and help Pakistan to overcome load-shedding problem.

The extended bilateral energy cooperation also consists of ongoing wind projects namely Karachi first wind farm, Karachi second wind farm and Punjab wind and solar projects are at its advanced stages. The government of Pakistan also shows its intention to build a run of the river hydro project at Sukkur Barrage with China Three Gorges Project Corporation. Moreover, Joint Development agreement was due to be month for the 120 Megawatt Taunsa Hydroelectric projects where the discharge is 10,000 cusecs is ready for joint development agreement

2.7.3 The Sponsor: Welt Konnect (Pvt) Ltd

www.weltkonnect.com

Welt Konnect (Pvt) Ltd (a subsidiary of the Transtech Group) is a Power Project Developer working in Pakistan. Its niche in the Alternative Energy sector lies in the provision of Renewable Energy Engineering particularly Wind & Solar Projects as Independent Power Producers (IPP's), various commercial applications & CDM projects. These integrated systems are designed, simulated and tested by its team of experts and engineers' using the most advanced software's and tools the industry has to offer at this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in this ever growing field of Renewable Energy.

In today's world, access to latest Technology & Power Requirements is no longer a privilege but has become a basic necessity of life and as digital natives of the 21st century it is our duty to facilitate the provision of Technological Advancement to the people of under-developed regions to bring them at par with citizens of other developed countries in term of access to Engineering Technology and Clean Sustainable Energy with this objective in mind Welt Konnect Pvt Ltd was established by the Transtech Group to achieve and support this cause by rendering innovative and cost effective services with utmost vigor and enthusiasm to its customers and partners across the globe.

With a highly professional, experienced and talented team, along with the Groups invaluable foreign associates, Welt Konnect is uniquely positioned to excel and cater to the diverse and ever changing needs of the Energy Sector of Pakistan.

With a number of ongoing and completed Hydro, Wind and Solar Power Generation Projects, TransTech Group is making leaps in the Renewable Energy Sector of Pakistan.

Under the Group's flagship, Welt Konnect (Pvt) Ltd is already well on its way to develop Pakistan's First 50 MW Solar Power Plant in the Cholistan Desert of Punjab, Pakistan. The Group is undertaking similar projects in other parts of the country which will in time prove to be pioneers of the Renewable Energy Sector in Pakistan.

2.7.4 M.R. Consultants

www.mrconsultant.pk

M.R. Consultants is the overall Project Consultant and coordinated all the project development activities. The scope of work for M.R. in Project includes the feasibility

study, coordination with all project development teams, tariff petition and energy purchase agreement.

M.R. provides consultancy services in the fields of Renewable Energy (RE), Energy Efficiency (EE) and Environment. M.R. provides high quality energy engineering and management consulting services to enable rapid deployment of efficient, cost-effective, reliable, and environment-friendly renewable energy systems. Our customized technical solutions and services are dedicated to investment firms, energy groups, industries, financing institutions and public authorities involved in the development and/or acquisition of renewable and thermal power plants.

These services are backed with in-depth grip on technical, financial and administrative aspects at every stage that enables us to employ best practices in project development. This ultimately leads to implementation in accordance with the most efficient planning, which is a vital element in power projects in order to save unnecessary and huge overheads during execution.

The M.R. team also has the expertise to deal with the legal aspects of power projects including Generation License, Tariff Application & justification, Energy Purchase Agreement and Implementation Agreement. The professional team of M.R. is well acquainted with the policies, regulations, methodologies and standards of the complete power projects cycle.

2.7.5 China Electric Equipment Group (CEEG) and CEEG Solar Institute (CEEG SI)

www.ceeg.cn

CEEG (China Electric Equipment Group Corporation), headquartered in Nanjing, China, has its origin from a State Energy Ministry supported enterprise. Jiangsu Zhongdian Equipment Manufacturing Co., Ltd was founded in 1990 and then re-organized into the China Electric Equipment Group Corporation in 2003. It now owns four major industries, including power transformer, PV technology, insulation materials and complete substation. Besides, it has 15 share-holding or wholly-invested subsidiary companies in Jiangsu, Shanghai, Jiangxi and Hong Kong etc. On May 18, 2007, China Sunergy was listed on the American NASDAQ Stock Market (Stock code: CSUN), thus became the first enterprise going public on NASDAQ from Nanjing area.

CEEG holds “foresight, innovation and responsibility” as its core values. It has been awarded in succession with the following honors – China Top Brand, National Inspection-free Product and China Well-known Trademark etc. It is also chosen as a National 4A Grade Well-standardized Enterprise, National Environment-friendly

Enterprise and National AAA Grade Credit Enterprise etc. CEEG, insisting on the strategy of "going with the giants and keeping pace with the world", has successively established long-term strategic cooperation with many excellent enterprises both in China and abroad, including Dupont USA, Schneider France, DSI USA, MKM Germany, and Wuhan Iron and Steel (Group) Corp. China etc.

CEEG's power transformers and PV products have been qualified for CCC, UL and EU three product characteristic tests and many certifications such as IEC, CE, TUV and China Environment Labeling certification etc. CEEG's series of transformers have been utilized in numerous state major construction projects, such as Beijing Olympic Center, Beijing Capital International Airport, Shanghai Yangtse River Tunnel Project, State Manned Spaceflight Project, Xiaolangdi Hydropower Complex Project, Inner Mongolia Huitengshile Wind Power Station, Shenzhen-Hong Kong Sea-crossing Bridge and Suzhou World Heritage Conference etc. CEEG's PV solar energy industry, depending on the internationally advanced solar energy specialists, has been continuously taking lead in solar element conversion efficiency in the PV industry. After establishing complete photovoltaic industry chain, CEEG demonstrates obvious competitiveness in R&D of solar elements and modules and EPC of solar system projects. CEEG's PV industry has undertaken and is undertaking a lot of key scientific projects for state Eighth, Ninth, Tenth and Eleventh Five-Year Plan, and has established Sino-American, Sino-Italian, Sino-European, Sino-Spain and Sino-Japanese and many other international cooperation projects in the meantime. To grasp the future with foresight and insight, innovate on values and overthrow rules – with such ideas, CEEG is now facing the world and becoming more internationalized and brand-oriented on the basis of intension and standardization, actively getting listed in the world top-ranking electric and new energy enterprises and "powering our way into the world!"

Whereas CEEG SI (CEEG Solar Energy Research Institute Co., Ltd.) is comprehensive new energy system supplier with international advanced level which is founded by CEEG Group for wide application of worldwide solar & other new energy technology and great advancement for worldwide energy revolution. CEEG SI has a research team with abundant technical strength and work experience leaded by Zhizhang Liu who is the chief scientist on new energy application and Doctor Jianhua Zhao who keeps the world record (25%) in laboratory photoelectric conversion efficiency of P - type silicon solar cell.

CEEG SI provides a complete set of system solutions of 9 new energy application areas, and gives the service about system research, design, consultation and construction which mainly focuses on photovoltaic system and also contains new energy relevant products (incl. photo-thermal, wind power generation, water conservancy, ground source heat pumps, biomass energy, and tidal energy). As earlier domestic system supplier who has paid great efforts to R&D and market

promotion, CEEG SI undertakes and finish multiple project both national key technologies research and development program of china and international collaboration programs one after another.

CEEG SI has undertaken the first BIPV on-grid project in 4 provinces in China successfully, and it is the international training centre for solar application in developing country assigned by ministry of science and technology (MOST), the new energy workstation for Post doctor student in Jiangsu province, the managing unit for engineering center of module preparation and control system in Jiangsu province. CEEG SI has better popularity and influence both at home and abroad, and especially it gains more achievements in research and application of solar energy photovoltaic generating system.

CEEG SI has the honor to have undertaken electrical studies of many solar power projects in China. CEEG SI has a team of highly skilled and experienced professionals having worked in Chinese Power Industry, in the fields of Power System Analysis, Transmission Planning, Load-Forecasting and Generation Planning. The professional experience spreads over the whole range of operating voltages viz. 765 kV, 500 kV, 380 kV, 220 kV, 132 kV, 116 kV, 66kV and 33 kV.

CEEG SI possesses the technical skills to perform Load Flow, Optimal Power Flow, Short Circuit Analysis, Dynamic and Transient Stability Analysis for a grid system of any size.

The professionals of CEEG SI possess thorough hands-on experience on the latest, state-of-the-art tools of power system analysis.

2.7.6 AJK Surveyors (www.ajk.net.pk)

AJK Enterprises was established on 27th May, 2004 as a leading company of Professionals having rich experience in providing expert services such as civil works construction, reconnaissance visit to sites for on-the-site appraisal of site conditions, preparation of the most economical subsoil investigation programs, laboratory testing, evaluation of field data and laboratory test results including static and dynamic soil/design parameters.

AJK Enterprises can undertake the entire construction scope of a project. They have an effective management that can deliver projects as per contract requirements.

They are adept at handling heavy civil works for infrastructure projects. This expertise extends from earthworks to high-quality finishes. The civil team has a proven track record in completing ‘fast track’ projects consisting of infrastructure

development. AJK Enterprises provides geotechnical services that require technical interpretation of the geotechnical investigations. AJK Enterprises has professional staff specific for the geotechnical investigation and interpretation works. AJK Enterprises has a team of surveyors who are experienced and professional in their field. With proper team work their surveyors can go for challenging tasks related to surveying and topographical mapping. They have state of the art equipment and tools to do the job to the satisfaction of the client. In the recent years they have completed a number of projects related to topographical surveys.

2.7.7 Solar World

http://www.solarworld-usa.com

The Solar Modules used in the analysis of the Project are of Solar World.

With about 3,300 employees, the **SolarWorld** group is one of the world's largest solar energy businesses – and the largest U.S. solar manufacturer for more than 35 years. In its innovation, performance and environmental track record, the company is an industry leader. SolarWorld's family of companies dedicates itself exclusively to the business of solar energy. Plus, it combines all stages of the photovoltaic value chain, from the raw material silicon to turn-key solar power plants, so that it can uphold high quality and environmental standards at every stage.

SolarWorld operates factories in the United States and Germany as well as sales offices in all of the world's solar markets. The SolarWorld group offers products ranging from crystalline silicon ingots, wafers, cells and panels for grid-tied and off-grid power generation. The main building blocks are high-performance mono-crystalline and polycrystalline SolarWorld Sun module™ solar panels and custom-designed Sunkits® solar systems.

Sunkits solar systems enable installation firms to offer reliable, cost-effective systems, featuring tailor-designed rooftop solar arrays and everything installers need to complete a system, delivered directly to end consumers.

2.7.8 SMA

http://www.sma-america.com

The inverters and medium voltage transformers used in the modeling of the Project are of SMA.

SMA Solar Technology AG is the worldwide market leader for solar inverters, a leading supplier of transformers and chokes, and a provider of innovative energy supply solutions for mass transit and main-line rail transportation.

The inverter is technologically the most important component in any solar power system: it converts the direct current generated in photovoltaic cells into alternating current suitable for the grid. In addition, it is an intelligent system manager, responsible for yield monitoring and grid management. SMA Solar inverters are characterized by a particularly high efficiency of up to 99 %, which allows for increased electricity production. The multi award-winning product range covers solar inverters for roof systems, major solar projects and off-grid systems, enabling SMA to provide a technically optimized inverter solution for all size categories and system types. Its range of services is complemented by a worldwide service network. SMA's business model is driven by technological progress. The highly flexible manufacturing plants for solar inverters in Germany and North America have a capacity of approximately 11.5 GW a year. The SMA Group also operates a manufacturing plant for electromagnetic core components in Poland. Due to its flexible and scalable production, SMA is in a position to quickly respond to customer demands and promptly implement product innovations. This allows the Company to easily keep pace with the dynamic market trends of the photovoltaic industry and at the same time absorb short-term fluctuations in demand for solar inverters.

SMA Solar Technology AG is headquartered in Niestetal, near Kassel, and is represented in 19 countries on four continents. The Group employs a staff of over 5,300 worldwide, plus a number of temporary employees which varies on a seasonal basis. In recent years, SMA has received numerous awards for its excellence as an employer and in 2011 reached first place in the federal "Great Place to Work" competition.

Since June 27, 2008, the Company has been listed in the Prime Standard of the Frankfurt Stock Exchange (S92), and since September 22, 2008, the Company's shares have been listed in the TecDAX. In 2010, SMA generated sales of 1.9 billion euros.

3. COUNTRY PROFILE

3.1 General Overview

Area: 796,096 km^2
Population 165,000,000 (Approx.)

Located in South Asia, Pakistan, officially the Islamic Republic of Pakistan (Urdu: Islami Jumhuriyah Pakistan), shares an Eastern border with India (2,912km), a North-Eastern border with the People's Republic of China (523krn), a South Western border with Iran (909km) and a Western and Northern edge with Afghanistan (2,530km). The Arabian Sea is Pakistan's southern boundary with 1,064 km of coastline.

The name 'Pakistan' means 'Land of the Pure' in Sindhi, Urdu and Persian. It was coined in 1933 by Choudhary Rahmat Ali, who published it in the pamphlet "Now or Never". The name was coined from the names of five territories that were proposed as constituents of a separate country for the Muslims of British India. Officially, the nation was founded as the "Dominion of Pakistan" in 1947, and was renamed as the Islamic Republic of Pakistan in 1956.

The country has a total area of 796,940 km' and is nearly four times the size of the United Kingdom. From Gwadar Bay in south-eastern comer, the country extends more than 1,800 km to the Khunjerab Pass on China's border

The Indus Valley civilization, one of the oldest in the world and dating back at least 5,000 years, spread over much of what is presently Pakistan. In February 2008, Pakistan held parliamentary elections and in September 2008, after the resignation of former President MUSHARRAF, elected Asif Ali ZARDARI to the presidency.

Agriculture accounts for more than one-fifth of output and two-fifths of employment. Textiles account for most of Pakistan's export earnings, and Pakistan's failure to expand a viable export base for other manufactures has left the country vulnerable to shifts in world demand.

Over the past few years, low growth and high inflation, led by a spurt in food prices, have increased the amount of poverty - the UN Human Development Report estimated poverty in 2011 at almost 50% of the population. The government agreed to an International Monetary Fund Standby Arrangement in November 2008 in response to a balance of payments crisis.

Although the economy has stabilized since the crisis, it has failed to recover. Foreign investment has not returned, due to investor concerns related to governance,

energy, security, and a slow-down in the global economy. Remittances from overseas workers, averaging about $1 billion a month since March 2011, remain a bright spot for Pakistan.

Located in South Asia, Pakistan, officially the Islamic Republic of Pakistan (Urdu: Islami Jumhuriyah Pakistan), shares an Eastern border with India (2,912km), a North-Eastern border with the People's Republic of China (523krn), a South Western border with Iran (909km) and a Western and Northern edge with Afghanistan (2,530km). The Arabian Sea is Pakistan's southern boundary with 1,064 km of coastline.

4. PAKISTAN ENERGY MARKET

It is hard to believe that only seven years back, in 2004, Pakistan had 30% surplus in generating capacity compared with demand. There were discussions at that time of exporting even the surplus to India. And now in August 2011, power shortage has reached 7,000 Megawatt (MW), about 40% of the demand, which has resulted in 10 hours of load shedding in urban areas and much more in rural areas. According to the prevailing circumstances, the situation is going to worsen in future.

Up till 2003-04 the countrywide power demand growth was only 3%-4% per year, but rose to 10% in 2007-08 following a high economic growth**.** The 2005 Medium-Term Development Plan targeted an installed capacity of 27,420 MW by June 2010. However the actual capacity in June 2010 was only 20,651 MW, with a shortfall of 6,769 MW (25%). About 4,670 MW of capacity was added to the system between 2000 and 2010 of which only 1,619 MW was from hydro, including Ghazi Barotha which with installed capacity of 1,450 MW was commissioned in 2004.

The first thing that comes to mind when faced with energy shortage is the installed capacity of the generating facilities being less than the demand. True, but in addition, we must keep in mind that all capacity may not be available at all times because some units may be out of service due to scheduled maintenance, breakdown, or in case of hydroelectric power, the water level in reservoir may be less and/or the water to be released through the power units is less.

Total Installed capacity in 2009 was about 19,786 MW; net available varies from 14,500 MW in winter to 17,500 MW in summer. Hydropower units lose about 40% of their generating capacity in winter due to lower water levels in the reservoirs and lower availability of water for release through turbines. In 2008-09, total energy generation was 91,616 gigawatt-hours (GWh). The current capacity mix is: *hydel 31.7%, thermal 66.3%, and alternate energy and nuclear 2.0%.*Actual generation during 2008-09 from different sources was: Oil 34.9%, Gas 32.7%, hydel 30.6%, coal 0.1%, and nuclear 1.7%.

Energy Generation by Resource (%)

	Pakistan	India	China	USA	World
Oil	34.9	4.1	0.7	1.3	5.5
Gas	32.7	9.9	0.9	20.9	21.2
Hydel	30.6	13.7	16.9	6.5	16.2
Coal	0.1	68.6	79.1	48.8	40.8
Nuclear	1.7	1.8	2.0	19.2	13.5
Others	0.0	1.9	0.4	3.4	2.8

Table 4.1: Energy Generation by Resource

Pakistan has a very high potential of other renewable resource like solar and wind but their invest costs are high. Potential from wind is estimated at 40,000 MW. Potential of solar energy is also very high with solar radiation of 2 MWh per square meter and 3,000 hours of sunshine per year which is among the highest in the world.

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

Production of crude oil per day has decreased to 65,845 barrels during July-March 2008-09 from 69,954 barrels per day during the same period last year, showing a decline of 1.2 percent. The overall production of crude oil has decreased to 13.5 million barrels during July-March 2005-06 from 18.1 million barrels during the corresponding period last year, showing a decline of 1.1 percent. On an average, the transport sector consumes 49.794 of the petroleum products, followed by power sector (32.3%), industry (11.8%), household (2.5%), other government (2.3%), and agriculture (1.496) during last 10 years i.e. 1995-96 to 2004-05.

The average production of natural gas per day stood at 4,002million cubic feet during July-March, 2008-09, as compared to 3,973 million cubic feet over the same period last year, showing an increase of 4.5 %. The overall production of gas has increased to 1,460,679 million cubic feet during July-March 2008-09 as compared to 1,454,194 million cubic feet daily in the same period last year, showing an increase

of 4.5 percent. On average, the power sector consumes 36.6 percent of gas, followed by fertilizer (22.5 %), industrial sector (18.8 %), household (18.4 %), commercial sector (2.8 %) and cement (1.3 %) during last 10 years i.e. 1995- 96 to 2004-05. Total installed capacity of electricity (WAPDA, KESC, KANUPP AND IPPs) stood at 19,786 MW during July-March 2008-09, compared to 19,420 MW during July-March 2007-08. Total installed capacity of WAPDA stood at 11,363 MW during July-March 2008-09 of which, hydel accounts for 56.9 percent or 6,463 MW, thermal accounts for 43.1 percent or 4,930 MW.

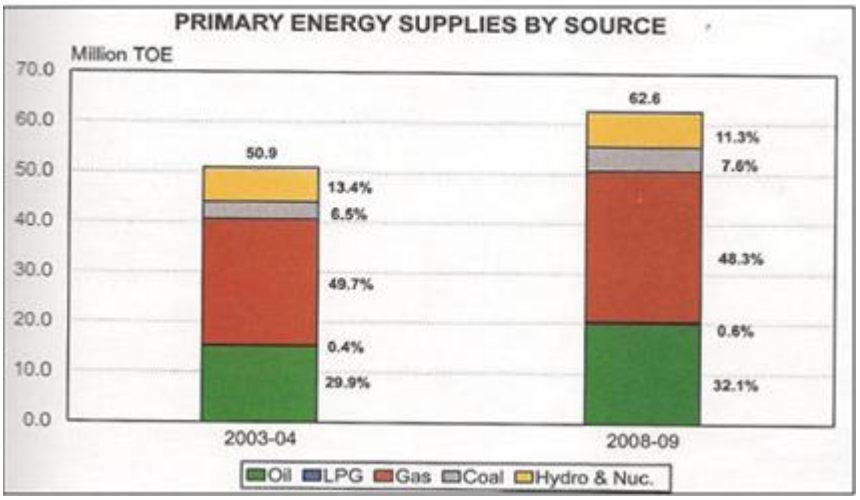


Figure 4.1: Primary energy Design

5. PAKISTAN ELECTRICITY MARKET

5.1 Electricity Suppliers

The electricity suppliers in Pakistan are given below:

- Water and Power Development Authority with 11,399 MW installed Capacity is the largest utility company in Pakistan and provides services to the entire country except Karachi.

- Karachi Electric Supply Company (KESC, http://ww.kesc.com.pk) with installed capacity of 1,955 MW supplies Karachi with electricity.

- Pakistan Atomic Energy Commission (PAEC, http://www.paec.gov.pk) has installed capacity of 462 MW from Chashma 1. Chashma 2 is expected to be operational in 2011 with 300 MWe net capacities.

- IPPs (Independent Power Producers) have an installed capacity of 7,678 MW (http://www.ppib.gov.pk).

WAPDA and PAEC are government entities, while KESC and IPPs operate in private sector.

Primary energy supplies by suppliers is shown in Figure 5.1.1

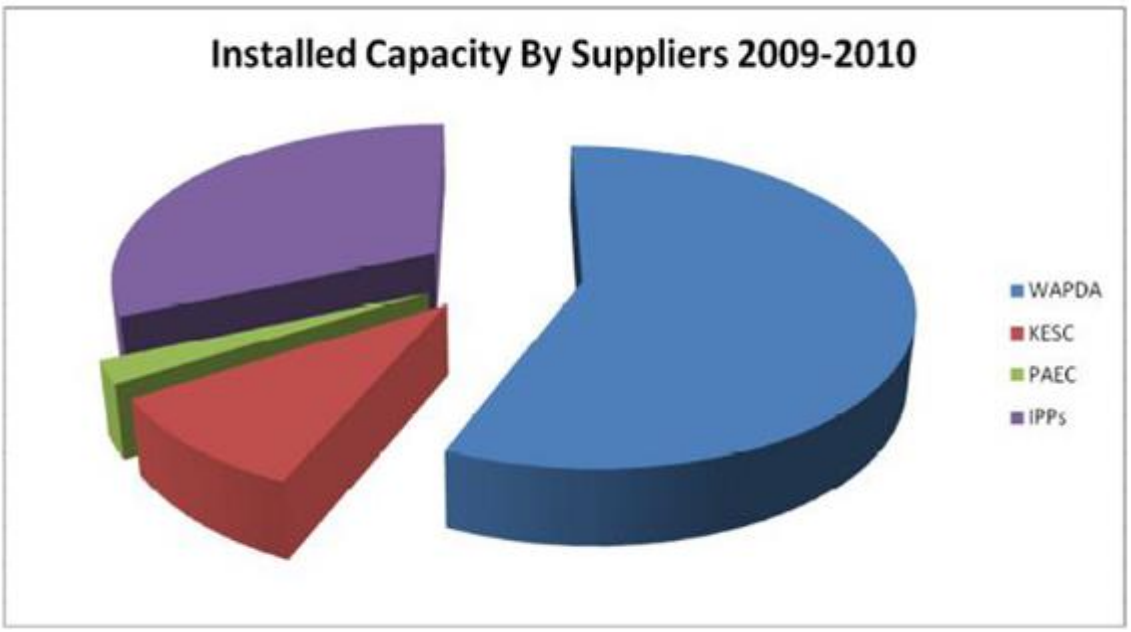


Figure 5.1.1: Primary energy supplies by suppliers

5.2 Electricity Generation Sources

Major sources of electricity generation are:

- Thermal (both Gas and Oil)
- Hydra Power
- Nuclear Power

Following statistics give a better picture of the changes in energy generation sources:

Energy Type	Potential	Source
Crude Oil	339 million barrels recoverable reserves.	Pak Eco Survey 2007-08
Natural Gas	31,266 trillion cubic feet recoverable reserves.	Pak Eco Survey 2007-08
Coal	185 billion tones recoverable reserves.	Pak Eco Survey 2007-08
Hydro Energy	46,000 MW identified potential	Govt. of Pakistan 2005
Nuclear power	Nuclear power of capacity 425 MWe	World Nuclear Association 2008

Table 5.2.1: Energy generation statistics

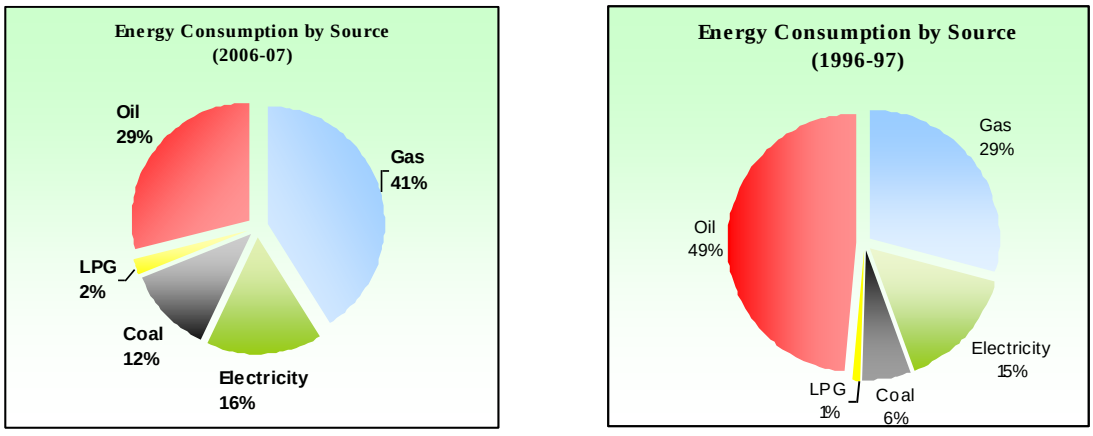


Chart 5.2.1: Comparison of Energy Consumptions

In terms of renewable sources, there are a few personal / off grid installation of wind and solar power. The on grid projects are all in the development phase except one project of 53 MW, which has inaugurated its first 5 MW capacity.

5.3 Power Crises

The country's power demand is 12,000 MW, out of which only 7,500 MW is being generated, reflecting a shortfall of 4,500 MW. More than 10 power generation plants out of 14, lying under Water and Power Development Authority (WAPDA) through Hydel resource of Tarbela Dam, have been shut down because of lesser water availability in the reservoirs.

Installed power generation capacity of the country is recorded up to 21,000 MW, while the demand of electricity in the country has reduced up to 12,000 MW in the sub-zero winter season. The power generation capacity of the second largest water reservoir, Mangla Dam, has reduced up to 75 percent from the installed capacity of 1,000 MW to approximately 250 MW, having the same reason of reduction in hydel resource.

Another major reason for reduction in power generation capacity, particularly by independent power producers (IPPs), which contribute the major chunk of electricity power to the national grid, is non-payment to fuel supplying companies. On the other hand, gas distribution companies Sui Northern Gas Pipelines Ltd and Sui Southern Gas Company are also reluctant to supply natural gas for power generation companies due to severe shortage in the country of up to 1.4 billion cubic feet (BCF). Another negligence of energy managers contributes the power shortfall of 300 MW to the national grid because of shutting down the Chashma Nuclear Power Complex 1 due to some technical faults.

Increase in electricity demand is directly linked to the growth of the country's economy. Keeping in view the sustained growth in all sectors of the economy in the coming years, it is expected that future demand for electricity will rise to more than 25,000 MW in near future. Supply of electricity as compared to demand has been stagnant for last decade or so with very little additions. The typical capacity factor of thermal IPPs is 60% and that of hydro power is 80%. Once transmission and distribution losses of 22% and auxiliary consumption of 4% are added, the situation starts to look further bleak.

Main drivers for the growth are industrial and domestic users. The demand for electricity from the industrial sector, given current growth trends, is going to rise substantially over the new five years. There has also been a rapid increase in the number of electricity consumers in recent years. This is due primarily to rapid urbanization and also the extension of the national grid to include an increased number of rural areas. In fact, village electrification has been a central part of the government's agenda.

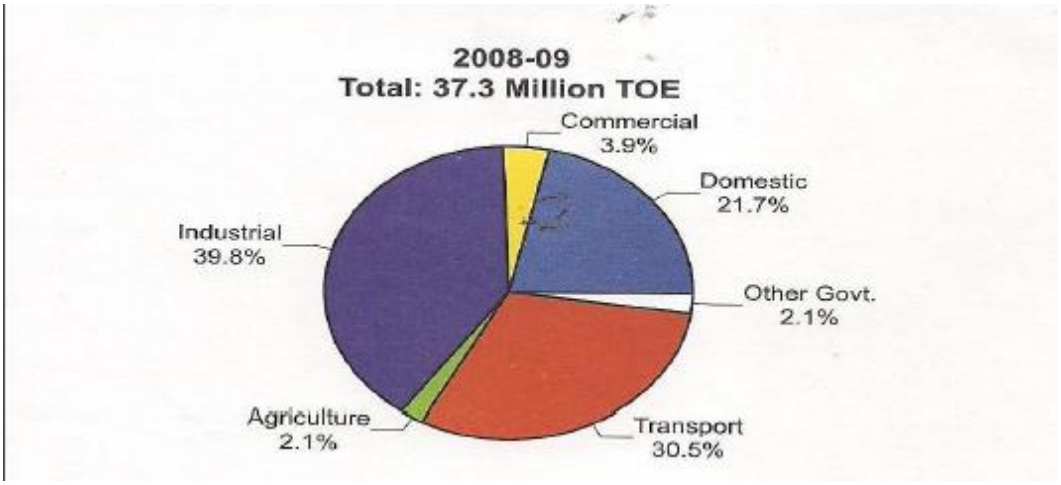


Chart 5.2.2: Energy consumption by Sector

Increase in electricity demand is directly linked to the growth of the country's economy. Keeping in view the sustained growth in all sectors of the economy in the coming years, it is expected that future demand for electricity will rise to more than 20,000 MW in near future. Supply of electricity as compared to demand has been stagnant for last decade or so with very little additions.

The typical capacity factor of thermal IPPs is 60% and that of hydro power is 80%. Once transmission and distribution losses of 22% and auxiliary consumption of 4% are added, the situation starts to look further bleak.

Source	Installed Capacity	Share	Installed Capacity	Share	%
	2008-2009	[%]	2009-2010	[%]	Change
WAPDA	11,454	57.9	11,399	56.5	-0.5
Hydel	6,555	57.2*	6,555	57.5*	0.0
Thermal	4,899	42.8*	4,844	42.5*	-1.1
IPPs	5,954	30.1	6,374	31.6	7.1
Nuclear	462	2.3	462	2.3	0.0
KESC	1,910	9.7	1,955	9.7	2.4
Total / Net	19,780	100	20,190	100	2.1

Table 5.2.2: Total Installed Capacity

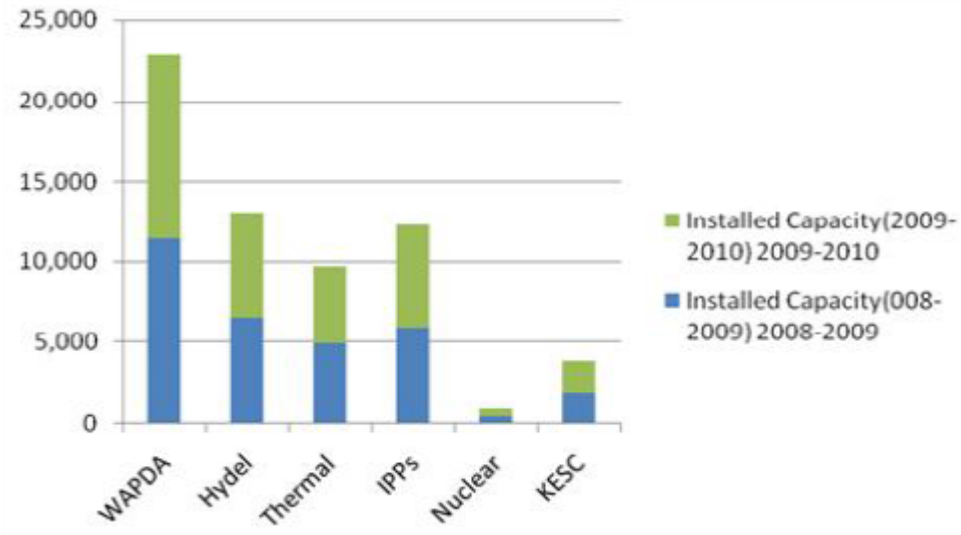


Chart 5.2.3: Total installed Generation Capacity

Main drivers for the growth are industrial and domestic users. The demand for electricity from the industrial sector, given current growth trends, is going to rise substantially over the new five years. There has also been a rapid increase in the number of electricity consumers in recent years. This is due primarily to rapid urbanization and also the extension of the national grid to include an increased number of rural areas. In fact, village electrification has been a central part of the government's agenda.

Electricity demand and supply analysis is shown in Chart 5.2.4

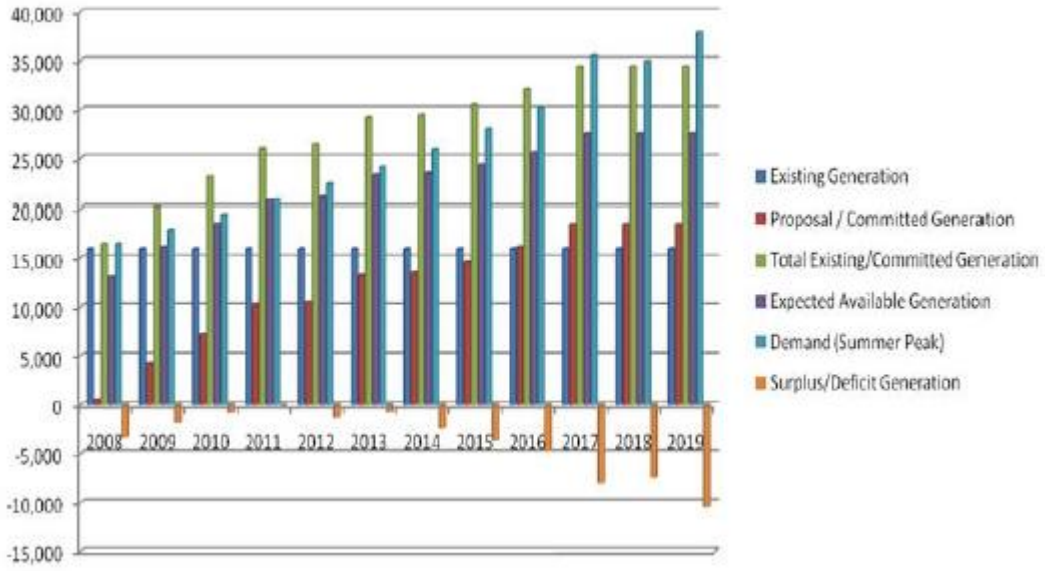


Chart 5.2.4: Electricity Demand Analysis

Generation	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Existing	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903	15,903
Proposed / Committed	530	4,235	7,226	10,115	10,556	13,307	13,520	14,607	16,134	18,448	18,448	18,448	18,448
Total	16,484	20,138	23,129	26,018	26,459	29,210	29,423	30,510	32,037	34,351	34,351	34,351	34,351
Expected Available	13,146	16,110	18,503	20,814	21,167	23,368	23,538	24,408	25,630	27,481	27,481	27,481	27,481
Demand (Summer Peak)	16,484	17,868	19,352	20,874	22,460	24,126	25,919	28,029	30,223	35,504	34,918	37,907	41,132
Surplus / Deficit	-3,338	-1,758	-849	-60	-1,293	-758	-2,381	-3,621	-4,593	-8,023	-7,437	-10,426	-13,651

Table 5.2.3: Electricity Demand analysis

5.4 Government of Pakistan Energy Security Action Plan

Energy is the lifeline of economic development but unfortunately Pakistan lacks integrated National Energy Security Plan for the 21st century. While preparing the MTDF 2005-10 for the energy sector, a long term view has been taken in the context of energy security requirement for the next 25 years.

5.4.1 Objectives of Energy Sector

Pakistan's energy requirement is increasing rapidly every year. The primary energy consumption in Pakistan grew by almost 80% in the past 15 years from 34 million tons oil equivalent (TOE) in 1994-95 to 61 million TOE in 2009-10. The country's energy supply currently comes primarily from indigenous natural gas which is 45% of the energy mix and oil imports at 35% of the energy mix, with the balance from hydel at 12%, coal at 6% and nuclear at 2% of the mix respectively.

Supply of indigenous natural gas has provided major support for Pakistan's economic growth over the past several decades and has enabled the construction of an extensive gas transmission and distribution grid in the country. Conventional gas reserves in the country are however expected to decline over the next few years and Pakistan needs to develop enhanced capability for exploration and production of offshore and unconventional gas reserves (tight gas, shale gas) and to arrange for significant gas imports via pipelines and as liquefied natural gas (LNG).

Additionally Pakistan must move forward with development of its large-scale coal reserves in the Thar coal-fields to ensure security of long-term energy supply. Steady growth in renewable energy sources such as hydel, nuclear, solar and wind must also remain part of the energy mix in the country.

Meanwhile urgent reforms in the power sector are required to grow power generation capacity and enhance transformation efficiency. The current "circular debt" is also a major issue for the energy sector and has become a significant barrier for energy development in Pakistan.

International financial resources and technical expertise will be required for development of the diverse energy segments in Pakistan and this will provide attractive opportunities for investments by global energy and finance organizations. The 2011 Energy Conference aimed to bring together key local and international stakeholders, including the government on one platform for an informed discussion on energy issues in Pakistan and to agree the way forward.

5.4.2 Strategy

The strategic directions for development of the energy sector and sustainable supply of energy at competitive price to all sectors of the economy include:

- Supply to be based on an optimum energy mix;
- Maximum utilization of the indigenous resources to meet the increasing energy demand with a major emphasis on increasing the coal share in the total energy mix by developing indigenous coal reserves, and setting up integrated coal mining, power generation, petro-chemical plants and coal gasification; development of hydro for power generation; increasing local oil and gas production by enhancing drilling activities particularly in off-shore areas; replacement of imported oil with imported gas; and promotion of accelerated nuclear and renewable/alternate energy sources (wind, solar) in overall energy mix;
- Enhancing participation in the sector, including manufacturing of plants and equipment by strengthening regulatory frameworks and related institutions
- Development of infrastructure, and
- Development of human resources with emphasis on technical skills and expertise.

The strategy also includes extension of LPG supply to the domestic sector, encouragement of CNG utilization in the transport sector and import of LNG to meet short-term gas requirements, if feasible. Incentives would also be provided for mechanized development of coal gasification technology.

5.4.3 Targets

The energy demand over the next five years is expected to grow at a rate of 7.4 percent per annum. To meet future requirements with indigenous resources, domestic exploration, if feasible, would be intensified. Simultaneously, the energy supply options would be diversified, with import of gas and LNG. In power generation a total of 23 hydro projects are planned to be initiated during the MTDF period, out of which 14 hydro projects will be completed, so that hydro-thermal mix is shifted towards hydro generation. Worldwide, pumped storage is utilized to generate about 70,000 MW through hydropower.

Similarly, 900 MW capacities would be increased through coal-based projects. Recognizing the importance of exploitation of renewable energy, projects totaling 890 MW are also envisaged for implementation during 2005-10.

The country's energy mix and demand projections by fuel for the short, medium and long term are outlined in Table 5.4.3.1, Chart 5.4.3.1 and Chart 5.4.3.2 below:

	Current		Short term		Medium Term				Long Term	
	2004		2010		2015		2020		2025	2030
Total MTOE	50.8		79.39		120.18		177.35		255.37	361.31
Oil	15.20	30%	20.69	26%	32.51	27%	45.47	25.7%	66.84	18.5%
Natural Gas	25.45	50%	38.99	49%	52.98	44%	77.85	44%	162.58	45%
Coal	3.30	6.5%	7.16	9%	14.45	12%	24.77	14.0%	68.65	19%
Hydro	6.43	12.7%	11.03	13.9%	16.40	13.6%	21.44	12.1%	38.93	10.8%
Renewable	0.00	0%	0.84	1.1%	1.60	1.3%	3.00	1.7%	9.20	2.5%
Nuclear	0.42	0.8%	0.69	0.9%	2.23	1.9%	4.81	2.7%	15.11	4.2%

Table 5.4.3.1: Country's Energy Mix

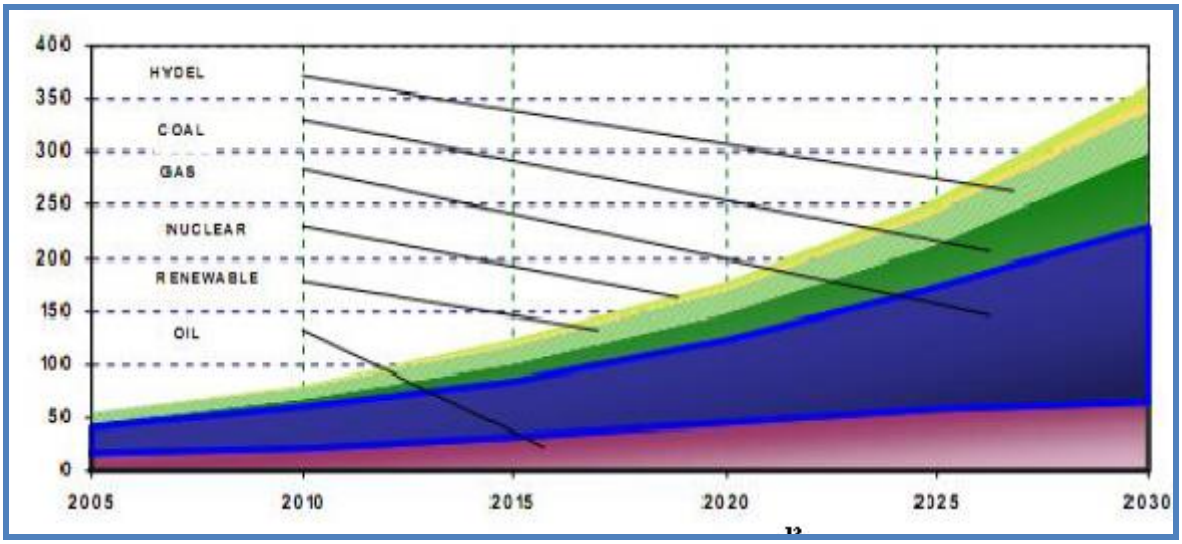


Chart 5.4.3.1: Demand Projections

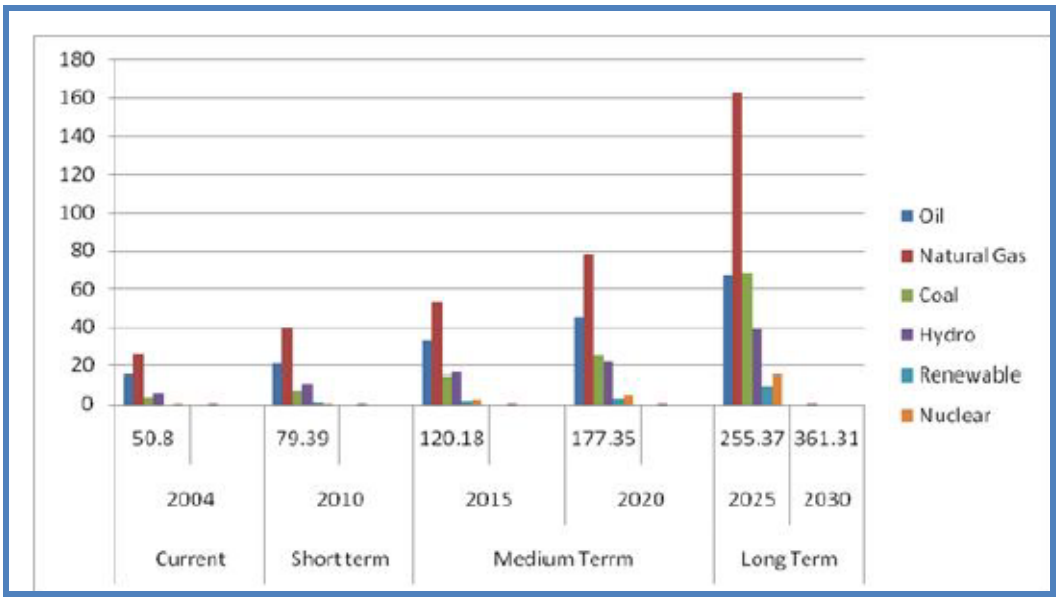


Chart 5.4.3.2: Demand Projections

The energy demand over the next five years is expected to grow at a rate of 7.4 percent per annum. To meet future requirements with indigenous resources, domestic exploration, if feasible, would be intensified. Simultaneously, the energy supply options would be diversified, with import of gas and LNG. In power generation a total of 23 hydro projects are planned to be initiated during the MTDF period, out of which 14 hydro projects will be completed, so that hydro-thermal mix is shifted towards hydro generation. Worldwide, pumped storage is utilized to generate about 70,000 MW hydro power.

Similarly, 900 MW capacity would be increased through coal-based projects. Recognizing the importance of exploitation of renewable energy, projects totaling 890 MW were also envisaged for implementation during 2005-10.

5.4.4 Objectives of Power Sector

The objectives for the development of the power sector include:

- To provide sufficient capacity for power generation at the least cost, and to avoid capacity shortfalls;
- To encourage and ensure exploitation of indigenous resources, which include renewable energy resources, human resources, participation of local engineering and manufacturing capabilities;
- To ensure that all stakeholders are looked after in the process, i.e. a win-win situation for all;
- To be attuned to safeguarding the environment.

5.4.5 Policy Provisions

The policy for power sector envisages:

- Utilization of indigenous resources for power generation and tilting the hydrothermal generation mix towards hydel by implementing maximum possible hydro based power projects;
- Maximizing generation through indigenous coal to increase its share to at least 18 percent (20,000 MW) by 2030;
- Increasing emphasis on nuclear power resources to increase generation from current 400 MW to 8800 MW by 2030. PAEC would enhance indigenization capability to maximize local content to reduce capital cost. Capacity of units would be increased from 300 MW to 600 MW and thereafter to 1000 MW;
- Facilitating captive power for old and new industries capacity available in sugar mills during off crushing season to be made available on national grid;
- Enhancing participation of private sector in power generation, transmission and distribution;

- Exploring the possibility for linking and developing the regional power grid for efficient and reliable use of power with emphasis on import of power from Tajikistan and Kyrgyzstan on 765 kV transmission line through silk mute;

- Strengthening regulatory bodies and making them truly autonomous, effective, transparent and credible;

- Promoting local engineering industry for power sector; encouraging the utilization of renewable energy (such as solar, wind, and biomass) especially for remote areas.

Total power demand and power generation plan are presented in Tables 5.4.5.1, Table 5.4.5.2 and Chart 5.4.5.1;

Year	Domestic	Commercial	Agriculture	Industrial	Others	Total(MW)
2005-06	7199	1216	1763	5891	1035	15,500
2006-07	7585	1251	1820	6481	1086	16,600
2007-08	8127	1312	1893	7252	1159	17,900
2008-09	8783	1354	1979	8181	1243	19,600
2009-10	9531	1408	2079	9267	1341	21,500

Table 5.4.5.1: Power demand

Year	Nuclear	Hydro	Coal	Renewable	Oil	Gas	Total	Cumulative
2005	400	6460	160	180	6400	5940	19540	NA
2010	0	1260	900	700	160	4860	7880	27420
2015	900	7570	3000	800	300	7550	20120	47540
2020	1500	4700	4200	1470	300	125620	24730	72270
2025	2000	5600	5400	2700	300	22490	38490	110760
2030	4000	7070	6250	3850	300	30360	51830	162590

Table 5.4.5.2: Power Generation Plan

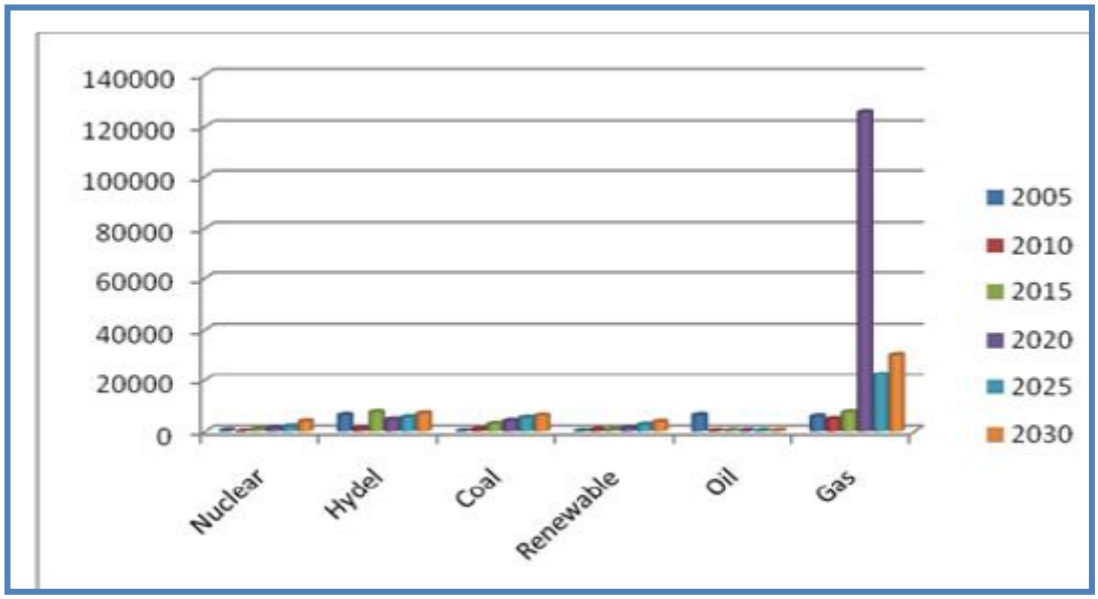


Chart 5.4.5.1: Power generation Plan

5.5 Transmission Network In Pakistan

After restructuring of WAPDA, transmission and distribution of electricity was delegated to NTDC. All high voltage lines and grid stations are now under control of the NTDC, which is also responsible for purchase of electricity from the generation companies as Central Power Purchasing Agent (CPPA). Distribution companies have the option to purchase electricity directly from the generation companies within their boundaries and distribute through medium voltage lines.

National Transmission & Dispatch Company (NTDC) Limited was incorporated on 6th November, 1998 and commenced commercial operation on 24th December, 1998. It was organized to take over all the properties, rights and assets obligations and liabilities of 220 KV and 500KV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA). NTDC operates and maintains twelve 500 KV and twenty nine 220 KV Grid Stations, 5077 km of 500 KV transmission line and 7359 km of 220 KV transmission line in Pakistan.

NTDC was granted Transmission License No.TL/01//2002 on 31st December 2002 by National Electric Power Regularity Authority (NEPRA) to engage in the exclusive transmission business for a term of thirty (30) years, pursuant to Section 17 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

The transmission system of WAPDA and KESC are interconnected through 220kV double circuit transmission lines. Transmission of electricity takes place at voltages of 500kV, 220kV, 132kV, 66kV and 33kV and distribution at 11kV. WAPDA suffers a power loss of more than 20% of the total electricity generated mainly due to the inefficiency of the transmission and distribution system. These losses are incurred due to power theft, corruption, and a number of other problems. Most of WAPDAs transmission lines are made of steel instead of copper, resulting in higher losses during transmission

5.6 Why to Invest in the Power Sector of Pakistan

Reasons for investing in Pakistan are best described with 5 components of any economy. These 5 aspects are:

5.6.1: Geo-strategic Location

Located in the heart of Asia, Pakistan is the gateway to the energy rich Central Asian States, the financially liquid Gulf States and the economically advanced Far Eastern tigers. This strategic advantage alone makes Pakistan a marketplace teeming with possibilities.

5.6.2: Trained Workforce

A large part of the workforce is proficient in English, hardworking and intelligent. Pakistan possesses a large pool of trained and experienced engineers, bankers, lawyers and other professionals with many having substantial international experience.

5.6.3: Economic Outlook

Pakistan is one of the fastest growing economies of the world having touched a GDP growth rate of 8.4% in 2005. Today Pakistan has over 170 million consumers with an ever growing middle class. Foreign Direct investment has risen sharply from an average of $300 million in the 1990s to over $3.7 billion in 2008-09. Fiscal deficit has declined from an average 7% of GDP in the 1990s to around 3% in recent years. And FOREX reserves have increased from $3.22 billion in 2000-01 to $11.6 billion in June 2009.

5.6.4: Investment Policies

Current investment policies have been tailor made to suit investor needs. Pakistan's policy trends have been consistent, with liberalization, de-regulation, privatization, and facilitation being its foremost cornerstones.

5.6.5: Financial Markets

The capital markets are being modernized, and reforms have resulted in development of improved infrastructure in the stock exchanges of the country. The Securities and Exchange Commission of Pakistan has improved the regulatory environment of the stock exchanges, corporate bond market and the leasing sector. Whilst the Federal Board of Revenue has facilitated structural reform in tax and tariffs and the State Bank of Pakistan has invigorated the banking sector into high returns on investment.

6. SOLAR ENERGY INDUSTRY

6.1 Solar Energy Background

Status of solar power today

At the end of 2009 the world was running 23 GW of photovoltaic (PV) electricity, the equivalent of 15 coal-fired power plants. At the end of 2010, this number should reach more than 35 GW. We have known for decades that just a portion of the energy hitting the Earth's surface from the Sun every day could power all our cities several times over. Solar can and must be a part of the solution to combat climate change, helping us shift towards a green economy. It is also a potentially prosperous industry sector in its own right. Some industry indicators show just how far photovoltaic energy has already come.

- The cost to produce solar power has dropped by around 22% each time world-wide production capacity has doubled reaching an average generation cost of 15c€/KWh in EU.

- Average efficiencies of solar modules have improved a couple percentage points per year. The most efficient crystalline silicon modules go to 19.5% in 2010 with a target of 23% efficiency by 2020, which will lower prices further. That increase in efficiencies is seen in all PV technologies.

- Solar power booms in countries where the boundary conditions are right.

- Over 1,000 companies are involved in the manufacturing of the established crystalline silicon technology and already more than 30 produce Thin Film technologies.

- The energy pay time back the electricity it took to create them in one to three years. The most cutting-edge technologies have reduced this to six months depending on the geographies and solar irradiation, while the average life of modules is more than 25 years.

Imagining a future with a fair share of Sun

The European Photovoltaic Industry Association (EPIA) and Greenpeace commissioned updated modeling into how much solar power the world could reasonably see in the world by 2030. The model shows that with a Paradigm Shift

scenario towards solar power, where real technical and commercial capacity is backed-up by strong political will, photovoltaic could provide:

- 688 GW by 2020 and 1,845 GW by 2030.

- Up to 12% of electricity demand in European countries by 2020 and in many Sunbelt countries (including China and India) by 2030. Around 9% of the world's electricity needs in 2030. Under an Accelerated scenario, which follows the expansion pattern of the industry to date and includes moderate political support, Photovoltaic's could provide:

- 345 GW by 2020 and 1,081 GW by 2030

- Around 4% of the world's electricity needs in 2020.

What are the benefits?

The benefits of a Paradigm Shift towards solar electricity as described in this model include:

- Provide clean and sustainable electricity to the world.

- Regional development, by creation of local jobs. New employment levels in the sector – as many as 1.62 million jobs as early as 2015, rising to 3.62 million in 2020 and 4.64 million in 2030.

- Clean electricity that contributes to international targets to cut emissions and mitigate climate change.

- Avoiding up to 4,047 million tons of CO2 equivalent every year by 2050. The cumulative total of avoided CO2 emissions from 2020 to 2050 would be 65 billion tons.

Solar photovoltaic technology has proven in recent years that, with the appropriate regulatory framework in place, it can be a major contributor to reaching the EU's target of 20% renewable energy sources (RES) by 2020. Technology improvements and economies of scale have spurred steady cost reduction, which will continue in coming years as the PV industry progresses toward competitiveness with conventional energy sources.

But already today, PV electricity is cheaper than many people think. In the coming years the technology will become even more cost-effective and competitive — and

qualify therefore as a vital part of Europe's energy future. Under the right policy and initiative, PV competitiveness with grid electricity can be achieved instantly.

Decreasing prices and PV's generation cost

Over the last 20 years, PV has already shown impressive price reductions, with the price of PV modules decreasing by over 20% every time the cumulative sold volume of PV modules has doubled. System prices have declined accordingly; during the last 5 years a price decrease of 50% has been achieved in Europe. System prices are expected to decrease in the 10 coming years by 36-51% depending on the segment.

Importantly, there is a huge potential for further generation cost decline: around 50% until 2020. The cost of PV electricity generation in Europe could decrease from a range of 0.16-0.35 €/kWh in 2010 to a range of 0.08-0.18 €/kWh in 2020 depending on system size and irradiance level.

6.1.1 Basics of Solar Energy

Solar energy is quite simply the energy produced directly by the sun and collected elsewhere, normally the Earth. The sun creates its energy through a thermonuclear process that converts about 650,000,000 tons of hydrogen to helium every second. The process creates heat and electromagnetic radiation. The heat remains in the sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation (including visible light, infra-red light, and ultra-violet radiation) streams out into space in all directions. Only a very small fraction of the total radiation produced reaches the Earth. The radiation that does reach the Earth is the indirect source of nearly every type of energy used today. The International Energy Agency projected that solar power could provide "a third of the global final energy demand after 2060, while CO2 emissions would be reduced to very low levels.

PV technology exploits the most abundant source of free power from the Sun and has the potential to meet almost all of mankind's energy needs. Unlike other sources of energy, PV has a negligible environmental footprint, can be deployed almost anywhere and utilizes existing technologies and manufacturing processes, making it cheap and efficient to implement.

Photovoltaic systems contain cells that convert sunlight into electricity. Inside each cell there are layers of a semi-conducting material. Light falling on the cell creates an electric field across the layers, causing electricity to flow. The intensity of the light determines the amount of electrical power each cell generates. A photovoltaic system does not need bright sunlight in order to operate. It can also generate electricity on cloudy and rainy days from reflected sunlight.

At the end of 2009 the world was running 23 GW of photovoltaic (PV) electricity, the equivalent of 15 coal-fired power plants. At the end of 2010, this number reached more than 35 GW. We have known for decades that just a portion of the energy hitting the Earth's surface from the Sun every day could power all our cities several times over. Solar can and must be a part of the solution to combat climate change, helping us shift towards a green economy. It is also a potentially prosperous industry sector in its own right.

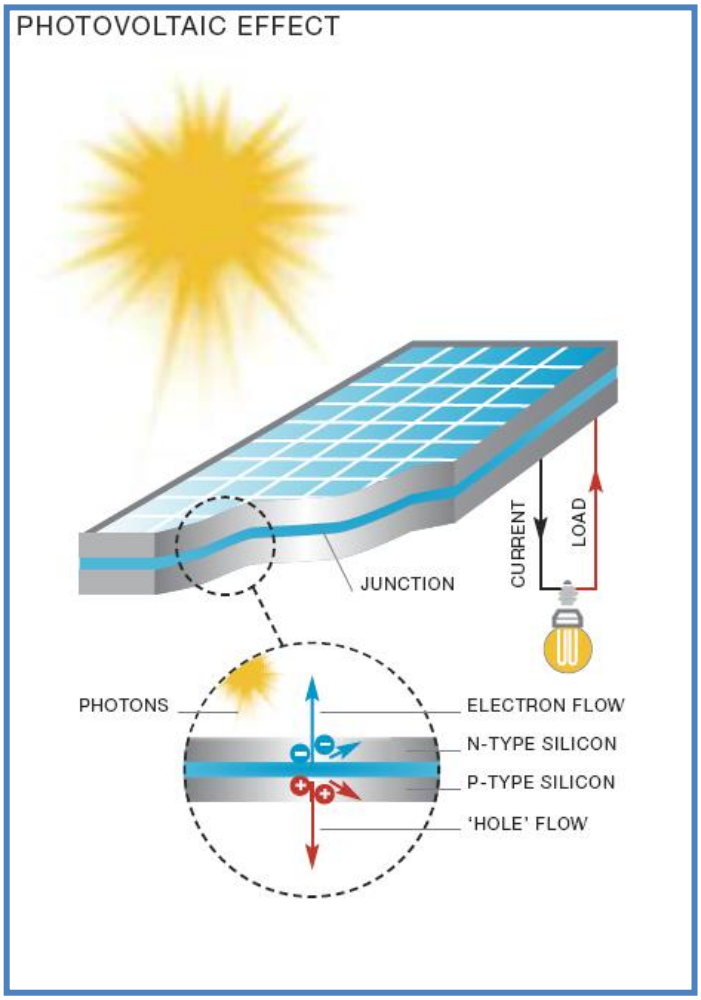


Figure 6.1.1.1: Photovoltaic Effect

6.1.2 Financial upsides to solar energy

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of PV modules has doubled. System prices have declined accordingly; during the last 5 years a price decrease of 50% has been achieved in Europe. System prices are expected to decrease in the 10 coming years by 36-51% depending on the segment.

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Importantly, there is a huge potential for further generation cost decline: around 50% until 2020. The cost of PV electricity generation in Europe could decrease from a range of 0.16-0.35 €/kWh in 2010 to a range of 0.08-0.18 €/kWh in 2020 depending on system size and irradiance level.

6.1.3 Future prospects with Solar Energy (EPIA Reports)

The **European Photovoltaic Industry Association (EPIA)** and **Greenpeace** commissioned updated modeling into how much solar power the world could reasonably see in the world by 2030. The model shows that with a Paradigm Shift scenario towards solar power, where real technical and commercial capacity is backed-up by strong political will, photovoltaic could provide:

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- Up to 12% of electricity demand in European countries by 2020 and in many Sunbelt countries (including China and India) by 2030. Around 9% of the world's electricity needs in 203

Under an Accelerated scenario, which follows the expansion pattern of the industry to date and includes moderate political support, photovoltaic could provide:

- 345 GW by 2020 and 1,081 GW by 2030
- Around 4% of the world's electricity needs in 2020

The benefits of a Paradigm Shift towards solar electricity as described in this model include:

- Provide clean and sustainable electricity to the world
- Regional development, by creation of local jobs.
- Clean electricity that contributes to international targets to cut emissions and mitigate climate change
- Avoiding up to 4,047 million tons of CO2 equivalent every year by 2050. The cumulative total of avoided CO2 emissions from 2020 to 2050 would be 65 billion tons

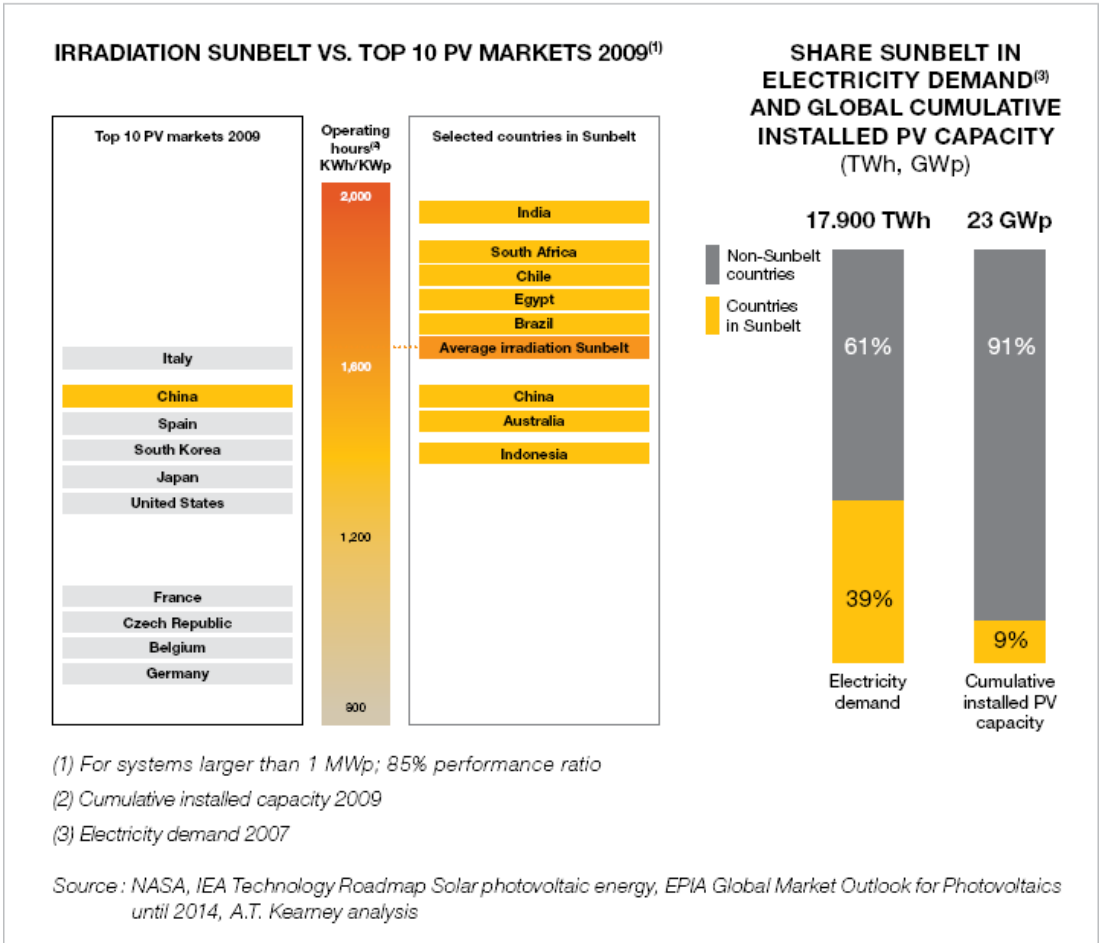


Chart 6.1.3.1: Sun Belt vs. Top 10 Markets

6.1.4 Corporate Social Roles of Solar Power

PV technology exploits the most abundant source of free power from the Sun and has the potential to meet almost all of mankind's energy needs. Unlike other sources

of energy, PV has a negligible environmental footprint, can be deployed almost anywhere and utilizes existing technologies and manufacturing processes, making it cheap and efficient to implement.

6.1.4.1 Environmental footprint of PV

The energy it takes to make a solar power system is usually recouped by the energy costs saved over one to three years. Some new generation technologies can even recover the cost of the energy used to produce them within six months, depending on their location. PV systems have a typical life of at least 25 years, ensuring that each panel generates many times more energy than it costs to produce.

6.1.4.2 Improves grid efficiency

PV systems can be placed at the center of an energy generation network or used in a decentralized way. Small PV generators can be spread throughout the network, connecting directly into the grid. In areas that are too remote or expensive to connect to the grid, PV systems can be connected to batteries.

6.1.4.3 Making cities greener

PV can seamlessly integrate into the densest urban environments. City buildings running lights, air-conditioning and equipment are responsible for large amounts of greenhouse gas emissions, if the power supply is not renewable. Solar power will have to become an integral and fundamental part of tomorrow's positive energy buildings.

6.1.4.4 No limits

There are no substantial limits to the massive deployment of PV. Material and industrial capability are plentiful and the industry has demonstrated an ability to increase production very quickly to meet growing demands. This has been demonstrated in countries such as Germany and Japan which have implemented proactive PV policies.

6.2 HISTORY OF SOLAR POWER

6.2.1 Solar Energy and Generations of Photovoltaic

Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar energy technologies include solar heating, solar photovoltaic, solar thermal electricity and solar architecture, which make considerable contributions to solving some of the most urgent problems the world now faces.

The term "photovoltaic" comes from the Greek Word meaning "light", and the name of the Italian physicist Volta, after whom the volt (and consequently voltage) are named. It means literally of light and electricity.

The photovoltaic effect was first recognized in 1839 by French physicist Alexandre-Edmond Becquerel. However, it was not until 1883 that the first solar cell was built, by Charles Fritts, who coated the semiconductor selenium with an extremely thin layer of gold to form the junctions. The device was only around 1% efficient. Russell Ohl patented the modern solar cell in 1946. Sven Ason Berglund had a prior patent concerning methods of increasing the capacity of photosensitive cells.

The modern age of solar power technology arrived in 1954 when Bell Laboratories, experimenting with semiconductors, accidentally found that silicon doped with certain impurities was very sensitive to light.

This resulted in the production of the first practical solar cells with a sunlight energy conversion efficiency of around 6 percent. This milestone created interest in producing and launching a geostationary communications satellite by providing a viable power supply. Russia launched the first artificial satellite in 1957, and the United States' first artificial satellite was launched in 1958. Russian Sputnik 3, launched on 15 May 1958, was the first satellite to use solar arrays. This was a crucial development which diverted funding from several governments into research for improved solar cells.

Solar Cells are classified into three generations which indicates the order of which each became important. At present there is concurrent research into all three generations while the first generation technologies are most highly represented in commercial production.

- **First Generation**

  First Generation technologies involve high energy and labor inputs which prevent any significant progress in reducing production costs. Single junction silicon devices are approaching the theoretical limiting efficiency of 33% and achieve cost parity with fossil fuel energy generation after a payback period of 5-7 years.

- **Second Generation (Thin Film)**

  Second generation materials have been developed to address energy requirements and production costs of solar cells. Second generation technologies are expected to gain in market share. The most successful second generation materials have been cadmium telluride (CdTe), copper indium gallium selenide, amorphous silicon and micro-morphous silicon.

- **Third Generation**

  Third generation technologies aim to enhance poor electrical performance of second generation (thin-film technologies) while maintaining very low production costs. Current research is targeting conversion efficiencies of 30-60% while retaining low cost materials and manufacturing techniques.

6.2.2 Development in Generations of Solar Power

6.2.2.1 Crystalline silicon technology

Crystalline silicon cells are made from thin slices (wafers) cut from a single crystal or a block of silicon. The type of crystalline cell produced depends on how the wafers are made. The main types of crystalline cells are:

- Mono crystalline (mc-Si):
- Polycrystalline or multi crystalline (pc-Si)
- Ribbon and sheet-defined film growth (ribbon/sheet c-Si)

The single crystal method provides higher efficiency, and therefore higher power generation. Crystalline silicon is the most common and mature technology representing about 80% of the market today. Cells turn between 14 and 22% of the sunlight that reaches them into electricity. For c-Si modules, efficiency ranges between 12 and 19%.

Advances and alternatives in cell manufacturing methods are producing cells with higher levels of efficiency. Some of the most promising emerging technologies include:

- **Buried contacts:**

  Instead of placing the fingers and bus bars on the front of the cell, they are buried in a laser cut groove inside the solar cell. The change makes the cell surface area larger, enabling it to absorb more sunlight.

- **Back contact cells:**

  The front contact of the cell is moved to the back. The cell's surface area is increased and shadowing losses are reduced. This technology currently provides the highest commercial cell efficiency available on the market.

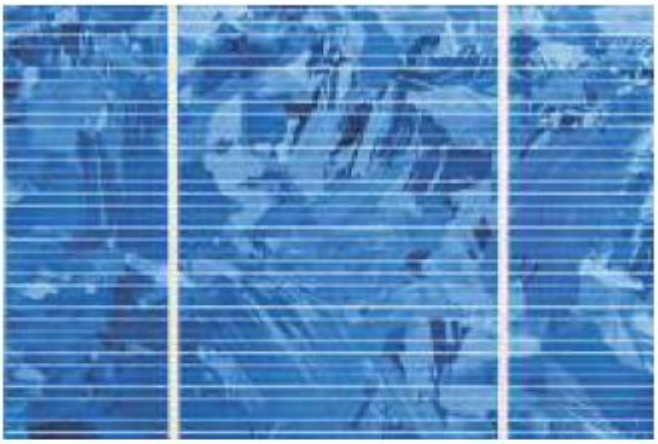
- **Pluto™:**

  Developed by Suntech, Pluto™ features a unique texturing process that improves sunlight absorption, even in low and indirect light.

- **HIT™ (Hetero-junction with Intrinsic Thin Layer):**

  Developed by Sanyo Electrics, the HIT™ cell consists of a thin, single-crystal wafer sandwiched between ultra-thin amorphous silicon (a-Si) layers. Using both amorphous and single crystal silicon improves efficiency.

CRYSTALLINE SILICON CELLS



Polycrystalline silicon
PV cell.

Monocrystalline
solar cell.

Figure 6.2.2.1.1: Crystalline Cells

6.2.2.2 Thin Films

Thin Film modules are constructed by depositing extremely thin layers of photosensitive material on to a low-cost backing such as glass, stainless steel or plastic. Once the deposited material is attached to the backing, it is laser-cut into multiple thin cells. Thin Film modules are normally enclosed between two layers of glass and are frameless. If the photosensitive material has been deposited on a thin plastic film, the module is flexible. This creates opportunities to integrate solar power generation into the fabric of a building or end-consumer applications.

Four types of Thin Film modules are commercially available:

- Amorphous silicon (a-Si)
- Multi-junction thin silicon film (a-Si/µc-Si)
- Cadmium telluride (CdTe)
- *Copper, indium, gallium, (di)selenide/ (di)sulphide (CIGS) and copper, indium, (di)selenide/(di)sulphide (CIS)*

Typical module power ranges from 60 to 350 W depending on the substrate size and efficiency. There is no common industry agreement on optimal module size for Thin-Film technologies. As a result they vary from 0.6 to 1.0 m² for CIGS and CdTe, to 1.4 to 5.7 m² for silicon-based Thin Films. Very large modules are of great interest to the building sector as they offer efficiencies in terms of handling and price.

6.2.2.3 Concentrator photovoltaic

Concentrator photovoltaic (CPV) utilize lenses to focus sunlight on to solar cells. The cells are made from very small amounts of highly efficient, but expensive, semi-conducting PV material. The aim is to collect as much sunlight as possible. CPV cells can be based on silicon or III-V compounds (generally gallium arsenide or GaA). CPV systems use only direct irradiation. They are most efficient in very sunny areas which have high amounts of direct irradiation.

The concentrating intensity ranges from a factor of 2 to 100 suns (low concentration) up to 1000 suns (high concentration). Commercial module efficiencies of 20 to 25% have been obtained for silicon based cells. Efficiencies of 25 to 30% have been achieved with GaAs, although cell efficiencies well above 40% have been achieved in the laboratory.

The modules have precise and accurate sets of lenses which need to be permanently oriented towards the Sun. This is achieved through the use of a double-axis tracking system. Low concentration PV can be also used with one single-axis tracking system and a less complex set of lenses.

Figure 6.2.2.2.1: Thin Film Module

6.2.2.4 Third generation photovoltaic

After more than 20 years of research and development, third generation solar devices are beginning to emerge in the marketplace. Many of the new technologies are very promising. One exciting development is organic PV cells. These include both fully organic PV (OPV) solar cells and the hybrid dye-sensitized solar cells (DSSC). For both technologies, manufacturing costs is constantly decreasing and is expected to reach 0.50€/W by 2020. This is enabled by the use of the R2R manufacturing process and standard printing technologies. The major challenges for this sector are the low device efficiency and their instability in the long-term.

Third generation PV products have a significant competitive advantage in consumer applications because of the substrate flexibility and ability to perform in dim or variable lighting conditions. Possible application areas include low-power consumer electronics (such as mobile phone rechargers, lighting applications and self-powered displays), outdoor recreational applications, and BIPV.

6.2.2.5 Historical and future evolution

Crystalline silicon technologies have dominated the market for the last 30 years. Amorphous silicon (a- Si) has been the technology most used for consumer applications (e.g. calculators, solar watches) due to its lower manufacturing cost while c-Si technologies have been used mainly in both stand-alone and on-grid systems.

Within the c-Si technologies, mono- and multi-crystalline cells are produced in fairly equal proportion. However, multi-crystalline cells are gaining market share. Ribbon c-Si represents less than 5% of the market. While a-Si has been the preferred clear Thin-Film technology used over the past three decades, its market share has decreased significantly compared to more advanced and competitive technologies. For example, CdTe has grown from a 2% market share in 2005 to 13% in 2010. Technologies such as Concentrator PV (CPV), organics and dye-sensitized solar cells are beginning to enter the market. They are expected to achieve significant market share in the next few years, capturing around 5% of the market by 2020.

6.2.3 Supply potential of Solar Energy

There is more than enough solar irradiation available to satisfy the world's energy demands. On average, each square meter of land on Earth is exposed to enough sunlight to generate 1,700 kWh of energy every year using currently available technology. The total solar energy that reaches the Earth's surface could meet existing global energy needs 10,000 times over.

A large amount of statistical data on solar energy availability is collected globally. For example, the US National Solar Radiation database has 30 years of solar irradiation and meteorological data from 237 sites in the USA. The European Joint Research Centre (JRC) also collects and publishes European solar irradiation data from 566 sites1. Where there is more Sun, more power can be generated. The sub-tropical areas of the world offer some of the best locations for solar power generation.

While only a certain part of solar irradiation can be used to generate electricity, this 'efficiency loss' does not actually waste a finite resource, as it does when burning fossil fuels for power. Efficiency losses do, however, impact on the cost of the PV systems. International Energy Agency (IEA) calculations show that if 4% of the world's very dry desert areas were used for PV installations, the world's total primary energy demand could be met.

There is already enormous untapped potential. Vast areas such as roofs, building surfaces, fallow land and desert could be used to support solar power generation. For example, 40% of the European Union's total electricity demand in 2020 could be met if all suitable roofs and facades were covered with solar panels.

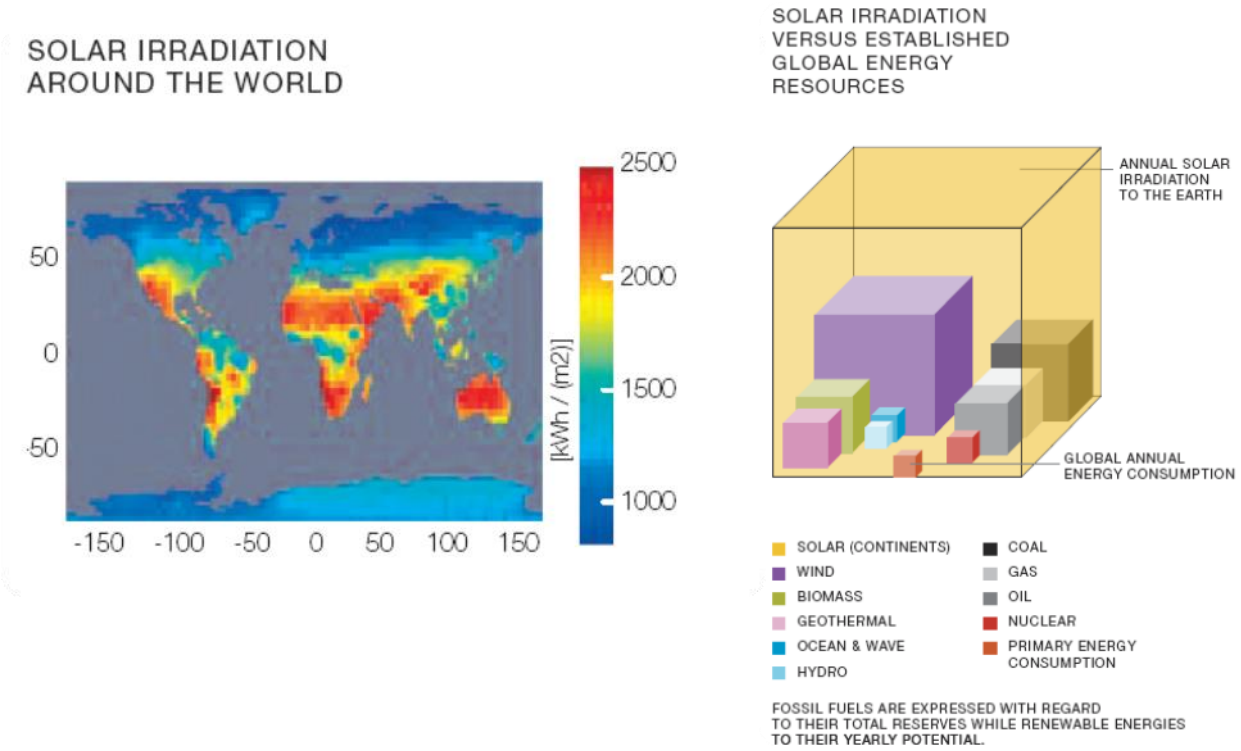


Chart 6.2.3.1: Global Irradiation

6.3.1 PV System Configuration

The key parts of a solar energy generation system are:

- Photovoltaic modules to collect sunlight
- An inverter to transform direct current (DC) to alternate current (AC)
- A set of batteries for stand-alone PV systems
- Support structures to orient the PV modules toward the Sun.

The system components, excluding the PV modules, are referred to as the balance of system (BOS) components.

6.3.1.1 PV cells and modules

The solar cell is the basic unit of a PV system. PV cells are generally made either from crystalline silicon, sliced from ingots or castings, from grown ribbons or from alternative semiconductor materials deposited in thin layers on a low-cost backing (Thin Film).

Modules can be connected to each other in series (known as an array) to increase the total voltage produced by the system. The arrays are connected in parallel to increase the system current. The power generated by PV modules varies from a few watts (typically 20 to 60 Wp) up to 300 to 350 Wp depending on module size and the technology used. Low wattage modules are typically used for stand-alone applications where power demand is generally low. Modules can be sized according to the site where they will be placed and installed quickly. They are robust, reliable and weatherproof. Module producers usually guarantee a power output of 80% of the Wp, even after 20 to 25 years of use. Module lifetime is typically considered of 25 years, although it can easily reach over 30 years.

6.3.1.2 Inverters

Inverters convert the DC power generated by a PV module to AC power. This makes the system compatible with the electricity distribution network and most common electrical appliances. An inverter is essential for grid-connected PV systems. Inverters are offered in a wide range of power classes ranging from a few hundred watts (normally for stand-alone systems), to several kW (the most frequently used range) and even up to 2,000 kW central inverters for large-scale systems.

6.3.1.3 Batteries and charge controllers

Stand-alone PV systems require a battery to store energy for future use. Lead acid batteries are typically used. New high-quality batteries, designed specifically for solar applications and with a life of up to 15 years, are now available. The actual lifetime of a battery depends on how it is managed. Batteries are connected to the PV array via a charge controller. The charge controller protects the battery from overcharging or discharging. It can also provide information about the state of the system or enable metering and payment for the electricity used.

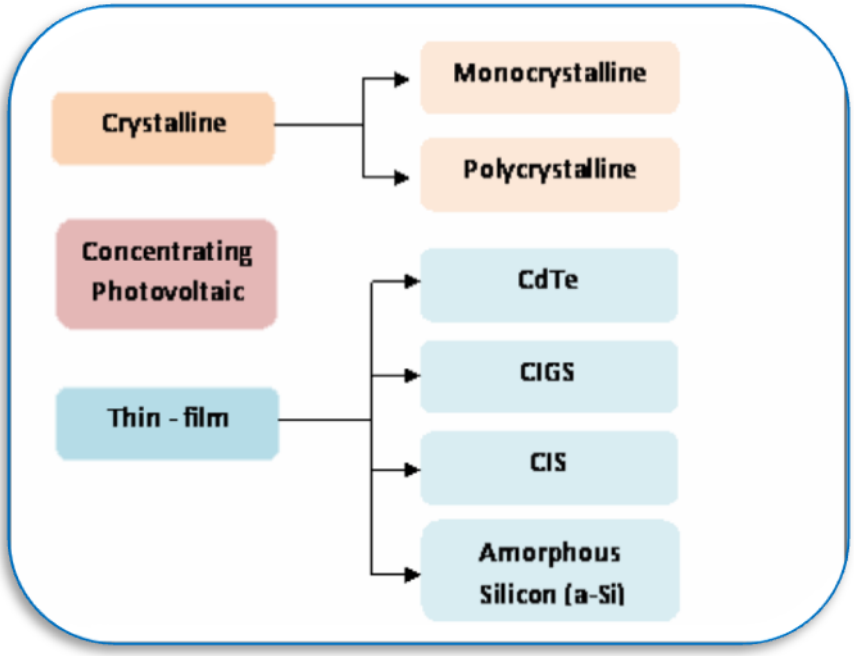
6.3.2 Categories of Solar Modules

- **Mono-crystalline silicon (mono-silicon or single silicon)**

  Right now, these are the most efficient type of solar panels. In other words, when sunlight hits these puppies, more of it turns into electricity than the other types below. As a result of their high silicon content, they're also more expensive, but you need fewer of them. That's why they're ideal for roofs. You can tell if you have a mono-crystalline solar panel by its square cells.

- **Polycrystalline silicon (multi-crystalline, multi-silicon, ribbon)**

"Poly" panels have lower silicon levels than "mono" panels. In general, that makes them less expensive to produce, but they're also slightly less efficient. The good news is that their overall construction design can often make up for the efficiency loss, so they're also good for roofs. You can tell poly-silicon panels by their groovy mélange of silicon woven through thin rectangular conduit wires.



- **Thin film (amorphous silicon, cadmium telluride, copper indium gallium (di)selenide)**

  Everyone talks about "thin film" because they're really inexpensive to make and they don't mind the heat, which is all cool. Except right now, they're very inefficient, which means you'll see them in big solar farm projects with a lot of land, but not on your roof.

- **BIPV (building integrated photovoltaic)**

  BIPV's can look like real roofing tiles (solar shingles are an example). That's nice, but good looks do cost a lot more. Second, they're way less efficient than conventional PV, which means you need a sunny spacious roof to make a dent in your electric bill. Finally, they may not last as long as regular panels. Right now, 1bog doesn't contract for BIPV systems.

Figure 6.3.2.1: Photovoltaics

6.4 Solar Energy Applications Market

6.4.1 OFF Grid Applications

For isolated properties where there is no grid connection, solar PV panels can be used independently using batteries backup to provide additional supply when there is not enough daylight to generate electricity or when more energy is needed than the system is generating. Aside from providing power for homes solar photovoltaic is suitable for other off-grid applications.

Solar powered lighting for outbuildings / barns / sheds

Systems can be sized to run small off-grid applications, especially useful for rural locations such as farms.

Solar powered electric fencing / security systems / electric gates

Similar to above, these systems can be sized to each application off grid with batteries.

Solar powered pumps

One of the most practical and best paybacks there is. Solar powered pumps are ideal for irrigation or water sources in remote locations off grid.

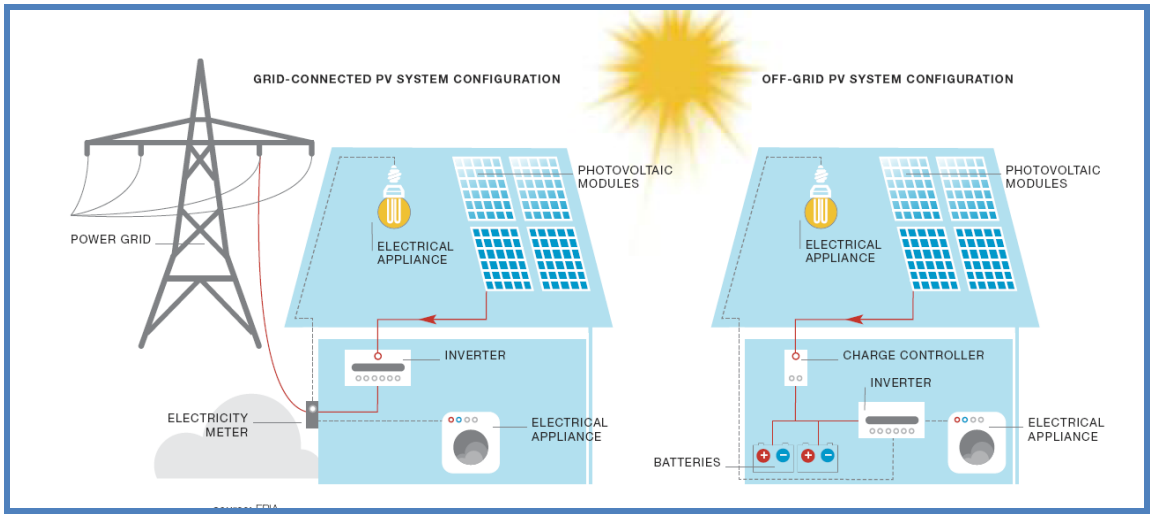


Figure 6.4.1.1: On-Grid and Off-Grid Applications

6.4.2 ON Grid Applications

Solar market for on-grid system comprises of residential, commercial, and utility applications.

Residential

Residential deployments are typically small (<5 KW) roof-mounted installations to supplement power usage to residential dwellings. Presently, residential deployments are the second highest in volume only after the commercial segment. Due to limited roof area, module efficiency is very important for residential deployments in order to achieve meaningful electricity generation. Although the residential market is currently dominated by silicon solar panels, thin-film is making inroads into the residential market.

Commercial

Commercial installations are medium to large (several KW to a MW) deployments to supplement electricity requirements of commercial sector customers including enterprise and public sector. As a result, both thin-film and silicon solar technologies are being deployed in the commercial segment. Other criteria important for commercial segment deployments include material safety, flexible form factor (avoiding penetrating mounts), and ease of installation that lowers the total system cost. The commercial segment is presently the largest segment within the solar market.

Utility

The utility segment comprises very large installations deployed as solar farms (1MW and higher) to complement electricity requirements of large power companies and utilities. Since the deployment areas are not a constraint, the efficiency requirements are typically low to medium. The utility segment is the third largest and fastest growing segment of the PV market. This segment is currently dominated by several thin-film technologies due to lower efficiency requirements and lower cost advantages combined with in-house expertise to develop, install and operate utility scale projects.

6.5 SOLAR FARM DEVELOPMENT

6.5.1 Financial Considerations during Solar Farm Development

6.5.1.1 Financial Concerns of development

The most important aspect for any project development initiative is the cost involved and the returns expected in form of ROE or IRR on investments. The generation cost refers to the price of a single unit of electricity – normally expressed as one kilowatt hour (kWh). The concept of Levelized Cost of Electricity (LCOE) allows to calculate the real cost of PV electricity and to compare this with the cost of other sources of electricity.

This method is preferred as it covers all investment and operational costs over the system lifetime, including the fuels consumed and replacement of equipment. Using LCOE makes it possible to compare a PV installation with any kind of power plant. For each system the LCOE calculation takes into account:

- The lifetime of the plant
- Investment costs
- Operational and maintenance costs
- The discount factor (WACC)
- The location of the plant, which for PV is essential to consider the difference in solar exposure

The starting base for the calculation is the total installed PV system cost. The cost of a PV system is split into the following elements:

- PV modules
- Inverter (enables connection of the system to the electricity grid)
- Structural components (for mounting and connecting the modules)
- The cost of installation (including the following costs: project development, administrative requirements, grid connection, planning, engineering and project management, construction and margins of the installers)

The module price reflects around 45-60% of the total installed system price, depending on the segment and the technology. Therefore, it is still the most important cost driver.

	LCOE Base Case (€cts/kWh)			LCOE Advanced Case (€cts/kWh)		
Country	2010	2020	2030	2010	2020	2030
Nigeria	0.152	0.089	0.063	0.141	0.066	0.045
Pakistan	0.145	0.085	0.060	0.135	0.063	0.043
Peru	0.153	0.090	0.063	0.142	0.066	0.045
Philippines	0.182	0.107	0.076	0.169	0.079	0.054
Qatar	0.155	0.091	0.064	0.144	0.067	0.046
Saudi Arabia	0.142	0.084	0.059	0.132	0.062	0.042
Senegal	0.134	0.079	0.056	0.124	0.058	0.040
Somalia	0.150	0.088	0.062	0.139	0.065	0.044
South Africa	0.139	0.082	0.058	0.129	0.060	0.041
Sri Lanka	0.150	0.088	0.062	0.139	0.065	0.044
Sudan	0.129	0.076	0.053	0.120	0.056	0.038
Syrian Arab Rep.	0.158	0.093	0.065	0.147	0.069	0.047
Tanzania	0.161	0.094	0.067	0.149	0.070	0.047
Thailand	0.160	0.094	0.066	0.149	0.070	0.047
Tunisia	0.174	0.102	0.072	0.162	0.076	0.051
Turkey	0.175	0.103	0.073	0.163	0.076	0.052
Uganda	0.164	0.096	0.068	0.152	0.071	0.048
UAE	0.144	0.085	0.060	0.134	0.063	0.043
Venezuela, RB	0.149	0.087	0.062	0.138	0.065	0.044
Vietnam	0.164	0.096	0.068	0.152	0.071	0.048
Yemen, Rep.	0.126	0.074	0.052	0.117	0.055	0.037
Zambia	0.141	0.083	0.058	0.131	0.061	0.042

Source: A.T. Kearney analysis

Table 6.5.1.1.1: Comparisons of LCOE base and advanced cases

When calculating the generation cost, the total system lifecycle cost has to be considered, including all costs made over the entire lifecycle of the PV system. Therefore, some additional cost drivers need to be taken into account:

- Price for operation and maintenance services
- Cost of one inverter replacement for each inverter
- Land cost (for large-scale ground-mounted systems only)
- Cost of take-back and recycling the PV system at the end of the lifetime

The generation cost assessed in the report reflects the technical generation cost, a theoretical value which might differ from the generation cost that can be achieved in the actual market. In practice, the capital cost is usually paid up-front. The remainder of the total cost is paid over the lifetime of the system. On the revenue side, every kWh produced corresponds to a flow of income over the entire lifetime of the system. As such, all costs and revenues that are not paid up-front have to be discounted in order to come up with a present value.

The discount factor used is differentiated across the market segments and the countries. A country-specific risk has been taken into account based on the differences in long-term government bond yields between the five countries assessed. Moreover, a differentiation has been made between private PV owners (residential systems) and business investors (all other market segments). It should be clearly noted that the cost of capital mentioned do not reflect the full cost of financing PV systems.

Future prospects of the Solar Industry

Multiple models have been developed for the accelerated growth of the solar industry from 2010 onwards to 2015 or 2020. Some underlying common assumptions while developing these models are as follows:

- **PV modules**

  An initial learning factor of 20% is assumed. For every doubling of the cumulative volume sold, the price will decrease by 20%. Whereas for Thin Film PV modules the learning rate is assumed to remain 20% until 2020, this rate could decrease towards 15% for Crystalline Silicon modules in 2020.

- **Inverters:**

  A learning factor of 20% is assumed for small-scale inverters (used in residential systems) and of 10% for large centralized inverters (used in all other market segments). The learning factors are based on the realized price reductions in the PV industry since the 1980s-1990s.

- **Structural components**

  The evolution of the cost of some components, such as cables and mounting structures, depends on the evolution of raw material prices, scale and learning effects. However, a significant part of their costs are influenced by PV module efficiency: the higher the efficiency, the fewer structural components are required.

- **Installation cost**

  The parameters that have been taken into account are similar to the ones that determine the evolution in the price of the structural components. The increase in labor cost is taken into account as well.

- **Cost per kWh for Solar PV Systems**

  To calculate the cost per kWh of electricity produced, the total energy output of the PV system has to be determined. This includes several parameters (as per costing methods developed by EPIA):

- **Solar irradiance**

- **Performance ratio**

  During the day, a PV system does not produce at 100% of its capacity due to for example shading of the modules. The general standard is to assume about 75% for residential systems and 80% for larger systems.

- **Lifetime**

  To calculate generation cost, based on continuous technology developments, a gradual increase of the technical guaranteed lifetime of the PV modules, starting at 25 years and increasing to 35 years in 2020, is assumed.

- **PV module degradation**

  This affects the performance of the PV system over its lifetime. The assumption is based on the generally accepted guaranteed performance of the PV modules – namely 80% of the initial performance after 25 years.

6.5.2 Non-Financial Solar Farm Development guidelines

A solar farm is a large area of land with multiple ground mounted solar arrays. The solar panels convert the sun's energy into electricity that can be sold directly to the utility grid or to a neighboring facility. Developing a solar farm is complex and requires a company with the knowledge and resources available to make the project a reality. Photovoltaic solar farms use hundreds or thousands of panels covered with photovoltaic cells to convert the sun's light directly into electricity. They generate more power when daylight lasts longer - during summer months and in the south.

Solar farms that use PV technology may install stationary or rotating panels in rows. The more panels, the more space is needed - and the more electricity is generated. A PV solar farm can range from a few acres to hundreds of acres in size. Soil composition, water access, and proximity to power lines and substations all play a part in the selection of a site. Zoning issues affect the location of solar farms.

Landowners' legal rights to contract for long terms can influence site selection between private and federally owned land.

High quality resource assessments are the base for successful deployment of renewable energy sources. Their availability will lower the investors' uncertainty and risk about the availability of solar radiation. Investors would then be able to calculate lower surcharges and make their investment cheaper or optimize their systems better on the available resource and increase their revenues. Policymakers designing market introduction policies can better assess the level of necessary support in the beginning of market introduction. With this they can optimize the support schemes by fine-tuning the necessary amount of financial support, or by adding support for more systems and therefore speeding up the market introduction of these technologies.

To get an installation built, most solar farms rely on a combination of loans and grants from both public and private sources. National programs run by government lenders foreign bodies are one source of financing. Private investors and public/private partnerships are typical sources of funds. Other options that may be part of the financing deal include leasing land from a user of the solar power generated by the farm. Rebates and tax credits can help defray the costs of solar farm installation. Feed-in tariffs and solar renewable energy certificates can help make the operation of a solar farm profitable.

7. CARBON CREDITS

7.1 Emission Reduction Mechanisms

The Kyoto Protocol to the United Nations Framework Convention on Climate Change will strengthen the international response to climate change. Adopted by consensus at the third session of the Conference of the Parties (COP) in December 1997, it contains legally binding emissions targets for (industrialized) countries. By arresting and reversing the upward trend in greenhouse gas emissions that started in these countries 150 years ago, the Protocol promises to move the international community one step closer to achieving the Convention's ultimate objective of preventing dangerous anthropogenic [man-made) interference with the climate system.

The developed countries are to reduce their collective emissions of six key greenhouse gases by at least 5%. This group target will be achieved through cuts of 8% by Switzerland, most Central and East European states, and the European Union (the EU will meet its group target by distributing different rates among its member states); 7% by the US; and 6% by Canada, Hungary, Japan, and Poland. Russia, New Zealand, and Ukraine are to stabilize their emissions, while Norway may increase emissions by up to 1%, Australia by up to 8%, and Iceland 10%. The six gases are to be combined in a "basket", with reductions in individual gases translated into "CO2 equivalents" that are then added up to produce a single figure.

Each country's emissions target must be achieved by the period 2008 - 2012. It will be calculated as an average over the five years. 'Demonstrable progress" must be made by 2005. Cuts in the three most important gases carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) will be measured against a base year of 1990 (with exceptions for some countries with economies in transition). Cuts in three long-lived industrial gases — hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and Sulphur hexafluoride (SF6) - can be measured against either a 1990 or 1995 baseline. A major group of industrial gases, chlorofluorocarbons, or CFCs, are dealt with under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.

Actual emission reductions will be much larger than 5%. Compared to emissions levels projected for the year 2000, the richest industrialized countries (OECD members) will need to reduce their collective output by about 10%. This is because many of these countries will not succeed in meeting their earlier non-binding aim of returning emissions to 1990 levels by the year 2000, and their emissions have in fact risen since 1990. While the countries with economies in transition have experienced

falling emissions since 1990, this trend is now reversing. Therefore, for the developed countries as a whole, the 5% Protocol target represents an actual cut of around 20% when compared to the emissions levels that are projected for 2010 if no emissions-control measures are adopted.

The Kyoto Protocol provides that nations can redeem a part of their climate protection commitments by implementing projects aimed at reducing emissions in other countries. These projects are primarily to be carried out by the private sector.

These investment projects can financially benefit from generating additional emissions reductions as compared to a business as usual case.

7.1.1 Emissions Trading

There are three methods in Kyoto Protocol which permits the acquisition of emissions credits by means of project-based investment abroad. Kyoto includes "flexible mechanisms" which allow Annex 1 (who have accepted GHG emission reduction obligations) economies to meet their GHG targets by purchasing GHG emission reductions from elsewhere. These can be bought either from financial exchanges (such as the new EU Emissions Trading Scheme) or from projects which reduce emissions in non-Annex 1 economies under the Clean Development Mechanism (CDM), or in other Annex-1 countries under the JI.

7.1.2 Clean Development Mechanism (CDM)

Emissions Trading, also called Carbon Trading, involves trading carbon emission credits within nations. Allowances are created, thereby making emissions a commodity that can be traded between industries etc. The Kyoto Protocol says that it is ok to trade in emissions, but that it should not be the major means to achieve one's commitments. Some European countries and corporations have started implementing such programs to get a head start and to see how well it will work.

7.1.3 Joint Implementation (JI)

Clean Development Mechanism (CDM) allows richer countries to offset their CO2 emission against the emissions prevented when technology that cuts down on greenhouse gas emissions is deployed in poor countries.

7.2 Role Of CDM In The Project

The Project is a power generation project with renewable resource and zero emission. When put into operation, the project can provide power supply to the northern Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. It can deliver good environmental and social benefits. It is also consistent with the spirit of the Kyoto Protocol and qualified for the application of CDM projects. If the project is approved and registered as a CDM project, CERs can provide extra financial resource for the project. It will provide favorable conditions for the project financing, improve competitiveness of the project, and reduce investment risk during the project implementation process.

The Cholistan Solar PV Project is a 50 MW solar PV installation project, planned to be implemented in phases of 5 MW each. The project will be a pure solar PV grid connected installation. The project would become operational and start generating CERs directly after the completion of the first phase of the project, with work on the other phases continuing. The project is expected to help alleviate the huge energy deficit in Pakistan. It will be the first Solar PV project of its magnitude in Pakistan and will be a large source of clean energy. The project is expected to be using Poly Crystalline silicon solar cells.

The area of this project will be about 375 Acres and annual amount of electricity going to the grid will be about 76,000 MWh approx. As a result over 40,000 tons of CO_2 emissions will be abated per year. Cholistan Solar Farm is a 50 MW electricity generation plant designed to produce electricity by solar energy in Cholistan Desert in the province of Punjab, Pakistan. It employs solar photovoltaic (PV) technology that converts solar energy directly into electricity, while emitting zero greenhouse gases (GHG) into the atmosphere. The project is planned to be implemented in phases of 5 MW each and would become operational and start generating CERs right after the completion of the first phase of the project, with work on the other phases continuing. The generated electricity will be supplied to the national grid.

The project conforms to the government policy that promotes development of renewable energy technology and contributes to lowering dependence on electricity generation by fossil fuels which is over 66% of total generation in Pakistan. It is expected to help alleviate the huge energy deficit in Pakistan. It is the first Solar PV project of its size in Pakistan and will be a good source of clean energy.

Refer to Volume 6 for detailed studies for the Project under the Clean Development Mechanism – Project Idea Note (PIN's), Letter of Intent (LOI) by the Designated National Authority (DNA) Project Design Document (PDD's), PDD Evaluation Matrix,

the Prior Consideration Form and the Host Country Approval (HCA) by the DNA of Pakistan

8. REGULATORY REGIME

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

- Ministry of Water and Power
- National Electricity Regulatory Authority (NEPRA)
- Water and Power Development Authority and its subsidiaries
- Karachi Electric Supply Corporation Limited (KESC)
- Independent Power Producers
- Private Power Infrastructure Board
- Alternative Energy Development Board (AEDB)

8.1 Ministry Of Water And Power

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

8.2 Water And Power Development Authority (WAPDA)

WAPDA was created in 1958 as a Semi-Autonomous Body for the purpose of coordinating, and giving a unified direction, to the development of schemes in the Water and Power Sectors. These were previously being dealt with by the respective Electricity and Irrigation Departments of the Provinces.

In 1992, the Government approved WAPDA's Strategic Plan for the Privatization of the Pakistan Power Sector. This Plan sought to meet three critical goals:

- Enhance capital formation,
- Improve efficiency and rationalize prices
- Gradually move towards full competition by providing the greatest possible role for the private sector through privatization.

This major decision was taken to improve the viability of Pakistan's electric power sector which was characterized by extensive government involvement in management, political interference, and a tariff plagued by cross-subsidies. A critical element of the Strategic Plan was the creation of a Regulatory Authority to oversee the restructuring process and to regulate monopolistic services.

The existence of an independent and objective regulatory entity reduces the risk to investors in the market. Accordingly, an autonomous regulatory agency is essential for the short and long-term stability of the sector.

The introduction of this regulatory regime reflects the desire of the Government to improve the efficiency and availability of electric power services by protecting the interest of the investor, the operator, and the consumers. It also shows the intention to increase competition and to deregulate power sector activities where there is competition.

In this regard several regulatory bodies were formed, namely:

- National Electric Power Regulatory Authority (NEPRA)
- Private Power Infrastructure Board (PPIB)
- Provincial Power Development Boards/Cells

Further, as part of the country's new electricity market restructuring and liberalization program, in the year 2000 WAPDA was subject to a vertical disintegration process. As a result the power wing of WAPDA, comprising of generation, transmission and the distribution of electricity has been restructured into fourteen (14) public limited companies. These fourteen (14) Corporate Entities are:

- Four (4) Thermal Power Generation Companies (GENCOs)
- One (1) National Transmission &Power Dispatch Company (NTDC)
- Nine (9) Distribution Companies (DISCOs)

8.3 National Electric Power Regulatory Authority (NEPRA)

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

8.4 National Transmission and Dispatch Company (NTDC)

National Transmission & Dispatch Company (NTDC) Limited was incorporated on 35 August 1998 and commenced commercial operation on 1st March 1999. It was organized to take over all the properties, rights and assets obligations and liabilities of 220kV and 500kV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA).The NTDC operates and maintains nine 500kV Grid Stations, 4,160km of 500kV transmission line and 4,000km of 220kV transmission line in Pakistan.

NTDC was granted Transmission License No.TL/01//2002 on 31st December 2002 by National Electric Power Regularity Authority (NEPRA) to engage in the exclusive transmission business for a term of thirty (30) years, pursuant to Section 17 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

Under the regime set out in the License, the NTDC is entrusted to act as:

- Central Power Purchasing Agency
- System Operator
- Transmission Network Operator
- Contract Registrar and Power Exchange Administrator

8.5 Private Power Infrastructure Board (PPIB)

PPIB was created in 1994 to act as One-Window organization to facilitate the implementation of projects under various private power policies announced by the GoP from time to time. Its main task is to negotiate the Implementation Agreements (lAs) and provide support in negotiation Fuel Supply Agreements (FSAs) and Power Purchase Agreements (PPAs). PPIB also provides guarantees to private investors for the performance of Government entities (WAPDA. KESC, etc.) on behalf of the GoP; and monitors the performance of IPPs, WAPDA/NTDC, KESC, fuel suppliers and other government agencies under various contracts. To its credit, the PPIB has successfully implemented Private Sector Power Projects in Pakistan with a cumulative capacity of 5,577 MW,

8.6 Alternative Energy Development Board

Pakistan, like other developing countries of the region, is facing a serious challenge of energy deficit. Renewable Energy (RE) resources can play an important role in

bridging this deficit. More importantly, RE can also play an important role in rural electrification. Realizing the importance of RE, the Government of Pakistan created the Alternative Energy Development Board (AEDB) in May 2003 to act as the central national body on the subject of Renewable Energy. The main objective of this Organization is to facilitate, promote and encourage development of Renewable Energy in Pakistan with a mission to introduce Alternative/Renewable Energy at an accelerated rate to achieve 10 percent share of RE in the energy mix of the country,

The current initiative is directed towards creating a market-based environment that is conducive to private sector investment and participation. The AEDB provides a one window point of operations for investors in the alternate energy sector. They perform all of the functions of the PPIB for alternate energy projects below 50 MW. This is done in order to reduce the timeframe required for the completion of these projects, which are deemed essential to meet Pakistan's short term and long-term energy requirements. Due to this, alternate energy projects to not go through the PPIB.

Another of the mandates of the AEDB is to form international associations in an effort to transfer foreign technology and expertise to Pakistan. It is their objective to reduce the cost of alternate energy by transfer wing as much of the manufacturing process to Pakistan as possible

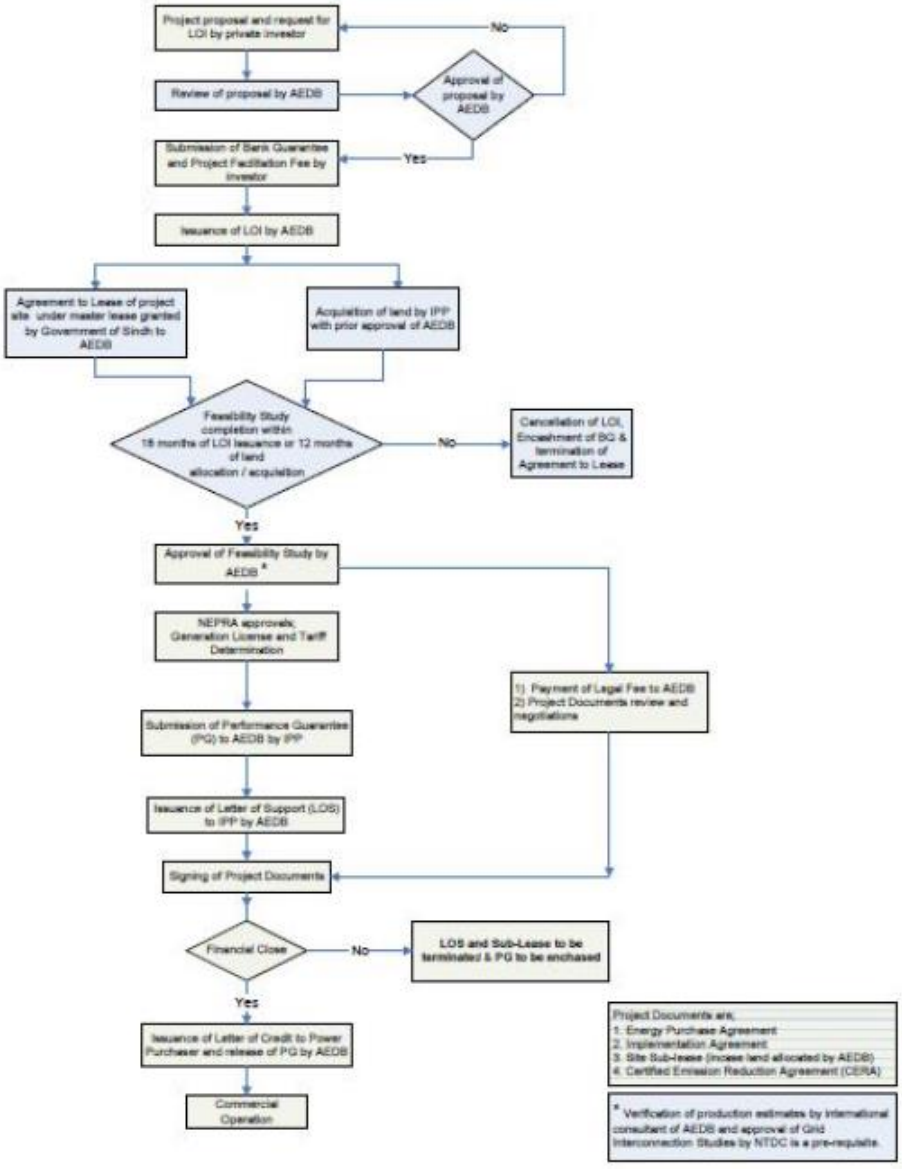
8.7 Provincial Power Cells

Power and irrigation departments exist in each of the four provinces and in AJK, whose prime function is to manage water resources for agriculture and small power generation units of less than 50 MW. Each of these departments has a Chief Engineer, Power Cell, who heads the department's technical management capacity with respect to provincial power projects.

The AEDB also moved towards establishing Alternative Energy Cells with the Sindh and Baluchistan governments by designating official government focal points to serve as liaison officers with the AEDB on RE issues. In northern Pakistan the Sarhad Hydro Development Organization (SHYDO) and the Northern Areas Public Works Department (NAPWD) have been engaged in the development of mini and microhydel schemes.

9. Licensing / Permitting / Security

9.1 Solar Power Project Flow Chart



9.2 Letter Of Intent (LOI)

First step is to get the sponsors registered with AEDB/PPDB or the concerned Board and obtain the Letter of Intent (LOI) from the Government. This letter entitles the sponsors to start working on the power project at official level and get support from the concerned Board and other government departments in the preparation of feasibility study and acquisition of land for the project.

9.3 Acquisition Of Land

PPDB/AEDB have acquired land from Government of Punjab for allocation to Solar Power Projects in the District of Bahawalpur/Bahawalnagar, Cholistan Desert in the province of Punjab. This land is being sub-divided and sub-let for various projects to the sponsors. There are two lease agreements i.e. one between Government of Punjab and PPDB/AEDB for large portions of the land acquired by them and the second between PPDB/AEDB and the project company for the portion required for individual projects.

However, PPDB/AEDB does not take the responsibility to ensure the acquisition of land. The investors have alternate option to buy private land and charge to the project capital cost.

9.4 Company Registration

In order to avail special incentives offered for the power projects such as exemption from income tax and import duties, a special purpose company ("the Project Company') has to be incorporated with only business authorized being electricity generation and sale. This company can be a private limited company or if the sponsors wish to have the company listed on stock exchanged, a public limited company.

9.5 Generation License

Rights to produce and sell electricity in Pakistan are granted by NEPRA through 'Generation License'. Project Company has to make an application to NEPRA for Generation License which authorizes a company to produce and sell electricity in the country.

9.6 Tariff Determination

Once generation license is granted to the Project Company, a separate application is required to be made for approval of the tariff at which the Company will sell electricity to the Power Purchaser. The Power Purchaser can be National Transmission and Distribution Company (NTDC) or one of the Distribution Companies (DISCO's) which in this project is Multan Electric Power Company (MEPCO).

9.7 Building Permissions

All required permissions and NOCs from all relevant authorities are being obtained by the PPDB/AEDB collectively for all power projects in the area.

9.8 Letter Of Support (LOS)

Once the tariff has been approved, the Project Company is required to move for arrangement of financing. PPDB/AEDB will issue a Letter of Support for the Project Company giving government guarantees until EPA and IA are fully effective to ensure sponsors and lender of the full government support. A bank guarantee is required to be submitted before issuance of LOS.

9.9 Energy Purchase Agreement (EPA)

Agreement between the Power Purchaser and the Project Company is called Energy Purchase Agreement (EPA). This agreement lists terms and conditions for the sale and purchase of electricity between the two companies. In a draft of EPA between WAPDA (the respective DISCO or NTDC) and Seller, the Purchaser and the Seller agree on the following:

- Seller plans to develop and implement a Solar PV Power Generating Plant with a nameplate capacity of 50 MW to be located at the site in Cholistan, on a build, own and operate ("BOO") basis.
- Seller wishes to sell and deliver, and the Power Purchaser wishes to purchase and receive the net energy output
- Simultaneously Seller is entering into an Implementation Agreement with the Government of Pakistan (the 'GoP)

9.10 Implementation Agreement (IA)

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

2014

First 50 MW Solar PV Power Project Cholistan Feasibility Study Report

Volume 5 (Updated)

Environmental Studies: IEE & EIA

CEEG 中电电气 China Electric Equipment Group & MR

中水电国际投资有限公司 CWE INVESTMENT CORPORATION

WK WELT KONNECT Driving You Into The Future

By

CEEG Solar Energy Research Institute Co, Ltd (CEEG SI) & MR Consultants

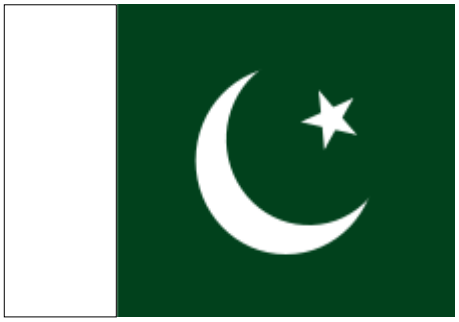
For

CWE Investment Corporation

Joint Venture

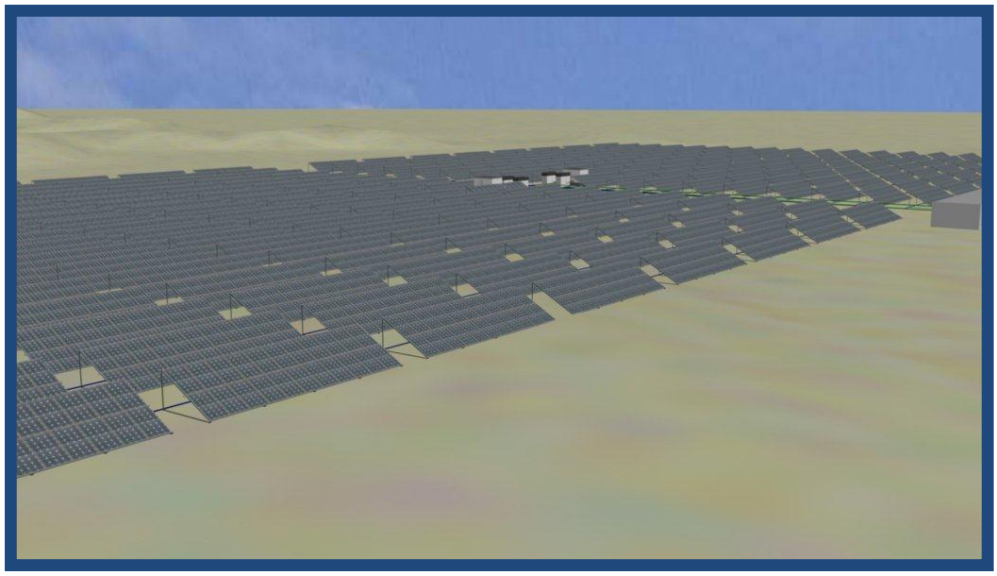
Welt Konnect (Pvt) Ltd

04/10/2014



Feasibility Study Report
First 50 MW Solar PV Power Project
In Cholistan, Punjab, Pakistan

April, 2014



Volume 5 (Updated)
Environmental Studies: IEE & EIA

JOINT VENTURE

CHINA WATER AND ELECTRIC INVESTMENT CORPORATION
&
WELT KONNECT (PVT) LTD

中水电国际投资有限公司
CWE INVESTMENT CORPORATION

TRANS TECH GROUP

WELT KONNECT
Driving You Into The Future

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EXECUTIVE SUMMARY OF THE PROJECT

China Three Gorges (CTG) being a large international clean energy company, houses main businesses of including construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, initially starting with water conservancy & power projects, has now expanded its scope of business into Power Production through Wind, Solar and Nuclear Energy. Their vision is to be the World's largest clean energy group specializing in large-scale hydropower project development, management and operations; while also proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The Total assets of the Group stand around 41,316 million USD, with a revenue generation of 3,787 million USD, 99.47% from sales of electricity, and 1,418 million USD net profits.

Whereas China Water and Electric Investment Corp. (CTGI) *is a new overseas-investment subsidiary company of CTG,* which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CWE Investment Corporation (CWEIC) has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CWEIC is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include Sonda Jehrruk Coal Mine & Power Generation, 1100 MW Kohala Hydropower Project, 720 MW Karot Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

Whereas Welt Konnect (Pvt) Ltd (a subsidiary of the Transtech Group) is a Power Projects Developing company working in Pakistan. Its niche in the Energy Sector lies in the provision of Renewable Energy Engineering solutions particularly for Wind & Solar Power Projects as Independent Power Producers (IPP's) under the Clean Development Mechanism of the UNFCCC. These integrated solutions and systems are designed, simulated and tested by its team of experts and engineers' using the most advanced software's and tools the industry has to offer at this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in the ever growing and critical field of Renewable Energy.

In Accordance with their development strategies respectively, in 2009 after consultation with the Esteemed Punjab Government Welt Konnect (Pvt) Ltd (WK) and China Three Gorges (CTG), planned to invest in the development & construction of Pakistan's first 50 MW Solar PV Power Farm in Cholistan in collaboration as a

Joint Venture. For development of which consequently two MOU's were signed with the Punjab Government in the presence of the Honorable Chief Minister Mr. Shahbaz Sharif, dated June 5th 2010 and later November 6th 2010 after having chalked out a way forward. An MOU was also signed with GTZ for support in developing the project under the Clean Development Mechanism of the UNFCCC.

The Project Site was located near the Cholistan Desert, District Bhawalnagar, with nearest city of Bahawalpur and an installed capacity of 50MWp Photovoltaic Panels and was to function as an Independent Power Producer (IPP) under the rules and regulations of Pakistan.

The project pre-feasibility study was completed by mid-2011. Subsequently after submission of the Pre-Qualification Documents, to the Punjab Power Development Board (PPDB) along with the Pre-Feasibility Report, Project Proposal, the required Bank Guarantees of 50'000.USD (fifty thousand) and the requisite fees, the Joint Venture (JV) successfully obtained an LOI (Letter of Intent) from the Board duly signed and accepted by both parties on 27-08-2011, along with Government Approvals and Support.

Teams were then immediately deployed to initiate work on the feasibility analysis of the project, and competent teams of Engineers & Specialists were deployed for conducting the Environmental Studies, which were successfully completed and compiled in the initial version of Volume 5 of the Feasibility Study Report. The studies revealed there were no Environmental Hazards related to the Project.

Although the subject 50 MW Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under the schedule II classified by Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001, on advice of the Ministry of Climate Change vide its CDM Cell, both studies were conducted and submitted to EPA Punjab which after its due diligence issued a No Objection Certificate (NOC)/Environmental Approval to the Project vide Letter No. DD(EIA)/EPA/F-362(IEE)/2012/544/0309,Dated 13/09/2012, Subject: Environmental Approval.

Whereas the Complete Feasibility Study Report containing the No Objection Certificate (NOC)/Environmental Approval to the Project granted by EPA Punjab, in its FSR Volume 5 was approved by the Panel of Experts (POE) of PPDB in its second meeting and notified vide Letter No. PPDB/05/2013, Dated 01/01/2013, Subject: Approval of 50MW Solar Power Project in Marot Cholistan Punjab.

However due to the change and relocation of the Project Site to the Quaid- E-Azam Solar Park at Lal Suhanara, Bahwalpur, the Feasibility Study Report (FSR) including the Environmental Studies which had been conducted for development of the 50MW Solar PV Power Project on the previous project site of Marot Cholistan

Desert Punjab, have now been re-conducted and updated to reflect such change and acquire all project related Approvals again.

The project site under the Vision of the Chief Minister of Punjab Mr. Shahbaz Sharif, has been shifted to the new location of the Quad-E-Azam Solar Park near to Lal Sohanra, Cholistan, Bahawalpur which in total comprises dedicated land of 6,500 acres for the purposes of establishing Solar Power Generation Stations of approximately 2000 MW's.

The New Project Site allocated to the Joint Venture comprising Welt Konnect Pvt Ltd & CWEI is composed of 250 Acres piece of land as allocated by the Energy Department of the Government of Punjab, through its Letter No.S.O(C)(ED)4-5 2014, Dated: 13th February 2014, Subject: Allocation/Earmarking of Land for 50MW Solar Project in QA Solar Park Bahawalpur. The Project is composed of Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354.

The updated studies reveal no environmental hazards related to the Project. The minor adjustments required during construction phase have been addressed and mitigation plan provided. There are no settlements within 05-08 Km of the Project Site, which further supports the Project in this location.

Both the updated Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) were submitted to the competent authority of EPA Punjab for consideration, with all its concerns raised vide Letter No. DD (EIA)/EPA/F-362(IEE)/2013, dated 10/03/2014, answered in the documents which after its due diligence issued a No Objection Certificate (NOC)/Environmental Approval vide Letter No. DD(EIA)/EPA/F-362(IEE)/2012/0104/681, Dated 15/04/2014, Subject: Environmental Approval.

The Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) of the proposed project were conducted in accordance with the stipulations of Pakistan's environmental laws and the environmental guidelines of the International Finance Corporation (IFC). The process and the results of the IEE are described in this document

The Joint Venture is now submitting the Updated final Feasibility Study along with this Updated Volume 5, for approval by the Panel of Experts (POE) of the Punjab Power Development Board (PPDB). After sanctioning of which competent companies in the field of Solar Photovoltaic's will be selected through a Short Listing Criteria based on Experience, Financial And Technical Competencies of such firms in development & construction of Power Projects and Project Management, which shall be advertised in the News Papers & other relevant media. Consequently the Request for Proposal (RFP) shall be circulated and shared amongst the qualifying companies for finalization of the Engineering Procurement & Construction (EPC) Contract after which a petition for Generation License and a petition for tariff would

simultaneously be filed with the National Electric Power Regulatory Authority (NEPRA) directly for the second stage tariff as allowed under their policy, before issuance of the LOS (Letter Of support) by AEDB. This is intended to save time and cut through avoidable red tape in the development of Independent Power Producers in Pakistan.

The Joint Venture has also completed substantial work on the financial modeling for the project. The JV believes that keeping in view the recent improvement and trend in the viability of the technology, possibility of fast track implementation and current energy crises, this project is of paramount importance for Pakistan and will prove to be a pioneer in the Solar PV industry, paving the way for future progress in this ever growing field and at the same time provide a viable profitable investment opportunity to all stake holders of the country.

1 INTRODUCTION AND ENVIRONMENTAL APPROVAL FOR THE PROJECT

The subject Solar Farm is a 50 MW electricity generation plant designed to produce electricity by solar energy in Cholistan Desert in the province of Punjab, Pakistan. It employs solar photovoltaic (PV) technology that converts solar energy directly into electricity, while emitting zero greenhouse gases (GHG) into the atmosphere. The project is planned to be implemented in phases of 5 MW each and would become operational and start generating CERs right after the completion of the first phase of the project, with work on the other phases continuing. The generated electricity will be supplied to the national grid.

The project conforms to the government policy that promotes development of renewable energy technology and contributes to lowering dependence on electricity generation by fossil fuels which is over 66% of total generation in Pakistan. It is expected to help alleviate the huge energy deficit in Pakistan. It is the first Solar PV project of its size in Pakistan and will be a good source of clean energy.

The area of this project will be about 1011714.105m^2 (250Acres) and annual amount of electricity going to the grid will be about 73.496 Million kWh. As a result over 30,000 tons of CO_2 emissions will be abated per year approximately.

As a large international clean energy company, China Water And Electric Investment Corporation (“CWEI” or the “client”) main businesses include: construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CWEI, starting with water conservancy projects, has now expanded the scope of its business into power generation through wind, solar and nuclear energy. With the vision of being the World’s largest clean energy group specializing in large-scale hydropower development, project management and operations; proactively developing Wind Power, Solar Power and other forms of renewable energy; CWEI is steadily expanding and exploring avenues of overseas business.

Welt Konnect Pvt. Ltd (“WK” or the “client”) a subsidiary of the Transtech Group is a duly established company under the laws of Pakistan specializing in Power Project Development. Its niche in the Alternative Energy sector lies in the provision of Renewable Energy Engineering particularly Wind & Solar Projects as Independent Power Producers (IPP’s), various commercial applications & CDM projects. These integrated systems are designed, simulated and tested by its team of experts and engineers using the most advanced software’s and tools the industry has to offer at

this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in this ever growing field of Renewable Energy.

MR Consultants ("MR" or "the Consultant") is an international consulting company that offers engineering consultancy services in the fields of energy, hydropower and transport since 1990.

After due diligence the Joint Venture awarded MR Consultants the contract, to provide technical consultancy Services for conducting the Feasibility Study Report (FSR) in accordance with the requirements of the Letter of Intent (LOI) issued by Punjab Power Development Board (PPDB) under the 2006-2009 Punjab Power Policy coupled with an energy yield assessment for the PV Plant of 50MW, located in the region of Cholistan Desert in the province of Punjab Pakistan. This report describes the results of the IEE during the Feasibility Study performed for the 50MW PV Plant on the site (Longitude 71 49.196, Latitude 29 17.650). The study also investigated solar power technology options that were appropriate for a large scale solar power facility in Bahwalpur, Punjab and the economic viability of such a solar power facility

The IEE & EIA Studies cover the assessment of the solar power plants' significant environmental impacts and identification of the most appropriate mitigation measures based on the review of the environmental aspect in the plants' feasibility study report by MR consultants and their recent site visit in 2014. The scope of the IEE also includes a review of Welt Konnect and CWEI corporate policies and operational framework for environmental and social management. The IEE concludes that the proposed project will have insignificant environmental and negligible social impacts. Welt Konnect (Pvt.) Ltd. is fully committed to its environmental and social responsibility and discharges this responsibility in adherence to principles of good corporate governance.

One of the most important feature of solar PV systems is that there are no emissions of carbon dioxide - the main gas responsible for global climate change - during their operation. Although indirect emissions of CO2 occur at other stages of the lifecycle, these are significantly lower than the avoided emissions. PV does not involve any other polluting emissions or the type of environmental safety concerns associated with conventional generation technologies. There is no pollution in the form of exhaust fumes or noise.

Decommissioning a system is unproblematic. Although there are no CO2 emissions during operation, a small amount does result from the production stage. PV only emits 21.65 grams CO2/kWh, however, depending on the PV technology. The average emissions for thermal power, on the other hand, are 900g CO2/kWh. By substituting PV for thermal power, a saving of 835879 g/kWh is achieved.

The benefit to be obtained from carbon dioxide reductions in a country's energy mix is dependent on which other generation method, or energy use, solar power is replacing. Where off-grid systems replace diesel generators, they will achieve CO2

savings of about 1 kg per kilowatt-hour. Due to their tremendous inefficiency, the replacement of a kerosene lamp will lead to even larger savings, of up to 350 kg per year from a single 40 Wp module, equal to 25kg CO2/kWh. For consumer applications and remote industrial markets, on the other hand, it is very difficult to identify exact CO2 savings per kilowatt-hour.

Recycling of PV modules is possible and raw materials can be reused. As a result, the energy input associated with PV will be further reduced. If governments adopt a wider use of PV in their national energy generation, solar power can therefore make a substantial contribution towards international commitments to reduce emissions of greenhouse gases and their contribution to climate change. Natural gas is the most environmentally sound of the fossil fuels, because it produces roughly half as much carbon dioxide as coal, and less of other polluting gases. Nuclear power produces very little CO2, but has other major safety, security, proliferation and pollution problems associated with its operation and waste products.

Exemption from EIA or IEE

In addition by virtue of the appropriate research, concrete reasons and paperwork, Please be informed that the matter of IEE and EIA reports for the 50MW Solar PV Power Project, was taken up with the Federal Government Ministry of Water and Power, with respect to the Exemption of the said Solar Power Project from either of EIA And IEE Studies, under the Pakistan Environmental Protection Act, 1997 (which primarily deals with the creation of EPA's and their ambit of functioning with general guidelines) and the PAKISTAN ENVIRONMENTAL PROTECTION AGENCY (REVIEW OF IEE AND EIA) REGULATIONS, 2000 (the only document dealing in detail with IEE and EIA Studies.), ***As a result of which we a conditional No Object Certificate (NOC) has already been issued and is below.***

You will find below a more detailed explanation to the above synopsis.

As can be seen in the language of article 12 of the Pakistan Environmental Protection Act, 1997, provided below and its relevant portion quoted here:

> "No proponent of a project shall commence construction or operation unless he has filed with the Government Agency designated by Federal Environmental Protection Agency or Provincial Environmental Protection Agencies, ***as the case may be***, or, ***where the project is likely to cause an adverse environmental effects an environmental impact assessment, and has obtained from the Government Agency approval in respect thereof***."

the proponent is Not required to do the IEE or EIA if that is not required as the case may be and/or the project does not have an adverse effect on the Environment. We are very well aware that Solar Power Project particularly Photovoltaic's has no such effect.

Now coming to the PAKISTAN ENVIRONMENTAL PROTECTION AGENCY (REVIEW OF IEE AND EIA) REGULATIONS, 2000 whose relevant sections 3**. Projects requiring an IEE**, 4 **. Projects requiring an EIA** and 5 **Projects not requiring an IEE or EIA,** are provided below. It can clearly be seen that We neither fall in Schedule 1 or Schedule II of the Regulations Governing the functioning of the EPA's with respect to the IEE and EIA reports.

3. Projects requiring an IEE

A proponent of a project falling in any category listed in Schedule I shall file an IEE with the Federal Agency, and the provisions of section 12 shall apply to such project.

4. Projects requiring an EIA

A proponent of a project falling in any category listed in Schedule II shall file an EIA with the Federal Agency, and the provisions of section 12 shall apply to such project.

5. Projects not requiring an IEE or EIA

(1) A proponent of a project not falling in any category listed in Schedules I and II shall not be required to file an IEE or EIA:

Provided that the proponent shall file –

(a) an EIA, if the project is likely to cause an adverse environmental effect;

(b) for projects not listed in Schedules I and II in respect of which the Federal Agency has issued guidelines for construction and operation, an application for approval accompanied by an undertaking and an affidavit that the aforesaid guidelines shall be fully complied with.

(2) Notwithstanding anything contained in sub-regulation (1), the Federal Agency may direct the proponent of a project, whether or not listed in Schedule I or II, to file an IEE or EIA, for reasons to be recorded in such direction: Provided that no such direction shall be issued without the recommendation in writing of the Environmental Assessment Advisory Committee constituted under Regulation 23.

(3) The provisions of section 12 shall apply to a project in respect of which an IEE or EIA is filed under sub-regulation (1) or (2)."

12. Initial environmental examination and environmental impact assessment.—(1) No proponent of a project shall commence construction or operation unless he has filed with the Government Agency designated by Federal Environmental Protection Agency or Provincial Environmental Protection Agencies, as the case may be, or, where the project is likely to cause an adverse environmental effects an environmental impact assessment, and has obtained from the Government Agency approval in respect thereof.

(2) The Government Agency shall subject to standards fixed by the Federal Environmental Protection Agency—

(a) review the initial environmental examination and accord its approval, or require submission of an environmental impact assessment by the proponent; or
(b) review the environmental impact assessment and accord its approval subject to such conditions as it may deem fit to impose, require that the environmental impact assessment be re-submitted after such modifications as may be stipulated or reject the project as being contrary to environmental objectives.

(3) Every review of an environmental impact assessment shall be carried out with public participation and no information will be disclosed during the course of such public participation which relates to—

(i) trade, manufacturing or business activities, processes or techniques of a proprietary nature, or financial, commercial, scientific or technical matters which the proponent has requested should remain confidential, unless for reasons to be recorded in writing, the Director General of the Federal Agency is of the opinion that the request for confidentiality is not well- founded or the public interest in the disclosure outweighs the possible prejudice to the competitive position of the project or its proponent; or
(ii) international relations, national security or maintenance of law and order, except with the consent of the Federal Government; or
(iii) matters covered by legal professional privilege.

(4) The Government Agency shall communicate its approval or otherwise within a period of four months from the date the initial environmental examination or environmental impact assessment is filed complete in all respects in accordance with the prescribed procedure, failing which the initial environmental examination or, as the case may be, the environmental impact assessment shall be deemed to have been approved, to the extent to which it does not contravene the provisions of this Act and the rules and regulations.

(5) Subject to sub-section (4) the appropriate Government may in a particular case extend the aforementioned period of four months if the nature of the project so warrants.

(6) The provisions of sub-sections (1), (2), (3), (4) and (5) shall apply to such categories of projects and in such manner as may be prescribed.

(7) The Government Agency shall maintain separate registers for initial environmental examination and environmental impact assessment projects, which shall contain brief particulars of each project and a summary of decisions taken thereon, and which shall be open to inspection by the public at all reasonable hours

and the disclosure of information in such registers shall be subject to the restrictions specified in sub-section (3).**"**

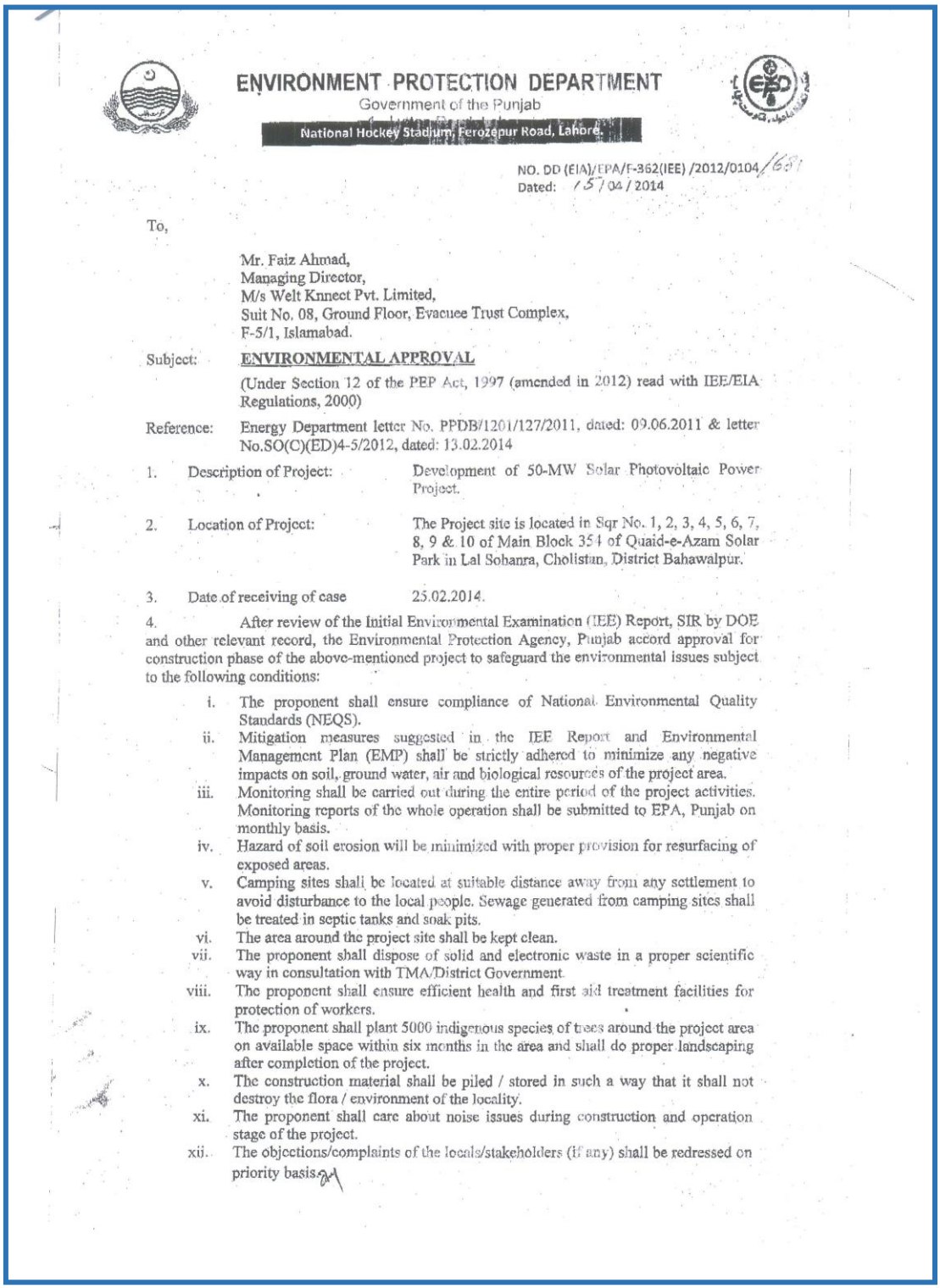
Hence the project is exempt from the IEE and EIA studies and an NOC in this regard has already been issued.

Initial Environment Examination (IEE) and Environmental Impact Assessment (EIA)

However on advise of the Clean Development Mechanism Cell Ministry of Climate Change, both the IEE and EIA studies were conducted and submitted to EPA Punjab which after its due diligence issued a No Objection Certificate (NOC)/Environmental Approval to the Project vide Letter No. DD(EIA)/EPA/F-362(IEE)/2012/544/0309,Dated 13/09/2012, Subject: Environmental Approval, which is provided below in Figure 1.3 & 1.4.

Whereas due to the change in Project Site both the updated Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) were submitted to the competent authority of EPA Punjab again for consideration, with all its concerns raised vide Letter No. DD (EIA)/EPA/F-362(IEE)/2013, dated 10/03/2014, answered in the documents, which after its due diligence issued a No Objection Certificate (NOC)/Environmental Approval vide Letter No. DD(EIA)/EPA/F-362(IEE)/2012/0104/681, Dated 15/04/2014, Subject: Environmental Approval, provided below in Figure 1.1 & 1.2.

The IEE and EIA are provided below in Section 2 and 3 respectively late in the booklet.



ENVIRONMENT PROTECTION DEPARTMENT
Government of the Punjab
National Hockey Stadium, Ferozepur Road, Lahore.

NO. DD (EIA)/EPA/F-362(IEE) /2012/0104/681
Dated: 15/04/2014

To,

Mr. Faiz Ahmad,
Managing Director,
M/s Welt Knnect Pvt. Limited,
Suit No. 08, Ground Floor, Evacuee Trust Complex,
F-5/1, Islamabad.

Subject: **ENVIRONMENTAL APPROVAL**

(Under Section 12 of the PEP Act, 1997 (amended in 2012) read with IEE/EIA Regulations, 2000)

Reference: Energy Department letter No. PPDB/1201/127/2011, dated: 09.06.2011 & letter No.SO(C)(ED)4-5/2012, dated: 13.02.2014

1. Description of Project: Development of 50-MW Solar Photovoltaic Power Project.

2. Location of Project: The Project site is located in Sqr No. 1, 2, 3, 4, 5, 6, 7, 8, 9 & 10 of Main Block 354 of Quaid-e-Azam Solar Park in Lal Sohanra, Cholistan, District Bahawalpur.

3. Date of receiving of case 25.02.2014.

4. After review of the Initial Environmental Examination (IEE) Report, SIR by DOE and other relevant record, the Environmental Protection Agency, Punjab accord approval for construction phase of the above-mentioned project to safeguard the environmental issues subject to the following conditions:

i. The proponent shall ensure compliance of National Environmental Quality Standards (NEQS).
ii. Mitigation measures suggested in the IEE Report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area.
iii. Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on monthly basis.
iv. Hazard of soil erosion will be minimized with proper provision for resurfacing of exposed areas.
v. Camping sites shall be located at suitable distance away from any settlement to avoid disturbance to the local people. Sewage generated from camping sites shall be treated in septic tanks and soak pits.
vi. The area around the project site shall be kept clean.
vii. The proponent shall dispose of solid and electronic waste in a proper scientific way in consultation with TMA/District Government.
viii. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.
ix. The proponent shall plant 5000 indigenous species of trees around the project area on available space within six months in the area and shall do proper landscaping after completion of the project.
x. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.
xi. The proponent shall care about noise issues during construction and operation stage of the project.
xii. The objections/complaints of the locals/stakeholders (if any) shall be redressed on priority basis.

Figure 1.1: NOC 2014 by EPA Punjab Part 1

xiii. The proponent shall provide compensation to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the relevant rates and that are agreed upon. There under all conflicting issues regarding compensation, etc. should be settled amicably by the competent authority before the start of the project activities.

xiv. The proponent shall obtain NOC / clearance from all other concerned departments before commencement of work.

xv. The proponent shall appoint Environmental Manager having qualification of M.Sc. Environmental Sciences or equivalent qualification recognized by the competent authority/ forum for the project and shall convey his name along with his complete Mailing Address and Phone Numbers.

5. The Proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.

6. The Proponent shall be liable for compliance of Regulations 13, 14, 17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

7. This approval is accorded only for the construction phase of the project. The proponent will obtain approval for operational phase of the project in accordance with regulation 13(2)(b) and Regulation 18 of the IEE/EIA Regulations, 2000.

8. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.

9. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under regulation 16 of IEE / EIA Regulations, 2000.

10. This approval can be withdrawn at anytime without any prior notice if deem necessary in the public / national interest.

(AMEN HANIF)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab
Ph: # 042-99232228.

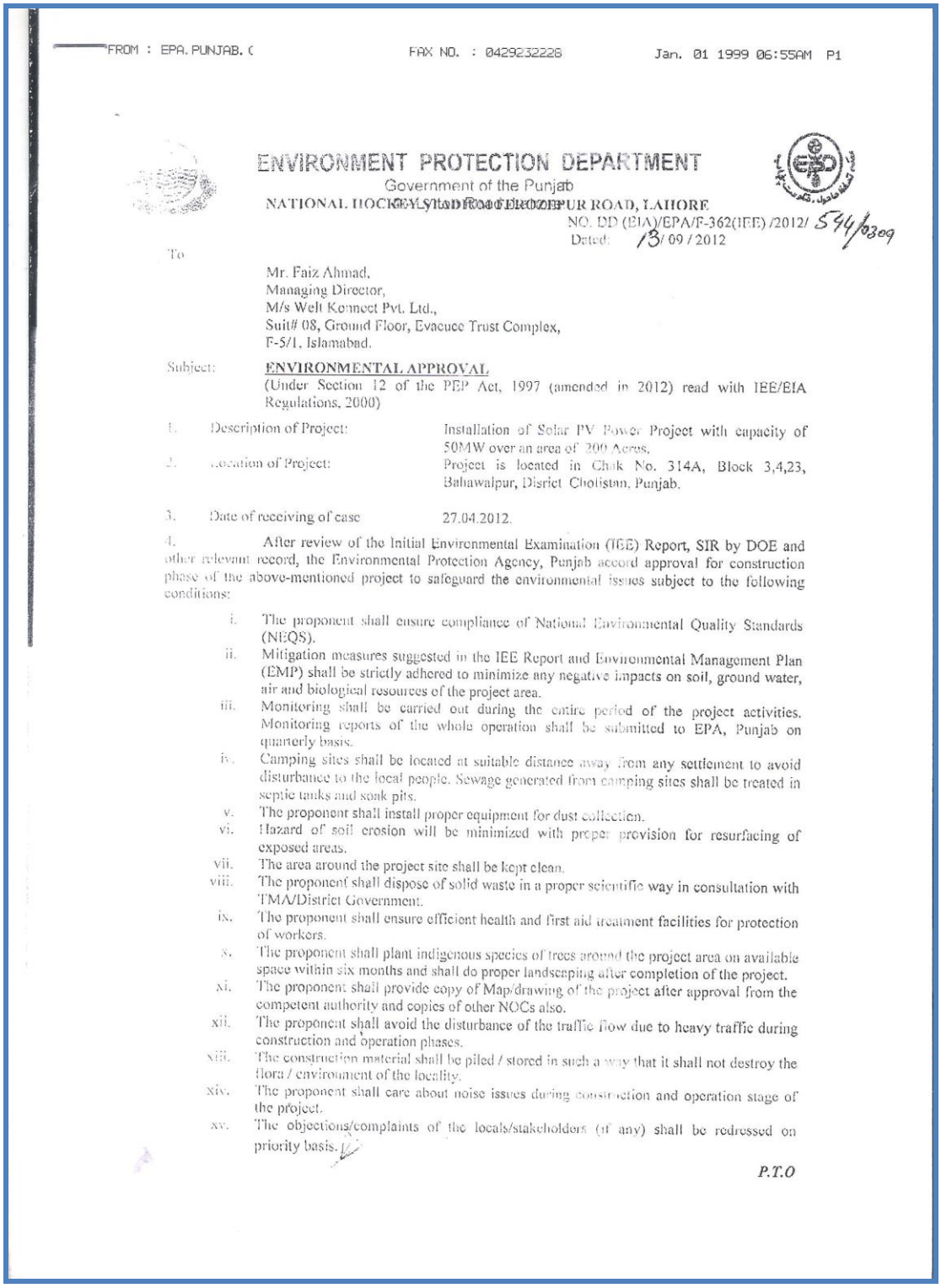
NO. & DATE EVEN.

A copy is forwarded for information to:

1. The District Officers (Environment), Bahawalpur w.r.t. his letter No. 854/EIA/DO/EPA/BWP dated 29.03.2014. He is requested to ensure compliance of the above-mentioned conditions under intimation to this office.

(AMEN HANIF)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab

Figure 1.2: NOC 2014 by EPA Punjab Part 2



FROM : EPA. PUNJAB. (FAX NO. : 0429232228 Jan. 01 1999 06:55AM P1

ENVIRONMENT PROTECTION DEPARTMENT
Government of the Punjab
NATIONAL HOCKEY STADIUM, FEROZEPUR ROAD, LAHORE

NO. DD (EIA)/EPA/F-362(IEE) /2012/ 544/309
Dated: 13/ 09 / 2012

To

Mr. Faiz Ahmad,
Managing Director,
M/s Well Konnect Pvt. Ltd.,
Suit# 08, Ground Floor, Evacuee Trust Complex,
F-5/1, Islamabad.

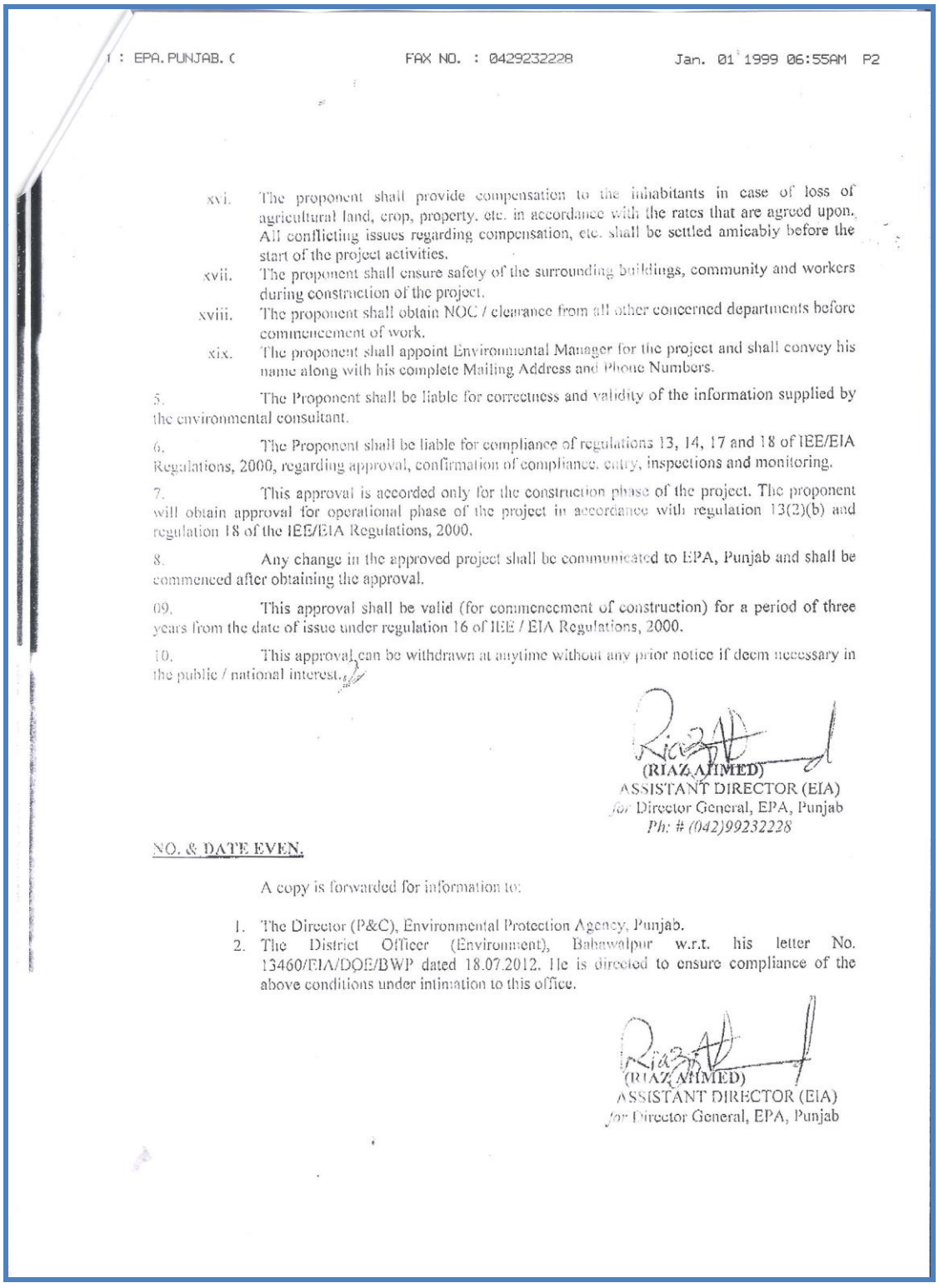
Subject: **ENVIRONMENTAL APPROVAL**
(Under Section 12 of the PEP Act, 1997 (amended in 2012) read with IEE/EIA Regulations, 2000)

1. Description of Project: Installation of Solar PV Power Project with capacity of 50MW over an area of 200 Acres.
2. Location of Project: Project is located in Chak No. 314A, Block 3,4,23, Bahawalpur, District Cholistan, Punjab.
3. Date of receiving of case 27.04.2012.
4. After review of the Initial Environmental Examination (IEE) Report, SIR by DOE and other relevant record, the Environmental Protection Agency, Punjab accord approval for construction phase of the above-mentioned project to safeguard the environmental issues subject to the following conditions:

i. The proponent shall ensure compliance of National Environmental Quality Standards (NEQS).
ii. Mitigation measures suggested in the IEE Report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area.
iii. Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on quarterly basis.
iv. Camping sites shall be located at suitable distance away from any settlement to avoid disturbance to the local people. Sewage generated from camping sites shall be treated in septic tanks and soak pits.
v. The proponent shall install proper equipment for dust collection.
vi. Hazard of soil erosion will be minimized with proper provision for resurfacing of exposed areas.
vii. The area around the project site shall be kept clean.
viii. The proponent shall dispose of solid waste in a proper scientific way in consultation with TMA/District Government.
ix. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.
x. The proponent shall plant indigenous species of trees around the project area on available space within six months and shall do proper landscaping after completion of the project.
xi. The proponent shall provide copy of Map/drawing of the project after approval from the competent authority and copies of other NOCs also.
xii. The proponent shall avoid the disturbance of the traffic flow due to heavy traffic during construction and operation phases.
xiii. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.
xiv. The proponent shall care about noise issues during construction and operation stage of the project.
xv. The objections/complaints of the locals/stakeholders (if any) shall be redressed on priority basis.

P.T.O

Figure 1.3: NOC 2012 by EPA Punjab Part 1



: EPA. PUNJAB. C FAX NO. : 0429232228 Jan. 01 1999 06:55AM P2

xvi. The proponent shall provide compensation to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the rates that are agreed upon. All conflicting issues regarding compensation, etc. shall be settled amicably before the start of the project activities.

xvii. The proponent shall ensure safety of the surrounding buildings, community and workers during construction of the project.

xviii. The proponent shall obtain NOC / clearance from all other concerned departments before commencement of work.

xix. The proponent shall appoint Environmental Manager for the project and shall convey his name along with his complete Mailing Address and Phone Numbers.

5. The Proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.

6. The Proponent shall be liable for compliance of regulations 13, 14, 17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

7. This approval is accorded only for the construction phase of the project. The proponent will obtain approval for operational phase of the project in accordance with regulation 13(2)(b) and regulation 18 of the IEE/EIA Regulations, 2000.

8. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.

09. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under regulation 16 of IEE / EIA Regulations, 2000.

10. This approval can be withdrawn at anytime without any prior notice if deem necessary in the public / national interest.

(RIAZ AHMED)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab
Ph: # (042)99232228

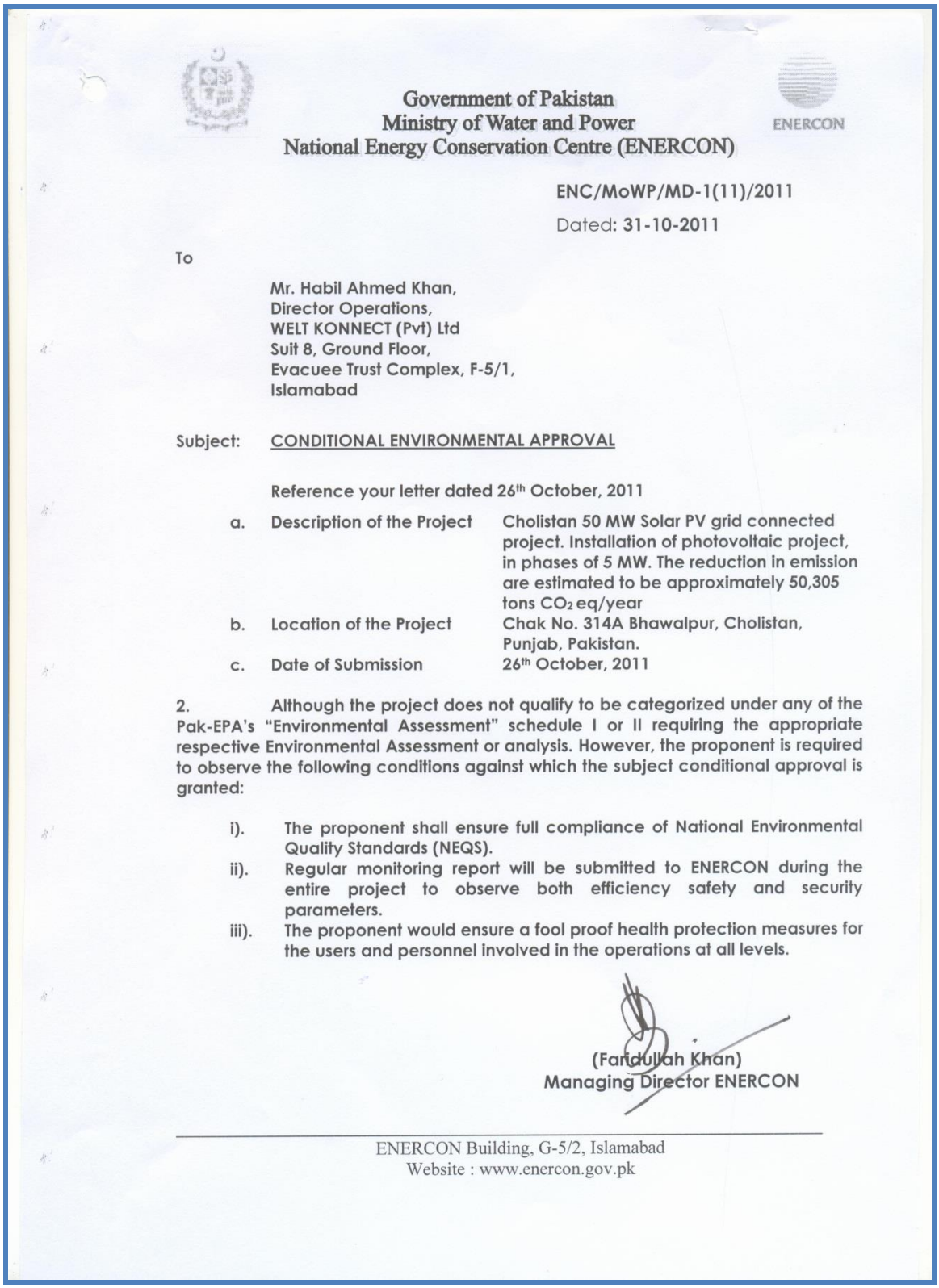
NO. & DATE EVEN.

A copy is forwarded for information to:

1. The Director (P&C), Environmental Protection Agency, Punjab.
2. The District Officer (Environment), Bahawalpur w.r.t. his letter No. 13460/EIA/DOE/BWP dated 18.07.2012. He is directed to ensure compliance of the above conditions under intimation to this office.

(RIAZ AHMED)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab

Figure 1.4: NOC 2012 by EPA Punjab Part 2



Government of Pakistan
Ministry of Water and Power
National Energy Conservation Centre (ENERCON)

ENERCON

ENC/MoWP/MD-1(11)/2011

Dated: 31-10-2011

To

Mr. Habil Ahmed Khan,
Director Operations,
WELT KONNECT (Pvt) Ltd
Suit 8, Ground Floor,
Evacuee Trust Complex, F-5/1,
Islamabad

Subject: CONDITIONAL ENVIRONMENTAL APPROVAL

Reference your letter dated 26th October, 2011

a.	Description of the Project	Cholistan 50 MW Solar PV grid connected project. Installation of photovoltaic project, in phases of 5 MW. The reduction in emission are estimated to be approximately 50,305 tons CO_2 eq/year
b.	Location of the Project	Chak No. 314A Bhawalpur, Cholistan, Punjab, Pakistan.
c.	Date of Submission	26th October, 2011

2. Although the project does not qualify to be categorized under any of the Pak-EPA's "Environmental Assessment" schedule I or II requiring the appropriate respective Environmental Assessment or analysis. However, the proponent is required to observe the following conditions against which the subject conditional approval is granted:

i). The proponent shall ensure full compliance of National Environmental Quality Standards (NEQS).
ii). Regular monitoring report will be submitted to ENERCON during the entire project to observe both efficiency safety and security parameters.
iii). The proponent would ensure a fool proof health protection measures for the users and personnel involved in the operations at all levels.

(Faridullah Khan)
Managing Director ENERCON

ENERCON Building, G-5/2, Islamabad
Website : www.enercon.gov.pk

Figure 1.5: Conditional NOC by Ministry of Water and Power Enercon

2 INITIAL ENVIRONMENT EXAMINATION (IEE)

I. Application Form (As per Schedule IV in PEPRA 2000)

1	Name and Address of Proponent	Welt Konnect (Pvt) Ltd Suit 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad.	Phones: Fax: Telex:	0092-51-2870422-3 0092-51-2870424	
2	Description of Project	Cholistan Solar Farm is a 50 MW electricity generation plant designed to produce electricity by solar energy in Cholistan Desert in the province of Punjab, Pakistan. It employs solar photovoltaic (PV) technology that converts solar energy directly into electricity, while emitting zero greenhouse gases (GHG) into the atmosphere. The project is planned to be implemented in phases of 5 MW each and would become operational and start generating CERs right after the completion of the first phase of the project with work on the other phases continuing. The generated electricity will be supplied to the national grid. The project conforms to the government policy that promotes development of renewable energy technology and contributes to lowering dependence on electricity generation by fossil fuels which is over 66% of total generation in Pakistan. It is expected to help alleviate the huge energy deficit in Pakistan. It is the first Solar PV project of its size in Pakistan and will be a good source of clean energy. The area of this project will be about 809371.284 m^2 (200Acres) and annual amount of electricity going to the grid will be about 125,469 MWh. As a result over 60,000 tons of CO_2 emissions will be abated per year.			
3	Location of Project	Sqr . 1,2,3,4,5,6,7,8,9 & 10 of Main Block 354 of Quaid-e-Azam Solar Park, Punjab (Copy of Map is attached)			
4	Objectives of Project	To set up a clean energy Independent Power Producer in the Solar Photovoltaic sector harnessing the power of the sun.			
5	IEE	IEE	**YES**/No		
6	Have alternatives been considered and reported in IEE or EIA		**YES**/No		
7	Existing Land Use	None, Barren Land, without any productivity or human habitation	Land Requirement	500 Acres	
8	Is the basic Site data available or has it been measured?	(only tick yes if the data is reported in the IEE/EIA) Meteorology (including rainfall) Ambient Air	**Available** **Yes**/No **Yes**/No **Yes**/No **Yes**/No	**Measured** **Yes**/No **Yes**/No **Yes**/No **Yes**/No	

		Quality Ambient Water Quality Ground Water Quality		
9	Have estimates of the following been reported?	Water Balance Solid Waste Liquid Waste treatment	**Estimated** **Yes**/No **Yes**/No **Yes**/No	**Reported** Yes/**Not Applicable** Yes/**Not Applicable** Yes/**Not Applicable**
10	Source of Power	Natural Solar Energy	Power Requirement	None
11	Labor Force (number): As Per EPC Contract	Construction: As Per EPC Contract Operation: Approx. 10	All local labor force. Only management and consultant officials from other locations.	

Verification

I do solemnly affirm and declare that the information given above and contained in the attached IEE/EIA is true and correct to the best of my knowledge and belief.

Date 25th February 2014

_____

Signature, name and designation of proponent (with official stamp/seal)

II. Policy Legal and Administrative Framework

As per the general criteria the project should be consistent with the national laws and sustainable development policies, strategies and plans including:

- **Pakistan Environmental Protection Act- 1997**

The project is in compliance with the PEPA 1997, and as mentioned in Para 12 of the said act, this project being a solar PV project in a desert with almost no population or wildlife or plantation, does not have any adverse effect on the environment whatsoever. However an Environment studies have been filed with the relevant authorities for their consideration.

- **National Energy Conservation Strategy**

The project complies with the three explicit objectives of the NECS: conservation of natural resources, promotion of sustainable development, and improvement of efficiency in the use and management of resources; and would also abide by policies outlined for pollution control as in S.No 4, 8, 10, 12 and 13 of the 14 core programme areas.

- **National Environment Policy**

The project is in unison and support of the NEP, particularly contents of 3.4, 3.4(h), 3.6, 3.7, 3.9, 4.1, 4.3, 4.4, 5.4, 5.5 and 5.6.

- **National Forestry Policy**

The project is in harmony with the National Forestry Policy and although being situated in a desert namely Cholistan it will contribute to the national grid and hence meet the objectives of Para 1.2 by generating power from solar energy which will indirectly hinder cutting of mountain trees for firewood. It also supports Para 7, 10.2, and 10.3.

- **National Renewable Energy Policy**

The project complies with NREP, articles 4 (4.4), 8.1, and 8.3 (8.3.3)

- **Medium-term Development Framework**

The project supports Medium term Development Framework objectives such as poverty reduction, upgrading of physical infrastructure, energy security, accelerated development of lesser developed areas, and environment.

- **Pakistan Environmental Protection Agency Regulations 2000**

  Environmental impact assessment or Initial Environment Examination is not required for solar power projects in Pakistan as per section 3 and 4 of the Pakistan Environmental Protection Agency's Regulations 2000. However a complete IEE Document has been prepared for the project.

- **Other Relevant Policies and Plans of the Government**

  The project complies and is in harmony with all relevant concerned policies of the government of Pakistan. The project will not result in any obligation towards the investor country other than CER authorization.

III. Description of the Project

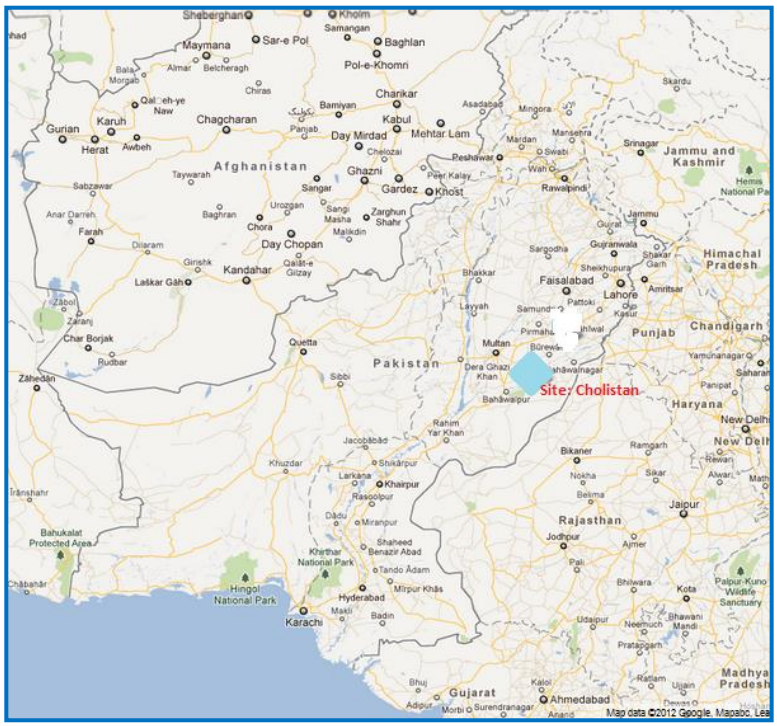
Project Location

Comprehensive due diligence was carried out by experts and representatives from all stakeholders of the project, which was followed by a review and selection procedure. The site allocated encompasses an area of 250 Acres (Sqr No: 1,2,3,4,5,6,7,8,9 & 10 of Main Block 354 of QASP), which is approximately 4 to 5 Km away from the nearest Grid Station and about 35 to 45 km from Bahawalpur (the nearest urban city). **Extract 1** shows the Coordinates of the project, while **Extract 2** shows the geographical location of the project.

Extract 1: Coordinates of the project

50 MW Project Coordinates		
Node	**Longitude (East)**	**Latitude (North)**
1	71 49.196	29 17.650
2	71 49.817	29 17.650
3	71 49.196	29 16.998
4	71 49.817	29 17.324
5	71 49.608	29 17.324
6	71 49.608	29 16.998

Extract 2: Geographical location of the project



Scope and Layout

After review of the equipment which would need to be utilized to ensure optimized performance and maximum yield generation, the Project Layout has been designed to utilize 33 of 1.6 MW Inverter combined units of SMA 800 SCP Series Inverters further connected to 33 SMA Low to Medium range voltage transformers at approximately 360V AC, one for each 1.6MW unit respectively, leading finally to the switch gear or transformer from medium to high voltage range for connection to the Grid Station at 132KV . Each unit of 1.6 MW is consists of 3366 panels, 2 inverters and 1 transformer.

A string concept is being used with 22 modules connected to a string, and 17 strings connected on a Bus leading to the SMA Inverters connection in parallel with a total of 9 such connections. The total number of PV modules used in this arrangement would be 3366 units per 1.6 MW with a total of approximately 30 such units for the complete 50 MW setup. **Extract 3** shows the technical specifications of the modules.

Extract 3 Technical specifications of the modules

Module Technology	Crystalline	Thin-Film
Generation	1st	2nd
Market Shares (2008)	84 %	16 %
Data Availability	Old Technology; Data is available for analysis	Relatively Newer Technology; Data is scant for reliability analysis
Efficiency	Mono crystalline: 17 % Poly crystalline: 13.5	9 %
Lowest Retail Price ($/watt)	High Mono Crystalline: 1.20 Poly Crystalline: 1.08	Low 0.81
Weight to Power Ratio	Small	Large
Module Size	Large range 65 – 240 W	Small Range 65 – 130 W

The modules to be selected for the project should have in built features for extreme weather conditions to be suitable for the project site. The modules would be subject to conditions such as temperatures exceeding 50 °C, wind speeds exceeding 5 m/s, and precipitation on panels in case of rare occasional occurrence of a sand-storm. Therefore, modules should consist of materials that have high tolerance to these conditions and more, meaning a high factor of safety and resilience. Additionally, the modules should allow for easy and fast maintenance along with cleaning operations

Construction

The land acquired by the Joint Venture consists primarily of flat ground and sand dunes. Construction of the solar farm will be focused on the flat areas. Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading. The panels would be mounted on racks, facing due south, at an angle of 30 degrees above horizontal to maximize the system for annual energy production. The mounting racks would be aligned in rows along an east-west axis across the entire area defined for the project. Depending on the height of the panels off the ground, it is estimated that approximately five to six feet of spacing between rows would be required to prevent shading from one row of modules onto the other.

A single string of 22 modules has the dimensions: 12 m x 3 m. An inverter requires 153 such strings connected in a 17 x 9 pattern. The dimensions of one such inverter

unit would be 200 m x 54 m. The total land requirement for 62 such inverter units would be 670,000 m^2 (166 acres) which is clearly within the value of the acquired land. There are three options that can be utilized when setting the tracking system of a photo-voltaic powered power plant namely single axis, dual axis or no tracking system.

Design optimization shows that for such a large number of panels, a tracking system would require a large initial investment as well as yearly maintenance for a relatively lower amount of increase in yield. Therefore the company has opted to utilize no tracking system

The modules would be clamped to a long term resistant mounting structure (details of which are provided in subsequent sections). The mountings will be made with considerations of stress analysis in weight and wind conditions.

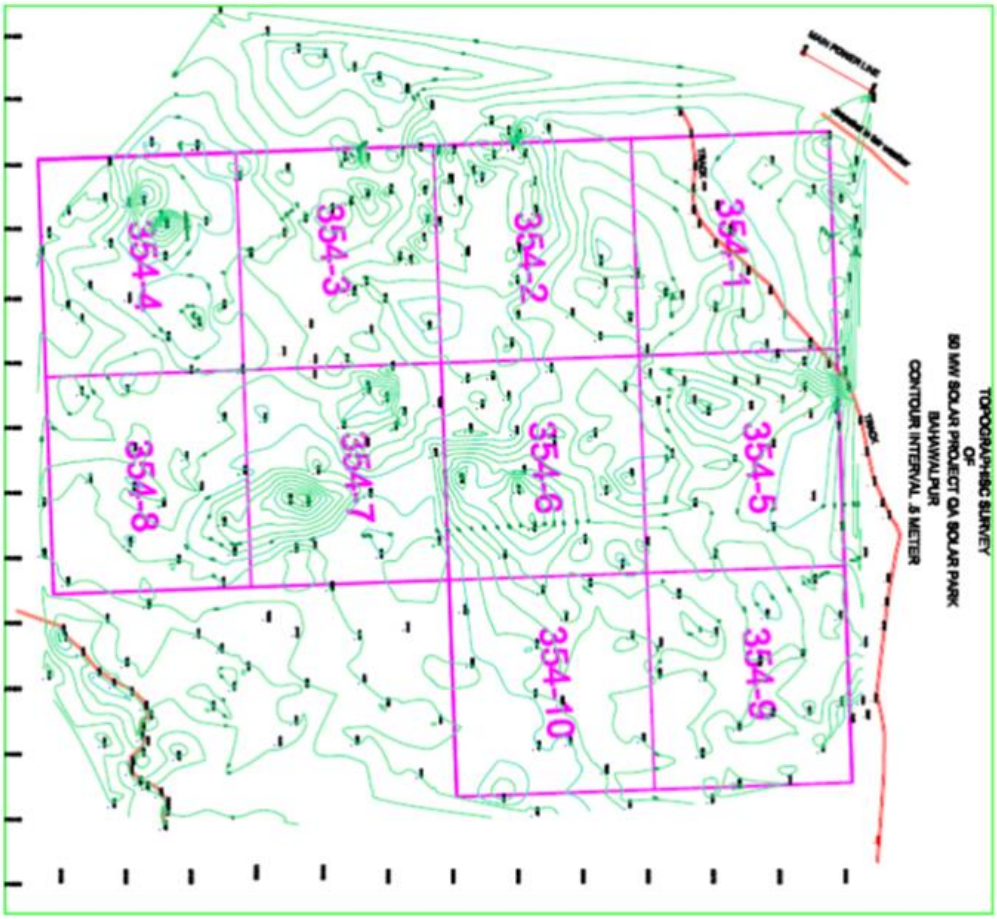
IV. Description of Environment

Site Condition

The land acquired by the Joint Venture consists primarily of flat ground and scarce sand dunes at the peripheral of the site. Construction of the solar farm will be focused on the flat areas.

Cholistan has very low propensity towards natural disasters or similar risks. Till date the nearest area to Cholistan which has faced the effects of a flood is Bahawalpur and that too only once in history. Cholistan and nearby areas for a significant radius are not prone to earth quakes (as per past records). The Project is strategically positioned between the Farm Lands being irrigated by man made canals taken out from the Indus River passing through Punjab on its way to Sindh which cover it on 3 sides and on the other hand a national park on the fourth side giving a natural cover. **Extract 4** represents the topographic survey of the project site.

Extract 4: Topographic Survey of the Site



Micro Climate Effects

The Pakistan Meteorological Department is both a scientific and a service department, and functions under the Ministry of Defense. It is responsible for providing meteorological service throughout Pakistan to wide variety of interest and for numerous public activities and projects which require weather information.

In its services to aviation the department's responsibility goes to some extent beyond national boundaries in fulfillment of accepted international agreements and obligations which include, among other things, the collection and rebroadcast of meteorological data.

Apart from meteorology, the department is also concerned with Agro meteorology, Hydrology, Astronomy and Astrophysics (including solar physics), Seismology, Geomagnetism, Atmospheric Electricity and studies of the Ionosphere and Cosmic Rays. Pakistan Meteorological Department shoulders the responsibility to investigate the factors responsible for global warming, climate change its impact assessment and adaptation strategies in various sectors of human activities.

Microclimate effects of Cholistan and nearby area are characterized by low and rare sporadic rain. The mean annual rainfall varies from less than 100 mm in the west to 200 mm in the east and as per collected Synthetic Data, installed SRA equipment on site and information gathered from Locals, it rains only 1 to 3 times a years.

Rain usually falls during monsoon (July through September), winter and spring (January through March). Aridity is the most striking feature of the Cholistan desert with wet and dry years occurring in clusters. Cholistan is one of the hottest regions of Pakistan. Temperatures are high in summer and mild in winter. The mean summer temperature (May, June) is 34 ^{o}C with the highest reaching above 51 ^{o}C. **Extract 5** gives us the meteorological details of the site.

Extract 5 The meteorological details of the site

	Average Temperature ^{0}C		Average Humidity %	Precipitation (mm/day)
Months	**Min**	**Max**		**Mean**
Jan	6.95	19.9	45.3	0.30
Feb	9.19	22.9	38.2	0.61
Mar	15.1	29.3	29.3	0.66
Apr	20.8	34.2	27.4	0.52
May	25.3	37.9	30.3	0.54
Jun	28.2	38.2	43.4	1.22
Jul	28.0	35.1	61.8	3.63
Aug	26.9	33.4	67.7	2.95
Sep	24.8	33.8	55.4	1.22
Oct	19.3	32.6	33.5	0.40
Nov	13.8	27.8	31.6	0.09
Dec	8.99	22.2	39.1	0.23

Soil, Water and Vegetation Condition

The investigated site is located at Marot, Tehsil Fort Abbas, District Bhawalnagar. The area is mainly underlain by Sandy Silty Clay up to the maximum explored depth.

Soil

The onsite material is generally classified as SANDY SILTY CLAY (CL-ML) group of Unified Soil Classification System. Prior to any construction activity, the site must be cleared of all debris and surface vegetation. The leveling and grading can be carried out by normal earth moving machine. It is recommended that immediately after excavation for construction of foundation or other substructures, the excavation bottoms and slopes are cleared of all debris, proof rolled and covered by a 5 cm thick blinding concrete layer.

Water

The site is facilitated with a very favorable level of water table, less than 20m below ground level. The project team would drill bores to gain access to this water table

and its supply. Simultaneously for initial work scope, there are existing wells within approachable distance which are being used by local habitants for their live stock.

Vegetation

Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading. The panels would be mounted on racks, facing due south, at an angle of 30 degrees above horizontal to maximize the system for annual energy production.

V. Anticipated Impacts and Mitigation Measures

Impacts during Construction

The civil, mechanical and electrical works will be minor and will spread over the large project site. Considering the nature and magnitude of construction works and the ecological insensitivity of the project site, it is certain that the construction would create only minor and manageable environmental disturbances such as noise from trucks and excavation equipment, which are insignificant impacts due to the absence of communities in the area. No toxic and hazardous materials will be used in the construction apart from diesel oils for vehicles, which will be properly stored. The construction contracts will require the EPC contractors to be responsible for undertaking effective measures for environmental impact mitigation. Environmental performance of the EPC contractors will be monitored by the joint on site project management team, specifically the personnel of HSE Department.

Impacts during Operation

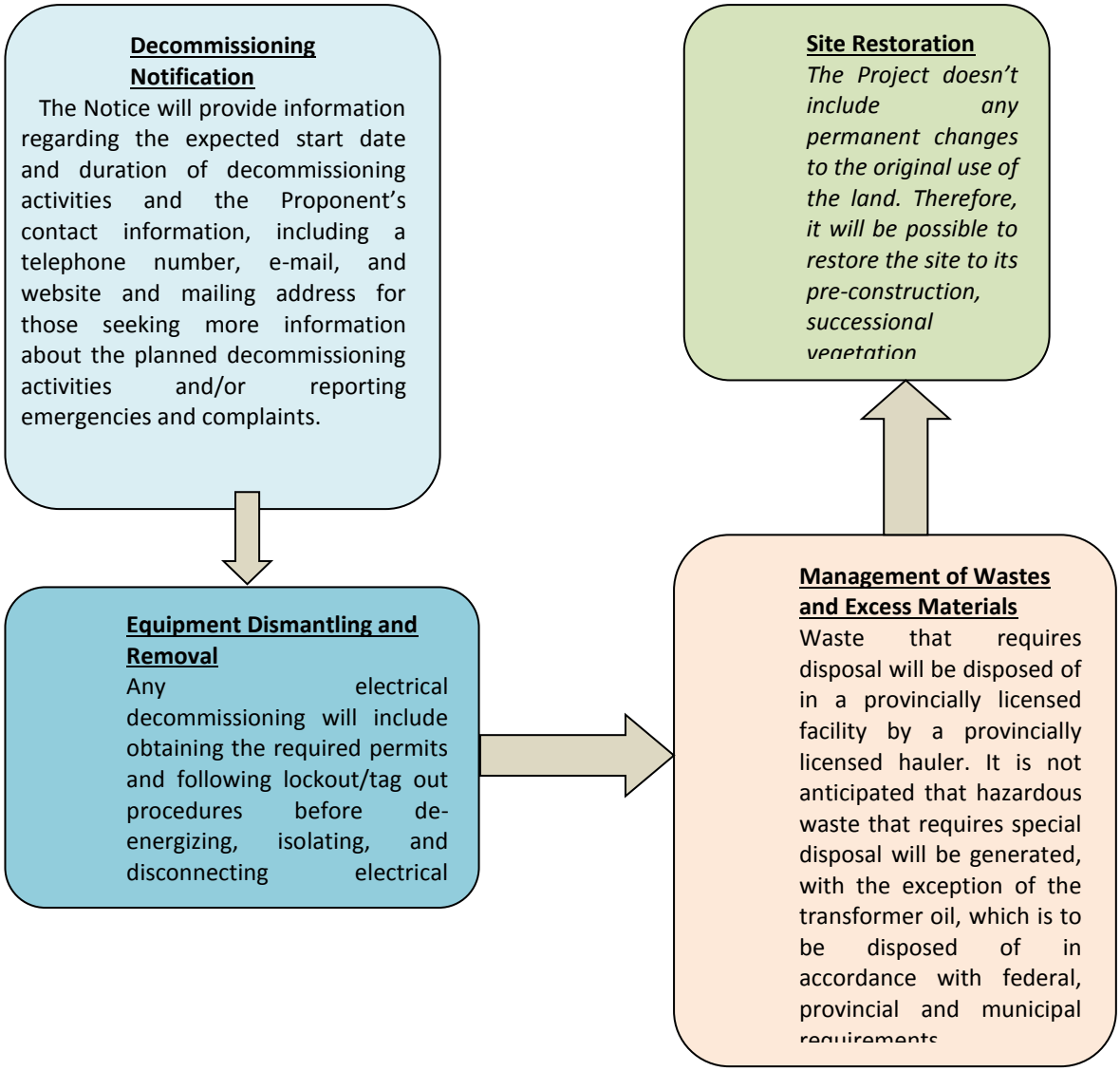
The solar power plant does not create noise and gaseous emissions during operation. A small volume of wastewater would be daily generated from washing dust from surface of the solar panels. This wastewater contains only suspended solids and will be drained into the storm drainage basin. Not more than 10 staff for operation and for maintenance such as PV surface cleaning; Domestic wastes generated by this small number of people could be readily handled by a septic tank system.

The potential impacts could be visual and reflection. However, as the project site and the surrounding areas provide no significant aesthetic value, the sights of a large area covered with solar PV panels will have no visual impact. With the old design of solar PV arrays, reflected sunlight may cause problems if the system is close to a road and is facing in a direction which the reflected sunlight may cause problems. This problem will not occur in this Project as its surface of solar PV panels is designed to absorb sunlight and minimize sunlight reflections. Though the reflection problem will not occur because the panels are designed to absorb sunlight, the project team will plant trees along the road as green belt.

Decommissioning

Welt Konnect & CTGI will ensure that the entire Project Location is restored back to its pre-construction condition (successional vegetation land use or as may be appropriate at that time) and that the decommissioning is conducted in accordance with the applicable local (Bahawalpur and Cholistan bodies), provincial (Punjab Government) and federal requirements. In addition, potential effects and mitigation pertaining to significant natural features on and/or in proximity to the Project Location will documented. Overall, no significant adverse impacts to the environment are expected as a result of decommissioning the Project. **The Flow Chart below (Extract 6: From Feasibility Report)** shows the flow chart of the decommissioning procedure.

Extract 6: Decommissioning Plan



Social Impacts

There will be reduction of poverty in an economically depressed region with very little industry and high unemployment as jobs are created during installation as well as operation for both unskilled and skilled workers. The skill sets of locals will be improved through training and capacity building for employment in the project contributing to technical advancement.

VI. Analysis of Alternatives

Alternative Sites

With the help of the Punjab Government, 4 sites were short listed and identified in Cholistan, towards Southern Punjab with presence of the required minimum infrastructure, high irradiation levels and solar potential. After due scrutiny and deliberation by Experts over the sites; the 500 Acres strip of land located in (Chuk. No: 314 A Block No: 3, 4, 23, 24) approximately 3 to 4 Km away from the Marot Grid Station and about 50 km from Bahawalpur, the nearest urban city, was selected and finalized. The location enjoys a flat terrain with innocuous sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself a technically and logistically feasible location for the setup of a large solar power station.

Alternative Measures

The Project's feasibility study reviewed the technical aspects and conceptual designs of multiple potential PV suppliers that would meet the requirements as set by the CTGI and Welt Konnect (Pvt.) Ltd. The winning EPC contractor will be chosen based on the following general criteria, apart from the selection criteria as will be mentioned in the pre-qualification documents:

- Displays understanding and skills to develop optimum design for the PV system for the selected site
- Has used best engineering principles in the conceptual design
- Demonstrates engineering ingenuity that will help reduce the projects capital and operation and maintenance costs
- Has over two years of experience in project management with a well developed and trained department for
    - Health
    - Safety and
    - Environment

The EPC contractors selected during the pre-qualification phase will be required to develop a complete environment management plan as part of their bidding documents.

VII. Grievance Redress Mechanism

At least 2 channels for environmental complaints will be created. These would comprise of complaints using emails, and telephone. The details of both these channels would be mentioned on all direction and site boards for the project. The most effective channel for response is by telephone because the contact can be made anytime and is two-way communication. No matter which channel is used, the responders from the HSE (Health, Safety and Environment) team will firstly obtain the information from the complainer as much as possible to identify source of the problem and inform the operations or maintenance departments. When the operations or maintenance department receives the information from HSE, they will find out if the complaint is caused from their operation. In case “yes”, they will fix the problem or stop their operation.

A follow up will be carried out when the operation will call back HSE staff for the situation so that HSE staff can communicate to the complainer as soon as possible. Moreover, HSE staff will also meet the complainer, if required and possible, at site for better understanding and curing his/their feelings and inform them the progress of mitigation measures from time to time until the problem has been solved.

VIII. Environmental Management Plan

Management System

After the completion of this 50MW Solar PV Project, a joint management organization will be established with the principle of requiring "few on-duty staff". After the electrical equipment and machinery have entered their stable operation mode, the PV plant shall be managed with "no on-call staff and few on-guard staff".

The WK & CTGI 50 MW PV Plant is divided into the production area and the utility area. The production area includes facilities such as Solar PV panels, etc. The complex will have multiple functions of administration, living, and production. The offices of the building will consist of relay protection room (including the DC panel room), central control room, communication room, and general purpose offices. The control room, the room for distributing high and low voltage electricity, and power distribution will be arranged conveniently so as to reduce the total length of cable laying and save construction cost. The other section is for daily lives including dormitories, dining room, and kitchen.

Housekeeping of Facility

OEMs for Solar panels are responsible for providing the generic maintenance plans for solar panels which include cleaning. The joint management between Welt Konnect, CTGI and EPC Contractor will be required to further determine the suitable cleaning requirements for the panel. This would be done by sharing complete site information (dust, dirt, pollen and/or pollution in the site environment; the frequency of rain or snow) with the OEMs for Solar panel, and ask them for site specific cleaning plans and details for the solar panels. Innovative methods for different maintenance and operation aspects are being employed all over the globe.

Safety and Security Concerns

Responsibility for security concerns before the construction of the project will lie with the EPC Contractor with monitoring authority of Welt Konnect and CTGI. Post-construction the responsibility will lie with the joint management to develop a team and an SOP mentioning the number of personnel required for the security purpose of the facility.

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and an SOP mentioning the number of personnel required for the security purpose of the facility.

Risk Management

The risk management plan, documents the procedures that will be used to manage risk throughout the project. In addition to documenting the results of the risk identification, it also covers who will be responsible for managing various areas of risk, how risks will be tracked throughout the project, and how plans of action will be implemented.

Risk management plan is an assessment tool that may is used in the project oversight process. For the 50 MW Solar PV Power Project in Cholistan, the RMP includes at least the following information:

- Purpose and scope
- Risk management methodology
- Overview or summary of risk
- Risk identification
- Risk analysis
- Risk response planning
- Risk monitoring and controls

Emergency Response Processes

During the construction and operation of the project, the guideline of “safety first, (accident) prevention foremost” will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personnel safety of the workers. The safety and health supervision department will provide appropriate inspection equipment, as well as necessary public education service for production safety.

HSE personnel will be required to draft emergency shutdown procedures for the plant in collaboration with the maintenance and project department during the detailed design phase of the Project. These would include all procedures in case of fire, lightning, flood, other natural disasters, etc. The procedures would be based on the guidelines from OSHA Standards (29 CFR 1910).

Social Development

For the purpose of measuring Social Development the "**JEDI** - Jobs and Economic Development Impact" model of evaluating socio economic factors has been employed. The (JEDI) models are user-friendly tools that estimate the economic impacts of constructing and operating power generation and biofuel plants at the local level. Based on project-specific and default inputs (derived from industry norms), JEDI estimates the number of jobs and economic impacts to a local area (usually a state) that could reasonably be supported by a power generation project.

For example, JEDI estimates the number of in-state construction jobs from a new solar project. JEDI models are input-output models designed to provide reasonable estimates, not exact numbers. JEDI also provides estimates on land lease and property tax revenues, when appropriate.

Various ownership and financing structures can be incorporated by the user as well. Results obtained for the impact of this project on the local employment can be represented by empirical changes on employer payroll. This can be seen in **Extract 7:** Empirical results of Using JEDI with Cost estimates on employer payroll.

PV System Annual Operating and Maintenance Costs			Manufactured Locally (Y or N)
	Cost	**Local Share**	
Labor			
Technicians	$136,667	100%	
Subtotal	$136,667		
Materials and Services			
Materials & Equipment	$113,333	100%	N
Services	$0	100%	
Subtotal	$113,333		
Sales Tax (Materials & Equipment Purchases)	$9,350	100%	
Average Annual Payment (Interest and Principal)	$1,508,000	0%	
Property Taxes	$0	100%	
Total	$1,767,350		
Other Parameters			
Financial Parameters			
Debt Financing			
Percentage financed	80%	0%	
Years financed (term)	10		
Interest rate	10%		
Tax Parameters			
Local Property Tax (percent of taxable value)	0%		
Assessed Value (percent of construction cost)	0%		
Taxable Value (percent of assessed value)	0%		
Taxable Value	$0		
Property Tax Exemption (percent of local taxes)	100%		
Local Property Taxes	$0	100%	

Local Sales Tax Rate	8.25%	100%
Sales Tax Exemption (percent of local taxes)	0%	
Payroll Parameters	**Wage per hour**	**Employer Payroll Overhead**
Construction and Installation Labor		
Construction Workers / Installers	$21.39	45.6%
O&M Labor		
Technicians	$21.39	45.6%

Extract 7: Empirical results of Using JEDI with Cost estimates on employer payroll

The current recession being faced by the globe has shifted the attention towards major socio-economic disasters such as inflation, industries crashing, unemployment rise, and standards of living reducing dramatically. Pakistan and the nearby region has been a victim of these conditions prior to recessions and is expected to keep facing similar situations in the aftermath of recess.

Projects like these provide us with the two major solutions to problems which form the foundation of social and economic disasters; Employment and cheap power for comfort. Through projects of this scale and nature, direct benefits to the community and economy are that of:

- Immediate employment
- Cheap energy and comfort

Some indirect and important benefits are:

- A Creation of a local market and/or of a local industry for PV products and services
- Security of energy supply
- Poverty alleviation, Creation of education facilities (need of skilled personnel)
- Recovery of vegetation due to improved irrigation / improved access to safe drinking water due to solar water purification

All methods employed during the engineering, procurement and construction phase have not only been screened to develop opportunities in Pakistan but also to cater to important requirements such as providing a healthy environment to the community. This project will also play a crucial role in improving awareness on renewable energy and in turn on the right consumption pattern of power for consumers.

The project holds complete compliance to every law and rule set down by the Government of Pakistan, Provincial government of Punjab, regulatory bodies for

power, and regulatory bodies for Economics such as SECP and regulatory requirements of Environment.

At an early stage of PV power development it is not likely that PV modules or cells for large power plants will be produced in Pakistan, so the creation of local industry should not be overestimated in beginning of the development of a the national PV market.

Environmental Impacts Mitigation

The requirements set by the Government of Pakistan and the Provincial Government of Punjab on different aspects of environment have been reviewed in detail. Apart from the primary requirements of IEE, EIA and NEQS there are multiple legislations and laws that need to be considered for any power generation projects in Pakistan. For renewable energy projects, these laws and legislations belong to 14 various sectors.

Solar projects are out of the scope of noise sector, as opposed to those of wind power projects.

Renewable Energy Projects do not have relevance to the sectors or concerns of Toxic or hazardous substances, Air Quality, Marine and Fisheries (except for any wind power projects undertaken which is off-shore), mineral Development and Public health and safety.

PV Power and Biogas projects do need to consider all laws set by sectors of livestock and solid wastes.

Important issues with the Solar PV Project and other similar projects in the region have to pay serious attention to the selection site for power generation to cater to the environmental standards as set by sectors like forest conservation, Parks and Wildlife conservation, cultural environment, Environmental protection, Land use and water quality and resources.

Considering the size of this project, primary focus was kept on the laws and legislations of land use set by the Provincial Government of Punjab, meaning the Land acquisition Act 1984, Soil Reclamation Act 1964 and The Punjab Development of Damaged Areas Act 1952. Damaged areas have been defined as any area that is declared damaged by the government through notification.

The Project Site is not used for agriculture farming due to very arid climate and undulating topography. Neither is livestock grazing an option due to the limiting weather conditions of the Land There is scarcity of drinking water both for humans and scarce livestock. As a result livestock production is less than its potential.

Groundwater is never the less available less than 20 meters below the surface however in some locations it is too saline to drink. The main method of keeping animals in areas further away from this hyper-arid region is a free availability of forage and monsoon rains which leave water stored in the pools dug in past by their owners.

Main soil types of Cholistan desert are sand dunes (44%), sandy soils (37%), loamy soils (2%) and saline-sodic clayey soils (17%).

The 50 MW Cholistan Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under the schedule II classified by Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. The project has also been planned to fulfill all requirements of Clean Development.

IX. Conclusions And Recommendations

Environmental impact assessment or Initial Environment Examination is not required for solar power projects in Pakistan as per section 3 and 4 of the Pakistan Environmental Protection Agency's Regulations 2000. However a complete IEE Document has been prepared for the project. This step has been taken to document all the reasons that are in line with all policies and regulations mentioned in this report; based on which the project has already obtained a No Objection Certificate.

The project site is not used for agriculture, is not located in a sensitive ecosystem, and has no historical and cultural value. This nature of the project site coupled with the clean nature of solar power generation ensures that the Project will not cause any significant, lasting environmental and social impacts during construction, operation and decommissioning. Only minor and transient environmental disturbances would be experienced at the project site during construction and operation, and they will be minimized through implementation of the Environment Management Procedures. It is then recommended that the Project be considered environmentally and socially feasible, and that this IEE is adequate to justify environmental and social feasibility of the Project. There is no need for further analysis and the environmental and social assessment of the Project is considered complete.

Project owners are fully committed to their environmental and social responsibility and discharge this responsibility in adherence to principles of good corporate governance. In their daily business operations, CTGI and WK fully meet the environmental, occupational health, and safety requirements and risk management within the basic framework of globally recognized environmental management system standard. Its staff and contractors are fully committed to their environmental responsibility and discharge their responsibility within the HSE policy and operational framework.

WK and CTGI discharge their social responsibility through: (i) fair treatment of its employees in full compliance with all applicable laws and regulations; and (ii) supporting community participation and development activities through its CSR program. Involuntary resettlement and indigenous peoples are not relevant issues in the operations of the project owners and are unlikely to become relevant issues in its future operations.

3 ENVIRONMENT IMPACT ANALYSIS (EIA)

I. Application Form (As per Schedule IV in PEPRA 2000)

1	Name and Address of Proponent	Welt Konnect (Pvt) Ltd Suit 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad.	Phones: Fax: Telex:	0092-51-2870422-3 0092-51-2870424
2	Description of Project	Cholistan Solar Farm is a 50 MW electricity generation plant designed to produce electricity by solar energy in Cholistan Desert in the province of Punjab, Pakistan. It employs solar photovoltaic (PV) technology that converts solar energy directly into electricity, while emitting zero greenhouse gases (GHG) into the atmosphere. The project is planned to be implemented in phases of 5 MW each and would become operational and start generating CERs right after the completion of the first phase of the project with work on the other phases continuing. The generated electricity will be supplied to the national grid. The project conforms to the government policy that promotes development of renewable energy technology and contributes to lowering dependence on electricity generation by fossil fuels which is over 66% of total generation in Pakistan. It is expected to help alleviate the huge energy deficit in Pakistan. It is the first Solar PV project of its size in Pakistan and will be a good source of clean energy. The area of this project will be about 809371.284 m^2 (200Acres) and annual amount of electricity going to the grid will be about 125,469 MWh. As a result over 60,000 tons of CO_2 emissions will be abated per year.		
3	Location of Project	Sqr . 1,2,3,4,5,6,7,8,9 & 10 of Main Block 354 of Quaid-e-Azam Solar Park, Punjab (Copy of Map is attached)		
4	Objectives of Project	To set up a clean energy Independent Power Producer in the Solar Photovoltaic sector harnessing the power of the sun.		
5	IEE/EIA	**EIA** **YES**/No		
6	Have alternatives been considered and reported in IEE or EIA	**YES**/No		
7	Existing Land Use	None, Barren Land, without any productivity or human habitation	Land Requirement	500 Acres
8	Is the basic Site data available or has it been measured?	(only tick yes if the data is reported in the IEE/EIA) Meteorology (including rainfall) Ambient Air Quality Ambient Water Quality Ground Water Quality	**Available** **Yes**/No **Yes**/No **Yes**/No **Yes**/No	**Measured** **Yes**/No **Yes**/No **Yes**/No **Yes**/No
9	Have estimates of the following been reported?	Water Balance Solid Waste Liquid Waste treatment	**Estimated** **Yes**/No **Yes**/No **Yes**/No	**Reported** Yes/**Not Applicable** Yes/**Not Applicable** Yes/**Not Applicable**

10	Source of Power	Natural Solar Energy	Power Requirement	None
11	Labor Force (number): As Per EPC Contract	Construction: As Per EPC Contract Operation: Approx. 10	All local labor force. Only management and consultant officials from other locations.	

Verification

I do solemnly affirm and declare that the information given above and contained in the attached IEE/EIA is true and correct to the best of my knowledge and belief.

Date 25th February 2014

Habil Ahmed Khan
Director Operations

II. Policy Legal and Administrative Framework

As per the general criteria the project should be consistent with the national laws and sustainable development policies, strategies and plans including:

- **Pakistan Environmental Protection Act- 1997**

The project is in compliance with the PEPA 1997, and as mentioned in Para 12 of the said act, this project being a solar PV project in a desert with almost no population or wildlife or plantation, does not have any adverse effect on the environment whatsoever. However an Environment studies have been filed with the relevant authorities for their consideration.

- **National Energy Conservation Strategy**

The project complies with the three explicit objectives of the NECS: conservation of natural resources, promotion of sustainable development, and improvement of efficiency in the use and management of resources; and would also abide by policies outlined for pollution control as in s.no 4, 8, 10, 12 and 13 of the 14 core programme areas.

- **National Environment Policy**

The project is in unison and support of the NEP, particularly contents of 3.4, 3.4(h), 3.6, 3.7, 3.9, 4.1, 4.3, 4.4, 5.4, 5.5 and 5.6.

- **National Forestry Policy**

The project is in harmony with the National Forestry Policy and although being situated in a desert namely Cholistan it will contribute to the national grid and hence meet the objectives of Para 1.2 by generating power from solar energy which will indirectly hinder cutting of mountain trees for firewood. It also supports Para 7, 10.2, and 10.3.

- **National Renewable Energy Policy**

The project complies with NREP, articles 4 (4.4), 8.1, and 8.3 (8.3.3)

- **Medium-term Development Framework**

The project supports Medium term Development Framework objectives such as poverty reduction, upgrading of physical infrastructure, energy security, accelerated development of lesser developed areas, and environment.

- **Pakistan Environmental Protection Agency Regulations 2000**

Environmental impact assessment or Initial Environment Examination is not required for solar power projects in Pakistan as per section 3 and 4 of the Pakistan Environmental Protection Agency's Regulations 2000. However a complete IEE Document has been prepared for the project.

- **Other Relevant Policies and Plans of the Government**

The project complies and is in harmony with all relevant concerned policies of the government of Pakistan. The project will not result in any obligation towards the investor country other than CER authorization.

III. Description of the Project

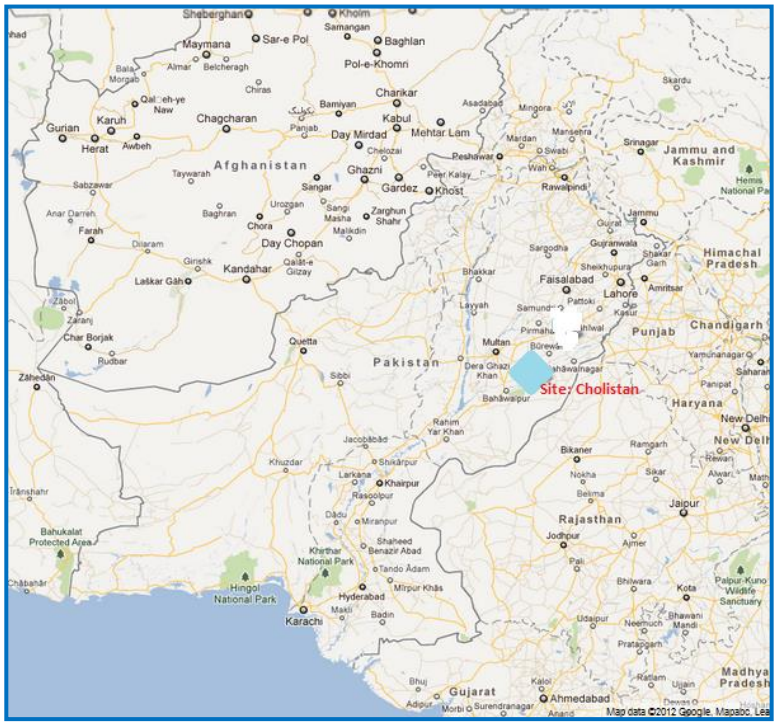
Project Location

Comprehensive due diligence was carried out by experts and representatives from all stakeholders of the project, which was followed by a review and selection procedure. The site allocated encompasses an area of 250 Acres (Sqr No: 1,2,3,4,5,6,7,8,9 & 10 of Main Block 354 of QASP), which is approximately 4 to 5 Km away from the nearest Grid Station and about 35 to 45 km from Bahawalpur (the nearest urban city). **Extract 1** shows the Coordinates of the project, while **Extract 2** shows the geographical location of the project

Extract 1: Coordinates of the project

50 MW Project Coordinates		
Node	**Longitude (East)**	**Latitude (North)**
1	71 49.196	29 17.650
2	71 49.817	29 17.650
3	71 49.196	29 16.998
4	71 49.817	29 17.324
5	71 49.608	29 17.324
6	71 49.608	29 16.998

Extract 2: Geographical location of the project



Scope and Layout

After review of the equipment which would need to be utilized to ensure optimized performance and maximum yield generation, the Project Layout has been designed to utilize 28 of "1.6 MW Inverter" combined units of SMA 800 CP Series Inverters (Actual power output at test conditions is 1.76 MW for each unit) which are further connected to 28 SMA Low to Medium range voltage transformers at approximately 360V AC, one for each 1.6 MW unit respectively, leading finally to the switch gear or transformer from medium to high voltage range for connection to the Grid Station at 132KV . Each unit of 1.6 MW will consist of 7480 panels, 2 inverters and 1 transformer.

A string concept is being used with 22 modules connected to a string, and 17 strings connected on a Bus leading to the SMA Inverters connection in parallel with a total of 9 such connections. The total number of PV modules used in this arrangement would be 3366 units per 1.6 MW with a total of approximately 30 such units for the complete 50 MW setup. **Extract 3** shows the technical specifications of the modules

Extract 3 Technical specifications of the modules

Module Technology	Crystalline	Thin-Film
Generation	1st	2nd
Market Shares (2008)	84 %	16 %
Data Availability	Old Technology; Data is available for analysis	Relatively Newer Technology; Data is scant for reliability analysis
Efficiency	Mono crystalline: 17 % Poly crystalline: 13.5	9 %
Lowest Retail Price ($/watt)	High Mono Crystalline: 1.20 Poly Crystalline: 1.08	Low 0.81
Weight to Power Ratio	Small	Large
Module Size	Large range 65 – 240 W	Small Range 65 – 130 W

The modules to be selected for the project should have in built features for extreme weather conditions to be suitable for the project site. The modules would be subject to conditions such as temperatures exceeding 50 oC, wind speeds exceeding 5 m/s, and precipitation on panels in case of rare occasional occurrence of a sand-storm. Therefore, modules should consist of materials that have high tolerance to these conditions and more, meaning a high factor of safety and resilience. Additionally, the modules should allow for easy and fast maintenance along with cleaning operations.

Construction

The land acquired by Welt Konnect consists primarily of flat ground and sand dunes. Construction of the solar farm will be focused on the flat areas. Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading. The panels would be mounted on racks, facing due south, at an angle of 30 degrees above horizontal to maximize the system for annual energy production. The mounting racks would be aligned in rows along an east-west axis across the entire area defined for the project. Depending on the height of the panels off the ground, it is estimated that approximately five to six feet of spacing between rows would be required to prevent shading from one row of modules onto the other.

A single string of 224 PV modules require approximately 16 meters x 42 meters where as a single inverter (3740 units of PV modules) requires 100 meters x 120 meters. The total requirement for construction of 209,440 units of PV modules is approximately 600,000 m^2 (150 acres) which is clearly within the value of the acquired land. There are three options that can be utilized when setting the tracking system of a photo-voltaic powered power plant namely single axis, dual axis or no tracking system.

Design optimization shows that for such a large number of panels, a tracking system would require a large initial investment as well as yearly maintenance for a relatively lower amount of increase in yield. Therefore the company has opted to utilize no tracking system

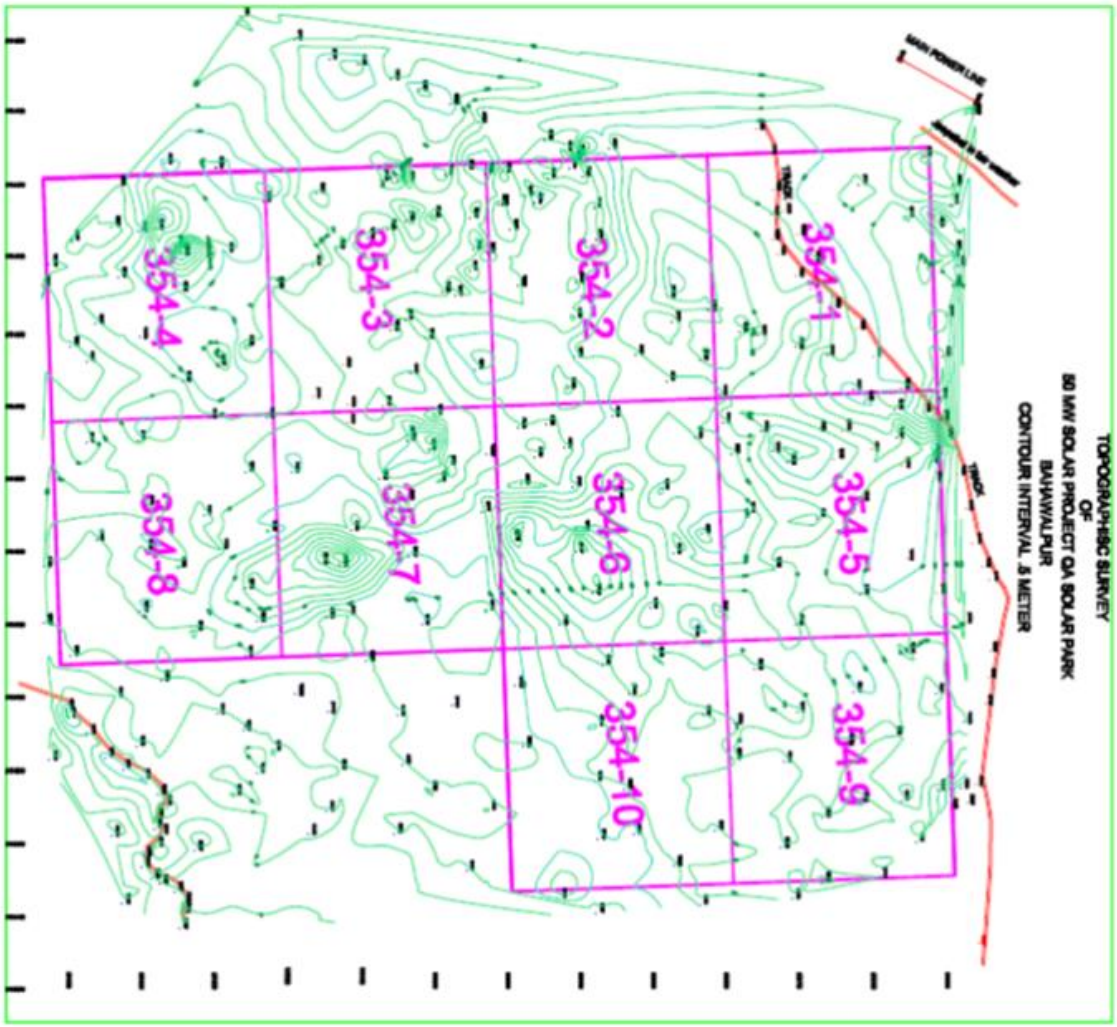
The modules would be clamped to a long term resistant mounting structure (details of which are provided in subsequent sections). The mountings will be made with considerations of stress analysis in weight and wind conditions.

IV. Description of Environment

Site Condition

The land acquired by the Joint Venture consists primarily of flat ground and scarce sand dunes at the peripheral of the site. Construction of the solar farm will be focused on the flat areas. Cholistan has very low propensity towards natural disasters or similar risks. Till date the nearest area to Cholistan which has faced the effects of a flood is Bahawalpur and that too only once in history. Cholistan and nearby areas for a significant radius are not prone to earth quakes (as per past records). The Project is strategically positioned between the Farm Lands being irrigated by man made canals taken out from the Indus River passing through Punjab on its way to Sindh which cover it on 3 sides and on the other hand the Marot Fort with its high elevation. **Extract 4** represents the topographic survey of the project site.

Extract 4: Topographic Survey of the Site



Micro Climate Effects

The Pakistan Meteorological Department is both a scientific and a service department, and functions under the Ministry of Defense. It is responsible for providing meteorological service throughout Pakistan to wide variety of interest and for numerous public activities and projects which require weather information.

In its services to aviation the department's responsibility goes to some extent beyond national boundaries in fulfillment of accepted international agreements and obligations which include, among other things, the collection and rebroadcast of meteorological data.

Apart from meteorology, the department is also concerned with Agro meteorology, Hydrology, Astronomy and Astrophysics (including solar physics), Seismology, Geomagnetism, Atmospheric Electricity and studies of the Ionosphere and Cosmic Rays. Pakistan Meteorological Department shoulders the responsibility to investigate the factors responsible for global warming, climate change its impact assessment and adaptation strategies in various sectors of human activities.

Microclimate effects of Cholistan and nearby area are characterized by low and rare sporadic rain. The mean annual rainfall varies from less than 100 mm in the west to 200 mm in the east and as per collected Synthetic Data, installed SRA equipment on site and information gathered from Locals, it rains only 1 to 3 times a years.

Rain usually falls during monsoon (July through September), winter and spring (January through March). Aridity is the most striking feature of the Cholistan desert with wet and dry years occurring in clusters. Cholistan is one of the hottest regions of Pakistan. Temperatures are high in summer and mild in winter. The mean summer temperature (May, June) is 34 ^{o}C with the highest reaching above 51 ^{o}C. **Extract 5** gives us the meteorological details of the site.

Extract 5 gives us the meteorological details of the site

	Average Temperature ^{0}C		Average Humidity %	Precipitation (mm/day)
Months	**Min**	**Max**		**Mean**
Jan	6.95	19.9	45.3	0.30
Feb	9.19	22.9	38.2	0.61
Mar	15.1	29.3	29.3	0.66
Apr	20.8	34.2	27.4	0.52
May	25.3	37.9	30.3	0.54
Jun	28.2	38.2	43.4	1.22
Jul	28.0	35.1	61.8	3.63
Aug	26.9	33.4	67.7	2.95
Sep	24.8	33.8	55.4	1.22
Oct	19.3	32.6	33.5	0.40
Nov	13.8	27.8	31.6	0.09
Dec	8.99	22.2	39.1	0.23

Soil, Water and Vegetation Condition

The investigated site is located at Marot, Tehsil Fort Abbas, District Bhawalnagar. The area is mainly underlain by Sandy Silty Clay up to the maximum explored depth.

Soil

The onsite material is generally classified as SANDY SILTY CLAY (CL-ML) group of Unified Soil Classification System. Prior to any construction activity, the site must be cleared of all debris and surface vegetation. The leveling and grading can be carried out by normal earth moving machine. It is recommended that immediately after excavation for construction of foundation or other substructures, the excavation bottoms and slopes are cleared of all debris, proof rolled and covered by a 5 cm thick blinding concrete layer.

Water

The site is facilitated with a very favorable level of water table, less than 20m below ground level. The project team would drill bores to gain access to this water table and its supply. Simultaneously for initial work scope, there are existing wells within approachable distance which are being used by local habitants for their live stock.

Vegetation

Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading. The panels would be mounted on racks, facing due south, at an angle of 30 degrees above horizontal to maximize the system for annual energy production.

V. Analysis of Alternatives

Alternative Sites

With the help of the Punjab Government, 4 sites were short listed and identified in Cholistan, towards Southern Punjab with presence of the required minimum infrastructure, high irradiation levels and solar potential. After due scrutiny and deliberation by Experts over the sites; the 500 Acres strip of land located in (Chuk. No: 314 A Block No: 3, 4, 23, 24) approximately 3 to 4 Km away from the Marot Grid Station and about 50 km from Bahawalpur, the nearest urban city, was selected and finalized. The location enjoys a flat terrain with innocuous sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself a technically and logistically feasible location for the setup of a large solar power station.

Alternative Measures

The Project's feasibility study reviewed the technical aspects and conceptual designs of multiple potential PV suppliers that would meet the requirements as set by the CTGI and Welt Konnect (Pvt.) Ltd. The winning EPC contractor will be chosen based on the following general criteria, apart from the selection criteria as will be mentioned in the pre-qualification documents:

- Displays understanding and skills to develop optimum design for the PV system for the selected site
- Has used best engineering principles in the conceptual design
- Demonstrates engineering ingenuity that will help reduce the projects capital and operation and maintenance costs
- Has over two years of experience in project management with a well-developed and trained department for
    - Health
    - Safety and
    - Environment

The EPC contractors selected during the pre-qualification phase will be required to develop a complete environment management plan as part of their bidding documents.

VI. Potential and Significant Environment Impacts

Photovoltaics (PV) are seen to be generally of benign environmental impact, generating no noise or chemical pollutants during use. It is one of the most viable renewable energy technologies for use in an urban environment, replacing existing building cladding materials.
It is also an attractive option for use in scenic areas and National Parks, where the avoidance of pylons and wires is a major advantage.

Land use

The impact of land use on natural ecosystems is dependent upon specific factors such as the topography of the landscape, the area of land covered by the PV system, the type of the land, the distance from areas of natural beauty or sensitive ecosystems, and the biodiversity. The impacts and the modification on the landscape are likely to come up during construction stage by construction activities, such as earth movements and by transport movements. Furthermore, an application of a PV system in once-cultivable land is possible to damnify soil productive areas.

Routine and accidental discharges of pollutants

During their normal operation PV systems emit no gaseous or liquid pollutants, and no radioactive substances. In the case of CIS and CdTe modules, which include small quantities of toxic substances, there is a potential slight risk that a fire in an array might cause small amounts of these chemicals to be released into the environment. In large-scale central plants a release of these hazardous materials might occur as a result of abnormal plant operations and it could pose a small risk to public and occupational health. Thus there must be emergency preparedness and response in case of an accidental fire or exposure to heat. Emissions to soil and groundwater may occur due to inadequate storage of materials.

Visual impacts

Visual intrusion is highly dependent on the type of the scheme and the surroundings of the PV systems. It is obvious that, if we apply a PV system near an area of natural beauty (as the project site is also near tourist locations such as “Fort Abbas”); the visual impact would be significantly high. In case of modules integrated into the facade of buildings, there may be positive aesthetic impact on modern buildings in comparison to historic buildings or buildings with cultural value. Following considerations should be a part of the impact mitigation measures:

* Optimal architectural solutions to minimize potential impact on visual amenity and building aesthetics. Advances in the development of multi-functional PV facades,

which perform aesthetic and practical functions such as shading and heat extraction, have provided an important stimulus for architectural expression.
* Proper siting and design of large PV installations.
* Use of color to assemble the PV modules in large scale systems.

Integrated PV electrification schemes, which help to regenerate rural areas and user associations, have successfully overcome the problems of managing and maintaining remote schemes by establishing mechanisms for collecting user payments, arranging regular maintenance, obtaining finance and providing advice on energy efficient appliances.

Depletion of natural resources

The production of current generation PV's is rather energy intensive (especially the poly crystalline and the mono-crystalline modules) and large quantities of bulk materials are needed (thin film modules have less primary energy requirement per W than the a-Si PV modules (a-Si are thin films also!) because of the difference in cell efficiency, so can be an answer to that problem). Also, small quantities of scarce materials (In/Te/Ga) are required; also limited quantities of the toxic Cd.

In general the Cd emissions attributed to CdTe production amount to 0.001% of Cd used (corresponding to 0.01 g/GWh). Furthermore Cd is produced as a byproduct of Zn production and can either be put ton beneficial uses or discharged into the environment. Several aspects have to be studied to minimize environmental impacts related to the production of the PV cells:

* Prospects for thinner cell layers;
* The full potential of the concentrator PV technologies;
* Prospects for more efficient material utilization;
* Safer materials and alternatives; and
* Module recycling technology and its efficiency.

Air pollution

As far as life cycle assessment is concerned, the environmental performance of the system depends heavily on the energy efficiency of the system manufacturing and especially electricity production. The emissions associated with transport of the modules are insignificant in comparison with those associated with manufacture. Transport emissions were still only 0.1–1% of manufacturing related emissions. In the case of poly- and mono-crystalline modules, the estimated emissions are 2.757–3.845 (kg CO2/kWp), 5.049– 5.524 (kgSO2/kWp) and 4.507–5.273 (NOx/kWp).

Noise intrusion

As with all types of construction activity, there will be little noise. Also, there will be some employment benefits during the construction phase and especially for large scheme projects, such as this 50 MW Solar PV Project, during the operational phase.

Waste management

A life cycle analysis of batteries for stand-alone PV systems indicates that the batteries are responsible for most of the environmental impacts, due to their relatively short life span and their heavy metal content.

Impacts during Construction

The civil, mechanical and electrical works will be minor and will spread over the large project site. Considering the nature and magnitude of construction works and the ecological insensitivity of the project site, it is certain that the construction would create only minor and manageable environmental disturbances such as noise from trucks and excavation equipment, which are insignificant impacts due to the absence of communities in the area. No toxic and hazardous materials will be used in the construction apart from diesel oils for vehicles, which will be properly stored. The construction contracts will require the EPC contractors to be responsible for undertaking effective measures for environmental impact mitigation. Environmental performance of the EPC contractors will be monitored by the joint on site project management team, specifically the personnel of HSE Department.

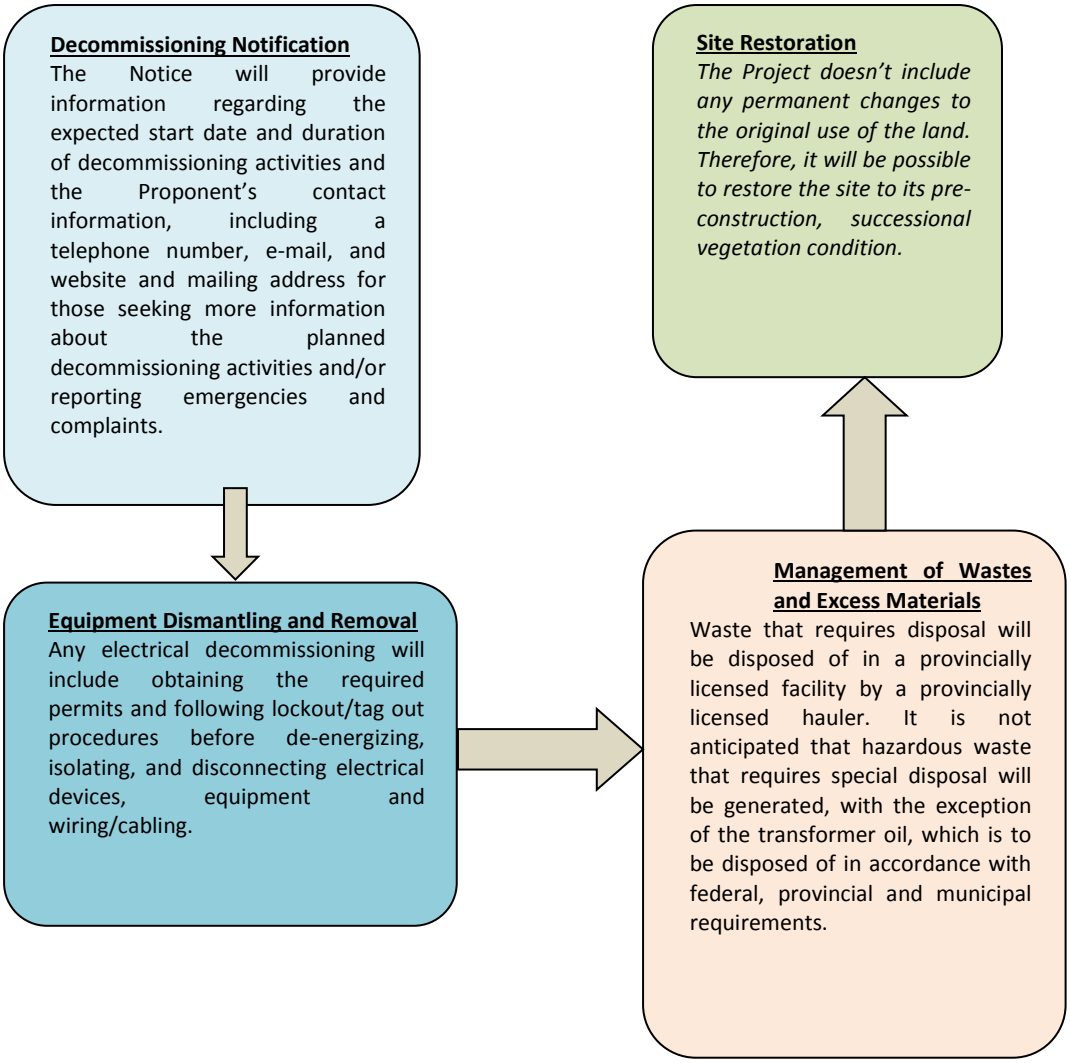
Impacts during Operation

The solar power plant does not create noise and gaseous emissions during operation. A small volume of wastewater would be daily generated from washing dust from surface of the solar panels. This wastewater contains only suspended solids and will be drained into the storm drainage basin. Not more than 10 staff for operation and for maintenance such as PV surface cleaning; Domestic wastes generated by this small number of people could be readily handled by a septic tank system.

The potential impacts could be visual and reflection. However, as the project site and the surrounding areas provide no significant aesthetic value, the sights of a large area covered with solar PV panels will have no visual impact. With the old design of solar PV arrays, reflected sunlight may cause problems if the system is close to a road and is facing in a direction which the reflected sunlight may cause problems. This problem will not occur in this Project as its surface of solar PV panels is designed to absorb sunlight and minimize sunlight reflections. Though the reflection problem will not occur because the panels are designed to absorb sunlight, the project team will plant trees along the road as green belt.

Decommissioning

Welt Konnect & CTGI will ensure that the entire Project Location is restored back to its pre-construction condition (successional vegetation land use or as may be appropriate at that time) and that the decommissioning is conducted in accordance with the applicable local (Bahawalpur and Cholistan bodies), provincial (Punjab Government) and federal requirements. In addition, potential effects and mitigation pertaining to significant natural features on and/or in proximity to the Project Location will documented. Overall, no significant adverse impacts to the environment are expected as a result of decommissioning the Project. **The Flow Chart below (Extract 6: From Feasibility Report)** shows the flow chart of the decommissioning procedure.



Extract 6: Decommissioning Plan

Social Impacts

There will be reduction of poverty in an economically depressed region with very little industry and high unemployment as jobs are created during installation as well as operation for both unskilled and skilled workers. The skill sets of locals will be improved through training and capacity building for employment in the project contributing to technical advancement.

VII. Grievance Redress Mechanism

At least 2 channels for environmental complaints will be created. These would comprise of complaints using emails, and telephone. The details of both these channels would be mentioned on all direction and site boards for the project. The most effective channel for response is by telephone because the contact can be made anytime and is two-way communication. No matter which channel is used, the responders from the HSE (Health, Safety and Environment) team will firstly obtain the information from the complainer as much as possible to identify source of the problem and inform the operations or maintenance departments. When the operations or maintenance department receives the information from HSE, they will find out if the complaint is caused from their operation. In case “yes”, they will fix the problem or stop their operation.

A follow up will be carried out when the operation will call back HSE staff for the situation so that HSE staff can communicate to the complainer as soon as possible. Moreover, HSE staff will also meet the complainer, if required and possible, at site for better understanding and curing his/their feelings and inform them the progress of mitigation measures from time to time until the problem has been solved.

VIII. Measures for preventing or Mitigating Environmental Impacts

The requirements set by the Government of Pakistan, and the Provincial Government of Punjab on different aspects of environment have been reviewed in detail. Apart from the primary requirements of IEE, EIA and NEQS there are multiple legislations and laws that need to be considered for any power generation projects in Pakistan. For renewable energy projects, these laws and legislations belong to 14 various sectors.

Solar projects are out of the scope of noise sector, as opposed to those of wind power projects. Renewable Energy Projects do not have relevance to the sectors or concerns of Toxic or hazardous substances, Air Quality, Marine and Fisheries (except for any wind power projects undertaken which is off-shore), mineral Development and Public health and safety.

PV Power and Biogas projects do need to consider all laws set by sectors of livestock and solid wastes.

Important issues with the Solar PV Project and other similar projects in the region have to pay serious attention to the selection site for power generation to cater to the environmental standards as set by sectors like forest conservation, Parks and Wildlife conservation, cultural environment, Environmental protection, Land use and water quality and resources.

Considering the size of this project, primary focus was kept on the laws and legislations of land use set by the Provincial Government of Punjab, meaning the Land acquisition Act 1984, Soil Reclamation Act 1964 and The Punjab Development of Damaged Areas Act 1952. Damaged areas have been defined as any area that is declared damaged by the government through notification.

The Project Site is not used for agriculture farming due to very arid climate and undulating topography. Neither is livestock grazing an option due to the limiting weather conditions of the Land There is scarcity of drinking water both for humans and scarce livestock. As a result livestock production is less than its potential. Groundwater is never the less available less than 20 meters below the surface however in some locations it is too saline to drink. The main method of keeping animals in areas further away from this hyper-arid region is a free availability of forage and monsoon rains which leave water stored in the pools dug in past by their owners.

Main soil types of Cholistan desert are sand dunes (44%), sandy soils (37%), loamy soils (2%) and saline-sodic clayey soils (17%).

The 50 MW Cholistan Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under the schedule II classified by Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. The project has also been planned to fulfill all requirements of Clean Development.

Furthermore, unfavorable effects of Solar Energy Technologies (SETs) are usually minor and they can be minimized by appropriate mitigation measures. The potential environmental burdens of SETs are regularly site specific, depending on the size and nature of the project. These burdens are usually associated with the loss of amenity (e.g. visual impact or noise—during the installation and the demolition phases) and the impacts can be minimized by:

1. The appropriate siting of central solar systems, which involves careful evaluation of alternative locations and estimation of expected impact (away from densely populated areas and not in protected areas or areas of significant natural beauty); the residential solar systems can be installed anywhere, especially integrated in the roofs;
2. The appropriate operational practices (including rational water use, safety measures, waste disposal practices, use of biodegradable chemicals, etc.);
3. The engagement of the public and relevant organizations in the early stages of planning, in order to ensure public acceptance;
4. The use of the best available technologies/techniques and the improvement of technology (e.g. use of air as the heat-transfer medium in central tower systems, ‘‘advanced’’ Sterling engines);
5. The integration in the building’s shell;
6. The sensible planning constraints and pre-development assessments (e.g. on water use, habitat loss, estimation of expected CO2 savings, etc.);
7. The training of workers, use of special sunglasses during operation and construction, use of heat insulating uniforms, familiarization with the system;
8. The re-establishment of local flora and fauna, giving the environment enough time to come up to its previously state again; and
9. Thorough Environmental Impact Assessment Studies for central solar systems.

IX. Environmental Impact Monitoring Program

Environmental Component	Project Stage	Parameters	Standard	Location	Frequency	Institutional Responsibility	
						Implementation	Supervision
Noise	Construction	Noise level in dB(A)	Standards as per Industrial practices	Project Site	At the start of concerned activities (Such as equipment installation or startups)	EPC Contractor and WK	Welt Konnect (Pvt) Ltd.
Physical Works	Construction	As will be specified in Contractor's plan	As will be specified in Contractor's plan	Project Site	Monthly	EPC Contractor	Welt Konnect (Pvt) Ltd.
Occupational, Healthy and Safety	Construction	As specified in HSE Plan	HSE, OSHA and other applicable standards	Project Site	Weekly	EPC Contractor	Welt Konnect (Pvt) Ltd.
	Operation	As specified in OHS Plan	Applicable standards of OSHA	Project Site	Weekly	EPC Contractor	Welt Konnect (Pvt) Ltd.

Figure IX.1: Environmental Monitoring Program

Significant changes in the project (e.g. projected expansions, changes in technology), changes in the type of finance (e.g. from loan to equity), and/or foreclosures will be preceded by a re-assessment of environmental risk. This is in order to determine whether the changed project carries environmental and social risks and opportunities that were not considered in the initial review. The environmental monitoring of the project should continue until the loan has been repaid, the financial institution or investor has divested its equity share in a company, or the operation has been cancelled.

X. Conclusions and Recommendations

Environmental impact assessment or Initial Environment Examination is not required for solar power projects in Pakistan as per section 3 and 4 of the Pakistan Environmental Protection Agency's Regulations 2000. However a complete IEE Document has been prepared for the project. This step has been taken to document all the reasons that are in line with all policies and regulations mentioned in this report; based on which the project has already obtained a No Objection Certificate.

The project site is not used for agriculture, is not located in a sensitive ecosystem, and has no historical and cultural value. This nature of the project site coupled with the clean nature of solar power generation ensures that the Project will not cause any significant, lasting environmental and social impacts during construction, operation and decommissioning. Only minor and transient environmental disturbances would be experienced at the project site during construction and operation, and they will be minimized through implementation of the Environment Management Procedures. It is then recommended that the Project be considered environmentally and socially feasible, and that this IEE is adequate to justify environmental and social feasibility of the Project. There is no need for further analysis and the environmental and social assessment of the Project is considered complete.

Project owners are fully committed to their environmental and social responsibility and discharge this responsibility in adherence to principles of good corporate governance. In their daily business operations, CTGI and WK fully meet the environmental, occupational health, and safety requirements and risk management within the basic framework of globally recognized environmental management system standard. Its staff and contractors are fully committed to their environmental responsibility and discharge their responsibility within the HSE policy and operational framework.

WK and CTGI discharge their social responsibility through: (i) fair treatment of its employees in full compliance with all applicable laws and regulations; and (ii) supporting community participation and development activities through its CSR program. Involuntary resettlement and indigenous peoples are not relevant issues in the operations of the project owners and are unlikely to become relevant issues in its future operations.

SETs present tremendous environmental benefits when compared to the conventional energy sources. In addition to not exhausting natural resources, their main advantage is, in most cases, total absence of almost any air emissions or waste products. In other words, SE can be considered as an almost absolute clean and safe energy source.

On the other hand, it must be realized that no manmade project can completely avoid some impact to the environment, so neither can SET installations. Potential environmental burdens depend on the size and nature of the project and are often site-specific. Most of these burdens are associated with loss of amenity (e.g., visual impact or noise in the case of central systems).

However, adverse effects are generally small and can be minimized by appropriate mitigation measures, including the use of the best available abatement technologies.

Technologies or techniques that can be used to eliminate or minimize potential environmental impacts from SETs may involve, in some cases, the use of air emission or odor control equipment, design tools for optimal design and siting of the installations, best practice guidelines, improved pieces of equipment (such as gearless or lubricant-free motors), or completely innovative design (e.g., closed-cycle plants, submerged plants, etc.)

It is up to the involved factors (investors, developers, and permitting authorities) to make the appropriate decisions by taking environmental issues into serious consideration. To that end, an Environmental Impact Assessment for central solar systems, which should estimate the magnitude of potential environmental impacts and propose appropriate mitigation measures, can play a significant role to proper project design and to a subsequent project public acceptance.

National Transmission and Despatch Company Limited (NTDCL)

Grid Interconnection Study for Evacuation of Power from 50 MW Welt Konnect Solar PV Plant in Quaid-e-Azam Solar Park at Cholistan

(Draft Final Report)

Prepared by

Planning (Power) Department
5th Floor, PIA Tower, Egerton Road, Lahore.

April 2014

Executive Summary

1. The Government of Pakistan (GoP) plans to develop 1000 MW Quaid-e-Azam solar park at Lal Suhanra as a major step towards development of solar generation in Pakistan. M/s Welt Konnect intends contribute to this plan by setting up 50 MW solar PV power plant in Quaid-e-Azam solar park. M/s Welt Konnect has hired the services of Planning Power Department of NTDC to carry out grid interconnection study in order to propose interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network.

2. This is draft final report of the grid interconnection study in which the results of extensive system studies including load flow, short circuit, transient stability and power quality studies have been presented pertaining to the interconnection of 50 MW Welt Konnect solar PV power plant. The adequacy of the proposed interconnection scheme regarding performance of 50 MW Welt Konnect power plant and of the system network in its vicinity has been evaluated in the light of Grid Code.

3. For the grid interconnection study, NTDC has used the latest system network model data & transmission expansion plans of NTDC and MEPCO, whereas, M/s Welt Konnect has provided the data of its power plant on data request from NTDC. Most of the data was provided by M/s Welt Konnect but some assumptions for the missing data pertaining to dynamic model parameters of 50MW Welt Konnect solar PV power plant have been made to conduct the studies.

4. The load flow analysis has been carried out for operating scenarios of summer 2015 and 2016 with the induction of 50 MW Welt Konnect solar PV power plant and the results of load flow studies have been presented in this report. It has been found that the power from 50 MW Welt Konnect solar power plant can reliably be evacuated to the system under normal and N-1 contingency conditions.

5. The proposed interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant is given as under:

   "A 132 kV double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra single circuit line at the 132 kV switchyard of 50 MW Konnect solar PV power plant."

6. The project sponsor initially proposed 1x60 MVA power transformer at 132/15 kV voltage level but it is recommended in this report that 2x60 MVA power transformers at 132/15 kV voltage level should be installed at Welt Konnect

power plant to ensure supply of power under N-1 contingency condition as mentioned the Grid Code.

7. Short circuit studies have been carried out with proposed Interconnection option to compute the maximum three phase and single phase short circuit levels after the induction of 50 MW Welt Konnect solar PV power plant. It is found that the proposed solar generation has no adverse impact on the existing network in its vicinity and the short circuit currents remain within the installed switchgear ratings at the existing substations. On the other hand, the standard switchgear of the short circuit rating of 40 kA would be sufficient at 132kV switchyard of the 50MW Welt Konnect solar PV power plant.

8. Transient stability analysis with the proposed interconnection scheme for 50 MW Welt Konnect solar PV power plant has been carried out using the NEPRA Grid Code Criteria. The stability of the solar PV plant and the power system has been checked with application of faults at the 132 kV switchyard of 50 MW Welt Konnect solar PV power plant and at the substations in the vicinity of the plant. It has been found that 50 MW Welt Konnect solar PV power plant and the surrounding power system network remain stable with no adverse effects after subjected to faults as per Grid Code requirement.

   The LVRT requirements for 50 MW Welt Konnect solar PV power plant are also met as mentioned in Grid Code Addendum for solar power plants (under approval by NEPRA).

9. The issues of power quality with the induction of the 50 MW Welt Konnect solar PV power plant have also been studied. The study results indicate that the power quality parameters including flicker and voltage unbalance, remain within the permissible limits as mentioned in relevant IEC standard. However, this is the responsibility of developer of the 50 MW Welt Konnect solar PV power plant to install necessary monitoring and compensating equipment at its switchyard to meet the power quality standards as per requirements of Grid Code Addendum for solar power plants (under approval by NEPRA).

10. On the basis of the results of the detailed system studies, it is concluded that the proposed interconnection scheme has no technical constraints in evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network.

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1. Introduction

The Government of Pakistan plans to establish 1000 MW Quaid-e-Azam solar park at Lal Suhanra, Cholistan as a major step towards development of solar generation in Pakistan. M/s Welt Konnect intends to contribute to this plan by adding a 50 MW solar PV power plant in Quaid-e-Azam solar park.

M/s Welt Konnect has hired the services of Planning Power department of NTDC to carry out grid interconnection study in order to propose interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network.

This is draft final report of the grid interconnection study in which the results of extensive system studies including load flow, short circuit, transient stability and power quality studies, pertaining to the interconnection of 50 MW Welt Konnect solar PV power plant, have been presented. The adequacy of the proposed interconnection scheme regarding performance of 50 MW Welt Konnect power plant and of the system network in its vicinity has been evaluated in the light of Grid Code.

2. Proposed Interconnection Scheme

The interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network is proposed as below:

> *"A 132 kV double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra single circuit line at the 132 kV switchyard of 50 MW Konnect solar PV power plant."*

The geographical diagram showing the above scope of work for the proposed solar generation is shown in Figure #1. The geographical diagram showing all the proposed solar power plants (with total gross capacity of 1000 MW) in Quaid-e-Azam solar park is shown in Figure #2.

It is important to highlight that the existing 132 kV single circuit, Bahawalpur – Lal Suhanra, will become Yazman – Lal Suhanra, after the expected commissioning of Yazman 132 kV grid station in year 2015.

3. Study Assumptions and Criteria

3.1 Study Assumptions

The system studies are based on the following assumptions:

- Latest load forecast.
- Latest generation expansion plan.
- Latest transmission expansion plans of NTDC and DISCOs especially, the expansion plans of MEPCO.
- The 132 kV and 11 kV capacitors particularly proposed by MEPCO have also been incorporated in the studies.
- The system has been assumed to be operating in an interconnected manner, however, 132 kV bus bar at the existing Bahawalpur 220/132 kV substation have been assumed as split bus; and 132 kV line openings have been assumed at some parts in the surrounding MEPCO network in order to keep power flows within line capacities wherever necessary, as per system requirements.
- In the studies, the following reinforcements have been assumed in MEPCO network, a requirement for evacuation of power from all the solar power projects to be connected at 132 kV network of MEPCO:
    i. By-passing of existing 132 kV S/C from Bahawalpur old to Lodhran at the following substations;
        a. Baghdad-ul-Jaded substation
        b. Lodhran substation.
    ii. 132 kV shunt capacitors (36 MVAR) proposed at Hasilpur 132 kV substation when 1000 MW (total gross capacity) of solar generation at Quaid-e-Azam Solar Park, will be inducted in the system.
- As per information provided by project sponsor, the total gross & net capacity of Welt Konnect solar PV power plant have been assumed as 50 MW & 44.8MW respectively and the modeling of Welt Konnect solar power plant has been made as under:

- Power generation of Welt Konnect Solar PV would generate power at low voltage of 0.4 kV (after DC/AC conversion) which would be stepped up to a medium voltage of 15 kV through 15/0.3 kV transformers.

- Seven collector groups of 6.4 MW each to be connected to a 15 kV collector station bus bar which would be stepped up to high voltage of 132kV through 132/15 kV transformers.

  In the report, 2x60 MVA transformers have been used instead of originally proposed 1x60 MVA transformer by the project sponsor in order to meet N-1 contingency requirement of NEPRA.

  The detailed plant layout showing PV collector systems of 50 MW Welt Konnect solar power plant has been attached as Figure #3.

- Other solar power plants (with 50 MW gross capacity each) planned to be inducted in Solar Power Park in three phases (Phase-I, II & III) have also been assumed in the system studies. In general, the net capacities of the solar power plants have been used in the system studies.

3.2 System Study Criteria

The system studies have been carried out keeping in view of the following system operating criteria/limits in accordance with NTDC's Grid Code:

Voltage Limits:	±5% under normal and ±10% under contingency conditions. However, voltages at generation and/or substations may be kept upto +8% under normal operating conditions as per network configuration and/or system requirements.
Transmission Line and Transformer Loading Limits:	100% of rating under normal and N-1 contingency conditions.
Frequency Limits:	49.8 – 50.2 Hz (Frequency Band during Gen ramping up & load pickup) under normal condition 49.4 – 50.5 Hz (Max. Acceptable Frequency Band) under N-1 condition.

The short circuit studies have been carried out to compute maximum three phase and single phase fault levels by using the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to Zero
- Set shunt to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.1 p.u.

The transient stability studies have been carried out to assess the dynamic performance of the solar power plant and grid after being subjected to the following disturbances as given in NEPRA's Grid Code:

- Permanent three-phase fault on any transmission line, cleared in 5 cycles and the outage of the associated line.
- Failure of a circuit breaker to clear a fault (Stuck Breaker Condition) in 5 cycles, with backup clearing in 9-cycles after fault initiation.

In addition to the above stability criteria for a conventional power plant, the following Low Voltage Ride Through (LVRT) requirements are also to be met by a solar power plant as mentioned in the Grid Code Addendum for solar power projects which is under approval by NEPRA:

- The PV Solar Power Project must withstand a voltage dip down to 30% Retained Voltage for a duration of at least 100 msec for a normal clearing case and at least for 180 msec in case of Stuck Breaker condition.
- The PV Solar Power Project will manage active power restoration, after voltage recovery, at a rate of at least 20% of nominal output power per second.

4. Load Flow Analysis

The load flow analysis has been carried out for operating scenarios of summer 2015 & 2016 in order to evaluate adequacy of the proposed interconnection scheme for 50 MW Welt Konnect solar power plant on the system network under normal and single line (N-1) contingency conditions. The description of the simulated scenarios is given as under:

4.1 Peak Load June 2015

Load flow study for peak load of June 2015 under normal operating condition has been carried out and is attached as Exhibit #1. In this scenario, Welt Konnect solar power plant and three other solar power plants of 50 MW gross capacity each, have been assumed in operation. As per load flow study, it is found that power from Welt Konnect solar power project can be evacuated to the 132 kV system of MEPCO under normal condition without any transmission constraint, i.e., the loading of the transmission lines and transformers in the system as well as system voltage profile would remain within limits.

The load flow studies have also been carried out with critical single line contingency (N-1) analysis in the vicinity of Welt Konnect solar power project and are attached as Exhibit #2-8 in Appendix-1. The results of the contingency studies are summarized as under;

Exhibit #	Contingency Conditions	Remarks
2	Welt Konnect solar power plant – Solar PP-2 S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
3	Welt Konnect solar power plant – Solar PP-4 S/C out	-do-
4	Solar PP-1 – Lal Suhanra 132kV S/C out	-do-
5	Bahawalpur Cantt. – Lal Suhanra 132 kV S/C out	-do-
6	Solar PP-4 – Yazman 132kV S/C out	-do-

Exhibit #	Contingency Conditions	Remarks
7	Bahawalpur – Yazman 132kV S/C out	-do-
8	Bahawalpur Cantt. – Bahawalpur 132 kV S/C out	-do-

4.2 Peak Load June 2016

Load flow study for peak load of June 20165 under normal operating condition has been carried out and is attached as Exhibit #9. In this scenario, 50 MW Welt Konnect solar power plant and additional solar power plants with a total gross solar generation as 950 MW have been assumed. As per load flow study, it is found that the power from 50 MW Welt Konnect solar power plant in the presence of all of other the solar power projects can be evacuated to the National Grid under normal without any transmission constraint, i.e., the loading of the transmission lines and transformers in the system as well as system voltage profile would remain within limits.

The load flow studies also cover critical single line contingency (N-1) analysis in the vicinity of these solar projects and are attached as Exhibit #10-16 in Appendix-1. The results of the contingency studies are summarized as under;

Exhibit #	Contingency Conditions	Remarks
10	Welt Konnect solar power plant – Solar PP-2 S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
11	Welt Konnect solar power plant – Solar PP-4 S/C out	-do-
12	Solar PP-1 – Lal Suhanra 132kV S/C out	-do-
13	Solar PP-5 – Lal Suhanra 132kV S/C out	-do-
14	Solar PP-4 – Yazman 132kV S/C out	-do-

Exhibit #	Contingency Conditions	Remarks
15	Bahawalpur – Yazman 132kV S/C out	-do-
16	Bahawalpur Cantt. – Bahawalpur 132kV S/C out	-do-

4.3 Conclusion of Load Flow Analysis

The power from the 50 MW Welt Konnect solar power project can reliably be evacuated to the system through the proposed interconnection scheme under normal and N-1 contingency conditions.

5. Short Circuit Analysis

The short circuit studies have been carried out with proposed interconnection scope of work for 50 MW Welt Konnect solar power plant to compute the maximum three phase and single phase short circuit levels for the system scenario of Aug/Sept 2016. The studies have been carried out with all the existing and planned generation including all the planned 1000 MW solar generation at Quaid-e-Azam Solar Park, Lal Suhara and with interconnected transmission system. The results of the short circuit studies are summarized as under:

Name of Faulted Bus Bar	Voltage Level	Maximum Short Circuit Levels	
		Three Phase	Single Phase
Welt Konnect Solar PV Plant	132 kV	6.31 kA	4.09 kA
Lal Suhanra-New	220 kV	8.23 kA	4.86 kA
Bahawalpur	220 kV	11.18 kA	6.94 kA
Lal Shuanra-New	132 kV	9.63 kA	6.52 kA
Bahawalpur-New Bus Bar-1	132 kV	12.69 kA	8.97 kA
Bahawalpur-New Bus Bar-2	132 kV	6.84 kA	5.25 kA
Lal Suhanra (Old)	132 kV	6.73 kA	4.35 kA
Yazman	132 kV	6.14 kA	3.94 kA
Bahawalpur Cantt	132 kV	11.33 kA	7.82 kA
Solar PP-1	132 kV	6.43 kA	4.14 kA
Solar PP-2	132 kV	6.36 kA	4.11 kA
Solar PP-4	132 kV	6.25 kA	4.07 kA

5.1 Conclusions of Short Circuit Analysis

It is evident from the above table that the induction of 50 MW Welt Konnect solar power plant has no adverse impact on the existing 220 kV and 132 kV substations in the vicinity and the short circuit currents remain within the installed switchgear ratings. Moreover, the standard switchgear of the short circuit rating of 40 kA would be sufficient at 132kV switchyard of the solar plant and 220/132 kV substation at Lal Suhanra. The detailed results of short circuit studies are attached in Appendix-2.

6 Transient Stability Analysis

Transient stability studies have been carried out to evaluate the time domain response of bus voltage, frequency, active/reactive power flows on transmission lines, and active/ reactive power flows from Welt Konnect solar PV power plant after occurrences of faults. The transient stability simulations are used to check whether the solar power plant and power system remain stable or not after subjected to severe disturbances in the light of Grid Code.

6.1 Simulation Time Frame

The time domain stability simulations have been run as follows:

- Run simulation for initial one second for pre-fault steady state condition.
- Apply fault at one second and run the simulation for 1.1-second duration.
- At 1.1 second clear the fault and trip the required circuit.
- Run the simulation up to 10 seconds after clearing fault.

6.2 Modelling of Solar Power Plant

Transient stability studies have been carried out using following dynamic models available in the PSS/E model library for a solar power plant;

Generator Model	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1
Solar Radiation Model	IRRADU1

The parameters for the above dynamic models have been provided by M/s Welt Konnect solar power plant, however, for the missing parameters, assumption as mentioned in Appendix-3, have been made in order to complete the transient stability analysis. The assumed data/parameters are required to be validated from the EPC contractor/equipment manufacturer of Welt Konnect solar power plant.

6.3 Transient Stability Study Results

The solar plant and system network variables monitored and recorded in the simulations are provided below:

i. Bus Frequency plot
ii. Bus Voltage plot
iii. Line Power Flows, i.e., P (MW) & Q (MVAR) plots
iv. P (MW) & Q (MVAR) of Solar power plant

In order to interpret the stability plots, the bus numbers assigned to bus bars on various voltage levels at the switchyard of 50 MW Welt Konnect solar PV power plant are given as under:

Bus Number	Bus Name
7653	132 kV (HV) Bus at Welt Konnect solar plant
76531	15 kV (MV) Bus at Welt Konnect solar plant
765311	O.4 kV (LV) Collector Station-1 (CS-1) Bus at Welt Konnect solar plant

The response of Welt Konnect solar PV power plant to meet LVRT requirements can be observed from the results of transient stability simulations carried out in this section.

The transient stability studies for 5 cycles fault during peak load condition of September 2016 (summer season) for the 50 MW Welt Konnect solar PV power plant have been carried out. The plotted results of the dynamic simulations are attached as Appendix-4. The details of the faults and the outages with description of respective plots depicting their stability behaviour are provided in the Table-1 given below:

Table-1: Transient Stability Results for 5 Cycles Faults

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
1	3-phase fault at Welt Konnect 132 kV bus cleared in 5 cycles and the outage of Welt Konnect to	1	Frequency	Welt Konnect solar power plant and NTDC/MEPCO systems remain stable. No LVRT
		2	Voltage	
		3	P & Q Line Flows	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	Solar PP-4 132 kV single circuit.	4	P & Q of Solar power plant	problem at Welt Konnect solar power plant.
2	3-phase fault at Welt Konnect 132 kV bus cleared in 5 cycles and the outage of Welt Konnect to Solar PP-2 132 kV single circuit.	5	Frequency	-do-
		6	Voltage	
		7	P & Q Line Flows	
		8	P & Q of Solar power plant	
3	3-phase fault at Welt Konnect 132 kV bus cleared in 5 cycles and the outage of 132/15kV transformer.	9	Frequency	-do-
		10	Voltage	
		11	P & Q Line Flows	
		12	P & Q of Solar power plant	
4	3-phase fault Welt Konnect 15 kV bus cleared in 5 cycles and the outage of Welt Konnect collector station (6.4MW).	13	Frequency	-do-
		14	Voltage	
		15	P & Q Line Flows	
		16	P & Q of Solar power plant	
5	3-phase fault at Lal Suhanra(old) 132 kV bus cleared in 5 cycles and the outage of Lal Suhnara (old) to Solar PP-1 132 kV single circuit.	17	Frequency	-do-
		18	Voltage	
		19	P & Q Line Flows	
		20	P & Q of Solar power plant	
6	3-phase fault at Lal Suhanra (old) 132 kV bus cleared in 5 cycles and the outage of Lal Suhnara (old) to Solar PP-5 132 kV single circuit.	21	Frequency	-do-
		22	Voltage	
		23	P & Q Line Flows	
		24	P & Q of Solar power plant	
7	3-phase fault at Bahawalpur-Cantt 132kV bus cleared in	25	Frequency	-do-
		26	Voltage	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	5 cycles and the outage of Bahawalpur-Cantt to Lalsohanra 132 kV single circuit.	27	P & Q Line Flows	
		28	P & Q of Solar power plant	
8	3-phase fault at Bahawalpur-Cantt 132kV bus cleared in 5 cycles and the outage of Bahawalpur-Cantt to Bahawalpur 132 kV single circuit.	29	Frequency	-do-
		30	Voltage	
		31	P & Q Line Flows	
		32	P & Q of Solar power plant	
9	3-phase fault at Bahawalpur 132 kV bus cleared in 5 cycles and the outage of Bahawalpur to Yazman 132 kV single circuit.	33	Frequency	-do-
		34	Voltage	
		35	P & Q Line Flows	
		36	P & Q of Solar power plant	
10	3-phase fault at Bahawalpur 132 kV bus cleared in 5 cycles and the outage of Bahawalpur to Bahawalpur-Cantt. 132kV single circuit.	37	Frequency	-do-
		38	Voltage	
		39	P & Q Line Flows	
		40	P & Q of Solar power plant	
11	3-phase fault at Yazman 132 kV bus cleared in 5 cycles and the outage Yazman to Solar PP-4 132 kV single circuit.	41	Frequency	-do-
		42	Voltage	
		43	P & Q Line Flows	
		44	P & Q of Solar power plant	
12	3-phase fault at Yazman 132 kV bus cleared in 5 cycles and the outage Yazman to Bahawalpur 132 kV single circuit.	45	Frequency	-do-
		46	Voltage	
		47	P & Q Line Flows	
		48	P & Q of Solar power plant	

The transient stability studies for 9 cycles fault (stuck breaker) during peak load conditions of September 2016 (summer season) for 50 MW Welt Konnect solar power plant have been carried out. The plotted results of the simulations are attached as Appendix-4. The details of the faults and the outages with description of respective plots depicting their stability behaviour are provided in the Table-2 given below:

Table-2: Transient Stability Results for 9 Cycles Faults

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
1	3-phase fault at Welt Konnect 132 kV bus cleared in 9 cycles and the outage of Welt Konnect to Solar PP-4 132 kV single circuit.	49	Frequency	Welt Konnect solar power plant and NTDC/MEPCO systems remain stable. No LVRT problem at Welt Konnect solar power plant.
		50	Voltage	
		51	P & Q Line Flows	
		52	P & Q of Solar power plant	
2	3-phase fault at Welt Konnect 132 kV bus cleared in 9 cycles and the outage of Welt Konnect to Solar PP-2 132 kV single circuit.	53	Frequency	-do-
		54	Voltage	
		55	P & Q Line Flows	
		56	P & Q of Solar power plant	
3	3-phase fault at Welt Konnect 132 kV bus cleared in 9 cycles and the outage of 132/15kV transformer.	57	Frequency	-do-
		58	Voltage	
		59	P & Q Line Flows	
		60	P & Q of Solar power plant	
4	3-phase fault Welt Konnect 15 kV bus cleared in 9 cycles and the outage of Welt Konnect collector station (6.4 MW).	61	Frequency	-do-
		62	Voltage	
		63	P & Q Line Flows	
		64	P & Q of Solar power plant	
5	3-phase fault at Lal Suhanra(old) 132 kV bus cleared in 9	65	Frequency	-do-
		66	Voltage	
		67	P & Q Line Flows	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	cycles and the outage of Lal Suhnara (old) to Solar PP-1 132 kV single circuit.	68	P & Q of Solar power plant	
6	3-phase fault at Lal Suhanra (old) 132 kV bus cleared in 9 cycles and the outage of Lal Suhnara (old) to Solar PP-5 132 kV single circuit.	69	Frequency	-do-
		70	Voltage	
		71	P & Q Line Flows	
		72	P & Q of Solar power plant	
7	3-phase fault at Bahawalpur-Cantt 132kV bus cleared in 9 cycles and the outage of Bahawalpur-Cantt to Lalsohanra 132 kV single circuit.	73	Frequency	-do-
		74	Voltage	
		75	P & Q Line Flows	
		76	P & Q of Solar power plant	
8	3-phase fault at Bahawalpur-Cantt 132kV bus cleared in 9 cycles and the outage of Bahawalpur-Cantt to Bahawalpur 132 kV single circuit.	77	Frequency	-do-
		78	Voltage	
		79	P & Q Line Flows	
		80	P & Q of Solar power plant	
9	3-phase fault at Bahawalpur 132 kV bus cleared in 9 cycles and the outage of Bahawalpur to Yazman 132 kV single circuit.	81	Frequency	-do-
		82	Voltage	
		83	P & Q Line Flows	
		84	P & Q of Solar power plant	
10	3-phase fault at Bahawalpur 132 kV bus cleared in 9 cycles and the outage of Bahawalpur to Bahawalpur-Cantt. 132 kV single circuit.	85	Frequency	-do-
		86	Voltage	
		87	P & Q Line Flows	
		88	P & Q of Solar power plant	
11	3-phase fault at Yazman 132 kV bus cleared in 9 cycles and the outage	89	Frequency	-do-
		90	Voltage	
		91	P & Q Line Flows	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	Yazman to Solar PP-4 132 kV single circuit.	92	P & Q of Solar power plant	
12	3-phase fault at Yazman 132 kV bus cleared in 9 cycles and the outage Yazman to Bahawalpur 132 kV single circuit.	93	Frequency	-do-
		94	Voltage	
		95	P & Q Line Flows	
		96	P & Q of Solar power plant	

6.4 Conclusions of Transient Stability Analysis

The results of transient stability analysis indicate that 50 MW Welt Konnect solar power plant connected with the system network through the proposed interconnection scheme and the system networks of MEPCO & NTDC are strong enough to absorb the worst disturbances on either side, i.e., on solar power plant side or the Grid side. It can also be seen from the above stability plots that Welt Konnect solar power plant also fulfills the requirements of LVRT and the rate of power restoration after voltage dip is faster than 20% per second as required in Grid Code under approval.

In general, there is no problem of transient stability and LVRT pertaining to the Welt Konnect solar power plant with the proposed interconnection; and both Welt Konnect solar power plant and the power system remain stable when subjected to severe disturbances.

7. Power Quality Analysis

The power quality analysis is very important for a solar PV power plant that may cause flicker and distortions in the power supply due to inverter action. These issues become more significant for weak power systems having low short circuit strength. Therefore, power quality analysis including flicker and voltage unbalance, has been carried out with the proposed interconnection scheme of 50 MW Welt Konnect solar PV power plant for the worst case scenario of minimum system short circuit levels in Aug/Sept 2016.

7.1 Flicker

IEC61400-21 standard have been used for the calculation of flicker levels for steady-state continuous operation. The probability of 99th percentile flicker emission from a single inverter during continuous operation for short time Pst∑ and long time flicker level P1t∑ are assumed same and calculated by the following formula:

$$P_{st\sum} = P_{lt\sum} = \frac{1}{S_k} \cdot \sqrt{\sum_{i=1}^{N_{wt}} (c_i(\psi_k, v_a) \cdot S_{n,i})^2} \qquad \text{(A)}$$

Where

S_n is the rated apparent power of the one inverter

S_k is the short-circuit apparent power at PCC

N_{wt} is the number of inverters connected to the PCC

The value of c (φ_k) may not be greater than 1, therefore for the present analysis, the value of 1 for the worst case has been assumed. PCC is the point of common coupling which is 132 kV bus of the switchyard of 50 MW Welt Konnect solar power plant.

For the minimum short circuit case, the system network in the vicinity of Welt Konnect solar power plant has been modeled with minimum generation in operation, especially, in Muzaffargarh, Kot Addu & Multan areas and the generation in Quaed-e-Azam solar park has been reduced to 50%. The short circuit calculations have been done at 0.9 p.u. voltage. All the invertors of 50 MW Welt Konnect solar power plant have been assumed in operation for the

calculation of extreme value of flicker level at 132 kV bus of solar power plant. The values used in the calculation of flicker are as below:

S_n = 0.8 MVA

N_{WT} = 56

S_k for 132 kV bus = 1377.24 MVA

Using the above data in Equation (A), we get

$P_{St\Sigma} = P_{lt\Sigma}$= 0.004347 = 0.43%

Whereas, the acceptable value in IEC Standard is less than 4%. Therefore, the flicker level is far less than the maximum permissible limit which implies that the inverters at 50 MW solar power plant would not cause any flicker problem during steady state operation even in the weakest system conditions.

7.2 Voltage Unbalance

i. Voltage Step-Change

The rise of the voltage with solar PV units at the point of PCC should be less than 3%. With only one collector group at PCC of a solar plant under study and 50% generation in solar park in operation, this condition is evaluated by using the following formula;

$$\mathbf{K_{k1}} = \frac{S_{kV}}{\sum S_{Amax}} \qquad \text{(B)}$$

The value of K_{kl} > 33 represents less than 3% (1/33) step-change in voltage.

In the simulated case for Welt Konnect solar PV power plant, the short circuit power and apparent power come out as under:

S_{kV} = Short circuit power at the PCC = 1347.31 MVA

S_{max} = Maximum apparent power of one collector group connected to the PCC = 6.4 MVA

Using above values in Equation (B), we get

K_{kl} = Voltage Step-change factor = 210.51

It corresponds to 0.48% (1/210.51) step-change in voltage which is quite less than the permissible limit of 3%.

ii. Voltage Variation

The voltage variation with only one collector group at PCC of the solar plant under study can be estimated by the following formula:

$$\Delta u_a = k_{imax} \cdot \frac{S_{rE}}{S_{kV}} \qquad \text{(C)}$$

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

S_{kV} = Short-circuit power at the PCC

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

The above calculation gives an upper assessment for a safe margin basically. For a solar power plant, $K_{i,max}$ can be assumed to be 1. In the simulated case for Welt Konnect solar PV power plant, the values of short circuit power and apparent power come out as under:

S_{kV} = 1347.31 MVA

S_{rE} = 0.8 MVA

Using above values in Equation (C), we get

U_a = 0.000594 = 0.0594%

The above voltage variation is far less the acceptable limit of 2.34% in IEC Standard.

7.3 Conclusion of Power Quality Analysis

The important power quality parameters like flicker and voltage unbalance, have been computed for Welt Konnect solar PV power plant with the worst case scenario and compared with limits given in IEC standards. The study results indicate that the levels of flicker and voltage unbalance are within permissible limits of IEC standards, with the interconnection of 50 MW Welt Konnect solar PV power plant.

5. Conclusions and Recommendations

On the basis of detailed grid interconnection studies including load flow, short circuit, transient stability and power quality studies carried out for evacuation of power from 50 MW Welt Konnect solar PV power plant, the conclusions and recommendations are given as below::

i. The following proposed interconnection scheme has no technical constraints or problems in evacuation of power from 50 MW Welt Konnect solar PV power plant to the system networks of NTDC and MEPCO:

   "A 132 kV Double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra 132kV single circuit line at the 132 kV switchyard of 50 MW Konnect solar power plant."

ii. The project sponsor has proposed 1x60 MVA power transformer at 132/15kV voltage level in the switchyard of Welt Konnect solar power plant but it is recommended to install 2x60 MVA power transformers at 132/15kV voltage level to ensure supply of power under N-1 contingency condition. In addition, it is recommended to design the 132 kV switchyard of the 50MW Welt Konnect solar PV power plant with double bus bar arrangement.

iii. As per load flow analysis carried out for operating scenarios of summer 2015 and 2016, it has been found that the power from 50 MW Welt Konnect solar power plant can be dispersed to the system under normal and N-1 contingency conditions.

iv. As per short circuit analysis, the 50 MW Welt Konnect solar power plant has no adverse impact on the surrounding 132 kV and 220 kV substations and the short circuit currents remain within installed switchgear ratings. On the other hand, the standard switchgear with short circuit rating of 40 kA would be sufficient for the 132 kV switchyard of 50 MW Welt Konnect solar power plant.

v. As per transient stability analysis, 50 MW Welt Konnect solar power plant and the power system have been found to remain stable with no adverse effects after application of faults at the 132 kV switchyard of 50 MW Welt Konnect solar power plant and at the grid stations & other power plants in its vicinity. However, it is important to intimate that in order to carry out

transient stability analysis, some of the missing data for Welt Konnect solar PV plant regarding dynamic model has been assumed. The assumed data is required to be validated from the EPC contractor/equipment manufacturer of Welt Konnect solar power plant.

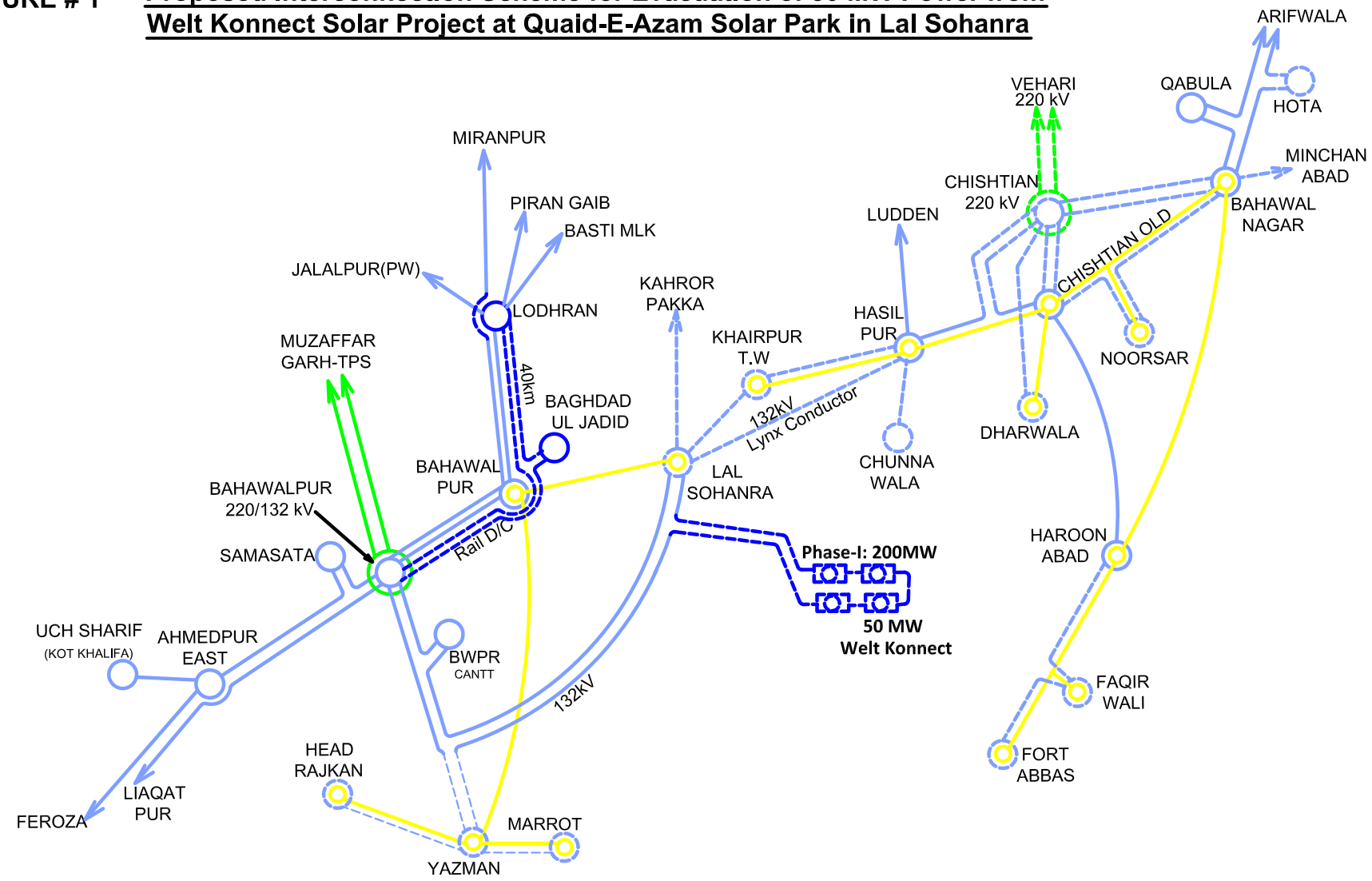
The LVRT requirements for 50 MW Welt Konnect solar PV power plant are also met as mentioned in Grid Code Addendum for solar power plants (under approval by NEPRA).

vi. The power quality related parameters computed in the studies have also been found well within permissible limits as mentioned in the relevant IEC standards. However, this is the responsibility of developer of 50 MW Welt Konnect solar PV power plant to install necessary monitoring and compensating equipment at its switchyard to meet the power quality standards as per requirements of Grid Code Addendum for solar power plants (under approval by NEPRA).

vii. The comments of project sponsor on draft grid interconnection study of 50MW Welt Konnect solar PV power plant are welcome for incorporation in the final report.

FIGURE # 1

Proposed Interconnection Scheme for Evacuation of 50 MW Power from Welt Konnect Solar Project at Quaid-E-Azam Solar Park in Lal Sohanra

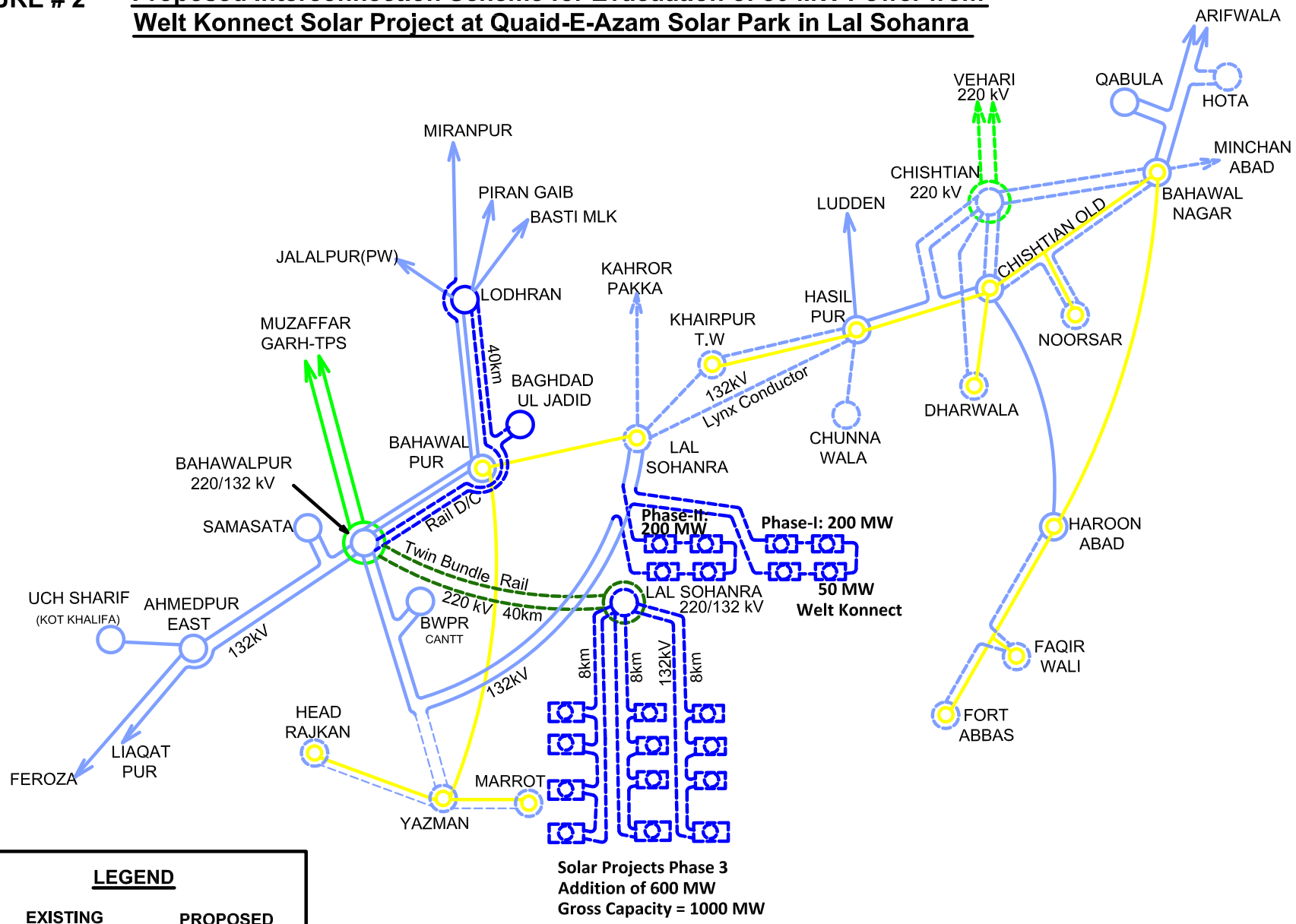


LEGEND

	EXISTING		PROPOSED	
	G/STN	T/L	G/STN	T/L
220kV	○	———	○	- - - -
132kV	○	———	○	- - - -
66kV	○	———		
SOLAR PROJECTS 50 MW			▣	

FIGURE # 2

Proposed Interconnection Scheme for Evacuation of 50 MW Power from Welt Konnect Solar Project at Quaid-E-Azam Solar Park in Lal Sohanra



LEGEND

	EXISTING		PROPOSED	
	G/STN	T/L	G/STN	T/L
220kV	○	———	○	- - - -
132kV	○	———	○	- - - -
66kV	○	———		
SOLAR PROJECTS 50 MW			▣	

Figure # 3

LAYOUT DIAGRAM OF 50 MW WELT KONNECT PV SOLAR POWER PLANT

Harmonic Emissions at the output of each Inverter should be kept within IEC Standard