QUAID-E-AZAM
Solar Power (Pvt.) Ltd.

Ref No: QAS-14/04/25-03

April 23, 2014

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

Subject: **APPLICATION FOR GRANT OF GENERATION LICENSE IN THE NAME OF QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED FOR 100-MW (PV) SOLAR POWER PLANT AT BAHAWALPUR.**

Dear Sir

I, Najam Ahmed Shah Chief Executive Officer, being the duly authorized representative of Quaid-e-Azam Solar Power (Private) Limited by virtue of Board Resolution No. QAS/02/13-4 dated 13th February 2014, hereby apply to the National Electric Power Regulatory Authority (NEPRA) for the grant of a generation license to Quaid-e-Azam Solar Power (Private) Limited for setting up of a 100-MW Solar Power plant pursuant to Section 15 read with Section 7(2)(a) of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997. Whilst the 100 MW solar power plant shall be functional at full capacity upon achieving commercial operations, it is expected to generate for sale 10 MW prior to commercial operations.

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 provision of the above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

A bank draft of the sum of Rupees 329,080/- being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations 1999 is also attached herewith.

Yours Sincerely

NAJAM AHMED SHAH
CHIEF EXECUTIVE OFFICER
QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED

Azam Solar Power (Pvt.) Limited

Quaid-e-Azam Solar Power (Pvt.) Ltd.

Government of Punjab

Ref No QAS/02/25-4

February 25, 2014

Chairman
National Electric Power Regulatory Authority
Islamabad

Subject: **BOARD RESOLUTION FOR 100 MW POWER GENERATION LICENSE FROM NEPRA**

Dear Sir

In the 8th Board meeting the following resolution was passed by the Board members unanimously, extract of resolution is given below

Resolved that Quaid e Azam Solar Power Pvt Ltd to apply for power generation license to NEPRA for 100 MW project

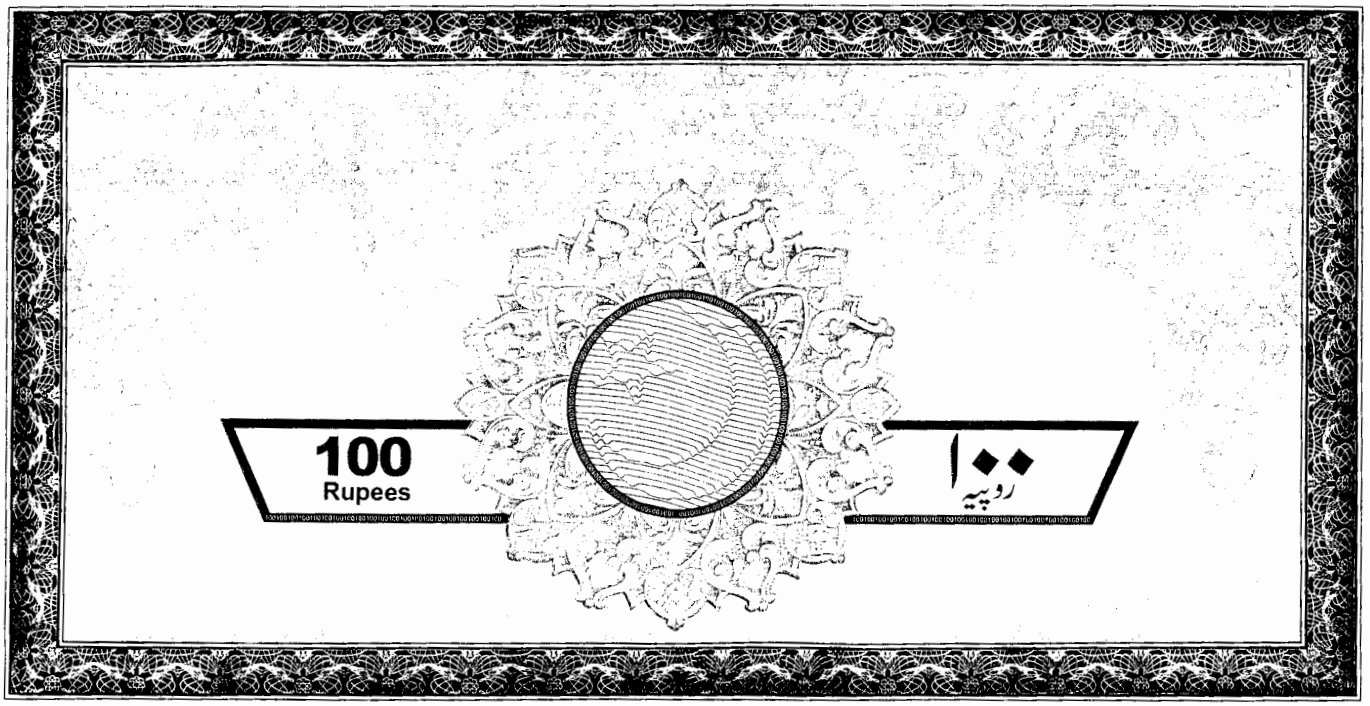
Further Resolved that BOD authorized the Chief Executive Officer to Correspond with NEPRA for Power generation license.

Extract certified to be true copy

Muhammad Badar Ul Munir,ACA
Company Secretary

Company Secretary
Quaid-e-Azam Solar Power (Pvt) Ltd.

D211295



BEFORE
THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

AFFIDAVIT of **MR. NAJAM AHMED SHAH** S/o Mr. Aftab Ahmed Shah, CNIC No. 42101-9779292-5 resident of B-18, GOR 6, Mohala Ferozpur Road, Lahore, Pakistan and authorized representative of Quaid-e-Azam Solar Power (Private) Limited, 3rd Floor, NIB Bank Building, 83-A, E/1, Main Boulevard, Gulberg-III, Lahore ("**Company**").

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

1. I am the Chief Executive Officer of the Company.

2. I am the authorized representative of the Company by virtue of Board Resolution No. QAS/02/13-4 dated 13th February 2014.

3. The contents of accompanying Generation License Application dated April 23, 2014 to the National Electric Power Regulatory Authority (NEPRA) along with the 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 there from.

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

DEPONENT

VERIFICATION

It is hereby verified on solemn affirmation at Lahore, Pakistan on the April 23, 2014 that the contents of the above Affidavit are true and correct to the best of my knowledge and belief and that nothing, material or relevant thereto, has been concealed or withheld there from.

DEPONENT

No. PPDB/ 204 /2014
PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT
1st Floor, Central Design Building,
Irrigation Secretariat, Old Anarkali, Lahore
(Ph: 042-99213877 Fax: 99212796)
Date 17-02-/2014

M/s Quaid-e-Azam Solar Power (Pvt) Ltd.
Suit # 503, 5th Floor, Shaheen Complex,
Egerton Road,
Lahore

Subject: Letter of Interest (LOI) for Development of 100 MW Solar PV Power Project (Raw Site) Located at Quaid-e-Azam Solar Park District Bahawalpur.

Reference: Your request to PPDB through letter No. QAS/02/10-4 dated February 10th, 2014 for issuance of Letter of Interest (herein after referred to as LOI) to your Company under Punjab Power Generation Policy -2006 (Revised 2009) (hereinafter referred to as the Policy) for development of 100 MW Solar PV power project (the "Project") to be located at Quaid-e-Azam Solar Park District Bahawalpur.

Your Company has submitted Feasibility Study Report (the "FSR") of the Project, alongwith your statement of qualification to PPDB. The blanket exemption about submission of Bank Guarantee under the Policy before issuance of LOI, granted by the competent authority, on a Summary moved by Energy Department will be available to you subject to approval of FSR by PPDB appointed Panel of Experts (POE). This LOI is being issued to your Company on behalf of Government of the Punjab, without submission of Bank Guarantee to PPDB, subject to the following:-

PPDB appointed Panel of Experts (POE) shall examine and approve the submitted FSR. The FSR, alongwith other content should include;

1) Environmental Impact Assessment Study,
2) Detailed design of power house,
3) Load flow and stability studies, design of interconnection/transmission lines,
4) Details pertaining to infrastructure, Project cost, its financing and terms & conditions, and
5) Tariff calculations and assumptions of financial calculations including economic and financial analysis.

Validity of this LOI is till the approval of FSR by POE, where after or before it, any violation of the policy will automatically terminate this LOI. Issuance of this LOI or its termination or your failure for getting approval of FSR thereunder, cannot form the basis of any claim for compensation or damages by your Company or any party claiming through

your Company against Government of the Punjab/PPDB or any of its agencies, employees or consultants on any grounds.

This LOI has been issued in duplicate on the date hereof, and it shall come into effect when one copy hereof is received by PPDB after having been duly countersigned by you. Nevertheless, this LOI shall lapse if the countersigned copy is not received at PPDB within thirty (30) days of its issuance.

(MS. SANIYA AWAIS)
Managing Director
Punjab Power Development Board

Accepted and agreed

for & on behalf of

Dated: 17/2/14

CC.

1. Chairman Board PPDB Government of Punjab, Lahore
2. Secretary, Ministry of Water & Power, Islamabad
3. Chairman, P&D, Government of the Punjab, Lahore
4. Additional Chief Secretary Energy Department, Government of the Punjab, Lahore.
5. Chairman, NEPRA, Islamabad
6. Secretary to Chief Minister Punjab.
7. Chairman WAPDA, WAPDA House Lahore
8. Chief Executive Officer ,MEPCO Khanewal Road Multan
9. Chief Executive Officer Alternate Energy Development Board, Islamabad

NATIONAL TRANSMISSION & DESPATCH CO. LTD

Chief Operating Officer /
General Manager (CPPA) NTDCL

No. GM/CPPA/CE-II/MT-IV/QSPPL/ 1733-36 **Dated:** 17 / 03/2014

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

Fax 051-9210215

Subject: **Power Acquisition Request for Purchase of Power from 100 MW Solar Power Project offered by M/s Quaid-e-Azam Solar Power (Pvt) Limited (QSPPL) at Lal Suhanra against Upfront Tariff for Solar Power Projects**

In pursuant to NEPRA Interim Power Procurement (Procedures and Standards) Regulation 2005 and its amendment to-date, Power Acquisition Request (PAR) of subject project is attached.

Following information required vide Clause (4) of above mentioned NEPRA Regulation, on prescribed formats (Schedule I) are also enclosed for supporting the request:

a. **Form I (1 of 2):**
DISCO-Wise Peak Demand & Demand at Interconnection Points (MW)
b. **Form I (2 of 2):**
Peak Demand at Interconnection Points (Grid Stations) of NTDC & DISCOs
c. **Form II (1 of 2):**
Peak Load
d. **Form III:**
Information about Generation Capacity under Proposed Procurement Request

This issues with the approval of Procurement Committee of BOD NTDCL.

DA/As above

(TAHIR MAHMOOD) 17/3/14
General Manager (CPPA) NTDCL

CC to:

i. Chief Executive Officer AEDB, 2nd Floor, OPF Building G-5/2.
ii. MD PPDB, 1st Floor, Central Design Building, Irrigation Secretariat, Old Anarkali, Lhr.
iii. Mr. Najam Ahmed Shah, Chief Executive Officer, M/s Quaid-e-Azam Solar Power (Pvt) Limited, 3rd Floor, NIB Bnak Buildng, 83-A, E/1, Main Boulevard, Gulberg – III, Lahore.

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

003584

SECP

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE
LAHORE

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No.0085152

I hereby certify that QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is Limited by Shares.

Given under my hand at Lahore this Sixteenth day of September Two Thousand and Thirteen

Fee Rs.124,000/-

CERTIFIED TO BE TRUE COPY
31/10/13
DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

(LIAQAT ALI DOLLA)
Additional Registrar of Companies

No.ARL/ 52-68 Dated: 16/9/2013

PAKISTAN COURT FEE
Quaid-E-Azam Solar Power (Pvt) Ltd

COMPANIES ORDINANCE, 1984

(PRIVATE COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

OF

QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED

I. NAME:

The name of the Company is the "QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED".

II. REGISTERED OFFICE:

The Registered Office of the Company shall be situated in the province of Punjab.

III. OBJECTS:

The Company is a public-sector for-profit company, established by the Government of the Punjab, Energy Department, wholly owned & controlled by the Government. The objects for which the Company is established are all or any of the following (and in construing the following sub-clauses, the scope of no one of such sub-clauses shall be deemed to limit or affect the scope of any other such sub-clauses):

1. To carry on the business of setting up of Solar Energy Power Projects, construction of Grid Station, transmission lines and other works incidental and ancillary thereto.

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

3. To locate, establish, construct equip operate use manage and maintain solar power generator plants, thermal power generator plants, geo thermal power plants, solar power plants, wind power plants, biomass based power plants, power grid stations, transforming, switching, conservation 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 centers, shops, dispensing machines for prepayment cards and other devices, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities.

4. To carry out the business of sale/purchase of electricity as per power regime regulations in the country.

5. To operate and maintain the existing Solar Power system and keep the same in good repair.

6. To collaborate with solar energy companies, utilities, and government to attract research grants from state and federal government agencies.

7. To initiate projects on solar energy programs. The projects could be from solar energy companies to study specific aspects of solar energy, and /or other sources.

8. To use the present systems as demonstration units for visitors from community, industry groups and clients of solar energy products suppliers and installers.

9. To provide training in installation, operation and maintenance of solar energy plants/ projects and equipment relating to it.

10. To initiate research projects with respect to solar energy power generation plants.

11. To carry on the business as manufacturer, exporters, importers, contractor, subcontractor, seller buyer, agent of solar panels and equipments, components and parts including rotor blade, braking systems, towers, nacelle, control units, generator etc.

12. To carry on the business as manufacturer, exporters, importers, contractor, subcontractor, seller buyer, agent of renewal energy systems especially solar etc.

13. To carry on the business of setting up industrial plants, project consultancy, product marketing and management consultants in the field of Solar Energy.

14. To provide consultancy regarding installations of all types of projects and plant & machinery and business management regarding distribution, marketing and selling and to collect, prepare, distribute, information and statistics relating to any type of business or industry relating to solar systems and solar energy.

15. To carry on, manage, supervise and control the business of transmitting, manufacturing, supplying, generating, distributing and dealing in electricity and all forms of energy and power generated by solar energy including ~~nuclear~~, steam, hydro or tidal, water, wind, solar, hydrocarbon fuel or any other form, kind or description Subject to Fulfilment of Legal Requirements

16. To plan, develop, establish, erect, construct, acquire , operate, run, manage, hire, lease, buy, sell, maintain, enlarge, alter, renovate, modernize, work and use power system networks of all types including ultra high voltage (UHV), extra-high voltage (EHV), high voltage (HV), high voltage direct current (HVDC), medium voltage (MV) and low voltage (LV) lines and associated stations, substations, transmission and distribution centers, systems and networks and to lay cables, wires, accumulators, plants, motors, meters, apparatus, computers, telecommunication and telemetering equipments and other materials connected with generation, transmission, distribution, supply and other ancillary activities relating to the electrical power and to undertake for and on behalf of others all these activities in any manner.

17. To carry on the business of setting up industrial solar energy plants, project consultancy, product marketing and management consultants.

18. To provide consultancy regarding installations of all types of projects and plant & machinery and business management regarding distribution, marketing and selling and to collect, prepare, distribute, information and statistics relating to any type of business or industry relating to solar systems and solar energy.

19. To carry on business activities for manufacturing, distribution, generation, transmission, supervisions and control of all types of power either mechanical, hydraulic, gas, wind farms, solar etc.

20. To provide consultancy, expert services, advises, designs, drawings in relation to supervision and control of power in [redacted] and abroad and to undertake solar energy related projects.

21. To carry on the business of developing, maintaining and operating [illegible] generation and distribution of electricity or any other form of power [illegible] by laying a network of new distribution lines.

22. To carry on the business of providing solutions to companies, entities, bodies, government or semi government or private agencies in the energy markets and providing regulatory consulting, analytical services and comprehensive load services in respect of Energy Sector.

23. To arrange for the maintenance and management of a renewable energy source (Solar Energy) to the benefit of the Operating Area.

24. To promote and support a range of environmentally friendly and renewable energy projects and initiatives with view of making country a carbon neutral community.

25. The purpose of the company is to establish (700 MW) Solar Power Projects in public sector in province of Punjab.

26. To carry on all or any of the business of the generating, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of solar energy and produets or their services associated therewith and of promoting the conservation and efficient use of solar power and to perform all other acts which are necessary in the business of generation, distribution and supply of solar power in province of Punjab.

27. To locate, establish, construct, operate, use, manage and maintain solar power plants, solar power grid stations, sub-stations, cables bridges, dispensing machines, transforming, switching and conversion and transmission facilities, cable lines, solar power schemes, offices, IT resources, warehouse, workshop, electronic printing facilities and other storage facilities.

28. To purchase or otherwise acquire the solar power products from the competitive market (national or international) in this regard.

29. To carry on the business of solar power plants, machinery and apparatus and to purchase or otherwise acquire and treat, store, logistics, supply and sell and otherwise dispose of and generally wheeling in any renewable "solar" products.

30. To ascertain the tariff for the bulk supply that will secure recovery of operating cost, interest charges and depreciation of assets, redemption at due time of loans other than those covered by depreciation, expansion, projects, payment of taxes and return on investment to quote the tariff to bulk purchaser of electric power, and to prefer petition to the appropriate authority for the approval of schedule tariff and its adjustments, as desirable or necessary from time to time.

31. To carry on the business as special experts as renewable engineers providing consultancy services, preparation of feasibilities for all sorts of renewable related business and to import and deal in all sort of renewable goods.

32. To carry on the business in the province of Punjab for importers, transporters, dealers in all articles and commodities to or connected any other business of the company capable of being conveniently carried out or necessary for the promotion of the objects herein contained, as permissible under law.

33. To carry on the business of construction, erection and maintenance with all its ancillary services for or in respect of power houses, bridge, roads, business offices, markets, warehouses.

34. To carry on the business of the business of general order supplier including Government ,Semi-Government agencies, dealers, distributor, stockiest agent sub agents in any goods or products within the scope of the object of the company and subject to any permission required unde the law of the country.

35. To apply for, tender, offer and accept purchase or acquire any contracts/covenants in concessons for or in relation to the project execution, carrying out their improvements, managerial expetise, administrative control of works and convenience and undertake, execute, carryout, dispose if or otherwise turn to account the same.

36. To establish and manage, zonal, divisional and sub offices and to appoint representatives of the company and its affiliates concerns anywhere in the province.

37. To carry out joint ventures, agreements with other companies within the scope of the objects of the company.

38. To import, assemble, test, install, maintain, renovate, refurbish, recondition, commission, manage, acquire, supply and otherwise deal in plants, equipment and apparatus for the lawful business of the company.

39. To recruit, hire, engage, depute, employ, or borrow an individual or a team of, qualified and experienced professionals, experts, advisors, consultants, personnel, workers, firms, association of persons, or agents, either directly or indirectly, whether local or international and supporting & helping staff, on such terms & conditions as prescribed or in accordance with HR policy of the Company in order to carry out the business or objects of the Company.

40. To remunerate and to provide facilities, perks, emoluments, and benefits, to all the persons recruited, hired, engaged, deputed, employed or borrowed by the Company as per their terms & conditions or in accordance with HR policy of the Company; or any person or firm or company rendering services to the Company upon such terms & conditions as the Company may determine.

41. To provide other benefits such as retiring benefits, social security, old age benefits, on leaving the job or service or on death in harness to all the persons recruited, hired, engaged, deputed, employed or borrowed by the Company as per their terms & conditions or in accordance with HR policy of the Company; and to provide for their training or work abroad and to remove reward, promote, demote or replace them as the Company may from time to time determine in its HR policy.

42. To train professionals, personnel, workers and other staff, both in Pakistan and abroad to attain the requisite technical and managerial proficiency in various specialties connected with the objects of the Company.

43. To enter into negotiations, sign, and execute Memorandum of Understandings, contracts, agreements, concessions and joint ventures with the individuals and entities that may seem conducive to the Company's objects or any of them and to obtain from any such individual or entity any charters, contracts, rights, privileges and commission which the Company may think desirable and to carry on, exercise and comply with any such charters, contracts, decrees, rights, privileges and concessions.

44. To purchase, take on lease or in exchange, hire, apply for or otherwise acquire and hold for any interest, any rights, privileges, any tangible or intangible assets including lands, houses, offices, buildings, and premises, any fixed and movable machinery, plants, tools, stock-in-trade, patents and patents rights, copyrights, licenses, agency, dealerships, franchises, and any other assets, required or convenient to be used in or about the business of the Company or any branch, department, or subsidiary thereof, on its own ownership & possession or on behalf of any individuals or entities; and to improve, add, repair, maintain, reconstruct, rehabilitate, develop or replace such tangible or intangible assets; and to use, exercise, develop in respect of or otherwise turn to account any property, rights and information so acquired, subject to any permission required under the law.

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

46. To establish, promote, acquire or assist in establishing or promoting or acquiring and subscribing to or becoming a member of, any other company, firm, subsidiary, associate, separate business units, special purpose vehicles, association of persons or club to carry out any or part of Company objects or similar or in part similar or entirely different purposes or the establishment or promotion of which may be beneficial to the Company, as permissible under the law.

47. To open Bank Accounts with any bank or banks, whether local or foreign, of any type or nature in local or foreign currency; or to use or operate bank accounts opened or authorized by any Government whether local or foreign, or any other individual and to draw, make, accept, endorse, deposit, execute, issue, negotiate and discount cheques, cash or cash equivalent, promissory notes, bills of exchange, bills of lading, warrants, deposit notes, debentures, letters of credit and other negotiable instruments and securities legally permissible in favour of the Company or its personnel, clients or any individual or entity for the purpose of Company's business or objects.

48. To arrange local and foreign currency loans, grants or aids from Government (federal, provincial, district, local, or foreign) scheduled banks, industrial banks, financial institutions, development agencies or entities, donors, authorities, bodies whether local or foreign or any other individual or entities or Directors to carry on Company's business or objects; and to make payments of principal, interests and financial & other costs incurred to arrange or utilize such loans, grants or aids.

49. 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.

50. To sub-let all or any contracts from time to time and upon such terms and conditions as may be thought expedient.

51. To guarantee the performance of contract and obligations of the Company in relation to the payment of any loan, debenture-stock, bonds, obligations or securities issued by or in favor of the Company and to guarantee the payment or return on such investments.

52. To cause the Company to be registered, recognized or establish country offices in any foreign country.

53. To apply for and obtain necessary consents, permissions and licenses from any Government (federal, provincial, district, local, or foreign) and other authorities for enabling the Company to carry on any of its objects into effect as and when required by law.

54. To insure the property, assets, and employees of the Company against losses, damages, risks, accidents and liabilities of all kinds which may affect the Company, whether in respect of contracts, agreements, advances or securities, or in respect of staff or employees of the Company, or in respect of property belonging to or leased to or hired by the Company, either by setting apart funds of the Company or by effecting such insurances in any manner deemed fit by the Company, and to create any reserve funds, sinking fund, insurance fund or any other special fund whether for depreciation, replacement or for repairing, insuring, improving, extending or maintaining any of the property of the Company or for any other purpose conducive to its objects but not to act as an insurance company.

55. To settle disputes by negotiation, reconciliation, arbitration, litigation or other means and to enter into compromise with debtors, creditors, members, financial institutions, clients, Government and any other persons in respect of any difference or dispute with them.

56. To acquire for consideration or otherwise from any national or international organization, institution, corporation, company, person; technology, knowledge, know-how, processes, formulas, drawings, maps, imageries, data, designs, patents and services useful for carrying out all or any of the objects of the Company.

57. To carry on the business which may seem to the Company capable of being carried on in connection with any of the Company's objects or calculated directly or indirectly to enhance the value of or rendered profitable any of the Company's properties, assets or rights, but the Company shall not perform any unlawful act or business.

58. To work in conjunction with, and to confer or affiliate with any other individuals or entities to effectuate any and all of the foregoing objects of the Company whether in Pakistan or any part of the World.

59. To make, establish and maintain close relation and contacts with other companies, bodies, associations, societies, corporations, institutes, or individuals or entities, whether in Pakistan or Worldwide, having objects partly or entirely similar to that of the Company.

60. To manage, improve, exploit, sell, exchange, let, mortgage, dispose off, or otherwise deal in any manner with all or any of the property or assets whether tangible or intangible of the Company as may be thought expedient with a view to the promotion of its objects.

61. Pursuant to the aforesaid objects and subject at all times to the laws of the Islamic Republic of Pakistan, the Company is authorized to:

    a) To transact such other business as may be proper, necessary and desirable for or in connection with the objects of the Company or any of them.

b) To buy, sell, manufacture, refine, manipulate, import, export, and deal in all substances, services, apparatus, equipment, machinery and other things capable of being used in any such business as aforesaid or required either by wholesale or retail.

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

d) To apply for, purchase or otherwise acquire any patents, brevets invention, licenses, concessions, and the like, conferring any exclusive or non-exclusive or limited right to use, or any secret or other information as to any invention which may seem capable of being used for any of the purposes of the Company or the acquisition of which may seem calculated directly or indirectly to benefit the Company, and to use, exercise, develop, or grant licenses in respect of, or otherwise turn to account the property, rights or information so acquired.

e) To enter into partnership or into any arrangement for sharing profits, union of interest, co-operation, joint venture or reciprocal concession, with any person or company, local or foreign, carrying on or engaged in any business or transaction which this Company is authorized to carry on or be engaged in, or otherwise assist any such person or company, and to take or otherwise acquire shares and securities of any such company, and to sell, hold, re-issue with or without guarantee, or otherwise deal with the same, except doing business as an investment company.

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

g) To enter into arrangement with any individual or entities or with any other persons or entities, in any place where the Company may have interest that may seem conducive to the objects of the Company or any of them and to obtain from any such individual or entity any rights, privileges and concessions which the Company may think fit to obtain, and to carry out, exercise and comply with any such arrangements, rights, privileges and concessions.

h) To establish and support or aid in the establishment and support of associations, institutions, funds, and conveniences calculated to benefit employees of the Company or the dependants or connections of such persons, and to grant pensions and allowances, and to make payments towards their insurance.

i) To amalgamate with any other company whose objects are and/or include objects similar to those of this Company, whether by sale or purchase (for fully paid-up shares or otherwise) of the undertakings, subject to the liabilities of this or any such other company as aforesaid, with or without winding up or by sale or purchase (for fully paid-up shares or otherwise) of all or a controlling interest in the shares or stock of this or any such other company as aforesaid, or by partnership, or any arrangement of the nature of partnership, or in any other manner.

j) To sell or dispose of the undertaking of the Company or any part thereof for such consideration as the Company may think fit and, in particular, for shares, debentures or securities of any other company having objects altogether or in part similar to those of this Company.

k) To purchase, take on lease or in exchange, hire or otherwise acquire any movable or immovable property, and any rights or privileges which the Company may think necessary or convenient for the purpose of its business and, in particular, any lands, buildings, easement, machinery, plant and stock-in-trade.

l) To construct, improve, maintain, develop, work, manage, carry out, or control any manufactories, warehouses, shops, stores, and other works and conveniences which may seem calculated directly or indirectly to advance the Company's interests.

m) To sell, improve, manage, develop, exchange, lease, mortgage, enfranchise, dispose of, turn to account, or otherwise deal with, all or any parts of the property and rights of the Company.

n) To invest the money of the Company, not immediately required, in such manner as may from time to time be determined, but not to act as an investment, finance, or banking company.

o) To borrow or raise funds by means of loans or secure the payment of money from shareholders, directors, commercial banks, governments and government approved agencies in such manner as the Company shall think fit for its manufacturing, trading and allied business and, in particular, by the issue of debentures or debenture-stock, perpetual or otherwise, charged upon all or any of the Company's property and other assets, both present and future, including its capital, and to purchase, redeem, or pay any such securities, but not to act as an investment, finance, or banking company.

p) To guarantee the performance of contracts, agreements, obligations or discharge of any debt of the company ~~or on behalf of any company or person~~ in relation to the payment of any financial facility including ~~but not limited to~~ loan, advance, letter of credit or other obligations through creation of all types of mortgages, charges, pledges, hypothecation, on execution of the usual banking documents/instruments or otherwise encumbrance on any or all of the movable and immovable properties of the company, either present or future or both and issuance of any other securities or sureties by any other means in favour of banks, Non-Banking Finance Companies or any financial institutions and to borrow money for purposes of the company on such terms and conditions as may be considered proper.

q) To draw, make, accept, endorse, discount, execute and issue promissory notes, bills of exchange, bills of lading, warrants, debentures and other negotiable or transferable instruments, but not to act as an investment or banking company.

r) To adopt such means of making known the products of the Company as may seem expedient, including, in particular, by advertisement in the press, circulars, purchase and exhibition of works of art or interests, publication of books and periodicals, and grant of prizes, rewards and donations.

s) To apply for and obtain any provisional order or Act of legislature or any consents, permissions and licenses from the Government, central or provincial, and any agencies of the Government for enabling the Company to carry on any of its objects into effect, or for effecting any modification of the Company's constitution, or for any other purpose which may seem expedient, and to oppose any proceeding or application which may seem calculated, directly or indirectly, to prejudice the Company's interests.

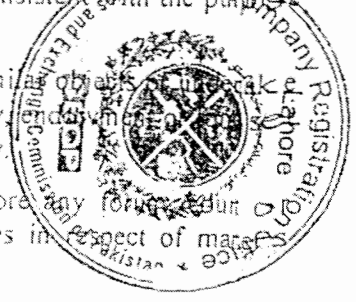
t) To sell any patent rights or privileges belonging to the Company or which may be acquired by it, or any interest in the same, and to grant licenses for the use and practice of the same or any of them and to let or allow to be used or otherwise deal with any inventions, patents or privileges in which the Company may be interested, and to do all such acts and things as may be deemed expedient for turning to account any inventions, patents and privileges in which the Company may be interested.

u) Raise funds and accept, grants, loans or financial assistance from any Government or organization, whether, domestic or international for use in work consistent with the purposes and objects thereof.

v) Acquire, take over or accept the assets of any other person with similar objects or undertak and accept the management of any moveable or immovable property, undertaking or business up to fulfill objects similar to all or any of the objects of the Company.

w) Institute, conduct, defend, settle and retract legal proceedings before any forum/court tribunal by or against the Company or its Members or employees in respect of matters affecting the affairs of the Company.

x) Contract out any management or operational functions which help to improve the efficiency and effectiveness of the Company's business.



y) Do all such other acts and things alone or in partnership with any other person, as the Company may consider necessary, incidental or conductive to the attainment of the aforesaid objectives.

62. Approval Clause: Notwithstanding anything stated in any object clause, the Company shall obtain such other approval or license from the competent authority, as may be required under any law for the time being in orce, to undertake a particular business.

63. Restrictive/Declaratory Clause: It is declared that notwithstanding anything contained in the foregoing 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, banking, leasing, and investment, managing agency or insurance business directly or indirectly as restricted under the law or any unlawful operation.

IV. LIABILITY

The liability of the members is limited.

V. CAPITAL

The Company shall have an authorized share capital of Rs. 10,000,000/- (Ten Million Pakistani Rupees Only) divided into 1,000 (One Thousand) ordinary shares of Rs. 10,000/- (Pakistani Rupees Ten Thousand Only) each with powers to increase and reduce the Capital of the Company and to divide the shares in the Capital for the time being into several classes in accordance with the provisions of the Companies Ordinance, 1984. All shares of the Company will be owned by the Government of the Punjab through its Energy Department, and the Directors will be the nominee directors of the Government of the Punjab.

"We, the several persons whose names and addresses are subscribed below, are nominated by the Government of the Punjab and desirous of being formed into the Company on behalf of and with the approval of the Government of the Punjab, in pursuance of this Memorandum of Association, and we respectively agree to act as nominee directors and take the number of shares in the capital of the Company on behalf of the Government of the Punjab as set opposite to our respective names as nominee". We further agree to withdraw our name and right as nominee director according to the directions of Government of the Punjab, as and when so directed"

NAME AND SURNAME (PRESENT & FORMER IN FULL, IN BLOCK LETTERS) WITH CNIC. #	FATHER / HUSBAND NAME (IN FULL)	NATIONALITY WITH ANY FORMER NATIONALITY	OCCUPATION	RESIDENTIAL ADDRESS (IN FULL)	NUMBER OF SHARES NOMINATED TO EACH SUBSCRIBER	SIGNATURE
GOVERNMENT OF THE PUNJAB, ENERGY DEPARTMENT through Nominee Ali Sher Ali Khan	-	-	-	Energy Department, Old Anarkali, Lahore	996	
MR. SHER ALI KHAN 37102-1228288-3 Minister, Energy Department, Government of the Punjab	Mr. Mumtaz Ali Khan	Pakistani	Public Representative	Kot Fateh Khan, Tehsil Fateh Jhang, Distt Attock	01	
MR. IRFAN ELLAHI 35201-1450651-5 Chairman, Planning & Development Board, Government of the Punjab	Mr. Fazal Ellahi	Pakistani	Government Servant	1-A, College Road, GOR-1, Lahore	01	
MR. MOHAMMAD JEHANZEB KHAN 173018-276764-5 Secretary, Finance Department, Government of the Punjab	Mr. Muhammad Aurangzeb Khan	Pakistani	Government Servant	16-Golf Road, GOR-1, Lahore	01	
MR. IRFAN ALI 35202-5336114-7 Secretary, Industries Department, Government of the Punjab	Mr. Shiekh Mumtaz Ali	Pakistani	Government Servant	11/A, Golf Road, GOR-1, Lahore	01	
				Total:	1,000 (One Thousand)	

CERTIFIED TO BE TRUE COPY
DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.
31/10/13

Securities and Exchange Commission of Pakistan
Company Registration Office
Lahore

Dated this 16th day of September, 2013

WITNESS TO THE ABOVE SIGNATURES:

Full Name: Muhammad Mehran Afzal

Signature: .....

Father's Name: Muhammad Afzal Ch.

Nationality: Pakistani

Full Address: Office No. 503, 5th Floor, Shaheen Complex, Egerton Road, Lahore.

C.N.I.C #: 34102-5984309-5

Occupation: Advocate High Court

(PRIVATE COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED

PRELIMINARY

1. Table 'A' Not to Apply

In these Articles, subject hereinafter provided, the Regulations contained in Table A of the First Schedule to the Companies Ordinance, 1984 shall apply to the Company so far as those are applicable to Private Companies, with the exception of the Regulations which are modified, altered or added hereunder:

2. Interpretation

In these articles, unless the context or the subject otherwise requires:

i. "AGM" means Annual General Meeting within the meaning of Section 158 of the Ordinance;

ii. "Attorney" includes an attorney duly constituted or appointed under power of attorney or any other authority in writing;

iii. "Board of Directors" means the Board of Directors (the Board) of the Company as constituted under provisions of these presents;

iv. "Chairman" means the Chairman of Board of Directors;

v. "CEO" means Chief Executive Officer of the Company within the meaning of Section 2(6) of the Ordinance;

vi. "EGM" means Extraordinary General Meeting within the meaning of section 159 of the Ordinance;

vii. "Legal Advisor" means as Advocate entitled to appear before any of the High Courts or the Supreme Court of Pakistan who shall be appointed by Chairman and approved by the Board;

viii. "Member" means member of the Company whose name appears and/or is borne on the Register;

ix. "Month" means English calendar month;

x. "Office" means the registered office of the Company;

xi. "Ordinance" means the Companies Ordinance, 1984 and every statutory modification thereof for the time being in force;

xii. "Prescribed" means as prescribed by the Board from time to time.

xiii. "Register" means register of members to be kept pursuant to the Ordinance;

xiv. "Seal" means common Seal of the Company;

xv. "Company Secretary" means any individual hired, to perform secretariat, administrative or other duties ordinarily performed by secretary of a company;

xvi. "Special Resolution" and "Ordinary Resolution" have the same meaning as assigned thereto respectively by the Ordinance;

xvii. "These Presents" means and include Articles of Association and any modification or alteration thereof;

xviii. "Written" and "in Writing" includes printing, lithography, type-writing, telex, email, facsimile (fax) and other modes of representing or reproducing words in a visible form;

xix. Words importing persons include the bodies corporate and otherwise firms registered or un-registered associations, and governmental non-governmental, semi-governmental organizations;

xx. Words importing plural number include the singular number;

xxi. Words importing singular number include the plural number;

xxii. Words of expressions in these presents shall, except where it is repugnant to the subject or context, bear the same meanings as in Standard English dictionary

PRIVATE COMPANY LIMITED BY SHARES

3. Private Company

The company is a Private Company within the meaning of Clause (28) of Section 2 Subsection (1) of the Companies Ordinance, 1984 and accordingly;

a. No invitation shall be issued to the public to subscribe for any shares, debentures or debenture-stocks of the Company.

b. The number of members of the Company (exclusive of persons in the employment of the Company) shall be limited to fifty; and

c. The right to transfer shares in the Company is restricted in the manner and to the extent hereinafter appearing.

BUSINESS OF THE COMPANY

4. Business

The business of the Company, its affairs and / or functions shall comprise of achieving objects given in the Memorandum of Association and includes undertaking of all or any of the several objects, and any act, deed or things done in pursuance thereof, ancillary and/or incidental thereto as expressed in, and authorized by the Memorandum of Association hereto annexed.

5. Commencement of the Business

The Company is entitled to commence its business from the date of its incorporation.

SHARE CAPITAL

6. Capital

The Company shall have an authorized share capital of Rs. 10,000,000/= (Ten Million Pakistani Rupees Only) divided into 1,000 (One Thousand) ordinary shares of Rs. 10,000/- (Pakistani Rupees Ten Thousand Only) each with powers to increase or reduce the Capital of the Company and to divide the shares in the Capital for the time being into several classes in accordance with the provisions of the Companies Ordinance, 1984.

7. Shares under Government of the Punjab's Control

The shares shall be under the control of Government of the Punjab through its Energy Department, which may allot or otherwise dispose of the same to such persons, firms, corporation or corporations on such terms and conditions and at any such time as may be thought fit.

8. Allotment

The share in the capital of the Company may be allotted or issued in payment of any property, land, machinery or goods supplied or any services rendered to the Company or promotion or formation of the Company or conduct of its business and any shares so allotted may be issued as fully paid shares. All shares of capital stock of the Company shall be common, voting and equal in all respects having

par value of Rs. 10,000/- (Pakistani Rupees Ten Thousand Only) except that in the event of distribution of assets after the dissolution of the Company Class A shares shall have a priority over Class B shares.

9. Share Certificates

Every person whose name is entered as a member in the Register shall, without payment, be entitled to receive within ninety (90) days after allotment or within forty five (45) days of the application for registration of transfer, a certificate issued in accordance with these Articles specifying the share or shares held by him and the amount paid up thereon. Provided that, in respect of a share or shares held jointly by several persons, the Company shall not be bound to issue more than one certificate, and delivery of a certificate for a share to one of several joint holders shall be sufficient delivery to all.

10. Certificate under Seal

The certificate of title to shares shall be issued under the authority of the Directors or of a committee of Directors when authorized thereto by the Directors in such manner and form as the Directors may from time to time prescribe. The Seal of the Company shall be duly affixed to every share certificate issued by the Company.

11. Issuance of New Certificate

If a share certificate is defaced, lost or destroyed, it may be renewed on payment of such fee, if any, not exceeding one hundred (100) Pakistani Rupee, and on such terms, if any, as to evidence and identity and payment of expenses incurred by the Company in investigating title as the Directors think fit.

12. Bar on Use of Company Funds

Except to the extent and in the manner allowed by Section 95, no part of the funds of the Company shall be employed in the purchase of, or in loans upon the security of, the Company's shares.

SHARES, TRANSFER AND TRANSMISSION

13. Transfer

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

14. Form of Transfer

Shares in the Company shall be transferred in the form which the Directors shall approve.

15. Ban on Transfer of Shares

Shareholders shall be limited and restricted in respect of their ability to transfer shares in accordance with the provisions of the Shareholders Agreement.

16. Closure of Register

On giving seven days previous notice in the manner provided in the Ordinance, the Register may be closed for such period or periods not exceeding forty five (45) days in any one year as the Directors may from time to time determine, but so that the Register shall not be closed for a longer period than thirty (30) days at a time.

17. Charge on the Shares

No share can be mortgaged, pledged, sold, hypothecated, transferred or disposed off by any member to a non-member without the previous sanction of the Board of Directors.

18. Transmission

The Successor in Interest, legal heirs, executors or administrators of a deceased shall be the only persons to be recognized by the Directors as having title to the shares. In case of shares registered in the name of two or more holders the successors in interest, survivors and the executors of the deceased shall be the only persons to be recognized by the Company as having any title to the shares.

MEMBERSHIP

19. Members

The subscribers to these presents and Memorandum of Association hereunto annexed shall be admitted to membership of the Company on behalf of the Energy Department, Government of the Punjab and shall be deemed to have agreed to become nominated members thereof in accordance with and in pursuance to these presents and whose names appear in the Register, shall be the member of the Company.

20. Roll of Members

The Company shall maintain roll of members clearly indicating their full names address and occupations and every member shall sign the same of member changes his address, he shall forthwith notify his new address to the Company Secretary who shall thereupon cause new address to the put on rolls of member. However, where such member does not notify any change of address, the address appearing on the rolls shall be deemed to be correct address. The said roll of members also called Register shall be maintained at the Office.

21. Membership

Subject to the foregoing and/or other provisions, membership of the Company shall be open to all persons, organizations or institutions.

22. Vacancy

Any vacancy among members shall be filled in as provided in Article 18 supra.

23. Proceedings in case of Vacancy

The Company shall function notwithstanding any vacancy occurring in any of its bodies and no act, direction or proceeding thereof shall be rendered invalid merely by reason of such vacancy or any defect in appointment of any of its officers.

24. Remuneration to Directors and Chairman

Except the remuneration against the full time employment of the Company, the Chairman and members of the Board shall not be paid any remuneration for their services as members of the Board but shall be provided traveling, boarding, lodging and transportation allowances / facilities and / or any other allowance / facilities as approved by the Board.

MEETING

25. First AGM

The First AGM shall be held within eighteen (18) months from the date of incorporation of the Company, at such time and place as the Board may determine.

26. Subsequent AGMS

Subsequent AGMs shall be held once every year at such time and place as may be determined by the Board, within four months following the close of its financial year and not more than fifteen calendar months after holding of preceding AGM.

27. EMGs

The above named General Meetings shall be called AGM. All meetings other than the AGM shall be called EGM.

28. Requisition for EGM

The Board may at any time call for an EGM and shall, on requisition of members representing not less than one-tenth of voting power on the date of deposit of requisition, proceed to call an EGM. Any such requisition shall specify objects of the meeting, be signed by the requisitionists and deposited at the Office. Such EGM shall be convened for purpose specified in the requisition only.

29 Meeting By Requisitionists

If the Board does not proceed to cause meeting to be held within twenty one (21) days from the date of requisition being deposited, the makers or a majority of them may themselves convene a meeting to be held not later than three months, from the date of deposit of requisition.

30. Manner of Meeting by Requisitionists

Any meeting convened by the requisitionists shall be convened in the same manner, as nearly as possible, in which meeting is convened by the Board.

31 Notice of Meeting

Subject to provisions of the Ordinance relating to special resolutions, at least twenty one (21) days prior notice (exclusive of day on which the notice is served or deemed to be served, but inclusive of day on which the notice is given), specifying the place, day and hour of the meeting, and in case of special business, the general nature of such business, shall be given of every General Meeting whether annual or extraordinary to members in the manner in which notices are required to be served in accordance with the provisions contained herein below.

32. Validity of Proceedings

Any accidental omission to give notice or its non-receipt by any of the members shall not invalidate proceedings of meeting.

33. Quorum

At least Sixty percent (60%) of voting power shall be the quorum for General Meeting for all purposes. No business shall be transacted at any General Meeting unless the quorum is present at the commencement of business.

34. Lack of Quorum

If within half an hour of the time appointed, the quorum is not present, the meeting if called on requisition of members shall be dissolved. In any other case, it shall stand adjourned to next day in at the same time and place, and if at the adjourned meeting, the quorum is not present within half an hour from the time appointed therefore, the meeting shall be adjourned.

35. Chair

The Chairman shall be entitled to take the chair at every General Meeting. If Chairman is unable due to sickness or some other unavoidable reasons, any one of the directors nominated by the Chairman for the said purpose, may be elected, to preside the meeting. Where the Chairman has not nominated any director, the directors so present may choose one of the members to preside.

6. Decisions at Meetings

All decisions in the meetings shall be taken by a simple majority. Provided however, the following decisions shall require concurrence of three fourth (3/4th) majority of Directors/Members:

a. Amendments to the Memorandum and Articles of Association of the Company;

b. Merger or consolidation of the Company with any other company;

c. Sale or transfer of all or substantial assets of the Company; and

d Increase or decrease in the share capital of the Company.

e. All other matters requiring special resolution under the Ordinance.

37. Adjournment of Meeting

The Chairman may, with consent of any meeting at which quorum is present (and shall if so directed by meeting); adjourn the same from time to time.

38. Manner of Voting

At any General Meeting, a resolution put to vote of the meeting shall be decided on show of hands unless a poll (before or on declaration of the result of show of hands) demanded in accordance with provisions of the Ordinance and unless a poll is so demanded, a declaration by Chairman that a resolution has, on a show of hands, been carried or carried unanimously or by a particular majority and an entry to that effect in minutes book shall be conclusive evidence of the fact, without proof of the number or proportion of votes recorded in favor of or against such resolution.

39. Poll

If a poll is duly demanded, it shall be taken in such manner as the Chairman shall direct and the result of such poll shall be deemed resolution of the meeting at which it was demanded.

40. Casting Vote

In the case of an equality of votes, whether on show of hands or on poll, the Chairman of meeting at which show of hands takes place, or at which the poll is demanded, as the case may be, shall be entitled to a casting vote.

41. Transaction of Other Business

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

VOTES OF MEMBERS

42. Voting Right

On show of hands and on poll, every member present in person shall have vote(s) according to share holding. Voting by proxy is allowed as envisaged under section 161 of the Ordinance.

43. Voting by Corporation or a member body Corporate

Any corporation or a body corporate, which is member, may be resolution of its directors or other governing body, authorize such person as it thinks fit, to act as its representative at any meeting. The person so authorized shall be entitled to exercise similar powers on behalf of corporation what he represents as that corporation could exercise if it where an individual present in person. A corporation or the body corporate, as the case may be, attending a meeting through such representative shall be deemed to be present at the meeting in person.

DIRECTORS

4. Composition

Unless otherwise determined, The Board of Directors shall comprise of Thirteen (13) Directors which will be duly nominated by Government of the Punjab. The First Board of Directors will be ex-officio nominee directors from public sector, later on two more ex-officio nominee directors from public sector along with Seven (07) positions of nominee directors will be filled by technical experts which will be intimated to SECP on Form 29 and all the concerned are then nominated by the government.

First Directors

The following shall be the first nominated Directors of the Company as nominated by Government of the Punjab;

1. Minister, Energy Department	Mr. Sher Ali Khan
2. Chairman, P&D Board	Mr. Irfan Ellahi
3. Secretary, Finance Department	Mr. Mohammad Jehanzeb Khan
4. Secretary, Industries Department	Mr. Irfan Ali

46. Election of the Directors

The Company is solely owned and controlled by Government of the Punjab through its Energy Department and all Directors of the Company are duly nominated by the Government of the Punjab on its behalf. Hence, according to the provisions of section 183 of Ordinance the provisions of Section 178 shall not apply on the Company.

47. Tenure of the First Directors

The first Directors including the Chief Executive Officer shall hold office up to the First Annual General Meeting in accordance with the provisions of the Companies Ordinance, 1984, unless any one of them resigns earlier or becomes disqualified for being Director or otherwise ceases to hold office.

48. Resolution for Removal of a Director

The Company is solely owned and controlled by Government of the Punjab through its Energy Department and all Directors of the Company are duly nominated by the Government of the Punjab on its behalf. Hence, according to the provisions of section 183 of Ordinance the provisions of Section 181 shall not apply on the Company.

49. Remuneration for Special Services

The Directors may sanction the payment of such additional sums as they may think fit to any Director for any special service he may render to the Company or be thought capable of rendering either by fixed sum or in any other form as may be determined by the Board subject to the provisions of the Companies Ordinance, 1984.

50. Traveling and Other Expenses

All traveling and other expenses in connection with the Board meetings shall be to the account of respective Directors as approved by the Board of Directors.

51. Vacancy in the Board

Any casual vacancy occurring on the Board of Directors shall be filled in by a resolution of the Board of Directors after getting approval of the Government of the Punjab and the person so appointed shall hold office for the remainder of the term of the Directors in whose place he is appointed.

52. Conflict of Interest

No Director shall be disqualified from his office by contracting with the Company either as vendor, purchaser or otherwise nor shall any Director be liable to account for any profit realized from any such contract or arrangement or the fiduciary relation thereby established, but the nature of his interest must be disclosed by him at the first meeting of the Directors after acquisition of his interest.

NOMINEE DIRECTORS BY CREDITORS

3. Nominee Director by Creditors

In addition to the duly nominated Directors of Company by Government of the Punjab, the Financial Institutions shall be entitled, during the currency of their respective loan to the Company to appoint one person on the Board of Directors of the Company to be called Nominee Director and to recall and/or replace such a person from time to time. Such Nominee Director on the Board of Directors of the Company may not be holders of share in the Capital of the Company and regulations and/or rules pertaining to the election, retirement, qualification and/or disqualification of Directors shall not apply to him.

BOARD OF DIRECTORS (THE BOARD)

Powers of the Board

The business of the Company shall be managed by the Board, which shall determine directions and scope of activities thereof in accordance with the objects specified in Memorandum of Association. In particular and without prejudice to the foregoing, the Board shall perform the following functions and exercise powers;

a) to authorize the Chief Executive Officer through General Power of Attorney to enter into any Contract, Agreement or Joint Venture on behalf of the Company,

b) to approve annual or half-yearly or periodical accounts,

c) to approve the terms and conditions of the office of Chief Executive,

d) to determine terms of and the circumstances in which a law suit may be compromised and a claim or right in favor of the Company may be released, extinguished or relinquished to institute, conduct, defend or abandon any legal proceedings by or against the Company in consultation with the Legal Advisor and in pursuance thereof, to compound and / or allow time for payment or satisfaction of any debt due and / or any claim or demand by or against the Company,

e) to refer any claims or demands or any other dispute by or against the Company to arbitration and observe and perform the awards, in consultation with Legal Advisor,

f) to approve plans and programs for the furtherance of objects of the Company,

g) to consider annual budgets placed before it and pass them with such modification as may be deemed necessary,

h) to approve annual account reports,

i) to appoint boards, committees, sub-committees and panels, consisting of persons who may or may not be members or employees in order to deal with any specific task as may be determined from time to time and to confirm appointment of Legal Advisor appointed by the Chairman,

j) to create a reserve and / or sinking fund,

k) to create subsidiary or any other special company for any purpose deemed expedient,

l) to borrow money against pledging of Company assets,

m) to invest the surplus fund of the Company,

n) to make loans for promotion of objects of the Company, however the Company shall not act as a banking company of financial institution,

55. Term of Office of Directors

The Company is solely owned and controlled by Government of the Punjab through its Energy Department and all Directors of the Company are duly nominated by the Government of the Punjab on its behalf. Hence, according to the provisions of section 183 of Ordinance the provisions of Section 180 shall not apply to the Company.

According to second proviso of Section 183, given below, all Directors nominated by Government of the Punjab shall hold office of Director during the pleasure of Government of the Punjab.

Second Proviso of Section 183:

"Provided further that a director nominated under this section shall hold office during the pleasure of the corporation, company, Government or authority which nominate him."

56. Function of the Board

Members of the Board shall function in their individual capacity exercising individual judgment under the Chairman.

57. Validity of Functions of the Board

No action or decision by the Board shall be rendered invalid or in operative on account of any vacancy or vacancies in its composition.

58. Meetings of the Board

The meetings of the Board shall be held in the following manner:

a. The Board shall hold at least two regular meetings in a financial year to be called by notice under signature of Company Secretary.

b. All meetings shall be presided by the Chairman or in his absence, by a Director nominated by the Chairman for the said purpose, may be elected to preside.

c. Minutes of meetings shall be recorded by Company Secretary or in his absence by member of the Board, appointed by the Chairman. The minutes shall be duly approved or corrected at the following regular meeting and filed in the permanent records.

d. Members of the Board shall not receive any remuneration for their services and / or any profit out of the business.

59. Notice of the Meeting

Every notice calling for meeting of the Board shall state in writing the date, time and place of meeting and be sent to every member ordinarily twenty one calendar days before the day appointed for the meeting.

60. Omission to Give Notice

Any inadvertent omission to give notice or non-receipt or late receipt thereof by any member shall not invalidate the proceedings of meeting.

61. Quorum

At least Sixty percent (60%) of voting power shall constitute quorum. No business shall be transacted at any Meeting unless the quorum is present at the commencement of business.

62. Decisions at the Board

Each member of the Board shall have one vote. All matters at meetings of the Board shall be decided by simple majority of votes of members present in persons if in case of equality of votes, the Chairman shall have a casting vote. However, the decision in the following matters shall be taken by unanimous consent of all the members present:

i. Change of Head Office Location;

i. Investment of the Company in other companies, individuals, firms, any governmental, semi governmental, autonomous authority;

ii. Purchase, sale or transfer of assets of the Company;

iii. Appointment of Auditors;

iv. Approval of the Annual Budget of the Company;

v. Long term borrowing from financial institutions or third parties.

vi. Altering the Memorandum and/or Articles or other constitutional documents of the Company.

vii. Changing the authorised or issued share capital of the Company or increasing or reducing its shareholding in any other company.

viii. Materially changing the nature or scope of the Business of the Company;

ix. Major decisions relating to the conduct (including the settlement) of material legal proceedings to which the Company is a party.

x. Approving the Company's statutory accounts and/or any change in the principal accounting policies of the Company;

xi. Forming policies in relation to the environment and health and safety issues for the Company; and

xii. Any proposal to wind up the Company.

xiii. Terms and conditions relating to repayment of loans by the Company;

67. Role of Chairman

i) The Chairman shall be responsible for satisfactory function of the Board.

ii) The Chairman shall represent the Company with regards to matters of Company's interest with general public and concerned commercial and official quarters.

68. Remuneration to Chairman

The Chairman shall not be entitled to any remuneration for his services as Chairman, but provided support in any manner whatsoever, in order to facilitate efficient functioning of the Board.

CHIEF EXECUTIVE OFFICER

69 First Chief Executive Officer

The Board of Directors may appoint a person to be the Chief Executive of the Company and vest in him such powers and functions as they deem fit in relation to the management and administration of the affairs of the Company subject to their general supervision and control. The Chief Executive, if not already a Director, shall be deemed to be a Director of the Company and be entitled to all the rights and privileges and subject to all the liabilities of that office.

70. Duties of the Chief Executive

The duties of Chief Executive shall be the administration of the Company. He shall also be responsible to supervise day-to-day working and management thereof.

71. Powers and Functions of the Chief Executive

The Chief Executive shall exercise general control over the Company and inter alia have all the powers to manage the affairs of the Company save as explicitly retained by the Board as per article 54 herein above.

COMPANY SECRETARY

72. Appointment

The Company Secretary shall be appointed by the Chairman Board of Directors and his appointment as such shall be approved by the Board.

73. Responsibilities of the Company Secretary

The Secretary shall include but not limited to the following be responsible for the following:

i. To ensure that the legal responsibilities of the Company, under the Ordinance, other statutes and byelaws are fulfilled and the Memorandum and Articles of Association are duly complied with;

ii. To maintain books and registers of the Company;

iii. To ensure that official returns, statistics, accounts are duly completed and submitted to Commission;

iv. To arrange with the Chairman to call and hold meetings of the Board and prepare record of proceedings;

v. To prepare agenda and other documents for regular, special and / or Board meetings and communicate the same along with notice to the Members / Directors;

vi. To ensure that property of the Company are adequately insured and deal with insurance matters arising there from;

vii. To ensure custody and administration of the property investments, other investment, patent, trade mark and trade agreements licenses;

viii. Any other task assigned by the Board.

4. No Executive Responsibility

The Secretary shall have no executive responsibility in relation to any personnel other than members of the staff immediately employed by Secretary's office.

Company Registration Office Lahore — Securities and Exchange Commission of Pakistan

THE SEAL

75. Authority to Affix Seal

The Directors shall provide for the safe custody of the seal, which shall not be affixed to any instrument except by the authority of a resolution of the Board or by a committee of Directors authorized in that behalf by the Directors, and two Directors or one Director and the Company Secretary shall sign every instrument to which the seal shall be affixed.

ACCOUNTS

76. Books of Accounts

The Company shall cause to be kept proper books of account with respect to the following:

i. All sums of money received and expended and the matters in respect of which the receipt and expenditure takes place;

ii. All sale and purchase of assets by the Company;

iii. All assets and liabilities of the Company;

77. Place at which the Books of Accounts to be Kept

The books of account shall be kept at the Office or such other places the Board shall think fit and be open to inspection by members of the Board during business hours.

78. Right of Members to Inspect Books of Accounts

The Members shall have right to inspect the accounts and books or papers subject to notice in writing to the Board except on the occasions when the Books are closed by the Board for periodical audits or before General Meetings as determined by Board.

79. Financial Statements

The Board shall cause to be prepared and laid before General Meeting such profit and loss accounts or income and expenditure accounts and balance sheets duly audited and reports as are required by the Ordinance.

80. Presentation of Reports and Balance Sheets before AGM

A balance-sheet, cash flow, income and expenditure account and other reports referred to supra shall be made out every year and presented before AGM, made up to date not more than four (04) months before such meeting. The balance sheet, cash flow, profit and loss account shall be accompanied by a report of Auditors and that of the Board.

AUDIT

81. Auditor

The Company at each AGM shall appoint auditor(s) to hold office until next AGM, provided that auditor appointed in the General Meeting may be removed before conclusion of the next AGM through special resolution.

82. Appointment of First Auditors

The first auditor shall be appointed by the Board within sixty days (60) from the date of incorporation of the Company who shall hold office until the first AGM.

83. Right of Access to Books and Information

Every Auditor of the Company shall have right of access at all times to the books, assets and accounts and vouchers and shall be entitled to require from the Board and officers such information and explanation as may be necessary for performance of his duties.

NOTICE

84. Notice to Members

The Company Secretary may give a notice to any member either personally or by sending it by email with read receipt or by post to him to his registered address.

85. Service of Notice

Where a notice is sent by email with read receipt, or by post, service of the notice, as the case may be, shall be effected by properly addressing, prepaying and posting a letter containing the notice and unless the contrary is proved, service of notice shall be deemed to have been effected at the time of which the letter would be delivered in the ordinary course of post.

86. Notice of General Meetings

Notice of every General Meeting shall be given in the manner described supra to every Member.

INDEMNITY

87. Indemnity by the Company

Every Member of the Company and the Board, the Chairman, Chief Executive Officer, Company Secretary or any other office or employee shall be indemnified by the Company against all costs, losses which they may incur or become liable to pay by reason of any contract entered into or act or deed done by them in discharge of their duties in good faith and any loss occasioned by any error of judgment, damage or misfortune which may happen in execution of their duties in connection with affairs of the Company.

SECRECY

88. Every Director, Company Secretary, Auditor, trustee, member of a committee, officer, servant, agent, accountant, or other person employed in the business of the Company shall observe strict secrecy representing all transactions of the Company, and the state of account with individuals and in matters relating thereto and shall not reveals any of the matters which may come to his knowledge in discharge of his duties except when required so to do by the directors or the Company in General Meeting or by a court of law.

ARBITRATION

). Differences Referred to Arbitration

Whenever any difference arises between the Company on the one hand and the members, their executors, administrators or assignee on the other hand, touching the true intent or construction or the incident or consequence of these present or of the statutes or touching any thing thereafter done, executed, omitted or suffered in pursuance of these presents or otherwise relating to these presents or to any statutes affecting the Company, every such difference shall be referred for the decision of the arbitrator.

Costs of Arbitration

The cost incidental to any such reference and award shall be at the discretion of the arbitrator or umpire respectively who may determine the amount thereof and direct the same to be shared between the parties to dispute or otherwise and may award by whom and in what manner the same shall be borne and paid.

WINDING UP

Disbursal of Surplus Assets

In the case of winding up or dissolution of the Company any surplus assets or property after satisfaction of all debts and liabilities shall be paid or disbursed among the members

Company Registration Office
Securities and Exchange Commission of Pakistan

"THIRD SCHEDULE"

(See section 156)

FORM A- ANNUAL RETURN OF COMPANY HAVING SHARE CAPITAL

1	Registration No.	0085152
2	Name of the Company	Quaid E Azam Solar Power (Pvt) Ltd

3	Form A made upto (Day/Month/Year)	25	04	2014
4	Date of AGM (Day/Month/Year)			

PART-A

5	Registered office address: 83-A, E-I Main Boulevard Gulberg III, Lahore.
6	Email Address: cfo@qasolar.com
7	Office Tel. No.: 042-35780363
8	Office Fax No.: 042-35790366
9	Nature of Business: Electricity Generation

10 Authorized Share Capital

Type of Shares	No. of Shares	Amount	Face Value
Ordinary Shares	1,000	10,000,000/-	10,000,000/-

11 Paid up Share Capital

Type of Shares	No. of Shares	Amount	Issue Price
Ordinary Shares	1,000	10,000,000/-	10,000,000/-

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

13 **Particulars of the holding company**

Name	N/A	
Registration No.	N/A	% Shares Held: N/A

14 **Chief Executive**

Name	Najam Ahmed Shah	NIC	42101-9779292-5
Address	House No. 6-B, GOR-18, Ferozepur Road, Lahore		

15 **Chief Accountant**

Name	Muhammad Badar Ul Munir	NIC	36302-0459420-7
Address	Kamran Manzil, Bosan Road, Multan		

16 **Secretary**

Name	Muhammad Badar Ul Munir	NIC	36302-0459420-7
Address	Kamran Manzil, Bosan Road, Multan		

17 **Legal Advisor**

Name	Abdul Majid Khan
Address	House no. 47, Street 14, Cavalry Ground Extension, Lahore

18 **Auditors**

Name	A.F Fergusons & Co. Chartered Accountants
Address: 23-C, Aziz Avenue Canal Bank Gulberg V, Lahore	

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

Name of Director	Address	Nationality	NIC (Passport No. if foreigner)
1. Najam Ahmed Shah	House No. 6-B, GOR-18, Ferozepur Road, Lahore	Pakistani	4 2 1 0 1 9 7 7 9 2 9 2 5
2. Sher Ali Khan	Energy Department, Old Anarkali, Lahore	Pakistani	3 7 1 0 2 1 2 2 8 2 8 8 3
3. Irfan Elahi	Planning And Development Department, Civil Secretariat, Lahore	Pakistani	3 5 2 0 1 1 4 5 0 6 5 1 5
4. Muhammad Jehanzeb Khan	Finance Secretary, Civil Secretariat, Lahore	Pakistani	1 7 3 0 1 8 2 7 6 7 6 4 5
5. Irfan Ali	Industries Department, Civil Secretariat, Lahore	Pakistani	3 5 2 0 2 5 3 3 6 1 1 4 7
6. Syed Maratib Ali	23 Aikman Road, GOR 1, Lahore	Pakistani	3 5 2 0 2 1 5 0 1 3 6 7 9
7. Arif Saeed	Service Industries Limited, Servis House, 2 Main Gulberg, Lahore	Pakistani	3 5 2 0 2 2 8 3 5 7 2 5 9
8. Tariq Hameed	83 G, Gulberg III, Lahore	Pakistani	3 5 2 0 2 2 5 4 8 7 7 9 1
9. Muhammad Ali Khokhar	House No. 184, Street No. 36, Sector F-10/1, Islamabad	Pakistani	3 6 3 0 2 7 3 9 1 8 6 2 5
10. Arif Iqbal Rana	LUMS Opposite Sector U, DHA, Lahore 54792	Pakistani	3 5 2 0 2 2 5 7 6 0 5 0 3
11. Muhammad Afzaal Bhatti	5 Club Road, GOR I, Lahore	Pakistani	3 5 2 0 2 3 5 7 6 0 5 0 3
12. Rehman Naseem	Tipu Sultan Road, Multan Cantt	Pakistani	3 6 3 0 2 5 3 4 8 7 9 6 1
13. Junaid Fareed	RECH, Township, Lahore	Pakistani	3 5 2 0 2 0 3 6 2 8 6 9 1

PART-B

20. List of members & debenture holders on the date upto which this Form A is made

Folio	Name	Address	Nationality	No. of shares	NIC (Passport No. if foreigner)
	Members				
	N/A				
	Debenture holders				
	N/A				

Use separate sheet, if necessary

21.	Transfer of shares (debentures) since last Form A was made			
	Name of Transferor	Name of Transferee	Number of shares transferred	Date of registration of transfer
	Members			
	N/A			
	Debenture holders			
	N/A			

Use separate sheet, if necessary

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

Date	26-04-2014	Day	Month	Year		Signature	
					Designation (Please tick)		Chief Executive/Secretary

INSTRUCTIONS FOR FILLING FORM-A

1. The Form shall be made upto the date of last AGM of the Company or the last date of the year where no AGM is held during the year.

2. Under nature of business, please give precisely the specific nature of business in which the company is engaged.

3. Under S. No.20 above, the aggregate number of shares held by each member should be stated, and the aggregates must be added up so as to agree with the number of shares stated against NO. 11.

4. When the shares are of different classes the columns should be subdivided so that the number of each class held, or transferred, is shown separately against S. Nos. 10,11,20 and 21.

5. If the space provided in the Form is insufficient, the required particulars should be listed in a separate statement attached to this return which should be similarly certified and signed.

6. The return and any statement attached hereto shall be signed by the chief executive or the secretary.

7. In case a body corporate is a member, NIC number may be omitted to be given.

8. In case of foreign nationals, indicate "passport number" in the space provided for "NIC No." Pakistani nationals will only indicate "NIC NO."

9. This form is to be filed within 30 days (45 days in case of listed company) of the date indicated in S.No.3 above.

Profile of Applicant's Management

Given below is the brief profile of the management of Quaid-e-Azam Solar Power (Private) Limited:

Najam Ahmad Shah

Najam, an Electrical Engineer by first degree, holds a Masters in Manufacturing and Supply Chain Management from Cranfield University, UK. Mr. Shah, a Fulbright Scholar and an Eisenhower Fellow, also holds a Masters in Public Administration from Harvard Kennedy School. He has served for many years with Siemens as Commissioning Engineer and Project Manager on various projects including KESC Bin Qasim Unit 6, HUBCO Power Plant and KAPCO CCPS. Later on, Najam joined Pakistan Administrative Service and has worked for 15 years in various assignments related to Procurement and Project Management, Planning & Development and District Administration & Coordination. As CEO of the company he believes in the importance of renewable energy, urgency of setting early wins and need to steer solar projects to pave way for others to join with comfort in the mission of fulfilling our energy needs for better and greener world.

Dr. Rana Abdul Jabbar Khan

Dr. Rana Abdul Jabbar Khan, currently providing his services to Quaid-e-Azam Solar as Chief Operating Officer, is an electrical engineer by first degree from University of Engineering and Technology Lahore, Pakistan. He has a PhD degree in electrical power engineering from the RMIT University, Melbourne, Australia and a masters degree in electrical power engineering from the University of Wollongong, Australia.

Dr. Khan joined GEPCO as a junior engineer in 1993. Later on, over the years, he served as Sub Divisional Officer, Assistant Director Planning, Executive Engineer and Regional Manager at GEPCO. He also provided his services to PEPCO as consultant and FESCO as Chief Executive Officer. Dr. Khan has also served as the principal of Rachna College of Engineering and Technology, Gujranwala. He also rendered services in NTDC as Manager Design and Standards. He is a member of several engineering associations in Australia, the

UK and the USA. His extensive experience in the Power Sector and well recognized leadership skills makes him an excellent addition to the company. He has over 45 research papers published internationally to date. He has also been invited as guest key note speaker on various issues in the power sector in different countries from time to time. As recognition of his meritorious services, he has been nominated twice for Presidential Award.

Muhammad Badar Ul Munir

Muhammad Badar Ul Munir is QA Solar's Chief Financial Officer. He has nearly 10 years of experience in financial operations, audit and management, including 4 years at Ernst & Young, during previous employments; he held various executive positions, including CFO from 2010 until the end of 2013 at another Public Sector Company. He is member of the Institute of Chartered Accountants of Pakistan and holds a Master's Degree in Economics.

Sayyed Mubasher Masood

Mr. Mubashar, currently employed in Quaid-e-Azam Solar Power (Pvt.) Limited as Chief Legal Officer is a man of proven ability. He has provided his services in Legal Departments of LESCO and NTDCL as Legal Director and General Manager (Legal & Corporate Affairs) respectively. His experience of about 18 years also includes managerial position in SMEDA and in IDBP as Vice President Litigation. He also served as Manager of Legal Department at CITIBANK for a couple of years.

Syed Raza Ali Zaidi

Mr. Zaidi currently works as Procurement Manager at Quaid-e-Azam Solar Power (Pvt.) Limited. His responsibilities include timely procurement of all technical equipment required for the erection of 100MW Solar Power Plant at Lal Suhanara, Bahawalpur. He is a Project Management Professional and holds dual Masters' degree in Management as well as in Business Administration from reputed international and local universities. He has worked in Pakistan Tobacco Company as a Supply Chain Financial Analyst and as a Projects and Utilities Manager in Proctor and Gamble.

Ahmad Shamyl Akhlaq

Mr. Shamyl is a PV expert with a Masters degree in Renewable Energy from University of Nottingham, UK. He is currently working as a Research Analyst at Quaid-e-Azam Solar. His expertise in the field of solar energy makes him an

excellent addition to the QA Solar team. He has previously worked in Mobilink for a couple of years.

Rehman Ur Rauf

Mr. Rehman is a fresh graduate from University of Wisconsin, USA, with Bachelors in Mechanical Engineering. He is currently employed in Quaid-e-Azam Solar as a Research Associate. His previous work experience includes an internship at New Bong Escape Hydropower Project in Mangla Dam. Rehman is interested in pursuing his career in Alternate energy as he believes it to be the answer to the energy crisis in Pakistan.

Syed Taha Bin Tariq

Mr. Taha, currently employed as a Research Associate, is a fresh graduate from LUMS with a Bachelors Degree in Electrical Engineering. He has a vast experience of several electrical power projects during his internships in Tri Pack Films Limited and Pak Elektron Limited. He is interested in pursuing his career in alternate energy, especially solar energy as he believes that part of the answer to the current energy crises in Pakistan lies in solar power.

9. Evidence of Financial Resources

Letter of Intent from GoPb	Annexure 12
Letter of Intent from Bank of Punjab	Annexure 13
Cash and Bank Certificates	Annexure 14

No.FD(W&M)7-442/2013
GOVERNMENT OF THE PUNJAB
FINANCE DEPARTMENT

Lahore, the February 11, 2014

To

The Chief Executive Officer,
Quaid-e-Azam Solar Power (Pvt.) Ltd.
Suit 503 – Shaheen Complex,
Egerton Road, Lahore.

Subject: **LETTER OF INTENT FROM PUNJAB GOVERNMENT**

I am directed to refer to your letter No.QAS-14/02/01-02 dated 31.01.2014 on the subject noted above.

2. I am further directed to convey confirmation of our intent to finance the 100 MW Quaid-e-Azam Solar Power Project at Bahawalpur through equity participation to the extent of 30% of the estimated project cost of Rs.16.5 billion approximately.

(FATIMA TAHIR)
SECTION OFFICER (W&M)

C.C.

Managing Director, Punjab Power Development Board

11/2/2014

THE BANK OF PUNJAB

The Bank of Punjab
Head Office, BOP Tower,
Main Boulevard, Gulberg-3, Lahore
Tele No. 111-200-100; Fax No. 042-35783781

Date: February 8, 2014.
Ref No: C&IBG-II/HO/BOP/043/2014.

Mr. Najam Ahmed Shah
Chief Executive Officer,
Quaid-e-Azam Solar Power (Pvt.) Ltd.
503, Shaheen Complex, Egerton Road,
Lahore.

Dear Sir,

100 MW Solar Power Project

With reference to your letter No. QAS-14/02/01-01 dated January 31st, 2014, requesting us to issue a Letter of Intent so as to facilitate you for securing Letter of Intent (LOI) from Punjab Power Development Board (PPDB) for the QA Solar Project.

We, hereby confirm that BOP is in the process of considering your request to part finance for a 100 MW Solar Power Project to be set up at Quaid-e-Azam Solar Park, Bahawalpur which is expected to have a project cost of around US Dollar 130-150 Million equivalent to approximately Pak Rupees 14.30 - 16.5 billion with a loan repayment tenor of around 10 years.

This finance shall be available to you on terms & conditions which shall be subsequently advised to you upon clearance of the subject financing by our Board of Directors, internal credit approvals and compliance with all SBP Prudential Regulations.

Assuring you of our best cooperation & assistance.

Regards

Nasir Mehmood
Unit Head Investment Banking

Asim Jahangir Seth
Head C&IBG-II

TO WHOM IT MAY CONCERN

It is hereby certified that the company is newly incorporated and has not completed the financial year, therefore no financial statements are available.

Muhammad Badar Ul Munir, ACA
Chief Financial Officer

12. Project Cost and Financing

Given below is the detail of estimated project cost and its financing:

- Project Cost

Total cost for establishment of 100 MW*p* DC solar power plant on the basis of feasibility study is estimated at PKR 15.0 Billion i.e. USD 150Million. This cost comprises of Engineering, Procurement & Construction (EPC) Cost, Project Development Cost, Technical Consultants/ Quality Assurance, Legal/ Financial Consultants, Interest during Construction (IDC) and contingencies. These capital costs will be incurred to take the project into operations. The following table presents the cost estimates for the total project

Project Cost	PKR M	USD M
EPC Cost	13,500.0	135.0
Project Development Cost/ Other Capex	200.0	2.0
Technical Consultants/ Quality Assurance	100.0	1.0
Legal/ Finance Consultants	50	0.5
Interest During Construction	603.4	6.0
Contingencies	545.0	5.5
Total	**15,000.0**	**150.0**

- Financing Plan

The project will be financed with a debt equity combination of 75:25. The equity for the project shall be arranged form the Government of Punjab, whereas debt is to be raised both from local financial institutions lead by Bank of the Punjab. Table below depicts the debt and equity contribution to the project.

Project Financing	% Age	PKR M	USD M
Equity	25%	3,750.0	37.5
Debt	75%	11,250.0	112.5
Total	100%	**15,000.00**	**150.00**

15. Feasibility Study

The feasibility study for this 100 MWp DC Solar PV Plant was carried out by the consultants of the applicant i.e. JV of ECSP and 8P2 (German Experts in Solar PV). This feasibility study (Annexure 22) includes all the technical aspects and financial analysis required for the plant.

The Panel of Experts (PoE) appointed by PPDB has reviewed the feasibility study and their approval is provided as Annexure 23.

Feasibility Study	Annexure 22
Approval of Feasibility Study by PPDB	Annexure 23

Feasibility Study

Q u a i d - e - A z a m S o l a r

Type of Report:	Feasibility Study
Plant:	**Quaid-e-Azam**
Operator:	Quaid-e-Azam Solar Power (Pvt) Limited
Report Number:	13K4369/Quaid-e-Azam_1/Kd/2013
Date:	2014-02-04

8.2 Ingenieurpartnerschaft Obst & Ziehmann
Brandstwiete 4
D- 20457 Hamburg
Tel: +49 40 / 18 12 604-20
Fax: +49 40 / 18 12 604-99
e-mail: Ralf.Meyerhof@8p2.de

ECSP
83-A, E/1, Main Boulevard, Gulberg-III,
Lahore, Pakistan

General Data

The company Quaid-e-Azam Solar Power (Pvt) Limited (QA Solar) intends to build a photo-voltaic power plant on the site 20 km south east of Bahawalpur in the Cholistan desert.

Assignment

Task:	8.2 Ingenieurpartnerschaft Obst & Ziehmann (8.2) was commissioned to perform a feasibility study to evaluate the suitability and potential of the site.
Client:	Quaid-e-Azam Solar Power (Pvt) Limited Lahore, Pakistan
Order Date:	2013-12-06
Contractor:	8.2 Ingenieurpartnerschaft Obst & Ziehmann Brandstwiete 4 D-20457 Hamburg
Author:	Dipl.-Ing. (FH) Ralf Meyerhof
Project Number:	13K4369/Quaid-e-Azam_1/Kd/2013

Basic Data: Plant Location and PV System

Client:	QA Solar
Solar Park:	Quaid-e-Azam Solar Park (Phase 1)
Site:	Cholistan-Desert

Latitude	29.4° north
Longitude	71.78° east
Altitude above sea level	116 m

Revisions

Number	Modifications
R0	Draft Version
R1	Pre-Feasibility
R2	Pre-Feasibility – update 27.12.
R3	Pre-Feasibility – update 29.12
R4	Pre-Feasibility – update 8.01
R5	Feasibility – update 2014-01-17
R6	Feasibility – Final 2014-02-04

Contents

Table of Figures

1 Executive Summary

This Study has the objective to assess the feasibility of the 100 MW Quaid-e-Azam Solar Park, situated in the Cholistan desert and planned as the pilot project towards a 1 GW solar power development at the same site. The assumptions, results and conclusions of this study have been refined and confirmed during a site visit in January, 2014.

Most input parameters have been provided by the Engineering Consultancy Services Punjab (ECSP). The quality and preparation of data are of a high standard. The analysis of the provided data and the results from the site visit let us conclude that there are good conditions in place for developing the first 100 MW PV power plant. on the main infrastructure such as road access, water supply and security wall is under construction and suitable. The assumed development conditions for the first 100 MW are also applicable for the remaining 900 MW of planned capacity.

Solar parks of this size are not the norm, but through the vast knowledge collected over many years of experience with this technology, it is possible to develop highly efficient parks irrespective of their size.

Concerning the mounting possibilities the fixed installation shall be implemented as it has least capital and operational risks. The tracking devices require more maintenance due to their moving parts. It is recommended to develop small areas of the 100 MW park with tracking systems, so that experience with this technology can be gathered and used to decide if tracking systems should be considered in future PV park developments.

In the base case with fixed mounted crystalline modules the power plant generates 3.860 Gigawatt hours of electricity over 25 years. To allow for some uncertainty in the irradiation assumptions the financial base case is based on a production of 97% ~ 3.750 Gigawatt hours over 25 years.

The base case assumes a tariff for the electricity injected to the grid of 21,73 PKR/kWh for the first 10 years and 9,76 PKR/kWh thereafter. The total project costs are assumed to be 150 million USD of which 70% will be financed by a bank. The base case shows an IRR of 17% for the equity with a payback time of 5 years. The discounted cash flows (10%) amount to a Net Present Value of 21 million USD.

The main drivers for the financial case are the tariff, debt financing conditions and solar irradiation. We estimate the uncertainty for the long term average irradiation at site with 5% and the annual fluctuations from year to year also with 5%.

The project time plan is very aggressive. The main risks for the time plan are delays for necessary approvals in the design phase and the delivery time for the High voltage substation. The construction of the solar field itself is not critical as the site is ideal for installation and well prepared.

The Quaid-e-Azam Solar Park will be very beneficial to the people of Pakistan receiving more power from the ultimately best source of power generation possibilities.

In addition, the project would in mostly all cases be a very good financial investment. Even in the bad case scenarios there will be an IRR of nearly 10%.

2 Project information and outstanding items

This feasibility study summarizes and assesses the given information and includes additional results from an extensive site visit.

2.1 Technical Project Description

The overall Quaid-e-Azam Solar Park - located in the Cholistan desert region of the Bahawalpur district - shall be started in the first phase with a 100 MW installation. This part shall be connected to the 132 kV overhead power line that runs passed the park. Module technology and design is not yet fixed.

2.2 Project Status

A master plan was developed by ECSP. Within the master plan an overview of available information, the first steps of investigation into resources, rights and general information is given.

3 List of Abbreviations

a	Year
A	Ampere
AC	Alternating Current
BOS	Balance of System
CE	Conformité Européenne
DC	Direct Current
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DWD	Deutscher Wetterdienst (German Meteorological Service)
EN	European Standard
EPC	Engineering, Procurement and Construction
h	Hour
HTA	High Tension between 1 kV and 50 kV AC
HTB	High Tension exceeding 50 kV AC
I	Electric Current
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
kV	Kilovolt
kVA / MVA	Kilovolt-ampere / Megavolt-ampere
kW	Kilowatt
kWh	Kilowatt hour
kWp	Kilowatt peak
MWp	Megawatt peak
O&M	Operations and Maintenance
PR	Performance Ratio
PV	Photovoltaic
RFP	Request for Proposal
TA	Technical Advisor
TC	Technical Consultant
U	Voltage
V	Volt

4 Overview of Photovoltaic Technology

4.1 Basic Principles of Solar Photovoltaic Plants

Solar photovoltaic plants use the global irradiation (GI), which is converted into electric energy. Adequate project locations should offer at least 1.200 kWh/m^2 per year.

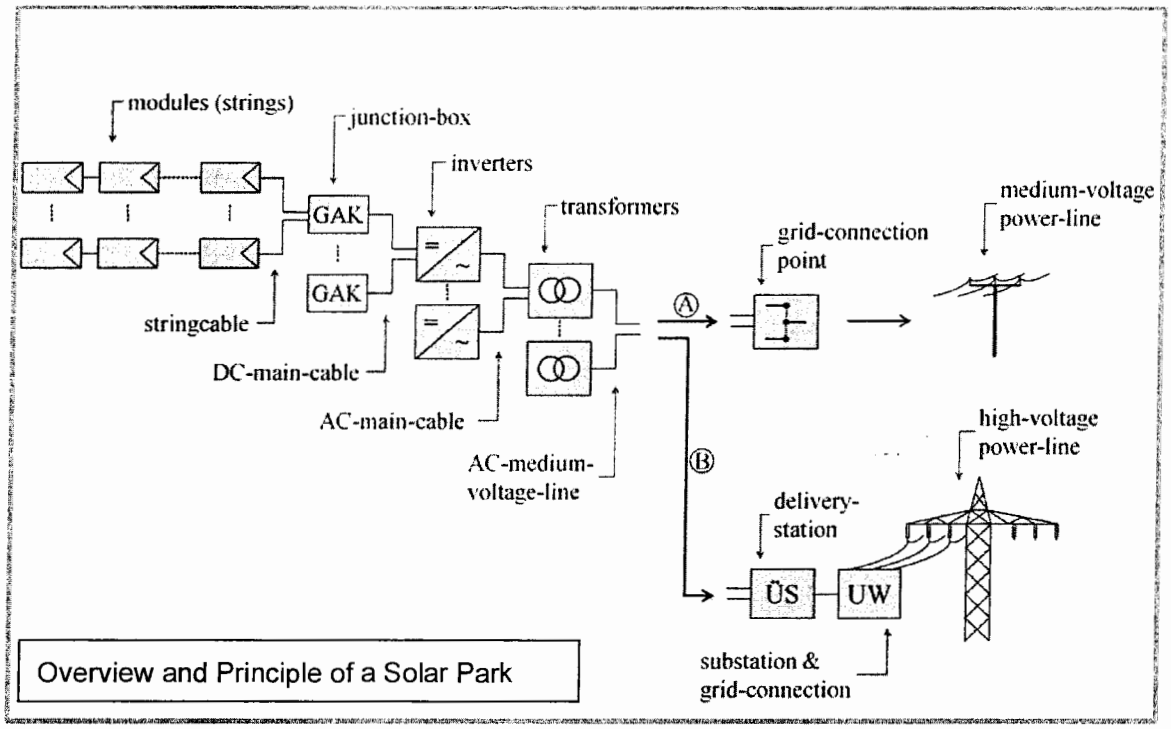


Figure 1 Single Line Diagram Photovoltaic System

4.2 Basic Principles of Photovoltaic Modules

Photovoltaic technologies differ primarily by the type of the manufacturing process, which leads to different price ranges, manufacturing cost and performance for the different technologies. Photovoltaic technology is based on the photoelectric effect, in which the photons emitted by the sun impact a semiconductor surface and are absorbed. The semiconductor is typically made of silicon.

These absorbed photons hit the atoms and thus are releasing electrons, which causes a chain reaction that multiplies the effect of electrons released. The electrons move from lower potential to higher. This increase of potential results in the generation of current through potential difference (voltage). The reactions and release of electrons is continuous.

The purity level of the conductor material is important and that there are no gaps at the molecular and atomic level of the semiconductor material. The higher the purity of the used material, the greater is the likelihood that it achieves the maximum potential of a photoelectric cell.

The efficiency of a solar cell (η) is the percentage of power from solar energy, incident on the panel, converted to electrical energy. This term is calculated using the ratio of the maximum power point of the cell, Pm, divided by the light power that reaches the cell, the global irradiance (E, in W / m^2) under standard conditions (STC, 1000 W/m², 25°C, AM 1,5), and the surface area of the solar cell (A_c in m^2).

$$\eta = \frac{Pm}{E\ x\ Ac}$$

Pm [W] = Cell power at maximum power point at STC
E [W/m²] = power of global irradiation on cell area
A_c [m²) = cell surface area

A solar cell can operate in a wide range of voltages and currents. This can be achieved by varying the load resistance in the electric circuit on the one hand and on the other, by varying the impedance of the cell from the value zero (short circuit) to very high (open circuit). The theoretical maximum power point can be determined this way, i.e. the point in which the product of voltage V and current I are maximized in time. In other words, the load for which the cell can deliver the maximum electric power for a given level of radiation.

Another important variable is the Normal Operating Cell Temperature (NOCT) of the module. This is a characteristic cell value defined as the temperature of the cells, which they reach at an irradiance of 800 W/m^2, an ambient temperature of 20°C and a wind speed of 1 m/s.

Three main cell categories can be defined:

- Monocrystalline
- Polycrystalline
- Thin Film

Monocrystalline Technology

The manufacturing process of monocrystalline cells requires more effort in comparison to other technologies; however, these cells offer higher efficiency – typically within 15-20%.

The advantages are:

- The loss of efficiency due to the higher temperature is lower than for other types of crystalline module technologies.
- Mature and commercially proven technology.
- Long lifetime of panels.
- Low degradation of maximum 0.1% - 0.5% per year (manufacturer guarantee is 0.7% degradation per year; however reality proves to be less).
- Lower installation costs.
- More environmentally friendly than other technologies, for example, some thin film technologies use cadmium. Mono-crystalline cells are not harmful to the environment.

The disadvantages are:

- The initial investment costs are higher.
- Higher risk of damages during transport or during operation at sites with high wind speeds.

Polycrystalline Technology

This technology exists since 1981. The manufacturing process is simpler when compared with mono-crystalline technology.

Advantages:

- Lower production costs.

Disadvantages:

- Lower efficiency, due to lower purity of the cell material: 13-16% (module size)
- Because of the lower efficiency, slightly more ground surface area is required to reach the same capacity (as for mono crystalline).

Thin Film Technology

This technology is called Thin Film because only a couple nanometers of the semiconductor material is placed on a substrate material. Hence a very low amount of material is needed. The main semiconductor materials in use are:

- Amorphous Silicon (a-Si)
- Cadmium Telluride (CdTe)
- Copper Iridium Gallium Selenium (CIS / CIGS)
- Organic photovoltaic cells

Thin Film technologies have a low market share, except of the CdTe material. Depending on the technology, standard thin film module efficiencies have reached 7-14%, Prototypes of these technologies reach 16% and more which is expected to be transformed to standard products in the future.

Advantages:

- Easier to manufacture, thus lower costs.
- Homogenous appearance.
- Flexible, hence for use at different applications and surfaces.
- Less affected by high temperatures and shadowing.

Disadvantages:

- Faster degradation rate of up to 0.7% per year.
- Lower efficiency leads to greater surface area requirements, for the same capacity.

4.3 Mounting structures and tracking systems

The photovoltaic panels may be installed on fixed structures or on structures that are tracking the sun. Trackers can be equipped with either a single axis or dual axis tracking system.

Fixed structures are usually just tilted to face south (north in southern hemisphere), or may have south as their main angle and a slight inclination to the east and west as secondary angle (for example 10°). This roof-shape inclination would offer lower peak capacity, however the generation curve would be less spiked and allow an energy generation distribution to be more equal over the day.

For tracker solutions, the aim is to follow the sun and maintain the panels perpendicular to the axis of incidence of the sun. Thus a greater efficiency in converting solar energy can be achieved. The dual axis tracking can follow the sun both in azimuth and angle - this means that the sun can be tracked over the course of the day, from east to west and the tilt angle can also be adjusted to compensate for the changing angle the sun has over the year. The decision to choose any of the three types of mounting structure is based on a technical and economic evaluation. When choosing a tracking system, the extra energy generation in combination with the energy price must be compared to the additional investment and maintenance costs required for tracking systems.

4.4 Inverter Technology

Because photovoltaic panels generate DC electricity, it must be converted to alternating current before it can be fed into the grid. This is achieved by an electronic device called an inverter that performs this function.

State of the art inverters offer a broad range of operational stages, which generally fulfill all the requirements of the international grid codes in terms of fault-ride-through and reactive power provision. Inverter stations provide a protective shell in which PV-strings can be connected to inverters. Centralized inverters typically have a capacity from 500 kWp to 1.5 MWp of DC PV-Power, depending on the size of inverter.

From the inverter stations the AC power is stepped-up by a MV or HV-Transformer, and then connected to a medium or high voltage grid (for instance 132 kV as in Pakistan).

4.5 Control System

A PV plant typically is controlled by a SCADA System (Supervisory Control and Data Acquisition) and can remotely be managed and supervised. However, for preventive, planned and corrective maintenance, adequate staff and qualified contractors must be identified for the Operations & Maintenance (O&M) of the plant.

6 Site Description and Assessment

6.1 Geographic Parameters

The site of Quaid-e-Azam Solar Park is located in the southern region of the Punjab province about 20 km south east of Bahawalpur (geo coordinates 71.78° east / 29.4° north).

Most of the Bahawalpur district (about 2/3) is called Cholistan desert.

The overall site for up to 1.000 MW targeted PV-power includes slightly different conditions according to land use (agriculture) and soil conditions (unused arid regions and desert).

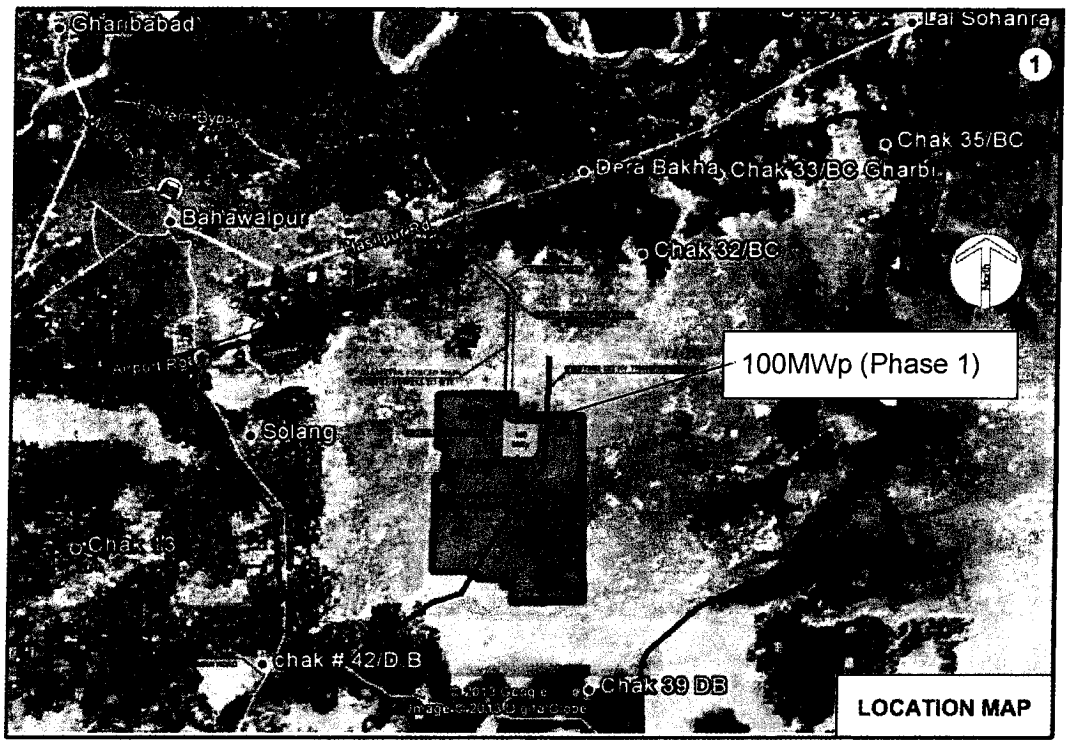


Figure 2 Overview Quaid-e-Azam Solar Park

6.2 Climate conditions

Climate conditions have influence on construction and foundation lay-out as well as energy production. The region is part of the Cholistan Desert. The name might be a little misleading as the site is surrounded by agricultural used land. There are seasonal variations from cold winters to hot summers with up to 40 or even 50°C.

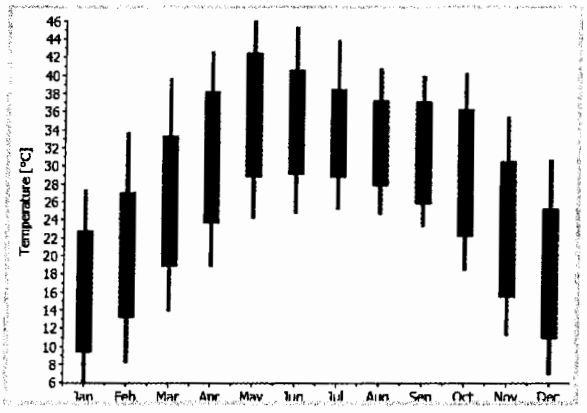


Figure 3 Site Temperature Range

The monsoon season lasts from May through September with a peak in July and August. 60-70% of the yearly rainfall is in those months. The average rain fall per year is about 170-200 mm.

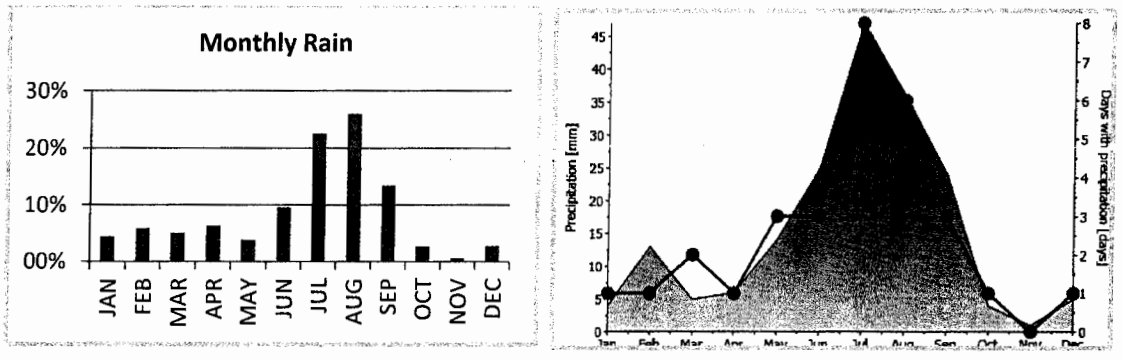


Figure 4 Rainfall

Drainage from the site seems not to be an issue. Few dried out puddles could be found and seepage into the sandy ground seems to be effective.

Figure 5 Soil

There is an average of 8 to 9 hours of clear sky per day throughout the year and 2900 h – 3300 h sun hours annually.

The region is a distinctly low wind area with means of less than 2,5 m/s. With the monsoon season the wind speeds up especially at daylight. Storm events are logged by the meteoro-

logical station of Bahawalpur with maximum gust wind speeds of 20-30 m/s and single events of up to 40 m/s (~15m above ground).

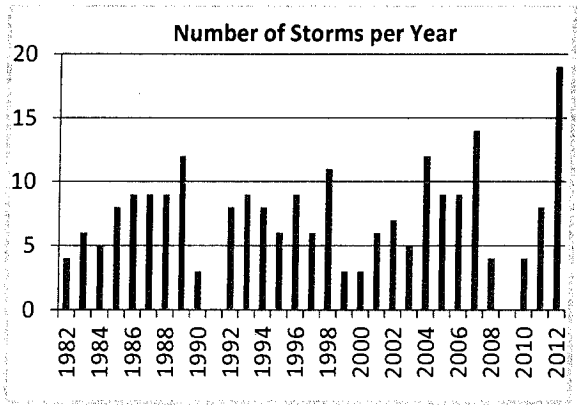


Figure 6 Storms

Micro climate effects can cause dusty and windy conditions which should be evaluated more deeply. Broken up surface causes swirling dust at wind speeds of higher 5-6 m/s (4Bfd)

Seasonal flooding could be a point to consider as the inflows of the Indus, Satluj and Panjnad are all close by and at similar elevation (~115 m site level to ~110 m river level above sea level). Recent events of flooding did have no impact in this specific region.

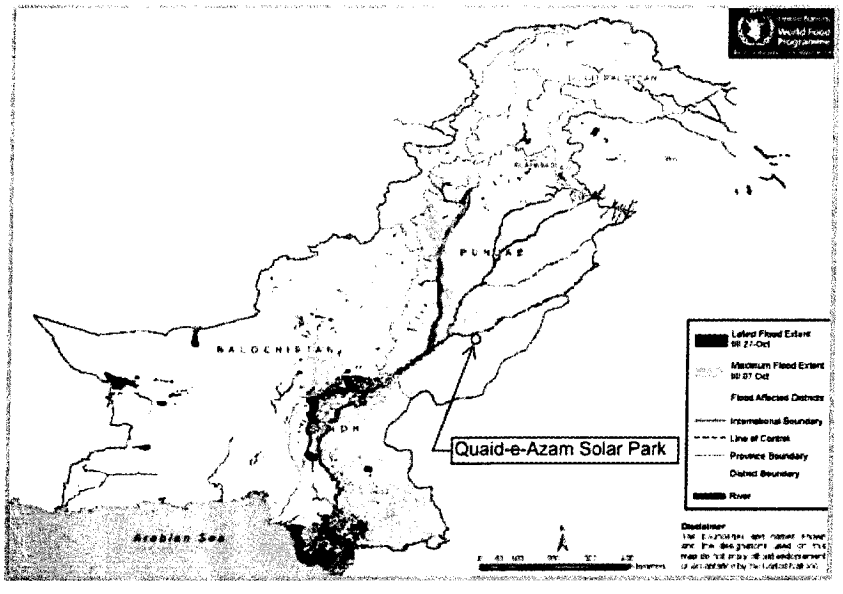


Figure 7 Risk of Flooding (Source: World Food Programme (http://de.wfp.org/))

Impact on the project:

The inverters for this site should be designed for high ambient temperatures and all of the Inverters, transformers etc. should be installed on elevated terrain. Dusty conditions shall be considered for the design of filters for all electric equipment and buildings. The position of the modules and other structures should be chosen so that an intelligent drainage and seepage network can be incorporated into the park.

6.3 Environmental Aspects

The area is at present free of pollution. No industrial activities are present. There are few agriculture activities around the site. Pakistan Environment Protection Agency (Pac-EPA) has no regulations or requirements for solar power generation (PEPA Regulations 2000). Low rainfall and some wind causes slight erosion of soil. No protected wild plants or animals are reported for that site. The ecosystem is described as fragile. The acoustic environment is good with low noise from some local traffic on dirt roads.

Impact on the project:

No critical aspect can be detected as long as all obligatory safety rules are respected e.g. for oil pollution from facilities and transformers.

A large population of rodents lives in that area. They are known to eat plastics and cables. During site visit we saw only their holes in the ground.

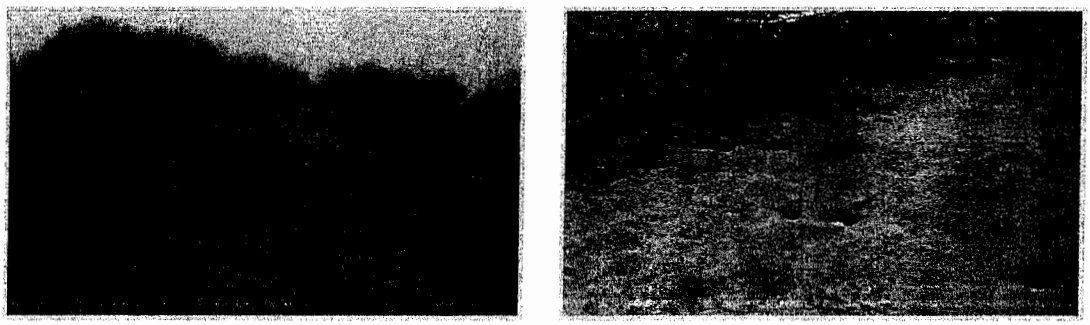


Figure 8 Rodents

6.4 Topography and grounding

The soil in this desert like region is mostly sandy to dusty and slightly salty. Several halophytic shrubs grow in this region. Broken ground stabilizes after two to three years.

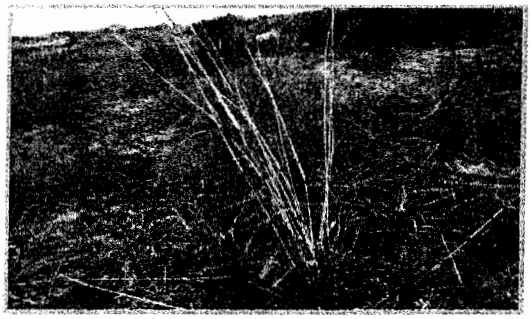


Figure 9 Vegetation

For heavy transport traffic it has to be prepared. The natural state layer is not suitable as a foundation bearing layer. Further investigations with focus on necessary preparations are required. Detailed soil study has been carried out.

On behalf of the large area for the fully developed solar park of 1000 MW the terrain is mostly even. Various landmarks like steep slopes, gullies, roads, cables, pipes and others are already identified and marked. Stabilized dunes are common in some sections. For the planning of the solar park a closer look at the data and a small scale on site viewing is required.

Figure 10 Dust development

Once the loose sand of the dunes is cleared, the table of stabilized ground becomes visible. It is compacted by rain water and small amounts of salt (slight salty taste). The ground looks ideal for pile ramming but with some mechanical resistance. More details are stated in the geological survey.

Figure 11 Superficial digging at the edge of a dune

Potential risk of earthquakes is a clear point of consideration as the site is found in the 2A seismic zone with basic earthquake intensity less than Grade VI in that region. Geological activity is frequent. Overall the region is of stable structure. More information is required for proper design of substructures and foundations. The ground conditions can be described as intermediately complicated.

Summary of soil conditions (*Selecting Halopbytic Shrubs for the Cholistan Desert by M. Abdullah,* M. Akram,* W.A. Khan* and N.J. Davidsont*)

New and more reliable data is available in the detailed soil study.

Table 3 Soils characteristics of desert field research station, Dingarh, Cholistan Desert

Location	Depth (cm)	Texture	ECe (dS/m)	pH	K^+ (ppm)	Na^+ (meq/L)	$Ca^{2+} + Mg^{2+}$ (meq/L)	SAR	P (ppm)	N (%)
1. Sandy soils	0–30	Very fine sand	0.08	7.8	3.9	0.35	0.45	0.47	0.9	0.03
	30–60	Fine sand	0.10	7.9	3.9	0.28	0.72	0.46	1.2	0.03
	60–90	Fine sand	0.09	7.9	3.9	0.43	0.47	0.89	1.5	0.03
	90–120	Loamy sand	0.09	8.0	3.9	0.28	0.50	0.56	2.0	0.03
2. Clay soils	0-30	Clay loam	0.11	8.5	6.2	0.35	0.80	0.55	5.2	0.04
	30-60	Clay loam	0.07	8.4	3.9	0.47	0.23	1.42	4.5	0.03
	60–90	Loam	0.37	7.9	33.5	0.65	3.05	0.52	10.2	0.04
	90–120	Silty clay	0.34	8.0	37.4	0.98	2.39	0.89	15.0	0.05

Figure 12 Soil Analysis

Electric grounding should be no problem as the ground water table is about 5 to 6m below surface.

Impact on the project:

Overall conditions are more or less standard and various solutions can be developed to realize the project. Foundations for Buildings have to be well prepared. Pile driven sub construction seems to be the best foundation for PV-generator. The overall design, selection of components and all constructions and foundations as well as cabling have to take these conditions into consideration.

5.5 Meteorology including Solar Resource

Pakistan is exposed to strong solar radiation, long hours of sunshine, and abundant solar energy resources. The annual sunshine hours range between 2900 h – 3300 h, with a daily average of 8.1 h - 9.2 h sunshine hours.

Bahawalpur District is located in the south of Punjab Province. The Meteorological Station in Bahawalpur District is located at 71.78 degrees east longitude and 29.4 degrees north latitude (in terms of the geographical coordinates), and the Observation Field is 116 m above the sea level. The basic available meteorological data and the sunshine hours from 1982 to 1991 and from 1996 to 2012 (27 years) of this Meteorological Station have been collected and can be requested by QA Solar.

The region of Cholistan desert is over all hot and dry as shown in the following table:

	Sunhours *	T Amb	WindVel
	h	°C	m/s
January	10	13,5	2,0
February	11	17,8	2,3
March	12	23,2	2,6
April	13	30,2	2,6
May	13	36,5	2,7
June	14	39,4	4,2
July	14	39,0	3,4
August	13	36,8	2,9
September	12	32,9	2,3
October	11	27,8	2,1
November	11	22,2	1,9
December	10	15,5	2,3
Annual average	2900-3300	27,9	2,6

Figure 13 Meteo Data Site

Source: SolarGIS and Meteorological Station Bahawalpur District
Sun hours: Hours (* Meteonorm 7`, explanation in)
T Amb: Average ambient temperature
WindVel: Average wind velocity

For determining the best data source for the solar irradiation predictions we used data sources from NASA, meteonorm and SolarGIS. In the following we describe the differences and define the preferred meteorological dataset for the yield assessment.

The high level of global horizontal irradiation with the typical shape of seasonal variation through the monthly values shows only differences of 2-3% on yearly basis between different sources.

SolarGIS provides irradiation data based on calculations from satellite images. The database represents long-term global data (1999 to 2012). The spatial resolution is 250 m. SolarGIS typically has an uncertainty of 3.5% based on experiences in other countries of the MENA region and Middle East. For Pakistan and the region of Cholistan we assume an uncertainty of 5% due to missing close reliable reference meteo stations with measurement for irradiance values. Another uncertainty comes from the relatively flat angle of the satellite view and a recent shift of the satellite position in the orbit with some effect to long term data.

Meteonorm uses several sources for mean values with an internal and mainly unknown calculation. Different long term values (averages over 10 and 20 years) from different versions (meteonorm 6 and 7) with some small differences to each other are provided. For long term calculations also long term historical data are the best choice. For the youngest 20 year average (1986-2005) and due to only small number of ground based and close reference we calculate an uncertainty of 10%.

The NASA source also uses satellite images but with own calculations for irradiance data. For Pakistan we can recommend an uncertainty of not better than 15% due to experiences in India.

For energy yield calculations in the region of Cholistan the SolarGIS data are most reliable and shall be taken as the basis for the QA Solar Park.

Just for information we put together the different sources as a table and diagram.

Irradition Sources Bahawalpur Average monthly sum	Meteonorm 7 1986-2005 GlobHor	Solar GIS 1999-2012 GlobHor	NASA 1981-2011 GlobHor
	kWh/m².mth	kWh/m².mth	kWh/m².mth
January	104	102	112
February	118	124	125
March	157	180	163
April	179	197	180
May	194	209	202
June	182	190	200
July	184	181	193
August	182	185	176
September	170	175	159
October	144	160	144
November	114	115	115
December	99	103	104
Annual sum kWh/m²*a	1827	1921	1873

Figure 14 Results from different sources for irradiance data

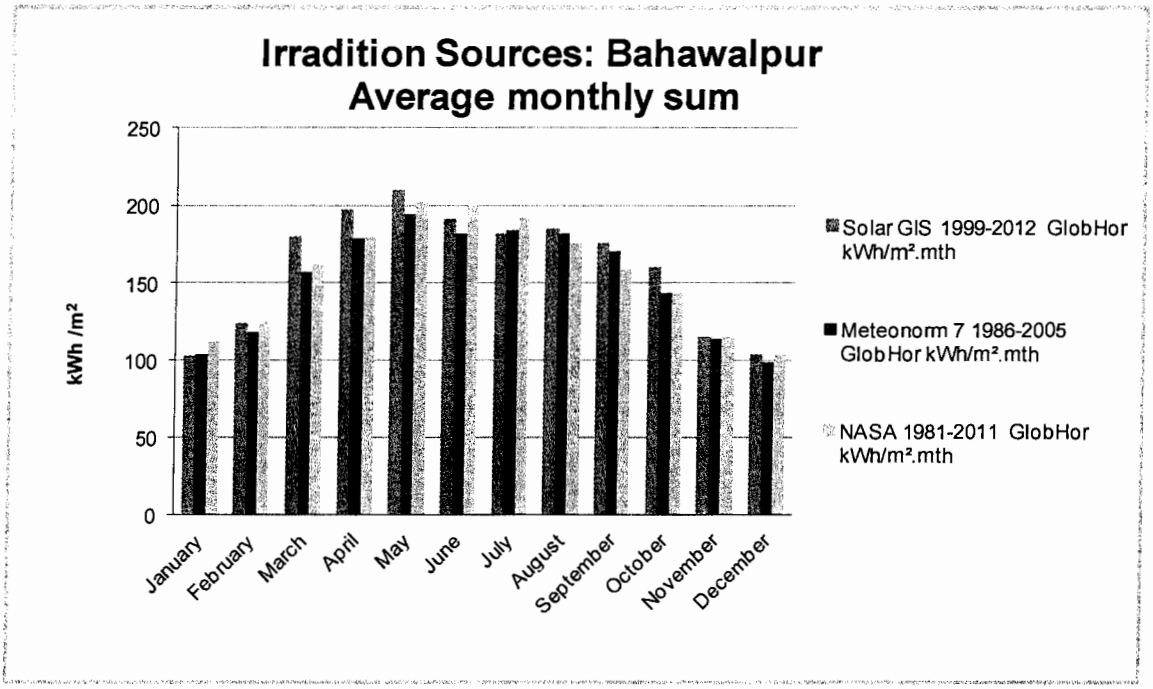


Figure 15 Comparison of results from different sources for irradiance data

Interesting but not relevant for energy yield calculation is another diagram which demonstrates the number of sun hours. "Sun Hour" is defined as a global irradiance >120 W/m² on a plane facing direction to the sun. That does not mean that the sun itself must be visible. Even at hazy or misty conditions this value and more can be reached.

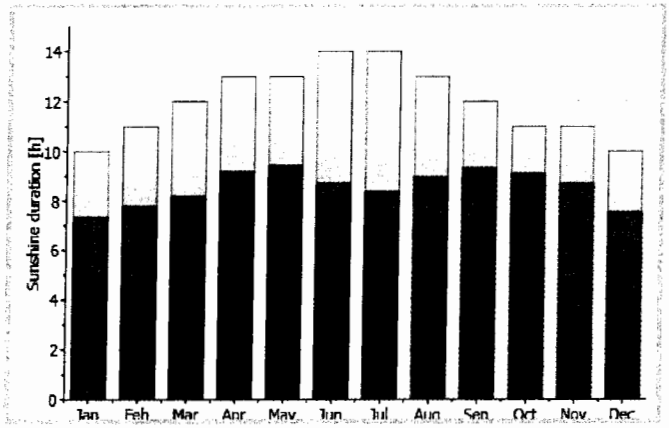


Figure 16 Sun Hours (Source: Meteonorm 7)

Yellow = astronomical, theoretically when the sun is above horizon
= real, with a global irradiance >120/m² on a plane, facing to the sun position

6.6 Transport Access

The site lies 8.0 km south of the Bahawalpur-Hasilpur highway, 6.0 km east of the Bahawalpur-Yazman road, and the north of Kudwala road. In Bahawalpur the nearest airport is located, at a distance of 13 km and the nearest railway station at a distance of 20 km.

Presently the QA Solar Park site is accessible via a jeep track off the road along Ahmadpur Canal 3 km from site. For reliable access, C&W Department is already constructing a road off from the Bahawalpur-Hasilpur road and that will end at the solar park entrance, almost in the middle of its northern periphery.

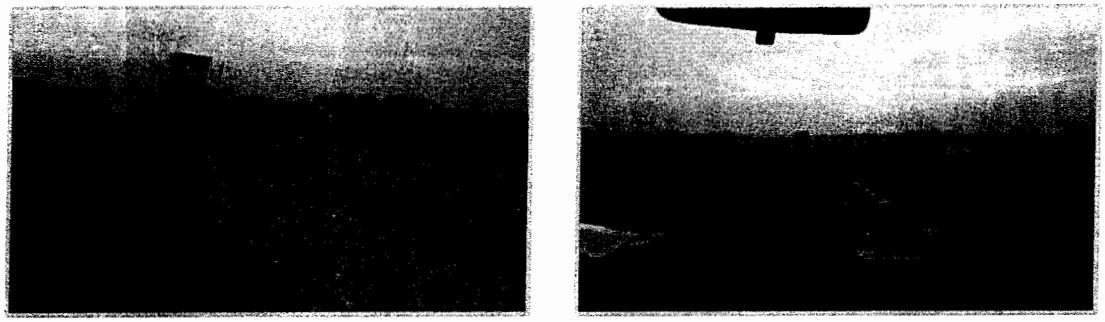


Figure 17 Access Road

The master planning report for infrastructure development of Quaid-e-Azam Solar Park, Cholistan states the following:

1) Road Traffic Planning

The main roads of the overall solar park are planned through the western and eastern corridors and inter-connected at the northern and southern boundaries in the form of a ring for ensuring complete connection to all the solar farms and the general services area. The main road in the eastern corridor will be located parallel to the existing 132 kV transmission line at a minimum distance of 30 m for safety reasons.

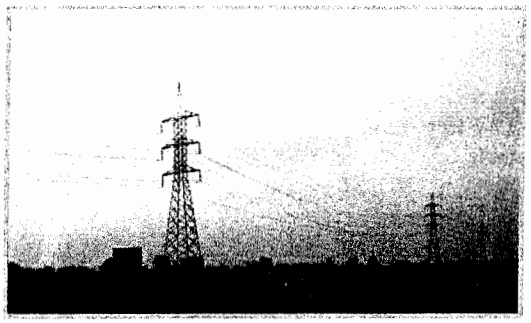


Figure 18 HV Power Line 132 kV

Road-C will be provided in the sub-corridor C while road B will pass through corridor B. Besides accommodating the roads, the corridors will also be used for overhead power lines, buried water pipelines, telecommunication lines and other utilities. The main roads passing through the corridors have a total width of 12.7 meters with a carriageway of 7.3 meters, and has a 50 mm thick asphalt wearing course over water bound macadam base, treated shoulders 1.2 m wide and earthen berms 1.5 m wide. Cross slope of the road will be 1.5% for easy surface drainage. As the terrain is sandy, side slopes are adopted as 1:4 for stability purpose. Right of way for the roads is recommended as 40m.

2) Design of Road Works

The roads will turn orthogonally at 90° as much as possible, Precautionary lights are recommended along the roads. Considering the small population, and light traffic, the road turnings are planned to be rounded off only at the roadway edge. No public transportation will be permitted to enter the solar park. Solar farm sponsors will arrange vehicles according to their own needs for travelling in and out of the farm along with parking lots within their farm boundaries.

3) Road Vertical Design

As the land within the solar park is undulating, the range of longitudinal gradient of roads is recommended to be 0.3%. In specific cases like escarpments, the gradient limitation may be relaxed according to site conditions. In order to ensure smooth longitudinal curve of the road, cut and fill balance method should be used. Factors such as comfort, smooth ride, engineering parameters and proper visibility are to be considered in vertical design, especially at road turnings whereas the longitudinal slopes of roads on both sides of the turning should remain the same.

4) Road bed / Subgrade

The road bed is required to be strong, stable and economical and should be prepared according to the local conditions including geology, hydrology and available material as well as other construction requirements. Accordingly the subgrade is proposed to have a minimum thickness of 300 mm having CBR values 8 %. Compaction of fill material in the subgrade should be 95 % of AASHTO T-180 (MDD). Borrow pits and spoil heaps should be properly dressed to avoid any hazards.

5) Pavement

It is expected that during construction of the solar farms, there will be considerable vehicle movement on the roads, however during the operation stage; the traffic will be quite light. The road pavement has been accordingly designed on the basis of one million ESAL traffic load and subgrade CBR requirement of 8 %. The road surface needs to be stable and strong enough to meet the requirements of being smooth, anti-sliding and having a good drain system. Accordingly, the consultants have proposed a sub-base thickness of 150 mm, overlain with 175 mm thick water bound macadam meeting the standard AASHTO specification. The asphalt wearing course is designed to have a thickness of 50 mm. The shoulders will have a

double surface treatment over the 150 mm thick water bound macadam. Thickness of sub-base and subgrade will be the same as that for the main carriageway.

The roads are proposed to be constructed phase-wise based on traffic needs. The first road is proposed to be built from the end of access road being constructed by C&W up to the phase-I area.

6) Road Traffic Safety Facilities

Necessary traffic safety facilities are proposed according to safety regulations, to ensure the safety of vehicles and pedestrians."

The EPC will be just responsible for the road developments on site.

As the road developments are not finalized yet, the risk of delays for the construction start occurs.

5.7 Water Access

The desert like region has only little water resources from rain (200mm/a) and some ground-water (likely fresh water) from seepage next to some channels but outside of the site. Water can be obtained from a borehole during and after construction. The capacity has to be evaluated with respect to other users e.g. for agriculture. Water can also be obtained from tube wells along the canals. These tube wells are almost 8 km away from solar park site, such it is planned to lay a forced main of 8" diameter from three tube wells to the solar park site where it will be stored in a ground storage tank of 50,000 gallons. The solar farm will be supplied through a 4" diameter outlet and will have its own ground storage tank. These systems are in the planning phase.

Water will be required for dust prevention during the construction phase and eventually for cleaning of modules in the operation phase.

5.8 Grid Access

Currently there is no grid access directly on site, but a 132 kV overhead line, from Lal Sohanra to Samasata, passes directly along the site boundary. This power line is the proposed interconnection point for evacuating the power generated by the PV park. A 132 kV step-up station will be needed for connection to the 132 kV lines.

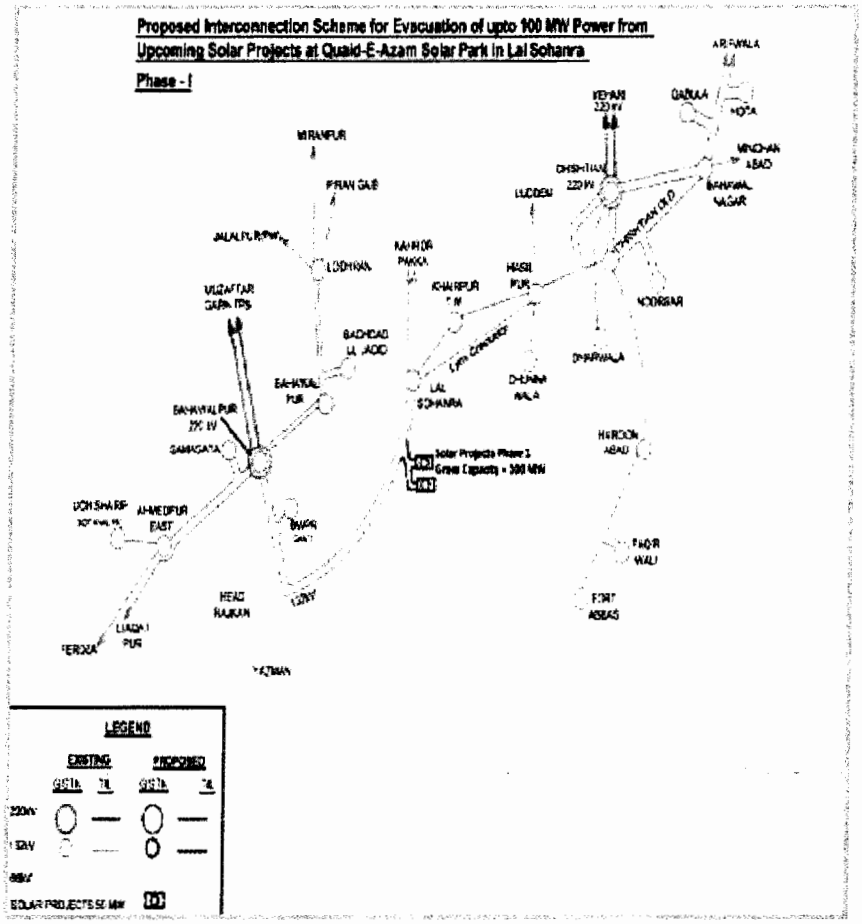


Figure 19 Interconnection Plan

An 11 kV grid is available from which arrangements of power supply are being made by Punjab Industrial Estate & management company (PIEDMC) belonging to the Punjab Industries Department. It is planned to have power available on site at construction start. In the case that the infra-structural development is not finalized by the start of construction phase, a diesel generator solution will have to be provided.

6.9 Facility Access

The QA solar park is about 18 km away from Bahawalpur, where facilities such as a fire department, a police station and a hospital are available.

The fire station can meet the fire protection requirements of the park. As such there is no need to build a dedicated fire station within the park itself. The water for fire-fighting is proposed to be supplied through the main water supply pipe running between the eastern and western corridors.

According to the features of the solar power generation park, and on the basis of the relevant specifications of Code of Design on Building Fire Protection and Prevention (GB50016-2006), fire hydrants will be provided in the general services area and the 220 kVA step-up station. The outdoor fire hydrant shall be erected along the roadside, and the arranged distance between the hydrants shall be no more than 120 m. The fire devices shall be designed according to the secondary load power supply standard, using double circuit power supply and switching automatically at the end. The fire devices shall use fire protection or fire-resistant cables. The fire protection and firefighting system of each plot in the

park is part of safety requirement and shall be designed and provided by each solar farm entrepreneur.

The distance to the hospital is acceptable. An emergency kit has to be provided in each station on site, along with an emergency guideline, the emergency number and a description of the travel route to enable a rapid aid.

The distance to the police station is also acceptable, but it is recommended that the site has its own full time security staff located near or on the site.

7 Plant Layout and Description of Technical Equipment

7.1 Power supply infrastructure

For this first Phase of 100 MW of the Quaid-e-Azam Solar Park an 11 kV overhead power line is planned and will come from the north.

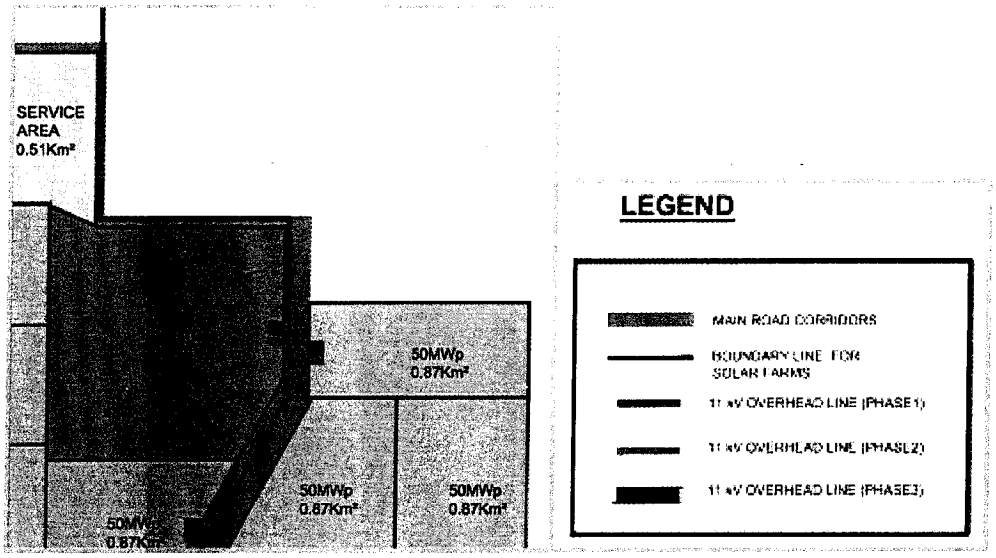


Figure 20 Power Supply 11 kV (red line)

This power line will be large enough for supply the auxiliary power, but not large enough to evacuate the produced electricity of the park.

7.2 Power plant technology configurations

In general several technology configurations can be realized.

Easiest and cheapest technology configuration is fixed mounted module installation with a 25-30° tilt to the south with central inverters. The density of installed PV power to ground space is highest and the specific energy output by installed PV power is lowest.

Alternatively a dual axis tracking system is the complete opposite, it is more expensive, it has the lowest density of installed PV power to ground space and the highest specific energy output of installed PV Power.

A compromise of these two technologies exists in the form of the single axis tracking system. This option offers a good cost to power ratio. Due to this insight, several versions of single axis tracking systems (with horizontal North-South axis) were compared.

Pile rammed substructure are the best recommended foundations for PV racks, according to geotechnical investigations, but the best foundation for this specific site should only be decided on after further investigation.

Impact on the project

Detailed yield analyses have to be carried out for multiple options. RFP should not be fixed to one option but to the highest yield/cost ratio.

7.3 Required infrastructure developments

To date the area of the solar park is mainly unused desert region with a HV overhead power line running from north-south. All types of infrastructure need to be developed; this includes water supply, energy supply, road access (both to and around the park).

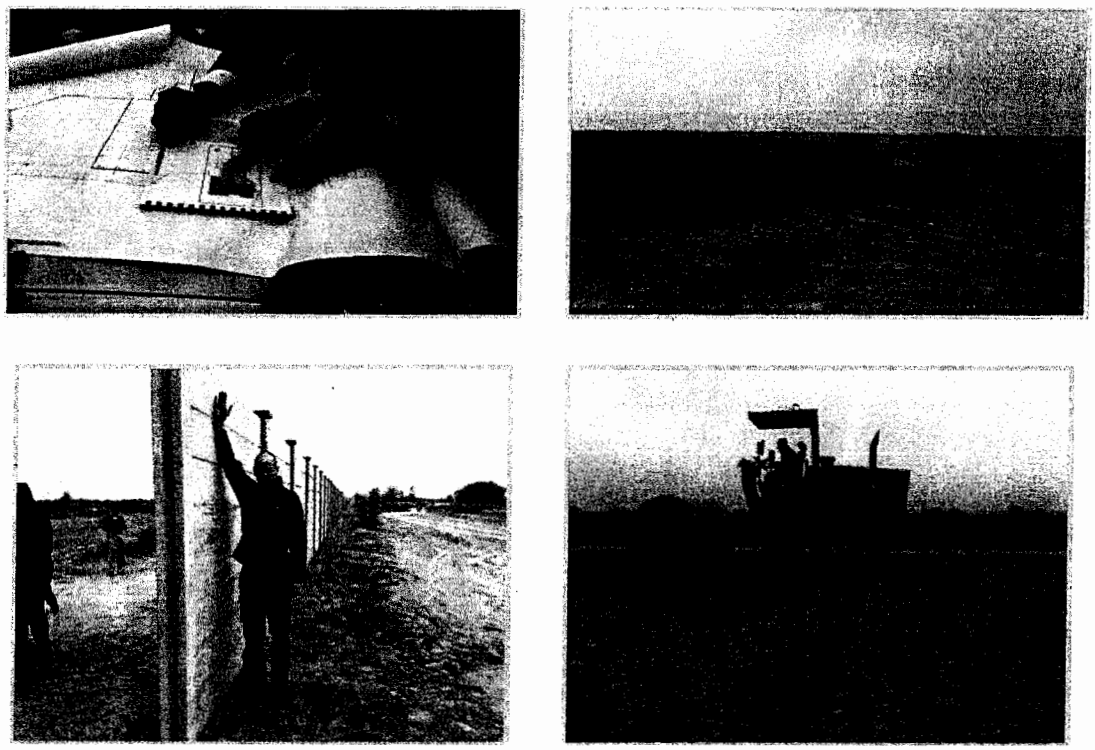


Figure 21 Infrastructure developments (Access Road, Wall)

7.4 Grid connection

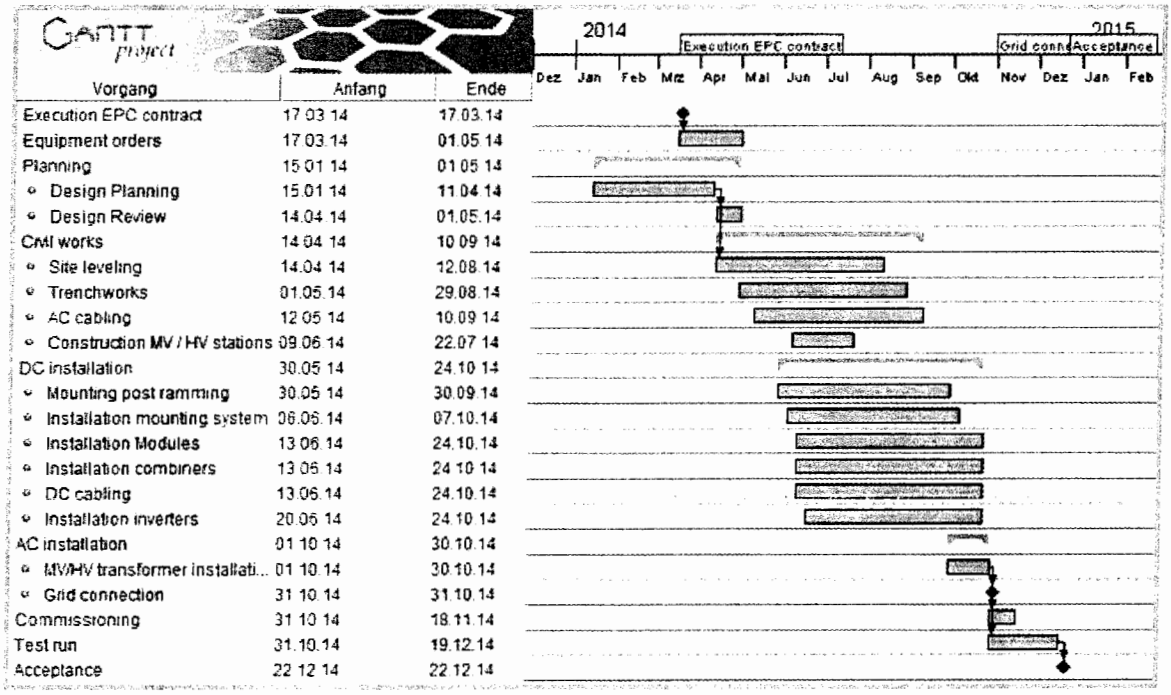
A grid connection, for this first phase of 100 MW, can be realized by connecting the park to the north-south running overhead 132 kV power line that runs right along the east border of the park. Suitable step up transformers (park internal) and substation are required.

Impact on the project:

Delivery time for a substation transformer is very uncertain due to potentially very specific design parameters. We can only give a broad range of 4-9 months. So this sub-project should be started first.

7.5 Time line

A time line for development, construction, commissioning and test run is been given below. The overall schedule is based on a European setup where all infrastructure and permitting issues are known and been taken care There is a high uncertainty for the specification and delivery of the HV Substation. This critical path can extend the project by up to 4 months time. For Pakistan it will be challenging due to the uncertainty of available infrastructure and labour for construction start and maybe permitting or logistical issues.



Vorgang	Anfang	Ende
Execution EPC contract	17.03.14	17.03.14
Equipment orders	17.03.14	01.05.14
Planning	15.01.14	01.05.14
Design Planning	15.01.14	11.04.14
Design Review	14.04.14	01.05.14
CivII works	14.04.14	10.09.14
Site leveling	14.04.14	12.08.14
Trenchworks	01.05.14	29.08.14
AC cabling	12.05.14	10.09.14
Construction MV / HV stations	09.06.14	22.07.14
DC installation	30.05.14	24.10.14
Mounting post ramming	30.05.14	30.09.14
Installation mounting system	06.06.14	07.10.14
Installation Modules	13.06.14	24.10.14
Installation combiners	13.06.14	24.10.14
DC cabling	13.06.14	24.10.14
Installation inverters	20.06.14	24.10.14
AC installation	01.10.14	30.10.14
MV/HV transformer installati...	01.10.14	30.10.14
Grid connection	31.10.14	31.10.14
Commissioning	31.10.14	18.11.14
Test run	31.10.14	19.12.14
Acceptance	22.12.14	22.12.14

Figure 22 Tentative Schedule

8 Grid interconnection

In developed countries, many years of experience with, grid connected renewable energy power plants have shown that it is possible to integrate these power plants into the grid under consideration of clearly defined technical aspects. PV plants, especially, are also able to offer reactive power 24/7 and can thereby help to stabilize the grid.

8.1 Possible electrical faults and their impact on the grid

In general, measures have to be taken in order to assure that all types of electrical faults as well all other states of the PV plant are managed in accordance with the relevant national grid code (NEPRA Grid Code June-2005) and potentially existing so-called "Technical Conditions for Grid Connection" of the corresponding grid operator. The needs can be fulfilled by selecting the right safety equipment and a safety concept which includes all components from inverter up to the grid connection point.

7.2 Impact on the evacuation network

With respect to the transmission grid at high voltage level the conditions for a safe grid integration of 100 MVA nominal AC power and in particular the planned extension of the PV plant at the given location need to be assessed. The corresponding key indicators for this assessment are the short circuit power and the impedance angle of the grid at the grid connection point.

7.3 Balancing power

Due to their very nature, PV plants as such are not suitable for providing balancing power. According to the installed inverters the PV plant has to be operated far below nominal power at certain times of the day to ensure the requested reactive power. Usually inverters react slowly to the request to change the share of reactive power. Due to the slow reaction of the inverters and the need for fast power balancing, a compensation system has to be implemented. The PV plant needs to be assessed, so that adequate measures to provide the required balancing power can be implemented and an overall monitoring and control system installed.

7.4 Grid control strategies

Basically grid control strategies can only be set up with a somewhat clear understanding of the potential energy mix of a specific region in the future. Once this mix is known at least on "target basis", it is feasible to exploit the potential of modern inverters to the full extent, for instance their capabilities of providing reactive power on demand in more or less real time or in case of low voltage. Accordingly to the aims of the master plan the requirements of the grid code have to be broken down into requirements for the PV-plants. Therewith the PV-plant can be designed to support a proper control of the grid.

7.5 Technical Specifications

Define technical specifications for grid interconnection and the according equipment in compliance with international and national standards (voltage and frequency range, power factor, voltage drop, current rating, switching capability, safety features, control and monitoring etc.)

Prior to setting up technical specifications for the grid connection a comprehensive analysis, of the existing grid codes, relevant guidelines and national regulations, has to take place with the target to establish the exact conditions for a safe, technically and economically viable grid connection of the PV plant. Following this analysis, detailed technical requirement specifications concerning the behavior of the grid connected PV plant can be set up in order to make sure that faults and deviations from the established set of conditions result in predefined actions. Key issues in this respect are:

- Decoupling of the PV plant in case of short circuit and voltage or frequency deviation above or below defined thresholds
- Dynamic grid support in case of short term voltage drops
- Provision of reactive power and control of effective power as required

9 Energy Yield Assessment

9.1 Solar irradiation data

Some solar data is available back to the early 1980s from the Meteo Station of the Bahawalpur District. The given sunshine hours can only indicate the volatility through the years which is around 20%. Beside these sun hour data there are also other sources for irradiation data available e.g. satellite data. Dimension shall be kWh/m² instead of sun hours to calculate energy values. In a first analysis the annual horizontal global irradiation was evaluated at 1920 kWh/m².

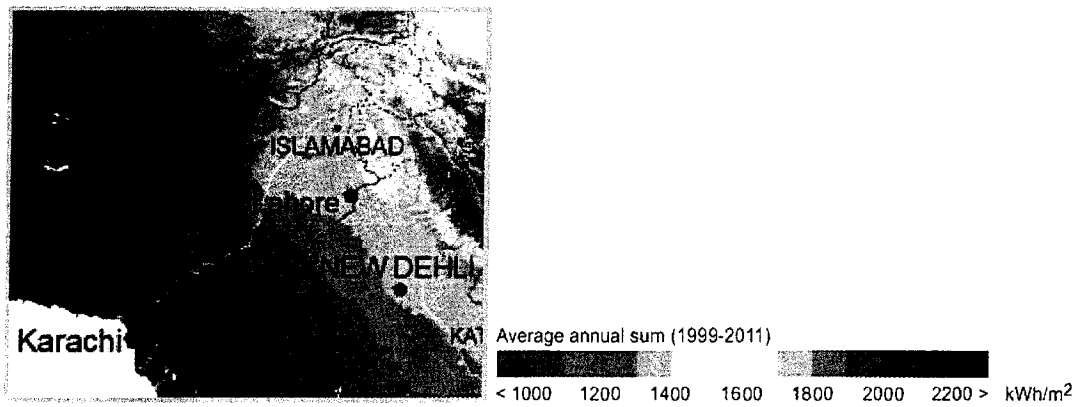


Figure 23 Global horizontal irradiation (GHI) for Pakistan (Source: SolarGIS 2012)

Through a comparison of the data of Bahawalpur meteorological station and GIS data, we recommend to use the GIS data as irradiation data for further analyses. The uncertainty of SolarGIS data we assume to be 5%.

	GlobHor	BeamNor	T Amb	WindVel
	kWh/m².mth	kWh/m².mth	°C	m/s
January	102,3	107,7	13,5	2,0
February	124,0	123,8	17,8	2,3
March	179,7	163,4	23,2	2,6
April	196,5	148,9	30,2	2,6
May	208,5	127,9	36,5	2,7
June	190,3	94,3	39,4	4,2
July	181,1	81,9	39,0	3,4
August	184,8	117,4	36,8	2,9
September	175,3	136,6	32,9	2,3
October	160,2	161,5	27,8	2,1
November	115,1	110,5	22,2	1,9
December	103,0	106,0	15,5	2,3
Annual average kWh/m²*a	1920,8	1479,7	27,9	2,6

Figure 24 Meteo data at site (Source: SolarGIS)

GlobHor: Average monthly sum of global irradiation in horizontal plane
BeamNor: Average vertical beam to module plane
T Amb: Average ambient temperature
WindVel: Average wind velocity

8.2 Performance Ratio

A solar cell is the smallest semiconductor element within a PV module to perform the immediate conversion of sunlight into electrical energy by the photovoltaic effect. Depending on the employed technology, the degree of efficiency amounts up to 18%. This value seems to be quite low but the free supply of primary energy (solar radiation) and the corresponding absence of power dissipation in the conventional sense should be taken into consideration. By using appropriate technology, the direct current generated by the solar modules is converted into alternating current that can be fed into the public power supply.

The conversion into alternating current implicates losses depending on the PV system configuration, the choice of components and to a minor degree on the local site conditions.

If these losses are identified and evaluated, the system operation quality – the performance ratio (PR) – can be ascertained.

The PR is stated as percent and describes the relationship between the actual and theoretical energy outputs of the PV plant considering module efficiency.

PR = energy yield / (unshaded annual irradiation on array surface * module efficiency according to STC)

$$PR = 100 \times \left[\frac{E_{AC}}{E_{Irradiation} \times A_{Array} \times \eta_{STC}}\right]$$

E_{AC} = energy coming from the inverter or measured at the energy meter in kWh
$E_{Irradiation}$ = unshaded irradiation at module level in kWh
A_{Array} = total surface of all solar modules in m²
η_{STC} = module efficiency at STC

The module efficiency (contrary to the cell efficiency) considers the gross module surface and can be calculated as follows:

$$\eta_{STC} = \left[\frac{P_{Module}}{A_{Module} \times 1.000}\right]$$

8.3 Shading analyses

From vegetation and terrain no relevant shading objects could be identified during the site visit in January, 2014. The environmental study shall state whether trees have to be left on site.

8.4 Expected losses

8.4.1 System Operation Quality / Performance Ratio

A fundamental step in understanding this important quality criterion is the explanation of the typical loss factors affecting the energy yield with different weights. In every simulation step, all described aspects have an hourly impact on the overall result.

- Irradiation gain by inclination of modules

In non-equatorial zones, the degree of irradiation at module level can be improved by the inclination of modules southwards (northern hemisphere) or northwards (southern hemisphere) against the horizontal. When reaching a normal module inclination angle of 25-30 degrees, the irradiation gain can amount up to 13-15 % in temperate zones. It is expressed by the surface-factor F(A) ~ 1,13 – 1,15. The inclination angle causes an additional irradiation because the ground reflects the light to the modules. This reflection on different soil types is expressed by the Albedo Factor. There are empirical values for different soil surfaces. For example, the solar reflectance of grassland and cropland is about 20%. The effect on the energy yield is scarcely weighty but it is even so considered in the yield simulations. The product of irradiated amount of energy at module level and module efficiency (not cell efficiency, which is higher) is the basis for the initial value for the PR calculation and is defined to be 100%.

8.4.2 Description of types of technical losses:

- **Technical losses because of shading**

If there are objects in the immediate environment of the planned solar plant causing shading of the solar generator, these shadings can be considered and simulated previously within a shading analysis. A distinction is made between "horizon shading" and "nearby shading".

Horizon shading causes a shading effect which has a permanent impact on the entire genera-tor field. The simulation considers this effect by adjusting the horizon line. Objects that are in a large distance to the modules, e.g. mountain ranges, are typical horizon shadings. Such shadings always affect a larger module field, i.e. an array.

Nearby shading has a temporally and spatially impact only on several parts of the generator field. Other parts of the plant remain absolutely unaffected. Objects at close distance to the modules act as cast shadows, e.g. power poles, trees but also row shading in large rack-mounted solar fields.

Depending on the site conditions, these aspects are considered in the yield simulation.

- **Technical losses because of dirt**

Dirt on the modules also causes shading effects which can change over time and seasonally. This shading impact on the energy yield depends for example on the surrounding landscape, cultivation and precipitation. The impact can only be appraised and is based on experience values. Consequently, the uncertainty is high. Then again, the degree of this shading effect is quite low and amounts to 1-2% under normal conditions in Central Europe.

- **Technical losses because of part-load operation**

The intensity of irradiation in solar plants changes in the course of the year. The conversion into electricity does not happen linearly to the changing irradiation conditions.

- **Technical losses because of temperature fluctuation**

Ambient temperature and degree of irradiation have an influence on the cell temperature and so affect the energy conversion process. According to the defined STC value of 25° C, the

electrical power output decreases with higher cell temperature and increases with lower cell temperature. The module model shows this characteristic by means of temperature coefficients for current and voltage.

- **Technical losses because of reflection**

In particular, inclined irradiation causes reflection of sunlight at the glass and cell surface. Although this is a small effect, it is considered by an empirically determined factor: IAM (Incidence Angle Modifier) = 0,05.

- **Technical losses because of fluctuations in module performance**

Due to production reasons, the module performances are subject to slight fluctuations (see data sheet „module performance"). Because of the different manufacturing technologies the module wiring to module strings causes the so-called mismatch effect.

- **Technical losses because of weathering and degradation**

Changes in the energy yield because of weathering are not considered in the simulation. Performance guarantees of the manufacturer and different practical results diverge a lot. Former long-term study findings cannot be applied easily to modules produced with today's manufacturing processes and product features. But it is assumed that today's processes and technologies lead to a higher module quality. The consideration of a correction value for weathering / degradation is recommended for the overall result.

- **Technical losses because of cable losses**

The whole wiring of the solar park is subjected to cable losses due to the natural resistance of conductors - the so-called ohmic resistance. Due to small-scaled plant design and cable dimensioning for maximum performance, losses normally amount to 1-2%.

- **Technical losses because of DC/AC inversion**

The conversion of direct current into grid compatible alternating current entails inevitable losses. The manufacturer's data of the inverters relating to the European standard efficiency regard typical European operating conditions. The temporal distribution of the performance quantity is evaluated here.

- **Technical losses because of transformation (transformer losses)**

Transformer losses depend simultaneously on several parameters and so unfortunately cannot be simulated correctly. That's why, depending on transformer quality, the performance ratio and the yields include a blanket value.

Up to now the technical design is not decided yet. First brief analyses have been calculated for three typical designs. The above described losses come out of the yield calculations as a so called waterfall diagram, see below for the fixed mounted structure.

Starting with the Horizontal Global Irradiance the tilted installation increases the irradiance on tilted module plane – in the shown example - by 8%. Near shadings and glass reflections reduce that gain.

Once the irradiance reaches the active cell it is converted to electric power by the efficiency of the cell ("PV conversion").

The electrical system then causes more losses which depend on the characteristic behavior of the components cabling design and operation.

Between "Energy injected to grid" and "Array nominal energy (at STC effic.)" the PR is calculated.

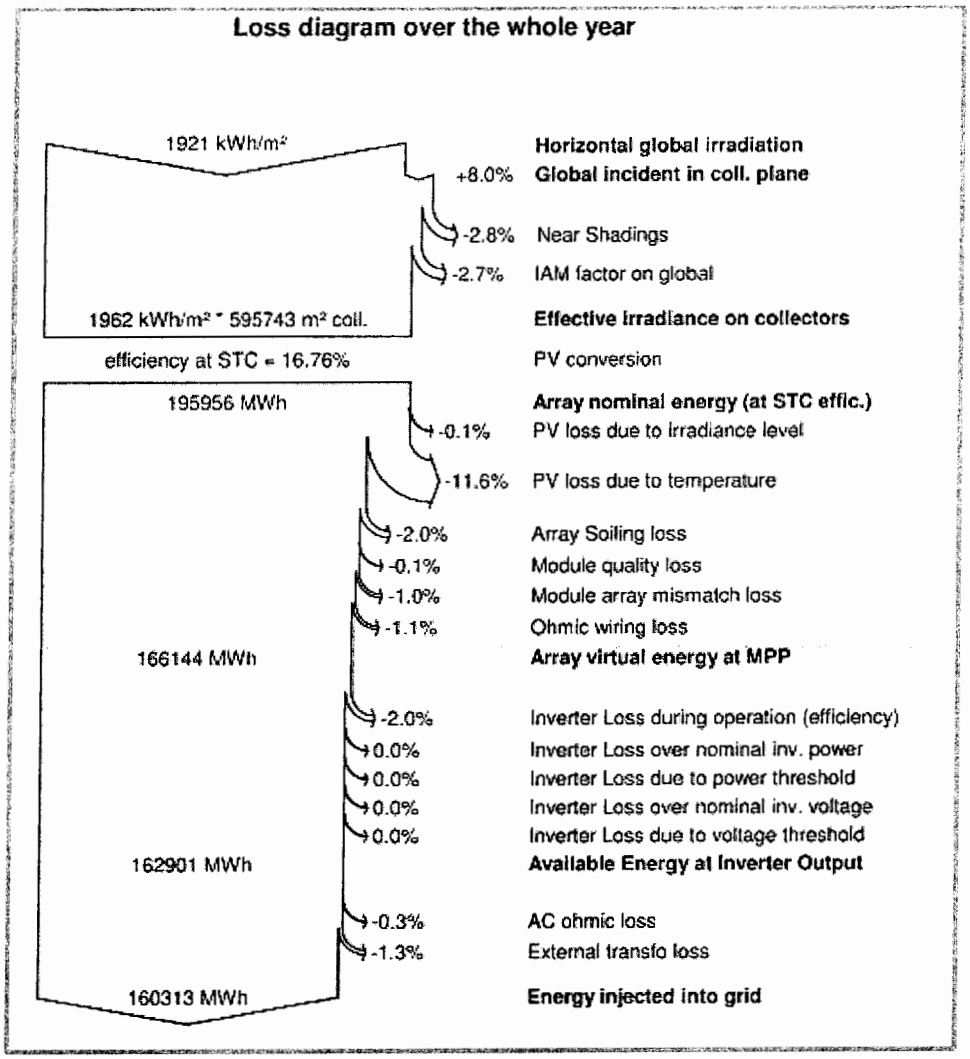


Figure 25 Waterfall diagram of losses

8.5 Energy yield simulation for most suitable technical design

Different pre-assessments have been calculated with the simulation software PV Syst. PV Syst takes as an input the meteorological data as well as a given system design and a component selection. Then it simulates a whole operational year in two-minutes-steps.

The options for technical design are fixed tilted, single axis tracker and dual axis tracker. The first high level yield assessments show following annual outputs to grid at P50 level. The results are calculated for the point of interconnection with the HV grid.

	Fixed mounted 20° to south	Single Axis N-S horizontal	Dual Axis on pylon
Irradiation in module plane kWh/(m²*a)	2.075	2.216	2.518
Performance Ratio (PR) %	77.3	79.4	76.1
Specific output kWh/kWp	1.603	1.758	1.915

Figure 26 Simulation results by technical design (details in Appendix 1, Chapter 10)

The overall yield can be calculated by multiplying the specific yield by the total park power in kWp.

All results include transformer losses and cable losses to the point of interconnection to the HV Power line.

8.6 Uncertainty of simulation

Assuming the system will be constructed as per our simulation with the components we assumed and the components been delivered as per datasheet there will be meteorological and operational uncertainty left.

The meteorological uncertainty we assume with 10% according to initial long term irradiance resource data (5%) and year to year irradiance variations as well as temperature losses.

The operational risks include soiling losses, downtime due to components errors and forced downtime due to grid failures or other external events. In our simulation we assumed 2% of soiling losses and no external events.

8.7 Risk mitigation

Risk mitigation for meteorological data is not possible in practice.

The internal operational risks of soiling losses and component defects can be mitigated very well through a staged quality assurance process for component selection and functionality tests.

The internal operations risk can be mitigated by a professional operation and maintenance service or its control.

The evaluation of external operational risk is not part of this feasibility study but assumed to be low.

9 Financial Analysis

9.1 Financial model – methodology

The financial model is designed to translate the technical model of the power plant into a financial investment case to allow for a decision to execute on the project and if so to start financing negotiations.

Most of the input parameters will be uncertain up and until the power plant is operational, hence the decision to build and to finance has been taken. To allow for decision under uncertainty a sensitivity analysis is carried out.

In the sensitivity analysis key driving factors will be established and the impact on the base case analysed.

9.1.1 Input parameters

Main input parameters for the financial model are,

- the estimated annual electricity yield given in MWh per year (based on site-specific solar irradiation),
- investment costs or capital expenditure (CAPEX),
- annual operation expenses (OPEX)
- economic assumptions in general and
- the financing parameters.

9.1.2 The model

The financial model is calculating the yearly cash flow of the power plant using the input parameters. Besides the annual cash flow defined decision criteria are calculated to enable an evaluation of the project.

During the scenario analysis one or more input parameters are changed within their expected possibilities to see the robustness and impact of such changes to allow for decision under uncertainty.

9.1.3 Output parameters

As a result, the financial model calculates

- the **Net Present Value (NPV)** of the project, a measure for the discounted cash flow. The NPV is a profit based criteria which takes into account the profit of all future years discounted to present with a set discount factor. The discount factor shall be in line with the risk of the project. A low risk project shall have a lower discount factor than a high risked project.
- the **Equity Internal Rate of Return (IRR)**, a measure for capital efficiency. The IRR will tell how much return the bound equity is returning. It is not a measure for the profitability.
- the **payback period**, a measure of risk for the bound equity. The faster the equity is returned the less capital risk a project has.
- the **levelized cost of electricity (LCOE)** of the investment is the discounted cost of the kWh of electricity is produced during the lifetime of the project. The LCOE does not need any assumption of the value of energy produced or the financing options. Therefore the LCOE will be used to select the best EPC bidder for the project and shall be in line with the financial criteria above.

- **Weighted Cost of Capital (WACC)** of the investment to calculate an appropriate discount rate for the whole project, not just the equity. The formula is the cost of debt weighted with the percentage of debt and the equity IRR weighted with the share of equity of the total costs.

9.2 Cost Summary of Technologies

The following table shows the basic installation cost including substation and grid connection for fixed mounted systems, single axis tracker and dual axis tracker for the same module type and installed PV power (MWp).

The cost comparison does not take the cost of land, development and financing into consideration. The stated costs refer to standard field installations of multi crystalline technology but not to the terrain specific costs. However, the terrain for the project close to Bahawalpur is considered to be a low cost terrain.

This table does not show the differences in total energy yield for the different systems. As mentioned Chapter 8.5 a dual axis tracking system can harness up to 20% more energy as compared to fixed installation.

CAPEX	Fix	Single-Axis	Dual-Axis
EPC Cost	USD/kWp	USD/kWp	USD/kWp
Solar Modules	650	650	650
Site Preparation	50	50	50
Structure	100	250	550
Inverter	130	130	130
DC Field	100	100	100
DC-AC	100	100	100
Planning	50	50	50
Others	50	50	50
EPC Profit	120	120	120
Total	**1.350**	**1.500**	**1.800**

Figure 27 EPC cost estimations

Annual Cost	Fix	1-Axis	2-Axis
Opex	USD/kW	USD/W	USD/W
Remote Monitoring	2,0	2,0	2,0
Operations & Maintenance	6,0	9,0	17,0
Replacement Reserve Account	5,0	6,0	7,0
Security	0,6	0,6	0,6
Insurance	10,1	11,3	13,5
Accountancy and administration	1,0	1,0	1,0
Profit & Reserve	5,6	5,6	5,6
Sum	**30,4**	**35,5**	**46,7**

Figure 28 O&M cost estimations

9.3 Base case assumptions

For the calculation of financial decision parameters the financial assumptions play an important role. Since large scale photovoltaic power plants are relatively new in general and especially in Pakistan, and there is no field experience with Pakistani banks regarding the financing. Therefore we suggest to take a conservative but realistic approach in respect to the financial assumptions.

All financial assumptions are based on publicly available data or, wherever not available, on assumptions drawn from analogies.

9.3.1 Plant Assumptions

Technology

The base case assumes crystalline module technology on a fixed mounted structure. At the end of the sensitivity analysis we expand on the financial differences of tracking systems.

System size

The system is comprised of about 350.000- 400.000 modules with an aggregate DC capacity of 100 MWp. The technical layout of the solar power plant is attached hereto in Appendix 1a.

Annual Energy yield

The annual specific energy yield of the base case system is expected to be 1.603 kWh/kWp. The detailed simulations performed are described in chapter 8.5 above. We expect a performance guarantee on 97% of that simulation. Therefore the financial case is based on 1.554,91 kWh/kWp.

Annual degradation of module efficiency

The assumed annual degradation of module efficiency amounts 0,30%, this value is in line with long-term industry experience and relevant scientific studies.

Start of operations

The start of operations is the date of grid connection commissioning. We made the assumption the start of operations is October 1st, 2014. For the financial case we assume feed into the grid and payments by December 1st, 2014.

System lifetime

Even though solar power plants are proven to work for a duration of 25-30 years, in the financial model an operation time of 25 years is assumed.

9.3.2 Revenue Assumptions

Feed in tariff

The feed in tariff reflects the value per kWh solar electricity injected to the grid. Based on current discussions and preliminary negotiations with the power off-taker a feed in tariff of 21,73 PKR/kWh for the first 10 years and 9,76 PKR/kWh thereafter is assumed.

Annual indexation and exchange rate

The financial analysis is based on USD.

For the analysis the exchange rate to one USD is set at 110 PKR.

The effective tariff in PKR will be escalated on a variety of price indices to compensate for inflation and exchange rate changes. We assume the indexation to exactly mitigate the currency risk of the tariff to the USD. Therefore this model is assuming a fixed exchange rate of 110 PKR / USD - and to mitigate the uncertainty of this assumption - does not assume any tariff increases.

9.3.3 Financial Assumptions

Income tax

No income tax rate is applied to the electricity sale.

Taxable depreciation

A linear depreciation over the operation period of 25 years is applied to CAPEX and financing costs.

Interest on liquid funds

An interest on liquid funds of 4,0% is assumed.

9.3.4 Cost Assumptions

Investment cost (CAPEX)

The investment cost or capital expenditure (CAPEX) include EPC remuneration, other investments into the infrastructure, project developments cost, consultants, interest during construction and a contingency of about 3,7%. The overall CAPEX is estimated with USD 150 million for the base case.

Annual cost (OPEX)

The annual cost or operating expenditure (OPEX) include remote monitoring, operations & maintenance, replacement cost, insurance, security and administration. The overall OPEX is estimated with USD 3,37 million for the first full year.

Annual inflation rate

The annual inflation rate for Pakistan is assumed to be 8-10 % over the operation period on average. As the tariff is indexed to inflation most of the OPEX inflation shall be covered automatically. For reasons of safety an additional 2,5% OPEX increase every year is assumed.

9.3.5 Project Finance Assumptions

Equity ratio

An equity ratio of 30 % of the total investment is assumed, this translates to an equity investment of USD 45 million. With a share of 30 % equity and 70 % debt, the financing structure of the project is very sound compared to international project financing standards for comparable projects. A ratio of 20 % equity and 80 % debt might be feasible for consecutive projects.

Total debt

A non-recourse project financing facility is assumed to cover 70 % of the total investment. This translates to a total debt amount of USD 105 million.

Nominal interest

A nominal interest rate of KIBOR + 3 % is assumed for the project financing debt facility as we have been advised. For international funding a rate of Libor + 5% shall be feasible for consecutive projects.

Debt Service Reserve Account

A debt service reserve account (DSRA) is a reserve account from which interest and debt service is being paid if the project is in default and cannot cover the due amounts from project cash flow. The idea is that banks and sponsors gain time to fix an issue with the project financing before the project enters into a full default. Six months is a standard period for the DSRA. For this account a 4.0 % interest has been assumed.

Period of loan

A debt tenor of 10 years from the start of operations of the solar power plant is assumed. It is assumed that debt will be repaid with an initial grace period of 6 months after starting operations. The final payment is expected to occur on June 30th, 2025.

Quarterly repayment

An annuity repayment structure is assumed with quarterly repayments.

Discount Rate

For the NPV calculation of the equity a discount rate of 10% is used. Solar PV is a low risk investment once the power plant is in production mode and the tariff for the electricity is secured. In European projects a NPV of some 6-10% is standard.

9.3.6 Summary of Assumptions

Project Data	Unit	Base Case
System size (kWp)	kWp	100.000
Energy yield (kWh)	kWh/kWp	1.555
Annual degradation of module efficiency	%	0,3%
Tarrif Assumtions	**Unit**	**Base Case**
Start of operations		01.12.2014
Lifetime of System	Years	25
Operation in 2014 in months		1
Feed in tariff (FIT) year 1 - 10	USD/kWh	0,20
Feed in tariff (FIT) year 11 - 25	USD/kWh	0,09
Annual Indexation of FIT	%	0,00

Financial Assumptions	Unit	Base Case
Income tax	%	0%
Depreciation period CAPEX	Years	25
Depreciation period financing cost	Years	25
Interest on liquid funds	%	4%
Investment cost	**Unit**	**Base Case**
EPC Cost	USD	135.000.000
Development and other CAPEX	USD	2.000.000
Technical Consultants / Quality Assurance	USD	1.000.000
Legal / Finance Consultants	USD	1.000.000
Interest during construction	USD	7.329.375
Contingencies	USD	3.670.625
Turn-key investment cost	**USD**	**150.000.000**

Annual cost	Unit	Base Case
Remote Monitoring	USD	200.000
Operations & Maintenance	USD	600.000
Replacement Reserve Account	USD	500.000
Security	USD	62.500
Insurance	USD	1.012.500
Accountancy and administration	USD	100.000
Others	USD	562.000
Total annual cost	**USD**	**3.037.000**
Annual Inflation beyond indexation	%	2,5%

Project Finance	Unit	Base Case
Total debt	USD	105.000.000
Nominal interest	%	13,5%
Tenor	Years	10
Grace period before repayment of principal	Months	6
Equity Ratio	%	30%
Minimum DSCR		1,38
Debt Service Ratio Account (DSRA)	Months	6
First quarterly payment due	Date	30.06.2015
Date of final payment	Date	30.06.2025

9.4 Base Case results

In the base case with fixed mounted crystalline modules the power plant generates 3.750 Gigawatt hours over 25 years.

Output	Unit	
Lifetime Production	GWh	3.751
Equity needed	USDk	45.000
Debt needed	USDk	105.000
Tarrif	PKR / kWh	17,30
DSCR min		1,38

Figure 29 Financial Results Base Case - 1

The base case shows an IRR of 17% for the equity with a payback time of 5 years. The with 10% discounted cash flows amount to a Net Present Value of USD 28 million.

Output	Unit	Comment
IRR	%	17,0%
NPV at 10%	USDk	20.994
Payback Equity	Years	5
LCOE at 8%	USD/kWh	0,12
WACC	%	14,5%

Figure 30 Financial Results Base Case - 2

The table below shows the details of the of the cash flow calculation of the base case in USD.

QA Solar	Fix / CR													
Cash flow projection	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Income	**2.243.727**	**30.855.118**	**30.762.553**	**30.670.265**	**30.578.254**	**30.486.520**	**30.395.060**	**30.303.875**	**30.212.963**	**30.122.324**	**30.031.957**	**10.785.657**	**10.753.300**	**10.721.040**
Operational Expenses														
Remote Monitoring	-16.667	-205.000	-210.125	-215.378	-220.763	-226.282	-231.939	-237.737	-243.681	-249.773	-256.017	-262.417	-268.978	-275.702
Operations & Maintenance	-50.000	-615.000	-630.375	-646.134	-662.288	-678.845	-695.816	-713.211	-731.042	-749.318	-768.051	-787.252	-806.933	-827.107
Replacement Reserve Account	-41.667	-512.500	-525.313	-538.445	-551.906	-565.704	-579.847	-594.343	-609.201	-624.431	-640.042	-656.043	-672.444	-689.256
Security	-822	-62.500	-62.500	-62.500	-62.500	-62.500	-62.500	-62.500	-62.500	-62.500	-62.500	-62.500	-62.500	-62.500
Insurance	-84.375	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500	-1.012.500
Accountancy and administration	-8.333	-102.500	-105.063	-107.689	-110.381	-113.141	-115.969	-118.869	-121.840	-124.886	-128.008	-131.209	-134.489	-137.851
Other Costs (incl. Initial financing cost):	-46.833	-576.050	-590.451	-605.213	-620.343	-635.851	-651.748	-668.041	-684.742	-701.861	-719.408	-737.393	-755.828	-774.723
Total operational costs	**-248.697**	**-3.086.050**	**-3.136.326**	**-3.187.859**	**-3.240.681**	**-3.294.823**	**-3.350.318**	**-3.407.201**	**-3.465.506**	**-3.525.269**	**-3.586.526**	**-3.649.314**	**-3.713.672**	**-3.779.639**
Interest expenses	0	-14.398.513	-13.797.697	-12.925.724	-11.929.939	-10.792.764	-9.494.121	-8.011.085	-6.317.474	-4.383.388	-2.174.681	0	0	0
Repayment principal	0	4.429.106	-6.141.115	-7.013.089	-8.008.874	-9.146.049	-10.444.691	-11.927.727	-13.621.339	-15.555.425	-17.764.131	-9.806.665	0	0
Interest on Current Account	39.901	251.633	423.666	424.073	424.490	424.918	425.357	425.806	426.267	426.739	325.902	127.010	29.452	29.973
Payments into/out of operating account	-49.739	-567.471	-10.055	-10.307	-10.564	-10.828	-11.099	-11.377	-11.661	-11.953	-12.251	-12.558	-12.872	-13.193
Payments into/out of DSRA account	-1.945.291	-8.024.115	0	0	0	0	0	0	0	0	5.066.074	4.903.333	0	0
CF before tax and distribution	39.901	9.459.709	8.101.024	7.957.359	7.812.687	7.666.974	7.520.187	7.372.290	7.223.250	7.073.029	11.886.343	2.347.463	7.056.208	6.958.181
Income tax		0	0	0	0	0	0	0	0	0	0	0	0	0
Net Cash flow	39.901	9.459.709	8.101.024	7.957.359	7.812.687	7.666.974	7.520.187	7.372.290	7.223.250	7.073.029	11.886.343	2.347.463	7.056.208	6.958.181
Status operating account	49.739	617.210	627.265	637.572	648.136	658.965	670.064	681.440	693.101	705.054	717.305	729.863	742.734	755.928
Status DSRA account	1.945.291	9.969.406	9.969.406	9.969.406	9.969.406	9.969.406	9.969.406	9.969.406	9.969.406	9.969.406	4.903.333	0	0	0

QA Solar	Fix / CR													
P&L projection	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Income	2.243.727	30.855.118	30.762.553	30.670.265	30.578.254	30.486.520	30.395.060	30.303.875	30.212.963	30.122.324	30.031.957	10.785.657	10.753.300	10.721.040
Operational Expenses	-248.697	-3.086.050	-3.136.326	-3.187.859	-3.240.681	-3.294.823	-3.350.318	-3.407.201	-3.465.506	-3.525.269	-3.586.526	-3.649.314	-3.713.672	-3.779.639
EBITDA	1.995.030	27.769.068	27.626.227	27.482.406	27.337.573	27.191.697	27.044.742	26.896.673	26.747.457	26.597.055	26.445.432	7.136.343	7.039.628	6.941.401
Interest expense	0	-14.398.513	-13.797.697	-12.925.724	-11.929.939	-10.792.764	-9.494.121	-8.011.085	-6.317.474	-4.383.388	-2.174.681	0	0	0
Interest income	0	251.633	423.666	424.073	424.490	424.918	425.357	425.806	426.267	426.739	325.902	127.010	29.452	29.973
Depreciation	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000	-6.000.000
Earnings before Tax	**-4.004.970**	**7.622.188**	**8.252.195**	**8.980.755**	**9.832.125**	**10.823.851**	**11.975.977**	**13.311.394**	**14.856.250**	**16.640.407**	**18.596.652**	**1.263.353**	**1.069.080**	**971.375**
Income tax loss previous year	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Income tax loss carried forward	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nominal income tax	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Income tax payable (t.b.paid next Period)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Profit after Tax	-4.004.970	7.622.188	8.252.195	8.980.755	9.832.125	10.823.851	11.975.977	13.311.394	14.856.250	16.640.407	18.596.652	1.263.353	1.069.080	971.375

Figure 31 Financial Results Base Case - Details

9.5 Sensitivity Analysis

9.5.1 Sensitivity input parameters

For some key parameters their impact on the output has been analysed. The table below shows the best and worst case single occurrences of the altered parameters.

Project Data	Unit	Base Case	Worst Case	Best Case	Comment
System size (kWp)	kWp	100.000			
Energy yield (kWh)	kWh/kWp	1.555	1.446	1.664	+/-7%
Annual degradation of module efficiency	%	0,3%	0,5%	0,1%	

Tariff Assumtions	Unit	Base Case	Worst Case	Best Case	Comment
Start of operations		01.12.2014			
Lifetime of System	Years	25			
Operation in 2014 in months		1			
Feed in tariff (FIT) year 1 - 10	USD/kWh	0,16	0,16	0,14	21,73 PKR @ 110 PKR/USD
Feed in tariff (FIT) year 11 - 25	USD/kWh	0,09	0,00	0,00	9,76 PKR @ 110 PKR/USD
Remunerated kWh	%	1,00			all energy valuated
Total feed in tariff	USD/kWh	0			
Annual Indexation of FIT	%	0,00	0,00	0,00	Blended Value

Financial Assumptions	Unit	Base Case	Worst Case	Best Case	Comment
Income tax	%	0%			
Depreciation period CAPEX	Years	25			
Depreciation period financing cost	Years	25			
Interest on liquid funds	%	4%			

Investment cost	Unit	Base Case	Worst Case	Best Case	Comment
EPC Cost	USD	135.000.000	148.500.000	121.500.000	+15/-10%
Development and other CAPEX	USD	2.000.000			QA other Capex
Technical Consultants / Quality Assurance	USD	1.000.000			8.2, ECSP...
Legal / Finance Consultants	USD	1.000.000			
Interest during construction	USD	7.329.375			WC at Debt rate
Contingencies	USD	3.670.625			
Turn-key investment cost	**USD**	**150.000.000**			

Annual cost	Unit	Base Case			Comment
Remote Monitoring	USD	200.000			
Operations & Maintenance	USD	600.000			
Replacement Reserve Account	USD	500.000			
Security	USD	62.500			15 people
Insurance	USD	1.012.500			0,75% of EPC Capex
Accountancy and administration	USD	100.000			
Others	USD	562.000			
Total annual cost	**USD**	**3.037.000**	**3.340.700**	**2.429.600**	
Annual Inflation beyond indexation	%	2,5%	5,0%	0,0%	

Project Finance	Unit	Base Case			Comment
Total debt	USD	105.000.000			
Nominal interest	%	13,5%	15%	13%	Kibor + 3%
Tenor	Years	10			
Grace period before repayment of principal	Months	6			
Equity Ratio	%	30%	40%	30%	
Minimum DSCR		1,38			
Debt Service Ratio Account (DSRA)	Months	6			
First quarterly payment due	Date	30.06.2015			
Date of final payment	Date	30.06.2025			

10.5.2 Sensitivity results – single parameters

Some variations on single uncertain input parameters have been varied to understand the main drivers of the financial case.

The assumption on the Feed in Tariff (FIT) is the single most important external factor influencing the debt service coverage ability and the overall profitability of the investment. In this case however, the Tariff follows the cost budget of the project. Therefore a sensitivity analysis on the Tariff is not required.

Also the annual indexation on the tariff is crucial for the financial soundness of the investment. Due to the indexation of various cost items during the lifetime of the power plant the uncertainties on inflation are hedged, therefore not relevant.

The assumptions on production will have the highest impact on the financial case because the estimated production will determine the Tariff.

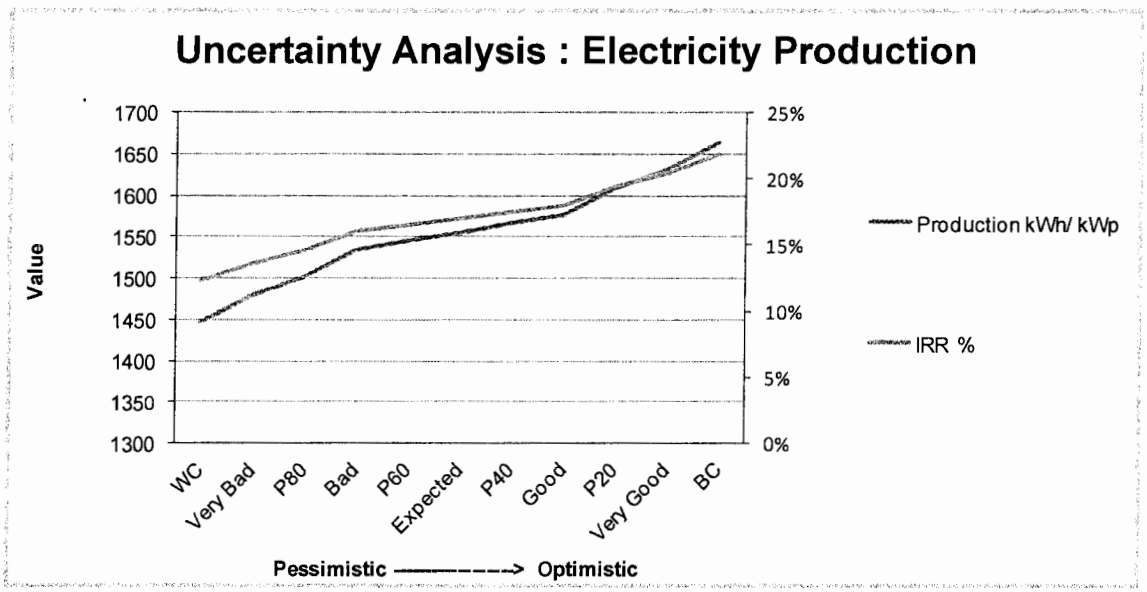


Figure 32 Uncertainty Analysis - Electricity Production

The assumptions on CAPEX will have a high impact on the financial case if changes in CAPEX before or during the construction phase will not be reflected in the Tariff or the EPC contract.

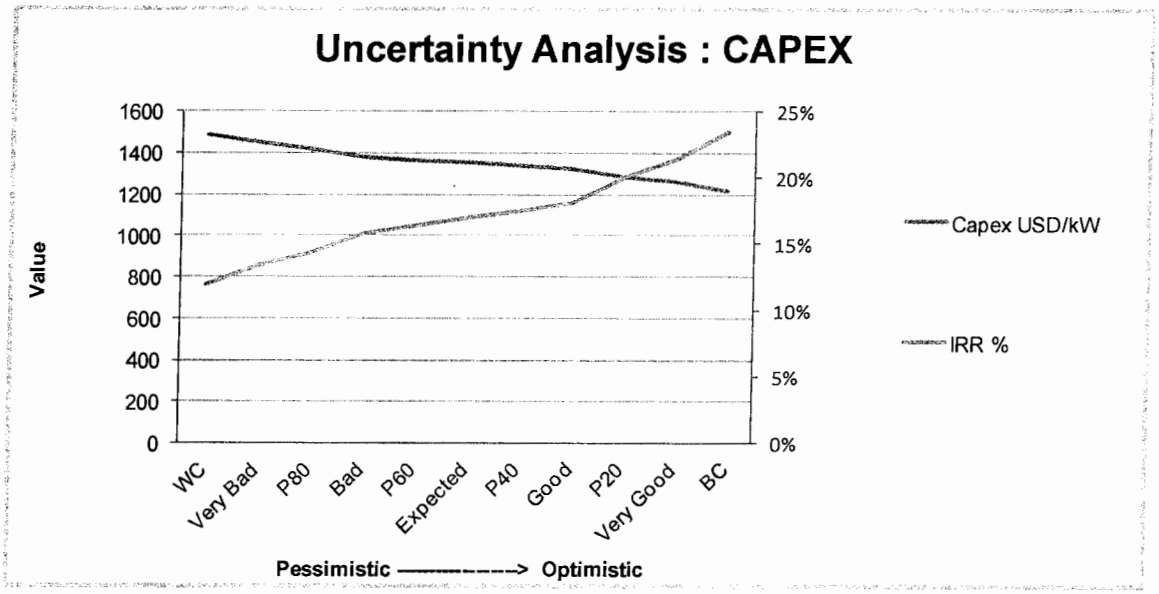


Figure 33 Uncertainty Analysis - CAPEX

The assumptions on Interest of debt do have the least influence. But they cannot be hedged and will stay as an uncertainty.

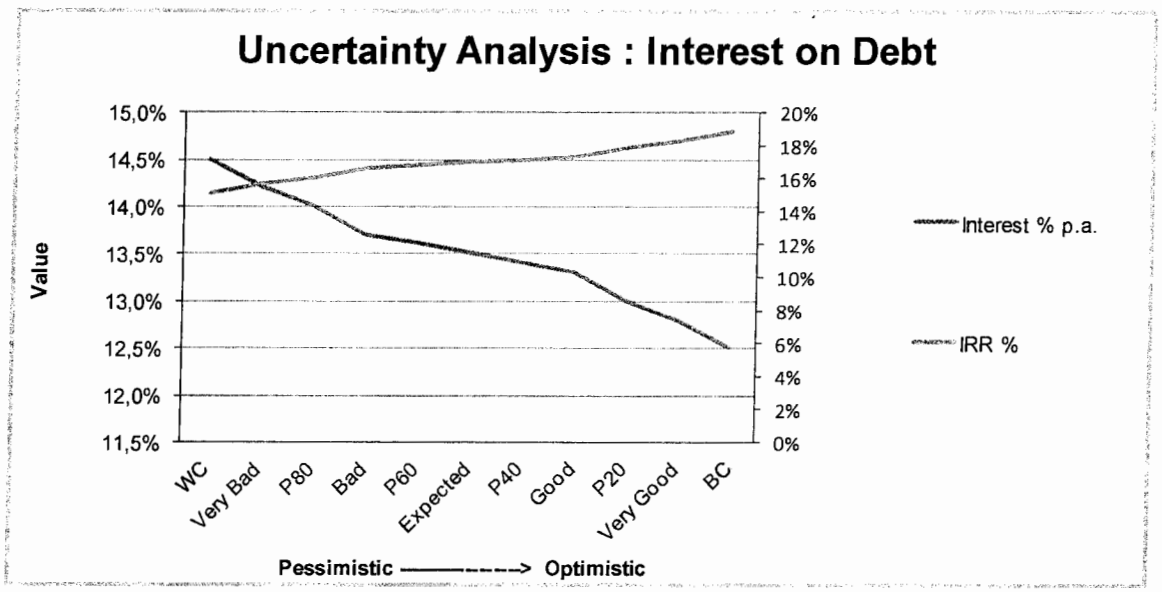


Figure 34 Uncertainty Analysis - Interest on Debt

The following table is an overview of alternatively changing single input parameters to worst assumption and also to best assumption and the result on energy output, capital structure of the project as well as financial parameters. It can be seen very clearly that the assumptions on Production and CAPEX are the main drivers of any sensitivity. Using IRR (interest on equity) or the metrics of NPV (discounted cash flow) does come to the same conclusion.

Input		Fix / CR	Single Deviations from Assumptions													
Production	kWh/ kWp	**1.555**	1.446	1.555	1.555	1.555	1.555	1.555	1.555	1.664	1.555	1.555	1.555	1.555	1.555	1.555
Opex	USD/kW	**30**	30	33	30	30	30	30	30	30	24	30	30	30	30	30
Opex Index	% p.a.	**2,5%**	2,5%	2,5%	5,0%	2,5%	2,5%	2,5%	2,5%	2,5%	2,5%	0,0%	2,5%	2,5%	2,5%	2,5%
Operations 2014	Months	**1**	1	1	1	0	1	1	1	1	1	1	3	1	1	1
Interest	% p.a.	**13,5%**	13,5%	13,5%	13,5%	13,5%	14,5%	13,5%	13,5%	13,5%	13,5%	13,5%	13,5%	12,5%	13,5%	13,5%
Tenor	Years	**10**	10	10	10	10	10	10	10	10	10	10	10	10	12	10
Equity	%	**30%**	30%	30%	30%	30%	30%	30%	40%	30%	30%	30%	30%	30%	30%	30%

Output	Basecase		Financial Numbers													
Lifetime Productic	GWh	**3.751**	3.488	3.751	3.751	3.739	3.751	3.751	3.751	4.013	3.751	3.751	3.773	3.751	3.751	3.751
Equity needed	USDk	**45.000**	45.000	45.000	45.000	45.241	45.163	45.000		45.000	45.000	45.000	44.517	44.837	45.000	45.000
Debt needed	USDk	**105.000**	105.000	105.000	105.000	105.563	105.380	105.000	90.000	105.000	105.000	105.000	103.874	104.620	105.000	105.000
Tarrif	PKR / kWh	**1730%**	1730%	1730%	1730%	1730%	1730%	1730%	1785%	1730%	1730%	1730%	1730%	1730%	1588%	1730%
DSCR min		**1,38**	1,27	1,38	1,35	1,37	1,32	1,38	1,60	1,48	1,38	1,40	1,39	1,44	1,39	1,38
Output			**Financial Indicators**													
IRR	%	**17,0%**		17,0%	15,6%	15,9%	15,1%	17,0%	17,1%	21,9%	17,0%	17,8%	19,5%	18,9%	16,7%	17,0%
NPV at 10%	USDk	**20.994**		20.994	15.344	18.399	15.849	20.994	29.074	35.041	20.994	25.077	26.238	26.005	20.316	20.994
Payback Equity	Years	**5**	7	5	5	5	6	5	5	4	5	5	4	4	5	5
LCOE at 8%	USD/kWh	**0,12**	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,11	0,12	0,11	0,11	0,12	0,12	0,12
WACC	%	**14,5%**		14,5%	14,1%	14,2%	14,7%	14,5%	14,9%	16,0%	14,5%	14,8%	15,3%	14,4%	14,5%	14,5%

Figure 35 Uncertainty Analysis - single Variations

9.5.3 Sensitivity Scenarios

Alterations of single input parameters are not very likely outcomes of expected reality. Therefore, a couple of scenarios have been developed, from very pessimistic to very optimistic.

The following main iterations from the expected base assumptions have been taken:

- Irradiation: +/- 7 %,
- CAPEX: +10 /-10 %
- Equity / Debt ratio: 30/70 and 40/60
- Tenor: 10 and 12 years

There are no iterations on the tariff performed as the price for the generated kWh is a function of the cost, thus Tariff is not a risk factor. The following Tariffs have been calculated for variations in Equity / Debt ratio and Tenor:

Tenor	Equity/Debt	Tarrif in PKR		
Years		Year 1-10(12)	Year 11 (13)-25	Blended
10	40 / 60	21,73	9,76	17,85
12	40 / 60	20,76	9,76	16,63
10	30 / 70	21,82	7,86	17,30
12	30 / 70	20,70	7,86	15,88

Figure 36 Financing Scenarios

The base case is assumed to be the most likely case. In reality we would expect the probability of a better or worse result with 50 %. Therefore, the base case is also named as P50 case. Corresponding, in the P80 case it is expected to be safe with a probability of 80 % that the reality will turn out better. A P20 case is an optimistic case with only 20 % probability that the reality will turn out better.

Basecase		Scenarios								
Input	Unit	Very Bad	P80	Bad	P60	Expected	P40	Good	P20	Very Good
Production	kWh/ kWp	1.479	1.500	1.533	1.544	**1.555**	1.566	1.577	1.609	1.631
Degradation	% p.a.	0,44%	0,40%	0,34%	0,32%	**0,30%**	0,28%	0,26%	0,20%	0,16%
Capex	USD/kW	1.445	1.418	1.377	1.364	**1.350**	1.337	1.323	1.283	1.256
Opex	USD/kW	32,5	31,9	31,0	30,7	**30,4**	29,8	29,2	27,3	26,1
Opex Index	% p.a.	4,3%	3,8%	3,0%	2,8%	**2,5%**	2,3%	2,0%	1,3%	0,8%
Operations 2014	Months	0,3	0,5	0,8	0,9	**1**	1,2	1,4	2	2,4
Interest	% p.a.	14,2%	14,0%	13,7%	13,6%	**13,5%**	13,4%	13,3%	13,0%	12,8%
Tenor	Years	10	10	10	10	**10**	12	12	12	12
Equity	%	40%	40%	40%	40%	**30%**	30%	30%	30%	30%

Figure 37 Uncertainty Scenarios

10.5.4 Results - sensitivity scenarios

Also in the two most pessimistic cases, the project is regarded as favorable in terms of IRR and NPV. Therefore, the project qualifies as a very safe investment.

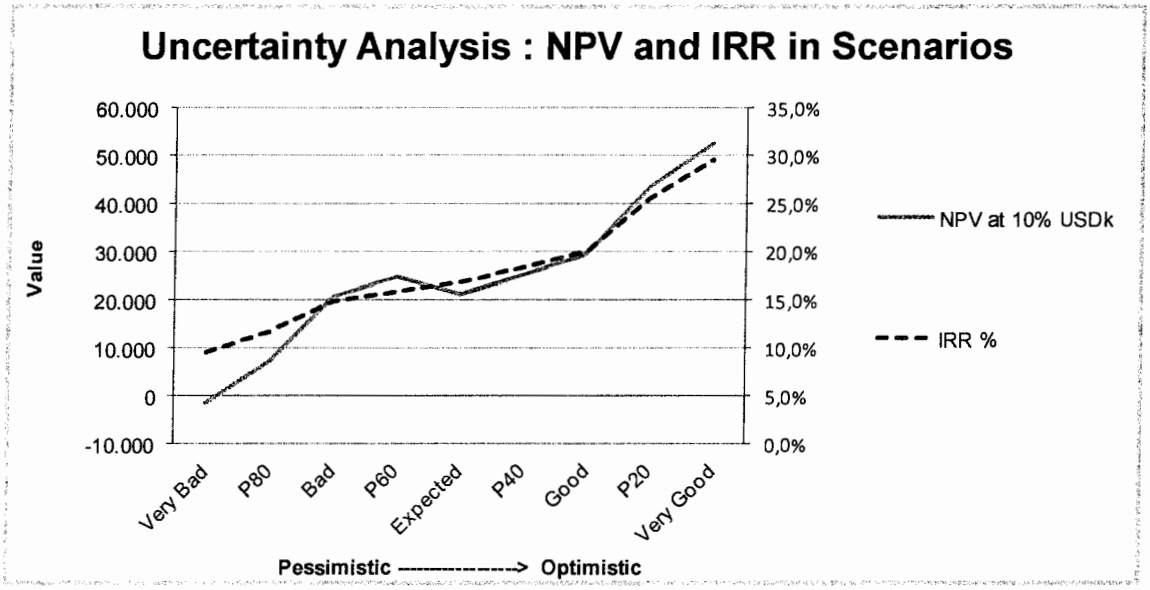


Figure 38 Uncertainty Analysis - Scenarios - NPV & IRR

The tables below show the output for all financial criteria. Even in a very bad scenario the project will yield a positive IRR.

Output	Unit	Very Bad	P80	Bad	P60	Expected	P40	Good	P20	Very Good
IRR	%			14,8%	15,9%	**17,0%**	18,4%	20,1%	25,5%	
NPV at 10%	USDk			20.433	24.765	**20.994**	24.991	29.640	43.450	
Payback Equity	Years			6	5	**5**	5	4		
LCOE at 8%	USD/kWh			0,12	0,12	**0,12**	0,11	0,11	0,10	
WACC	%			14,2%	14,5%	**14,5%**	14,9%	15,3%	16,8%	

Figure 39 Uncertainty Analysis - Scenarios - Results 1

In the pessimistic scenarios the equity ratio was assumed to be 40%. For that reason the debt is lower than in the optimistic scenarios.

All cases show a DSCR above 1.3 which is normally for Solar projects sufficient.

Output	Unit	Very Bad	P80	Bad	P60	Expected	P40	Good	P20	Very Good
Lifetime Production	GWh			3.677	3.714	**3.751**	3.789	3.827		
Equity needed	USDk					**45.000**	44.511	44.024		
Debt needed	USDk	96.579	94.688						99.338	97.103
Tarrif	PKR / kWh					**17,30**				
DSCR min			1,40	1,52	1,56		1,43	1,47	1,60	

Figure 40 Uncertainty Analysis - Scenarios - Results 2

10.6 Variation in installation types

In result of comparing different possibilities of mounting the solar modules, the fixed mounted base case is more robust against the bad case scenarios in comparison to the tracking solutions. This is because of the lower CAPEX requirement relative to the output values. Only the very optimistic cases see a significant upside for the tracking option.

Input		Fix / CR	1-Axis CR	2-Axis CR
Production	**kWh/ kWp**	**1.555**	**1.705**	**1.858**
Degradation	% p.a.	0,30%	0,30%	0,30%
Capex	**USD/kW**	**1.350**	**1.500**	**1.800**
Opex	**USD/kW**	**30,4**	**35,5**	**46,7**
Opex Index	% p.a.	2,5%	2,5%	2,5%
Operations 2014	Months	1	1	1
Interest	% p.a.	13,5%	13,5%	13,5%
Tenor	Years	10	10	10
Equity	%	30%	30%	30%

Figure 41 Installation Variations - Input Parameter

Results of installation type variations – base case assumptions

The results for the fixed installation and the single axis tracking option are considerably close. The dual axis tracking option seems to be too expensive for the additional output.

Output - Basic	Basecase	Fix / CR	1-Axis CR	2-Axis CR
Lifetime Production	GWh	[illegible]	4.113	[illegible]
Equity needed	USDk	[illegible]	49.728	[illegible]
Debt needed	USDk	[illegible]	116.032	[illegible]

Figure 42 Installation Variations – Results 1

The financial indicators are mostly indifferent between base case and single axis tracking case.

Output - Indicators		Fix / CR	1-Axis CR	2-Axis CR
IRR	%	[illegible]	15,9%	[illegible]
NPV at 10%	USDk	[illegible]	19.486	[illegible]
Payback Equity	Years	[illegible]	5,0	[illegible]
LCOE at 8%	USD/kWh	[illegible]	0,118	[illegible]

Figure 43 Installation Variations – Results 2

Results of installation type variations – sensitivity scenarios

To compare the base case and the single axis tracking case, we have analysed their relative performance under the different environmental scenarios.

The table below shows the difference in Input parameters due to technology. The values of the single axis case have been subtracted by the base case. The negative numbers correspond to higher energy output and higher CAPEX and OPEX numbers for the single axis tracker.

Basecase vs 1-Axis			Scenarios								
Input	Unit	WC	Very Bad	P80	Bad	P60	Expected	P40	Good	P20	Very Good
Production	kWh/ kWp	-140	-143	-145	-148	-149	-150	-151	-152	-156	-158
Degradation	% p.a.	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Capex	USD/kW	-165	-161	-158	-153	-152	-150	-149	-147	-143	-140
Opex	USD/kW	-5,6	-5,5	-5,4	-5,2	-5,2	-5,1	-5,0	-4,9	-4,6	-4,4

Figure 44 Installation Variations – Fix vs Single Axis 1

The colored cells are from the perspective of the base case. Green favours the base case, red the single axis case. The more optimistic the scenarios get, the better the single axis case will be.

Output	Unit	WC	Very Bad	P80	Bad	P60	Expected	P40	Good	P20	Very Good
Lifetime Production	GWh	-328	-338	-345	-356	-359	-363	-366	-370	-381	
Equity needed	USDk	-6.999	-6.788	-6.649	-6.441	-6.372	-6.728	-6.674	-6.620		
Debt needed	USDk	-10.498	-10.183	-9.974	-9.662	-9.559		-10.906	-10.780	-10.407	-10.161

Figure 45 Installation Variations – Fix vs Single Axis 2

The indicators IRR and NPV do come to different preferences only in the optimistic scenarios. Here, the base case is always more efficient with regards to the use of equity, however the single axis case generates more profit. The reason is simply the higher value of energy output in the optimistic cases with more energy produced from a single axis tracking system.

Output	Unit	WC	Very Bad	P80	Bad	P60	Expected	P40	Good	P20	Very Good
IRR	%	1,0%	0,8%				1,1%	1,1%	1,1%	1,1%	
NPV at 10%	USDk	5.823	4.240	3.210	1.697	1.202	1.508	1.068	546	995	
Payback Equity	Years										

Figure 46 Installation Variations – Fix vs Single Axis 3

10.6.1 Recommendations

The Quaid-e-Azam Solar Park will be very beneficial to the people of Pakistan receiving more power from the ultimately best source of power generation possibilities.

In addition the project would in mostly all cases be a very good financial investment. Even in the bad case scenarios there will be an IRR of nearly 10%.

Concerning the mounting possibilities we favour the fixed installation as it has least capital and operational risks. The tracking devices require more maintenance due to their moving parts. We recommend to concentrate on fixed mounted structures for the first project and advise the bidders accordingly.

11 Appendices

Appendix 1: Main results of Yield Simulation, **(1a) Fix Mounted**, unlimited sheds

PVSYST V5.71	8.2 Obst&Ziehmann	17/12/13	Page 3/4

Brandstwiete 4 - 20457-Hamburg - Germany

Grid-Connected System: Main results

Project : **Bahawalpur**

Simulation variant : **cSi_20Grd_fix-multi_100MW-Trafo**

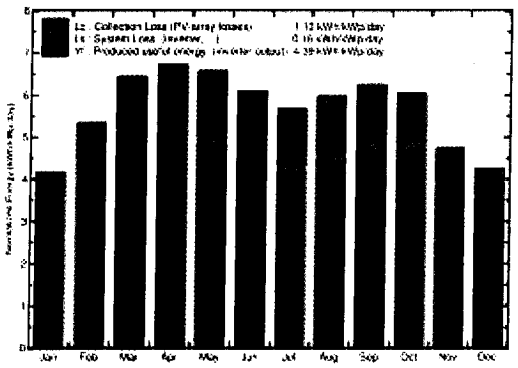
Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	Sheds disposition, tilt	20°	azimuth	0°
PV modules	Model	CS6P - 270M	Pnom	270 Wp
PV Array	Nb. of modules	370368	Pnom total	**99999 kWp**
Inverter	Model	Protect PV.500	Pnom	510 kW ac
Inverter pack	Nb. of units	164.0	Pnom total	**83640 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results

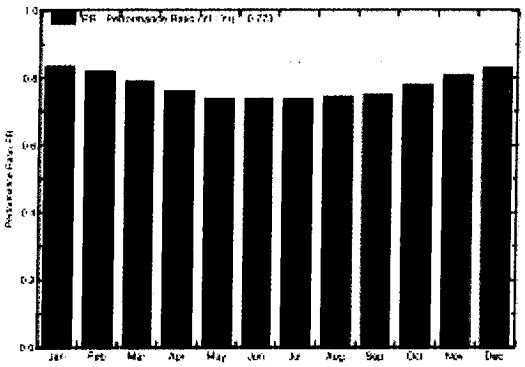
System Production — **Produced Energy** **160313 MWh/year** Specific prod. 1603 kWh/kWp/year

Performance Ratio PR 77.3 %

Normalized productions (per installed kWp): Nominal power 99999 kWp



Performance Ratio PR



cSi_20Grd_fix-multi_100MW-Trafo

Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	102.3	13.46	129.2	121.6	11170	10763	14.51	13.98
February	124.0	17.78	149.0	141.5	12649	12196	14.25	13.74
March	179.7	23.24	199.2	189.9	16272	15689	13.71	13.22
April	196.5	30.23	201.7	191.7	15883	15322	13.22	12.75
May	208.5	36.46	203.7	193.3	15528	14995	12.80	12.36
June	190.3	38.43	182.9	171.7	13995	13515	12.64	12.40
July	181.1	38.98	175.7	164.6	13394	12941	12.80	12.36
August	184.8	36.76	185.1	175.1	14287	13789	12.95	12.50
September	175.3	32.92	187.2	177.7	14565	14056	13.06	12.60
October	160.2	27.80	167.4	178.5	15155	14618	13.58	13.10
November	115.1	22.16	142.0	134.0	11902	11485	14.07	13.58
December	103.0	15.50	131.9	123.7	11343	10943	14.43	13.93
Year	1920.8	27.94	2075.0	1962.2	166144	160313	13.44	12.97

Legends: GlobHor Horizontal global irradiation — EArray Effective energy at the output of the array

T Amb Ambient Temperature — E_Grid Energy injected into grid

GlobInc Global incident in coll. plane — EffArrR Effic. Eout array / rough area

GlobEff Effective Global, corr. for IAM and shadings — EffSysR Effic. Eout system / rough area

Main results of Yield Simulation, **(1b) Single Axis Tracker** (horizontal axis north-south)

PVSYST V5.71	8.2 Obst&Ziehmann	17/12/13	Page 4/5

Brandstwiete 4 - 20457-Hamburg - Germany

Grid-Connected System: Main results

Project : **Bahawalpur**

Simulation variant : **cSi_SingleAxxis_8m_BT_100MW-Trafo**

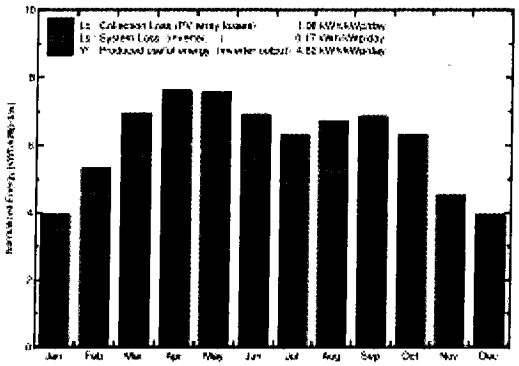
Main system parameters	System type	**Grid-Connected**		
Near Shadings	Linear shadings			
PV Field Orientation	tracking, tilted axis, Axis Tilt	0°	Axis Azimuth	0°
PV modules	Model	CS6P - 270M	Pnom	270 Wp
PV Array	Nb. of modules	370368	Pnom total	**99999 kWp**
Inverter	Model	Protect PV.500	Pnom	510 kW ac
Inverter pack	Nb. of units	164.0	Pnom total	**83640 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results

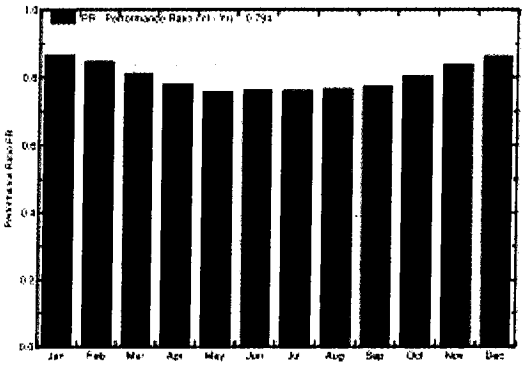
System Production — **Produced Energy** **175836 MWh/year** Specific prod. 1758 kWh/kWp/year

Performance Ratio PR 79.4 %

Normalized productions (per installed kWp): Nominal power 99999 kWp



Performance Ratio PR



cSi_SingleAxxis_8m_BT_100MW-Trafo

Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	102.3	13.46	122.2	117.9	10957	10569	15.05	14.51
February	124.0	17.78	148.6	144.2	13013	12557	14.70	14.18
March	179.7	23.24	215.0	209.9	18055	17413	14.09	13.59
April	196.5	30.23	228.3	223.3	18445	17792	13.56	13.08
May	208.5	36.46	234.1	228.6	18323	17686	13.14	12.68
June	190.3	39.43	208.6	201.2	16263	15703	13.21	12.76
July	181.1	38.98	194.7	189.3	15286	14778	13.19	12.74
August	184.6	36.76	207.9	203.0	16473	15898	13.30	12.84
September	175.3	32.92	205.1	200.2	16428	15856	13.45	12.98
October	160.2	27.80	195.5	190.4	16270	15704	13.97	13.49
November	115.1	22.16	135.9	131.3	11776	11374	14.54	14.05
December	103.0	15.50	122.0	117.4	10880	10505	14.97	14.46
Year	1920.8	27.94	2215.9	2156.7	182180	175836	13.80	13.32

Legends: GlobHor Horizontal global irradiation — EArray Effective energy at the output of the array

T Amb Ambient Temperature — E_Grid Energy injected into grid

GlobInc Global incident in coll. plane — EffArrR Effic. Eout array / rough area

GlobEff Effective Global, corr. for IAM and shadings — EffSysR Effic. Eout system / rough area

Main results of Yield Simulation, **(1c) Dual Axis Tracker**

Hint: Result for 1 MW PV plant. For 100 MW please multiply *Produced Energy* by 100

PVSYST V5.71	8.2 Obst&Ziehmann	17/12/13	Page 3/4

Brandstwiete 4 - 20457-Hamburg - Germany

Grid-Connected System: Main results

Project : **Bahawalpur**

Simulation variant : **cSi_2Axis_15-17_noBT_1MW_Trafo**

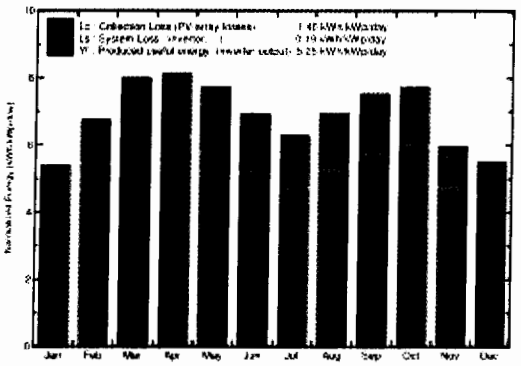
Main system parameters	System type	**Grid-Connected**		
Near Shadings	Linear shadings			
PV Field Orientation	Tracking two axis			
PV modules	Model	CS6P - 270M	Pnom	270 Wp
PV Array	Nb. of modules	3696	Pnom total	**998 kWp**
Inverter	Model	Protect PV.500	Pnom	510 kW ac
Inverter pack	Nb. of units	2.0	Pnom total	**1020 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results

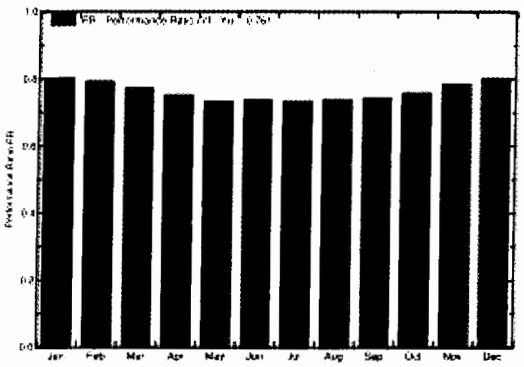
System Production — **Produced Energy** **1911 MWh/year** Specific prod. 1915 kWh/kWp/year

Performance Ratio PR 76.1 %

Normalized productions (per installed kWp): Nominal power 998 kWp



Performance Ratio PR



cSi_2Axis_15-17_noBT_1MW_Trafo

Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	102.3	13.46	166.9	153.2	139.6	133.5	13.97	13.46
February	124.0	17.78	188.6	175.7	155.1	149.4	13.81	13.31
March	179.7	23.24	247.6	233.6	198.1	191.0	13.46	12.97
April	196.5	30.23	243.8	230.8	189.8	183.1	13.10	12.63
May	208.5	36.46	239.4	226.5	181.3	175.1	12.74	12.30
June	190.3	39.43	207.4	195.4	157.6	152.5	12.80	12.37
July	181.1	38.98	194.6	183.1	147.6	142.8	12.78	12.34
August	184.6	36.76	215.3	203.5	164.6	156.9	12.87	12.42
September	175.3	32.92	225.7	212.9	173.3	167.3	12.91	12.47
October	160.2	27.90	239.9	224.4	188.2	181.5	13.19	12.72
November	115.1	22.16	178.5	164.9	144.9	139.8	13.65	13.17
December	103.0	15.50	170.0	156.1	141.4	136.4	13.99	13.49
Year	1930.8	27.94	2517.9	2360.2	1981.0	1911.1	13.23	12.77

Legends: GlobHor Horizontal global irradiation — EArray Effective energy at the output of the array

T Amb Ambient Temperature — E_Grid Energy injected into grid

GlobInc Global incident in coll. plane — EffArrR Effic. Eout array / rough area

GlobEff Effective Global, corr. for IAM and shadings — EffSysR Effic. Eout system / rough area

solargis | climData

DATA SUPPLY SHEET

Typical meteorological year (TMY)

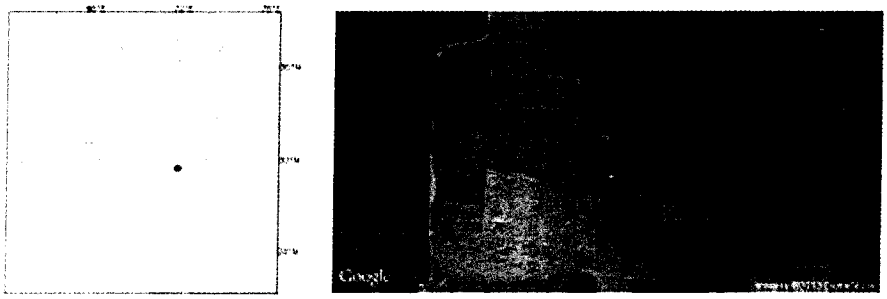
Report number: SG-306-1312-12-1
Issued: 04 December 2013 09:15 CET/CEST (GMT +1/+2)

Site info

Site name:	Punjab Punjab, Pakistan
Coordinates:	29° 28' 26.03" N, 71° 42' 51.56" E
Elevation a.s.l.:	117 m a.s.l.
Slope inclination:	0°
Slope azimuth:	201° south

Location on the map: http://solargis.info/imaps/#loc=29.473897,71.714321&tl=Google:Satellite&z=17

Geographic position



Google Maps © 2013 Google

Supplied data

Parameters:	Global horizontal irradiation
	Diffuse horizontal irradiation
	Air temperature at 2m height
	Wind speed
Summarization period:	one artificial year
Summarization type:	hourly

solargis | climData

Site: Punjab, Pakistan, latlon: 29.473897,71.714321°

SolarGIS database: technical information

SolarGIS v1.8 is high-resolution climate database operated by GeoModel Solar.

SOLAR RADIATION DATA

Primary parameters: Global Horizontal Irradiance and Direct Normal Irradiance

Data description:
satellite data:
- Meteosat PRIME satellites (© EUMETSAT, Germany) 1994 - present, 15-minute or 30-minute values for Europe, Africa and Middle East
- Meteosat IODC satellites (© EUMETSAT, Germany) 1999 - present, 30-minute values for Asia
- GOES EAST satellites (© NOAA, USA) 1999 - present, 30-mirute (partially 3-hourly) values for Americas
- MTSAT satellites (© JMA, Japan) 2007 - present, 30-minute values for Pacific region

atmospheric data:
- Water Vapour derived from CFSR and GFS databases (© NOAA NCEP)
- Atmospheric Optical Depth calculated from MACC database (© ECMWF)
- Snow Depth from GFS and CSFR (© NOAA)

Data resolution: Original time resolution is 15-minute and 30-minute (depending on the satellite; for GOES EAST it is partially 3-hourly), original satellite data spatial resolution is 3 to 5 km, and it is disaggregated to 250 metres using high-resolution Digital Elevation Model SRTM v2 (© 2000-2006 SRTM Mission team)

Methods:
- Clear-sky model: broadband simplified Solis (Ineichen 2008)
- Satellite model: modified version of Heliosat2 by Perez et al. (2002), adapted for multispectral data by Duerr and Zelenka (2008) and implemented for operational calculations by Cebecauer et al. (2010 a,b) and Suri et al. (2010), Cebecauer et al. (2011)
- Snow detection: Romanov and Tarpley (2004), Duerr and Zeenka (2008)
- Diffuse irradiance: Perez model (Perez et al 1987)
- Direct normal irradiance: DirIndex (Perez et al. 1992, Perez et al. 2002)
- Disaggregation: Ruiz Arias et al. (2010)

METEOROLOGICAL DATA

Primary parameters: Air Temperature at 2 metres, Wind speed at 10 m, Wind direction, Relative humidity, Atmospheric pressure

Data description: Post-processed from CFSR and GFS models (© NOAA)

Period covered by data: 1994/1999/2007 (depending on the region) till the present time

Data resolution: Time resolution is interpolated from original hourly and 3-hourly data, spatial resolution is approx. 7/35/57 km (depending on the parameters and time)

Due to the nature of numerical meteorological models, meteo data may not accurately represent the local microclimate and these parameter have higher uncertainty compared to solar.

Service provider: GeoModel Solar s.r.o. , Milana Marečka 3, 84107 Bratislava, Slovakia; Registration ID: 45 354 766, VAT Number: SK2022962766; **Registration:** Business register, District Court Bratislava I, Section Sro, File 62765/B
http://solargis.info, contact@solargis.info

No.PPDB/ 292 /2014

PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT

1st Floor, Central Design Building,
Irrigation Secretariat, Old Anarkali, Lahore
(Ph: 99212794 Fax: 99212796)

Date 06/3 /2014

1. General Manager CPPA NTDC
   6th Floor, PIA Building
   Egerton Road, Lahore.

2. CEO MEPCO
   MEPCO, Khanewal Road
   Multan.

3. CEO AEDB
   House # 3 Street # 8 Sector F-8/3
   Islamabad.

4. Director General
   PCRET
   PCRET House # 25, Sector H-9 Islamabad.

5. Mr. Rehan Akhtar
   DGM Finance
   WPPO NTDC,108, WAPDA House Lahore

6. CEO,
   M/s Q.A Solar Power Ltd,
   NIB Building 3rd Floor Gulberg, III Lahore

Subject: **MINUTES OF 1ST PANEL OF EXPERTS MEETING FOR 100 MW QA SOLAR POWER LTD CHOLISTAN PUNJAB HELD ON 4.3.2014**

Please refer the subject meeting held on 04.3.2014. In this connection, please find enclosed the Minutes of the Meeting of the same for your kind information and necessary action.

MANAGING DIRECTOR
Punjab Power Development Board
5/3/2014

Encl: As above

Cc: - Ps. to Additional Chief Secretary, Government of Punjab, Energy Department, Lahore

Punjab Power Development Board
Energy Department

Subject: **MINUTES OF 1ST PANEL OF EXPERTS MEETING OF Quid-e-Azam SOLAR POWER LTD FOR DEVELOPMENT OF 100 MW SOLAR PV POWER PROJECT IN CHOLISTAN PUNJAB**

The meeting of Panel of Experts of PPDB for M/s Quid-e-Azam Solar Power Ltd was arranged on 04.03.2014 at 15.00 Hrs under the Chairmanship of Managing Director PPDB in the Committee Room of Energy Department . The following were the participants of the meeting:

Present:

1.	Mrs.Saniya Awais	Managing Director PPDB (In Chair)
2.	Mr. Muhammad Tahir	Additional Chief Engineer CPPA NTDC
3.	Mr. Muhammad Hanif Memmon	Deputy Manager CPPA NTDC
4.	Mr. Riaz Tabassum	Deputy Manager CPPA NTDC
5.	Mr. Navid H. Bukhari	Director, AEDB
6.	Mr.Munawar A. Sheikh	Director, PCRET, Islamabad
7.	Mr. Sami Ullah Shaikh	Incharge /DD, PCRET, Lahore

On Invitation:

8.	Mr. Najam A. Shah	CEO, Q.A. Solar Power
9.	Dr. Gerwin Dreesmann	Partner, M/s 8.2 Ingenieurpartnerschaft Obst & Ziehmann
10.	Dr. Rana A. Jabbar	COO, Q.A. Solar Power
11.	Mr. Muhammad Badar	CFO, Q.A. Solar Power
12.	Mr. Raza Ali Zaidi	Procurement Manager Q.A. Solar Power
13.	Mr. Farukh Shameem Wynne	Associate, M/s Grant Thornton
14.	Mr. Hamid Rasheed	Financial Analyst, M/s Grant Thornton
15.	Mr. Muhammad Imran Ashraf	Manager, M/s Grant Thornton
16.	Mr. Bashir Ahmed	SGM, ECSP
17.	Mr. Rashid Majid	Resident Contract Advisor,M/s 8.2 Ing Obst&Ziehmann

In attendance:

18.	Mr. Salman Aizad	Manager Projects (Renewable Energy) PPDB
19.	Mr. Tariq Latif Chaudhary	Assistant Manager (Tariff) PPDB
20.	Ms. Afifa Jabeen	Assistant Manager (Legal) PPDB
21.	Mr. Asad Najeeb	PSO (AC&E), Energy Department

PROCEEDINGS:

The Meeting started with the welcome from the Chair. The Managing Director PPDB requested the CEO Quid-e-Azam Solar Power Ltd for briefing to the Panel of Experts (POE) on the Feasibility Study as required by the Punjab Power Policy 2006 revised 2009.
about the project submitted to PPDB. After introducing the teammates of QA Solar Power he requested Dr.Geswec of German Consultant Company for the project, M/s 8.2 Consultancy Germany to make presentation.

Serial #	DISCUSSION	DECISION
1.	The German Expert provided details of project. They informed that the name plate size of installed 100MWp solar PV Panels. The Site selected near Bahawalpur where 132 KV line already passing through the QA Solar Park. The Project shall be executed by the QA Solar Power specific purpose company formed by Govt of Punjab to execute the project on EPC basis. The CEO QA Solar Power Ltd informed that through rigorous process amongst 12 prequalified companies 6 companies, submitted their technical bids and three companies have been technically qualified for opening of their Financial EPC Bids. After the evaluation successful EPC Bidder shall be selected for the execution of the Project.	
2.	During the presentation AEDB representative raised its concern about references and basis of the Solar Irradiation and meteorological data referred in the F.S. It was explained that actual ground measurement data is not available in Pakistan to calculate energy content of solar irradiation. Therefore ground data from neighboring country combined with satellite data nearest to Punjab	

	was used. AEDB representative suggested that the data already available with Met. Office Islamabad may also be acquired for supporting already available information, but CEO QA Solar pointed out that Met. Department has already been approached by the only data available with them is about sunshine hours and not about its intensity. This data will, hence, not be very useful for the feasibility study.	
3.	**Discussion on type of technology:** AEDB asked QA Solar to clarify what type of PV technology will be used. QA Solar said this was dependent on the EPC contractor and that the FS had been prepared on basis of using poly-crystalline PV panel. It was explained by QA Solar that the EPC contractor shall provide 25 years performance guarantee for the installed PV system. Further while discussing about the choice of technology with regard to fixed or moving type of PV modules, it was recommended by the POE members that the Fixed type solar module should be selected. The representative of AEDB further pointed out that following minor anomalies may be corrected ; a. Correction of Geographic coordinates of the plant b. Losses need to be clarified on the basis of International standards c. Discrepancy in PV Panel Wattage (230 vs 270) size, taken as reference	The typographic errors/omission was noted and to be corrected by QA Solar Power
4.	It was also highlighted that the Grid Interconnection study has been carried out by Planning Department of NTDC and they have report is positive in all aspects for power plant connectivity. The IEE Report was submitted to EPA Punjab and approved. On the Financial part of the F.S the POE members observed that; 1. Overall CAPEX mentioned in the Report under its Section 9 (Financial	The POE members resolved the matter and directed M/s QA Solar Power Ltd that feasibility study will clearly mention that the numbers presented in the study will be revised on basis of firm EPC bid for preparation of tariff application.

	Analysis) are very encouraging and is on far better side than CAPEX assumed by NEPRA in its Upfront Tariff calculations. 2. Under Section 9 (Financial Analysis), term Feed in Tariff has been used repeatedly instead of Reference Tariff. Which was explained by QA Solar Power that these are guidelines and EPC bids are under process the actual number shall be incorporated as per EPC results. • Section 9.2 elaborates three scenarios of CAPEX and OPEX, however, ultimate yearly tariff profile of the project in the form of Reference Tariff Table (for which M/s QA Solar has submitted the Report to PPDB for approval and based thereon will submit its tariff petition to NEPRA) has not been witnessed in the Report. • It is suggested that each of the cost facet either CAPEX or OPEX may be discussed separately. For OPEX cost components, like O&M and Insurance etc. may also provide resultant Reference Tariff components separately. • Separate calculations in respect of Interest during Construction may also be mentioned in the Report. • Debt Servicing schedule may also be made part of the Report • Financial charges with respect to Debt component of the CAPEX may also be mentioned along with its details. • It is suggested that indexation to be applied for each of the Reference Tariff components may also be mentioned in the Report.	After detailed discussion and deliberation, It was unanimously decided by all POE members that the observations, corrections and suggestions pointed out by POE members will be incorporated in the report. The updated report will be shared with POE panel, through circulation, and shall stand approved without further meeting if no objection is received from POE on revised version of Feasibility Study.

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

----------x----------x----------

16. Photovoltaic (PV) Technology

Energy technology used for this 100 MW p DC Solar PV Power Plant is Solar Photovoltaic (PV), the details of which are explained in sub section (a). The other aspects and details of this technology are explained in the subsequent sub sections.

a) Technology used for the Project

b) Fuel used for Power Generation

c) Emission Values

a) Technology Used For the Project

The renewable technology that is being used for the project is Photovoltaic (PV) cell. The working principle behind the PV technology is the photo-electric effect in which photons are emitted by the sun; impact a semiconductor's surface resulting in generation of electricity.

The purity level of the semi-conductor material is very important and that there are no gaps at the molecular and atomic level of the semiconductor material. The higher the purity of the used material, the greater is the likelihood that it achieves the maximum potential of a photoelectric cell.

The efficiency of a solar cell (η) is the percentage of power from solar energy, incident on the panel, converted to electrical energy. This term is calculated using the ratio of the maximum power point of the cell, Pm, divided by the light power that reaches the cell, the global irradiance (E, in W / m^2) under standard conditions (STC, 1000 W/m^2, 25°C, AM 1,5), and the surface area of the solar cell (A_c in m^2)

$$\eta = \frac{Pm}{E \; x \; Ac}$$

Pm [W] = Cell power at maximum power point at STC

E [W/m^2] = power of global irradiation on cell area

A_c [m^2] = cell surface area

Another important variable is the Normal Operating Cell Temperature (NOCT) of the module. This is a characteristic cell value defined as the temperature of the cells, which they reach at an irradiance of 800 W/m^2, an ambient temperature of 20°C and a wind speed of 1 m/s.

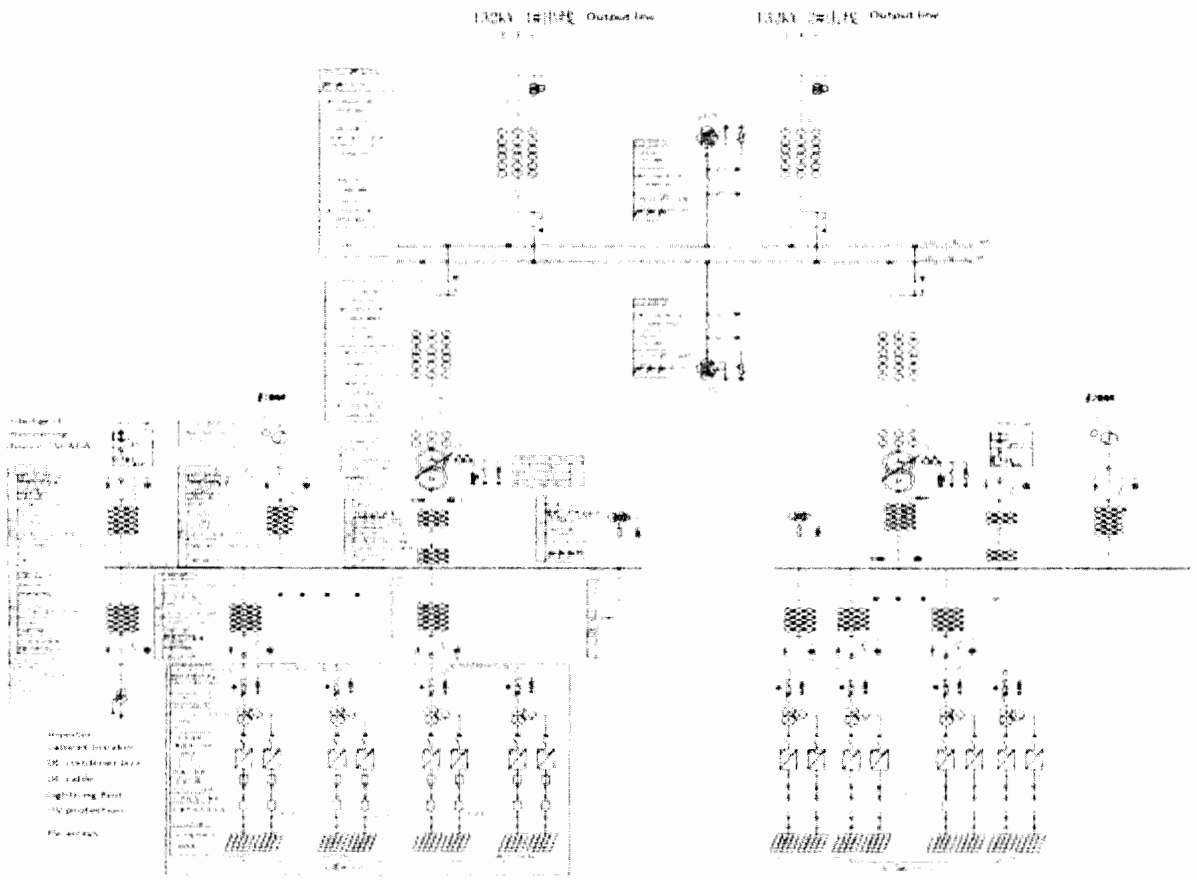
Three main cell categories can be defined:

1. Monocrystalline
2. Polycrystalline
3. Thin Film

For this project, polycrystalline photovoltaic (PV) cell is being used. This type of PV cell is selected in favor of other types, because it provides higher efficiency and it is considerably cheaper in comparison with other types of PV cells. In addition to that, polycrystalline PV cells are more suitable for the climatic conditions of Bahawalpur where temperature reaches up to 50°C. Poly-crystalline cell's efficiency drop at higher temperatures is considerably less than that of mono-crystalline cell. With regards to the thin film, it was not in consideration because of its low efficiency and higher rate of degradation in efficiency over its lifetime. Keeping all these factors in view, poly-crystalline cell is the most suitable choice for the project. The following paragraphs detail the design and components of the project.

Design of the Plant

Provided below is the SLD of Quaid-e-Azam Solar 100 MWp DC Solar Power Project at Lal Sohanra Park, Bahalwalpur.



All the system components for the following DC functions on SLD include:

- Module Arrays (fixed – tilted)
- Combiner and Recombiner Boxes
- Inverters
- DC cables
- DC connectors
- Disconnects, switches, protection, fuses
- Grounding
- Switchgear
- Transformers (including LV/MV and MV/132kV)
- AC cables
- AC connectors
- Protection
- Grounding
- Grid Connection
- Electric meter etc.

b) Fuel: Renewable Energy Source Used for Power Generation

Solar Photovoltaic technology will be used for power generation in the 100 MWp DC Solar PV Plant by Quaid-e-Azam Solar Power (Pvt.) Ltd. Renewable energy source used for the project is sunlight.

Keeping the environmental objectives of the Government of Pakistan in view, along with the target for renewable energy set by the AEDB, solar power generation can strongly contribute to the identified power shortage. The development of solar power generation projects could reduce dependence on fuels for thermal power generation, increase diversity in Pakistan electricity generation mix, and reduce greenhouse gas emissions. Pakistan being in one of the best solar zones is ideally located to take advantage of the solar energy technologies. This energy source is widely distributed and abundantly available in the country with about 2900-3300 sun hours and around 1.9 - 2.3 MWh per m^2 per year. It has an average daily global insolation of approximately 19 - 20 MJ/m^2 per day with annual mean sunshine duration of 8.1 to 9.2 hours a day. These values are among the highest in the world. Such conditions are ideal for installation of PV and other solar energy applications.

The total solar irradiation identified for the project location over the year has been estimated at 1920.8 KWh/m^2. As a result of this radiation, the plant will be able to provide 160,313,000 kWh in the first year to the grid. Details of monthly radiation level in KWh/m^2 along with the resultant power generation in kWh are provided in the table below:

Month	Solar Irradiance (kWh/m^2)
January	102.3
February	124.0
March	179.7
April	196.5
May	208.5
June	190.3
July	181.1
August	184.8
September	175.3
October	160.2
November	115.1
December	103.0
Total	1,920.8

Ref: Feasibility Study attached as Annexure 22

c) Emission Values

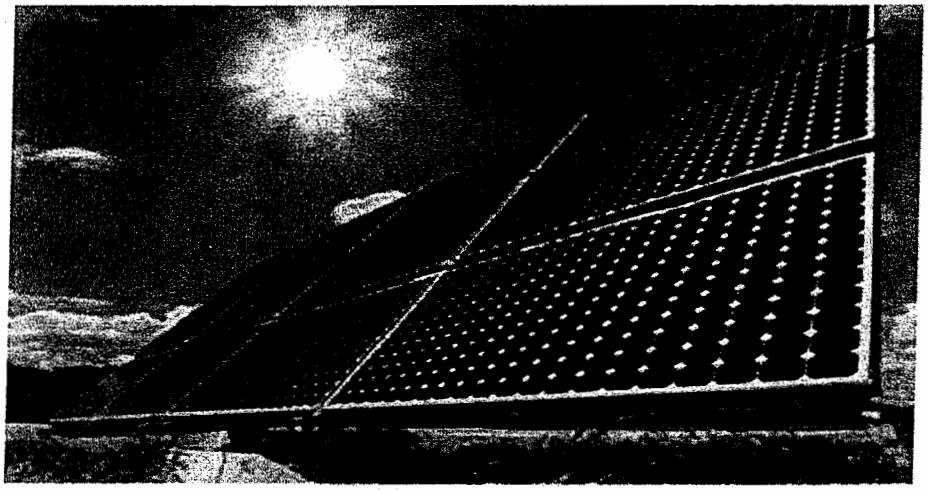
Electricity produced from the Sun is green and environment friendly. The production of electricity from the Sun does not result in emission of any harmful gases e.g. carbon dioxide, carbon mono oxide, methane and sulphur dioxide etc. Thus the emission value in the case of a solar power plant is zero as opposed to the emission values of coal or oil based thermal power plants.

17. Grid Connectivity Study

Following the bidding document's requirements, NTDC grid code is compliant. Grid study of the project has been carried out by the NTDC. Study reveals constraint free results. NTDC has communicated through their letter that their system is ready to take power generated from this project.

Load Flow Study	Annexure 24
Power Evacuation Plan	Annexure 25
Advanced Technical Studies including Short Circuit, Stability and reliability	Annexure 26
Power House Design	Annexure 27
NTDC Approval of Grid Connectivity Study	Annexure 28

National Transmission and Despatch Company Limited (NTDCL)



Load Flow Study Report for Evacuation of Power from 1000 MW Solar Power Plants in Quaid-e-Azam Solar Park at Lal Suhanra

Prepared by

Planning (Power) Department
5th Floor, PIA Tower, Egerton Road, Lahore.

January 2014

Load Flow Study Report for Power Evacuation from 1000 MW Solar Power Plants in Cholistan

1. Introduction

The evacuation scheme for 1000 MW (gross capacity) solar power from Quaid-e-Azam solar park at Cholistan comprises of three phases. Phase-1 will comprise of power evacuation from 2 Nos. of solar power plants (gross capacity 100 MW) at 132 kV voltage level to the MEPCO network. In Phase-2 additional 6 Nos. of solar power plants (gross capacity of 300 MW) at 132 kV voltage level can evacuate power. Later on additional 600 MW (gross capacity) solar power generation has been planned to be evacuated in Phase-3 through interconnection scheme at 220 kV voltage level.

2. Project Scope of work

The proposed scope of work is provided as under;

Phase-1: First 100 MW Solar Power Evacuation at 132 kV Voltage

- A 132 kV D/C transmission line approx. 4 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur – Lal Suhanra S/C at solar power plants.

Phase-2: Additional 300 MW Solar Power Evacuation at 132 kV Voltage

- A 132 kV D/C transmission line approx. 8 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur Cantt. – Lal Suhanra S/C at solar power plants.
- A 132 kV D/C transmission line approx. 4 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur – Lal Suhanra S/C at solar power plants.
- A 132 kV D/C transmission line approx. 40 km long on Rail conductor from Bahawalpur New to Lodhran & looping In/Out of one circuit at Baghdad-ul-Jaded.

Phase-3: Additional 600 MW Solar Power Evacuation at 220 kV Voltage

- A 220/132 kV collector substation at/around Lal Suhanra substation with 3x250MVA, 220/132 kV transformers.
- A 220 kV D/C transmission line, approx. 40 km long on twin-bundled Rail conductor from 220 kV Lal Suhanra to Bahawalpur substation.

- Three 132 kV D/C transmission lines, each approx. 8 km (total 24 km) long on Rail conductor, from 220 kV collector substations to individual solar power projects.

The geographical diagram showing the above scope of work for the proposed solar generation is shown in Figure # 1.

3. Load Flow Studies

The load flow 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, some line openings have been assumed at some parts of the network as per system requirements.
- In the studies, the following reinforcements have been assumed as per system requirement of MEPCO network:
    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. Capacitor Bank of 36 MVAR proposed at 132 kV Hasilpur substation in year 2015.
    iii. Following line openings have been proposed during Phase-I in MEPCO network when solar power projects are in operation for reliable operation during the time when solar power is available;
        a. Hasilpur – Chishtian T/L

        The above line should be switched on when solar generation is not available.
    iv. Following line openings have been proposed during Phase-II in MEPCO network when solar power projects are in operation for reliable operation during the time when solar power is available;
        a. Hasilpur – Ludden T/L
        b. Karorpca – Mailsi T/L

The above line should be switched on when solar generation is not available.

v. Following line openings have been proposed during Phase-III in MEPCO network when solar power projects are in operation for reliable operation during the time when solar power is available;

a. Hasilpur – Chistian-New T/L
b. Hasilpur – Ludden T/L
c. Bahawalpur-Old – Miranpur T/L
d. Lodhran – P.Gain T/L
e. Karorpca – Mailsi T/L

The above lines should be switched on when solar generation is not available.

The description of the simulated scenarios is given as under;

3.1 Peak Load Aug/Sep 2014

Load flow study for peak load condition of Aug/Sep 2014 under normal system condition for Phase-1 is attached as Exhibit #1-A and for Phase-2 the load flow study is attached as Exhibit #1. In Phase-1 power from two solar power projects (50MW each) can be evacuated. Under Phase-2, the power from eight solar power projects (50 MW each) with a total gross capacity of 400 MW from Quaid-e-Azam solar park has been evacuated to the surrounding MEPCO network through two 132kV D/C lines.

As per load flow study, it is found that power from these solar power projects can be evacuated to the 132 kV system of MEPCO under normal and contingency condition without any transmission constraint, i.e., the loading of the transmission lines and transformers 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 #2-5. The results of the contingency studies are summarized as under;

Exhibit #	Contingency Conditions	Remarks
2	Solar PP-4 – Bahawalpur 132 kV S/C out	No system constraints.
3	Solar PP-1 – Lal Suhanra 132 kV S/C out	-do-
4	Solar PP-5 – Lal Suhanra	-do-

	132kV S/C out	
5	B.Pur Cantt. – B.W.P-N 132kV S/C out	-do-

3.2 Peak Load Aug/Sep 2015

Load flow study for peak load condition of Aug/Sep 2015 under normal system condition is attached as Exhibit #6. In Phase-3, the power from additional twelve solar power projects (50 MW each) with a total gross capacity of 600 MW from Quaid-e-Azam solar park has been evacuated through the 132 kV lines to the 220/132 kV grid station within solar park and then from 220 kV grid station to Bahawalpur 220 kV grid station through 220 kV D/C transmission line.

As per load flow study, it is found that power from these solar power projects can be evacuated to the National Grid under normal and contingency condition without any transmission constraint, i.e., the loading of the transmission lines and transformers 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 #7-9. The results of the contingency studies are summarized as under;

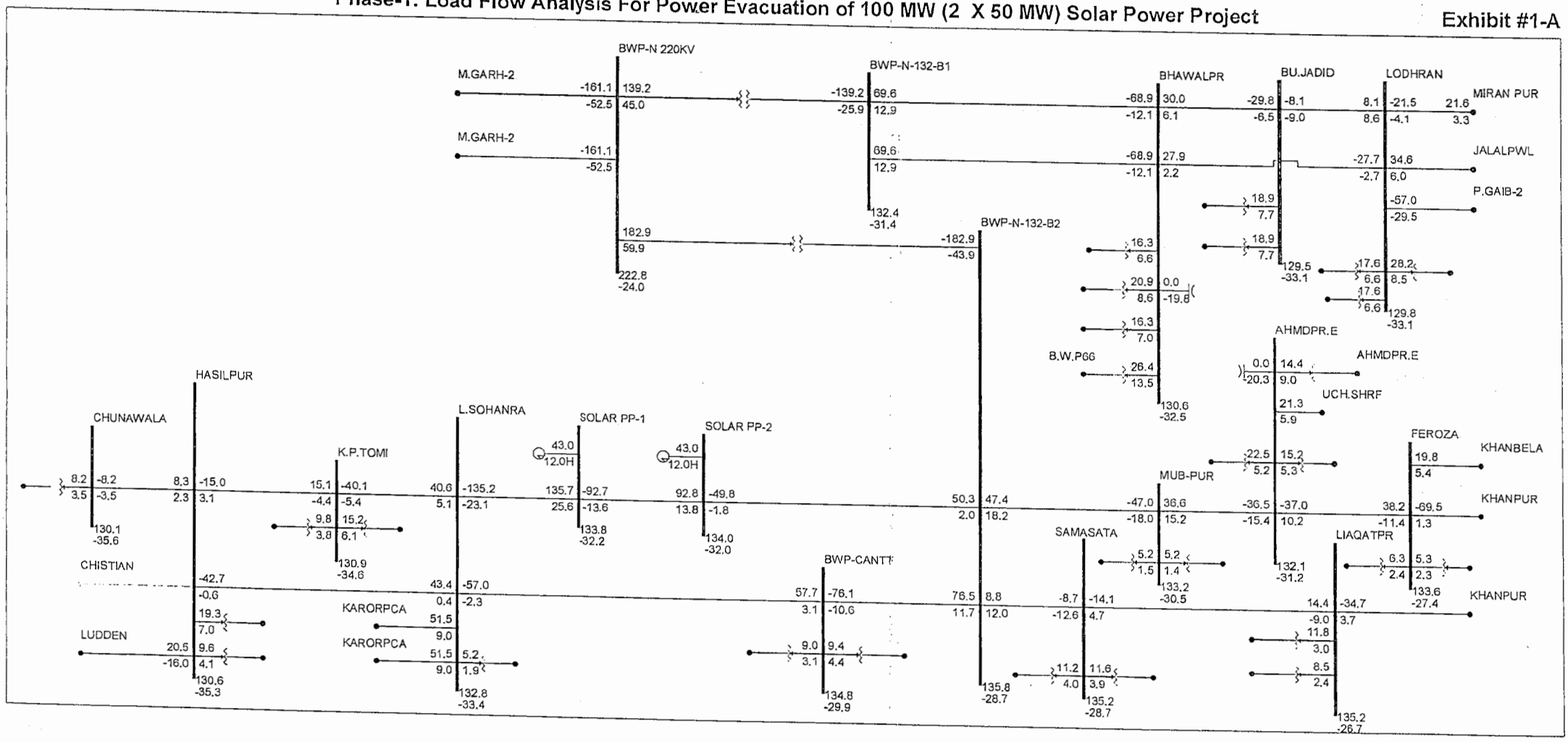
Exhibit #	Contingency Conditions	Remarks
7	Lal Suharna(Solar Park) G/S – Bahawalpur 220 kV S/C out	No system constraints.
8	Bahawalpur – M.Garh 220 kV S/C out	-do-
9	Solar PP-9 – Lal-Suharna G/S 132 kV S/C out	-do-

Conclusions

- The power from the solar park can be evacuated to the system through the proposed interconnection schemes in Phase-1, Phase-2 and Phase-3.
- The necessary network re-arrangements and reinforcements in MEPCO network as mentioned in the study assumptions are also required to be followed for reliable dispersal of scheme from the upcoming 1000 MW (gross capacity) solar power projects in Quaid-e-Azam solar park, Cholistan.

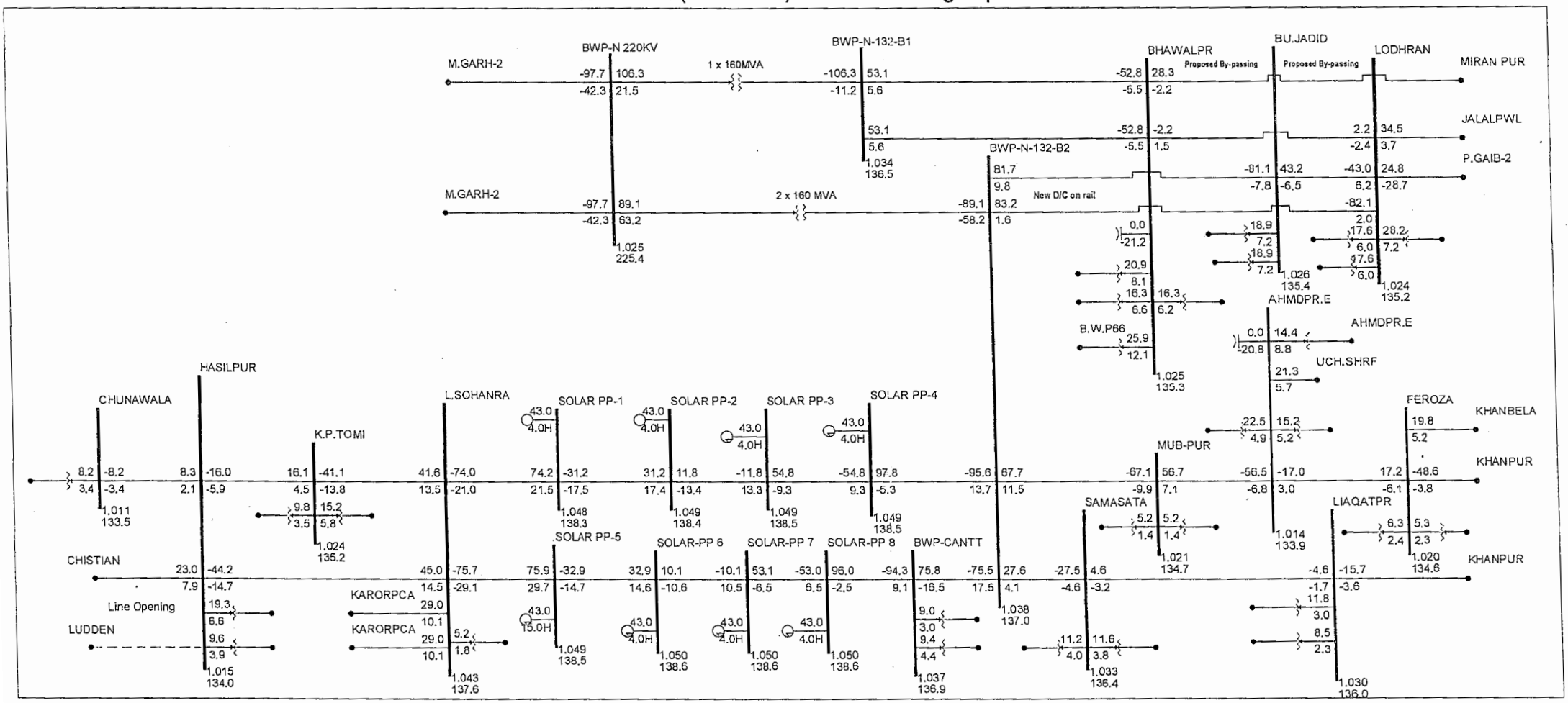
Phase-1: Load Flow Analysis For Power Evacuation of 100 MW (2 X 50 MW) Solar Power Project

Exhibit #1-A



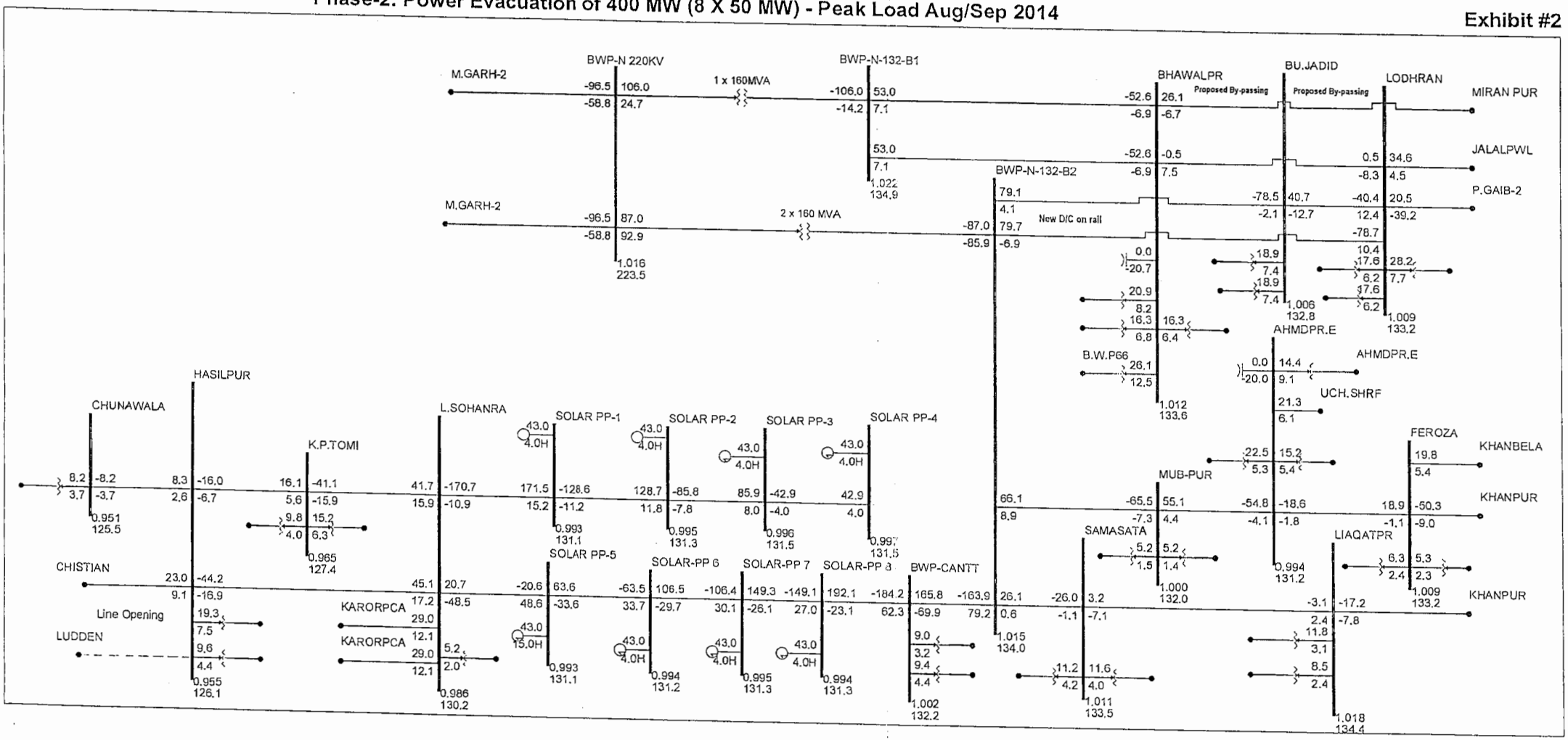
Phase-2: Power Evacuation of 400 MW (8 X 50 MW) - Peak Load Aug/Sep 2014

Exhibit #1



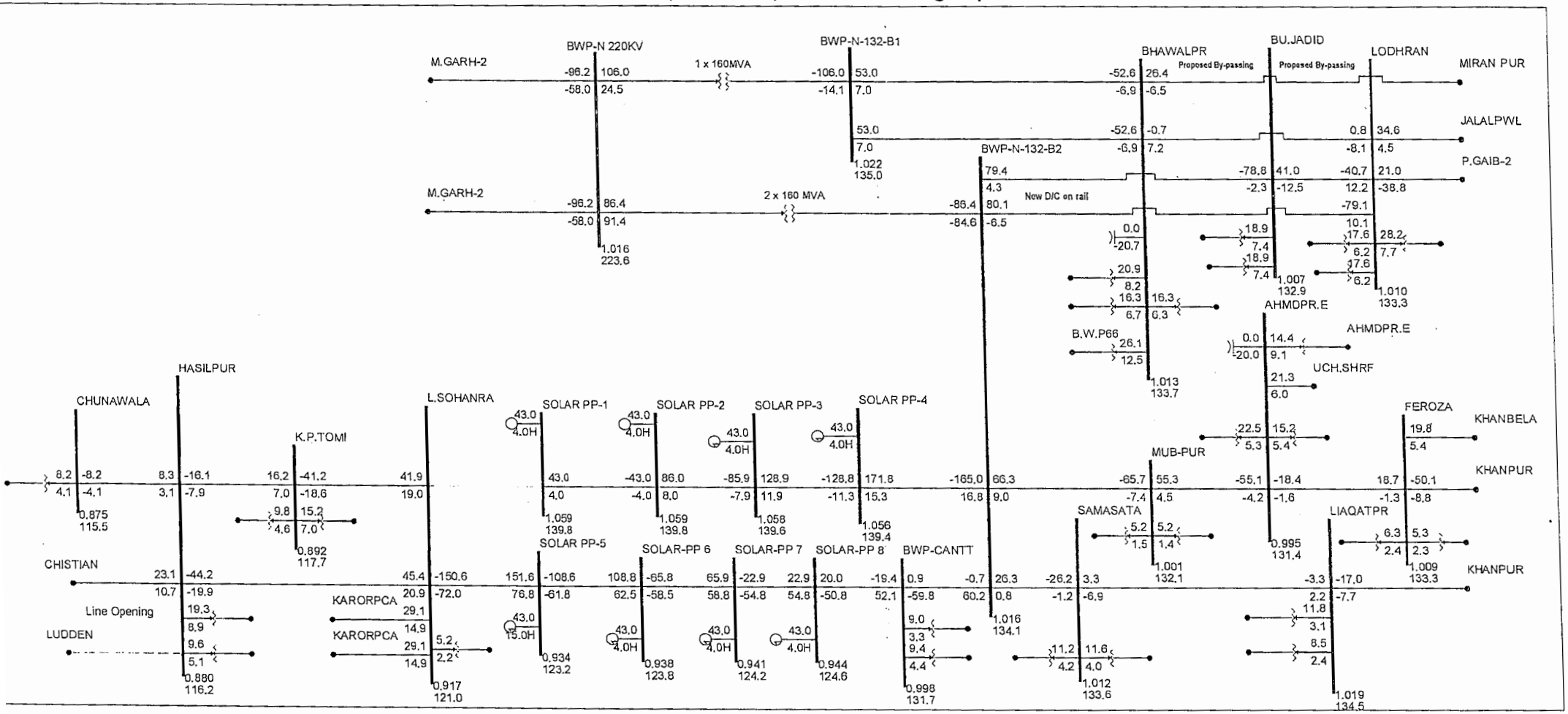
Phase-2: Power Evacuation of 400 MW (8 X 50 MW) - Peak Load Aug/Sep 2014

Exhibit #2



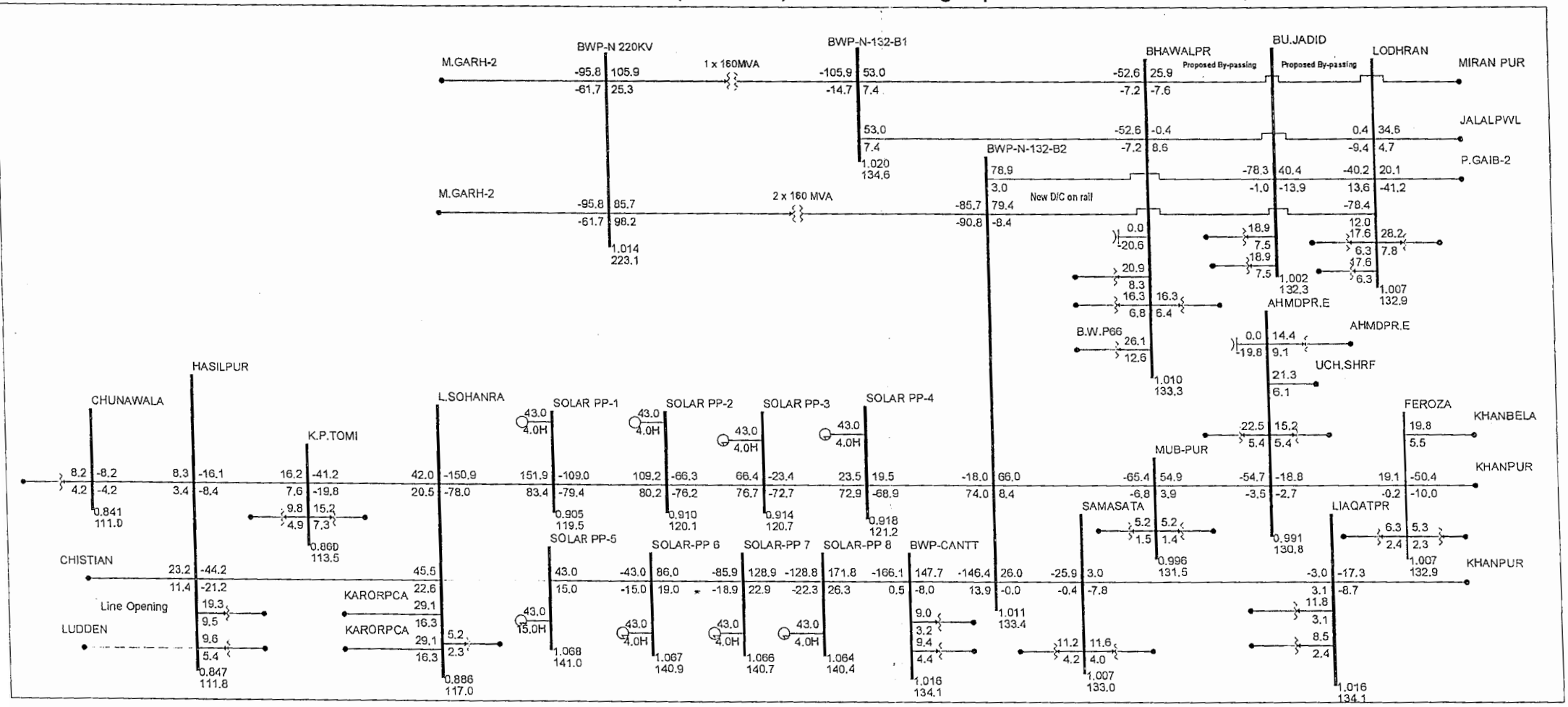
Phase-2: Power Evacuation of 400 MW (8 X 50 MW) - Peak Load Aug/Sep 2014

Exhibit #3



Phase-2: Power Evacuation of 400 MW (8 X 50 MW) - Peak Load Aug/Sep 2014

Exhibit #4



Phase-2: Power Evacuation of 400 MW (8 X 50 MW) - Peak Load Aug/Sep 2014

Exhibit #5

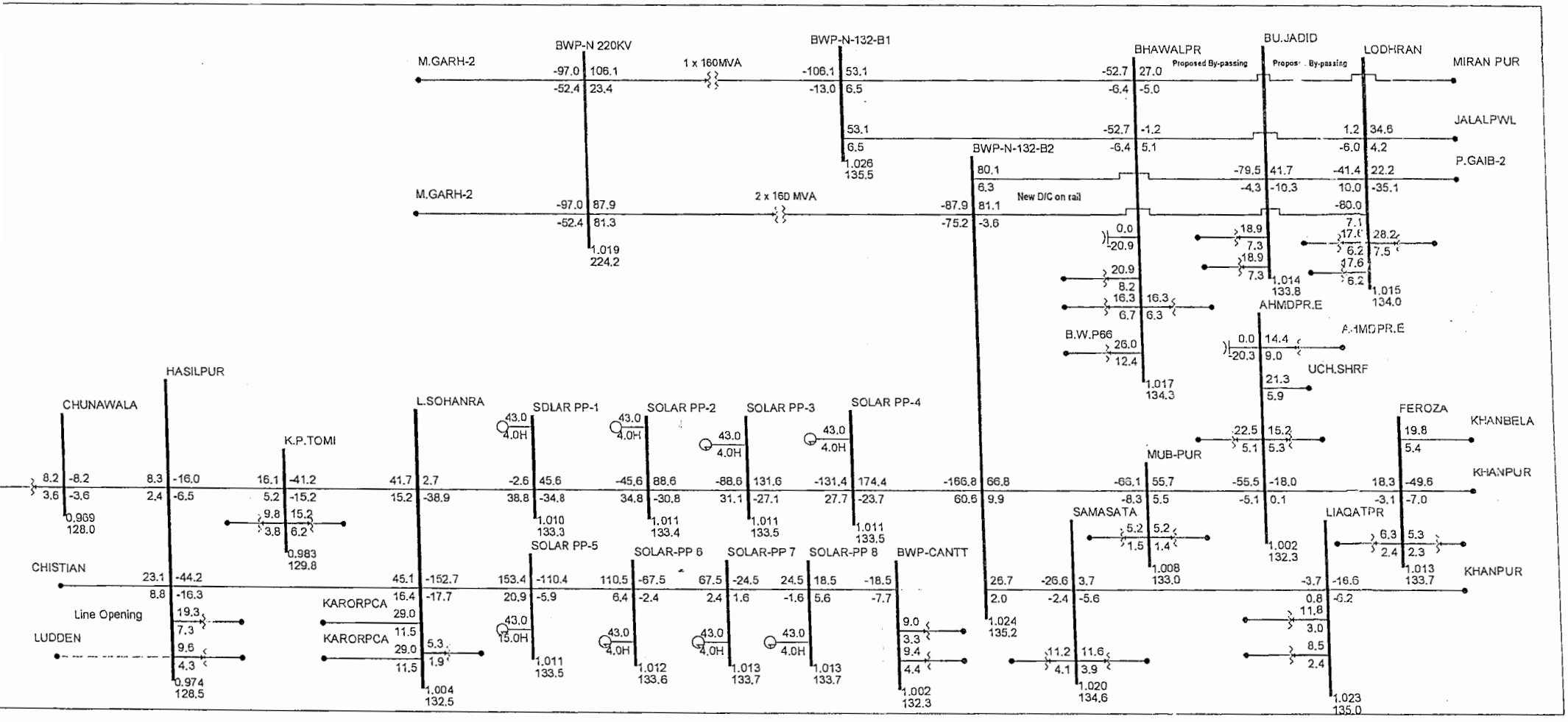
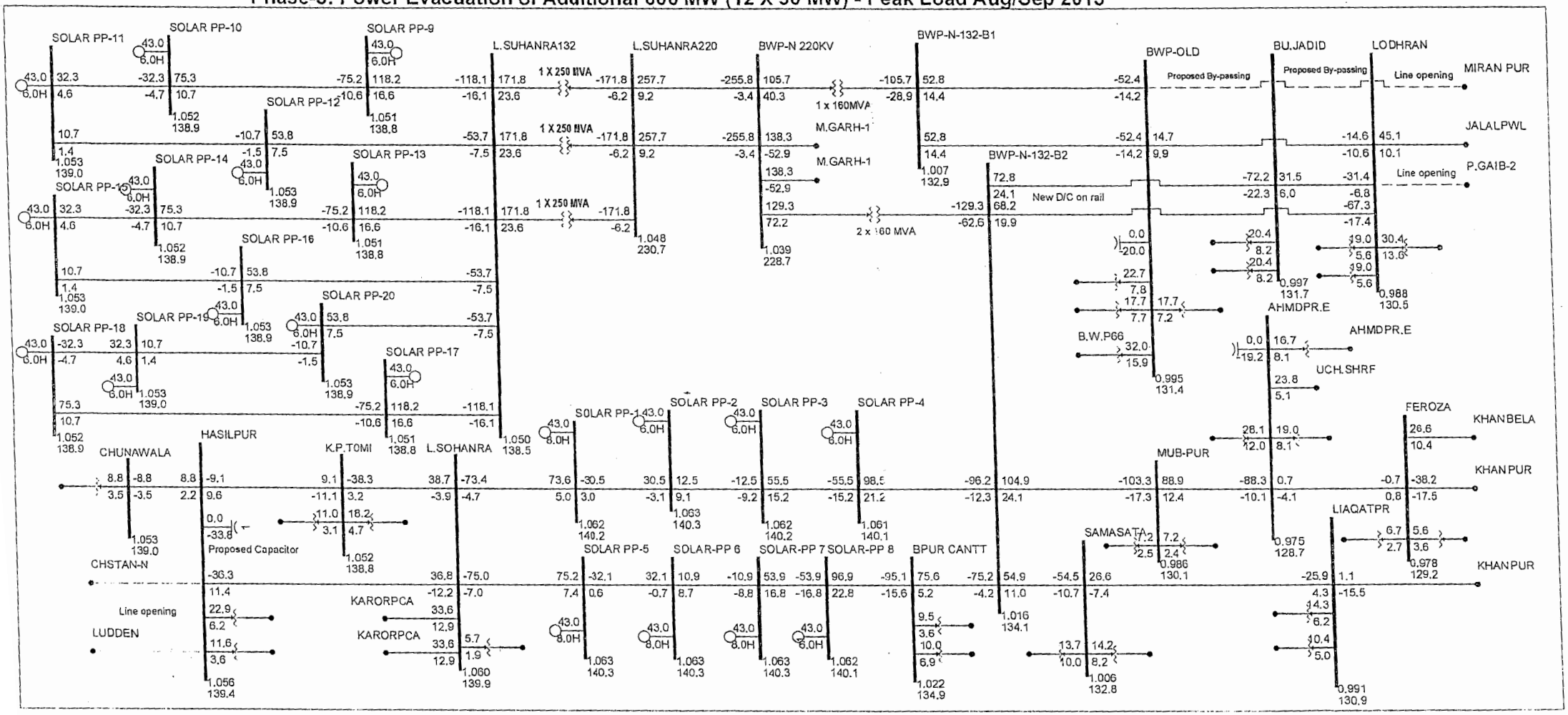


Exhibit #6

Phase-3: Power Evacuation of Additional 600 MW (12 X 50 MW) - Peak Load Aug/Sep 2015



Phase-3: Power Evacuation of Additional 600 MW (12 X 50 MW) - Peak Load Aug/Sep 2015

Exhibit #7

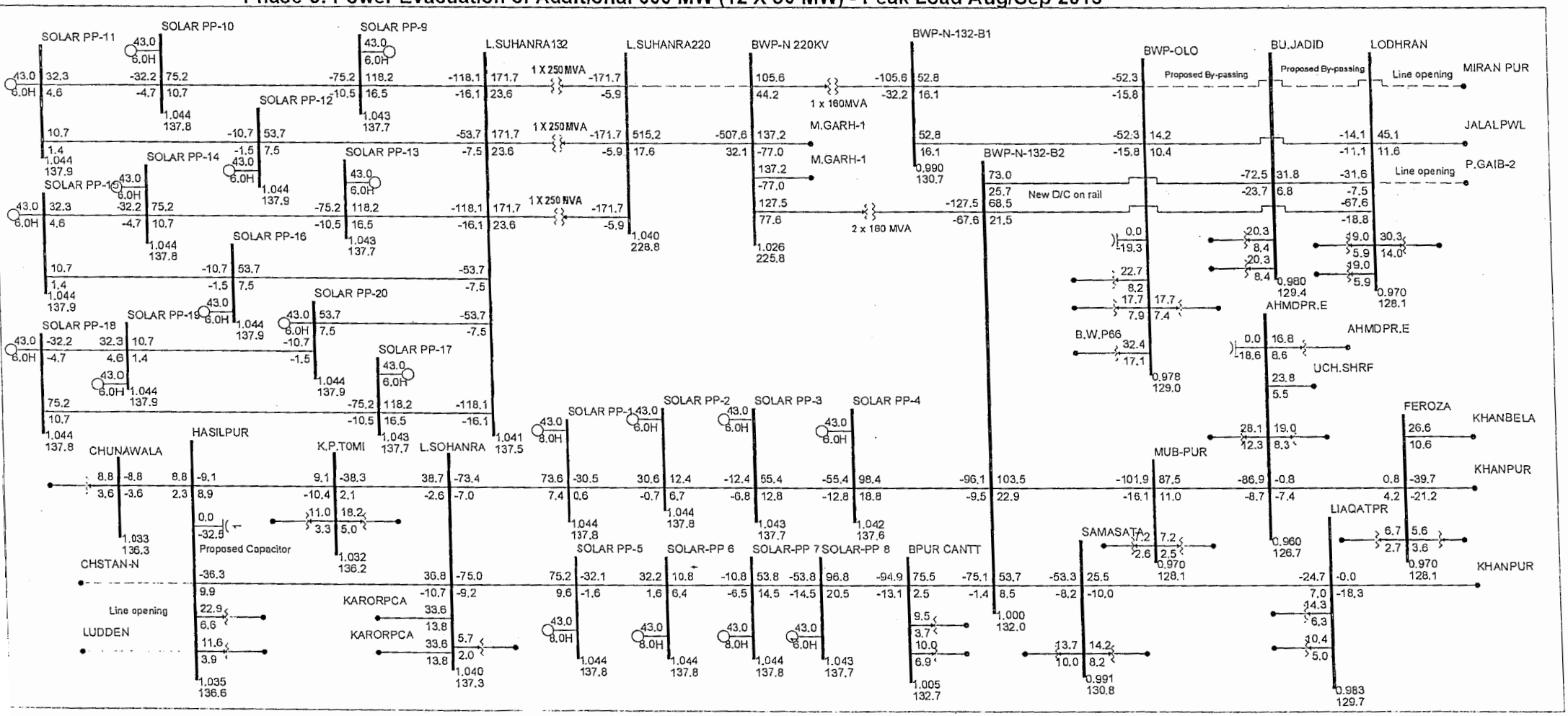
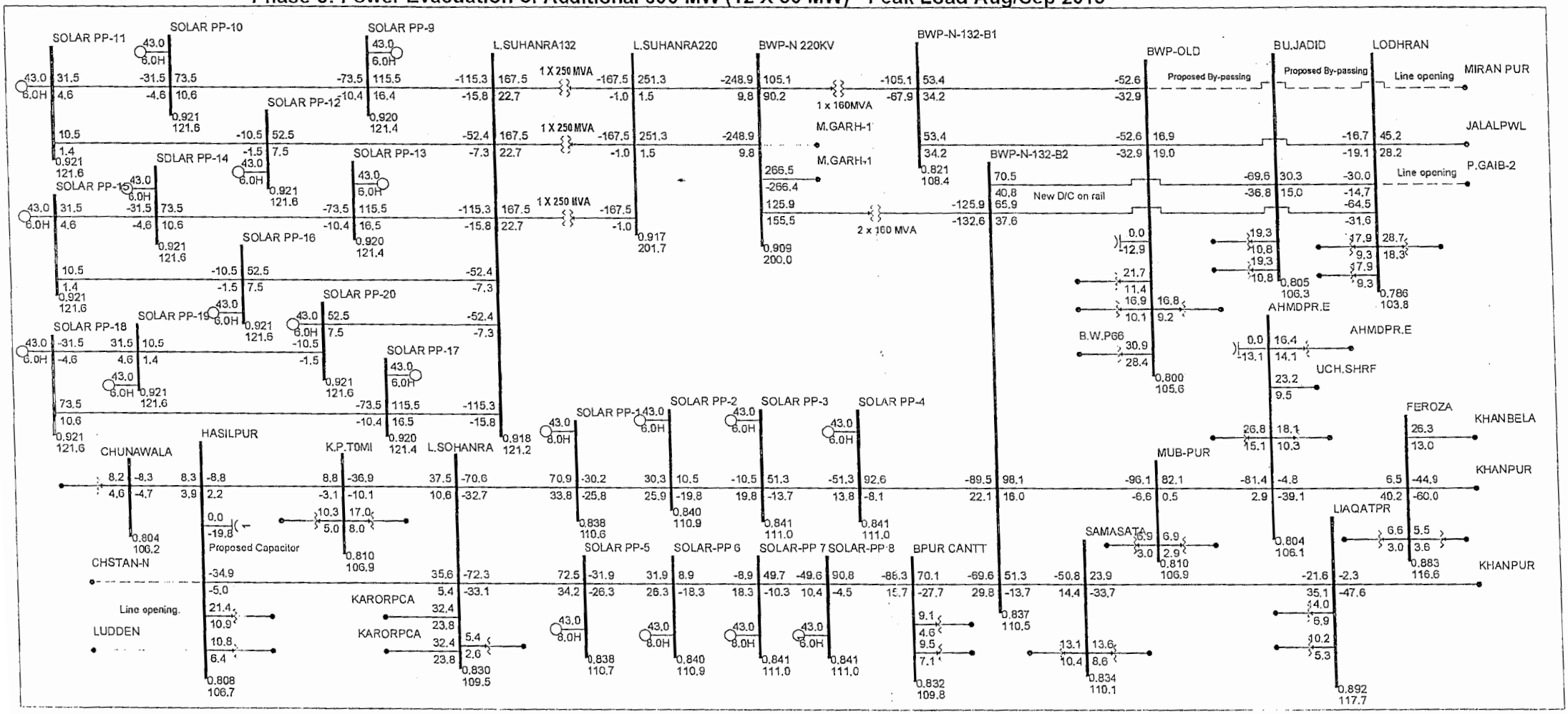


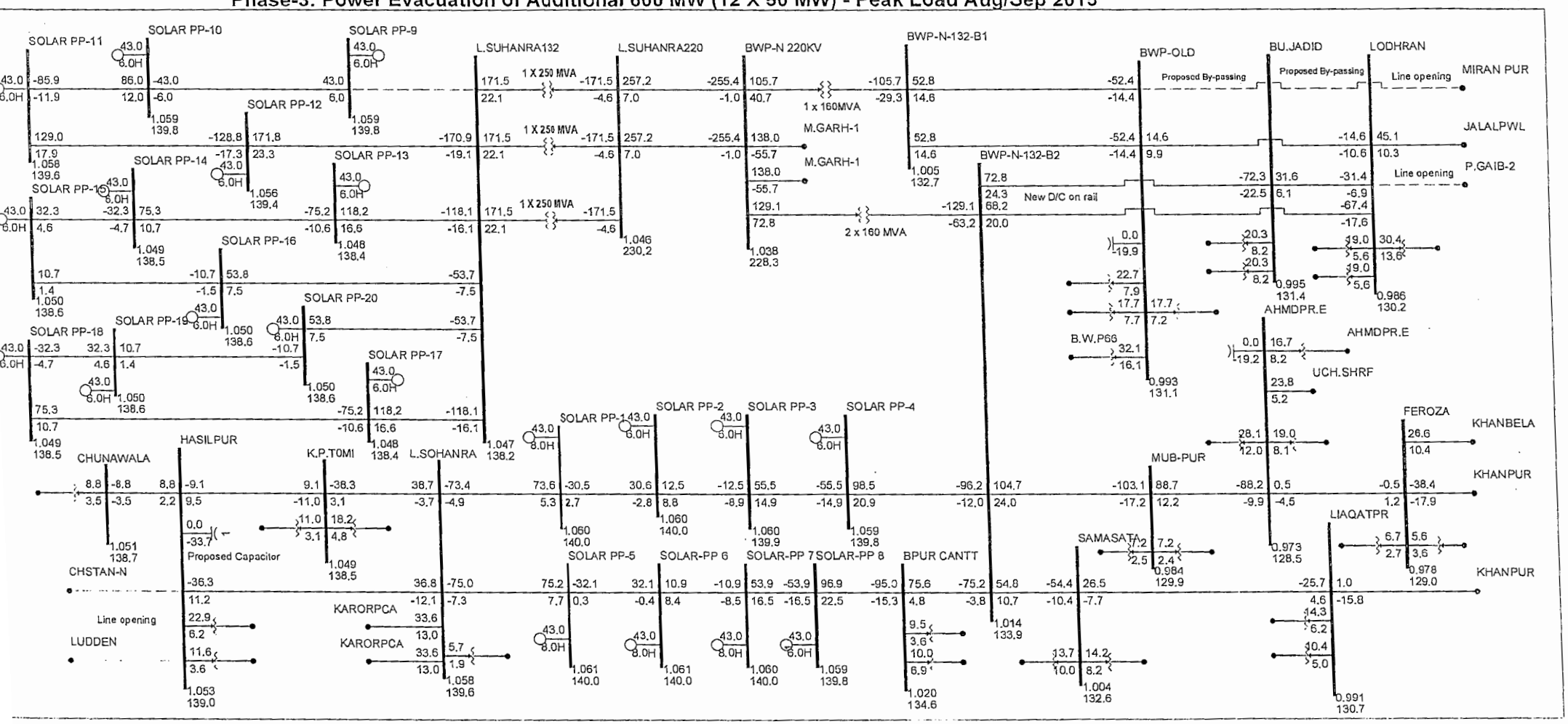
Exhibit #8

Phase-3: Power Evacuation of Additional 600 MW (12 X 50 MW) - Peak Load Aug/Sep 2015



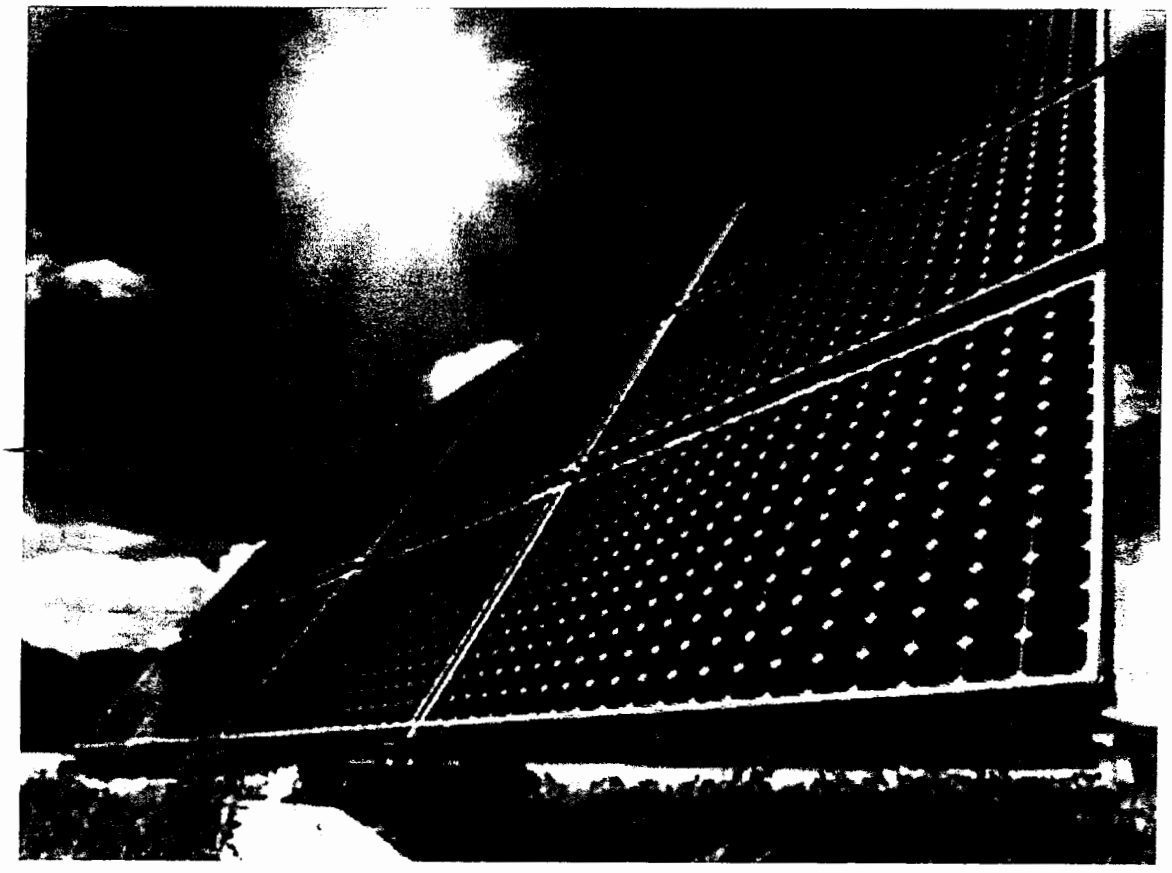
Phase-3: Power Evacuation of Additional 600 MW (12 X 50 MW) - Peak Load Aug/Sep 2015

Exhibit #9



QUAID-E-AZAM SOLAR PARK AT LAL-SUHANRA

POWER EVACUATION PLAN BY NTDCL



NATIONAL TRANSMISSION AND DESPATCH COMPANY LIMITED

September, 2013

Table of Contents

Introduction

There are two major types of solar power technology viz Photovoltaic (PV) systems and Concentrated Solar Power (CSP) systems. The sun is the most plentiful energy source for the earth. All wind, fossil fuel, hydro and biomass energy have their origins in sunlight. Solar energy falls on the surface of the earth at a rate of 174 petawatts, (1 petawatt = 10^{15} watt). The solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850,000 exajoules (1EJ=10^{18} J) per year. In 2002 this was more energy in one hour than the world used in one year.[1]

At the global level power generation is largely dependent on fossil fuels, which emit tons of carbon dioxide and other pollution every second. More ironic is the fact that fossil fuel will eventually run out. In order to make the development of our civilization sustainable and cause less harm to our environment, development of new source of substitute clean energy is inevitable.

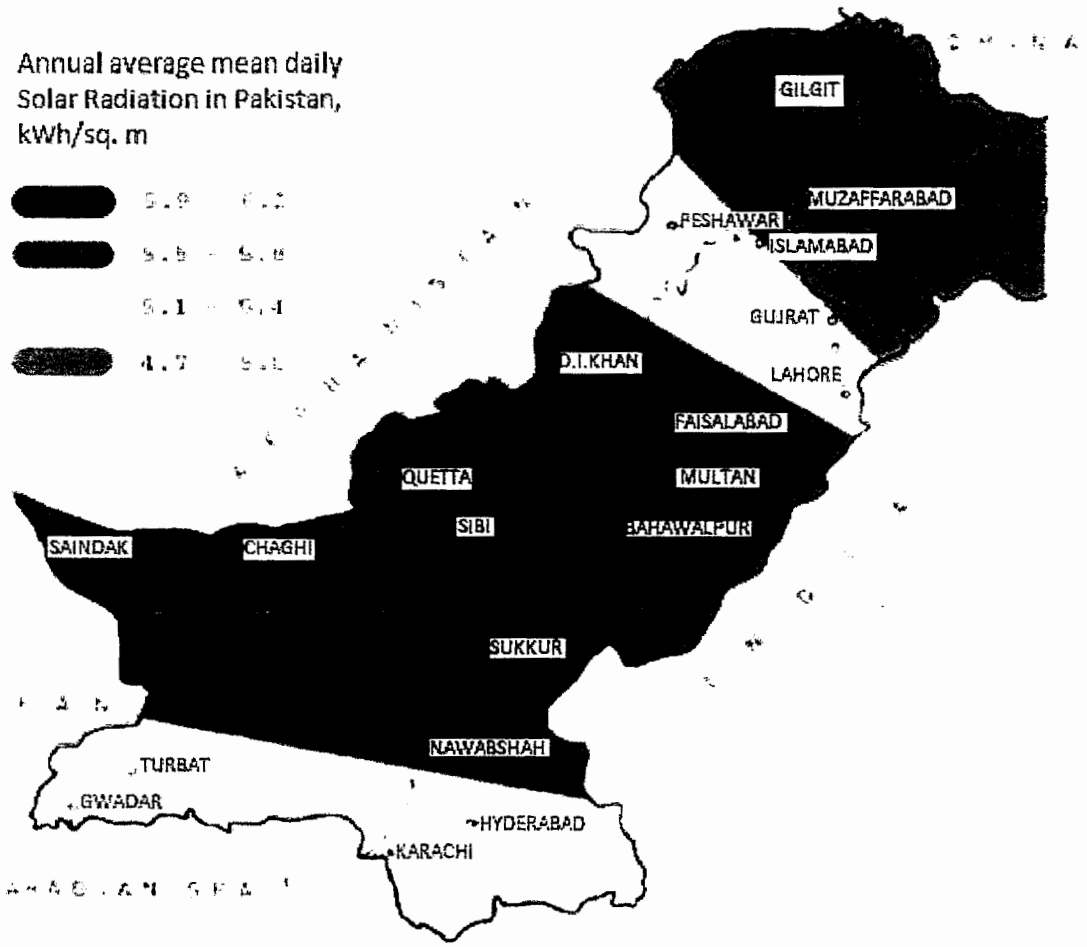
To mitigate the current energy crisis development of Solar Power is one of the best possible short term solutions predominantly during the day time. There is an urgent need to intensify the efforts for development and utilization of solar energy. AEDB should take steps to establish R&D cells to promote and develop solar power in the country.

Nature has gifted Pakistan with ideal climatic conditions to harness energy from the sun-------- 'the solar energy'. All we need to do is to act quickly and make up for the lost time.

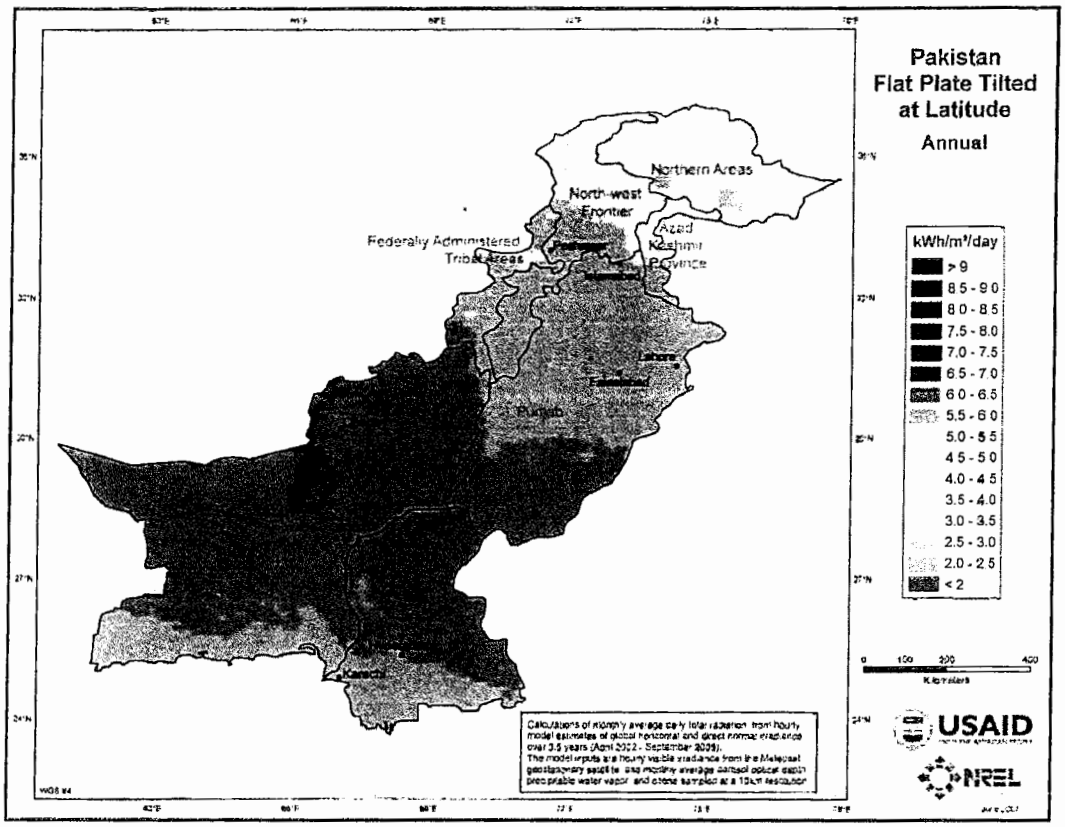
[2]Solar Generation in Various Countries

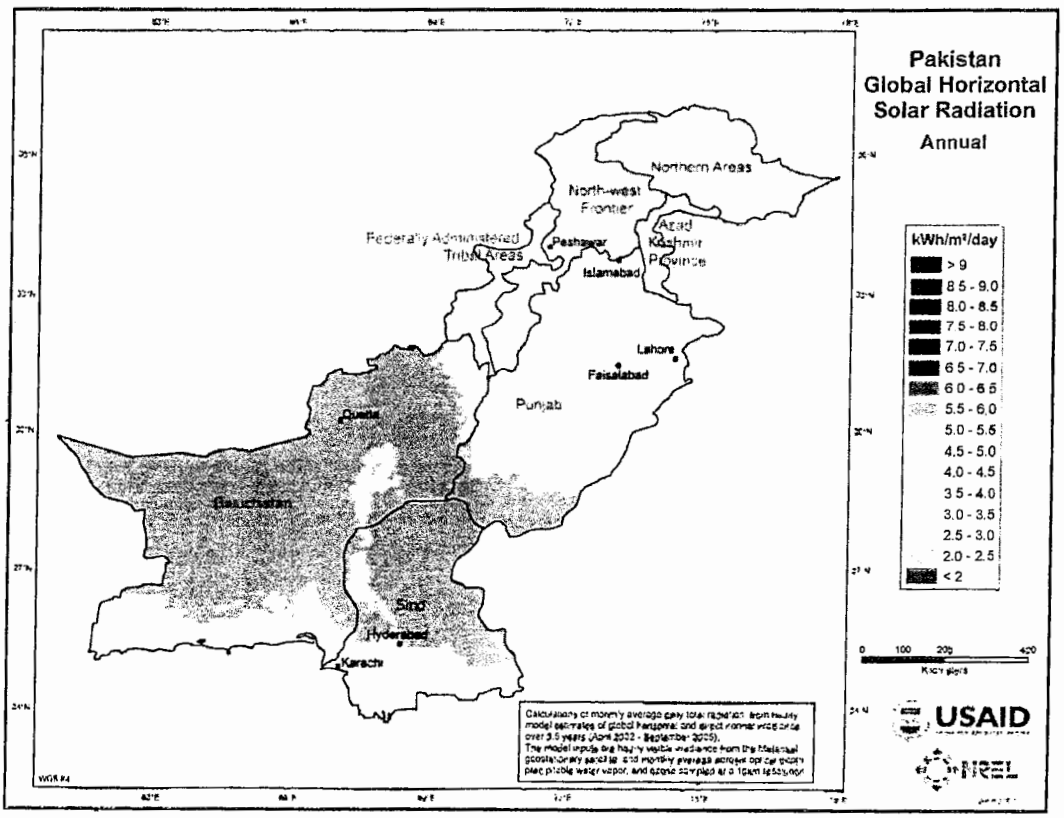
Sr. No.	Country	Installed Capacity (MW)	Solar Capacity (MW)	%age of Solar Power
1	Germany	168,523	32,643	19.37%
2	Italy	123,882	16,241	13.11%
3	Spain	107,257	4,537	4.23%
4	China	1,185,714	8,300	0.70%
5	India	192,787	1,176	0.61%
6	USA	1,260,689	7,312	0.58%

[3]Solar Energy Potential in Pakistan

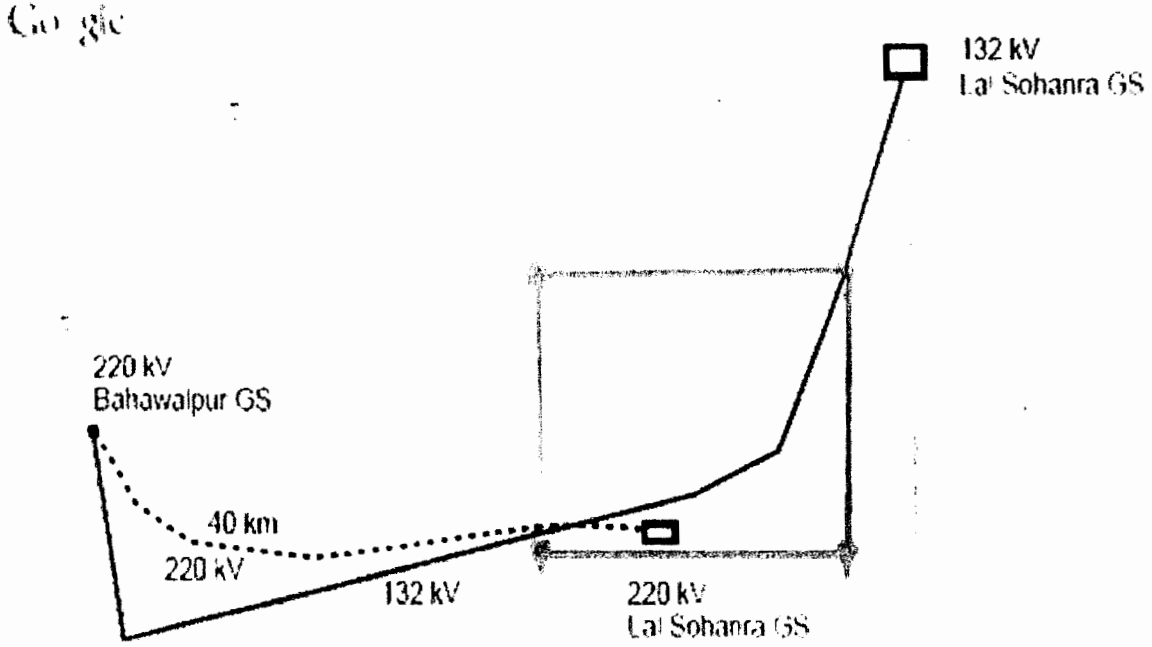


Pakistan has enormous solar energy potential. The country receives high levels of solar radiation throughout the year. In fact Solar Energy is available at a rate of 1 kilowatt per square meter in Pakistan and has capacity to generate over 2.9 million megawatts electricity per annum. Pakistan is amongst the countries which receive highest daily solar insolation level (Mega Joules per square meter) and annual mean sunshine days.


Pakistan
Flat Plate Tilted
at Latitude
Annual
kWh/m²/day
> 9
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0
5.0 - 5.5
4.5 - 5.0
4.0 - 4.5
3.5 - 4.0
3.0 - 3.5
2.5 - 3.0
2.0 - 2.5
< 2
Northern Areas
North-west Frontier
Federally Administered Tribal Areas
Azad Kashmir
Peshawar
Islamabad
Lahore
Faisalabad
Punjab
Karachi
USAID
NREL


Pakistan
Global Horizontal
Solar Radiation
Annual
kWh/m²/day
> 9
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0
5.0 - 5.5
4.5 - 5.0
4.0 - 4.5
3.5 - 4.0
3.0 - 3.5
2.5 - 3.0
2.0 - 2.5
< 2
Northern Areas
North-west Frontier
Federally Administered Tribal Areas
Azad Kashmir
Peshawar
Islamabad
Lahore
Faisalabad
Punjab
Quetta
Baluchistan
Sind
Hyderabad
Karachi
USAID
NREL

Quaid-e-Azam Solar Park Location on Map
Total Area = 11300 acres



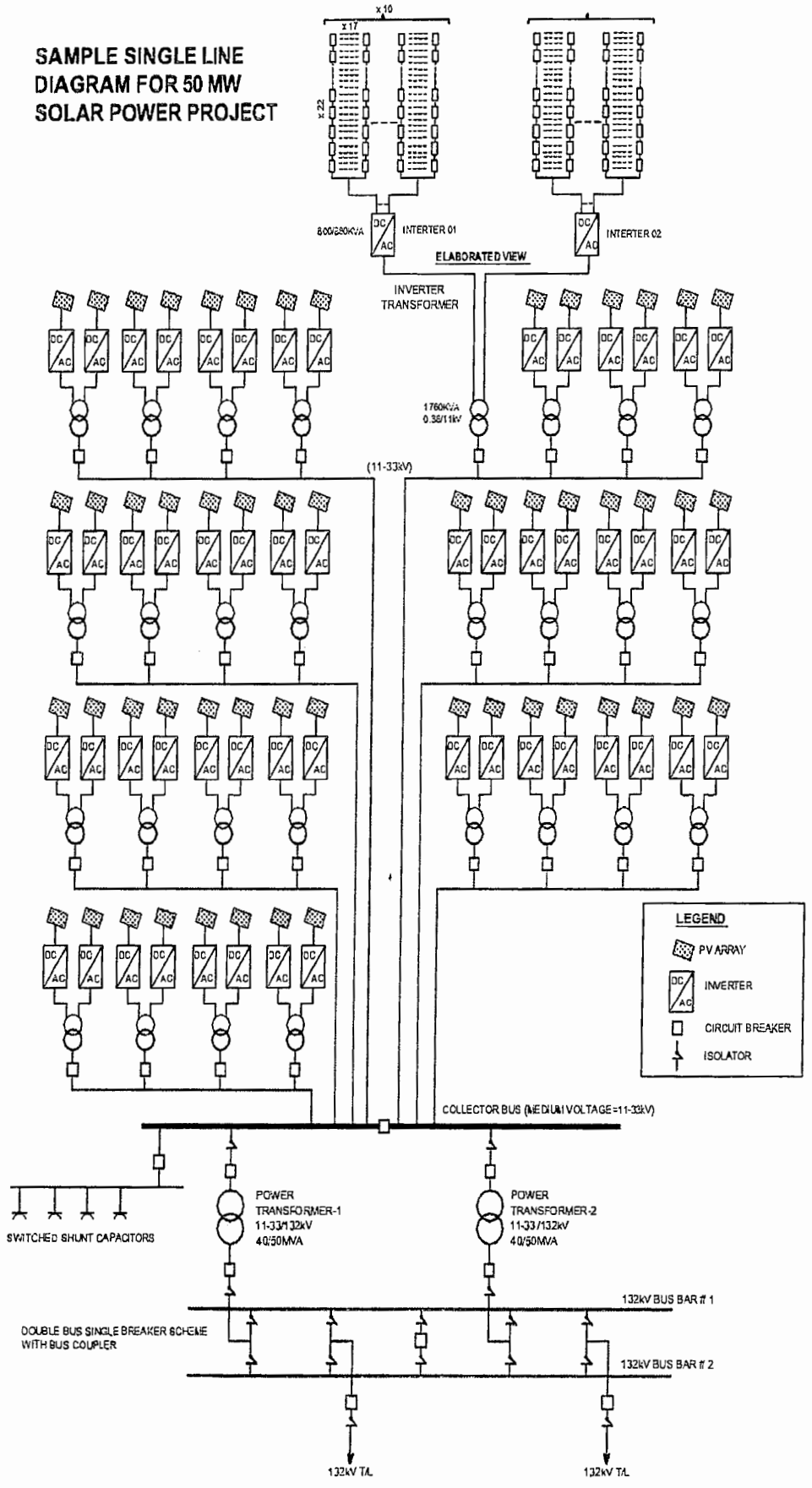
Note: Solar Power Plants can be placed between points B & C on 132 kV transmission line

Solar Power Capacity at Lal-Suhanra

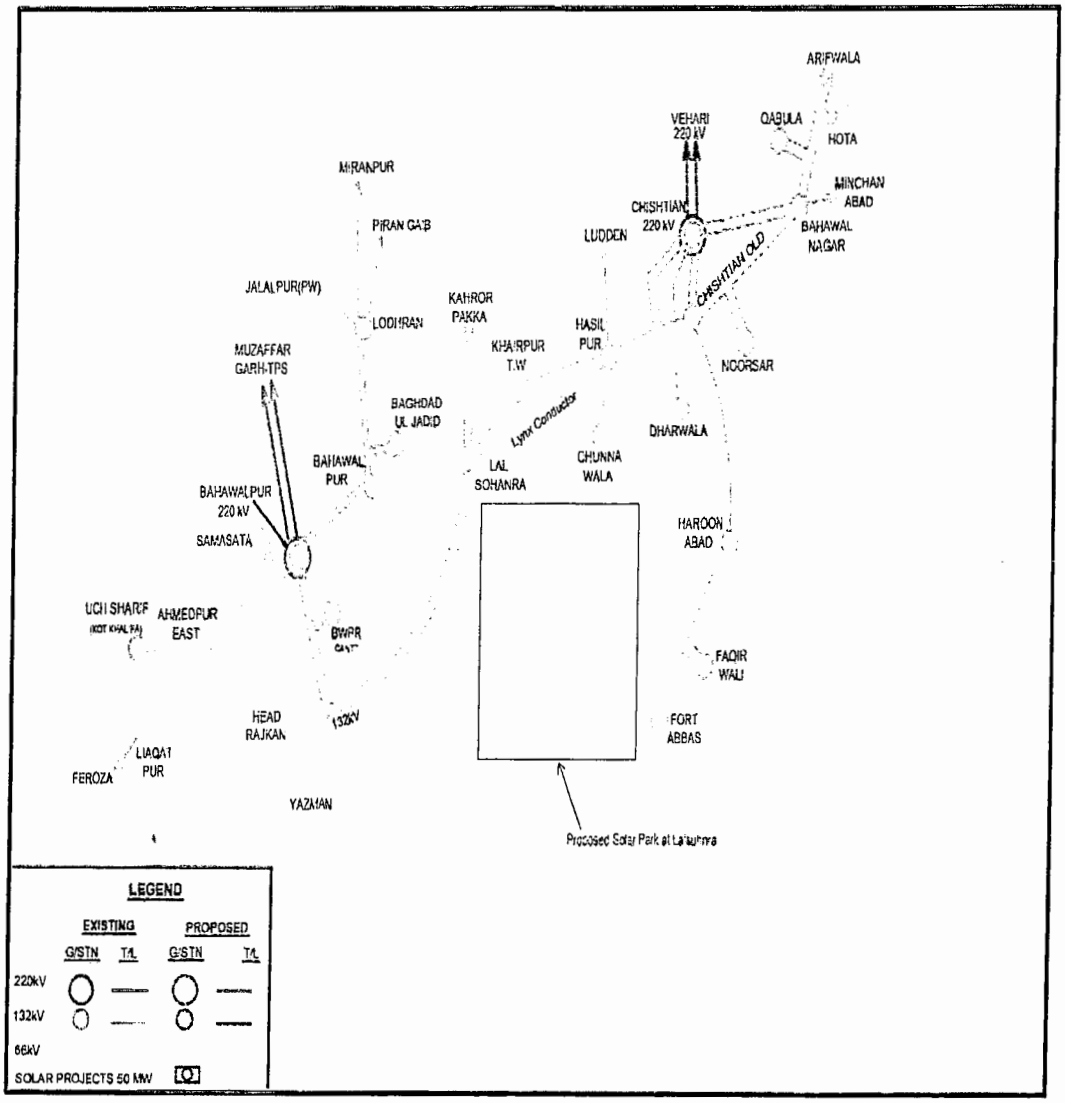
Proposed Phase	Proposed Capacity (MW)
Phase-I	100
Phase-II	300
Phase-III	600
Total	**1000**

Government of Punjab has allocated 11,300 acres of land for the solar park at Lal-Suhanra. Accordingly Ministry of Water and Power has directed NTDC to ensure evacuation of power from the said park through 220 kV Transmission Lines and MEPCO to evacuate power from 132 kV network.

SAMPLE SINGLE LINE DIAGRAM FOR 50 MW SOLAR POWER PROJECT



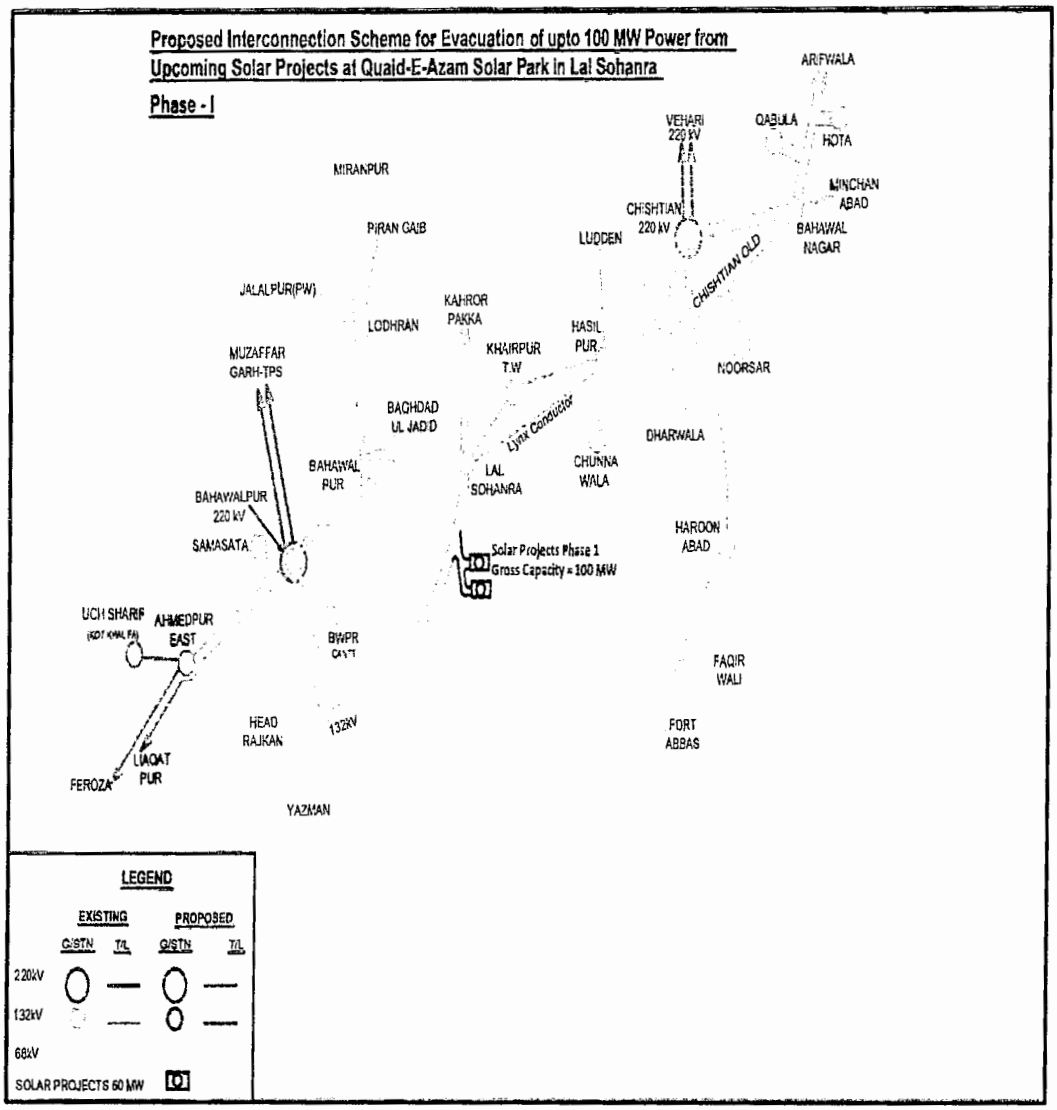
MEPCO System Network around Quaid-e-Azam Solar Park



MEPCO network around Quaid-e-Azam solar park comprises of 33 kV, 66 kV and 132 kV voltage levels.

Proposed Interconnection Scheme for evacuation of 1000 MW from Quaid-e-Azam Solar Power Park

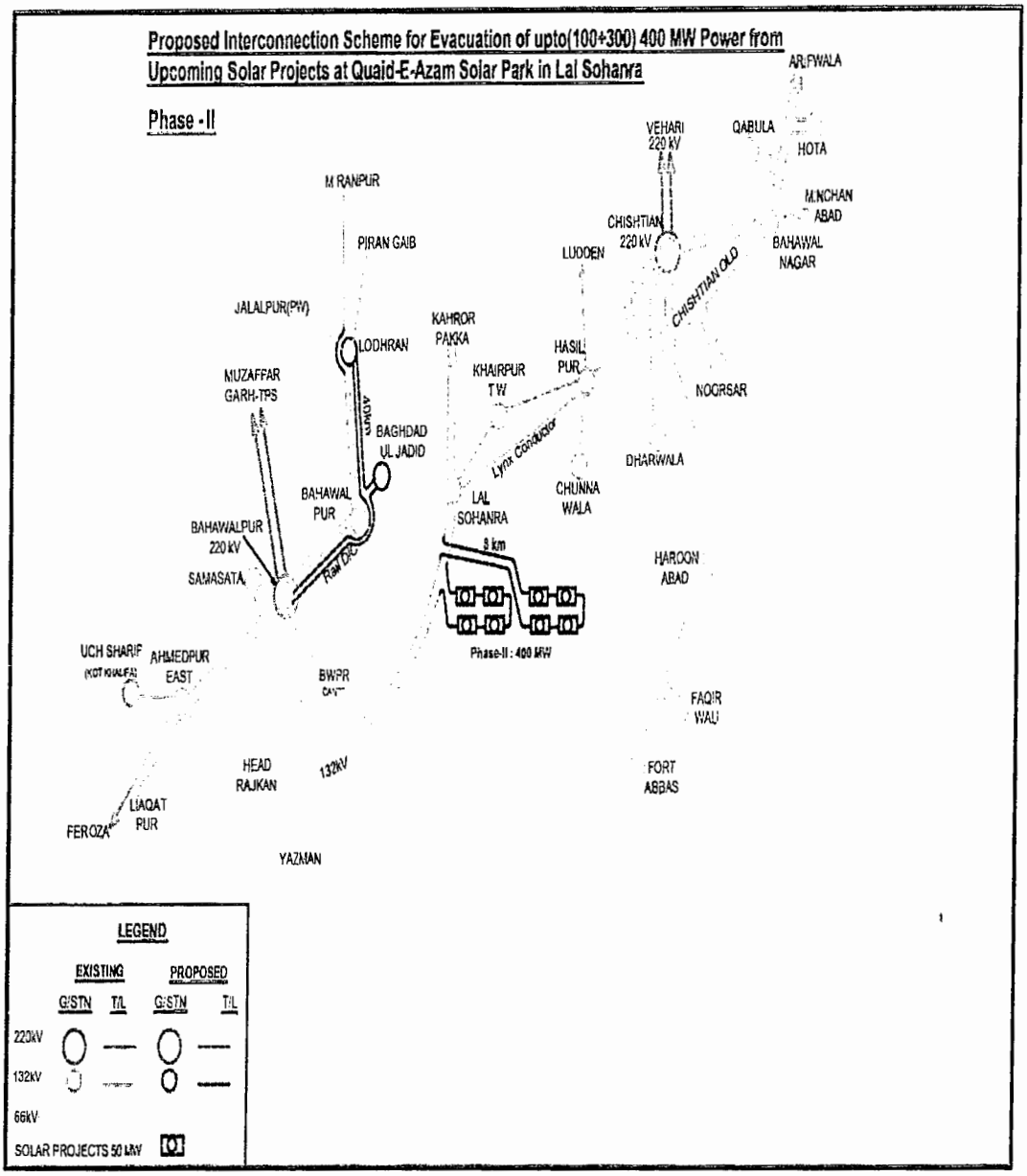
Phase – I (100 MW)



Scope of Work (To be Completed by MEPCO):

A 132 kV D/C transmission line approx. 4 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur – Lal Suhanra S/C at solar power plants.

Phase – II (300 MW)



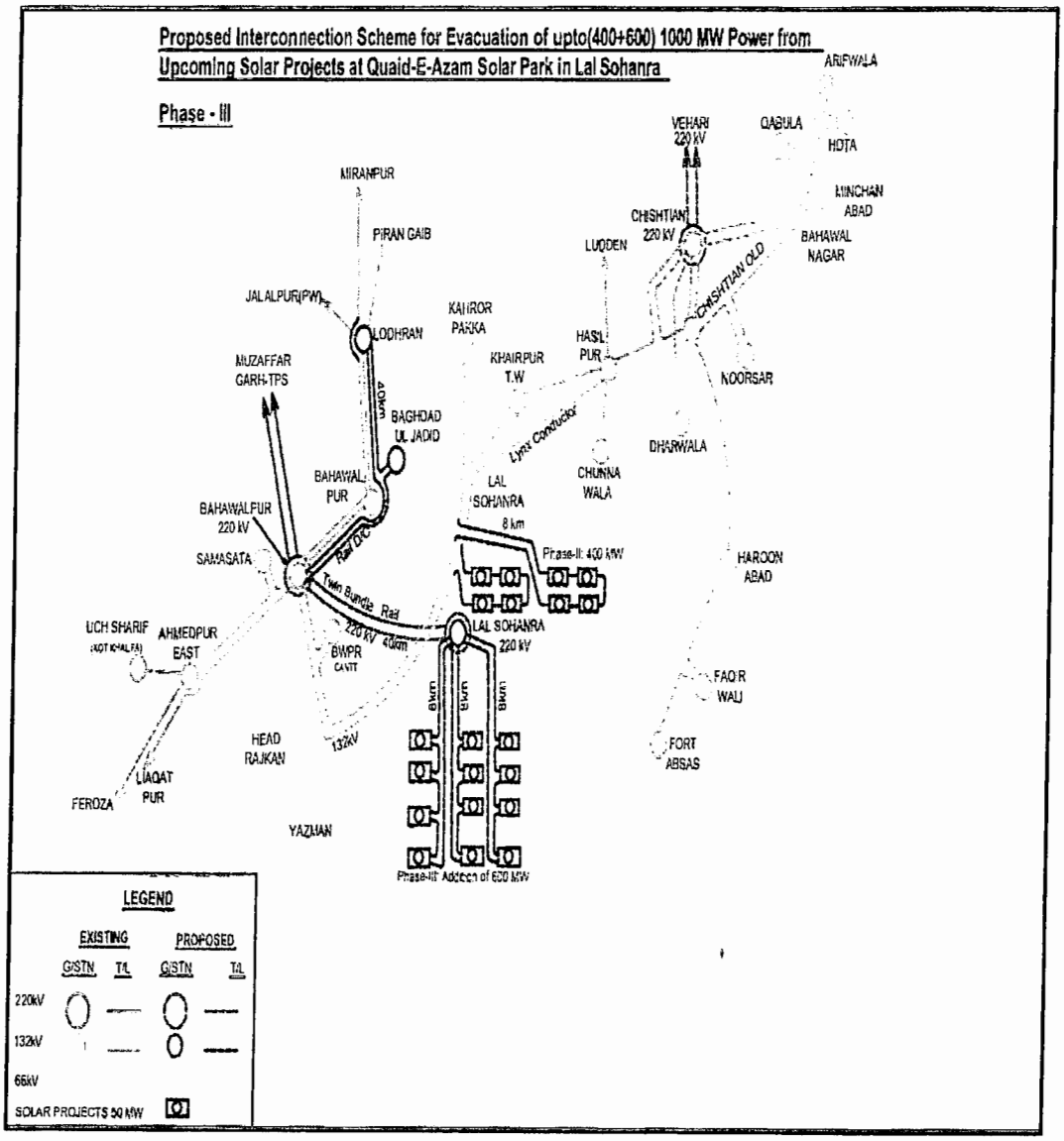
Scope of Work (To be Completed by MEPCO):

(i) A 132 kV D/C transmission line approx. 8 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur Cantt. – Lal Suhanra S/C at solar power plants.

(ii) A 132 kV D/C transmission line approx. 4 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur – Lal Suhanra S/C at solar power plants.

(iii) A 132 kV D/C transmission line approx. 40 km long on Rail conductor from Bahawalpur New to Lodhran & looping In/Out of one circuit at Baghdad-ul- Jaded.

Phase – III (600 MW)



Scope of Work (To be Completed by NTDC):

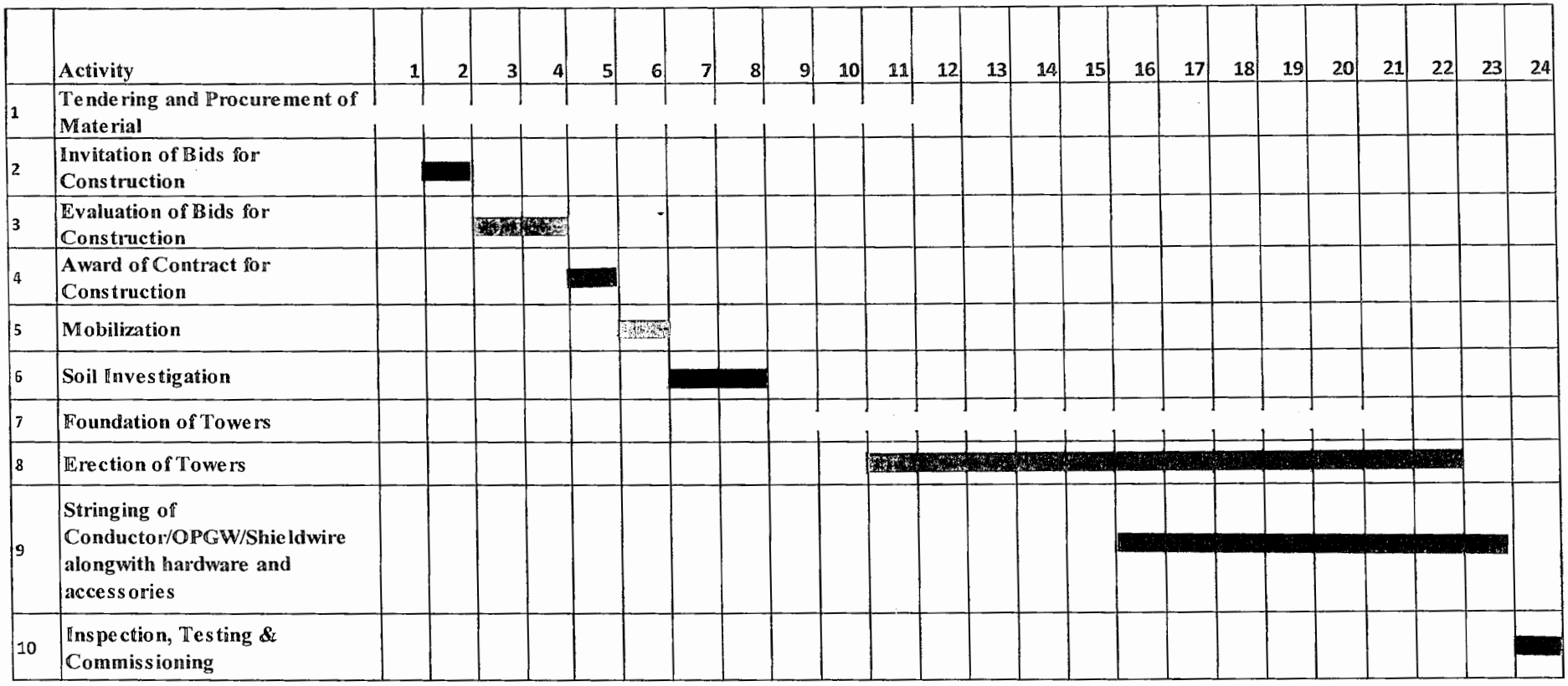
(i) A 220/132 kV collector substation at/around Lal Suhanra substation with 3x250MVA, 220/132 kV transformers.

(ii) A 220 kV D/C transmission line, approx. 40 km long on twin-bundled Rail conductor from 220 kV Lal Suhanra to Bahawalpur substation.

(iii) Three 132 kV D/C transmission lines, each approx. 8 km (total 24 km) long on Rail conductor, from 220 kV collector substations to individual solar power projects.

Schedule: Phase –III

Schedule of Construction of 220KV T/Line (No. of months)



	Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Tendering and Procurement of Material																								
2	Invitation of Bids for Construction																								
3	Evaluation of Bids for Construction																								
4	Award of Contract for Construction																								
5	Mobilization																								
6	Soil Investigation																								
7	Foundation of Towers																								
8	Erection of Towers																								
9	Stringing of Conductor/OPGW/Shieldwire alongwith hardware and accessories																								
10	Inspection, Testing & Commissioning																								

Project Completion Schedule of 220kV AIS Grid Station Quaid-e-Azam Solar Park

Sr.	Activity	Months																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Tendering and Procurement of Equipment																								
2	Invitation of Bid for Construction																								
3	Evaluation of Bids																								
4	Award of Contract																								
5	Mobilization																								
6	Soil Investigation																								
7	Equipment/ Control House Building Design Release																								
8	Civil Construction																								
9	Equipment Installaion																								
10	Testing & Commissioning																								

Approval Status of PC-I for Power Evacuation from Quaid-e-Azam Solar Park

PC-I for the evacuation of power from Quaid-e-Azam Solar Park at lal-Suhanra has been submitted to Ministry of Water & Power (MoW&P) for arranging approval from GoP. Simultaneously, MoW&P has already been requested to arrange anticipatory approval. A copy of formal request is attached in annexure.

Financing

It has been communicated through Government of Punjab Energy Department letter No. SO(P) ED/21-93/2013 that ADB has indicated availability of financing for Evacuation of Power from Quiad-e-Azam Solar Park. Ministry of Water and Power has advised NTDC to initiate formal request through proper channel to tap this financing window.

Summary of the Estimated Cost for Phase-III

Phase	Local (Rs. million)	FEC (Rs. million)	Total (Rs. million)
Phase-III	1659	1644	3303

Annexure

NATIONAL TRANSMISSION & DESPATCH CO. LTD

General Manager Planning (Power) NTDCL

No. GMPP/CEPP/MPP-I-249/6131-35 Date: 21.08.2013

Mr. Aftab Ahmed Nadeem
Joint Secretary (NTDCL)
Ministry of Water and Power
Govt. of Pakistan
Islamabad.

Subject Request for Anticipatory Approval

Dear Sir,

The request for anticipatory approval for the following projects on the prescribed format is attached herewith for processing and getting approval from the competent authority.

i) Interconnection scheme for dispersal of power from 1000 MW Quaid-e-Azam Solar Park near Yazman in Cholistan.

ii) Transmission interconnection scheme for dispersal of power from proposed 6600 MW Pakistan Power Park at Gadani (Balochistan) to National Grid

iii) 220 kV substations at Jhimpir & Gharo and extension at 500 kV substation Jamshoro for interconnection of Wind Power Plants.

With profound regards

DA/As above.

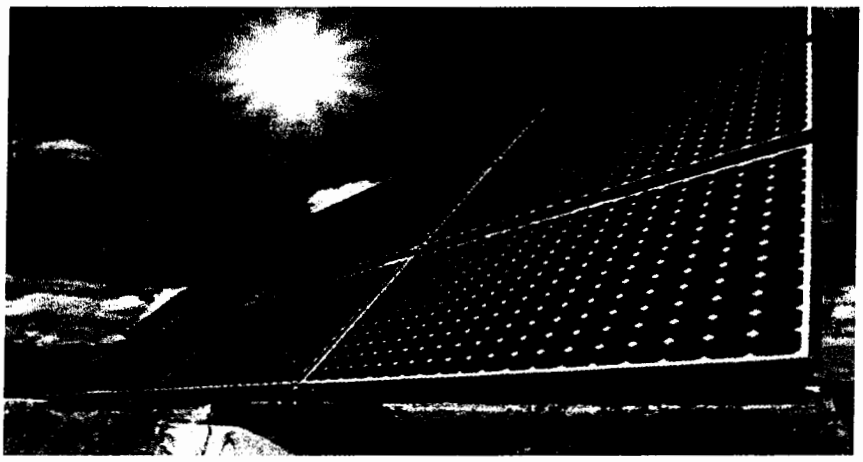
(Nisar Ahmad Bazmi)
General Manager Planning Power

For Info:

- MD NTDCL, WAPDA House, Lahore
- MD Punjab Power Development Board, Govt. of Punjab, Lahore.
- Sr. Chief Energy, Planning & Development Division, Govt. of Pakistan, Islamabad.
- GM (GSC), WAPDA House, Lahore

4th Floor, PIA Tower, Egerton Road, Lahore, Pakistan [illegible] www.ntdc.com

National Transmission and Despatch Company Limited (NTDCL)



Advanced Technical Studies Report for Evacuation of Power from 1000 MW Solar Power Plants in Quaid-e-Azam Solar Park at Lal Suhanra

Prepared by

Planning (Power) Department
5th Floor, PIA Tower, Egerton Road, Lahore.

January 2014

Table of Contents

Executive Summary

1. For interconnection of 1000 MW solar power plants at Quaid-e-Azam Solar Park at Lal Suhanra, detailed load flow studies have been already provided. In this report, the results of short circuit, transient stability and power quality studies have been presented.

2. The proposed interconnection scheme for evacuation of power from 1000 MW Solar power plants in the Solar Park at Lal Suhanra, is given as under:

Phase-1: First 100 MW Solar Power Evacuation at 132 kV Voltage

- A 132 kV D/C transmission line approx. 4 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur – Lal Suhanra S/C at solar power plants.

Phase-2: Additional 300 MW Solar Power Evacuation at 132 kV Voltage

- A 132 kV D/C transmission line approx. 8 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur Cantt. – Lal Suhanra S/C at solar power plants.
- A 132 kV D/C transmission line approx. 4 km long on Rail conductor for looping In/Out of the proposed 132 kV Bahawalpur – Lal Suhanra S/C at solar power plants.
- A 132 kV D/C transmission line approx. 40 km long on Rail conductor from Bahawalpur New to Lodhran & looping In/Out of one circuit at Baghdad-ul-Jaded.

Phase-3: Additional 600 MW Solar Power Evacuation at 220 kV Voltage

- A 220/132 kV collector substation at/around Lal Suhanra with 3x250MVA, 220/132 kV transformers.
- A 220 kV D/C transmission line, approx. 40 km long on twin-bundled Rail conductor from 220 kV Lal Suhanra to Bahawalpur substation.
- Three 132 kV D/C transmission lines, each approx. 8 km (total 24 km) long on Rail conductor, from 220 kV collector substations to individual solar power projects.

3. Since solar power technology is new in Pakistan, therefore, plant data from various equipment manufactures/suppliers is not available in Pakistan at present. The detailed parameters of 50 MW Solar PV plant by M/s DACC available in Planning Power NTDC, have been used for all the analysis in this report. These analyses

would be required to be carried out again at the interconnection/design stages of the solar power plants according to their equipment specifications.

4. 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 1000 MW solar power plants at Lal Suhanra. It is found that the proposed solar generation of 1000 MW has no adverse impact on the existing 220kV and 132 kV substations in their vicinity and the short circuit currents remain within installed switchgear ratings. On the other hand, standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 132 kV switchyards of solar plants and 220/132 kV substation at/around Lal Suhanra.

5. Transient stability analysis of the proposed interconnection scheme has been carried out using the NEPRA Grid Code Criteria. The stability of solar plants and the power system has been checked with application of faults at the 132 kV switchyard of solar plant and 220 kV substations of Lal Suhanra & Bahawalpur followed by the outage of the associated transmission lines. The solar power plants and the power system have been found strong enough to remain stable and synchronized with no adverse effects. In generation, the proposed scheme successfully passed the stability checks. The LVRT requirements as mentioned in Grid Code Addendum for solar power plants are also successfully met.

6. The issues of power quality with the induction of solar power plants have been studied in detail. The study results indicate that the power quality parameters remain within the permissible limits as mentioned in relevant IEC standard. In short, no power quality issues have been encountered in the studies. Moreover, this is the responsibility of developer of a solar power project to install necessary monitoring and compensating equipment at its switchyard to meet power quality standards as per requirements of Grid Code Addendum for solar power plants.

7. On the basis of above advanced technical analysis presented in this report, it is concluded that the proposed interconnection scheme has no technical constraints or problems in evacuation of power from 1000 MW solar PV power plants to the system networks of NTDC and MEPCO. It fulfills all the criteria of reliability and stability under short circuit and transient conditions. The power quality related parameters computed in the studies have also been found well within permissible limits. Therefore, the proposed interconnection scheme for evacuation of power from 1000 MW Quaid-e-Azam solar power park is recommended to be adopted.

1. Short Circuit Analysis

1.1 Methodology and Assumptions

The latest system network data of NTDC and MEPCO as available with Planning (Power) NTDC has been used.

The methodology of IEC 909 has been applied in all short circuit analysis in this report for which provision is available in the PSS/E software used for these studies. The maximum fault currents have been calculated with 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.

Since solar power is a quite new in Pakistan, therefore, plant data from various equipment manufactures/suppliers is not available in Pakistan. The detailed parameters of 50 MW Solar PV project by M/s DACC available in Planning Power NTDC, have been used for the short circuit analysis in this report.

1.2 Short Circuit Study Results

The short circuit studies have been carried out with proposed interconnection scope of work for 1000 MW solar power plants to compute the maximum three phase and single phase short circuit levels after induction of solar power plants for the year 2016-17. The studies have been carried out with all the existing and planned generation including 1000 MW solar plants in operation and with interconnected transmission system. The results of the short circuit studies for the year 2016-17 are summarized as under:

Name of Faulted Bus Bar	Voltage Level	Maximum Short Circuit Levels	
		Three Phase	Single Phase
Lal Suhanra-New	220 kV	8.27 kA	4.88 kA
Bahawalpur	220 kV	11.25 kA	6.99 kA
Lal Shuanra-New	132 kV	9.49 kA	6.50 kA
Bahawalpur-New Bus Bar-1	132 kV	6.87 kA	5.27 kA

Name of Faulted Bus Bar	Voltage Level	Maximum Short Circuit Levels	
		Three Phase	Single Phase
Bahawalpur-New Bus Bar-2	132 kV	12.83 kA	9.07 kA
Lal Suhanra (Old)	132 kV	6.97 kA	4.52 kA
Bahawalpur (Old)	132 kV	6.87 kA	4.96 kA
Bughdad-ul-Jadid	132 kV	7.39 kA	4.78 kA
Lodhran	132 kV	7.61 kA	5.08 kA
Solar PP-1	132 kV	6.66 kA	4.33 kA
Solar PP-2	132 kV	6.59 kA	4.27 kA
Solar PP-3	132 kV	6.53 kA	4.24 kA
Solar PP-4	132 kV	6.48 kA	4.42 kA
Solar PP-5	132 kV	6.73 kA	4.35 kA
Solar PP-6	132 kV	6.68 kA	4.33 kA
Solar PP-7	132 kV	6.65 kA	4.31 kA
Solar PP-8	132 kV	6.61 kA	4.30 kA
Solar PP-9	132 kV	9.11 kA	6.31 kA
Solar PP-10	132 kV	8.75 kA	6.14 kA
Solar PP-11	132 kV	8.55 kA	6.03 kA
Solar PP-12	132 kV	8.48 kA	5.96 kA
Solar PP-13	132 kV	9.11 kA	6.31 kA
Solar PP-14	132 kV	8.75 kA	6.14 kA
Solar PP-15	132 kV	8.55 kA	6.03 kA
Solar PP-16	132 kV	8.48 kA	5.96 kA
Solar PP-17	132 kV	9.11 kA	6.31 kA
Solar PP-18	132 kV	8.75 kA	6.14 kA
Solar PP-19	132 kV	8.55 kA	6.03 kA
Solar PP-20	132 kV	8.48 kA	5.96 kA

1.3 Conclusions of Short Circuit Analysis

It is evident from the above table that the induction of 1000 MW solar power plants have no adverse impact on the existing 220 kV and 132 kV substations in their vicinity and the short circuit currents remain within installed switchgear

ratings. Moreover, the standard switchgear of the short circuit rating of 40 kA would be sufficient to be installed at 132kV switchyards of solar plants and 220/132 kV substation at Lal Suhanra. The detailed results of short circuit studies are attached in Appendix-1.

2 Transient Stability Analysis

Transient stability studies have been carried out to evaluate the response of generator (angle and speed), bus voltage, frequency, active/reactive power flows on transmission lines etc. after occurrences of faults. The transient stability simulations are used to check whether the system acquire a stable state with good damping of transients due to non-linearity in the system or it would go astray and get unstable.

2.1 Stability Criteria:

Transient stability studies have been carried out to assess the dynamic performance of the solar power plants and grid after being subjected to the following disturbances as given in NEPRA's Grid Code:

- Permanent three-phase fault on any transmission line and associated components. It is assumed that the fault will be cleared in 5 cycles.
- 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 above stability criteria for a conventional power plant, the following Low Voltage Ride Through (LVRT) requirements are also to be met by solar power plant as mentioned in the Grid Code Addendum which is under approval in NEPRA.

2.2 Low Voltage Ride Through (LVRT) Requirements

- A PV Solar Power Project must withstand a voltage dip down to 30% Retained Voltage for a duration of at least 100 ms for a normal clearing case and at least for 180 ms in case of Stuck Breaker.
- 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.

The LVRT requirements for the solar power plants can be observed from the results of transient stability simulations carried out in this section.

2.3 Methodology and Assumptions

As explained in previous section, plant data from various equipment manufactures/suppliers is not available in Pakistan. The detailed dynamic model

parameters 50 MW Solar PV plant by M/s DACC, available in Planning Power NTDC, have been used for the transient stability analysis with the induction of 1000 MW solar plants in Quad-e-Azam solar park at Lal Suhanra in this report.

The simulations have been run in time domain 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.

2.4 Modelling of Solar Power Plant

Transient stability studies have been carried out using following generic models available in the PSS/E model library for solar power plant;

Generator Model	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1
Solar Radiation Model	IRRADU1

The parameters for the above generic models have been assumed as of the 50MW solar power project sponsored by M/s DACC (attached in Appendix-2) as mentioned in Section 1.1. It is important to intimate that the transient stability analysis of each solar power plant will be required to be carried out at later stage during detailed interconnection study/design stages according to the specifications of the equipment used in power plants.

The geographical diagram showing the scope of work for the proposed solar generation is shown in Figure#1 and the load flow plot on which the stability analysis is based for the system scenario of Aug/Sep 2016 when solar power output would be maximum, is attached as Exhibit#1-A. Solar PP-1 has been modelled in detailed with the following scheme;

- The proposed Solar PP-1 would generate power at low voltage of 0.3 kV (after DC/AC conversion) which would be stepped up to a medium voltage of 22 kV through 22/0.3 kV transformers.
- Five collector groups of 8.6 MW each to be connected to a 22 kV collector station bus bar which would be stepped up to high voltage of 132 kV through 132/22 kV transformers.

2.5 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 Plant

The transient stability studies for 5 cycles fault during peak load condition of Aug/Sep 2016 (summer season) for the 1000 MW solar power plants have been carried out. The plotted results of the simulations are attached as Appendix-3. 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 Bahawalpur 220 kV bus cleared in 5 cycles and the outage of Bahawalpur to Lal Suhanra-New 220 kV single circuit.	1	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		2	Bus Voltage	
		3	P & Q Line Flows	
		4	P & Q of Solar Plant	
2	3-phase fault at Lal Suhanra-New 220 kV bus cleared in 5 cycles and the outage of Bahawalpur to Lal Suhanra-New 220kV single circuit.	5	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		6	Bus Voltage	
		7	P & Q Line Flows	
		8	P & Q of Solar Plant	
3	3-phase fault at Bahawalpur 132 kV bus cleared in 5 cycles and the outage of Bahawalpur to Solar PP-4 132 kV single circuit.	9	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		10	Bus Voltage	
		11	P & Q Line Flows	
		12	P & Q of Solar Plant	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
4	3-phase fault at Lal Suhanra-New 132kV bus cleared in 5 cycles and the outage of Lal Suhanra-New to Solar PP-12 132 kV single circuit.	13	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		14	Bus Voltage	
		15	P & Q Line Flows	
		16	P & Q of Solar 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-5 132 kV single circuit.	17	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		18	Bus Voltage	
		19	P & Q Line Flows	
		20	P & Q of Solar 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-1 132 kV single circuit.	21	Frequency	Solar power plants and NTDC/MEPCO systems remain stable
		22	Bus Voltage	
		23	P & Q Line Flows	
		24	P & Q of Solar Plant	
7	3-phase fault at Solar PP-1 132 kV bus cleared in 5 cycles and the outage Lal Suhnara (old) to Solar PP-1 132 kV single circuit.	25	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		26	Bus Voltage	
		27	P & Q Line Flows	
		28	P & Q of Solar Plant	
8	3-phase fault at Solar PP-1 132 kV bus cleared in 5 cycles and the outage Solar PP-2 to Solar PP-1 132 kV single circuit.	29	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		30	Bus Voltage	
		31	P & Q Line Flows	
		32	P & Q of Solar Plant	
9	3-phase fault at Solar PP-1 22 kV bus cleared in 5 cycles and	33	Frequency	Solar power plants and NTDC/MEPCO
		34	Bus Voltage	
		35	P & Q Line Flows	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	the outage of Solar PP-1 collector station (10MW).	36	P & Q of Solar Plant	systems remain stable. No LVRT problem at Solar Plant.
10	3-phase fault at Solar PP-1 132 kV bus cleared in 5 cycles and the outage of 132/22kV transformer.	37	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		38	Bus Voltage	
		39	P & Q Line Flows	
		40	P & Q of Solar Plant	

The transient stability studies for 9 cycles fault (stuck breaker) during peak load conditions of Aug/Sep 2016 (summer season) for the 1000 MW solar power plants has been carried out. The plotted results of the simulations are attached as Appendix-3. 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 Bahawalpur 220 kV bus cleared in 9 cycles and the outage of Bahawalpur to Lal Suhanra-New 220 kV single circuit.	41	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		42	Bus Voltage	
		43	P & Q Line Flows	
		44	P & Q of Solar Plant	
2	3-phase fault at Lal Suhanra-New 220 kV bus cleared in 9 cycles and the outage of Bahawalpur to Lal Suhanra-New 220kV single circuit.	45	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant..
		46	Bus Voltage	
		47	P & Q Line Flows	
		48	P & Q of Solar Plant	
3	3-phase fault at Bahawalpur 132 kV bus cleared in 9 cycles and the outage of Bahawalpur to Solar PP-4 132 kV single circuit.	49	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant..
		50	Bus Voltage	
		51	P & Q Line Flows	
		52	P & Q of Solar Plant	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
4	3-phase fault at Lal Suhanra-New 132kV bus cleared in 9 cycles and the outage of Lal Suhanra-New to Solar PP-12 132 kV single circuit.	53	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		54	Bus Voltage	
		55	P & Q Line Flows	
		56	P & Q of Solar Plant	
5	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.	57	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		58	Bus Voltage	
		59	P & Q Line Flows	
		60	P & Q of Solar 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-1 132 kV single circuit.	61	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		62	Bus Voltage	
		63	P & Q Line Flows	
		64	P & Q of Solar Plant	
7	3-phase fault at Solar PP-1 132 kV bus cleared in 9 cycles and the outage Lal Suhnara (old) to Solar PP-1 132 kV single circuit.	65	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		66	Bus Voltage	
		67	P & Q Line Flows	
		68	P & Q of Solar Plant	
8	3-phase fault at Solar PP-1 132 kV bus cleared in 9 cycles and the outage Solar PP-2 to Solar PP-1 132 kV single circuit.	69	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		70	Bus Voltage	
		71	P & Q Line Flows	
		72	P & Q of Solar Plant	
9	3-phase fault at Solar PP-1 22 kV bus cleared in 9 cycles and the outage of Solar PP-1 collector station (10MW).	73	Frequency	Solar power plants and NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		74	Bus Voltage	
		75	P & Q Line Flows	
		76	P & Q of Solar Plant	
10	3-phase fault at Solar PP-1 132 kV bus	77	Frequency	Solar power plants and
		78	Bus Voltage	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	cleared in 9 cycles and the outage of 132/22 kV transformer.	79	P & Q Line Flows	NTDC/MEPCO systems remain stable. No LVRT problem at Solar Plant.
		80	P & Q of Solar Plant	

2.6 Conclusions of Transient Stability Analysis

The results of transient stability analysis indicate that the NTDC/MEPCO systems connecting with solar power plants through the proposed interconnection scheme 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 solar power plants also fulfil the requirements of LVRT and the rate of power restoration after voltage dip is faster than 20% per second as required in Grid Code.

In general, there is no problem of transient stability and LVRT pertaining to the proposed interconnection of the solar power plants; and the power system and the solar power plant remain stable when subjected to severe disturbances.

3. 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 has been carried out for the worst case scenario of minimum system short circuit levels in year 2016-17 for the interconnection scheme of solar power plants at Lal Suhanra.

3.1 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$\sum$ and long time flicker level P1t$\sum$ 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 Solar PP-1 plant.

For the minimum short circuit case, the system network in the vicinity of solar power park has been modeled with minimum generation in operation, especially, in Muzaffargarh, Kot Addu & Multan areas and the generation in solar park has been reduced to 50%. The short circuit calculations have been done at 0.9 p.u. voltage. All the invertors of a solar power plant under study (plant PP-1) 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 = 0.3 MVA

N_{WT} = 143

S_k for 132 kV bus = 1257.2 MVA

Using the above data in Equation (A), we get

$P_{St\Sigma} = P_{lt\Sigma} = 0.002852 = 0.28\%$

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 Solar PP-1 power plant would not cause any flicker problem during steady state operation even in the weakest system conditions.

3.2 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 our simulated case, the short circuit power and apparent power come out as under:

S_{kV} = Short circuit power at the PCC = 1234.75 MVA

S_{max} = Maximum apparent power of one collector group connected to the PCC = 8.4 MVA

Using above values in Equation (B), we get

K_{kl} = Voltage Step-change factor = 146.99

It corresponds to 0.68% (1/146.99) 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 a 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 our case, the values of short circuit power and apparent power come out as under:

$S_{kV.}$ = 1234.75 MVA

S_{rE} = 0.3 MVA

Using above values in Equation (C), we get

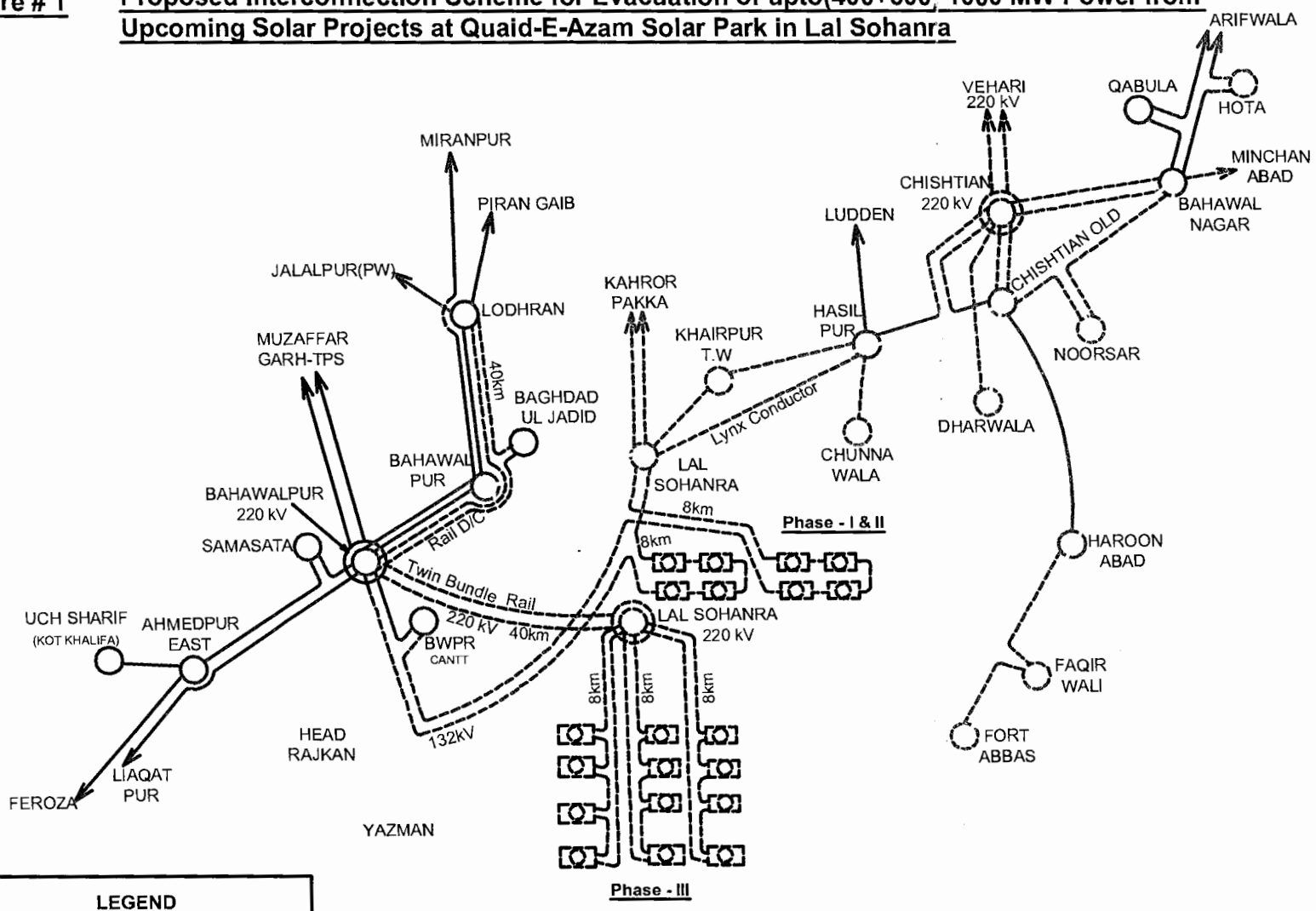
U_a = 0.000234 = 0.0234%

The above voltage variation is far less the acceptable limit of 2.34% in IEC Standard.

3.3 Conclusions of Power Quality Analysis

The important power quality parameters like flicker and voltage unbalance, with the inclusion of solar power plants, have been computed for the worst case scenario and compared with IEC permissible standards. The study results indicate that the levels of flicker and voltage unbalance are within the permissible limits of IEC, and therefore, pose no technical constraints pertaining to power quality issues with the interconnection of solar power plants at Quaid-e-Azam solar park at Lal Suhanra.

Figure # 1 **Proposed Interconnection Scheme for Evacuation of upto(400+600) 1000 MW Power from Upcoming Solar Projects at Quaid-E-Azam Solar Park in Lal Sohanra**

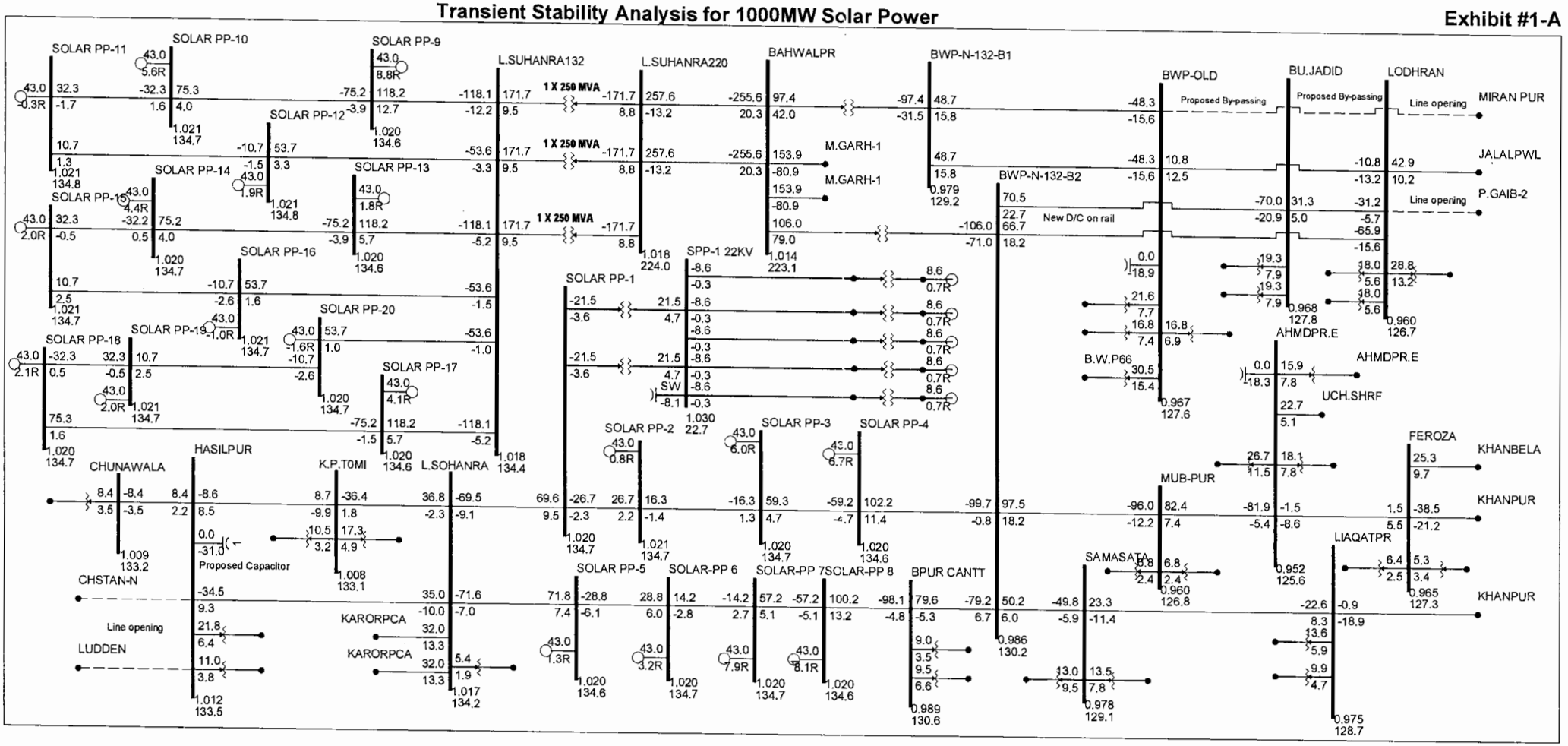


LEGEND

	EXISTING		PROPOSED	
	G/STN	T/L	G/STN	T/L
220kV	○	——	○	-----
132kV	○	——	○	-----
66kV				
SOLAR PROJECTS 50 MW	[○]			

Transient Stability Analysis for 1000MW Solar Power

Exhibit #1-A



Appendix-1

Short Circuit Study Exhibits

SHORT CIRCUIT CASE 2016

X---------- BUS ----------X		<-SCMVA-> MVA	<-Sym I''k rms--> /I/ AMP	AN(I) DEG
550 [BAHWALPR 220.00]	3PH	4285.96	11247.7	-63.25
	LG	2662.58	6987.5	-61.41

THEVENIN IMPEDANCE, X/R (OHM) Z+:2.074+j14.513, 6.99742 Z-:2.074+j14.512, 6.99611 Z0:8.110+j40.701, 5.01862

X---------- BUS ----------X		<-SCMVA-> MVA	<-Sym I''k rms--> /I/ AMP	AN(I) DEG
765 [L.SUHANRA220220.00]	3PH	3147.94	8261.2	-61.35
	LG	1859.40	4879.7	-58.79

THEVENIN IMPEDANCE, X/R (OHM) Z+:2.827+j20.214, 7.15136 Z-:2.827+j20.213, 7.15039 Z0:13.272+j61.496, 4.63359

X---------- BUS ----------X		<-SCMVA-> MVA	<-Sym I''k rms--> /I/ AMP	AN(I) DEG
7650 [L.SUHANRA132132.00]	3PH	2208.52	9659.8	-60.34
	LG	1496.27	6544.5	-57.56

THEVENIN IMPEDANCE, X/R (OHM) Z+:1.018+j10.762, 10.57597 Z-:1.018+j10.762, 10.57467 Z0:4.778+j25.856, 5.41159

X---------- BUS ----------X		<-SCMVA-> MVA	<-Sym I''k rms--> /I/ AMP	AN(I) DEG
7139 [BWPN-1 132.00]	3PH	2931.35	12821.3	-61.75
	LG	2070.61	9056.6	-61.00

THEVENIN IMPEDANCE, X/R (OHM) Z+:1.206+j7.787, 6.45600 Z-:1.206+j7.787, 6.45486 Z0:3.140+j17.430, 5.55157

X---------- BUS ----------X		<-SCMVA-> MVA	<-Sym I''k rms--> /I/ AMP	AN(I) DEG
7138 [BWNP-2 132.00]	3PH	1569.13	6863.2	-62.65
	LG	1204.93	5270.2	-62.92

THEVENIN IMPEDANCE, X/R (OHM) Z+:2.085+j14.389, 6.90077 Z-:2.085+j14.389, 6.90017 Z0:3.711+j27.475, 7.40396

X---------- BUS ----------X		<-SCMVA-> MVA	<-Sym I''k rms--> /I/ AMP	AN(I) DEG
7140 [BHAWALPR 132.00]	3PH	1563.31	6837.7	-61.03
	LG	1133.02	4955.7	-60.94

THEVENIN IMPEDANCE, X/R (OHM) Z+:2.497+j14.407, 5.77081 Z-:2.497+j14.407, 5.77036 Z0:5.433+j30.806, 5.67020

X---------- BUS ----------X		<-SCMVA-> MVA	<-Sym I''k rms--> /I/ AMP	AN(I) DEG

```
  7130 [BU.JADID    132.00] 3PH    1687.9(     7382.6    -60.81
                            LG     1091.3(     4773.5    -59.77
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:2.332+j13.455, 5.76994  Z-:2.332+j13.454, 5.76941  Z0:7.286+j35.310, 4.84652
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                                /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7120 [LODHRAN     132.00] 3PH    1738.71    7604.9    -60.88
                            LG     1159.33    5070.8    -59.90
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:2.268+j13.018, 5.73975  Z-:2.268+j13.017, 5.73924  Z0:6.666+j32.352, 4.85301
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                                /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  6419 [L.SOHANRA   132.00] 3PH    1593.26    6968.7    -54.37
                            LG     1031.81    4513.0    -54.45
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.503+j15.096, 4.30972  Z-:3.503+j15.095, 4.30923  Z0:9.133+j39.760, 4.35352
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                                /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7651 [SOLAR PP-1  132.00] 3PH    1522.36    6658.6    -54.54
                            LG      981.77    4294.1    -54.43
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.540+j15.898, 4.49025  Z-:3.541+j15.897, 4.48978  Z0:9.526+j42.129, 4.42261
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                                /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7652 [SOLAR PP-2  132.00] 3PH    1507.55    6593.8    -54.61
                            LG      976.40    4270.6    -54.45
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.543+j16.067, 4.53541  Z-:3.543+j16.067, 4.53494  Z0:9.537+j42.242, 4.42943
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                                /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7653 [SOLAR PP-3  132.00] 3PH    1494.32    6535.9    -54.74
                            LG      971.11    4247.5    -54.52
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.540+j16.211, 4.57934  Z-:3.540+j16.210, 4.57887  Z0:9.547+j42.351, 4.43601
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                                /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7654 [SOLAR PP-4  132.00] 3PH    1482.17    6482.8    -54.91
                            LG      965.65    4223.6    -54.64
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.533+j16.329, 4.62220  Z-:3.533+j16.329, 4.62173  Z0:9.557+j42.456, 4.44234
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
```

```
                                                    /I/    AN(I)
X---------- BUS ----------X                  MVA     AMP      DEG
  7655 [SOLAR PP-5  132.00] 3PH            1539.52   6733.6   -54.60
                            LG              994.73   4350.8   -54.49
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.494+j15.709, 4.49622  Z-:3.494+j15.709, 4.49575  Z0:9.367+j41.491, 4.42937
-------------------------------------------------------------------------------------------------------------------

                                  <-SCMVA-> <-Sym I''k rms-->
                                                    /I/    AN(I)
X---------- BUS ----------X                  MVA     AMP      DEG
  7656 [SOLAR-PP 6  132.00] 3PH            1529.38   6689.3   -54.69
                            LG              991.05   4334.7   -54.52
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.482+j15.824, 4.54406  Z-:3.482+j15.823, 4.54358  Z0:9.370+j41.563, 4.43560
-------------------------------------------------------------------------------------------------------------------

                                  <-SCMVA-> <-Sym I''k rms-->
                                                    /I/    AN(I)
X---------- BUS ----------X                  MVA     AMP      DEG
  7657 [SOLAR-PP 7  132.00] 3PH            1520.73   6651.5   -54.83
                            LG              987.41   4318.8   -54.61
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.466+j15.911, 4.59085  Z-:3.466+j15.911, 4.59038  Z0:9.373+j41.630, 4.44158
-------------------------------------------------------------------------------------------------------------------

                                  <-SCMVA-> <-Sym I''k rms-->
                                                    /I/    AN(I)
X---------- BUS ----------X                  MVA     AMP      DEG
  7658 [SOLAR-PP 8  132.00] 3PH            1513.29   6618.9   -55.02
                            LG              983.67   4302.4   -54.74
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:3.445+j15.972, 4.63680  Z-:3.445+j15.972, 4.63633  Z0:9.375+j41.693, 4.44731
-------------------------------------------------------------------------------------------------------------------

                                  <-SCMVA-> <-Sym I''k rms-->
                                                    /I/    AN(I)
X---------- BUS ----------X                  MVA     AMP      DEG
  7659 [SOLAR PP-9  132.00] 3PH            2083.53   9113.1   -59.86
                            LG             1443.68   6314.5   -57.32
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.148+j11.428, 9.95287  Z-:1.148+j11.428, 9.95177  Z0:4.862+j26.355, 5.42043
-------------------------------------------------------------------------------------------------------------------

                                  <-SCMVA-> <-Sym I''k rms-->
                                                    /I/    AN(I)
X---------- BUS ----------X                  MVA     AMP      DEG
  7660 [SOLAR PP-10 132.00] 3PH            2002.19   8757.3   -59.54
                            LG             1405.33   6146.7   -57.15
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.242+j11.904, 9.58802  Z-:1.242+j11.904, 9.58703  Z0:4.941+j26.807, 5.42567
-------------------------------------------------------------------------------------------------------------------

                                  <-SCMVA-> <-Sym I''k rms-->
                                                    /I/    AN(I)
X---------- BUS ----------X                  MVA     AMP      DEG
  7661 [SOLAR PP-11 132.00] 3PH            1955.83   8554.5   -59.37
                            LG             1379.28   6032.8   -57.06
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.298+j12.190, 9.39423  Z-:1.298+j12.190, 9.39329  Z0:5.014+j27.212, 5.42747
```

```
                                  <-SCMVA-> <-Sym I''k rms-->
                                              /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7662 [SOLAR PP-12 132.00] 3PH    1940.09    8485.7   -59.35
                            LG     1364.39    5967.7   -57.05
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.316+j12.285, 9.33315  Z-:1.316+j12.285, 9.33224  Z0:5.081+j27.569, 5.42600
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                              /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7663 [SOLAR PP-13 132.00] 3PH    2083.18    9111.5   -59.85
                            LG     1443.44    6313.4   -57.31
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.148+j11.428, 9.95287  Z-:1.148+j11.428, 9.95177  Z0:4.862+j26.355, 5.42043
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                              /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7664 [SOLAR PP-14 132.00] 3PH    2001.86    8755.9   -59.53
                            LG     1405.10    6145.7   -57.14
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.242+j11.904, 9.58802  Z-:1.242+j11.904, 9.58703  Z0:4.941+j26.807, 5.42567
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                              /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7665 [SOLAR PP-15 132.00] 3PH    1955.56    8553.4   -59.37
                            LG     1379.09    6032.0   -57.05
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.298+j12.190, 9.39423  Z-:1.298+j12.190, 9.39329  Z0:5.014+j27.212, 5.42747
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                              /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7666 [SOLAR PP-16 132.00] 3PH    1939.77    8484.3   -59.34
                            LG     1364.16    5966.7   -57.04
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.316+j12.285, 9.33315  Z-:1.316+j12.285, 9.33224  Z0:5.081+j27.569, 5.42600
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                              /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7667 [SOLAR PP-17 132.00] 3PH    2083.18    9111.5   -59.85
                            LG     1443.44    6313.4   -57.31
THEVENIN IMPEDANCE, X/R  (OHM)    Z+:1.148+j11.428, 9.95287  Z-:1.148+j11.428, 9.95177  Z0:4.862+j26.355, 5.42043
-------------------------------------------------------------------------------------------------------------------
                                  <-SCMVA-> <-Sym I''k rms-->
                                              /I/    AN(I)
X---------- BUS ----------X          MVA        AMP      DEG
  7668 [SOLAR PP-18 132.00] 3PH    2001.75    8755.4   -59.53
```

```
                                LG    1405.0[redacted]   6145.4   -57.14
THEVENIN IMPEDANCE, X/R  (OHM)     Z+:1.24[redacted]1.904, 9.58802  Z-:1.242+j11.904, 9.58[redacted]  Z0:4.941+j26.807, 5.42567
-------------------------------------------------------------------------------------------------------------------------------
                                <-SCMVA-> <-Sym I''k rms-->
                                             /I/    AN(I)
X---------- BUS ----------X         MVA       AMP      DEG
  7669 [SOLAR PP-19 132.00] 3PH   1955.45    8552.9   -59.37
                                LG    1379.01    6031.6   -57.05
THEVENIN IMPEDANCE, X/R  (OHM)     Z+:1.298+j12.190, 9.39423  Z-:1.298+j12.190, 9.39329  Z0:5.014+j27.212, 5.42747
-------------------------------------------------------------------------------------------------------------------------------
                                <-SCMVA-> <-Sym I''k rms-->
                                             /I/    AN(I)
X---------- BUS ----------X         MVA       AMP      DEG
  7670 [SOLAR PP-20 132.00] 3PH   1939.66    8483.8   -59.34
                                LG    1364.08    5966.3   -57.04
THEVENIN IMPEDANCE, X/R  (OHM)     Z+:1.316+j12.285, 9.33315  Z-:1.316+j12.285, 9.33224  Z0:5.081+j27.569, 5.42600
-------------------------------------------------------------------------------------------------------------------------------
```

Appendix-2

50 MW Solar PV Plant Model Parameters

50 MW Solar PV Plant Model Parameters

(Sponsored by M/s DACC)

PVGU1 Model Parameters	
0.02	TIQCmd, Converter time constant for IQcmd, second
0.02	TIpCmd, Converter time constant for IPcmd, second
0.4	VLVPL1 - Low Voltage power Logic (LVPL), voltage 1 (pu)
0.9	VLVPL2 - LVPL voltage 2 (pu)
1.11	GLVPL - LVPL gain
1.2	High Voltage reactive Current (HVRC) logic,voltage (pu)
2	CURHVRCR - HVRC logic, current (pu)
2	RIp_LVPL, Rate of active current change
0.02	T_LVPL, Voltage sensor for LVPL, second

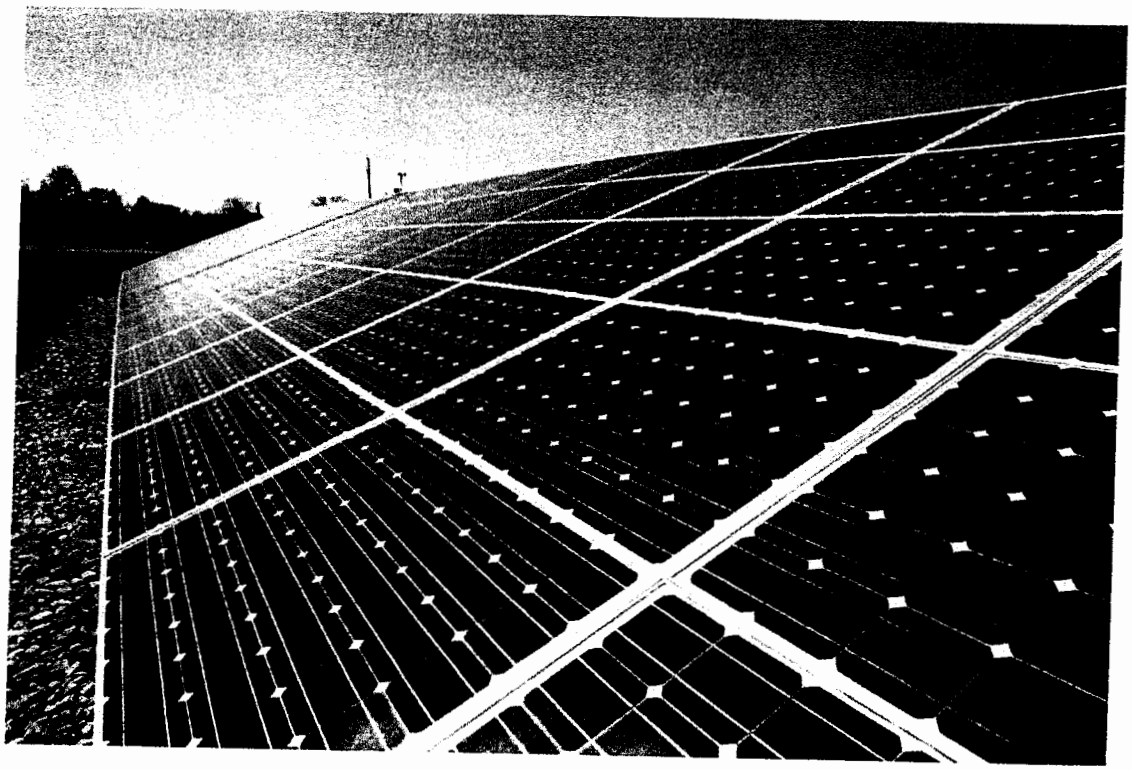
PVEU1 Model Parameters	
0.15	Tfv - V-regulator filter
18	Kpv - V-regulator proportional gain
5	Kiv - V-regulator integrator gain
0.05	Kpp - T-regulator proportional gain
0.1	Kip - T-regulator integrator gain
0	Kf - Rate feedback gain
0.08	Tf - Rate feedback time constant
0.47	QMX - V-regulator max limit
-0.47	QMN - V-regulator min limit
1.1	IPMAX - Max active current limit
0	TRV - V-sensor
0.5	dPMX - Max limit in power PI controller (pu)
-0.5	dPMN - Min limit in power PI controller (pu)
0.05	T_POWER - Power filter time constant
0.1	KQi - MVAR/Volt gain
0.9	VMINCL
1.1	VMAXCL
120	KVi - Volt/MVAR gain
0.05	Tv - Lag time constant in WindVar controller
0.05	Tp - Pelec filter in fast PF controller
1.7	ImaxTD - Converter current limit
1.8	Iphl - Hard active current limit
1.8	Iqhl - Hard reactive current limit
8.33	PMAX of PV plant

PANELU1	
0.16	P200, PDCmax at 200 W/m2, pu
0.38	P400, PDCmax at 400 W/m2, pu
0.59	P600, PDCmax at 600 W/m2, pu
0.85	P800, PDCmax at 800 W/m2, pu
1	P1000, PDCmax at 1000 W/m2, pu

IRRADU1	
5	T1, Time of the first data point, second
1000	I1, Irradiance at first data point, W/m2
10	T2, Time of the second data point, second
900	I2, Irradiance at second data point, W/m2
15	T3, Time of the third data point, second
850	I3, Irradiance at third data point, W/m2
20	T4, Time of the fourth data point, second
800	I4, Irradiance at fourth data point, W/m2
25	T5, Time of the fifth data point, second
700	I5, Irradiance at fifth data point, W/m2
30	T6, Time of the sixth data point, second
600	I6, Irradiance at sixth data point, W/m2
35	T7, Time of the seventh data point, second
700	I7, Irradiance at seventh data point, W/m2

Power House Design

(Typical)



The Report Includes the Typical Electrical Layout Design of a 100 MWp DC Project.

1 Introduction

The Power house equipment and design can be divided into three major sections DC power, AC power and control and monitoring equipment. All sections have their own significance and together make up an effective solar power generating system. The figure 1.1 shows the major equipment used in the solar power system.

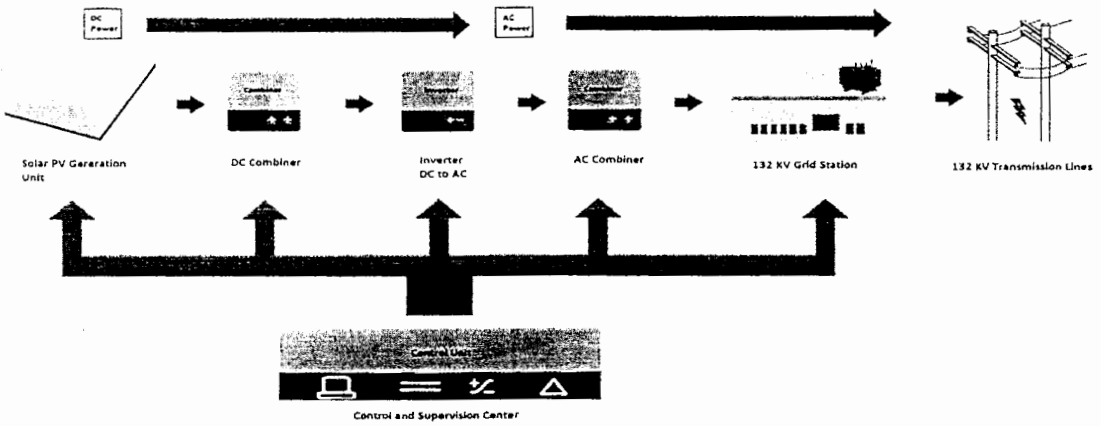


Figure 1.1:

1.1 DC Power System

DC stands for direct current and all the systems that generate and process direct current (DC) come under the DC power systems category. Following are the major components of a DC power System:

1.1.1 PV Modules

PV module is the major equipment for any solar PV generation system, it is the electrical generation unit which converts solar energy into electrical power. There are many types of PV module technologies for this project the type considered are polycrystalline (15%-18% efficiency) , monocrystalline (12%-16% efficiency) and Thin-film(6%-10% efficiency). PV module is the most costly equipment and has more than 50% share of the total projects cost. PV panels are readily available because of fast production rate and excess manufacture capacity.

1.1.2 DC Combiner Box

DC Combiners box is a component that combines the DC current from the PV modules. This component can be avoided if the inverter chosen for the Plant Design has an inbuilt DC combiner functionality.

1.1.3 Inverter

Inverter is the equipment that converts DC power to AC power and is an integral part of any PV plant. Features such as MPPT (Maximum Power Point Tracking), multi-power input and high conversion efficiency are very important while sizing the component in the design. Inverters are generally categorized on voltage and input power capacity, large sized centralized inverters are built on special order, other small sized inverters can be readily available from the market.

1.2 AC Power System

Alternate Current or AC power systems include all the components that use or process alternate current. Following are the major components of a AC power system:

1.2.1 AC Combiner Box

AC Combiner box is a component that combines the AC current form the Inverter. This component can be avoided if the inverter chosen for the plant design has an inbuilt AC combiner functionality.

1.2.2 132 KV Grid Station

The power generated has to be conditioned in-order to meet the requirements of the National grid that is 3 phase, 132KV and 50 Hz power standard before evacuating to main grid lines. For compliance with the power standards a power grid station has to be built this station includes components such as LV to MV transformers and switchgears, MV to HV Switch gears and transformers and Switch Boards etc. The major component of the grid station is MV to HV transformer that is built on special order in accordance with the design and could require 5 to 6 months manufacturers' delivery time.

1.3 Control, Supervision and Metering Systems

The control, supervision and metering system is required for the smooth and optimum power generation of the solar power the major components of the control systems are as follows:

1.3.1 SCADA System

Supervisory Control and Data Acquisition (SCADA) system is important for the effective monitoring of the Solar power plant. The system has the capacity to monitor all AC, DC component and can generate relevant reports in the required format plus it has the capability of removing faults by remote control mechanism. The SCADA system is designed and installed as per requirement of the plant. All components of the systems are readily available from the market however specialized human resource is required for installation.

1.3.2 Metering Systems

AC and DC metering is required for effective monitoring and record maintenance for the sale of the power to the National Grid. The AC side metering should be in accordance to the standards laid out by the energy purchasing and regulatory body.

1.3.3 Meteorological Sensors

Pyrometer and weather monitoring sensors are required to check the irradiation levels these are integrated with SCADA system for calculating different performance related indicators especially runtime monitoring and recording of solar irradiance. The sensors are required to comply with all the relevant international standards.

2.0 Technical Diagrams Provided

The list of technical diagrams provided for the project are the following:

Diagram No.	Details
1	Overall Layout Plan for PV Pant
2	Construction Project Plan
3	132kV Subsation General Layout Plan
4	132kV Booster Station Wing
5	132kV Substation Protection
6	Main Control Room Layout
7	Station Hardened Grounding
8	General Description of Cable Trench Construction
9	Cable Trench Construction Details 1
10	Cable Trench Construction Details 2
11	33kV Distribution Switchgear
12	11kV Box Transformer Foundation Construction
13	1MW Integrated Inverter Room Electrical Guidance
14	1MW Integrated Inverter Foundation Construction
15	1MW Integrated Inverter Installation Diagram

3.0 PV Panel Specifications (Preliminary)

Solar Panels - PV Modules			
i	Type of Modules	Polycrystalline	
ii	No. of PV Modules	In series	20 Modules
		In Parallel	20,000 Strings
iii	Total No. of PV Modules	Total Modules	400,000
iv	Array Global Power	Nominal (STC)	100,000 kWp
v	Total Module Area	650,752 sq. m	
vi	Panel's Frame	Aluminium	
vii	Panel Warranty	25 years	
viii	No. of cells in series	60 (6x10)	
ix	Junction Box	IP67	
x	Max Rated Power at STC	250 W	
xi	Open Circuit Voltage	37.54 V	
xii	Max Power Voltage	29.98 V	
xiii	Short Circuit Current	8.84 A	
xiv	Module Efficiency	15.29%	

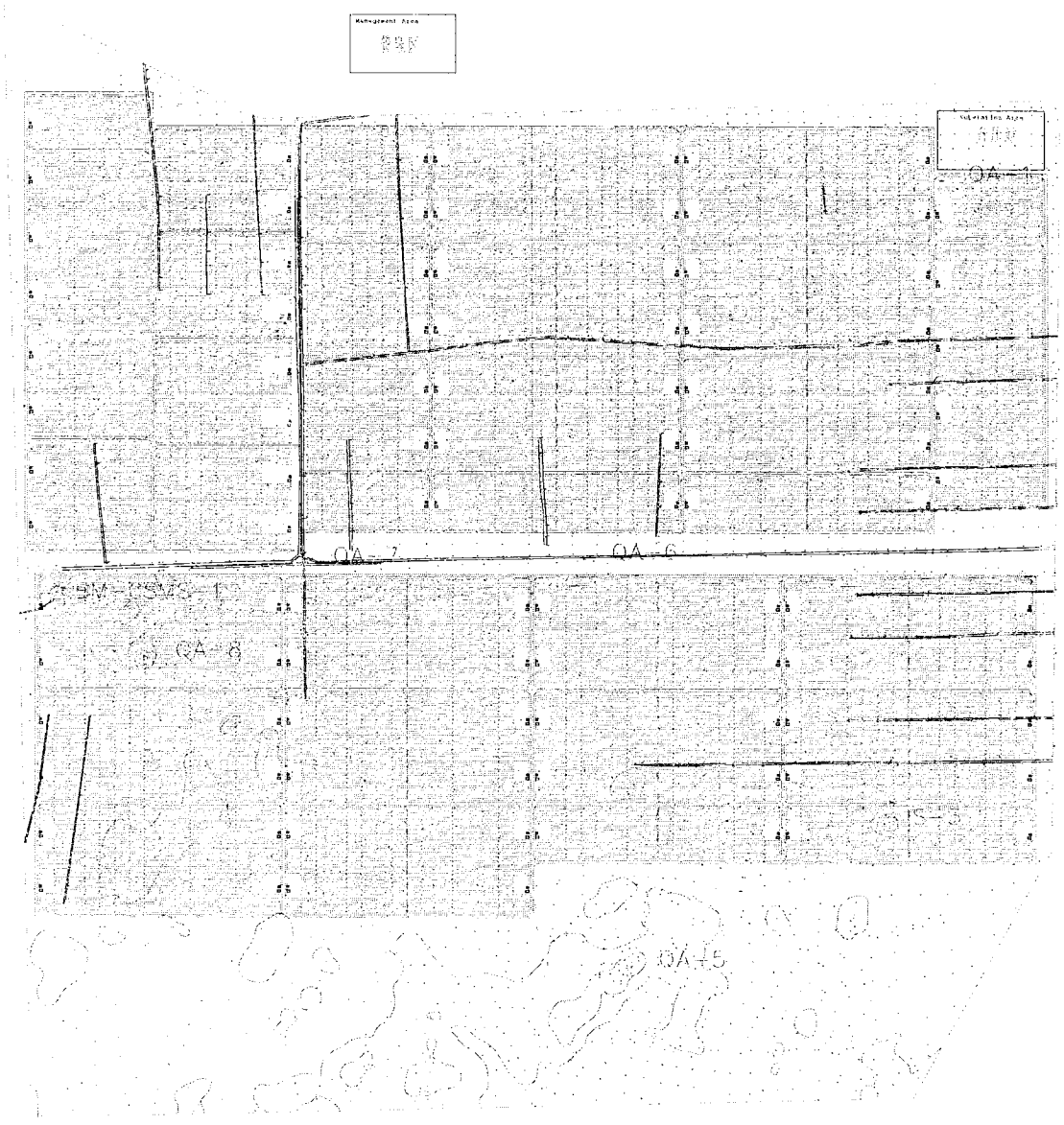
4.0 Inverter Specifications (Preliminary)

Inverters		
Input (DC)		
i	Max. DC Input Power	618 kW
ii	Max. DC Input Voltage	1000 V
iii	DC Voltage Range	450 - 1000 V
iv	MPP Voltage Range	500 - 820 V
v	Max. DC Current	1236 A
Output (AC)		
i	Rated AC Output Power	500 kW
ii	Max. AC Output Power	600 kW
iii	Rated AC Voltage Range	270 - 350 V
iv	Rated Output Current	916 A
v	Max. AC Current	1099 A
vi	Rated Grid Frequency	48 - 52 Hz
vii	THD of Grid Current	< 3%
viii	Power Factor	0.9 lag - 0.9 lead, adjustable
General Data		
i	Efficiency	98.70%
ii	Ambient Temperature Range	
iii	Protection Degree	IP20
iv	Warranty	5 Years

Electrical Drawings

The followings electrical drawings are provided:

Diagram No.	Details
1	Overall Layout Plan for PV Pant
2	Construction Project Plan
3	132kV Subsation General Layout Plan
4	132kV Booster Station Wing
5	132kV Substation Protection
6	Main Control Room Layout
7	Station Hardened Grounding
8	General Description of Cable Trench Construction
9	Cable Trench Construction Details 1
10	Cable Trench Construction Details 2
11	33kV Distribution Switchgear
12	11kV Box Transformer Foundation Construction
13	1MW Integrated Inverter Room Electrical Guidance
14	1MW Integrated Inverter Foundation Construction
15	1MW Integrated Inverter Installation Diagram



North
北

Notes:
1 This layout is for Pakistan 100Mwp grid connected solar power plant
2 The 100Mwp plant constitutes 100 units of 1Mwp arrays
3 The structure for 1xMwp is fixed angle installation, at an angle of between 29 and 31 degrees, oriention is south facing. There will be 4,444 nos. of 225w solar panels installed. Each 44 pieces nc solar panels will be one array. Totally there will be 101 nos arrays
4 Each group of arrays will feed 1Mva one integrated inverter and one transformer
5 The space from center to center between the arrays will be 9m
6 The road between the arrays will be 4m wide, covered with gravel. The radius of turning will be 9m
7 The unit of measure is meter
8 Issues not mentioned will comply with the construction and inspection norms and standards

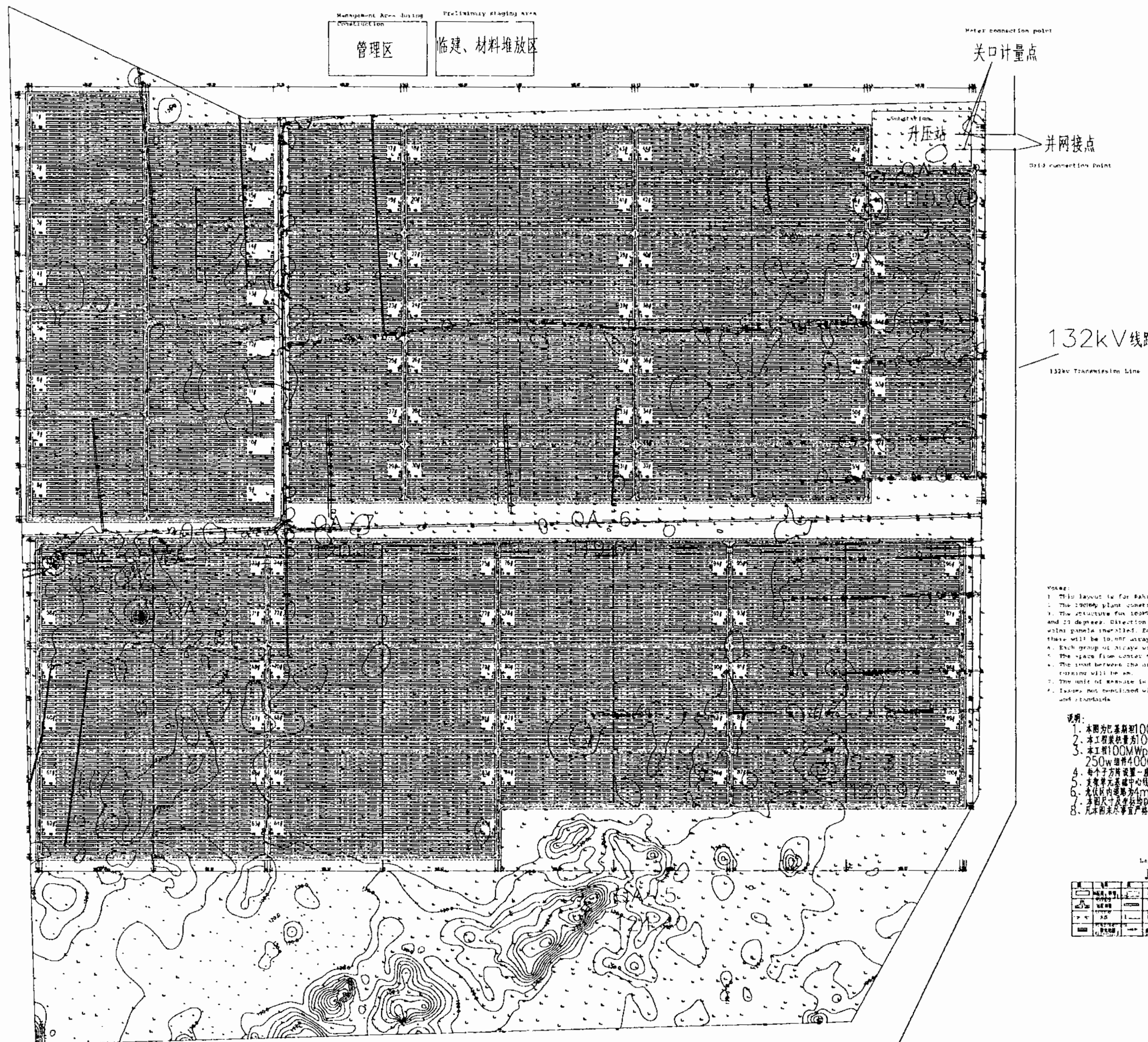
注：
1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]

Facade
Elevation
Fence
Contour lines

电站总平面布置图 1:1000
Overall Layout of the Plant
1: 1000 scale

西安特变电工电力设计有限责任公司	
巴基斯坦100MWp光伏并网电站	工程
2013年11月	比例 1:1000

5站平面布置
Overall Layout Plan for PV Plant



电池板平面布置图 1:1000

Overall Layout of the Plant

1: 1000 scale

Notes:

1. This layout is for Pakistan 100MWp Grid connected solar power plant
2. The 100MWp plant constitutes 100 units of 1MWp arrays
3. The structure for 100MWp is fixed angle installation, at an Angle of between 25 and 28 degrees. Direction is south facing. There will be 400,000 nos. of 250W solar panels installed. Each 40 pieces of solar panels will be one array. Totally there will be 10,000 arrays.
4. Each group of arrays will feed into one integrated inverter and one transformer
5. The space from center to center between the arrays will be 6m
6. The road between the arrays will be 4m wide, covered with gravel. The radius of turning will be 6m.
7. The unit of measure is meter
8. Issues not mentioned will comply with the construction and inspection norms and standards

说明:

1. 本图为巴基斯坦100MWp光伏并网电站总平面布置图.
2. 本工程装机量为100MWp，分为100个1MWp子方阵.
3. 本工程100MWp全部采用固定倾角式安装，安装倾角28度，方位角正南，共安装250w组件400000块，每40块电池组件构成一个支架单元，共计10000个支架单元.
4. 每个子方阵设置一座一体化逆变器和一座升压箱变.
5. 支架单元基础中心线间距为6.0m.
6. 光伏区内道路为4m宽碎石路，道路转弯半径除注明外为6m.
7. 本图尺寸及坐标均以米计.
8. 凡本图未尽事宜严格按照现行施工及验收规范为准.

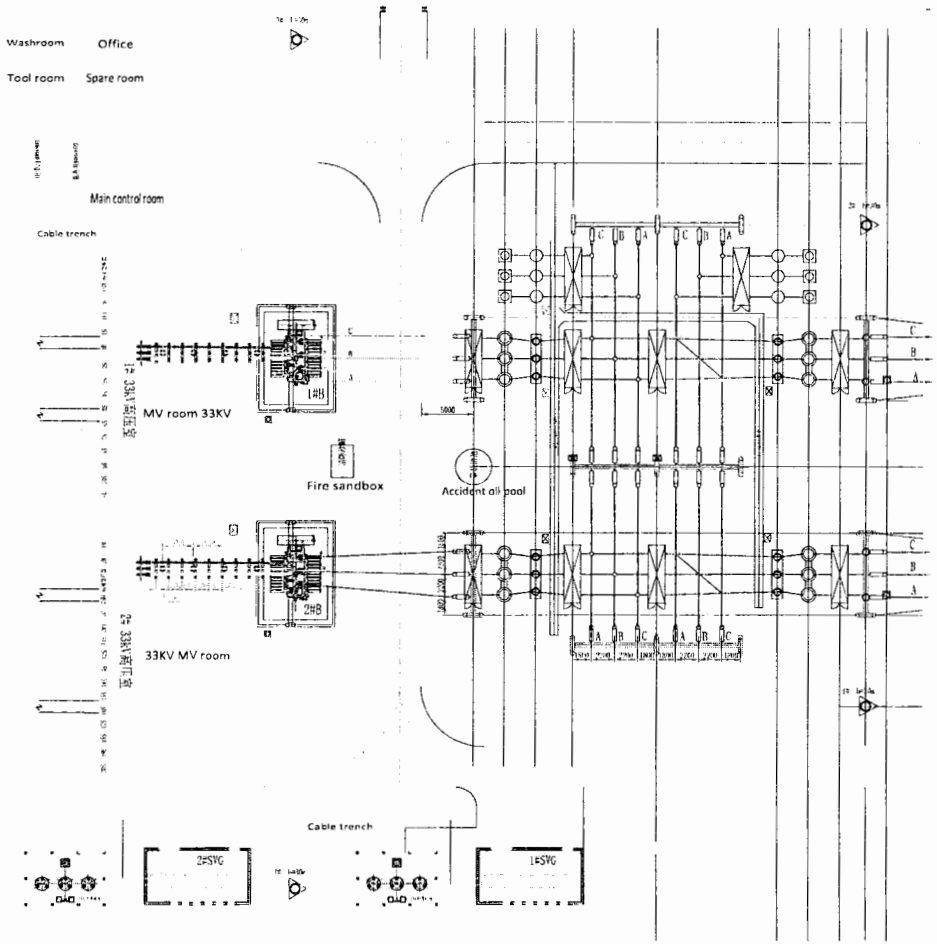
Legend

图例

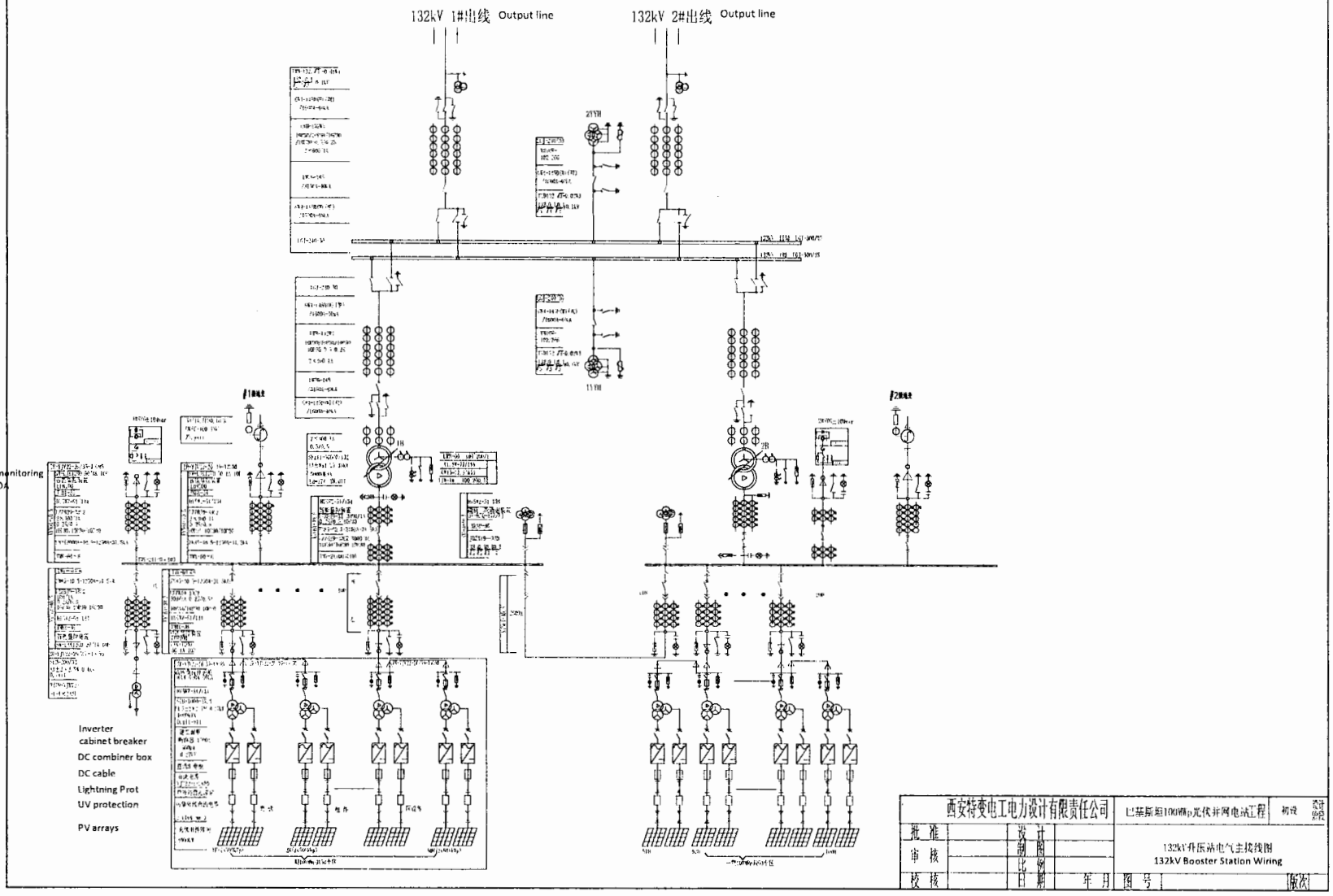
西安特变电工电力设计有限责任公司	
巴基斯坦100MWp光伏并网电站 工程	施工图
巴基斯坦施工项目部平面布置图 Pakistan Construction Project Layout Plan	
2013年11月	比例 1:1000	图号	版次

North

北

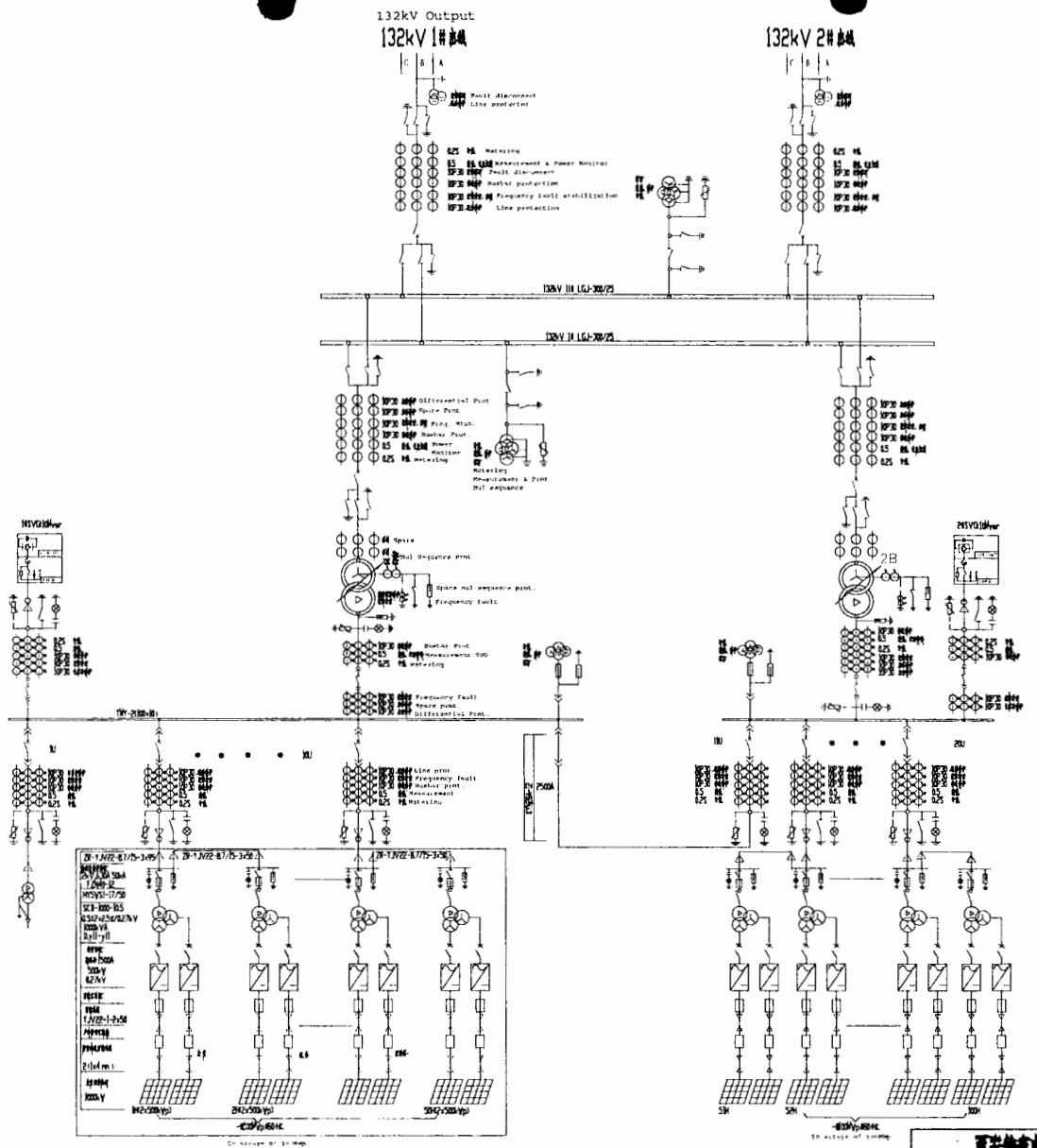


西安特变电工电力设计有限责任公司	
工程	132
132kV升压站电气总平面布置图	
132kv substation general layout diagram	
比例	图号



西安特变电工电力设计有限责任公司				巴基斯坦100MWp光伏并网电站工程	初设	设计阶段
批准		设计		132kV升压站电气主接线图 132kV Booster Station Wiring		
审核		制图				
校核		比例				
		日期	年 月	图号		版次

SIZE:A2-0.5A1



专业名		
专业名		
专业名		
专业名		
专业	会签	日期

西安特变电工电力设计有限责任公司		已备案的100MWp光伏并网电站	工程	初设	设计阶段
设计		132kV Substation Protection Equip Configuration			
审核		132kV升压站保护配置图			
校核		日期	年月	图号	版次

值班室 机动室

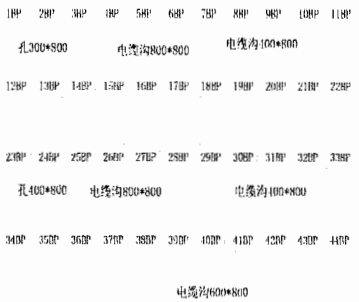
duty spare

office room

卫生间 工具室

washroom tool room

Main control room



Main Control Room Equipment List

主控室设备表

序号	名称	型号及规格	单位	数量	备注
	主保护及通讯室				
1	132kV线路保护测控屏	2260×800×600	面	2	Control scrn 132kv
4	132kV母线保护屏	2260×800×600	面	2	Control scn busbar
2	1#、2#主变压器保护屏	2260×800×600	面	2	Transformer prot sc
3	1#、2#主变压器测控屏	2260×800×600	面	2	Transformer chk scr
4	33kV母线保护屏	2260×800×600	面	1	Busbar prot scrn
5	公用测控屏	2260×800×600	面	1	Public chk scrn
6	远动屏	2260×800×600	面	1	Moving screen
7	安全稳定控制屏	2260×800×600	面	1	Safety/stab chk scr
8	失步解列屏	2260×800×600	面	1	Splitting screen
9~11	备用				Spare
12	故障录波屏	2260×800×600	面	1	False record scn
13	电能计量屏	2260×800×600	面	1	Power metering scr
14	电能质量在线监测屏	2260×800×600	面	3	Power quality scr
15	有功、无功功率控制屏	2260×800×600	面	1	Online monitor
16	光伏功率预测系统屏	2260×800×600	面	1	PV power prediction
17	同步向量测量屏	2260×800×600	面	1	synchr vector check
18	UPS电源屏	2260×800×600	面	1	UPS
19~22	直流电源屏	2260×800×600	面	4	DC power scrn
23~24	电力调度数据网络接入屏	2260×800×600	面	2	Power Distr.
25	通信接口屏	2260×600×600	面	1	Comm. connection
26~30	系统通讯屏	2260×600×600	面	5	包含48V通讯电源 System comm.
31~33	备用		面	3	Spare
31~40	低压配电屏	2260×800×800	面	6	LV distribution
41~44	备用		面	4	Spare

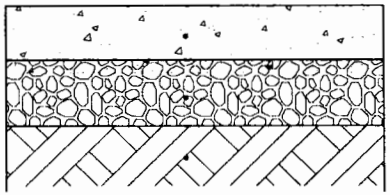
专业名			西安特变电工电力设计有限责任公司		巴基斯坦100MWp光伏并网电站 工程	初设	设计阶段
专业名			批准		设计	主控室屏面布置图 Main Control Room layout	
专业	会签	日期	审核		制图		
			校核		比例		
					日期 年 月	图号	版次

180mm厚C30混凝土面层(分块捣制,震捣密实,随打随抹平,每块路面长不大于6m,缝宽20mm,沥青砂子或沥青处理松木条嵌缝)

180mm Thick C30 concrete surface (prefabrication method, vibration, compaction, levelling)

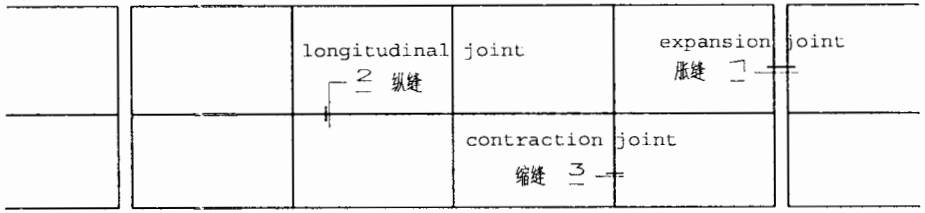
300mm厚级配砂石碾压 300mm Thick gravel compacted

路基碾压密实,密实系数>0.93 Road base compacted



硬化场地断面图

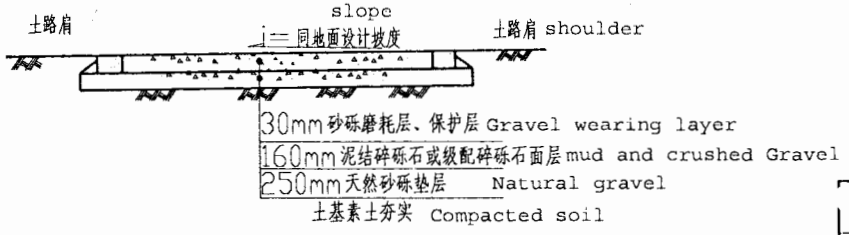
Hardened ground



硬化场地伸缩缝图(路面宽度<7m时不设纵缝,单位:m)

hardened ground expansion and contraction joints (if width of road less than 7m,no joints required)

铺油毡二层Asphalt felt



砂石路断面、结构层详图

说明:

1、膨缝间距在常温与夏季施工时为24~36m,低温及冬季施工时为15~18m.

2、管理区广场为现浇混凝土广场,施工时完成广场管理区地下管线敷设后,方可现浇地面。

3、垫层可代用材料:水泥结砂砾,水泥结粗砂,水泥结矿渣,配合比均为1:15.

4、压实度:土基0.93,垫层和面层0.95,填方路基路面底面以下0~800mm,范围内压实度不小于0.95,800mm以下范围内压实度不小于0.90.

5、图中标注除注明外均以mm为单位.

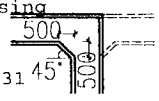
西安特变电工电力设计有限责任公司				特变电工库尔勒一期20MWp并网发电项目工程	施工图 设计阶段
批 准		设 计		Station hardened square 电站硬化广场、沙石道路详图	
审 核		制 图			
		比 例	1:100		
校 核		日 期	2013年9月	图 号 T1335S-Z0102-02	版次 A

1. Detailed diagram of outside cable trench construction
2. Top of Station cable trench cover should 150mm higher than elevation, longitudinal slope of trench cover top should be in harmony with slope of station.
3. Trench longitudinal slope should be not less than 0.3%, 2% cross slope, to guarantee smooth drainage. Trench bottom & inside wall should be brushed with 15 thick 1:2 cement mortar, Height of internal side is 200, after applying trench cover pointing with 1:3 cement mortar

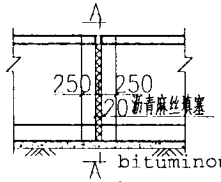
电缆沟施工总说明

1.本图册是室外电缆沟施工详图.
2.厂区沟道盖板顶面标高一般高出场地设计标高150mm,沟道盖板顶 面纵坡应与场地坡度相协调.
3.沟道设不小于 0.3% 的纵坡及 2% 的横坡,并坡向渗水井,以保证排水通畅. 沟道内底及内壁刷 15 厚1:2 水泥砂浆,两内侧高 200, 沟盖板铺设完毕后用 1:3 水泥砂浆勾缝.
4.沟道盖板可先预制,沟道盖板顶制后必须标明正反面;转角、交叉等处的异形盖板必须待沟道施工安装后现场浇制,其配筋率同标准盖板;盖板间隙用1:2水泥砂浆嵌缝.过道路或人行道处每隔五块设一块有手提孔盖板,其配筋率同标准盖板. 沟道转角处沟道埋设 L100X8 角钢,用以支撑盖板.
5.厂区内无汽车荷载沟道盖板选用02J331中B8-4,详图见31页.
6.厂区内穿越道路的有汽车荷载沟道盖板选用02J331中B8-9,详图见31页.
7.厂区沟道地沟梁选用02J331中L8-3.8,详图见53页.
8.穿越电站广场及跨道路处的地下沟道,在道路两侧各一米范围内,跨道路沟道断面(壁厚加大50 mm)及盖板、跨道路的沟道应达到设计强度后方可通车.
9.电缆沟道直角转角处为避免电缆折损,需设 45° 切角,见下图.
10.沟道每隔20m设置伸缩缝,缝宽20mm,内填沥青麻丝,见下图.
11.沟道两侧的回填土必须分层夯实,回填土方及夯实时沟道内必须有可靠的加固支撑,以防止沟壁的损坏.安装管道和电缆时,沟道的两侧不应有大量的堆载,堆载应严格控制,不得超过允许范围.
12.沟道,特别是预埋件,预留孔施工时必须与有关专业密切配合.
13.本图册中所选用的预埋件详见YT-2004施(预埋件图集).
14.沟道检查井为正方形,其长、宽为与之相连最宽沟道的尺寸,且不小于1200mm.
15.所有金属构件均涂红丹一度,油漆二度.

5.trench cover plate without vehicle load select 02J331, B8-4 details on page 31
6. trench cover on road crossing with car load select 02J331, b8-9, details on page 31
7. Trench cover beam to use 02J331 L8-3.8, details on page 53
4. Trench cover plate can be prefab. After trench cover plate is prefabricated, positive & negative side should be marked. Special shaped cover plate at corner & cross will be cast in place after construction of trench. Steel rebar used will be same as for standard cover plate. Space between cover plates will be pointing with cement mortar 1:2. Aisle & pavement will have cover plate with handle every 5 plates. Angle steel L100x8 will be buried at corner of trench to support cover plate.
8. Underground trench crossing station square/roads each side of road should be within 1m. Trench crossing section (thickness increase 50mm). Trench cover plates at road crossing should have design strength to take vehicle load.

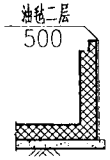


电缆沟转角详图
Cable trench angle detail



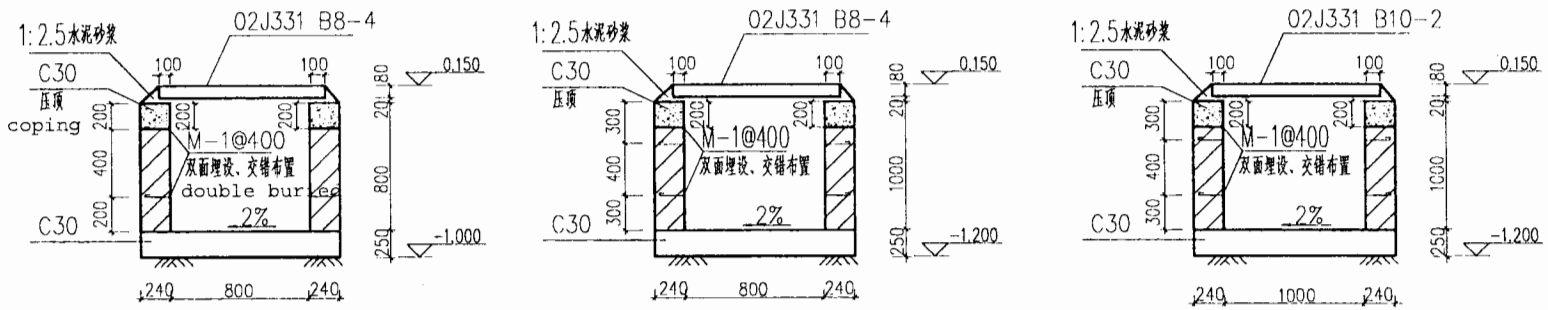
沟道伸缩缝立面图
Cable trench expansion joint

Asphalt felt 2 layers



A-A

西安特变电工电力设计有限责任公司				工程	施工图 设计阶段
批 准		设 计		General Description of 电缆沟施工总说明 Cable trench construction	
审 核		制 图			
校 核		比 例	1 / 100		
		日 期	2013年10月	图 号	X1306-T0105-01 版次 A



800x800砖砌沟道断面图 sectional dwg for brick trench

1. 电缆沟、转角过梁选用02J331 L8-3,具体做法见02J331第47页"电缆地沟".
2. 电缆沟长度详见总图.

800x1000砖砌沟道断面图 sectional dwg for brick trench

1. 电缆沟、转角过梁选用02J331 L8-3,具体做法见02J331第47页"电缆地沟".
2. 电缆沟长度详见总图.

1000x1000砖砌沟道断面图

1. 电缆沟、转角过梁选用02J331 L10-2,具体做法见02J331第47页"电缆地沟".
2. 电缆沟长度详见总图.

说明: Flat steel Q235B, anchor bar HPB300, welding rod E50xx

1. 扁钢为Q235B钢,锚筋为HPB300.焊条E50xx,焊缝高6mm. height of welding gap 6mm
2. 埋件为-50X5扁钢通长预埋. 50x5 flat steel is embedded
3. 锚筋长度=120,锚筋规格为 Φ6@150. Anchor bar length 120, dia 6@150
4. 基础表面所有与土壤接触部位刷环氧煤沥青二道,厚度≥500μm. coal tar epoxy paint coatin
5. 基础防护 basic foundation protection 500 micron

依据工程地质报告,场地土对基础混凝土钢筋具强腐蚀性,室外地面标高以下砂浆与砼要求如下:

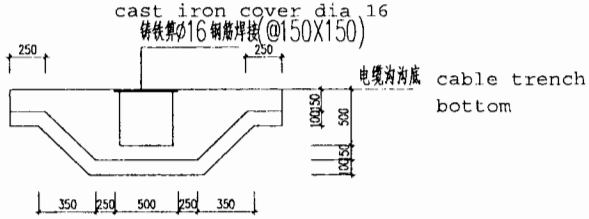
a. 水泥采用普通硅酸盐水泥. b. 最大氯离子含量(水泥用量的百分比)0.08,
c. 水灰比不大于 0.40. d. 混凝土的水泥用量不得小于340Kg/M .3
e. 钢筋保护层厚度≥50 f. 表面防护见右表

腐蚀性等级	构件名称	防护要求
强	沟壁	环氧沥青或聚氨脂沥青涂层,厚度≥500μm; 聚合物水泥砂浆, 厚度≥10mm; 树脂玻璃鳞片涂层,厚度≥300μm; 环氧沥青或聚氨脂沥青贴玻璃布,厚度≥1mm;

注:选其中一种材料,埋入土中混凝土均做防腐处理.

g. 基础底部设耐腐蚀垫层,耐腐蚀垫层可采用沥青混凝土,厚度不应小于100mm;或碎石灌沥青,厚度不应小于150mm(尺寸相应修改);或聚合物水泥砼,厚度不应小于100mm;

6. 沟壁采用M10水泥砂浆砌筑MU10 KP1型多孔砖孔洞内灌实细石砼,1:2.5水泥砂浆内掺5%防水剂抹面30厚,钢筋为HPB300.混凝土保护层厚度:50mm.
7. 电缆沟盖板顶标高均高出室外地面标高150mm,通过道路处盖板顶标高与道路平齐.盖板间用防水砂浆抹死.
8. 在预制,运输,安装,使用及检修过程中应注意板的上下面,严禁将板倒置,以防止板断裂.
9. 沟道的起点及终点在管线敷设完毕后用防火材料封堵. Fill fire protection material at ends
10. 本分册需与电气专业图纸及设备核对无误后,方可施工. Coordinate with electrical designer
11. 沟道内最低处设置集水坑,接Φ100排水管至就近雨水井,避免沟道内产生汇水. Make water collection pit at lowest point, dia 100
12. 沟道与电气直埋壕沟接口处均预留400x400孔. Space of 400x400 between trenches and equipment
13. 图中尺寸均为mm. All units are mm

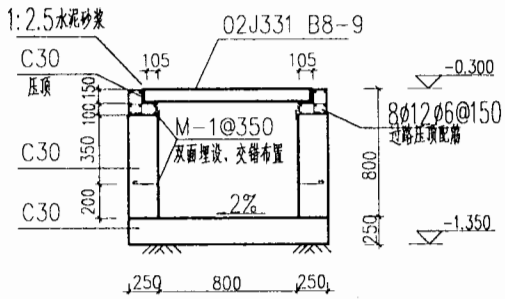


集水坑 Water collection pit

集水坑500x500

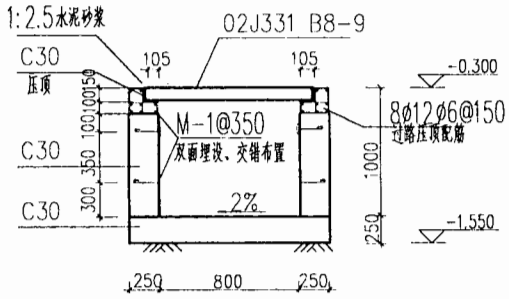
西安特变电工电力设计有限责任公司				工程	施工图	设计阶段
批准		设计		电缆沟施工详图1		
审核		制图				
校核		比例	1/100	Cable trench construction dtls		
		日期	2013年10月	图号	X1306-T0105-02	版次 A

1:2.5 cement mortar



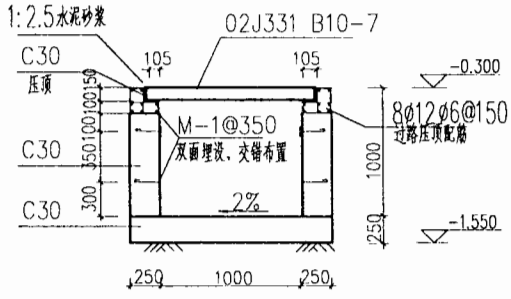
800x800过路沟道断面图

1. 电缆沟L_转角过梁选用02J331 L8-8,具体做法见02J331第47页"电缆地沟".
2. 电缆沟长度详见总图.



800x1000过路沟道断面图

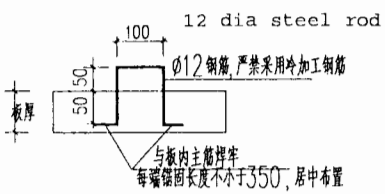
1. 电缆沟L_转角过梁选用02J331 L8-8,具体做法见02J331第47页"电缆地沟".
2. 电缆沟长度详见总图.



1000x1000过路沟道断面图 road crossing trench section

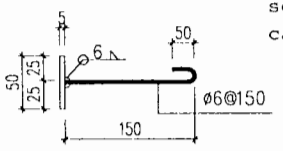
1. 电缆沟L_转角过梁选用02J331 L10-10,具体做法见02J331第47页"电缆地沟".
2. 电缆沟长度详见总图.
   Cable trench length details refer to general diagram

cable trench angle and beam use L10-10



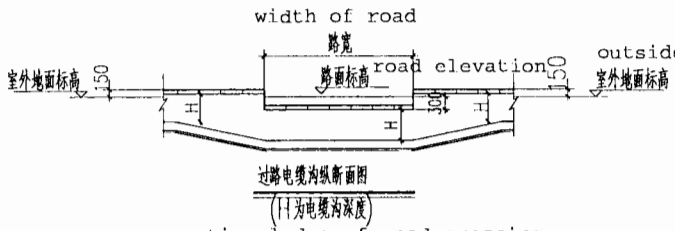
吊环设置详图
每块用两个吊环

hang ring, each piece uses 2



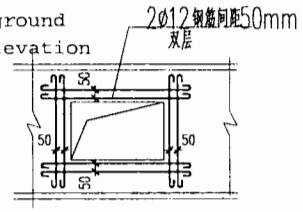
M-1
通长埋设

Normally buried



过路电缆沟纵断面图
(H为电缆沟深度)

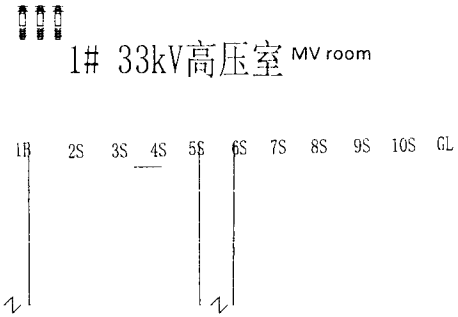
sectional dwg of road crossing cable trench

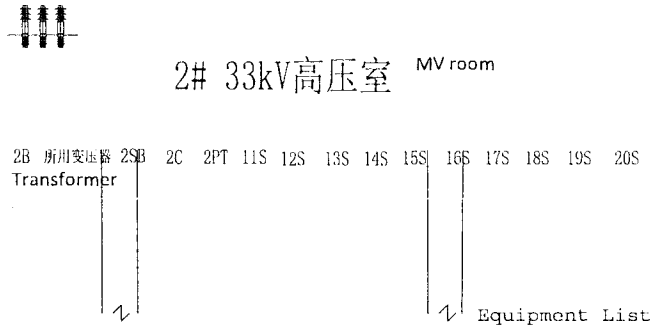


沟道开口处加筋图

trench access

西安特变电工电力设计有限责任公司				工程	施工图	设计阶段
批准		设计		电缆沟施工详图2		
审核		制图				
		比例	1/100	Cable trench construction 2		
校核		日期	2013年10月	图号	X1306-T0105-03	版次 A





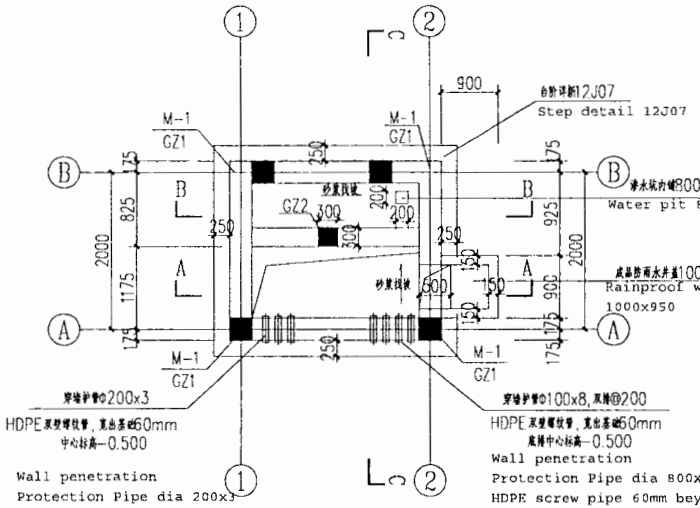
Equipment List

本期设备表

序号	名称 Descr.	型号规格 Type	单位 Unit	数量 Qty	备注 Remarks
1	高压开关柜 HV switch cabinet	KYN61-40.5	面	20	光伏电源进线 PV Power input
2	高压开关柜 HV switch cabinet	KYN61-40.5	面	2	所用电出线 Elec output wires
3	高压开关柜 HV switch cabinet	KYN61-40.5	面	2	SVG出线 SVG output wires
4	高压开关柜 HV switch cabinet	KYN61-40.5	面	2	电压互感器 Instrument transformer
5	高压开关柜 HV switch cabinet	KYN61-40.5	面	2	主变进线 Main transformer input wire
6	母线筒 Busbar	3150A	套	2	主变进线，共6m，厂家配套 Main transformer input wire 6m
7	动力箱 Power Box		台	2	详见低压系统图 Details in LV diagram
8	照明箱 Illumination box		台	2	详见低压系统图 Details in LV diagram

西安特变电工电力设计有限责任公司			巴基斯坦100MWp光伏并网电站工程	初设	第1张
批准		设计	33kV配电室开关柜平面布置图		
专业名		审核		比例	
专业名		校核	33kV distr. Switchgear	图号	版次
专业	会签	日期	年 月		

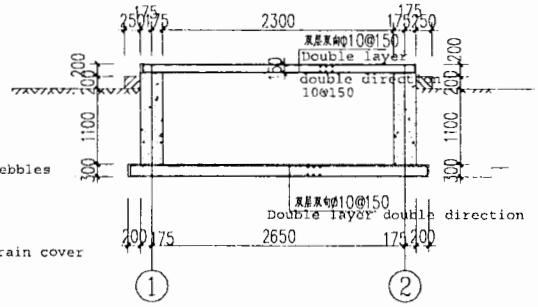
SIZE:A2=0.5A1



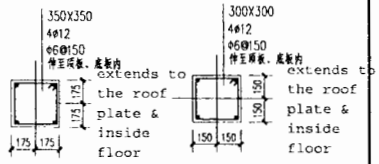
Wall penetration
Protection Pipe dia 200x3
HDPE screw pipe 60mm beyond
elevation height 0.500

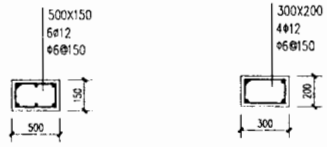
Wall penetration
Protection Pipe dia 800x8
HDPE screw pipe 60mm beyond
elevation height 0.500

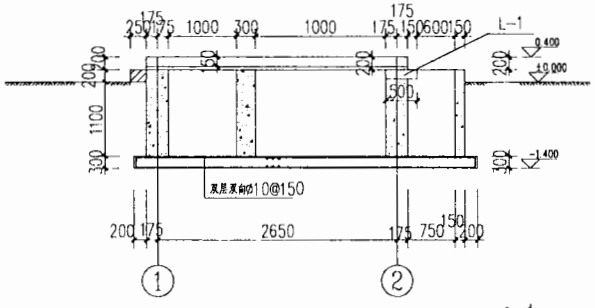
箱变基础平面图



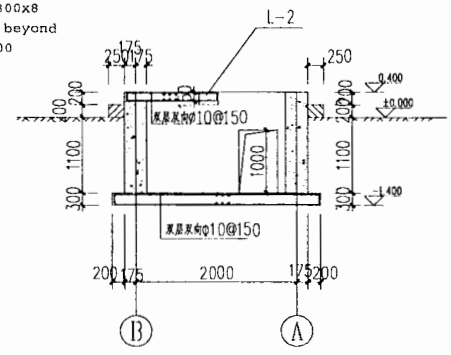
B-B剖面图



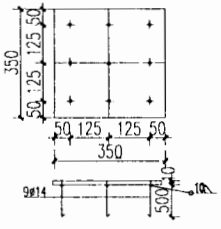




A-A剖面图

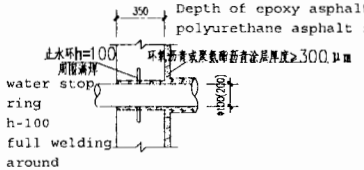


C-C剖面图



M-1详图

数量：4块



穿墙套管
Cross wall cover pipe

说明：

1、所有墙体内外均用抹水砂浆1：2.5抹平，30厚（掺3%有机硅）

2、砼：C30混凝土，混凝土保护层：梁40mm，基础50mm。
钢筋等级：Φ:HPB300，Φ:HRB400

3、砼基础顶平行度误差不得大于5mm,洞口GL截面选择240x300，4Φ12。

4、通风竖井，通过地下电缆沟与逆变器基础底部连接，室外电缆沟盖板选择钢盖板或者混凝土盖板，通风井顶部，做5%的排水坡度

5、本图施工前必须与厂家图纸核对无误后方可施工。

Notes:

1. Apply waterproof mortar to inside/outside walls 1:2.5, 30 thick (3% mix silicone)
2. C30 concrete, concrete protection layer 40mm beam, foundation 50mm steel rebar level HPB300, HRB400
3. Parallel error of foundation top to be less than 5mm, hole access GL cross section 240x300, 4 dia 12.
4. Ventilation shaft is connected through underground cable trench & under inverter foundation. Outside cables trench cover should be copper or concrete plate Top of ventilation shaft should have 5% drain slope
5. Before construction, this diagram should be compared with diagram of manufacturer to confirm

Xi'an TBEA Electric Design Co.Ltd.

Pakistan 100MW On Grid PV Power Plant Project

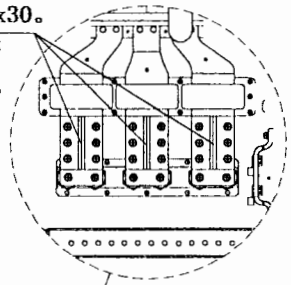
专业名			电工电力设计有限责任公司		巴基斯坦100MWp光伏并网电站 工程		设计阶段		
专业名			批准		设计		11kV box transformer foundation Construction drawing		
专业名			审核		制图				
专业名					比例				
专业	会签	日期	校核		日期	年 月	图号		版次

11kV箱式箱变基础施工图

SIZE: A3=0.25A1

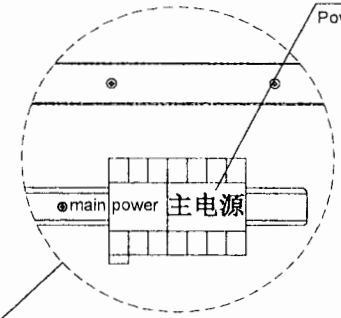
此铜排为三相交流输出接线排，
从左到右分别为A相、B相、C相，
每相铜排预留三个接线孔，
紧固螺栓规格为M16x30。

The copper lines are for three phase AC output connection line,
from the left to right respectively phase A, B, C,
each copper line reserves 3 connection points,
bolt specification is M16*30

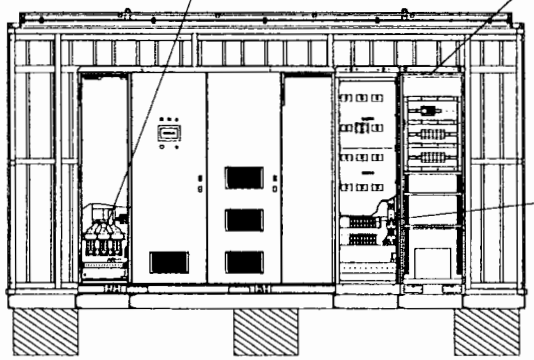


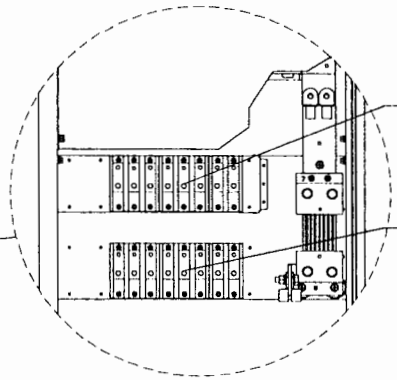
A
5:1

电站供电输入，3P4L
Power station supply input, 3P4L



B
5:1





Input
PV1+~PVn+输入

Input
PV1−~PVn−输入

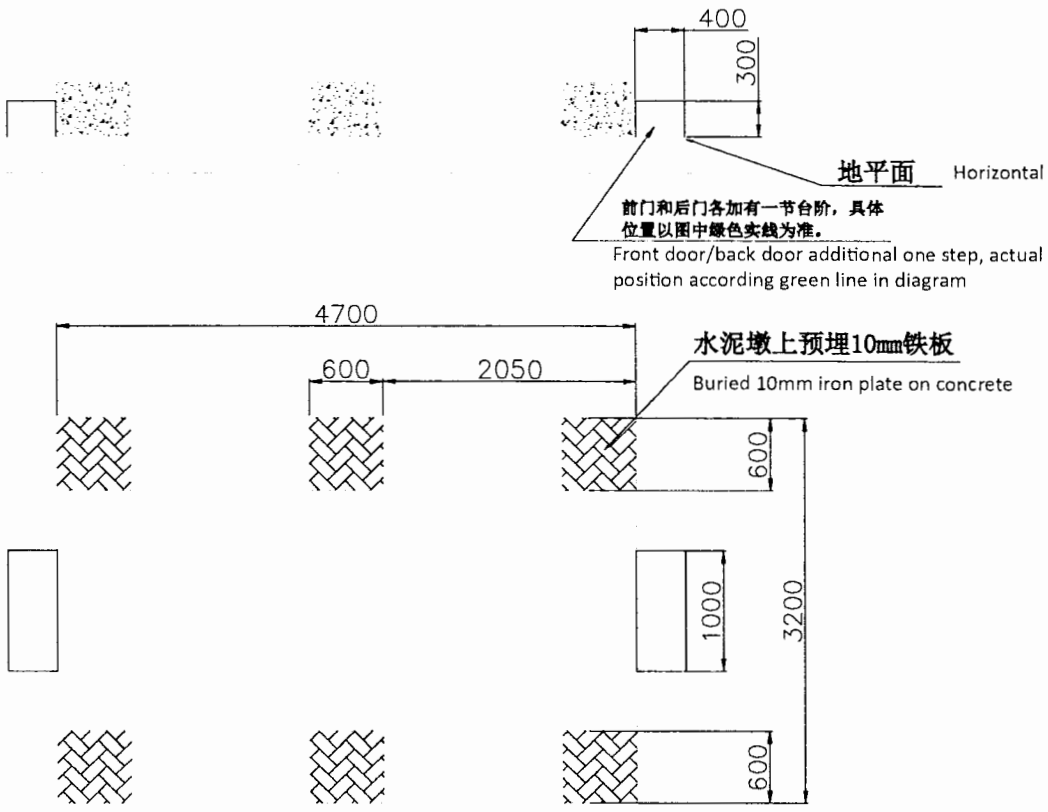
C
10:1

注：
1. 地基及其机房走线需根据实际情况设计；
2. 机房内机柜的接线采用下进下出线方式。

Note:
1. The foundation and inverter room walking aisle should be according to the actual design.
2. Inverter room cabinet cables using under connection.

						Pakistan 100Mwp Solar PV Grid connected power station project			设计阶段
			批准		设计		1MW Integrated Inverter Room Electrical Installation Guidance		
专业名			审核		制图				
专业名					比例				
专业	会签	日期	校核		日期	年 月	图号		版次

SIZE: A3=0.25A1



注：

1、户外房由3个600*3200水泥墩支撑.

2、水泥墩高度应保证高度一致，高出地基450mm,地平面以下的水泥地基厚度由土建设计员根据地质勘查报告确定。

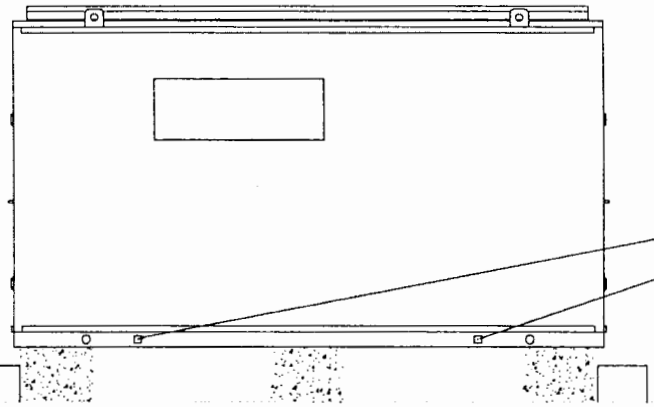
3、整栋移动房（内含机柜）重约9t.

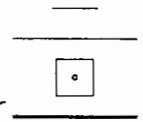
Notes:

- Outside room is supported by three concrete columns size 600x3200mm
- Height of the concrete columns should be uniform, should be 450mm above foundation, depth of concrete foundation under horizontal is determined by geotechnical survey report by civil designer
-Weight of whole moveable room (including inverter cabinets) is about 9 tons

						Pakistan 100MW On Grid PV Power Plant Project		设计阶段
批准			设计			1MW一体化逆变器基础施工图 1MW Integrated Inverter Foundation Construction		
审核			制图					
			比例					
专业名								
专业名								
专业	会签	日期	校核		日期	年月	图号	版次

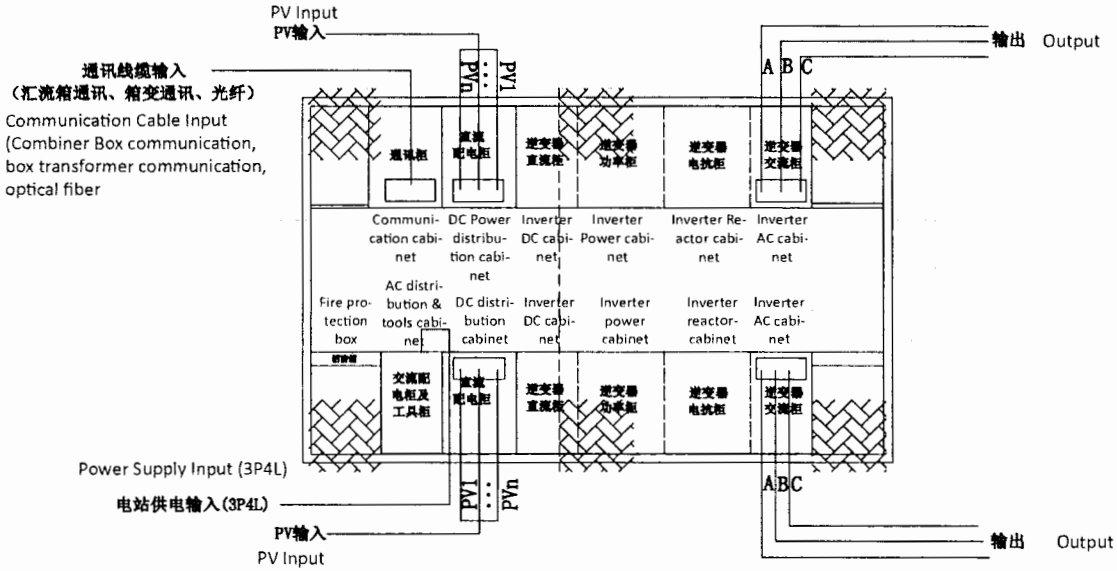
SIZE: A3=0.25A1





机房接地点(两侧共4个)
螺栓规格M8x20

Inverter Room Grounding Point (4 at two sides)
Bolt Type M8 x 20



注：

1. 机房走线需根据实际情况由电气设计员进行详细设计；

2. 机房内机柜的接线采用下进下出线方式；

3. 接线螺栓规格参考机房内逆变器的规格。

Note:

1. Detailed wiring design of inverter room should be done by electrical designer according to actual conditions
2. Connection of cables/wires in inverter room cabinet to be from bottom
3. Cable connection bolt type to comply with the inverter type in inverter room

						Pakistan 100MW On Grid PV Power Plant Project		设计阶段
			批准		设计			
专业名			审核		制图		1MW一体化逆变器安装示意图 1MW integrated Inverter Installation diagram	
专业名					比例			
专业	会签	日期	校核		日期	年 月	图号	版次

NATIONAL TRANSMISSION & DESPATCH CO. LTD.

Managing Director NTDCL

No.MD/NTDC/CPPA/4205-12 Dated: 24th January,2014

Syed Safeer Hussain,
Registrar,
NEPRA,
Islamabad.

SUB: GRID CODE ADDENDUM NO.2 FOR SOLAR PV POWER PROJECTS

This refers to G.M (CPPA) letter No.COO/GM/CPPA/CE-II/MT-IV/GCRP/10060-64 dated 17-12-2013 vide which final draft of Addendum No.2 to NTDC Grid Code relating to Solar PV Power Projects was submitted to NEPRA for approval after due deliberations by the stakeholders. The approval is still awaited. Meanwhile, Government of Punjab has made considerable progress in installation of 100 MW of Solar PV Project at Quaid-e-Azam Solar Park at Lal Suhanara. The Punjab Department of Energy is also geared-up for development of projects of remaining 900 MW at the said Park. The evacuation scheme of the Park was finalized long time ago and load flow study was also submitted to all relevant agencies. PC-1 of the project has also been recommended by CDWP for approval of ECNEC. Under these conditions the only issue left is approval of amendment of the Grid Code by NEPRA.

It appears that approval of the Authority has been held-up in view of controversy regarding how much of solar power can the NTDC system accommodate. The controversy was advocated despite the fact that the results of aforementioned load flow study met all the required standards of system operation. Furthermore, the prevailing conditions of power shortage together with ever increasing cost of furnace oil and diesel were also ignored by the proponents. NTDC had been advocating that under these conditions the questions being raised are frivolous and the issue is not how much solar power can be accommodated in the system but the real issue is how soon such plants can be commissioned. Besides, the first question asked by the potential investors is always whether Grid Code amendment for solar power has been approved by the regulator or not. A negative reply discourages such investors because their lenders do not accept lending proposals in the absence of an approved technical framework.

The aforesaid notwithstanding, NTDC has carried out further studies to determine the effect of solar power on NTDC system with reference of following parameters;-

1. Short Circuit
2. Transient Stability
3. Power Quality

A copy of the study is enclosed for reference. A review of the study will indicate that not only most of the parameters are meeting IEC standards; most of them are even better than the limits set by the IEC. The evacuation scheme fully meets the technical requirements set out in the draft Addendum No.2 to the Grid Code.

ACS (Energy)
Diary No. 458
Date 27/1/14

414-WAPDA House, Lahore. | TEL:+92-42 99202229, Fax: +92 42 99202053 | md@ntdc.com.pk, www.ntdc.com.pk

In view of the above, it is now proved that so long as 1000 MW Quaid-e-Azam Solar Park at Lal Suhanara is concerned, there is no issue of evacuation of power and that it will be absorbed in the NTDC system successfully without any problem. The capacity of the Park amounts to about 5% of total installed capacity. Therefore absorption of 5% has already been proved. This, however, need not be considered as upper limit. Considering potential of solar power to conserve fuel oils during better part of the day, a 10% ceiling for interim period might be an adequate choice.

Finally, it is also brought to the notice of the Authority that solar power projects are being utilized by utilities around the globe successfully. Utilization of solar power in Pakistan is even more beneficial because it can meet power shortage during shortage period in short to medium term and conservation of furnace oil during day time in the long term so as to utilize oil fired plants only during peak hours.

In view the aforesaid, the Authority is very earnestly requested to approve Addendum No.2 to the Grid Code as early as possible.

(Muhammad Zia ur Rehman)
Managing Director NTDCL

Copy to:

1. Secretary, Ministry of Water & Power, Islamabad.
2. Additional Chief Secretary Energy, Government of Punjab, Lahore.
3. Joint Secretary NTDC, MoW&P Islamabad.
4. CEO Punjab Power Development Board, Lahore
5. CEO Quaid-e-Azam, Solar Power Park Co. Govt. of Punjab, Lahore
6. General Manager (CPPA) NTDCL Lahore
7. General Manager (Power Planning) NTDCL Lahore

Master File

414-WAPDA House, Lahore. | TEL:+92-42 99202229, Fax: +92 42 99202053 | md@ntdc.com.pk, www.ntdc.com.pk

18. Location and Infrastructure

a) Project Location	
b) Site Map	
c) Infrastructure – Roads, Power Evacuation Line, Water Works	
Letter of Land Allocation from	Annexure 29

a) Project Location

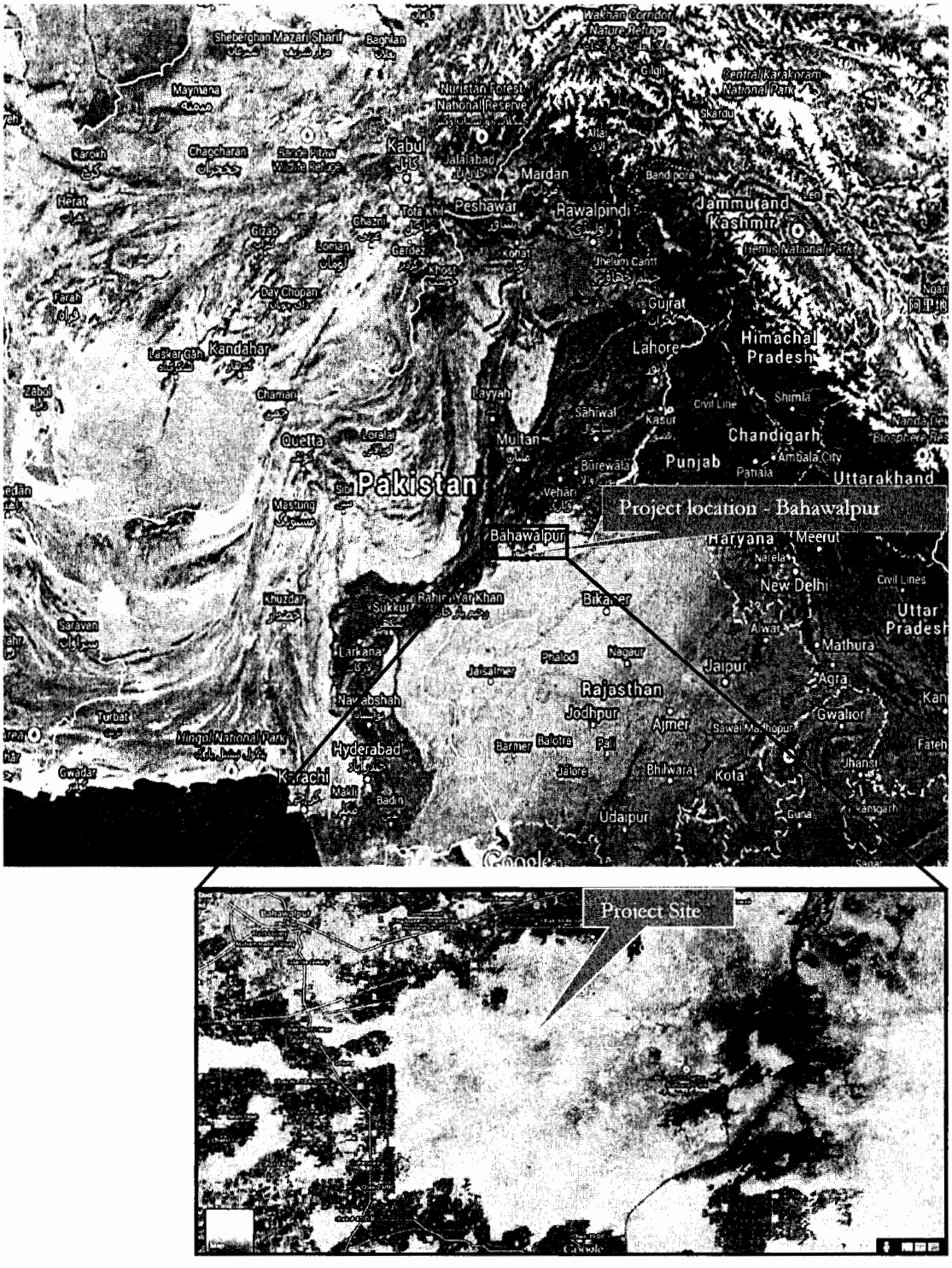
The site of the project is located within the premises of Quaid-e-Azam Solar Park, Lal Sohanra, which is approximately 18 kilometres from Bahawalpur City in the Province of Punjab. The land is allocated/leased from the Government of Punjab (GoPb) on an annual rental basis.

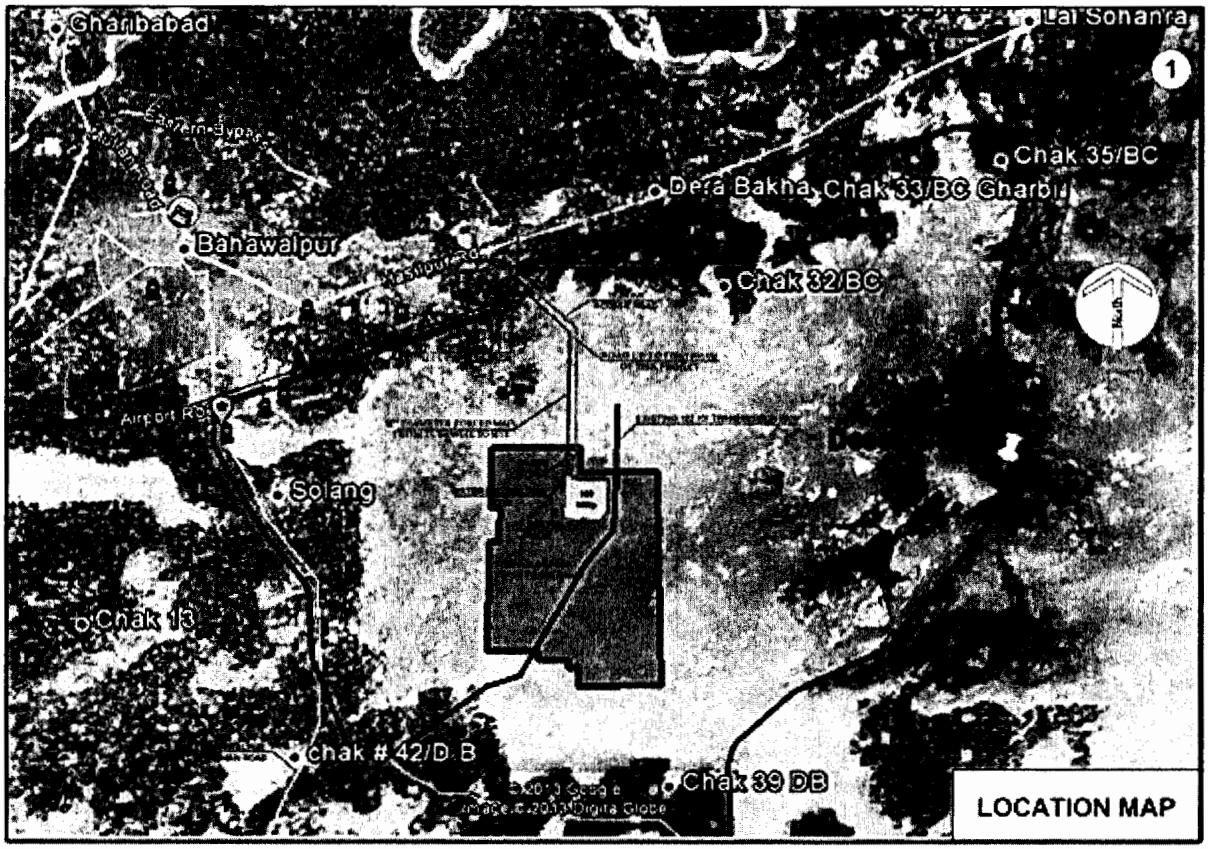
Bahawalpur District is located in southern Punjab, with a population of over 900,000, covering a total area of 24,830 km^2. About two-thirds territory of the district is covered by Cholistan desert. It is connected via road with Faisalabad, Lahore and Karachi, and by railway network to the entire Pakistan. The location of the project has the following inherent advantages:

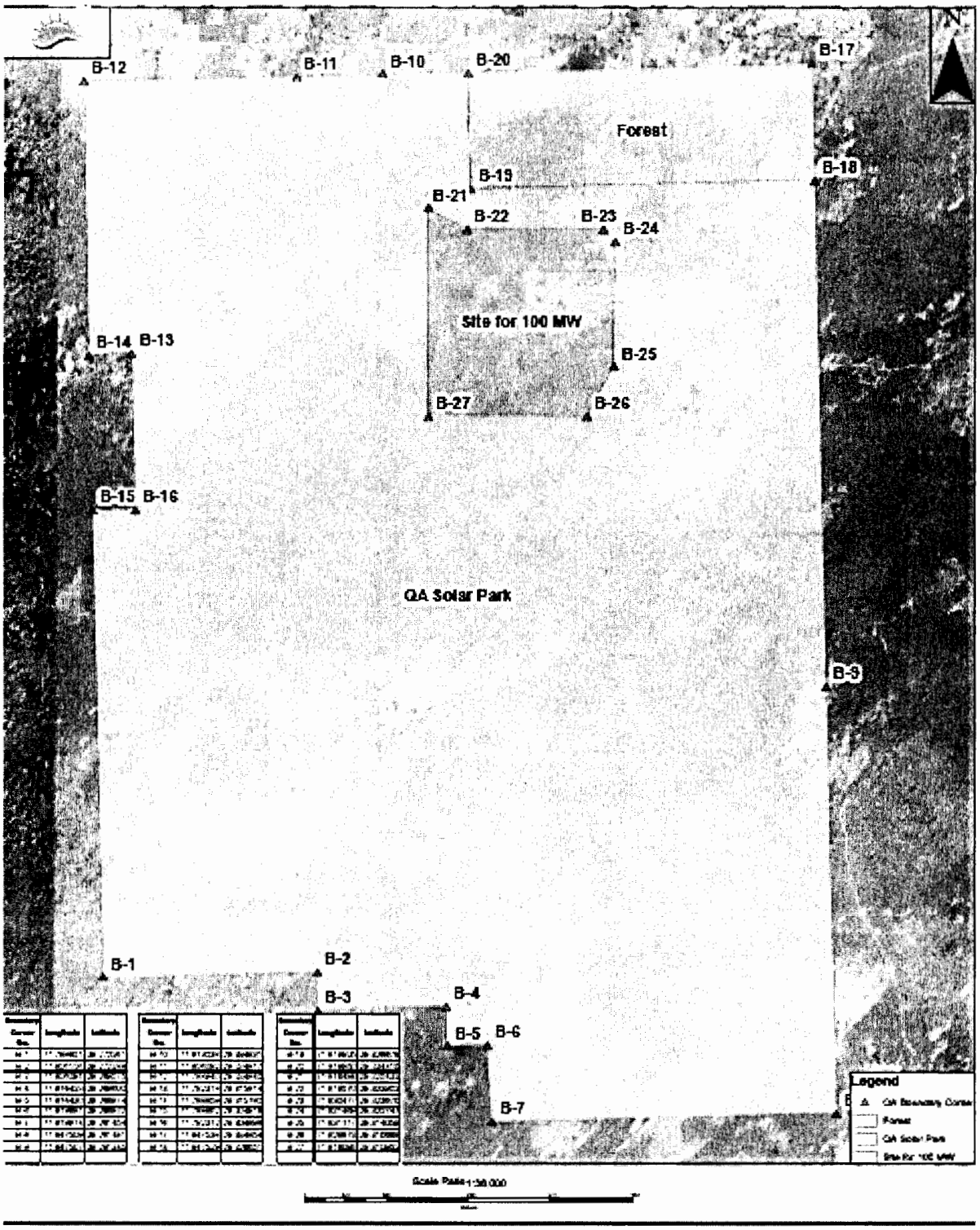
- Availability of land and supporting infrastructure
- Access to roads and railways
- Availability of semi-skilled labour

The site has a desert landscape, with ground elevations ranging from 119m to 130m. The Site coordinates are longitude 71.8° and latitude 29.33°. Total land area for the project is 40.5 square kilometers.

b) Site Map


Project location - Bahawalpur
Project Site
Pakistan
Bahawalpur
Kabul
Kandahar
Quetta
Peshawar
Rawalpindi
Lahore
Multan
Karachi
Hyderabad
Jaisalmer
Bikaner
Jodhpur
Jaipur
Ajmer
Udaipur
Kota
Himachal Pradesh
Punjab
Chandigarh
Uttarakhand
Haryana
New Delhi
Uttar Pradesh
Rajasthan
Jammu and Kashmir


Gharibabad
Lal Sohanra
1
Chak 35/BC
Dera Bakha, Chak 33/BC Gharbi
Bahawalpur
Chak 32/BC
North
Airport Rd
Solang
Chak 13
Chak # 42/D B
Chak 39 DB
LOCATION MAP


B-12
B-11
B-10
B-20
B-17
Forest
B-19
B-18
B-21
B-22
B-23
B-24
Site for 100 MW
B-25
B-14
B-13
B-27
B-26
B-15
B-16
QA Solar Park
B-9
B-1
B-2
B-3
B-4
B-5
B-6
B-7
Legend
Forest
Scale Ratio 1:50,000

c) Infrastructure

Roads:

Road access to the site has been completed by connecting the Bahawalpur Hasil pur road to the park. The length of this road is 9 km which also includes two bridges on canals. The carpeted road is capable for transportation of complete plant equipment to and from the site and for future transportation.

Power Evacuation Line:

132 kV power transmission line is already passing through the site. The load flow study by NTDC (Annexure 25) confirms that the power generated from the plant can easily be evacuated through this line without any reinforcement. The distance of the line from the site is less than 0.5 km.

Water Works:

Water will be required for dust prevention during the construction phase and eventually for cleaning of modules in the operation phase.

The plant site is located in a desert which renders the site to have ground water to be used. Water can be obtained from tube wells along the canals passing 8 km north of the site. The proposed tube wells are almost 8 km away from solar park site. The water pipes to bring water to the site are being constructed by PIEDMC and will be completed soon.

19. Technical Characteristics of Plant

a) Technology, Size, Number of Units
b) Interconnection with Grid, Distance, Voltage Level
c) Technical Characteristics of Generation Unit
d) Control, Metering, Instrumentation
e) Power Generation
f) Year, Make/Model, Commercial Operation Date and Project Life
g) Supply Voltage

a) Technology, Size, Number of Units

Given below is the detail of technology, size and number of units generated from the project.

Technology	Solar P.V (Polycrystalline)
Plant Size	100 MWp DC
Annual units Generation	160,313,000 kWh

b) Interconnection with Grid, Distance, Voltage Level

Given below is the detail of interconnection with grid, distance from the grid and voltage level:

Distance from Grid	500 m
Nearest Grid	Bahawalpur
Supply Voltage	132 kV/11kV

c) Technical Characteristics of the Generation Unit

Given below are the plant characteristics relating to generation voltage, frequency, power factor and related information's are given in the table below:

Generation Voltage	0.315 kV /11kV/ 35kV/ 132 kV
Frequency	50 Hz
Power Factor	0.95
Gen. Control	Auto
Time to Sync. Grid	Instant

d) Control, Metering, Instrumentation

Control equipment from renowned manufacturers shall be used for medium voltage and high voltage levels in the plant as per the requirement of NTDC. Main control shall be provided for MV lines, LV/MV transformers, MV/HV transformers, 132kV bus-bars and 132 kV transmission lines etc.

Metering equipment shall be installed at the point of common coupling between the HV transformer and busbar. Metering equipment shall be used as per requirement of relevant NTDC specification.

Measuring instruments for typical parameters like energy, current, voltage and power factor etc. shall be installed at suitable locations in the plant. SCADA system shall be installed for continuous monitoring and status of the said important parameters and every critical equipment of the plant.

e) Project Power Generation

The annual power generation value given below is based on the EPC contractor Annual power generation from the project will be 160,313,000 kWh which is expected to drop at the rate of 0.5% every year.

Installed Capacity	100 MW_p DC
Year 1 Power Generation	160,313,000 kWh

f) Year, Make / Model, Commercial Operation Date and Project life.

Information related to year, Make of the plant, Operation Date and Life of the Project is given in the table below.

Year	2014
Make	China
Commercial Operation Date	Early 2015
Project Life	25 Years

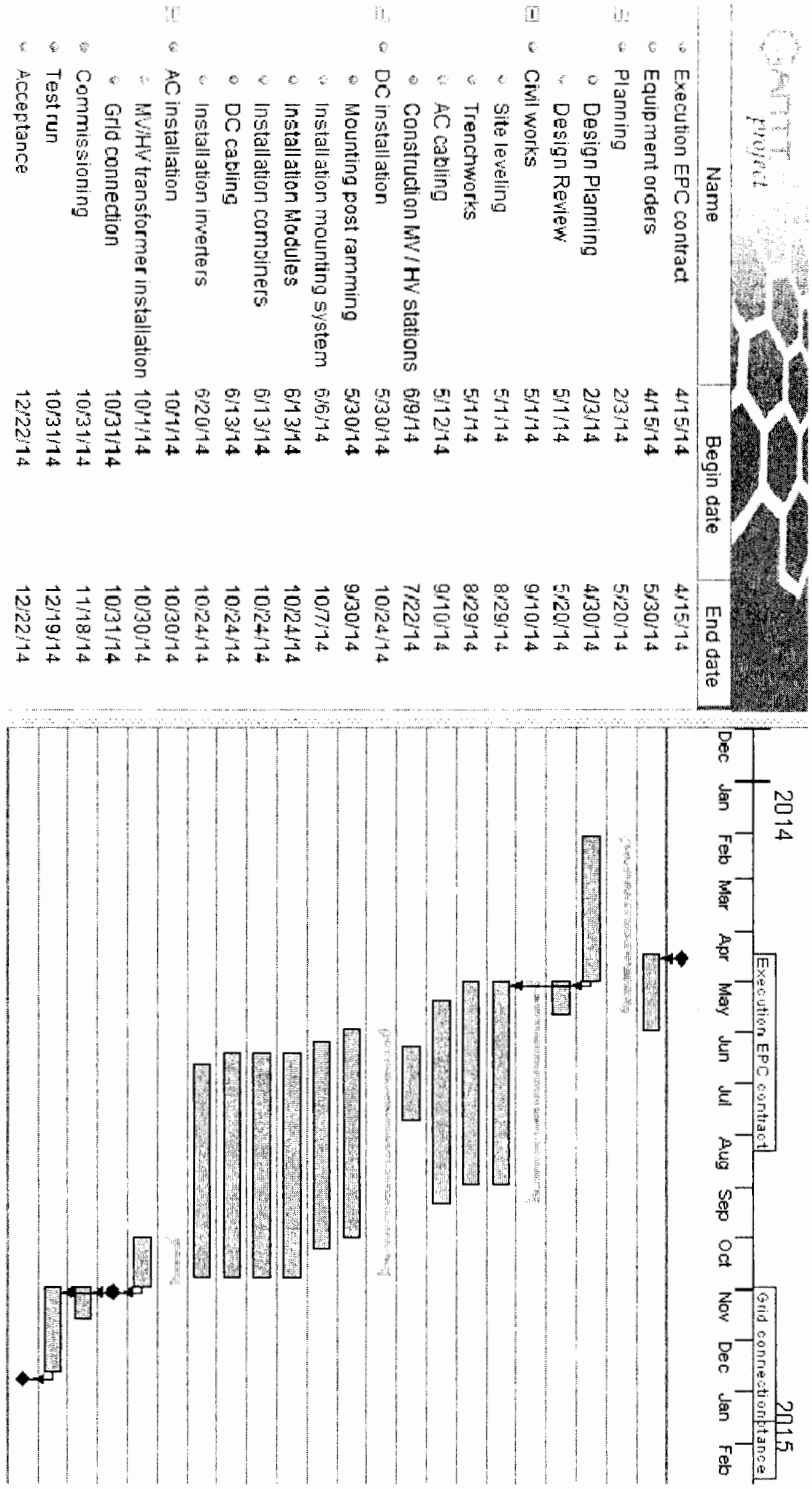
g) Supply Voltage

Information related to supply voltage and its supply to the grid is mentioned in the table below:

Supply Voltage	11KV/132 KV
Distance from Grid	500 m
Nearest Grid	Bahawalpur

20. Project Schedule and Milestones

The tentative project schedule with major milestones and commercial operation date is provided below.



21. Prospectus

Prospectus Annexure 30

Quaid-e- Azam Solar Power (Pvt.) Limited

Prospectus

Quaid-e-Azam Solar Power (Private) Limited

A Project of Government of Punjab

1. Sponsor's Profile

Quaid – e –Azam Solar Power Private Limited (QASPPL) has been established by the Government of the Punjab (GoPb) to undertake the first solar power project of 100MWp DC, under Independent Power Producer (IPP) framework, in Quaid – e – Azam solar Park with an objective to initiate and lead development of solar power projects in Pakistan. The total cost of the project is estimated at USD 150 Million and is proposed to be financed through a combination of debt and equity in ratio of 75:25 respectively. GoPb is executing this project through **Energy Department of GoPb** who is the sponsor of the project and shall ensure the provision of equity to meet the financing requirement of the project.

After the 18th amendment in the Constitution of Pakistan, provinces are now vested with full authority to develop power projects of any capacity through public or private sector and establish required regulatory framework. In view of existing energy crisis and opportunity provided by the new enabling framework, the Government of the Punjab decided to play a pro-active role in the energy sector. Energy Department has accordingly been mandated to vigorously pursue power generation, particularly focusing on renewable technologies in addition to the fossil fuel based generation.

Energy Department is responsible for developing / facilitating energy projects in the province and is actively playing its part in the initiation of new power projects and encouraging IPPs to develop renewable sources of energy.

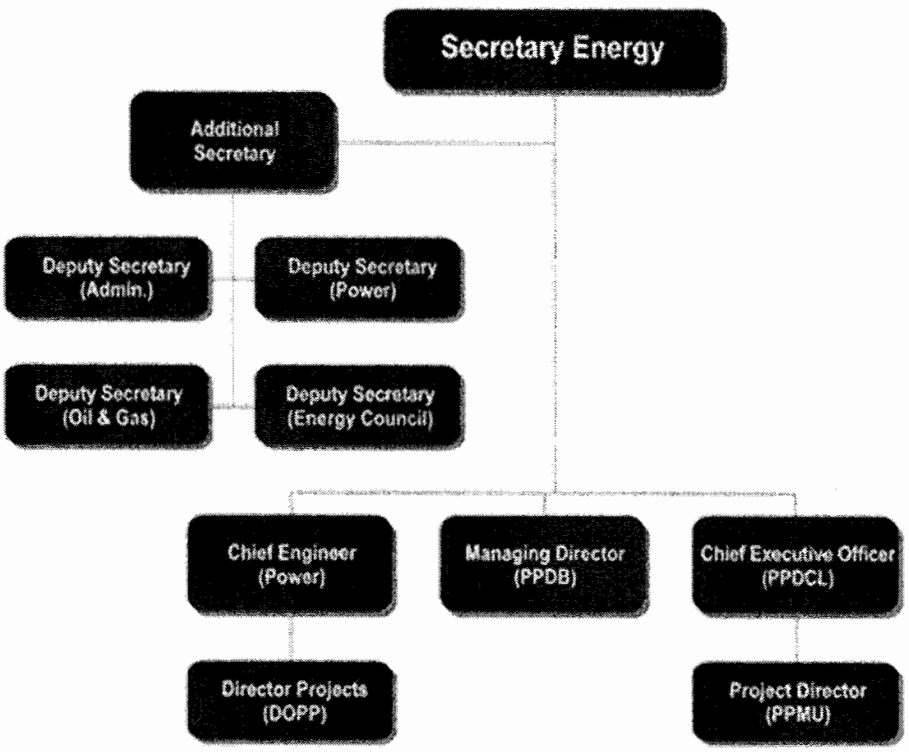
The table below provides the key functions and the organogram of Energy Department of GoPb.

Functions of the Energy Department	▪ Development of power generation by exploiting hydel, thermal and renewable energy resources ▪ Development of a power policy for Punjab which involves Legislation, policy formulation and sector planning ▪ Acquisition, revocation of amendment of Licenses of Electric Supply undertaking and approval of loads

- Input in development and execution of Regulation monitoring and granting Contractor Licenses and Supervisors Competency Certificate and other matters connected with Licensing Boards
- Involvement in matters connected with village electrification including formulation and devising criterion for selection of villages , matters connected with Tube-well electrification, matters relating to the Punjab Power Development Board (PPDB) and Punjab Power Development Company Limited (PPDCL)
- Monitoring of electricity tariff in Punjab
- Conservation of energy
- Off-grid distributed power generation
- Management and resolution with Federal Government on electricity charges

Organogram of the Energy Department

Energy Department



2. Project Description

Quaid-e-Azam Solar Park, located in Cholistan Bahawalpur, is an initiative of Government of the Punjab (GoPb), Pakistan to reduce reliance on fossil fuels in generation of electricity and to overcome the ever expanding gap between energy production and demand. It ultimately aims at generating 1000-MW of electricity from the solar energy through Quaid-e-Azam Solar Power (Pvt) Limited.

The project envisages setting up a 100 MW*p* DC Solar PV Power Project under "IPP" structure for which a separate company with the name of Quaid-e-Azam Solar Power (Private) Limited has been set up under the umbrella of the Energy Department of Government of the Punjab (GoPb).The Project aims to develop a 100MWp DC (Direct Current) Solar PV (Photovoltaic), fixed tilted generation plant. Consultants and advisors have been hired for the smooth progress of this project by international competitive bidding (ICB) under the regulations of PPRA. The project is envisioned to be completed through an EPC contract for which the EPC contractor is being hired through ICB. The EPC Contractor will also be providing the O&M services for the whole life of the plant.

Provision of the finances required for project implementation will be met through a mix of debt and equity with the ratio of 75:25. Estimated 25% of project cost will be injected as common equity by GoPb's Energy Department while the remaining 75% of project cost is proposed to be financed with a Term Finance Facility or Line of Credit secured for a period of 12 years, at a financing rate of 6 Month KIBOR + 3%. Project life of the solar plant is assumed for a period of 25 years with annual power generation of approximately 160,313,000 kWh.

The plant will evacuate AC (Alternating Current) power to the national grid through 132kV transmission lines located at the site. The power generated by the project is proposed to be sold to National Transmission and Dispatch Company (NTDC) through Central Power Purchasing Authority (CPPA).

The project time for construction to commercial generation of electricity, has been estimated to be 12 months, provided there are no unforeseen delays during project implementation.

3. Salient Features of the Project

Project	100 MWp DC Solar PV Plant
Site Location	Quaid-e-Azam Solar Park, Bahawalpur
Project Area	500 Acres
Sponsors	Government of Punjab
Project Company	Quaid-e-Azam Solar Power (Private) Limited
Capacity	100 MW*p* DC
Power Generation	160,313,000 kWh per annum
Construction Period	12 Months
Project Cost	PKR 15 Billion or USD 150 Million

Financing Plan

Description	% Age	PKR M	USD M
Equity	25%	3,750.00	37.50
Debt	75%	11,250.00	112.50
Total	100%	**15,000.00**	**150.00**

Financing Banks	The Bank of Punjab (BoP)
Financing Terms	KIBOR + 3% for a period of 12 years including grace period of 1.5 years.
Financial Advisors	Grant Thornton Consulting (Private) Limited (GTCL)
Legal Advisors	HaidermotaBNR & Co (HMC)
Technical Advisors	Engineering Consulting Services Punjab (ECSP)
Owner's Engineers	ILF Consulting Engineer

4. Environmental and Social Considerations

Initial Environment Examination (IEE) of the project has been undertaken by Engineering Consulting Services Punjab (ECSP) that shows no negative impact on environment as a result of this project. Further Environment Protection Department of Government of Punjab, through its letter dated 13th January 2014 granted environmental approval of the project.

The project is located at Lal Sohanra Park, Bahawalpur. There are no significant industrial activities in the area at present. However, there are few agricultural lands in the surroundings. Most of the inhabitants are dependent on the livestock for their sustenance. Seasonal wind storms cause slight erosion of soil/sand. As per latest survey few wild plants and rodents have been reported in the area. Overall ecosystem of the area is described as fragile. The acoustic environment is good with low noise from some local traffic on dirt roads.

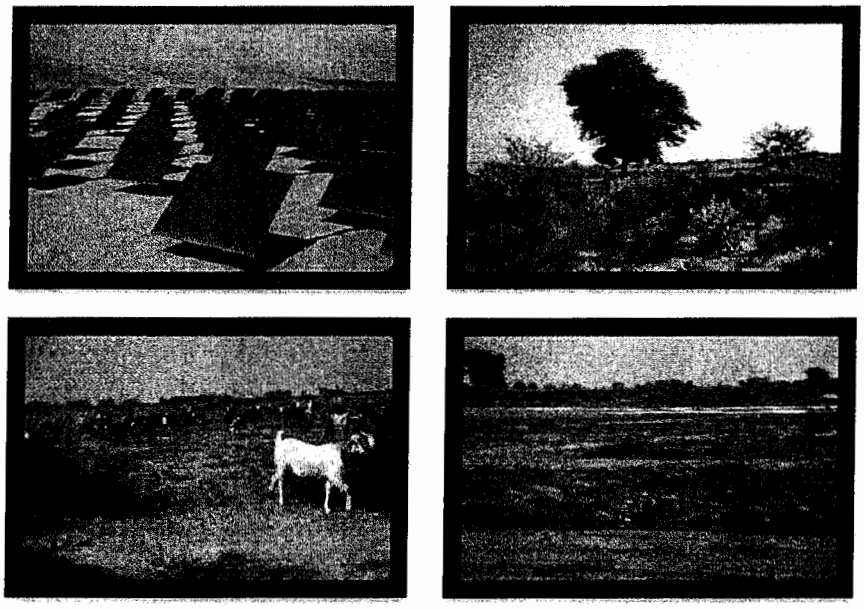
Burning of fossil fuels of energy remains the world's No. 1 source of carbon emissions which in turn is causing drastic temperature and climatic changes and destroying ecological systems. Solar Power is sometimes described as a zero emissions or emissions- free form of energy, thus with the generation of electricity using solar power, Quaid-e-Azam Solar Power (pvt.) Limited aims for Pakistan to take the first major step towards green revolution. This makes the plant eligible for Clean Development Mechanism (CDM).

22. ESSA- Environmental and Social Soundness Assessment

Initial Environment Examination Report	Annexure 31
Approval of Environment Protection Department	Annexure 32

ENERGY DEPARTMENT
GOVERNMENT OF THE PUNJAB

100 MWp Solar Photovoltaic Project, Bahawalpur – Pakistan



INITIAL ENVIRONMENTAL EXAMINATION (IEE) REPORT

NOVEMBER, 2013

Engineering Consultancy Services Punjab (Pvt.) Limited
83-A, E/1, Main Boulevard, Gulberg-III, Lahore.
Phone: 042-35717681-4 Fax: 042-35717685; Email: info@ecsp.com.pk

ENERGY DEPARTMENT
GOVERNMENT OF THE PUNJAB

100 MWp SOLAR PHOTOVOLTAIC (PV) PROJECT
CHOLISTAN, BAHAWALPUR

INITIAL ENVIRONMENTAL EXAMINATION (IEE) REPORT

Table of Content

ANNEXES

TABLES

FIGURES

BOX

ACRONYMES

AC	Alternating current
CDA	Cholistan Development Authority
CDM	Clean Development Mechanism
dB (A)	decibels
DC	Direct Current
EIA	Environmental Impact Assessment
EMC	Environment Management Committee
EMMP	Environment Management and Monitoring Plan
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EPD	Environmental Protection Department
ESP	Electro Static Precipitator
GHG	Greenhouse Gases
GIS	Geographical Information System
HSE	Health, Safety and Environment
IEE	Initial Environment Examination
IFC	International Finance Corporation
LAA	Land Acquisition Act, 1894
MW	Megawatt
NEQS	National Environmental Quality Standards
NOx	Nitrogen Oxides
PAP	Project Affected Persons
PCRWR	Pakistan Council for Research in Water Resources
PEPA	Pakistan Environmental Protection Act
PEPC	Pakistan Environmental Protection Council
PPE	Personal Protective Equipment
PV	Photovoltaic
RAP	Resettlement Action Plan
RCC	reinforced cement concrete
SOx	Sulphur Oxides
TL	Transmission line

EXECUTIVE SUMMARY

Introduction & Background

Energy crisis of the country have compelled the economic advisors to look for non-conventional sources of energy generation for quick solution of power shortages. Solar power generation is the next option which stands as renewable, environment friendly and clean energy. The Energy Department, Government of the Punjab has embarked upon 100 MWp Solar Photovoltaic Project to be located in the world's seventh largest desert, i.e., Cholistan, which is about 11 km from Bahawalpur city.

M/S Engineering Consultancy Services Punjab (Pvt) Limited (ECSP) has entrusted the responsibility of carrying out Initial Environmental Examination (IEE) for the project. This IEE report is prepared to initially assess the potential adverse environmental impacts likely to occur from the project's various stages, i.e., pre-construction, construction and operation.

As per Pakistan Environmental Protection Act (PEPA) the proposed project falls under the environmental category 'C' which means that the project will pose insignificant adverse impacts on the environment which can easily be mitigated by good engineering practices, with very low cost.

Policy, Legal and Administrative Framework

Under Clause 12 of PEPA, 1997, it is mandatory for the Proponent of any project to arrange Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) before the start of the project. **At present (Pak-EPA) has no regulation for solar power generation in their Schedule I or Schedule II (PEPA Regulations, 2000),** so it was decided to follow thermal power generation regulations for solar power generation being the closest energy generation reference. According to that regulation, this project needs an EIA for 100 MWp solar power generation unit. In view of the fact that the environmental impacts of solar power plant are lower as compared to thermal, the Energy Department decided that initially the consultants should conduct Initial Environmental Examination (IEE).

Methodology

The present solar power project is the first ever at national scale which is undergoing the environmental assessment; however, IEE methodology has to follow the

conventional approach to meet the minimum requirement of Punjab-EPA for social and environmental sustainability standards and policies.

The IEE process, however, has undergone the following steps mandatory for any environmental assessment:

- Review of secondary information;
- Collection of baseline information on physical, biological and socio-economic conditions prevailing in the project area;
- Impact assessment, mitigation and enhancement measures;
- Development of Environmental Management and Monitoring Plan; and
- Public consultation and disclosure.

Description of Project

Following are the salient features of proposed solar energy project:

Parameter	Detail
Type of area	Desert
Magnitude of the project	100 MWp
Solar power generation area	404 acres
Installation of other facilities	101 acres
Total land for proposed project area	505 acres
Type of technology	Photovoltaic (PV)
Width of utility corridor	170 meter
Project completion time	Around 24 months
Nearest TL interconnection	1 km
Traffic planning	Parallel to existing 132 KV TL
Type of equipment to be used	Fixed installation type X-Si solar cells
Project components	Grid station, switchyard, TL

Baseline Environmental and Social Conditions

According to environmental profile of the project area, the desert is under arid and harsh summer conditions with practically no population. The soil is rated as poor as it contains negligible amounts of organic matter. There is no proper air quality monitoring station present near the project area, hence no information about air and water quality, and noise level is available. Personal judgment explains that air and surface water are polluted due to shifting of sand dunes and generally the area falls

under silence zone. Drinking water source is hand pump which is away from the project boundary because ground water of Project Area is brackish.

The Project Area is reported to have rich wildlife, i.e., fauna and flora but these resources are under depletion due to harsh weather conditions. The threatened species present here are Nilgai antelope, Black buck, and Chinkara gazelle. By and large, the project area comes under the influence of Lal Sohanra National Park which is protected and important game reserve.

The socio-economic survey shows that no permanent settlement is present in the Project Area except a temporary Ranger's camp with 4-6 employees.

Anticipated Environmental and Social Impacts

The IEE of the proposed site indicates that a main impact arises from the construction and operational activities at site**. It is anticipated that no significant, long lasting and irreversible environmental and social adverse impact will emerge due to project interventions.**

The permanent positive impacts/benefits of implementation of solar power generation unit in Cholistan are more prominent than temporary adverse impacts, which include;

- It is a source of renewable, environmental friendly, clean energy and its 10-20 years sustainability sounds beneficial.
- It will reduce greenhouse gases emissions comparing it with coal fired/ diesel hence project may qualify for Clean Development Mechanism (CDM).
- Insignificant generation of atmospheric pollutants during operations.
- It will become an eye catch for tourism and educational institutions.

Besides positive impacts there are some under mentioned adverse but temporary impacts that may arise during various phases, however, these could be easily mitigated:

- During pre-construction phase there can be environmental problems regarding cutting of 111 trees and large number of shrubs. During construction phase there can be impacts of noise from construction machinery, nuisance and disturbance to community, impact on air quality and water quality from emissions and accidental spillage. There may also be

some impacts due to solid waste produced by construction activities, labor staying at site during operational phase as well as solar panel hazardous solid waste.

- In the operational phase, there will be few adverse impacts which can easily be mitigated, for instance, light pollution, high atmospheric temperature, and chance of electric shocks.

Mitigation of Adverse Environmental Impacts

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

Environmental Management and Monitoring Plan (EMMP)

The EMMP as described in the report summarizes project impacts and describes proposed mitigation measures and also identifies the authorities responsible for implementing those mitigation measures.

Public Consultation and Information Disclosure

The involvement of stakeholders for consultation and information gathering has been taken into account to fulfill the legal requirements of IEE and EIA Review Regulations, 2000. Since there is no community or affected person present within the Project Area, so only views of the Government officials are given in the report.

Conclusions and Recommendations

The overall findings of this IEE show that the proposed work has been undergone through exhaustive environmental screening process, which involved site visits, consultations with project stakeholders, review of documents, etc. It is believed that the process was sufficient to identify and examine all possible interactions between the project and the environmental and social conditions at the site. Several factors preclude any significant adverse environmental and social impact associated with the project.

It is anticipated that no significant, long lasting and irreversible environmental and social adverse impacts will emerge due to project interventions. Despite the

environmental friendly nature of the project it is recommended that the proponent should obtain an environmental approval (no objection certificate) from the Punjab-EPA before proceeding further into the construction activities as per regulatory requirements.

It is further recommended that the Proponent should also go for Environmental Impact Assessment (EIA) for the whole Master Plan i.e. 1000 MWp Solar Power generation Project.

1. INTRODUCTION

1.1 Background

Energy crises in the country have compelled the economic advisors to knock at every door from where electricity can be produced. Conversion of solar power into electricity through photovoltaic (PV) technology is new energy generation option which is renewable and environment friendly resource. Punjab Government Energy Department has taken a lead and decided to establish a 100 MWp solar photovoltaic (PV) project in Cholistan desert, some 11 km south of Bahawalpur City in an area of about 500 acres with associated infrastructure.

Engineering Consultancy Services Punjab (Pvt.) Limited (ECSP) has been engaged to carry out Initial Environmental Examination (IEE) process as a part of above mentioned services to fulfill the environmental regulatory requirements.

1.2 Project Location

The proposed project site is situated in Cholistan Desert approximately 11 km from south of Bahawalpur city in South Punjab, Pakistan and is pentagonal in shape with following coordinates:

Table 1.1: Coordinates Showing Project Location

Direction	North	East
A	773520.271	3245735.347
B	774980.758	3247182.020
C	774980.758	3246199.678
D	774726.969	3245735.531
E	773520.271	3245735.581

The satellite imagery of location of Cholistan Desert and blow-up of the Project Area are shown in the Figure 1.1.

Figure 1.1: Project Location through Satellite Imagery and Project Site Plan

1.3 Objectives of Study

Planning objectives of the environmental assessment are to carry out the identification of environmental impacts, positive or adverse, during construction, operation and maintenance activities of the proposed solar project. The specific objectives are given below:

- Identification of impacts on physical (including land, water, and air), biological/ecological, and socio-economic environment and suggesting mitigation measures thereof for the proposed project.
- Designing the project which meets the environmental standards.
- Conduction of safety audits of the proposed design to highlight the impact of the project on the workers of solar power plant safety in term of electric shock (OSHA guidelines 1970).

1.4 Limitations of the Study

Since the subject of solar power generation is new in the country, no environmental guideline or regulation is available with the EPA. Thermal power generation is the nearest scope to solar power generation which may be referred/used in this report. This regulation (PEPA Act 2000) states that thermal power generation up to 200 KW needs to conduct an IEE study before applying for environmental approval to Punjab-EPA (Annex-A). The environmentally benign nature of Solar Energy have ever compelled the Client to request the consultants for carrying out an IEE study for the first phase of 100 MWp photovoltaic power generation unit and the Proponent may go for detailed EIA study later.

British EPA requires a full EIA process[1] which is also considered mandatory by those Asian countries where solar parks have been constructed. The parallel example is Rajasthan Solar Power Park in India[2].

1.5 Environmental Sensitivity of the Project

According to impacts matrix (Table 6.2) of the proposed project with a planned generating capacity of 100 MWp, it is estimated that the proposed project falls in the

[1] Environmental Impact Assessment and water use license for the proposed solar park integrated project. (2011). Available at; www.eskom.co.za
[2] Hemant Kumar et al. (2012). Rajistan Solar Park_ an initiative towards empowering nation, Current trends in technology and science.

environmental category 'C' which translates into the fact that the proposed project will pose insignificant adverse impacts on the environment, i.e. minimal or even nil. In general terms such projects do not need well defined mitigation measures and all temporary adverse impacts can be minimized with good engineering practices as given in environment management plan (EMP). Under above referred clauses and the experience, environmental planning for the proposed unit of 100 MWp solar plant project envisages a brief environmental statement, i.e. IEE report. Anyhow, EIA report will be required later.

1.6 Purpose of the Report

The purpose and scope of this IEE report is to identify and assess the environmental impacts and propose mitigation measures for the significant adverse impacts that are likely to occur due to the implementation of this Project. This project includes the construction and operation of 100 MWp photovoltaic solar power station and associated infrastructure. A key feature of the IEE process is to work closely with the project engineers to ensure that the project design reflects environmental sensitivities and meets the social needs of the beneficiaries and the people living in the surroundings as per EMP.

The objectives of this report are:

- Impact assessment, mitigation and enhancement measures.
- Development of Environmental Management and Monitoring Plan (EMMP)
- Public consultation and disclosure.

2. LEGAL AND ADMINISTRATIVE REQUIREMENTS

Under Clause 12 of the Pakistan Environmental Protection Act 1997 (PEPA, 1997), in general it is mandatory for the Proponent of any project to arrange Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) before the start of the project. At present Pakistan Environment Protection Agency (Pak-EPA) has no regulation for solar power generation in their Schedule I or Schedule II (PEPA Regulations 2000). Thermal power generation is the closest energy generation reference which may be quoted for solar energy generation, according to which this project needs an EIA. It is, however, decided with the consultation of Punjab-EPA authorities that pilot phase of 100 MWp solar power generation unit will undergo an IEE, whereas EIA process will be conducted later. In consequences of the 18th Amendment passed in the National Assembly in 2010, Pak-EPA was devolved in provincial subjects, hence Punjab-EPA is undergoing a process of amendments in the PEPA Act, 2000 where solar and wind power generation subjects will soon be added by the time the regulations are amended, the experts of the consultants are preparing an EIA document plan which will follow this document shortly.

Anyhow, the legislation of Pakistan contains many laws in the form of Acts, and Ordinances which have direct or indirect relevance and implications in the layout, design, construction and operation of the Solar Plant Project. While discussing in this chapter, the prevailing operational manuals and guidelines and financial institutions are also considered.

2.1 National Policy and Administration Framework

The Pakistan National Conservation Strategy (NCS), approved by the Federal Cabinet in March 1992, is the principal policy document on environmental issues. The NCS outlined the country's primary approach towards encouraging sustainable development, conserving natural resources, and improving efficiency in the use and management of resources. The NCS has specific programs in core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment. The core areas that are relevant in the context of the proposed project are pollution prevention and abatement, conserving biodiversity, supporting forestry and plantations.

The Government of Pakistan promulgated "Pakistan Environmental Protection Act (PEPA) in 1997. Two organizations, the Pakistan Environmental Protection Council (PEPC) and the Pak-EPA (now developed), are primarily responsible for administering the provisions of the Act at the federal level. The PEPC oversees the functioning of the Pak-EPA. Its members include representative of the government industry, non-governmental organization, and the private sector. The Pak-EPA is required to ensure compliance of the National Environmental Quality Standards (NEQS) and establish monitoring and evaluation systems. The Pak-EPA was authorized to delegate powers to its provincial counterparts, the provincial EPAs or EPD (Environmental Protection Department in Punjab), but the provinces are now conferred full authority after development. One of the functions delegated by the Pak-EPA to provincial EPAs/EPD is the review and approval of environmental assessment reports of projects undertaken in their respective jurisdictions.

2.1.1 Pakistan Environmental Protection Act, 1997

The Pakistan's Environmental Protection Act, 1997, empowers the Pak-EPA to:

- Delegate powers including those of environmental examination/ assessment to the provincial EPAs/ EPD.
- Identify categories of the projects to which the environmental examination/ impact assessment provisions will apply.
- Develop guidelines for conducting IEE and procedures for the review and approval of the same.
- Develop environmental emission standards for parameters such as air, water and noise pollutants.
- Enforce the provisions of the Act through environmental protection orders and environmental tribunals headed by magistrates with wide-ranging powers, including the right to fine violators of the Act.

Under the provisions of the 1997 Act, the Pak-EPA has empowered four provincial EPAs/ EPD to manage the environmental concerns of their respective provinces .The provincial EPAs/ EPD can frame environmental regulations tailored to the requirements of their province, provided these regulations meet or exceed the

minimum standards set by the Pakistan EPA. They are also required to review and approve IEEs/ EIAs of all the development projects.

2.1.2 National Environmental Quality Standards, 2000

The NEQS 2000 specify the following standards:

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to land waters, sewage treatment facilities, and the sea (three separate sets of numbers).
- Allowable noise levels from vehicles.

2.2 Interaction with Other Provincial Agencies

It is the responsibility of project Proponent to ensure that project complies with the laws and regulations controlling the environmental impacts at pre-construction requisites, construction and operation stages of the project.

2.2.1 Punjab Environmental Protection Department

The Proponent will responsible for providing the complete documentation required by the Punjab Environmental Protection Department and remain committed to the approved project design. No deviation is permitted during the project implementation without the prior and explicit permission of the Punjab EPA/ EPD.

2.2.2 Provincial Departments of Forest and Wildlife

In case the implementation of the proposed project involves the clearing of vegetation and trees in project area, the project contractor will be responsible for acquiring "No Objection Certificate" (NOC) from concerned provincial Department. The application for NOC will need to be endorsed by the Proponent. Where the construction is to be carried out in close proximity of protected forests and wildlife areas, the Proponent is required to coordinate with the departments to ensure that impact on flora and fauna species are minimized. Energy Department is the Proponent of the project and is responsible for receiving an approval for the environmental clearance from the Punjab-EPA.

2.2.3 Provincial Revenue Departments

Under the National laws, the matters relating to land use and ownership are provincial subjects, and the Revenue department of the concerned province is

empowered to carry out the acquisition of private land and built-up property for public purposes, including on behalf of another Provincial or Federal Agencies. For those purposes, the lead department must lodge an application with the concerned provincial government to depute a Land Acquisition Collector (LAC) and revenue staff, which will be responsible for handling matters relating to land in case of any issue arise.

2.2.4 Agriculture Department

it also requires a liaison with the provincial departments of agriculture, horticulture and forestry in case of issues associated with these departments. The concerns could be relating to the affected vegetation resources, such as trees and crops. In case of some public buildings/ infrastructure is involved, Proponent will approach the building department for relocation/ assessment of compensation.

2.2.5 Coordination with District Government

The Project Proponent will coordinate with all concerned Government department and ensure that the project meets the criteria of District Government / Authorities as related to the establishment of construction camps and plants and the safe disposal of waste, solid waste and toxic material. Proponent will also ensure periodic monitoring of the EMP during both construction and operation period through deployment of an Environment Specialist.

2.3 Other Relevant Acts

2.3.1 Punjab Wildlife Protection Act, 1974

The Punjab Wildlife Protection Act, 1974 was passed by the provincial assembly of Punjab in 1974. This Act is applicable to the whole of the Punjab province for protection, conservation, preservation and management of Wildlife. This Act also addresses designated areas of sanctuaries and protection of rare and endangered species.

2.3.2 Local Government Act 2001 and Amended in 2003

These ordinances, issued following the devolution process, establish regulations for land use, the conservation of natural vegetation, air, water, and land pollution, the disposal of solid waste and wastewater effluents, as well as matters related to public health and safety.

2.3.3 Land Acquisition Act, 1894

The Land Acquisition Act 1894 is a law for the acquisition of land and which is implemented to fulfill the needs of Government and companies for land required by them for their projects, and secondly, to determine and pay compensation to those private persons or bodies whose land is to be acquired. The experience of the power of acquisition has been limited to a cash compensation policy purposes. The LAA is limited to a cash compensation policy for the acquisition of land and built-up property, and damage to other assets such as, crops, trees and infrastructure. The LAA does not take into account the rehabilitation and settlement of displaced population and restoration of their livelihoods. Presently, the requisite land for the proposed project is already owned by the project Proponent, as such no additional private or government land will need to be acquired for the project.

2.3.4 Protection of Trees and Brushwood Act, 1979

This Act prohibits cutting or lopping of trees and brushwood without permission of the concerned Forest Department and demands a NOC from Forest Department before cutting of trees.

3. APPROACH AND METHODOLOGY

Since construction of 100 MWp solar power station is a new idea in Pakistan, its environmental examination was approached in two ways. Firstly, it was handled in a conventional way in terms of preparing environmental statement (IEE report). Secondly, contemporary literature was comprehensively reviewed regarding technical details of the PV technology and the related information. Based on these approaches, this IEE report is prepared which explains the understanding of objectives, approach to the services, methodology for carrying out the activities & obtaining the expected output, and the extent and detail of such output.

The IEE methodology follows the conventional methods that meet the minimum Punjab EPA requirements as well as fulfills the IFC's guidelines on social and environmental sustainability standards and policies. In the present IEE process, the environmental and social aspects were fully taken into account while gathering field information on physical assets, biological resources and social settings of the project area. Following is given the hierarchy of the methods used in this study:

3.1 Review of Secondary Data

The secondary data was collected from various offices in terms of published reports of different government, non-government or private sector organizations revealing all relevant and desired information about the project area. Government departments contacted were CDA, Forest, Agriculture, Fisheries & Wildlife, Revenue and the Rangers situated in Bahawalpur. Other than Bahawalpur district & town administration, Punjab-EPA, Energy Department, and WWF offices at Lahore were also contacted for a thorough investigation of Cholistan Desert, in general, and the project area, in particular.

The review of design documents prepared in the Consultant's office helped the environment team to visualize the nature and extent of the project. They included project location and layout plan (Figure 1.1), satellite imagery, engineering survey sheets, related maps and the photographs. Similarly, information on location, general layout, depth of underground earth resources, wind direction, annual rainfall, natural slope of the land, subsurface hydrogeology, solar resource, existence of any surface water resources etc. and other appropriate information were used to assess the impacts of the project on the environment.

Various websites and uploaded reports of similar solar plants, especially implemented in Asian countries, were other source of information which was carefully reviewed for the sake of planning, designing and studying of the proposed project and assessment of foreseeable impacts and thus mitigations thereof. Master Plan of the proposed project was also duly taken into account as a base approach.

3.2 Collection and Analysis of Primary Data

The socio-environmental study team of the consultants visited the project area to collect the data regarding the baseline conditions of the existing environment. The site was thoroughly investigated from 12th to 19th November, 2013. The primary data were collected with reference to different project components and assessed in a systematic fashion. The data regarding climate, hydrology, geology, seismology, and other physical features of the project area were obtained from the secondary sources to prepare this IEE report.

The team of professionals responsible for data collection, field study, analysis and writing of report was composed by the following professionals along with description of their brief responsibilities:

1. Dr. Sultan Mahmood, Chief of Section, Environment, supervised the field team in Cholistan desert and guided them to use correct methodology of data collection process, as well as interviewed the district and town authorities of Bahawalpur including Rangers.
2. Engr. Athar Aslam, HSE Expert and Resettlement Specialist, emphasized on the status of the affected families for their resettlement options, as well as planned for the future construction activities.
3. Mr. Ghulam Dastgir, Senior Surveyor, recorded coordinates and used his foreign experience regarding GIS.
4. Mr. Usman Haider Mohammadi, Environmentalist, recorded field truths through environmental checklist, as well as helped other team members in recording the socio-economic data.
5. Engr. Salman Majeed, Junior Engineer, recorded ground truths through structured questionnaire and also helped out other team members in record keeping.

6. Mr. Shehzad Akhtar reviewed this IEE report with his valuable comments and necessary corrections.

The consultants thus collected environmental and social baseline data by keeping in view the characterization of the extent and quality. After collecting data from both primary and secondary sources, an analysis was made to assess the existing baseline conditions and potential impacts of the project, as well as other necessary parameters were converted on the following information:

Physical Environment

- A detail description of the topography and geology.
- Effects of electromagnetic field on human health;
- Disposal of photovoltaic cells;
- Climatic conditions and air quality in the project area which included particulate emissions, NOx, SOx, wind speed and direction, precipitation, relative humidity, ambient temperatures, and annual rainfall etc;
- Life cycle assessment of photovoltaic cells;
- Water quality standard for washing solar panels.

Ecological Environment

- Flora;
- Fauna;
- Reserved forests and wildlife sanctuaries in and around the project area;
- Endangered species (both flora and fauna), if any.

Social and Cultural Environment

- Demographic characteristics;
- Identification of poor and vulnerable groups, and to develop strategies to ensure that such groups should get benefit from the project;
- Adequate public/stakeholders consultation and participation;
- Identification of impacts on available common resources of the community

due to the project;

- Gathering information from the local communities on various environmental and social parameters of their localities;
- Socio-economic conditions in the study area;
- Impacts of noise, dust, exhaust emissions and odour on local System affected persons and on affected community;
- Impacts of proposed solar power plant on adjacent or nearby property;
- Impacts on employment and cultural values.

3.3 Screening of Potential Impacts and Mitigation Measures

After a thorough review of the field notes, data collected, extent of the proposed project activities and the detailed discussions held with the stakeholders and the design team, the potential impacts of the project were assessed and measures were proposed to mitigate the adverse environmental impacts and to enhance the positive impacts. The potential adverse impacts and mitigation measures were assessed covering the following aspects / phases for the environmental problems related to the project:

- Pre-construction
- Construction
- Operation & maintanance

3.4 Preparation of EMP and Institutional Requirements

Institutional capacity of the Proponent was reviewed and suggestions were made for the effective implementation of the mitigation measures and the monitoring requirements. As the supervision consultants and contractor(s) for this solar plant are yet to be finalized, therefore, generic guidelines have been provided in the EMMP for defining their roles and responsibilities.

3.5 Reporting

The team of consultants recorded all collected information in the form of IEE report as per guidelines of the Punjab-EPA.

4. PROJECT DESCRIPTION

This section deals with the present conditions of the project in terms of salient features, project justification, analysis of alternatives and construction arrangements.

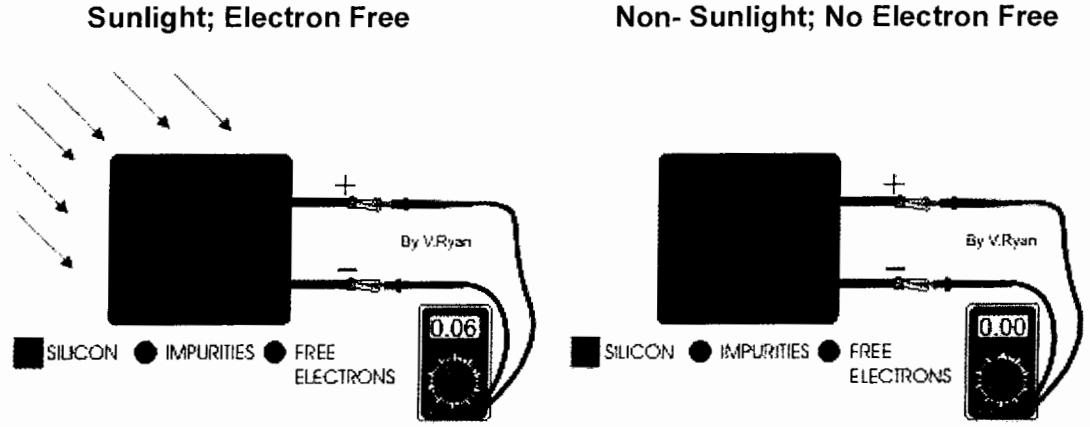
4.1 Need of the Project

The current resources of Pakistan are insufficient to meet the rapidly increasing power demand and thus acute power shortfall is vividly posing economic degradation. Keeping in view the ever increasing electricity requirements of the country and to utilize the waste land available, the proposed project of renewable solar energy was considered.

4.2 Technical Details of PV Technology

The Solar Photovoltaic (PV) systems produce energy by converting solar irradiation into electricity. The PV system consists of PV panels that hold the Solar Cells. Solar Cells are solid-state semiconductor devices that convert light into direct-current. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Materials presently used for photovoltaic include mono-crystalline, silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenide/ sulfide. Due to the increased demand for renewable energy sources, the manufacturing of solar cells and photovoltaic arrays has advanced considerably in recent years. The schematic diagram is shown in Figure 4.1.

Figure 4.1: PV Technology Schematic Diagram[3]



[3] Alfred Smee (1849)

Inverters are used to convert Direct Current (DC) into Alternating Current (AC). The AC energy can then be used to power anything that uses electricity.

4.2.1 Components of Solar Power Station

Following are the components of solar power station:

- PV solar Panels and arrays;
- PV Panel mountings;
- DC-AC current inverters and transformers; and
- Underground cabling/ overhead power lines.

PV panels are typically up to $6m^2$ in size and the rows will be approximately 1 km in length, made up of approximately 100 m sections depending on the optimal final design and layout of the development. The panels will be mounted on metal frames with a maximum height of approximately 3m above the ground, supported by concrete foundations or pile foundations. Erecting solar panels by using drilling and driving machine are shown in Figure 4.2.

Figure 4.2: Drilling and Height of Solar Panels

4.2.3 Recycling of Solar Panels[4]

Over the past few decades, production of energy through the use of photovoltaic (PV) technology has increased. The past ten years have seen the largest growth in demand for PV modules, with a rate of 35% in 2010 and predicted rates of 20% or more through 2015.The majority of the PV market consists of silicon-based modules,

[4] Kari Larsen (2009). Recycling solar PV panels *(www.renewableenergyfocus.com)*

most commonly constructed from crystalline silicon wafers. However, PV modules do not last forever; they have a life expectancy of about 30 years before they must be decommissioned. Failure of modules is often attributed to defects in the product, including "glass breakage, defect laminate, electrical defects, wrong designs, or process losses."

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

4.3 Salient Features of the Project

The proposed project is a part of Master Plan and will be spread over an area of approximately 500 acres in the Cholistan desert. The powerhouse units will be errected at ground level.

Since Cholistan desert land belongs to the government, its acquisition may not be a problem for the construction of solar power plant. Some of the salient features of proposed project to be constructed at Cholistan desert are given in Table 4.1.

4.4 Analysis of Alternatives

Different alternatives were also considered by the design engineers for the proposed project which include No Project Option (NPO), other power generation options, site alternatives, and design & technology alternatives. They are described in table 4.1.

4.4.1 No Project Option (N.P.O)

The current power production in Pakistan is about 12-14 thousand MW against a demand of 16-17 thousand MW per day thus a demand-supply gap is around 3-4 thousand MW for the year 2012-13 resulting in load shedding of almost 6 to 8 hours a day in urban centers of Pakistan and even more in the rural areas. This gap is increasing annually and causing a great economic loss to the country apart from the human suffering due to regular power outages.

Government of Pakistan is endeavoring hard to reduce the shortage of power. It is utilizing all available energy generating resources. It has started many thermal,

coals, nuclear and renewable power generation projects to fill the demand gap including solar resource. Considering this situation, the NPO, if exercised, will further deprive Pakistan in terms of continued crisis which can easily be generated from the cheaper sources. In the light of the above situation, NPO is not acceptable under prevailing power shortage scenario.

Table 4.1: Salient Features of the Project

Parameter	Detail
Type of area	Desert
Magnitude of the project	100 MWp
Solar power generation area	404 acres
Installation of other facilities	101 acres
Total land for proposed project area	505 acres
Type of technology	Photovoltaic (PV)
Width of utility corridor	170 meters
Project completion time	Around 24 months
Nearest TL interconnection	1 km
Traffic planning	Parallel to existing 132 KV TL
Type of equipment to be used	Fixed installation type X-Si solar cells
Project components	Grid station, switchyard, TL

4.4.2 Other Power Generation Options

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

Out of total installed generation capacity of about 20,215 MW in Pakistan, 6,463 MW belong to hydro, 6,590 MW thermal, 462 MW to nuclear and 6,414 MW to Independent Power Producers (IPPs). Around 286 MW was being produced by Rental Power stations (RPPs) which has turned into a total failure. The growth of nuclear power stations has not been a very feasible option from the point of view of providing quick and reliable relief. Unfortunately, hydropower generation issues are also politicized currently. It is, therefore, apprehended that no big hydropower generation unit will be completed in Pakistan in many years to come. Thus planners are forced to opt for other power generation venues, particularly renewable avenues, amongst them solar power generation appears the best option.

Solar power generation option remained under hot discussion for bridging the demand and supply gap because solar is not only a renewable power generation source and environment friendly but also suitable for Pakistan due to having vast wastelands like Cholistan, Thar and Thal. Though no feasibility study on solar power is available in the country especially on economic and technical aspects but some successful precedents are present in the neighboring countries.

4.4.3 Location Options

There were two options to erect solar plants in the country, either to establish this in Thar and other in Cholistan desert. Thar Desert has been planned for coal-based power generation, thus Cholistan desert is the next best option of the time which will also provide an economic boost to southern Punjab enhancing the value of the desert area in economic terms.

4.5 Construction Aspects

Standard IEE also discusses various construction aspects so that firm planning may be done on the basis of mitigation plan proposed in this report. Some of them are discussed below:

4.5.1 Contractor's Facilities

Contractor will have to construct facilities for labor, machinery and vehicles, etc. It is envisaged that there is lot of space available for the contractor around the project area without disturbing any resident, ecology or the infrastructure.

4.5.2 Work Force

It is expected that the skilled staff will be engaged in the construction and installation work during the construction stage of the project. The breakdown of the staff strength during the average and peak construction stages is expected as 100 and 200, respectively.

Table 4.2: Energy Source Comparison[5]

Energy Source	Pros	Cons
Solar Energy	Nonpolluting Most abundant energy source available Systems last 15-30 years	High initial investment Dependent on sunny weather Supplemental energy may be needed in low sunlight areas Requires large physical space for PV cell panels Limited availability of polysilicon for panels
Wind Energy	No emissions Affordable Little disruption of ecosystems Relatively high output	Output is proportional to wind speed Not feasible for all geographic locations High initial investment/ongoing maintenance costs Extensive land use
Hydropower	No emissions Reliable Capable of generating large amounts of power Output can be regulated to meet demand	Environmental impacts by changing the environment in the dam area Hydroelectric dams are expensive to build Dams may be affected by drought Potential for floods
Natural Gas	Widely available Cleanest-burning fossil fuel Often used in combination with other fuels to decrease pollution in electricity generation Made safe by adding artificial odor so that people can easily smell the gas in case of a leak	Transportation costs are high Lack of infrastructure makes gas resources unavailable from some areas Burns cleanly, but still has emissions Pipelines impact ecosystems
Petroleum	Efficient transportation fuel for the world Basis of many products, from prescription drugs to plastics Economical to produce Easy to transport	High CO_2 emissions Found in limited areas Supply may be exhausted before natural gas/coal resources Possible environmental impact from drilling/transporting
Biomass	Abundant supply Fewer emissions than fossil fuel sources Can be used in diesel engines Auto engines easily convert to run on biomass fuel	Source must be near usage to cut transportation costs Emits some pollution as gas/liquid waste Increases emissions of nitrogen oxides, an air pollutant Uses some fossil fuels in conversion
Coal	Abundant supply Currently inexpensive to extract Reliable and capable of generating large amounts of power	Emits major greenhouse gases/acid rain High environmental impact from mining and burning, although cleaner coal-burning technology is being developed Mining can be dangerous for miners
Uranium	No greenhouse gases or CO_2 emissions Efficient at transforming energy into electricity Uranium reserves are abundant Refueled yearly (unlike coal plants that need trainloads of coal every day)	Higher capital costs due to safety, emergency, containment, radioactive waste, and storage systems Problem of long-term storage of radioactive waste Heated waste water from nuclear plants harms aquatic life Potential nuclear proliferation issue
Geothermal	Minimal environmental impact Efficient Power plants have low emissions Low cost after the initial investment	Geothermal fields found in few areas around the world Expensive start-up costs Wells could eventually be depleted

[5] www.energy4me.org/energy-facts/environmental-protection/environmental-impact-by-source/

4.5.3 Construction Material and Transportation

Solar panels will be erected on steel rods fixed in the ground. Similarly, other construction material will also be used to build allied structures such as office, store room, parking area, switchyard, etc. using framed construction technology. The framed structure will consist of reinforced cement concrete (RCC) using mainly steel, cement, sand, aggregate for construction purposes.

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

5. BASELINE ENVIRONMENTAL CONDITIONS

This section provides baseline data (physical, biological and socio-economic parameters) related to the project area. Information is provided both in quantitative and qualitative terms and is based on secondary and primary data collection, site field visits and desk studies.

A baseline consists of the existing environmental and socio-economic and cultural status of the project area. The baseline information and indigenous knowledge is required for scoping potential environmental issues associated with the implementation of the project. On the basis of baseline information, the project interventions are assessed and mitigation measures are proposed. The baseline information also helps to indicate the specific issues to be monitored during project execution as well as during operational phase.

5.1 Physical Environment

Information placed below has been extracted from the secondary sources:

5.1.1 Physiographic Profile of Cholistan Desert

The project area falls in Cholistan Desert which is a part of the world's seventh largest desert, the Great Desert, which is stretched along the south border of Punjab province, Pakistan. The total area of proposed project is 505 acres; it lies between 33" 78'938 N and 224" 50'095 E at an altitude of about 112 m above sea level, the important geological features of the area is the old Hakra River, which was dried out about 600 years ago. Historically, the area received heavy monsoon downpours along with the Indus Valley, which is the home of world's oldest civilizations, Mohenjo-Daro and Harappa, date back to 5000 years. A gradual change in climate caused a shift in monsoon winds away from the area, resulting in a decline in precipitation, and ultimately converting the area into a desert.

The Cholistan desert is one of the key ecological arid zone facing extreme seasonal variations. It has a population of about 110,000 who are practicing a nomadic life style from many centuries. The economy of desert depends upon th herds of livestock that are adopted to local climatic extremes. The only mean of communication from the interior desert is by means of camels. There is little or no vegetation in desert areas due to extreme climatic conditions and the grazing

animals. The nomads mainly depend upon ethno-veterinary medical practices for animal health cares. The plants used are locally grown or indigoes to the area. Arshad et al., (2000) identified 118 species belonging to 32 families of Cholistan desert. The Cholistan desert has sustained the ethno botanical uses for these plants for a long time (Arshad et al., 2002)

5.1.2 Climate/Weather

The climate is sub-tropical, harsh, hot and arid, and influenced by seasonal monsoons. One of the most remarkable features of the project area is the occurrence of dry years in clusters, i.e., for 4-6 years continually. Annual and even daily temperature varies greatly. Mean summer temperature varies from 35 to 50 °C during May to June and winter from 15 to 20 °C during December to February. Annual rainfall is low and erratic, ranging from 100-250 mm annually, with its maxima during July to September in summer monsoons and January to March in winters. Arshad et al., 2006 reported that high temperatures, low humidity, strong winds and a high rate of evaporation transform the desert into a death valley with extremely harsh environments during summers.

5.1.3 Geology

There is no significant geology. This area is covered by unconsolidated alluvium and very recent sediments whereas areas closer to India are mainly desert. This is the part of Indus Basin or may also be defined as the western extension of the Rajasthan's Jisalmair Basin. However, few salient features about the area cover the project area and adjacent areas. The geological information about this region is based on 10 to 15 wells and 2D seismic data acquired by various companies in the last 50 to 55 years in Pakistan.

The rocks of Pre-Cambrian to recent age, exposed in the Aravali Range in the east (in India) and the sedimentary successions from Mesozoic to Tertiary at the Sulaiman Range provide the basis to predict the subsurface geology in this region; though drilling have provided wide scale of information about subsurface. Topography and geology of the project area is shown in Figure 5.1.

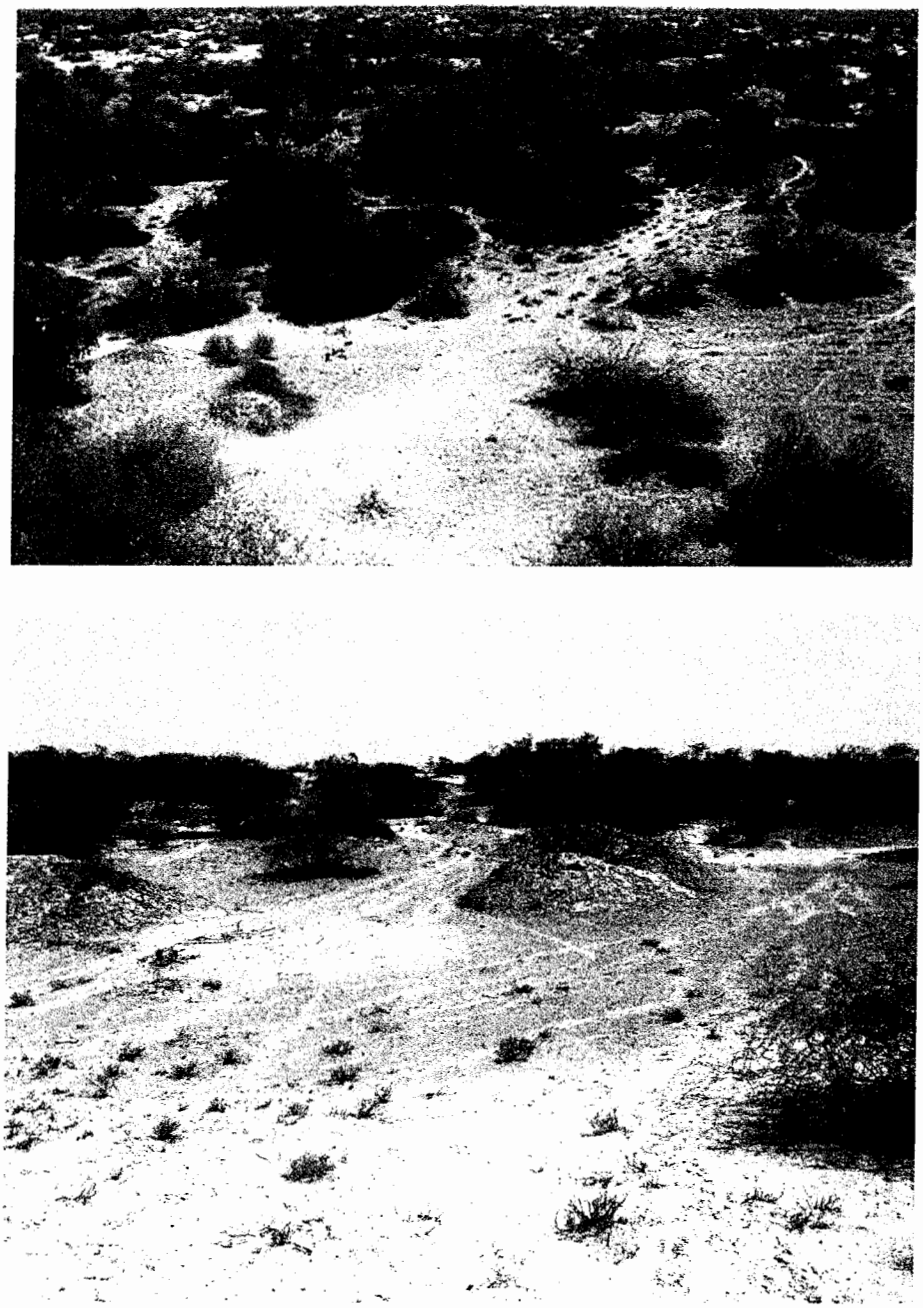


Figure 5.1: Topography and Geology of Project Area

5.1.4 Land Use

Land capability of a piece of land can be judged based on its ability to produce sustained common agricultural crops, grazing capacity and forestry suited for a particular area. Keeping in view the above definition, the land use statistics provide the information regarding the forest, arable agricultural land, and the status of ground water, etc. and help in establishing the basis for assessment of potential for planned developments. Detailed information regarding the existing land use of the project area is provided in Table 5.1.

Table 5.1: Land Use of Cholistan Desert[6]

SR#	LAND USE	AREA (ACERS)	AREA (%)
1	Total arable area	991,815	75%
2	Uncultivated (waste) area	324,387	24%
3	Forest area	12,064	1%
	Total reported area	**1,328,266**	**100%**
IRRIGATED AREA OUT OF ARABLE LAND			
1	Irrigated by canal	277,518	57%
2	Irrigated by tube wells	210,527	43%
	Total irrigated area	**488,045**	**100%**
WATER QUALITY OF ARABLE LAND			
1	Area in sweet water zone	176,815	18%
2	Area in brackish water zone	815,000	82%
	Total water area	**991,815**	**100%**

5.1.5 Soil

Soil of the project area can be rated as poor, because it contains negligible amounts of organic matter. This is characterized by large saline compacted areas with alluvial clay (interlunar flats or Dahars) in between low sandy ridges and dunes, which are generally stabilized to semi-stabilized or less frequently shifting dunes. Soil of interlunar flats varies in texture, structure, and the extent of salinity and solidity with pH ranging from 8.2 to 9.6. Sand dunes are much lower (less than 100 meters) than those found in the project area. The area is comprised by large wind-shifting sandy

[6] FAO, Global Forest Resources Assessment, 2000

dunes and ridges, interspaced with greatly reduced interlunar plains (Arshad et al., 2003).

5.1.6 Air Quality

Air quality of the area is good, but there is no permanent environmental monitoring station in the whole Area. During the site visits it has been observed that ambient air is clean at present as no heavy industry or other source of air pollution exists in the project area. Smoke is generated through domestic activities particularly cooking and heating where wood is a main source of fuel but the smoke emissions are not high as the project area has very small permanent population. However, sometimes there are increased concentrations of dust in the project area due to high speed winds, otherwise, the quality of air in the vicinity of the project area is clean. The vehicular movement data will be collected through Traffic Count Survey during detailed EIA. Potential air quality issues within the project area are also associated with the natural emission of dust[7]. However, windblown dust can be observed during strong winds.

5.1.7 Noise

There is no industry or any other source of noise pollution in the project area except some minor vehicular traffic. Noise level exceeding 85 dB is harmful to the human health and excessive noise level can damage eardrum and very high level may damage human lungs. Continuous exposure to excessive noise causes depression and even damages nervous system. Project area, however, fall under a sort of silence zone, i.e. noise level is around 50 dB (A).

5.1.8 Water

There are two main sources of water in the area, sub-soil or ground water and the surface water. The groundwater is mostly found at the depth of 30 – 40 meters and in most of the cases, it is highly brackish. The nearest source of fresh water is Bahawal Canal that is situated at about 4.5 kilometers north of project area. Water course from this canal irrigates some parts of the forest area situated at the boundary and is the sole source of surface water for occasional irrigation to agricultural fields. A few wells are present at places where water has relatively less

[7] Quantitative measurement of environmental monitoring was outsourced to GEL for dust emissions, noise level and quality of ground/surface & wastewater of the project area.

salt-contents and was used for washing purpose. The water of wells is used only when water in the Tobas is exhausted and there is no other option.

The surface water is the primary source and is received only from rain. Rain water is collected in ponds or land depressions, locally called Tobas and Kunds, while the sub-soil water is obtained through dug wells and peter-pumps. In the project area, rain is the source of fresh water. During rainy season, the rain water is collected in ponds (tobas). According to an estimate[8] there are more than fifteen hundred tobas in Cholistan desert. Factors such as amount of precipitation, location and size of toba, time for which the water is available and prevailing condition of the range, collectively affect the staying period of nomads at a particular water point. With few exceptions, water in most of the tobas does not last for longer periods, i.e. up to 3–4 months only due to high rate of evaporation and seepage. It has been observed that the inhabitants are very well conversant with the water saving techniques and hygiene measures. They usually try to practice such watering techniques for livestock that prevent the water from becoming polluted, a channel is constructed with mud-plaster beside the toba and water is filled in with the help of some container for watering the livestock.

5.1.9 Groundwater

The shallow and deep groundwater aquifers exist at site. The project area fall in the desert region and the water depth and quality at different locations are different. The hand pumps are installed in project area, which are not supplying potable water to the inhabitants of the area and they only use it for bathing and washing. Drinking water is taken from the forest hand pump that is located at the boundary of project area. Its depth is 400 ft. Kunds are important during water shortage period and are cemented.

5.1.10 Community Assets

As mentioned in Section 5.3 that no settlement is present in the project area except a Ranger's Camp which will be shifted at some suitable nearby place as soon as the project will start. Following is the detail of their assets under use in the camp:

[8] Pakistan Council for Research in Water Resources (PCRWR), Regional Office, Bahawalpur

5.2 Biological Environment

The assessment area for terrestrial flora and fauna encompasses the terrestrial environments at project and adjacent areas that may be affected by the project activities. Since the area under study is a typical desert thus information on aquatic resources was neither present nor recorded.

Table 5.2: Details of Community Assets

S#	Type of Structures	Quantity
1	Peter pump room	1
2	Camp building of Rangers	1
3	Solar panel for Ranger's camp	1
4	Hand pump	1
5	Peter pump	1
	Total Structures & Assets	

5.2.1 Flora

The assessment area for terrestrial flora encompasses the terrestrial environments at project and adjacent areas that may be affected by the project activities. The vegetation in the study area was studied by preparation of a floristic list on visual observation basis.

The project area is poor in tree-resources, and vegetation cover is very limited and is confined only to settlement areas, agricultural fields, along stream banks, and road sides. The vegetation is comprised of xeromorphic species, which are adapted to a variety of environmental stresses, particularly to extreme aridity, high salinity, high temperature and low nutrient availability[9].

The common project vegetation is classified into different ecological zones as follows:

- Sand-dune vegetation
- Inter-dune vegetation
- Vegetation on saline patches
- Aquatic vegetation

[9] Naz et al., 2010

- Cultivated areas
- Border vegetation

5.2.2 Use of medicinal plants by local inhabitant

A lot of work has been done on medicinal properties and folk uses of medicinal plants in neighboring countries, particularly in India, which shares habitats similar to the Cholistan desert. Unfortunately, while many plants of the area are frequently used by the local inhabitants, their medicinal importance is still not documented. One of the most striking examples is of Neurada procumbens, and over-exploitation of this important plant makes its local status critically endangered. This plant is extensively used as a cooling agent, a strong tonic and a strong stimulant for debility and impotency[10].

5.2.3 Wildlife Fauna

Information on wildlife fauna species was tried to compile on opportunistic observation but limited time spent in the project area could not help to witness most of the wildlife except a few species of free flying birds and some insects[11].

From the secondary sources of information it is learnt that project area is uniquely known as the host of a great variety of wildlife fauna which is specialized in living with the climatic extremes. Natural vegetation provides food and shelter for wild animals and birds. The wildlife of the area has not been studied systematically; however, a few surveys of Houbara bustard and Lizard have been conducted by the WWF Pakistan, Punjab Wildlife Research Institute and Pakistan National Museum Islamabad. Based on the observations by local inhabitants, hunters and wildlife officials, it is estimated that there has been 50 to 80% decrease in the wildlife population over the last decade. Many reasons can be attributed, but the most obvious seems to be the habitat-loss due to vegetation-depletion and excessive hunting. The common project wildlife is classified as follows:

a. Mammals

The mammals include in the project area (Indian Caracal) Felis caracal, (Jungle Cat) Felis chaus, (Indian Mongoose) Herpestes edwardsi, (Desert cat) Felis libyca,

[10] Qureshi et al., 2010
[11] Please refer to the Photo-log placed at Annex-D.

(Jakal) Canis aureus, (Fox) Vulpes vulpes, (Hedgehog) Hemiechnus auritus, (Chinkara) Gazella bennetti, (Nilgai) Boselaphos tragocamelus, (Honey Badger) Mellivora capensis, (Porcupine) Hystrix idica (Hare) Lepus nigricolis (Wolf) Canis lupus and (Wild boar) Sus scrofa cristatus.

b. Birds

The Birds in the project area (Grey partridge) Francolinus pondicerianus, (Indian Desert Finch – Lark), Ammomanes deserti phoenicuroides (Common Indian) Starling Sturnus vulgaris, (Hobara bustard) Chiamydotis undulate, (Great Indian bustard) Choriotis nigriceps, (Imperial sand grouse) Pterocles orientalis, (Indian gray shrike) Lanius excubita, (Spotted owl) Athene brama, (Lagar falcon) Falco biarmicus jugger, (Saker falcon Falco) biarmicus cherrug, (Desert buzzard) Buteo buteo vulpinus, (Indian sparrow hawk) Accipiter nisus melaschistos, (Tawny eagle) Aquila rapox vondhiana, (Harrier) Circus macrourus, (Indian ring dove) Streptopelia decaocto, (Little egret) Egretta garzetta (Pond heron) Aredeola grayii, (Golden backed wood pecker) Dinopium benghaleuse and (Warblers) Sylvia nana nana.

c. Reptiles and Amphibian

The Reptiles and Amphibian in the project area (Tiger bull frog) Rana tigrina, (Spiny tailed lizard) Uromastrix hardwicki, (Spotted Indian house geko) Hemilacytylus b rooki, (Indian monitor lizard) Varanus bengalensis, (Black cobra) Naja naja, (Common crate Bungarus caereleus, (Saw scaled viper) Echis carinatus, (Sand boa) Eryx conicus, (Brahminy blind snake) Typholops b raminus and (Brahminy blid snake) Typholops braminus.

d. Insects and Vectors

The Insects include Scorpions, spiders, ants, bees, wasps, moths and beetles have a long history within the region. Scarab beetles, members of the family Scarabaeoidea, consume dung and plant material and are the most numerous group of beetles in the area. The vectors are flies, mosquitoes, fleas and sand flies. Habitat management is the key to prevention of disease through control of such vectors.

5.2.4 Ecological Status of Wild Fauna

Table 5.3 is showing the status of wild fauna of Cholistan desert which is self-explanatory:

Table 5.3: Ecological Status of Wildlife Fauna

Faunal Species	*Rare*	*Threatened*	*Vulnerable*	*Common*
Long-eared Hedgehog				x
Nilgai antelope		x		
Black buck		x		
Chinkara gazelle			x	
Hog deer		x		
Red fox				x
Bengal Fox			x	
Golden Jackal				x
Porcupine				x
Caracal cat	x			
Mongoose				x
Jungle cat				x
Indian Wolf	x			
Wild boar				x
Honey Badger or Ratel	x			
Little Civet		x		
Indian (Black-naped) Hare				x
Smooth-coated Otter			x	
Indian rhino		x		

5.2.5 Game Reserves and Protected Areas

There was no game reserve or protected areas within the limits of the project area but about 5 km before the project area towards Hasilpur lies an important game reserve and protected area called Lal Sohanra National Park.

5.3 Social Environment

The project area lies at the entry point of Cholistan desert from Bahawalpur side. The project area has no village or settlement thus no resident or PAP except a Ranger's camp with 6-8 employees. They are not considered under the category of PAP because government will relocate the camp as soon as project will become under construction stage.

Lal Sohanra National Park is situated at coordinates of 42R 783277 3246603. Other relevant information as reported by the Wikipedia 2013 is given in the Box.

BOX: Profile of Lal Sohanra National Park

Lal Sohanra is a national park of Pakistan situated in Bahawalpur district of Punjab province, which is one of the largest national parks in South Asia. Lal Sohanra is spread over 153,000 acre and is notable for the diversity of its landscape, which includes areas of desert, forest and water.

The park itself is situated some 35 kilometers east of Bahawalpur and presents a synthesis of forest and desert life. It occupies land on both sides of Desert Branch canal, and is spread over an area of 127,480 acres (51,368 hectares) - out of which 20,974 acres (8,491 hectares) are green land (irrigated plantations), 101,726 acres (40,942 hectares) are dry land (desert), and 4,780 acres are wet land (ponds and lakes). The park's terrain is generally flat, interspersed with sand dunes measuring between 1 and 6 meters in height and occupying as many as thousands of acres apiece.

Many species of animals can be found throughout the park. These include several wild animals of the desert such as wildcat, rabbit, bustards and deer. Reptiles in the park include the monitor lizard, Russell's viper, Indian cobra, saw-scaled viper, wolf snake, John's sand boa and spiny- tailed lizard. More than 160 species of birds are also present, including the houbara bustard, griffon vulture, crested horny buzzard, marsh harrier, hen harrier, laggar falcon, peregrine falcon, kestrel, Eurasian sparrow hawk, Egyptian vulture, lark, shrike, wheatear, and barn owl.

Lake Patisar, a large body of water in the center of the park, is ideal for bird watching. In mid-winter, the lake is regularly home to between 10,000 and 30,000 ducks and common coot.

The Punjab government has planned to convert the Lal Sohanra National Park into a wildlife safari park of international standard. One of its most prominent attractions is currently the lion safari, which allows guests to see lions in their natural habitat at close range. In addition, the park's captive breeding suite holds a pair of rhinoceros which were gifted from Nepal. Rhinos were once found as far west as the Peshawar Valley during the reign of Mughal Emperor Babur, but are now extinct in Pakistan and western India.

Over 400 animals are currently being bred in the Lal Sohanra Park, including a large population of blackbucks, a breed of antelope most notable for its pronounced sexual dimorphism. The park is constantly supplied with new blackbucks in order to extend its efforts towards blackbuck conservation.

6. POTENTIAL ENVIRONMENTAL IMPACTS

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

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

6.1 Impact Assessment Procedure

In order to describe the significance of an impact it is important to distinguish between two concepts: sensitivity and magnitude. As far as possible the sensitivity and magnitude of the impact are described with reference to legal requirements, accepted scientific standards or accepted impact assessment practice, and/or social acceptability. Where no known published 'standard' criteria exist for determining the magnitude of effects, established professional criteria and best practice techniques are used and clearly described.

6.2 Sensitivity

Sensitivity is generally site specific and criteria are developed from baseline information gathered. The sensitivity of a receptor is determined based on review of

the population (proximity/ numbers/vulnerability), presence of biological features of the site or the surrounding area, soil, agricultural suitability, geology and geomorphology, existing air quality, presence of any architectural and historic heritage, landscape etc. Sensitivity, relates to the value, importance and tolerance of an environmental resource or receptor and should take into account where possible stakeholders views and public acceptability. Sensitivity can be categorized as high, medium, and low to the assessment of receptor sensitivity.

6.3 Magnitude

The assessment of magnitude is undertaken in two steps. Firstly the key issues associated with the project are categorized as being either adverse or beneficial. Secondly, beneficial and adverse impacts are then further subdivided into high, moderate and low based on consideration of the parameters listed below:

- duration of the impact;
- spatial extent of the impact;
- reversibility;
- likelihood; and
- Legal standards and established professional criteria.

In order to make the report meaningful and useful as more as possible, an attempt has been made to describe each impact in the following terms:

Positive impacts refer to beneficial effects and adverse impacts refer to harmful effects on e.g. natural resources, human beings and economy. In addition, it is the aim of the EIA to categorize the magnitude of impacts identified according to the categories outlined in Table 6.1.

6.4 Positive Environmental Impacts

It is envisaged that the implementation of solar power unit in Cholistan desert will pose following positive impacts on the environment for which no mitigation is required:

- It will be a source of clean and renewable energy and its 10 to 20 years viability can grant a lot of economic and financial benefits to the country.

Table 6.1: Criteria Used to Determine Magnitude of Impact

Parameter	Major	Moderate	Minor	Negligible
Duration of impact	Long term (more than 35 years)	Lifespan of the project Medium term (5 to 15 years)	Less than project lifespan	Temporary with no detectable impact
Spatial extent of the impact	Widespread far beyond project component site boundaries (e.g. powerhouse site, dam site, borrow pit area, etc. as applicable). Regional, national and international boundaries	Beyond immediate project components, site boundaries or local area	Within project components and site boundary	Specific location within project component or site boundaries with no detectable impact
Reversibility of impacts	Impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national limits and or international guidelines	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of impacts occurring	Occurs under typical operating or construction conditions	Occurs under worst case (negative impact) or best case (positive impact) operating conditions	Occurs under abnormal, exceptional or emergency conditions	Unlikely to occur

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

An impact matrix has been developed based on sensitivity and magnitude of impacts as shown in Table. 6.2

Table 6.2: Impact Matrix

Category	Pre-Construction	Construction	Operation	Total Impact
Physical Environment				
Temperature	0	0	-1	-1
Water				
• Surface Water	0	0	-2	-2
• Ground Water	0	0	0	0
• Wastewater	0	-1	+2	1
Air	0	-1	-1	-2
Noise	0	-1	0	-1
Light Pollution	0	0	-1	-1
Municipal Waste Disposal	0	-1	-1	-2
Hazardous Waste Disposal	0	0	-2	-2
Effluents Disposal	0	-1	-1	-2
Material Supply	0	-1	-1	-2
			Total	-14
Ecological Environment				
Flora				
• Trees	-1	0	0	-1
• Shrubs	-1	0	2	1
• Vegetation	-1	0	2	1
Fauna				
• Mammals	0	0	1	1
• Reptiles	0	0	2	2
• Birds	0	0	0	0
• Insects/Vectors	0	0	-2	-2
			Total	2
Social Environment				
Health & Safety	0	-1	-1	-2
Transportation	0	2	2	4
Civic and aesthetics	0	0	2	2
Employment	0	2	1	3
			Total	7
Key: + = Positive; - = Adverse; 3= High; 2= Medium; 1= Low; 0= Negligible				

In addition to the above, some more significant positive impacts on the vegetative cover of desert surface can be assessed. For instance, large scale arrangement of solar cell panels may block direct sunshine up to some extent, large spaces between the lines of photovoltaic cell can still absorb solar energy at various times of the day which may reduce the evaporation capacity of the desert surface which otherwise very high under dry desert conditions. It will create the condition for a little longer

water storage capacity of the surface to promote surface vegetation. Regular washing of solar cell panels will obviously soak the earth surface which will attain water supplement at regular intervals. Coupled with rainwater and sunshine, vegetation will be increased easily on the confined area. On the same footprint, confined area under solar panels will provide favorable condition to the recovery of vegetation, as well as the fence will not allow grazing animals or people to enter so vegetation and small wild animals will be protected. This phenomenon will therefore provide favorable conditions for the recovery of lost habitat of the flora and fauna. The dwarf grand flora (desert vegetation) having lower height than panels will be expected to grow significantly, also called forestation, because they will revive regular supply of water which is released after washing solar panels.

This project will be a source of clean and renewable energy, despite the high initial cost but its 10 to 20 years viability can result in economic and financial benefits to the country.

6.5 Adverse Environmental Impacts

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

6.5.2 Environmental Impact during Construction

(a) Impact of Noise

During construction period, noise level will increase due to movement of construction machinery and equipment including bulldozers, trucks, excavators, concrete mixers, vibrators and generators, etc. Noise level of construction machinery is expected to be around 80dB-120dB. This noise will have some impact closer to the construction site and the surrounding areas within 250 m. Since proposed solar power plant area is an open area thus noise generated by the construction machinery will be of little significance. In addition to that absence of any settlement, village or city nearby will further reduce the impact of noise produced by the machinery.

Apart from that, commuting construction related vehicles will add some noise to the surroundings of the construction area as well as the connecting routes with Bahawalpur but again it will yield negligible adverse impact.

The most affected persons by the noise may be the labor working at site who may use ear-plugs during working with the machinery.

(b) Impact on Air Quality

Solar power generation itself will not produce any toxic and harmful exhaust pollutants. However, the vehicular exhaust and dust blowing from the ground may have certain impact on local atmosphere. Dust blowing is mainly produced by excavation for engineering construction of solar panel foundations of box-type transformer, access roads, inverter room and production building, etc., loading and unloading of construction materials, like cement, lime, free stockpiling of dusty construction material, temporary stockpiling of earthwork and traveling of vehicles on the road, etc. Quantity of blowing dust mainly depends on wind speed and dry or wet status of the ground surface. If construction is performed in summer, when wind speed is high and the surface is dry, amount of blowing dust will be great, which will pollute air around the power plant especially in the direction of wind. If construction is performed in spring when wind speed is low, the blowing dust will be less and will have relatively less adverse impact on air quality. It is further to add that the air pollution caused by dust blowing during construction will be temporary and will disappear after the completion of construction.

(c) Impact on Water Quality

Windblown by the working of construction machinery along with dry weather conditions, in fact, will be main cause of surface water pollution due to slow shifting of sand dunes under desert conditions. Since there is no surface water available in the project area so there will be no chance of surface water pollution.

The proposed solar plant will not pose any adverse impact at all on the drinking water source. As concerns the drinking water facility for the construction labor, they will arrange their own facility. It is believed that future water point will be safe from windblown contaminants.

As concerns wastewater, the proposed project will hardly produce any wastewater except that produced temporarily by the labor camps. During construction activities water will mainly be used for concrete mix, so there are little chances for the production of any sizeable wastewater. Domestic sewage produced by on-site labor camp may be considered as the main source of wastewater in terms of contaminants, but it is visualized that it will be locally disposed of in the sumps thus no significant chance of environmental pollution.

(d) Impact due to Solid Waste

The solid wastes during construction are mainly the construction spoil and the domestic garbage of the contractors, which is a temporary activity, and will come to an end as soon as the project is completed and put into operation. So if during construction, the contractors handle construction waste safely and in a timely manner, the wastes will not have any adverse impact on the environment. In addition, some of the construction materials can be recycled and the other can be disposed of properly outside the project area. As there will be sizable number of labor at the site during peak construction days, great amount of work and domestic garbage will be expected to produce, including waste and old plastic bags, leftovers, waste packing materials, spoiled edibles etc. To prevent adverse impact on the public hygiene and health, such garbage will be collected and transported outside the project area at designated places for safe disposal.

(e) Impacts on Labor Health

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

(f) Impacts on Ecological Environment

The project area is located at the edge of desert where the ecological environment is relatively fragile and vegetation is not rich. As such, there will be minimum damage to the ecological environment due to construction work. As mentioned earlier that trees, shrubs and other surface vegetation will be cleared off before the start of construction, hence no further damage will be expected during construction

period. As regards the vehicular movement on the access roads, the chance of further ecological dames is meager.

6.6 Environmental Impact during Operational Stage

(a) Impact of Climate

Gales and sand storms in Cholistan desert may deteriorate air quality which will consequently reduce visibility, transparency and solar radiation. Therefore severe weather will impose significant adverse impact on the power generating capacity of the solar power unit. The impact of sand must be considered in designing the PV power plant and arrangements of regular washing of the panels must be ensured to prevent panel abrasion.

It is also estimated that increase in a few degrees of temperature due to solar panels irradiations will further deteriorate climatic conditions in peak summer times.

(b) Impact on Air Quality

The exhaust gases will generally be produced by the transport vehicles during operational phase of the project. Since the proposed project site is open and has better ventilation conditions, the smoke will be diffused rapidly and will not have significant impact on the atmosphere. It is also envisaged that air quality will not be adversely affected by the solar power generation operation.

(c) Impact on Water Quality

Photovoltaic power generation converts solar energy to electric energy and no exhaust is given off during the converting process. In photovoltaic power generation operation, major water requirement is for washing of the solar panels and some domestic use by the maintenance workers of the solar park. The amount of wastewater so generated at site will mostly be absorbed by the sandy nature of the land as well as gathered in soakage pits. Thus adverse impact of wastewater on local water environment will not be significant.

(d) Impact of Noise

Photovoltaic power generation system doesn't have mechanical transmission mechanism or moving components, so no noise is produced during operational period. Similarly, motor vehicles running on access roads will generate some noise but that will not affect the project area being open in all directions.

(e) Light Pollution

Solar panels reflect sunlight i.e. above 95% and it may disturb the drivers to face flashing sensation on the access roads while driving during sunny hours. Angle of solar panels is set at about 45^0 to 60^0 as well as they are installed 3-4 mm high thus it is expected that reflections will not be significant and can easily be managed by the drivers.

(f) Impacts due to Electromagnetic Radiation

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

(g) Impacts on Ecological Environment

The project area is almost a desert and has little ecological impact on Lal Sohanra National Park in terms of wild animals and plants protection. In addition to that a small area on the edge is a forest area which must be retained as it is. It is envisaged that operation of the power unit will not change the status of local animals and plants thus no adverse impact on the local and surrounding ecological environment, especially the national park.

(h) Impacts on Health

Water left after washing of the solar panels may promote vector growth underneath, thus health hazard for the people and animals around.

7. MITIGATION MEASURES FOR ADVERSE IMPACTS

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

7.1 Physical Environment

7.1.1 Prevention of Exhaust Gas and Dust Pollution

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

- The construction workers should regularly sprinkle water at the construction site to prevent the generation of suspended dust. The volume and frequency of sprinkling should be increased when the wind is strong and weather is dry. Access roads should also be included in this operation.
- Vehicles should run at a slow or limited speed to reduce dust emission, which should be around 15 km/h.
- Covered trucks should be used to deliver the construction material.
- The concrete batching plant should be set within the enclosed construction camp.
- Light-absorption system compatible with PV solar panels should be used just like the blue lights are used under foggy weather; because gales and sand storms will occur periodically in Cholistan.
- Cholistan has a long history of facing extreme temperatures during summers, up to 50°C. In the PV design climatic impact on solar cells and electrical equipment should be taken into consideration.
- Surface vegetation and some soil conservation techniques are protective measures against dust emission. They should be promoted

so that secondary dust may not be spread during operation stage of the project.

7.1.2 Noise Pollution Mitigation Measures

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

- The contractors should ensure the use of low noise and low vibration construction equipment.
- Regular service for construction equipment should be ensured and some workers may be trained in machinery operation to hold charge of some machines according to operation specifications.
- Construction work should be carried out during day time if possible.
- OSHA Guidelines on 'Noise Limits for Construction Site' should be followed[12].

7.1.3 Sewage and Waste Water Treatment Measures

The production of wastewater from the Project construction activities is mainly generated by washing the concrete truck mixers and other construction machinery, repairing equipment and maintaining vehicles, but the total amount of such waste water is small. The construction sites are relatively scattered, and the scope is also relatively wide, so the waste water can be used for spraying at the construction site. During the construction period, the sewage should be collected, and the domestic sewage should be transported outside for safe disposal. During normal operation of the power plant, the waste water is mainly the domestic sewage. The domestic sewage should be collected and regularly transported outside for safe disposal.

7.1.4 Solid Waste Disposal and Public Health Measures

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

[12] OSHA Guidelines 1970

- After the excavation and backfill, the left-over waste can be used as the filling material for the low-lying areas, if needed. After the backfill, these areas should be compacted and planted to avoid water and soil loss, vegetation growth and protect the environment;
- In addition, some of the construction waste excavation can be recycled the remaining can be transported together with the domestic waste to some nearby landfill.
- The power plant should be equipped with centralized solid waste collecting boxes which should be cleaned regularly. The solid wastes generated during the construction operation should be transported outside the plant to avoid spreading out due to wind blowing and effluent leakage from polluting the surrounding.
- During the normal operation of the power plant, the administrative staffs are mainly engaged in handling official business, monitoring and overhauling, and the solid wastes are mainly the office and domestic wastes. The living area should be provided with dust bins to collect the wastes, and the collected wastes should be transported to the nearby specified landfill site.
- Meanwhile, proper management of dietetic hygiene, domestic drinking water and environmental sanitation should be ensured to prevent the spread of infectious diseases and to protect the population health.
- A central disposal center for the wasted material of photovoltaic modules, transformer elements and cables should be located in the service area of the Plant. When the quantity of this waste reaches certain number, the waste should be uniformly sorted. The recyclable photovoltaic modules should be broken up and sent to relevant factories for recycling as required, while other parts that are hard to be recycled should be disposed of according to relevant regulations.

7.2 Ecological Environment

In order to preserve the ecological environment during construction, the construction operations should be arranged in accordance with the environment management

system requirements to shorten the construction period, and reduce the environmental impacts on surrounding landforms. Following ecological protection measures should be adopted for the project:

- The construction operations should be contained within the land acquired for the solar power plant in order to reduce the damage to surrounding land. The approach road and the temporary roads for movement of construction equipment should be properly planned for which no land acquisition is required. The existing earthen roads (or tracks) should be used during construction as far as possible to reduce the land damage and avoiding additional land acquisition. Moreover, the roads will be improved before construction phase for transportation of heavy machinery.
- The power generation and electrical equipment should be placed at the positions specified in design plan, and the construction machines and the equipment should not be piled without approval to control the floor space and protect the original landform.
- Preference should be given to environment-friendly equipment for construction, and construction operations should be planned to minimize dust and noise emissions, it should be guaranteed that any effluent discharges meet the environmental standards and guidelines.
- The top-soil should be intensively piled and protected, and after the construction, the exposed land surface should be re-covered with the original top-soil.
- The use of large machines should be minimized during the construction. After excavation, the foundation trenches should be concreted as soon as possible and backfilled in time. The surface layer of the trench should be improved to minimize the exposure time and reduce the dust emission. Blasting should be discouraged for excavation of foundation trenches so as to reduce the impact of dust and vibration on the surrounding environment.
- After construction, the cable ducts should be backfilled in time, with the

original landform recovered.

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

8. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

8.1 Environment Management Plan (EMP)

To ensure mitigation measures undertaken in subsequent stages of the project, an environmental management plan (EMP) has been prepared as part of the IEE. The EMP summarizes project impacts and describes proposed mitigation measures. It also identifies the authorities responsible for implementing mitigation measures.

The summary of responsibilities for environmental management and monitoring is given in Table 8.1 whereas detailed Environmental Management Plan is given in Table 8.2.

Table 8.1: Responsibilities for Environmental Management

Project Stage	Institution	Responsibilities
Pre-Construction	Environment Management Committee	Ensure EMP requirements are included fully in contract documentation.
Construction	Contractor	• Implement EMP • Undertake monitoring activities • Reporting to Site Engineer
	Environment Management Committee Project Supervisor/ Site Engineer	• Oversee and monitor environmental management activities and standards. • Undertake day-to-day supervision of EMP activities. • Ensure environmental impacts are acceptable. • Ensure adequate and prompt remedial actions are taken as required. • Liaise with public and respond to environmental issues.
	Environment Protection Agency, Punjab	• Ensuring observance of statutory environmental management and monitoring standards; • Auditing EMP and reviewing IEE report.
Operation	Executing Agency and Inhabitants	Operation and maintenance.

8.2 Environmental Monitoring Plan

Effective implementation of the mitigation measures to mitigate or minimize the environmental impacts would require the project to undertake a comprehensive monitoring program. The objective of the monitoring program is to ensure that the construction and operation activities are carried out in an environmentally sensitive

and responsible manner, and in accordance with the recommendations of IEE. Recommended monitoring plan of the proposed project are presented in Table 8.2.

Table 8.2: Environmental Management and Monitoring Program

Monitoring Category	Type of Monitoring	Minimal Frequency	Monitoring Agency
CONSTRUCTION PHASE			
Soils			
Soil Erosion	Check that any exposed soil is contained within the erosion controls.	Weekly	Contractor
	Monitor proper management of excavated soil/silt including timely removal of material from project site	Monthly	Contractor
Surface and Ground Water Quality			
Surface runoff management	Monitor measures to channelize surface runoff	As required	Contractor
Contamination from waste and sewage generated from construction activities	Monitor measures taken to prevent contamination of ground and/or surface water from waste and sewage generated from construction activities	Daily	Contractor
Air/Noise Pollution			
Dust emission during site preparation, excavation	Monitor adequacy of dust suppression measures undertaken	Daily	Contractor
Storage and transportation of construction materials, excavated soil and silt	Monitor adequacy of measures undertaken to prevent fugitive dust	Daily	Contractor
Noise emissions from construction vehicles	Monitor preventive measures being implemented to curb noise	Daily	Contractor
Solid Waste			
Disposal of solid waste	Monitor to ensure solid waste generated is being disposed properly	Daily	Contractor
Flooding			
Blockage of drainage due to construction activities	Monitor to ensure construction activities does not cause flooding at the project site.	Weekly	Contractor
Health and safety of construction workforce			
Health and safety requirements	Monitor adherence to all occupational and safety requirements	Weekly	Contractor

Monitoring Category	Type of Monitoring	Minimal Frequency	Monitoring Agency
Health check up of workers	Monitor adequacy of health checkup service provided.	Monthly	Contractor/ Engineer
Sanitary conditions of construction campsite	Monitor provision of shelter, water supply, excreta and solid waste management at campsites	Monthly	Contractor/ Engineer
Community Life and Economic Activities			
Access to public and private properties	Monitoring impact of project on dwelling and business in the project area	Daily	Contractor/ Engineer
Damage to public and private property	Monitor construction activities to ensure public and private property is not damaged	Weekly	Contractor/ Engineer/ EMC
	Review and monitor property damage report to ensure timely resolution of claims etc.	Monthly	Contractor/ Engineer/ EMC
Hardship and inconvenience to public and business	Monitor to ensure that communities and business face minimal hardship and inconvenience due to construction activities	Weekly	Contractor/ Engineer
OPERATION PHASE			
Operation and Maintenance of the System	Monitor implementation of preventive and all maintenance work	Monthly	EMC
Awareness campaign regarding environmental responsibility of the staff for sustainable management of resources and environment.	Review and monitor effectiveness of the awareness campaigns conducted	Quarterly	EMC

8.3 Institutional Arrangements and EMMP

Having well defined implementation arrangements, with specific assigned responsibilities, and adequate monitoring of the implementation and performance of mitigation measures, are critical to environmental management. The presence of a good and functional institutional framework and monitoring entities ensure that mitigation measures are an important and integral part of these arrangements.

Monitoring becomes part of the development process because mitigation measures are suggested and their performance is monitored. Feedback in the event of poor performance of a mitigation measure will allow appropriate corrective actions to be taken.

The Proponent of the solar power plant is. Energy Department thus implementation and monitoring requirements of environmental impact mitigation and monitoring measures will be met by them. The Environment Management Committee (EMC) of solar plant will take overall responsibility for undertaking and coordinating the mitigation and monitoring measures identified during the preconstruction and construction phases. The Proponent in consultation with the consultants and concerned government agencies will ensure that the mitigation and monitoring measures for the operation and maintenance phases are adequately transferred.

The civil works contractor will be required to ensure implementation of EMP activities in the construction stage under monitoring and supervision of the Site Engineer and EMC. Site Engineer will pay day-to-day supervision and reporting of the EMP.

9. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

This chapter describes the mechanism adopted and activities undertaken by the involvement of stakeholders in the consultation process, information collected and conclusions drawn during the public consultation process.

It is interesting to note that project area for the construction of 100 MWp solar power generation unit is void of the presence of any affected community, except the camping site of the Ranger's, thus this chapter will not contain any outcome of the PAP's views and the concerns.

Anyhow, some basic tools of the stakeholder's consultation are briefly mentioned below to understand the sessions held with some of the stakeholders. They are the legalities, stages of the consultation, techniques and tools used, consultation process and the outcome.

9.1 Legal Requirements of Public Consultations

According to the IEE and EIA Review Regulations 2000, public consultation is mandatory for any socio-environmental study. It is also mandatory for all the projects classified as category A to C.

9.2 Stages of Public Consultation

Acceptance of the project by the stakeholders will be assessed through the following steps:

- Identification of stakeholders for environmental perspective
- Extensive consultations with all stakeholders to obtain their opinion and concerns
- Participation of the consultants in the public hearing arranged by EPA to answer queries raised by other participants

9.3 Techniques and Tools used for Public Consultation

There is no community and settlement present in the proposed site, so public consultation was not carried out. Thus, only a summary of the consultations made with the key informants in terms of their feedback is shown in Table 9.1.

9.4 Interviews with Key Informants

During the IEE studies, well informed persons (local politician, head of a government departments and/or social activists) related to the Project Area were interviewed and all necessary information pertaining to the Project Area was recorded during data collection process. This process also supported the understanding of the Consultants as a lot of information was exchanged during interviews. Please refer to Table 9.1

Table 9.1: Concerns of Stakeholders

Category	Summary of Feedback
Visits to Government offices, line agencies and NGOs	• Pakistan is facing energy crisis, therefore, construction of the Solar Power Project is a good initiative by the Energy Department. • Presently there is no industry in the vicinity of project area due to shortage of energy resources. It is hoped that economic activities will increase in the project area as well as in the country after construction of the project • Energy Department should provide electricity on subsidized rates to boost the industries in the area. • During construction, Energy Department should try to minimize the damage to infrastructure and environment. • IUCN and WWF showed their reservations on the foreseeable damage to flora and fauna in the project area due to increased plan of human activities in the desert. • Development projects are generally delayed due to litigation. Energy Department should prefer to settle disputes on the spot through a resolution mechanism instead of litigation.
Interviews with well-informed persons falling in project area	Not applicable
Interviews with affected people and communities	Not applicable
Scoping sessions in affected villages	Not applicable

10. CONCLUSIONS AND RECOMMENDATIONS

The proposed project has undergone a fairly exhaustive environmental screening process, which involved site visits, consultations with project stakeholders, review of documents, etc. It is believed that the process has been sufficient to determine all possible interactions between the project and the environmental and social conditions at the site. Several factors preclude any significant adverse environmental and social impact associated with the project. These are:

- Absence of any significant sensitive terrestrial habitats in the project area;
- Construction of a building with provision of basic and allied facilities for the operational staff; and
- Improvement in the existing landscape.

Specific social and environmental benefits have been mentioned below which depend on the strict compliance of the mitigation measures suggested in EMP and best engineering practices:

10.1 Beneficial Effects

The solar power generation is a renewable energy source and utilizes/produces clean energy thus can win the favor of Clean Development Mechanism. Its concept is in line with the national energy development policy. The solar plant will grant efficient wheels to local economic development and meanwhile solar plant will become the local scenic spot for scientific education and tourism. In addition, it will promote the wildlife and vegetative cover.

10.2 Adverse Effects

There is no adverse impact of the construction of solar plant on the environment nor does it cause any pollution to the environment. The adverse impacts to the environment appear temporary because they are limited to the construction period and can be minimized by taking effective engineering measures.

10.3 Recommendations

It is recommended that the Proponent should obtain an environmental approval (no objection certificate) from the Punjab-EPA before proceeding further into the construction activities.

It is further recommended that the Proponent should also go for Environmental Impact Assessment (EIA) for the whole Master Plan i.e. 1000 MWp Solar Power generation at the Solar Power Plant.

ENVIRONMENT PROTECTION DEPARTMENT

Government of the Punjab

National Hockey Stadium, Ferozepur Road, Lahore.

NO. DD (EIA)/EPA/F-948(IEE) /2013/0701/41
Dated: /3 /01/2014

To,

Mr. Najam Ahmed Shah,
Chief Executive Officer,
M/s Quaid-e-Azam Solar Power (Pvt.) Limited,
Suit No. 503-Shaheen Complex, Egerton Road,
Lahore.

Subject: ENVIRONMENTAL APPROVAL

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

1. Description of Project: Development of 100-MW Solar Photovoltaic Park/ Project over an area of 505 acres.

2. Location of Project: The Project site is located near Laal Sohanra Park, District Bahawalpur.

3. Date of receiving of case 20.07.2012.

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 area around the project site shall be kept clean.
vi. The proponent shall dispose of solid waste in a proper scientific way in consultation with TMA/District Government.
vii. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.
viii. The proponent shall plant 5000 indigenous species of trees around the project area on available space within six months and shall do proper landscaping after completion of the project.
ix. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.
x. The proponent shall care about noise issues during construction and operation stage of the project.
xi. The objections/complaints of the locals/stakeholders (if any) shall be redressed on priority basis.
xii. 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. shall be settled amicably by the competent authority before the start of the project activities.

P.T.O

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

xiv. 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.

Salman Aslam.

(SALMAN ASLAM)
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. 16139/EIA/DO/EPA/BWP dated 10.10.2013. He is requested to ensure compliance of the above-mentioned conditions under intimation to this office.

Salman Aslam.

(SALMAN ASLAM)
ASSISTANT DIRECTOR (EIA)
for Director General, EPA, Punjab

23. Safety and Emergency Plans

Earthing System

The earthing system shall satisfy relevant standards and shall be designed following best practices. Earthing system shall consist of main copper earthing mesh along with copper earth bars installed at various locations around the perimeter of plant.

Subsidiary branch copper connections shall be made between the main earthing mesh and various items of the plant, metal frame works and housings etc. The power plant shall be provided with over-voltage protection system connected to proper earth mats. The main aim of over-voltage protection is to reduce the over-voltage to a tolerable level before it reaches the PV or other subsystems.

We shall also carry out site tests for soil resistivity to determine the parameters of the earthing system. The design and design calculations of the earthing system shall be subject to approval of the Employer.

Protective Equipment & Interlocking Devices

Bidder shall provide complete indicating, regulating, controlling, protecting and interlocking equipment necessary for safe and efficient operation of the plant and substation. The complete protection scheme shall be provided for Employer review and approval.

The protection equipment shall be complete with all relay panels, instruments, meters, interposing current and voltage transformers, transducers and all auxiliary equipment.

Fire Prevention / Protection plan

A fire prevention and response plan shall be provided to perform all work in a fire-safe manner. We shall supply and maintain on site adequate fire-fighting equipment capable of extinguishing incidence of fires. The following fire prevention/protection systems shall be provided:

- Mobile fire protection system

- Fire alarm and detection system (with a main panel in the control room)
- Carbon dioxide fire extinguishers for control room, indoor building and for outdoor installations in the switchyard.

Environmental protection and labor safety

Oil leakage and oily water will never happen when the booster station is operated normally, unless emergency accident happens to the transformer. Under the emergency circumstance, the oil contamination will flow to the general accident oil basin and oily water will be discharged to the septic tank after undergoing oil-water separation process.

Noise Source of Booster Station and Noise Prevention Measures

The noise of the booster station mainly refers to the transformer noise including transformer body noise and fan noise. The booster station noise will not exert significant influence on the surrounding environment. The bidding requirements of the transformer noise shall be controlled below 70dB when placing an order so as to reduce the influence of the transformers on the operation environment. The greening of the area shall be strengthened to make the noise of the main control buildings and auxiliary buildings about 45dB (A).

Excavation Safety Assurance

1. Mechanical construction personnel must be aware of safety, obtain relevant certificates in working, follow commanding and observe the integral assignment.
2. During excavation, work shall be carried out as per the signs of construction supervisor and safety supervisor. Proper sloping shall be carried out to prevent collapse.
3. Proper safety distance should be maintained, because stacking of materials, tools, mechanical equipment and soil as well as mechanical excavation beside foundation pit will add more loads beside the pit, which, plus the mechanical shock, would have some impact on slope stability. It is not allowed to place soil within 2.0 m of the foundation pit and to stack heavy goods or apply vehicle or vibration load within 5.0 m of the foundation pit.
4. The slope shall be checked up when the soil excavation has reached certain depth (after rain in particular). If crack, looseness and other potential hazards are spotted on the side slope, proper action shall be taken to avoid the potential hazards.

5. Water retaining wall shall be built around the foundation pit to stop surface water and rain water from penetrating into the soil behind the slope and foundation pit and the consequent decreased shear resistance of the slope.
6. As the deeper the excavation goes, the more dangerous it will be at the pit edge, protection facilities must be provided. To prevent personnel falling into the pit and cause safety accident, fencing shall be provided around the foundation pit. The protective railing should consist of an upper horizontal bar, a lower horizontal bar and columns. The upper bar shall be 1.2 m from the ground; the lower bar shall be 0.6 m from the ground; a toe bar shall be provided on the ground and fine mesh safety net (1.8 × 6 m) shall be provided as well. A column must be provided in every 2.0 m of horizontal bar. It shall be secured and firmed connected with the horizontal bar.
7. All construction personnel must access the foundation pit through ladder. It is not allowed to climb the pit wall to avoid falling. Materials and tools must be transported through a dedicated access walkway. The foundation pit shall be provided with a ladder and material transport access walkway.
8. Work Environment inside Foundation Pit
   a) During manual mucking, the operators must keep a safety distance over 2.5 m between each other.
   b) The excavation shall be carried out upside down. It is not allowed to cut the slope toe.
   c) During manual excavation, the surroundings must be carefully checked to remove loose rocks or rocks may fall on the pit wall to avoid personnel injury.
   d) During foundation excavation, sloping shall be carried out as per specified requirements. During sloping, slope stability shall be monitored all the time. In case of any problem endangering slope stability, strengthening shall be provided immediately.
   e) Construction at night must be carried out under sufficient lighting.

Construction Safety Measures

The safety goal is to avoid heavy accidents and to minimize the accident rate. The minor injury accident rate should be controlled under 0.5‰ and we should strive for constructing a standardized construction site.

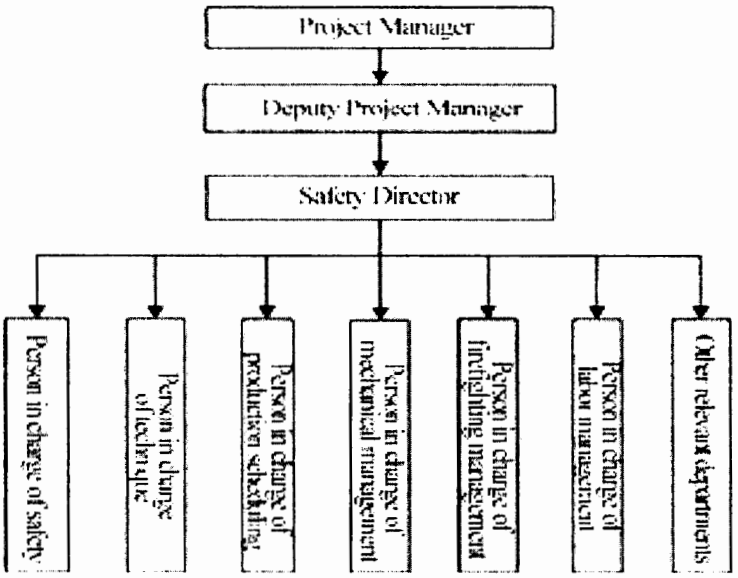
Monitoring Indexes of Safe construction

During the construction, the occurrence rate of any accidents should be strictly controlled under the lowest limit of the same kind of construction project, and

any serious accidents should be avoided so as to realize the safety goal of zero casualty.

The Guarantee System of Safe construction

For the guarantee system of safe construction, please see figure below.



Security Personnel Responsibility System

The project department should set up a quality department with full-time security personnel, and implement the safe construction responsibility system as below:

Personnel of all levels should sign the safety responsibility statement. The project manager, as the first person responsible for the project safety, should sign the safety responsibility statement with all departments and leaders of the construction teams; the leaders of all the construction teams should sign the safety responsibility statement with the respective subordinate construction groups and the group leaders.

The Positions and Responsibilities for Construction Safety

1. The project manager is the first person responsible for the comprehensive construction safety.

2. The deputy project manager, as the second person responsible, should assist the first person responsible and undertake the detailed responsibility for construction safety.
3. A leading group of construction safety should be established with the project manager as the director, the deputy project manager as the vice director and leaders of all departments as members. The group should listen to the report of safety work by the quality department, supervise and examine the project department's implementation of safety laws and regulations, and the measures of safe construction, and make decisions on and arrange the work of construction safety.
4. The quality department should formulate safety measures, examine and supervise the implementation of them, organize and conduct safety education and training, and mass activities of safety management, and realize the safety indexes made by the engineering headquarters. The department is also responsible for the training, evaluation and management of the personnel of special types.
5. Leaders of all the construction groups are directly responsible for construction safety.
    - They should provide safety education, organize group members to study the safety rules and operation methods, and are responsible for the implementation of them. They should also lead the teams and the subordinate groups to conduct safe activities.
6. The group leaders should check carefully, before the work of the day starts, the protection condition for workers, mechanical equipment, construction tools and safety facilities at the workplace and in the working environment. Any problems found should be corrected or reported in time so that they can be handled immediately. The group leaders should also organize safety activities and report them to leaders of upper levels.
7. Operation personnel in each process should strictly enforce the safety operating rules, and actively participate in various learning and training to enhance safety awareness.

24. Training and Development

Training and development of the local staff and the company personnel is necessary in the long run in order to independently and successfully run the plant after the contracted O&M period has expired.

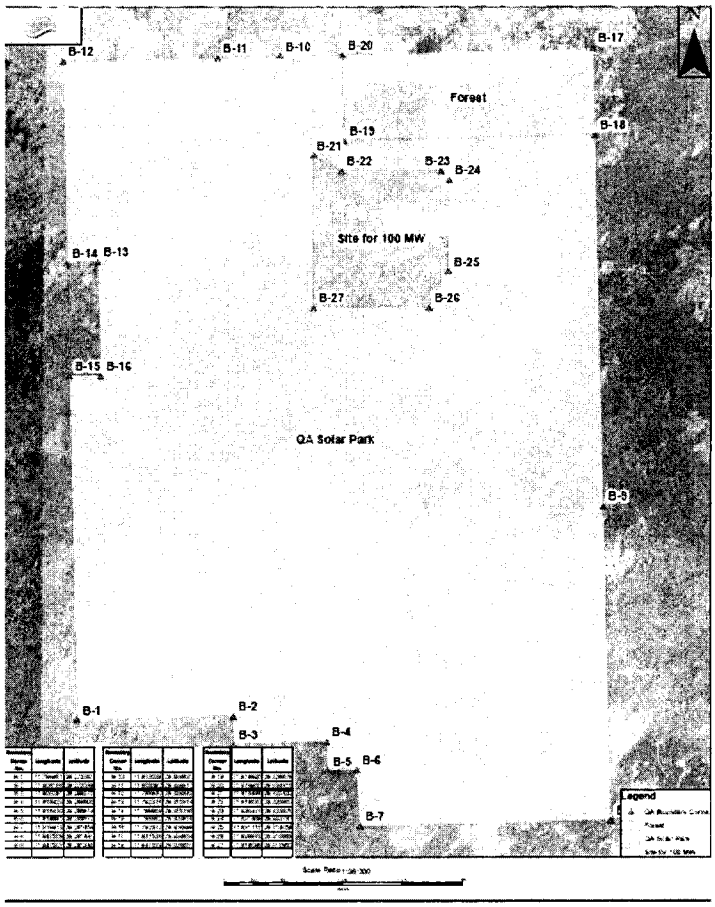
The EPC contractor will handle operations and maintenance of the plant for twenty-five years after the commissioning of the project. However, it is part of the contract with the EPC contractors that they would provide comprehensive training and arrange short term courses for the local work force that would equip them with the necessary knowledge of operating a solar power plant. EPC Contractor would also be handing out certificates to the local workforce upon successful completion of the training programs.

25. Schedule I

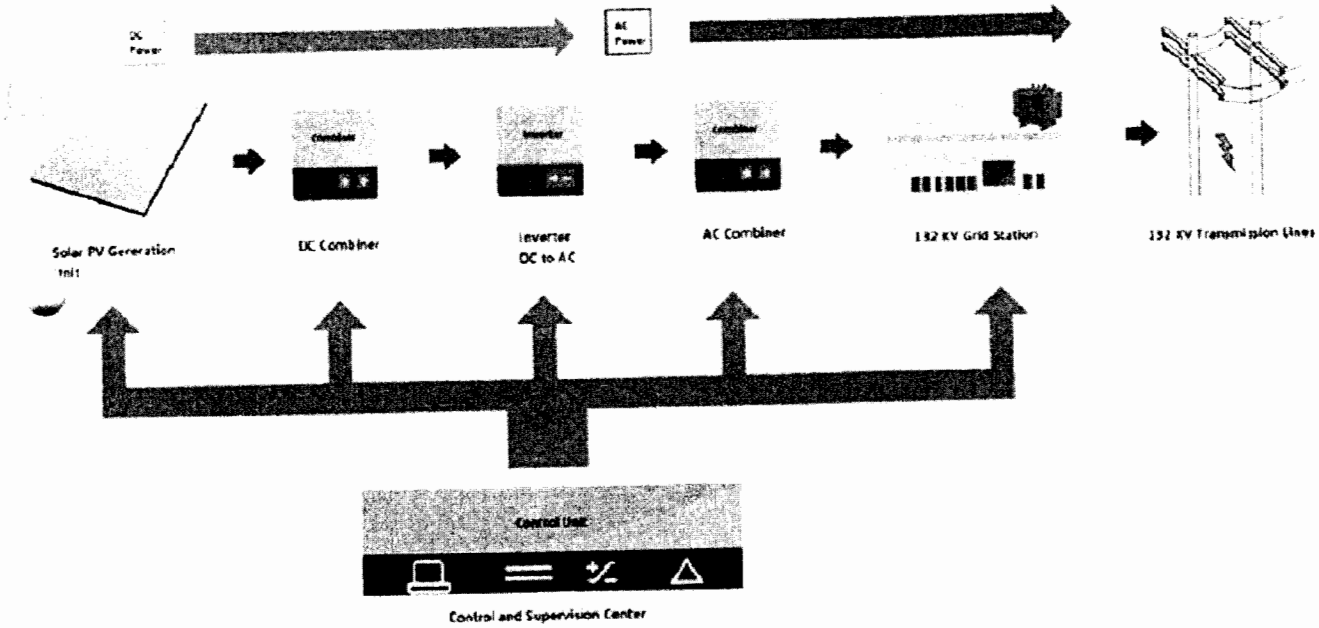
The location, size, type of technology, interconnection arrangements, technical limits, technical/ functional specifications and other details specific to the generation facility of the licensee are described in this schedule. However, the finalization of the EPC contractor is still under process and will be confirmed in due time.

Location Map

Longitude	Latitude
71.8	29.3



Process Flow Diagram

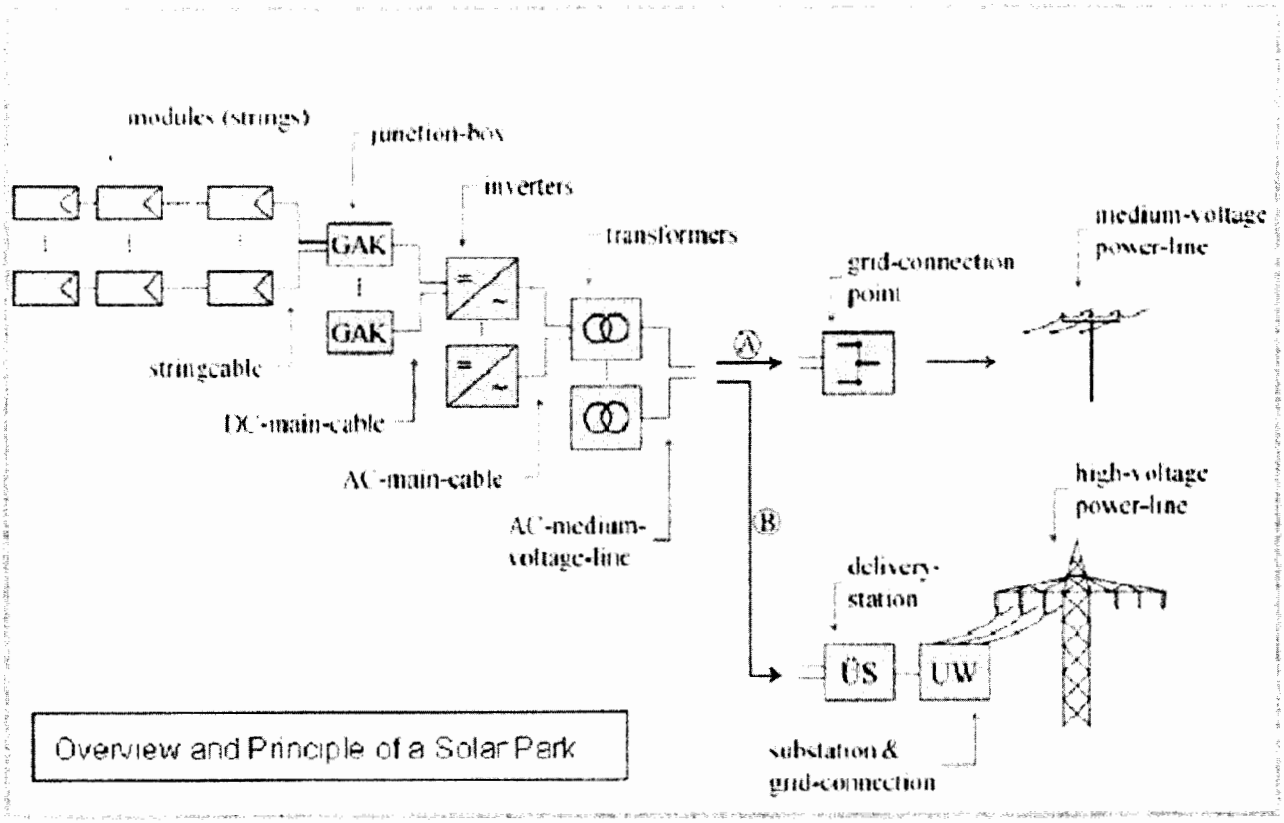


INTERCONNECTION ARRANGEMENT FOR DISPERSAL OF POWER FROM THE GENERATION FACILITY/SOLAR FARM

The power generated from the Quaid-e-Azam Solar Park Bahawalpur shall be dispered via 132 KV transmission line to NTDC/ MEPCO network. Futhermore, Power Evacuation Plan prepared by NTDC is also attached in annexure 25.

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

Schematic Diagram
For Interconnection/Transmission Arrangement for Dispersal of Power from QASPPL



Detail of Generation Facility

A. General Information

i	Name of Applicant/Company	Quaid-e-Azam Solar Power (Private) Limited
ii	Registered/Business Office	3rd Floor, 83A - E/1, Main Boulevard, Gulberg III, Lahore
iii	Plant Location	Lal Sohanra, Bahawalpur
iv	Type of Generation Facility	Solar Power

B. Solar Farm Technology & Capacity

i	Type of Technology	Photovoltaic (PV) Cell
ii	System Type	Grid Connected
iii	Installed Capacity of Solar Plant (MW)	100MWp DC

C. Typical Solar Equipment Details

a) Solar Module
• Type of Module – Polycrystalline • Grid Connected • Ground Mounted • Fixed-Tilted • Nominal Power- 100 MWp DC

b) Inverter
• For DC to AC conversion • Nominal Power- 100 MW

c)	**Transformers**	
i.	Transformer Power	132 kV
ii.	Type of Transformer	Step-up Out door type
d)	**Lightening Protection and Ear thing and Grounding System**	
i.	Number of Light Arrestors	Available
e)	**Testing and Measurement Equipment**	
i.	Multimeter (volt, amp, resistor)	
ii.	Irradiation Meter	
iii.	Mega Resistor Meter	
iv.	Earth Resistor Meter	
f)	**Control Room**	
i.	Data Record	Continuous data logging with data logging software
ii.	Control Room System	Computerized data acquisition system
g)	**Mounting Structure**	
i.	Structure Use	Array frames
ii.	Array Specification	Certified for seismic and wind requirements
iii.	Mounting Structure	Sustainable for 25 years
h)	**Grid Connection**	
i.	Type of Control Room	Control building for grid connection supervision available

ii.	Data Record	Continuous logging with data logging software
iii.	Control Room System	Computerized data acquisition system

D. Other Details

i.	Expected Life of Project from Commercial Operation Date (COD)	25 Years

26. Schedule II

The total installed gross ISO capacity of the generation facility, total annual full load (hours), average sun availability, total gross generation of the generation facility (in KWh), annual energy generation (25 year equivalent net AEP) KWh and net capacity factor of the generation facility of licensee is given in this schedule.

Schedule II Annexure 34

SCHEDULE-II

1	Total Installed Gross ISO Capacity of the Generation Facility / Solar Plant (MW)	100 MW_p DC
2	Total Annual Full Load (Hours)	1865
3	Average Sun Availability	5.18 hours per day
4	Total Gross Generation of the Generation Facility/Solar Farm (in kWh)	160,313,000 kWh per annum
5	Annual Energy Generation (25 year equivalent Net AEP) KWh	3,727,585,500 kWh
6	Net Capacity Factor	18.2%

Note

All the above figures are indicative as provided by the Licensee. The Net energy available to MEPCO for dispatch will be determined through procedures contained in the Energy Purchase Agreement.