ROSHAN POWER (PRIVATE) LIMITED

The Registrar,
National Electric Power Regulatory Authority,
2nd Floor, OPF Building, Sector G-5/2,
Islamabad.

Date: February 10, 2014
Ref: RPL/14/I/003
Reg. **50/2010**

Dear Sir,

APPLICATION FOR A GENERATION LICENSE OF
10 MW SOLAR POWER PROJECT
ROSHAN POWER (PRIVATE) LIMITED

I, Rao Mahmud Ilahi, Director Energy projects being the duly Authorized representative of Roshan Power Pvt. Ltd. by virtue of board resolution dated January 28, 2014, hereby apply to the National Electric Power Regulatory Authority (NEPRA) and for the Grant of a Generation License of 10 MW Solar Power Project to Roshan Power (Pvt.) Ltd pursuant to the section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provision of National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of 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.

Two Bank drafts (DD3050621 & DD3050671) in the sum of Rupees 131,632 (One Hundred Thirty One Thousand, Six Hundred & Thirty Two only) being the non-refundable License application fee calculated in accordance with Schedule-II to National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Best Regards,

Rao M. Ilahi
Director Energy Projects

ROSHAN POWER (PVT) LTD.

10-11 Gurumangat Road, Gulberg-III, Lahore, Pakistan. Ph: +92-42-111232266 Fax: +92-42-35712027
A Project of Beaconhouse

ROSHAN POWER (PRIVATE) LIMITED

Extracts of the Minutes of the Meeting of the Board of Directors of M/S Roshan Power Pvt. Ltd held at on January 28, 2014

BOARD RESOLUTION:

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

"**RESOLVED THAT** Roshan Power Pvt. Ltd (a company incorporated under the laws of Pakistan with its registered office located at 10-11, Gurumangat Road, Gulberg III, Lahore (the Company) be and is hereby authorized to file application for the grant of Generation License for submission at National Electric Power Regulatory Authority (NEPRA) in respect of its 10 MW solar power generation project to be located at Kasur, Province of Punjab, Pakistan. (the Project) and in relation thereto, enter into and execute all required documents, make all fillings and pay all applicable fees, in each case, of any nature whatsoever as required."

"**FURTHER RESOLVED THAT** in respect of application for the grant of Generation License (including any modification to the application for the Grant of Generation License) for submission to National Electric Power Regulatory Authority, **Mr. Rao Mahmud Ilahi** as **Director Energy Projects** holding CNIC number 904067-012431-3 be and hereby empowered and authorized for and on behalf of the Company to:

(i) review, execute, submit and deliver the Generation License Application (including any modification to the application for the Grant of Generation License) and related documentation required by National Electric Power Regulatory Authority, including any contracts, documents, power of attorney, affidavits, statements, letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature whatsoever;

(ii) sign and execute necessary documentation, pay the necessary fees, appear before the National Electric Power Regulatory Authority as needed, and do all acts necessary for completion and processing of the Generation License Application (modification to the application for the Grant of Generation License);

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

"**AND FURTHER RESOLVED THAT Mr. Rao Mahmud Ilahi** as **Director Energy Projects** holding CNIC number 904067-012431-3 be and is hereby authorized to delegate all or any of the above powers in respect of the foregoing to any other officials of the Company as deemed appropriate."

Mr. Nassir Mahmud Kasuri
Director / Chief Executive

Nauman Rahman
Company Secretary

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

SECP

COMPANY REGISTRATION OFFICE
LAHORE

Company Registration Office Lahore Securities and Exchange Commission of Pakistan

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No.**0074410**

I hereby certify that **ROSHAN 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 **Fourth** day of **January, Two Thousand** and **Eleven**.

Fee Rs.**5,000/-**

(SHAHBAZ SARWAR)
Joint Registrar (Incharge)

CERTIFIED TO BE TRUE COPY
13-01-2011
DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

JRL/7898 Dated 04th January 2011

THE COMPANIES ORDINANCE, 1984

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(PRIVATE COMPANY LIMITED BY SHARES)

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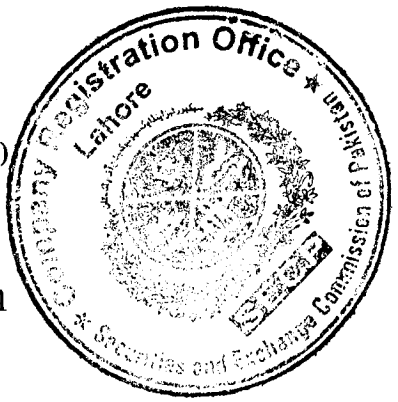


Memorandum of Association

of

ROSHAN POWER (PRIVATE) LIMITED

I. NAME :

The name of the Company is "**ROSHAN POWER (PRIVATE) LIMITED**".

II. REGISTERED OFFICE :

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

III. OBJECTS :

The objects for which the Company is established are to undertake any or all of the listed following:-

1. To carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity through any means or sources including the use of solar energy, and all other forms of energy and products or services associated therewith, and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation through any means or sources including the use of solar energy, transmission, distribution and supply after obtaining approval of relevant authorities inside and outside Pakistan.
2. To locate, establish, construct, equip, operate, use, supply, manage and maintain any type of energy based, including solar energy based, power plants, power grid station, transforming, switching, conversion and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment, offices, computer centers, shops, dispensing machines for pre-payment cards and other devices, show rooms, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities after obtaining approval of relevant authorities in and outside Pakistan.
3. To carry on all or any business of electricity generation by the use of solar energy and distribution of electricity after obtaining approval of relevant authorities inside and outside Pakistan.

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

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

6. To enter into any arrangements with the Government of Pakistan or provincial government or any local government or with any supreme, national, municipal or local authority, or with any person, and place where the Company may have interest that may seem conducive to the Company's objects, or, any of them in any mode and to obtain from such government or authority, or other persons any rights, privileges and concessions which the Company may think it desirable to obtain and to carry out, exercise and comply with any such arrangements, rights, privileges and concessions.

7. To take Government, Military or Private Contracts, for the supply of materials, articles and goods, providing of services, execution of projects of all descriptions related to electricity or energy including those of solar energy and technology, and to give, let, sublet, any contracts for any work to be done or supplies to be made or received as may be thought.

8. To enter into an agreement or any arrangement for sharing profits, union of interest, co-operation, joint-ventures, reciprocal concessions, or otherwise with any individual, firm co-operative or other society, company, association, corporate body, Government or local authority or other legal entity necessary or expedient for the purpose of carrying on any business of the Company in and outside Pakistan.

9. To open, close and operate banking accounts of the Company with any bank or banks and to draw, make, accept, endorse, discount, execute and issue promissory notes, bills of exchange, letter of credits, bills of lading, warrants, debentures and other negotiable or transferable instruments.

10. To receive money on loan, borrow money and secure payment of money in such manner as the Company shall think fit, and in particular by :-

(i) the issue of perpetual or redeemable and convertible or non-convertible PTSs, TFCs, debentures, or debenture stock (perpetual or otherwise), bonds, promissory notes, bills of exchange, and such other securities;

(ii) furnishing undertakings and guaranteeing the performance by the Company or any other person or company of any obligation undertaken by the Company or any other persons or company as the case may be, depositing securities, shares and documents of title;

(iii) hypothecating, charging and mortgaging all or any of the properties and assets (both present and future) of the Company and creating pledge on such properties; and

(iv) appointing attorneys, and giving them powers and authority for executing documents, registering documents, selling and managing the properties, under- taking any business of the Company and furnishing and creating such other securities as may be considered expedient; and for the purposes aforesaid, or otherwise, execute, complete and deliver agreements and such other documents as may be required.

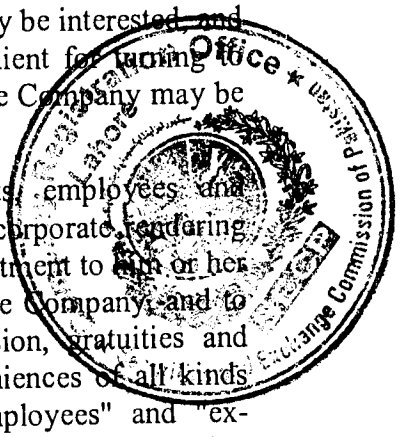
11. To guarantee the payment of money and the performance of contracts of engagements of the Company and to secure the payment of money and the performance of any contracts or engagements entered into by the Company and to discharge any debt or any obligations of or binding upon the Company by a mortgage or charge upon all or any part of the undertaking, property and rights of the Company (either present or future or both), or by the creation or issue of bonds, debenture stocks, or any other securities or by any other means.

12. To guarantee the payment of money unsecured or secured by or payable under or in respect of promissory notes, bonds, debentures, debenture stock (perpetual or otherwise), contracts, mortgages, charges, obligations, instruments and securities of the Company and generally to guarantee or become sureties for the performance of any contracts or obligations concerning the business of this Company.

13. To draw, make, accept, endorse, seal, execute, negotiate, purchase hold and dispose of cheques, promissory notes, bills of exchange, drafts, charter parties, bills of lading, warrants and other negotiable documents and contracts, deeds and other instruments and to cancel and vary such instruments, relating to the business of the Company.

14. To apply for, purchase, or otherwise acquire, and protect and renew in any part of the world any patents, patent rights, brevets d'invention trade marks, designs, licenses, concessions, and the like, conferring any exclusive or non-exclusive or limited right to their 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, and to expend money in experimenting upon, testing or improving any such patents, inventions or rights; and 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.



15. To employ and remunerate Directors, officials, agents, employees and servants of the Company and any person, firm or body corporate rendering services to the Company either by cash payment or by allotment to him or her or them, as the case may be, of shares or securities of the Company, and to benefit employees of the Company, and to grant pension, gratuities and allowances and to provide houses, amenities and conveniences of all kinds and for the purpose of this paragraph the words "employees" and "ex-employees" shall include respectively, present and former Directors and other officials, agents, employees, trainees and servants.

16. To improve develop, sell, exchange, take on lease, mortgage pledge, hypothecate, assign, transfer, dispose of, turn to account or otherwise deal with all or any part of the present and future property and assets, immovable and movable corporeal or incorporeal, tangible or intangible, and any right, title and interest therein of the Company, including rights, licenses privileges, concessions and franchises as may seem expedient.

17. To payout of the funds of the Company all expenses of and incidental to the formation, registration, advertisement of the Company and the issue and subscription of the share or loan capital including brokerage and / or commission for obtaining applications for or placing or guaranteeing the placing of shares or any debentures,debenture-stock and other securities of this Company and also all expenses relating to the issue of any circular or notice and the printing, stamping, and circulating of proxies and forms to be filled up by the members of the Company.

18. To pay for rights or property acquired by the Company and to remunerate any person or company whether by cash payment or by the allotment of shares, debentures or other securities of the Company as fully paid up.

19. To adopt such means of making known the business, services and products of the Company as may seem expedient and in particular by undertaking seminars, training and demonstration programs and by advertising in the press, by circulars and by purchase and exhibition of works of art or interests, by publication of books and periodicals and by granting prizes, rewards and donations.

20. To establish and maintain or procure the establishment and maintenance of any contributory or non-contributory pension or superannuation funds, provident fund, gratuity fund for the benefit of, and give or procure the giving

of donations gratuities, pensions, allowances or emoluments to any persons who are or were at any time in the employment or service of the Company, or of any company which is a subsidiary of the Company or is allied to or associated with the Company or with any such subsidiary company, or who are or were at any time in the employment or service of the Company, or of any company which is a subsidiary of the Company or is allied to or associated with the Company or with any such subsidiary company, or who are or were at any time Directors or officers of the Company or of any such other company as aforesaid, and the wives, widows families and dependents of any such persons, and also to establish and subsidize and subscribe to any institutions, associations, clubs or funds calculated to be for the benefit of or to advance the interests and wellbeing of the Company or of any such other company as aforesaid, and make payments to or towards the insurance of any such person as aforesaid and do any of the matters aforesaid, either alone or in conjunction with any such other company as aforesaid.

21. To open branches, register the Company and to undertake all or any of the business of the Company in any part of the world and to become a member of various associations and trade bodies whether in Pakistan or abroad.

22. To apply for and obtain necessary consents, permissions and licenses from any Government, State, Local and other authorities in and outside Pakistan for enabling the Company to carry any of its objects into effect or for extending any of the powers of the Company or for effecting any modification of the constitution of the Company or for effecting any modification of the constitution of the Company or for any other purpose which may seem expedient, and to oppose any proceedings or applications which may seem calculated, directly or indirectly to prejudice the interests of the Company, and to enter into arrangements with any Government authorities, central, provincial, municipal, local or otherwise, public or quasi public bodies, or with any other persons, in any place where the Company may have interests that may seem conducive to the objects of the Company or any of them and to obtain from any such Government, authorities or persons, any rights, privileges and concessions which the Company may think fit to obtain, and to carry out, exercise and comply therewith.

23. To insure the property, assets, and employees of the Company in any manner deemed fit by the Company, and to create any reserve fund, sinking fund, insurance fund or any other special fund whether for depreciation or for repairing, insuring, improving, extending or maintaining any of the property of the Company or for any other purpose conducive to the interests of the Company.

24. To invest the surplus moneys of the Company not immediately required in any manner but not to act as an investment company.

25. To guarantee the performance of contracts and obligations of the Company and / or its associated companies / undertakings in relation to the payment of any loan, debenture stock, bonds, obligations or securities issued by or in

favour of the Company or its associated undertakings and to give any guarantee or security by means of creating charge on assets of the Company for the purpose of procurement and repayment of any loans, debentures, debenture stock, bonds, redeemable capital, obligations or securities issued by the company or its associated companies / undertakings and to guarantee the payment of the interest thereon.

26. To advance money and/or give guarantees (whether secured or unsecured) to such persons or companies and on such terms as seem expedient and to guarantee (with or without security) the performance of contracts by any such persons or companies.

27. To import, export, buy, sell, own, install, and / or rent machinery and other equipment goods, materials and spare parts required for or in connection with the business of the Company.

28. To enter into partnership or other joint venture or co-operation with any person or company or other legal entity, local or foreign, carrying on or engaged in any business or transaction which this Company is authorized to carry on or engage in, or otherwise assist and such person or company or legal entity.

29. To receive, declare and distribute profits and to capitalize such portion of the profits of the Company as are not distributed among shareholders of the Company in the form of dividends, and as the Company may think fit, and to issue bonus shares, as fully paid up, in favour of the shareholders of the Company.

30. To file or register any documents required to be filed or registered under law, and to pay any fees, charges, expenses, rents, taxes, duties and other dues payable in connection with the business or operation of the Company.

31. To make rules or regulations not inconsistent with this Memorandum, to provide for all matters for which provision is necessary or expedient for the purpose of giving effect to the provisions of this Memorandum and the efficient conduct of the affairs of the Company.

32. To improve, manage, develop, grant rights or privileges in respect of, or otherwise deal with, all or any part of the property and rights of the Company and to establish laboratories, research and development centers to perform such research and development as the Company may deem advisable or feasible, and to expend money on experimenting upon and testing and improving or securing any process, or processes, patent or protecting any invention or inventions which the Company may acquire or propose to acquire or deal with.

33. To accept, buy, sell, market, supply, transfer (including transfer of actionable claims) or deliver any and every kind of moveable property for such price and subject to such terms, conditions and warranties as the Company may think fit.

34. To sell improve, manage, develop exchange, lease, mortgage, enfranchise, dispose of, turn to account, or otherwise deal with, all or any part of the property, assets or undertaking of the Company for such consideration as the Company may think fit, and in particular for shares, debentures, or other securities of any other company whether or not having objects altogether or in part similar to those of this Company, and to distribute among the members in specie any property of the Company.

35. To accept or give security, including but not limited to promissory notes, indemnity bonds guarantees assignments, receipts, bailment, pledges, hypothecations, liens, mortgages and charges, against the credit extended or moneys borrowed in connection with the business of the Company.

36. To settle disputes by negotiation, conciliation, mediation arbitration, litigation or other means and to enter into compromise with creditors, members and any other persons in respect of any difference or dispute with them.

37. To develop and / or transfer technology and to acquire or pass on technical know-how.

38. To train personnel and workers, both in Pakistan and abroad, to obtain technical proficiency in various specialties connected with the business of the Company and to impart training to personnel and workers of other companies on commercial basis.

39. To vest any real or personal property, rights or interests acquired by or belonging to the Company in any person or company on behalf of or for the benefit of the Company, and with or without any declared trust in favour of the Company, and to undertake and execute any trust the undertaking whereof may seem desirable, and either gratuitously or otherwise.

40. To pay underwriting commission and brokerage on any shares or securities issue by the Company.

41. To aid pecuniarily or otherwise, any association, body or movement having for an object the solution, settlement, or surmounting of industrial or labor problems or troubles or the promotion of industry or trade.

42. To distribute among the Members in specie any property of the Company, or any proceeds of sale or disposal of any property of the Company, but so that no distribution amounting to a reduction of capital be made except with the sanction (if any) for the time being required by law.

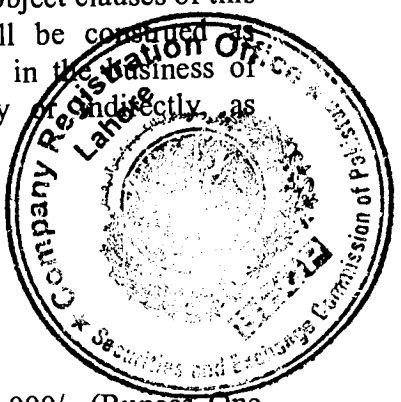
43. Notwithstanding anything stated in any object clause, the Company shall obtain such other approval or license from the competent authority, as may be required under any law for the time being in force, to undertake a particular business.

44. The Company shall not engage in banking business or business of an investment company, insurance or leasing or any unlawful business.

It is hereby declared that :-

(a) the objects specified in each of the paragraphs of this clause shall be regarded as independent objects, and accordingly shall in no way be limited or restricted (except where otherwise expressed in such paragraphs) by reference to or inference from the terms of any other paragraph or the name of the Company, but may be carried out in as full and ample a manner and construed in as wide a sense as if each of the said paragraphs defined the objects of a separate and distinct company;

(b) notwithstanding anything contained in the foregoing object clauses of this Memorandum of Association, nothing herein shall be construed as empowering the Company to undertake or indulge in the business of banking finance, investment or insurance directly or indirectly, as restricted under law or any unlawful operations.



IV. LIABILITY:

The liability of the Members is limited.

V. SHARE CAPITAL:

The Authorized Share Capital of the Company is Rs. 100,000/- (Rupees One Hundred Thousand only) divided into 1,000 ordinary shares of Rs. 100/- (Rupees One Hundred only) each. The Company shall have the power to increase, reduce or reorganize the Capital of the Company, subdivide the Share Capital of the Company, into different classes in accordance with the provisions of the Companies Ordinance 1984.

We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a Company, in pursuance of this Memorandum of Association, and we respectively agree to take the number of shares in the Capital of the Company as set opposite to our respective names.

Name and Surname (Present & Former) in Full (in Block Letters) and C.N.I.C. #	Father's Name (in Full)	Nationality with any former Nationality	Occupation	Residential Address (in Full)	Number of shares taken by each subscriber	Signature
1. MR. NASSIR MAHMUD KASURI C.N.I.C. # 35202-3010345-1	Mr. Khurshid Mahmud Kasuri	Pakistani	Educational Business	6 - A, Main Boulevard, Gulberg - II, Lahore.	340 Three Hundred Forty	
2. MR. KASIM MAHMUD KASURI C.N.I.C.# 35202-3010342-5	Mr. Khurshid Mahmud Kasuri	Pakistani	Educational Business	6 - A, Main Boulevard, Gulberg - II, Lahore.	330 Three Hundred Thirty	
3. MR. ALI MAHMUD KASURI C.N.I.C. # 35202-3010341-7	Mr. Khurshid Mahmud Kasuri	Pakistani	Educational Business	6 - A, Main Boulevard, Gulberg - II, Lahore.	330 Three Hundred Thirty	
				Total Number of Shares Taken	1,000 One Thousand	

Dated this 20th day of December 2010

Signature .....

Witness to the above signatories :

Full Name : MANSOOR IQBAL

C.N.I.C. # 35201-4201609-9

Father's
Full Name : MUHAMMAD IQBAL

Nationality : Pakistani

Occupation : Private Service

Full Address : H. No. E - 1 / 4 - B - 1,
Zulfiqar Lane,
Cavalry Ground,
Lahore - Cantt.

CERTIFIED TO BE TRUE COPY
13-01-2011
DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

THE COMPANIES ORDINANCE, 1984

--:o:--

(PRIVATE COMPANY LIMITED BY SHARES)

--:o:--

Articles of Association

of

ROSHAN POWER (PRIVATE) LIMITED

PRELIMINARY

1. Subject as hereinafter provided, the Regulations contained in Table 'A' of the First Schedule to the Companies Ordinance, 1984, (hereinafter referred to as Table 'A') 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.

PRIVATE LIMITED COMPANY

2. The Company is a Private Company within the meaning of Clause (28) of Section 2(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 provided that for the purpose of this provision when two or more persons hold one or more shares in the Company jointly they shall for the purposes of this clause be treated as a single member ; and

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

BUSINESS

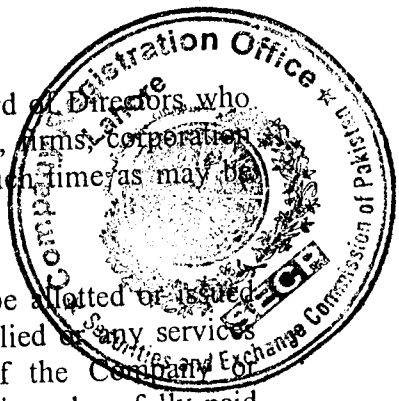
3. The Company is entitled to commence business from the date of its incorporation.

4. The business of the Company shall include all or any of the objects enumerated in the Memorandum of Association.

5. The business of the Company shall be carried out at such place or places in the whole of Pakistan or elsewhere as the Directors may deem proper or advisable from time to time.

CAPITAL

6. The Authorised Capital of the Company is Rs. 100,000/- (Rupees One Hundred Thousand only) divided into 1,000 ordinary shares of Rs. 100/- (Rupees One Hundred only) each with powers to increase, reduce, consolidate, sub-divide or otherwise re-organize the share capital of the Company.



7. The shares shall be under the control of the Board of Directors who 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. The shares 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.

SHARES, TRANSFER AND TRANSMISSION

9. Every person whose name is entered as a member in the Register of Members shall without payment, be entitled to a certificate under the Common Seal of the Company specifying the shares held by several persons. The Company shall not be bound to issue more than one certificate and delivery of a share certificate to any one of several joint holders shall be sufficient delivery to all.

10. The Directors may decline to register any transfer of share to transferee of whom they do not approve and shall not be bound to show any reasons for exercising their discretion subject to the provisions of Sections 77 and 78 of the Companies Ordinance, 1984.

11. 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.

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

GENERAL MEETING

13. The First Annual General Meeting shall be held within 18 months from the date of incorporation of the Company in accordance with the provisions of Section 158 and thereafter once at least in every year and within a period of four months following the close of its financial year and not more than fifteen months after the holding of its last preceding Annual General Meeting as may be determined by Directors. The Directors may, whenever they think fit, call an Extraordinary General Meeting of the shareholders in terms of Section 159 of the Companies Ordinance, 1984.

PROCEEDINGS AT GENERAL MEETING

14. Twenty one days' notice atleast specifying the place, day and hour of the General Meeting and in case of special business the general nature of such business, shall be given to the members in the manner provided in Table "A" but accidental omission to give such notice to or non-receipt of such notice by the member shall not invalidate the proceedings of the General Meeting.

15. The Chief Executive, with the consent of a meeting at which quorum is present and shall if so directed by the meeting may adjourn the meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place.

QUORUM

16. No business shall be transacted at any General Meeting unless a Quorum of members is present at the time when the meeting proceeds to business. Two members, present in person, representing not less than 25% of the total voting power either on their own account or as proxies, shall form a Quorum for a General Meeting.

VOTES OF MEMBERS

17. At any General Meeting a resolution put to the vote of the General Meeting shall be decided on a show of hands, unless a poll is demanded in accordance with the provisions of Section 167 of the Companies Ordinance, 1984.

18. On a show of hands every member present shall have one vote and on a poll, every member present in person or by proxy shall have one vote in respect of each share held by him.

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

CHAIRMAN

20. The Directors may from time to time appoint one of their members to be the Chairman of the Company for a period not exceeding three years on such terms and conditions as they deem fit. The Chairman shall preside over the meetings of the Board of Directors and members of the Company. In his absence, the Directors may elect one of them to preside over Board's / General Meetings. The questions arising at the meeting of the Directors shall be decided by a majority of votes. In the case of equality of votes, the Chairman or the Director presiding over the meeting, as the case may be, shall have a casting vote.

APPOINTMENT OF FIRST CHIEF EXECUTIVE

21. The first Chief Executive of the Company will be appointed by the Board of Directors within fifteen days from the date of incorporation of the Company who shall hold office till the first Annual General Meeting

APPOINTMENT OF SUBSEQUENT CHIEF EXECUTIVE

22. Within fourteen days from the date of election of Directors under Section 178 or the office of the Chief Executive falling vacant, as the case may be, the Directors of a Company shall appoint any person, including an elected Director, to be the Chief Executive, but such appointment shall not be for a period exceeding three years from the date of appointment.

DIRECTORS

23. Unless otherwise determined, the number of Directors shall not be less than two. The following will be the first Directors of the Company.

1. **MR. NASSIR MAHMUD KASURI**
2. **MR. KASIM MAHMUD KASURI**
3. **MR. ALI MAHMUD KASURI**

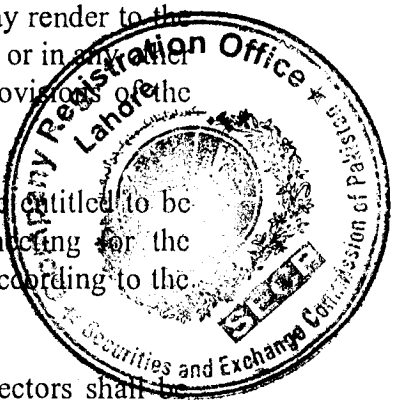
24. The election of the Directors shall be held in accordance with the provisions of Section 178 of the Companies Ordinance, 1984.

25. The first Directors including the Chief Executive, shall hold office upto 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.

26. A resolution for removing a Director shall not be deemed to have been passed if the number of votes against him is equal to, or less than the number of votes that would have been necessary for the election of Directors at the immediately preceding annual election of Directors in the manner aforesaid but as provided under Section 181 of the Companies Ordinance, 1984.

27. The remuneration of a Director except regularly paid Chief Executive and full time working Directors for performing extra services, including holding of the office of Chairman, and the remuneration to be paid to any Director for attending the meetings of the Directors or a committee of Directors shall from time to time be determined by the Board of Directors in accordance with law.

28. 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 Directors subject to the provisions of the Companies Ordinance, 1984.



29. The Director who resides out of station shall also be entitled to be paid such travelling and other expenses for attending the meeting for the Company as may be fixed by the Directors from time to time according to the provisions of the Companies Ordinance, 1984.

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

31. 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 realised 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 DIRECTOR

32. In addition to the elected Directors, the Financial Institutions shall be entitled, during the currency of their respective loan(s) 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(s) 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.

NOTICES

33. Notices for every meeting of the Board of Directors will be given in writing and there must be given a reasonable time in advance. The nature of the business to be transacted at an intended Board meeting will be specified in the notice.

MANAGEMENT

34. The whole business and affairs of the Company shall, subject to the control and supervision of the Board of Directors, be managed and controlled by the Chief Executive.

35. Subject to the limit fixed by the Directors, the Chief Executive may from time to time raise or borrow any sums of money for and on behalf of the Company from other companies, banks or financial institutions on such terms as may be approved by the Board of Directors from time to time.

36. Without prejudice to the powers conferred by these Articles, the Board of Directors shall have the following powers :-

(a) To take on lease, purchase, erect or otherwise acquire for the Company any assets, stocks, lands, buildings, property, rights or privileges which the Company is authorised to acquire at such price and generally on such terms and conditions as they think fit.

(b) To let, mortgage, sell, exchange or otherwise dispose of absolutely or conditionally all or any part of the assets, stocks, raw materials, properties, privileges and undertaking of the Company upon such terms and conditions and for such consideration as they think fit.

(c) To appoint any person or persons to be attorney or attorneys of the Company for such purposes and with such powers, authorities and discretions and for such period and subject to such conditions as they may, from time to time, think fit.

(d) To enter into, carry out, rescind or vary all financial arrangements with any bank, person, company, firm or corporation or in connection with such arrangements to deposit, pledge or hypothecate property of the Company or the documents representing or relating to the same.

(e) To make and give receipts, release and discharge all moneys payable to the Company and for the claims and demands of the Company.

(f) To compound or allow time to the payment or satisfaction of any debt due to or by the Company and any claim and demands by or against the Company and to refer claims or demands by or against the Company to arbitration and observe and perform the awards.

(g) To institute, prosecute, compromise, withdraw or abandon any legal proceedings by or against the Company or its affairs or otherwise concerning the affairs of the Company.

(h) To raise and borrow money from time to time for the purposes of the Company, on the mortgage of its property or any part thereof and/or on any bond or debenture payable to bearer otherwise repayable in such a manner and generally upon such terms as they think fit.

(i) To open, operate and maintain bank/banks account(s) individually or jointly as the Board may authorise or to any other person on its behalf.

BORROWING POWERS

37. The Directors may from time to time raise, borrow or secure the payment of any sums for the purposes of the Company in such manner and upon such terms and conditions as they think fit and in particular by the issue of debentures, debenture-stock or other securities charged upon all or any part of the property of the Company present or future.

38. Debentures, debenture-stock, or other securities may be issued with any special privileges as to redemption, surrender, allotment of shares, attending and appointment of Directors or other privileges subject to any permission required by law.

THE SEAL

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

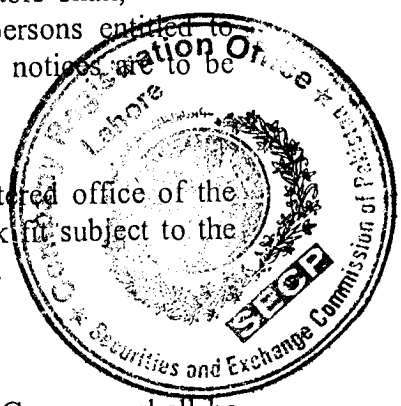
ACCOUNTS

40. The Directors shall cause to be kept proper books of account as required under Section 230 of the Companies Ordinance, 1984.

41. The Directors shall as required by Section 233 and 236 cause to be prepared and to be laid before the Company in General Meeting such profit and loss account or income and expenditure accounts and balance sheets duly audited and reports as are referred to in those Section.

42. A balance sheet, profit and loss account, income and expenditure account and other reports referred to in preceeding article shall be made out in every year and laid before the Company in the Annual general Meeting made up to a date not more than six months before such meeting. The balance sheet and profit and loss account or income and expenditure account shall be accompanied by a report of the auditors of the Company and the report of Directors.

43. A copy of the balance sheet and profit and loss account or income and expenditure account and reports of Directors and auditors shall, at least twenty one days preceding the meeting, be sent to the persons entitled to receive notice of General Meeting in the manner in which notices are to be given hereunder.



44. The books of account shall be kept at the registered office of the Company or at such other place as the Directors shall think fit subject to the provisions of Section 230 of the Companies Ordinance, 1984.

AUDIT

45. Once at least in every year the accounts of the Company shall be audited and correctness of the Balance Sheet shall be ascertained by one or more Auditors. The Auditors shall be appointed and their duties regulated in accordance with the provisions of Section 252 to 255 of the Companies Ordinance, 1984.

INDEMNITY

46. Every officer or agent for the time being of the Company may be indemnified out of the assets of the Company against any liability incurred by him in defending any proceedings, whether civil or criminal arising out of his dealings in relation to the affairs of the Company, except those brought by the Company against him, in which judgment is given in his favour or in which he is acquitted, or in connection with any application under Section 488 in which relief is granted to him by the Court.

SECRECY

47. No member shall be entitled to visit and inspect the Books of the Company without the permission of the Chief Executive or one of the Directors or to require discovery of any information regarding any detail of the Company's business or any matter which is or may be in the nature of trade secret, or secret process which may relate to the conduct of the Company's business and which in the opinion of the Directors, will not be in the interest of the members of the Company to communicate to the public.

ARBITRATION

48. 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 who will be qualified in Islamic law.

49. 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 attorney and client or otherwise and may award by whom and in what manner the same shall be borne and paid.

WINDING UP

50. If the Company is wound up, the liquidator may, with the sanction of a special resolution of the Company and any other sanction required by the Ordinance, divide amongst the members, in specie or kind, the whole or any part of the assets of the Company, whether they consist of property of the same kind or not.

We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a Company, in pursuance of these Articles of Association, and we respectively agree to take the number of shares in the Capital of the Company as set opposite to our respective names.

Name and Sumame (Present & Former) in Full (in Block Letters) and C.N.I.C. #	Father's Name (in Full)	Nationality with any former Nationality	Occupation	Residential Address (in Full)	Number of shares taken by each sub-scriber	Signature
1. MR. NASSIR MAHMUD KASURI C.N.I.C. # 35202-3010345-1	Mr. Khurshid Mahmud Kasuri	Pakistani	Educational Business	6 - A, Main Boulevard, Gulberg - II, Lahore.	340 Three Hundred Forty	
2. MR. KASIM MAHMUD KASURI C.N.I.C.# 35202-3010342-5	Mr. Khurshid Mahmud Kasuri	Pakistani	Educational Business	6 - A, Main Boulevard, Gulberg - II, Lahore.	330 Three Hundred Thirty	
3. MR. ALI MAHMUD KASURI C.N.I.C. # 35202-3010341-7	Mr. Khurshid Mahmud Kasuri	Pakistani	Educational Business	6 - A, Main Boulevard, Gulberg - II, Lahore.	330 Three Hundred Thirty	Ali M. Kasuri
				Total Number of Shares Taken	1,000 One Thousand	

Dated this 20th day of December 2010

Signature .....

Witness to the above signatories :

Full Name : MANSOOR IQBAL

C.N.I.C. # 35201-4201609-9

Father's
Full Name : MUHAMMAD IQBAL

Nationality : Pakistani

Occupation : Private Service

Full Address : H. No. E - 1 / 4 - B - 1,
Zulfiqar Lane,
Cavalry Ground,
Lahore - Cantt.

CERTIFIED TO BE TRUE COPY
13-01-2011
DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

THIRD SCHEDULE
(See section 156)
FORM A- ANNUAL RETURN OF COMPANY HAVING SHARE CAPITAL

664227
20/01/14

1	Registration No.	0074410
2	Name of the Company	Roshan Power (Pvt.) Limited

3	Form A made upto (Day/Month/Year)	29	10	2013
4	Date of AGM (Day/Month/Year)	29	10	2013

PART-A

5	**Registered office address:**	10-11 Gurumangat Road, Industrial Area Gulberg-III, Lahore
6	Email Address:	nauman.rahman@beaconhouse.edu.pk
7	Office Tel. No.:	(042) 111-232-266
8	Office Fax No.:	(042) 35712027
9	Nature of Business:	Power Generation

10 **Authorized Share Capital**

Type of Shares	No. of Shares	Amount	Face Value
Ordinary Shares	1,000	Rs.100,000	Rs. 100/-

11 **Paid up Share Capital**

Type of Shares	No. of Shares	Amount	Issue Price
Ordinary Shares	1,000	Rs.100,000	Rs. 100/-

12 **Amount of Indebtedness on the date upto which form A is made in respect of all Mortgages/Charges** — None

13 **Particulars of the holding company**

Name	None		
Registration No.	None	% Shares Held	None

14 **Chief Executive**

Name	Mr. Nassir Mahmud Kasuri	CNIC #	35202-3010345-1
Address	6-A Main Boulevard Gulberg-II Lahore		

15 **Chief Accountant**

Name	Mr. Mazhar Maqbool	CNIC #	36103-1654679-1
Address	H # 35/B-3, Block # 16, Khanewal		

16 **Secretary**

Name	Mr. Nauman Rahman	CNIC #	35202-3431528-3
Address	75-A Model Town, Lahore		

17 **Legal Adviser**

Name	N/A
Address	N/A

18 **Auditors**

Name	M/s. Ernst & Young Ford Rhodes Sidat Hyder
Address	Mall View Building 4-Bank Square Lahore

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

Name of Director	Address	Nationality	CNIC Number
1. Mr. Kasim Mahmud Kasuri	6-A Main Boulevard Gulberg-II Lahore	Pakistani	35202-3010342-5
2. Mr. Nassir Mahmud Kasuri	6-A Main Boulevard Gulberg-II Lahore	Pakistani	35202-3010345-1
3. Mr. Ali Mahmud Kasuri	6-A Main Boulevard Gulberg-II Lahore	Pakistani	35202-3010341-7

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	CNIC Number
	Members				
	Mr. Ali Mahmud Kasuri	6-A Main Boulevard Gulberg-II Lahore	Pakistani	330	35202-3010341-7
	Mr. Kasim Mahmud Kasuri	6-A Main Boulevard Gulberg-II Lahore	Pakistani	340	35202-3010342-5
	Mr. Nassir Mahmud Kasuri	6-A Main Boulevard Gulberg-II Lahore	Pakistani	330	35202-3010345-1
			Total	**1,000**	
	Debenture holders				
	None				

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
	Debenture holders			
	None			

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 29 | 10 | 2013

Signature
Designation

Nauman Rahman
Company Secretary

CERTIFIED TO BE TRUE COPY OF THE DOCUMENT FILED BY THE COMPANY HOWEVER THIS OFFICE ACCEPTS NO RESPONSIBILITY AS TO THE CORRECTNESS OF THE DETAILS GIVEN IN THE DOCUMENT

ASSISTANT REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

ANNEXURE-F: COMPANY PROFILE OF PROJECT COMPANY/PROJECT SPONSORS

COMPANY PROFILE

BPS (PVT.) LTD.

10-11 Gurumangat Road, Gulberg III, Lahore

CORPORATE PROFILE

INCORPORATION:

BPS (Pvt.) Ltd. incorporated on July 10th 1979 with the Registrar of Companies, Lahore.

REGISTERD OFFICE:

The Company has its registered office at 10-11, Gurumangat Road, Industrial Area, Gulberg-III, Lahore.

BOARD OF DIRECTORS:

Following are the members of Board of Directors:

1. Mr. Khurshid Mahmud Kasuri
2. Mrs. Nasreen Mahmud Kasuri
3. Mr. Ali Mahmud Kasuri
4. Mr. Kasim Mahmud Kasuri
5. Mr. Nassir Mahmud Kasuri

CHIEF EXECUTIVE:

Mrs. Nasreen Mahmud Kasuri is the Chief Executive of the company.

COMPANY SECRETARY:

Mr. Nauman Rahman is the Company Secretary of the company.

LEGAL ADVISOR:

M/s. Hamid Law Associates is the legal advisor to the company.

AUTHORISED CAPITAL:

The Authorized Capital of the company is Rs. 200,000,000/-.

PAID-UP-CAPITAL:

The Paid-up-Capital of the company is Rs. 167,232,800/-.

FINANCIAL YEAR:

Financial Year of the company closes on 30th June every year.

AREAS OF BUSINESS:

The company is into the activities of managing and renting out its Tangible Assets (Freehold and Leasehold properties).

BANKERS:

Followings are the list of banks to the company:

1. Askari Bank Ltd.
2. Faysal Bank Ltd.
3. National Bank Ltd.

BPS (Private) Ltd.

January 31, 2014

Mr. Salman Ahmed Khan
Unit Head
Group Corporate Banking
Faysal Bank Limited
310-Upper Mall,
Lahore.

Subject: **Provision of Expression of Interest to [illegible] credit & financing to M/s BPS (Pvt.) Ltd.**

Dear Sir

This is to inform you that M/s BPS (Pvt.) Ltd., are the main sponsor of a 10MW Solar Project being installed in District Kasur, with the name & Style of M/s Roshan Power (Pvt.) Ltd. (a company duly incorporated under the companies ordinance 1984.)

In pursuance we, the BPS (Pvt.) Ltd., intend to have the lending facility amounting to about US$ 16/- Million approximately for this power project. You are hereby requested to please indicate the expression of interest for granting the facility in Pak Rupee equivalent to US$ 16/- Million, to support the said Power Project.

As we are already availing the running finance facility, therefore we seek a positive response from you for generating the expression of interest letter to support the Power Project Financing.

Yours truly

Authorized Signatories

10-11, Gurumangat Road, Gulberg III, Lahore. Phone: (042) 111-232-266 Fax: (042) 35712027

TBEA SUNOASIS COMPANY LIMITED, CHINA (EPC CONTRACTOR)

APPENDIX TBEA-04 – Company Profile

TBEA SUNOASIS CO.,LTD. is one of the earliest enterprises engaged in solar energy system integration engineering design and construction, integration technology R&D and photo-votaic (PV) product manufacturuing in China. With more than a decade's fast development, it has developed a main business structure with PV, wind and thermal power generation engineering as the core, and dedicated itself to providing clients with integrated reliable and efficient clean energy solutions covering development of various power projects, investment & financing and EPC (engineering, procurement, construction, commissioning, and operation maintenance).

Today, the company is the largest hi-tech enterprise specially engaged in solar energy development and utilization and systems integration. TBEA Xinjiang SunOasis is composed of TBEA Electric Apparatus Co., Ltd, Tsinghua University Holding Company and China Environment Protection Company. TBEA Xinjiang SunOasis Co., Ltd wholly owns Xinjiang Sang'O Solar Equipment Co., Ltd. TBEA SunOasis has been a major shareholder in BP SunOasis Company Limited, which was a joint venture with British Petroleum PLC.

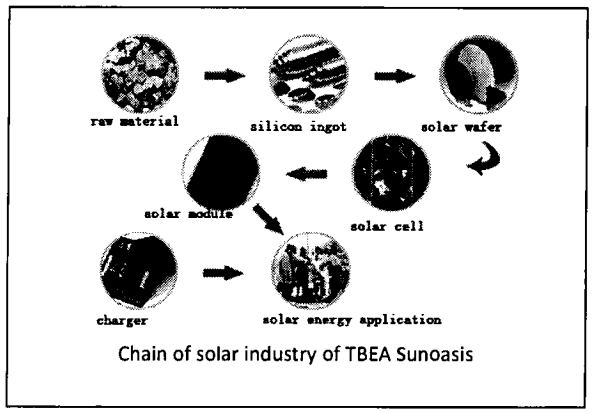
The company holds Grade 2 qualification for electric power project EPC and Grade B qualification for electric power engineering commissioning and electric power engineering design. It has a professional R&D and design team with most of its members having a doctor or master's degree

TBEA possesses more than 100 patents. It has undertaken many national R&D projects, such as the scientific research program and the technological supporting program for "100 megawatt PV system integration technologies and key equipment research and development" in the National 863 Project. It has also built a great number of PV projects with the installed gross capacity in excess of 2GW, and has project reserves and investments at the one million kilowatt level. These have turned the company into a large-scale business group leading development of PV integration technologies in China.

At the same time, the company also possesses strong wind and PV power resource development and investment capabilities.

In the PV power field, TBEA SUNOASIS CO.,LTD. has a comprehensive industrial chain covering coal, power, polysilicon, silicon pellets, components, R&D of on-grid inverters and EPC engineering services for PV system integration.

We are now a fully vertically and horizontally integrated hi-tech company that is dedicated to contribute to the sustainability of the environment, the improvement in the quality of life, and to strengthen the energy production base through the development of systematic and sustainable solutions.



Chain of solar industry of TBEA Sunoasis

All of its products have passed certification of Golden Sun, ETL, TUV and UL. In addition, the company has built the only "national engineering laboratory

for PV power generation control and integration" in the industry in China. Moreover, the "experimental power plant for megawatt PV system integration technologies" constructed in partnership with the National 863 Project has been in service.

By making use of its more than 70 years' experience in electrical equipment R&D and manufacturing, the company has independently developed a complete series of on-grid inverters ranging from 1KW to 1,250KW, 2.5MW integrated inverter-generator rooms and smart junction boxes with a conversion efficiency of 98.7% and 100% three phase imbalance resistance capability. The company has its total product sales ranking among top three in China and plays a significant role in construction of many national key PV construction projects. PV components produced by the company have excellent quality as an international brand and can ensure that the output power will not be lower than 92% within 12 years and not be lower than 85% within 25 years, marking the highest product quality assurance level in the industry.

When faced with the strategic opportunity that China vigorously promotes application of PV desert power plants and distributed power stations during the "twelfth five-year plan" period, the company has developed the PV system integration capability going beyond the GW level with technological innovation, management innovation and fast development as its starting point.

Additionally, through close cooperation with China Huadian Corporation, China Datang Corporation, China Power Investment Corporation, China Huaneng Group, China Energy Conservation and Environmental Protection Group and China General Nuclear Power Group amongst the "five power giants and four large power enterprises", the company has had large on-grid surface power stations built in more than 20 provinces of China, including Xinjiang, Qinghai, Ningxia, Inner Mongolia and Tibet.

Moreover, it has undertaken construction of the 6.6MW project at Shanghai Hongqiao High Speed Rail Station, also the largest BIPV power station in Asia, Shandong Lulan 159-m tower BIPV project, the highest single BIPV power station in the world, and many other distributed PV power generation projects. All of the said projects have been connected to grid and generated electricity as scheduled, ensuring investment benefits of owners and gaining high recognition of clients. Furthermore, 24 projects with the 20MV project of China Datang Corporation at the Qingtong Gorge and the 20MV project of China General Nuclear Power Group in Hami included, have been presented with the honorary titles of excellent projects by owner units. Amongst them, the 30MV project of China Power Investment Corporation in Taiyangshan has won the China electric power quality engineering award.

In the off-grid power station domain, the company has constructed more than 2,000 power stations for China Mobile, China Unicom, China Telecom and other large communication companies. In addition, it has also built the 500KW project at Ruoqiang County of Xinjiang Province, the largest independent PV power station in China, and the Mount Everest part of the communication base station power supply system for Beijing 2008 Olympic Torch, the highest PV power station in the world with an elevation of 5,800 m.

In the international market, the company has succeeded in promoting 500KW inverters and other products, and the 500KW PV on-grid project in Kazakhstan has been completed successfully and put into operation.

In the wind power field, TBEA SUNOASIS CO.,LTD. has a talent team made up of wind

resource development, investment & financing, design, construction and installation and operation maintenance professionals, which concentrates on studies of analyses and application of micro wind power resources, wind-PV hybrid power generation and integration technologies and other core technologies by means of combining "production, learning, research and application", and brings into full play the company's advantages in low-cost supply chain. Based on the 10 million kilowatt wind power development planning of Xinjiang and the national development planning of achieving an installed gross capacity of 100 million kilowatts, the company has developed, invested in and constructed the Turpan 100 MW national demonstration power station, which is also China's largest wind-PV hybrid power generation station.

In addition to this, the company has also won many other wind power projects in Jeminay, Haba River, Mulei and Agricultural No. 13 Division of XPCC with the total scale reaching 400MW. With these projects, the company is growing to be a cadre enterprise in China's wind power resource development and wind-PV hybrid power generation and integration technologies.

In the thermal power industry, relying on advantages in power equipment manufacturing and construction of transmission and distribution engineering package TBEA Transformer Industrial Group has developed over the years, TBEA SUNOASIS CO.,LTD. has cultivated a power system technology service team with installation, commissioning, transportation and inspection, maintenance and energy conservation modification as its main business. The team has obtained Grade 2 qualification for EPC and equipment installation, construction and commissioning, and double A credit rating certification in the electric power industry. To date, the team has undertaken commissioning services for several power plants, including the power plants of Xinjiang Zhonghe Ganquanbao Industrial Park, Xinte Energy Company and Hebei Shengyuan Chemical Industry Co., Ltd. for self supply.

In future, TBEA SUNOASIS CO.,LTD.will continue to center around its PV, wind power and thermal power service business, improve its core business capabilities in "EPC engineering construction and services, project resource development and BOT", promote operation mode innovation, incentive mechanism innovation and technology innovation, spare no efforts to develop the best products and provide the best services and solutions for clients in order to meet their needs, push forward development of the clean energy industry and finally become an excellent green energy service provider!

List of Major Recent Projects completed by TBEA

No	Project Name	Client	Detail	Location	Period
1	100MW Solar-Wind Hybrid project	TBEA	100MW EPC Solar-Wind Hybrid	Turpan	Mar-Sep 2013
2	Jiangsu Dongtai Coastal Economic Zone 50MW PV EPC project	SUMEC ENERGY ENGINEERING CO.,LTD	50MW EPC contract	Jiangsu	Sep-Mar 2013
3	CPIC's Third-phase 20MW On-grid PV project in Tulufan, Xinjiang	CPI Xinjiang Energy Chemical Group Co., Ltd.	20MW EPC contract	Tulufan, Xinjiang	May-Dec 2013
4	CPIC's Second-phase 20MW On-grid PV project in Luopu, Xinjiang	CPI Xinjiang Energy Chemical Group Co., Ltd.	20MW EPC contract	Luopu, Xinjiang	May-Dec 2013
5	CPIC's 20MW PV project in Damaoqi Bailingmiao, Construction	China Power Investment Corporation North China Branch	20MW EPC contract	Damaoqi Bailingmiao	Aug-Nov 2013
6	Datang International 20MWp On-grid PV EPC project in Hongsibu, Ningxia	Datang International Ningxia Qingtongxia PV Power Co.,Ltd	20MW EPC contract	Hongsibu, Ningxia	May-Dec 2013
7	Datang 30MW PV EPC project in Huancuishan, Tianzhen county	Datang Shanxi New Energy Co.,Ltd	30MW EPC contract	Huancuishan Tianzhen county	Apr-Dec 2013
8	Datang International Second-phase on-grid PV project in Gonghe, Qinghai	Datang International Qinghai Gonghe PV Power Co.,Ltd	20MW EPC contract	Gonghe, Qinghai	Aug-Dec 2013
9	Datang International First-phase on-grid PV project in Gonghe, Qinghai	Datang International Qinghai Gonghe PV Power Co.,Ltd	20MW EPC contract	Gonghe, Qinghai	Aug-Dec 2013
10	Datang International's First-phase On-grid PV EPC Project in Bayin, Zhuozi county, Inner Mongolia	Datang International Inner Mongolia New Energy Co.,Ltd	11MW EPC contract	Bayin, Zhuozi county, Inner Mongolia	May-Oct 2013
11	Huaneng first-phase 20MW on-grid PV EPC project in Shanshan	Huaneng Xinjiang Energy Development Co.,Ltd	20MW EPC contract	Shanshan	Jun-Dec 2013
12	Huaneng Solar park 20MWp on-grid PV EPC project in Hami Shichengzi	Huaneng Xinjiang Energy Development Co.,Ltd	20MW EPC contract	Hami Shichengzi	May-Dec 2013
13	Qinghai Yuhui Wulan Second-phase on-grid PV EPC project	Qinghai Yuhui New energy Co.,Ltd	20MW EPC contract	Qinghai Yuhui Wulan	Oct-Mar 2013
14	Jingxin Shaya first-phase 20MW on-grid PV EPC project	Shaya Jingxin Technology Co.,Ltd	20MW EPC contract	Jingxin Shaya	Nov-Mar 2013
15	Shanghai Aerospace Automobile Electromechanical Co., Jiayuguan 10MW grid-	Shanghai Solar Energy Technology Co., Ltd.	10 MW On-grid inverter procurement	Jiayuguan	Mar-Apr 2013

	connected PV project inverter procurement				
16	Qinghai Haibei Gangcha second-phase 10MW on-grid PV EPC project	Shanghai Aerospace Automobile Electromechanical Co.,LTD	10MW EPC contract	Qinghai Haibei Gangcha	May-Dec 2013
17	Ningxia Zhongwei City 10MW PV grid-connected project inverter procurement	Shanghai Solar Energy Technology Co., Ltd.	10 MW On-grid inverter procurement	Ningxia Zhongwei City	Jun 2013
18	CGNPC's First-phase 30MW On-grid PV EPC Project in Tumushuke,construction and installation(part 2)	CGN Tumushuke Solar Energy Co., Ltd.	30MW EPC contract	Tumushuke	May-Aug 2013
19	CGNPC's First-phase 30MW On-grid PV EPC Project in Tumushuke, construction and installation(part 1)	CGN Tumushuke Solar Energy Co., Ltd.	30MW EPC contract	Tumushuke	May-Aug 2013
20	CECIC's second-phase 20MW EPC On-grid PV Power Generation Project in Shanshan	CECEP Solar Energy Technology Co.,Ltd	20MW EPC contract	Shanshan	May-Dec 2013
21	CECIC's First-stage 20MW EPC On-grid PV Power Generation Project in Da Luntai	CECEP Luntai Solar Energy Technology Co.,Ltd	20MW EPC contract	Da Luntai	Oct-Apr 2013
22	CECIC's First-stage 20MW EPC On-grid PV Power Generation Project in Ku'erle	CECEP Ku'erle Solar Energy Technology Co.,Ltd	20MW EPC contract	Ku'erle	Oct-Jun 2013
23	Guangwei Industrial Park 10.2MW PV application demonstration EPC project	Guangwei Green energy Co.,Ltd	10.2MW EPC contract	Guangwei	May-Aug 2013
24	Longyuan Tibet Ali 10MWp micro- grid PV power generation project, Electrical Installation	Longyuan Tibet New energy Co.,Ltd	10MWp Electrical installation	Tibet	Oct-Aug 2013
25	Xinjiang CHC's 20MW on-grid PV EPC project in Awati	Xinjiang CHC Kashi Second-phase power Co.,Ltd	20MW EPC contract	Awati, Xinjiang	Sep-Dec 2012
26	Keleqin, Kazakhstan 1MW on-grid PV project	Keleqin, Kazakhstan	1MW EPC contract	КазЭкоВатт, Kazakhstan	Nov 2012
27	Datang International Second-phase 20MW on-grid PV project in Golmud, Qinghai	Datang International Qinghai Golmud PV Power Co.,Ltd	20MW EPC contract	Golmud, Qinghai	Sep-Dec 2012
28	China Three Gorges 10MW PV project in Qinghai Golmud (first-phase 5MW)	Three Gorges Golmud new energy power generation Co.,Ltd	20MW EPC contract	Qinghai Golmud	Apr 2012
29	CGNPC's First-phase 20MW On-grid PV EPC Project in Qinghe, additional 2MW	CGN Qinghe Solar Energy Co., Ltd.	2MW EPC	Qinghe	Jun-Aug 2012
30	Shanghai Aerospace Automobile Electromechanical Co., 10MW on-grid PV project in	Shanghai Solar Energy Technology Co., Ltd.	10MW EPC contract	Qinghai	Sep-Dec 2012

	Qinghai				
31	Xinjiang Keping first-phase 20MW on-grid PV EPC project	Keping Jiasheng Sun power Co.,Ltd	20MW EPC contract	Keping Xinjiang	Oct-Dec 2012
32	Hanergy first-phase first-step 20MW PV EPC project in Xinhe, Akesu	Hanergy Akesu PV power investment Co.,Ltd	20MW EPC contract	Xinhe, Akesu	Oct-Dec 2012
33	Liaoyuguan Industrial Zone Golden Sun Demonstration project, EPC general contracting(Part2)	Datang Guanxian PV power Co.,Ltd	10MW EPC contract	Liaoyuguan	Jun-Oct 2012
34	Xinjiang CHC's 40MW on-grid PV EPC project in Shitoucheng	Xinjiang CHC Nuoshui Wind Power Co.,Ltd.	40MW on-grid PV EPC project	Shitoucheng	Jun-Dec 2012
35	Concessions project (Hetian, Xinjiang) 20MW on-grid power station	CPIC (Xinjiang) Energy Co., Ltd.	20MW on-grid power station contract	Hetian, Xinjiang	Jun 2011-Dec 2012
36	Concession project (Hami, Xinjiang) 20MW on-grid power station	CPIC (Xinjiang) Energy Co., Ltd.	20MW on-grid power station contract	Hami, Xinjiang	Dec 2012
37	Concession project (Hami, Xinjiang) 20MW on-grid power station	CPIC (Xinjiang) Energy Co., Ltd.	20MW on-grid power station contract	Hami, Xinjiang	Jun 2011-Dec 2012
38	Concession project (Wuwei, Gansu) 20MW on-grid power station	CPI (Xinjiang) New Energy Holding Co., Ltd.	20MW inverters supply	Wuwei, Gansu	Jun 2011-Dec 2012
39	Concession project (Baiyin, Gansu) 20MW on-grid power station	CPI (Xinjiang) New Energy Holding Co., Ltd.	20MW inverters supply	Baiyin, Gansu	Jun 2011-Dec 2012
40	Datang international first-phase 20MW grid-on PV project in Golmud, Qinghai(8KM 110Kv transmission line from 110Kv Substation to Golmud 330Kv Center)	Datang International Qinghai Golmud PV Power Co.,Ltd	20MW EPC contract and 110KV transmission line	Golmud, Qinghai	Sep-Nov 2011
41	CPIC's First-phase 30MW On-grid PV Project in Mt. Taiyang	CPIC Ningxia Qingtongxia Energy Aluminum Group Co.,Ltd.	30MW on-grid PV EPC project	Mt. Taiyang	Sep-Dec 2011
42	Xitieshan 60MW PV on-grid generation project (third phase) construction (B1 bid package)	CGN (Big Qaidam) Solar Energy Developing Co., Ltd.	20MW on-grid power station construction	Xitieshan, Qinghai	Jun-Oct 2011
43	CGNPC's First-phase 20MW On-grid PV EPC Project in Hami	CGN Hami Solar Energy Co., Ltd.	20MW EPC contract	Hami, Xinjiang	Sep-Dec 2011
44	CPIC's First-phase 20MW On-grid PV Power Plant in Shanshan, Xinjiang	CPIC Xinjiang Energy Co.,Ltd.	10MW EPC contract	Shanshan, Xinjiang	Aug-Dec 2011
45	CECEP (Taiyangshan, Wuzhong) PV on-grid generation project (second phase) 20MWP program (first bid package) system integration	CECEP (Taiyangshan, Wuzhong) PV Generation Co., Ltd.	10MW on-grid power station system integration	Wuzhong, Ningxia	Jun-Aug 2011
46	CECEP (Big Qaidam, Qinghai) PV on-grid generation Project (first phase) 10MWP program system	CECEP (Big Qaidam, Qinghai) Solar Generation Co., Ltd.	10MW on-grid power station system integration	Big Qaidam, Qinghai	May-Aug 2011

	integration				
47	Xitieshan 30MW PV on-grid generation project (second phase) construction (B1 bid package)	CGN Solar Energy Developing Co., Ltd.	10MW on-grid power station construction	Xitieshan, Qinghai	June-Sep 2011
48	Bronze Valley (Datang, Ningxia) 10MW on-grid generation project	Angli Tiansheng (Shandong) PV Technology Co., Ltd.	10MW on-grid power station contract	Bronze Valley, Ningxia	May 2011
49	Datang New Energy's 10MW EPC Project in Qingtongxia	Shandong Atsun Solar Electric Technology Co., Ltd.	10MW EPC contract	Qingtongxia	May 2011
50	Yijing (Changzhou) 10MW roof PV power station project	Yijing (Changzhou) PE Technology Co., Ltd.	10MW roof PV power station	Gold Altar, Jiangsu	Sep 2011
51	Shanxi International Electric Power Lvliang BIPV 8MW project	Shan Xi Nake Solar Technology Co., Ltd.	8MW grid-connected power plant general contracting	Lvliang city, Shanxi province	Dec 2011
52	Datang International's First-phase 20 MW On-grid PV Project in Golmud	Qinhai Datang International Energy	20MW EPC contract	Golmud, Qinghai	Aug-Sep 2011
53	Datang International's Second-phase 20MW PV Project in Qingtongxia	Ningxia Datang International Qingtongxia Photovoltaic Power Generation Co., Ltd.	20MW EPC contract	Qingtongxia	Sep-Dec 2011
54	The first phase of Luan Jingtan 10MW grid connected project of CECEP	Alashan Solar Generation Co., Ltd, CECEP	10MW System Integration Installation	Luan Jingtan, Inner Mongolia	Mar2011
55	The second phase of Taiyangshan 20MW solar power project system integration and power transmission and transformation installation, CECEP	Solar Technology Co., Ltd of CECEP	10MW grid connected system integration project	Taiyangshan, Wuzhong, Ningxia province	May 2011
56	CECEPG Xitie Mountain 10MW PV on-grid plant project	CECEPG Co.,LTD	Wall, street base, retaining walls, roads, hardening, gutter construction contract	Xitie Mountain Qinghai	Mar 2011
57	Pinglu 5MW, Youyu 10MW PV Power Generation Supervision Project, Shanxi International PV Power Generation Co.	Xinjiang Kunlun Project Supervision Co.	50MW 100MW Project Supervision	Pinglu, Shanxi. Youyu	Feb 2011
58	Xitie Mountain 30MW PV on-grid Construction and Installation Project	CECEPG Co.,LTD	10MW Construction and Installation Project	Xitie Mountain Qinghai	Aug 2011
59	CECEPG System Integration of 10MWp Qinghai Dacaidan PV on-grid Project	CECEPG Co.,LTD	10MWp on-grid system integration project	Qinghai Xitie mountain	Jun 2011

60	Solar module bracket basic engineering project of the first phase project (20MWp) of Golmud PV plant, Qinghai	Longyuan Golmud New Energy Development Co., Ltd	Solar module bracket basic engg project of 20MW grid connected power plant	Golmud, Qinghai	May 2010
61	20MW grid connected power plant of Longyuan Golmud, Qinghai	Longyuan Golmud New Energy Development Co., Ltd	Installation engg of 20MW grid connected power plant	Golmud, Qinghai	Aug 2010
62	First phase of Luan Jingtan 10MW grid connected project of CECEP	Alashan Solar Generation Co., Ltd, CECEP	Civil engineering construction	Luan Jingtan, Inner Mongolia	Sep 2010
63	Xitieshan Qinghai 10MW grid connected project of CECEP	Solar Technology Co., Ltd of CECEP	10MW BIPV inverter	Xitieshan, Qinghai	Aug 2010
64	Qinghai Xitieshan 10MW solar plant 2 kilometers construction water supply, CECEP	Qinghai Qaidam Solar Generating Co., Ltd, CECEP	10MW solar plant 2 kilometers construction water supply	Xitieshan, Qinghai	Sep 2010
65	Qinghai Xitieshan 10MW civil engineering construction project of CGNPC	Solar Developing Co., Ltd of CGNPC	10MW civil engineering construction project	Xitieshan, Qinghai	Jan 2010
66	Xitieshan 10MW solar power grid connected project	Solar Developing Co., Ltd of CGNPC	10MW power substation construction, 10KV switch house, 110KV booster station construction	Xitieshan, Qinghai	May 2010
67	Shanghai Hongqiao Railway Station on-grid Project	The Third Railway Survey and Design Group Corporation	on-grid inverter	Shanghai Hongqiao Railway Station	Apr 2010
68	Xi'an Export Processing Zone 1MW on-grid Project	BP Solar Co.	1MW on-grid inverter	Xi'an	Nov 2010
69	TBEA (Hengyang transformer) Industrial Park, the user side and grid-connected photovoltaic power generation demonstration projects	TBEA Hengyang Transformer Co.	852.12KW on-grid power plant EPC	Hengyang, Hunan Province	Sep 2010
70	Xinjiang Joinworld user-side BIPV Demonstration Project	Xinjiang joinworld Co.	305.83KW on-grid power plant EPC	Urumqi, Xinjiang	Mar 2010
71	TBEA Real Estate BIPV Demonstration Project	TBEA Real Estate Co.	345.27KW on-grid power plant EPC	Changji, Xinjiang	Mar 2010
72	TBEA Xinjiang Transformer Factory user- side and on-grid PV power generation project	TBEA Xinjiang Transformer Co.	204.24KW on-grid power plant EPC	Changji, Xinjiang	Mar 2010

73	Xinjiang Cable Co. user side and on-grid PV power generation project	TBEA Xinjiang Cable Co.	663.04KW on-grid power plant EPC	Changji, Xinjiang	Mar 2010
74	BIPV Demonstration Project	TBEA Shangdong Luneng Taishan Cable Co.	479.57KW on-grid power plant EPC	Xintai city, Shangdong	Mar 2010
75	700KW PV electrical low voltage systems integration demonstration project	Ningbo Youlika Solar Energy Co.	700KW on-grid system integration	Ningbo, Zhejiang	Dec 2010
76	on-grid Roof Project of Xinjiang Silicon	TBEA Xinjiang Silicon Co.	100.6KW on-grid power plant EPC	Fukang, Xinjiang	Aug 2010
77	Xinjiang 2009 Shihezi 5MW Golden Sun PV on-grid project	Xinjiang Yutian New Energy Investment Co.	5MW major electrical equipment supply and system integration	Shihezi, Xinjiang	Oct 2010
78	Xinjiang 2009 Dabancheng 10MW Golden Sun PV on-grid project	Xinjiang Yutian New Energy Investment Co.	10MW major electrical equipments supply and system integration	Dabancheng, Xinjiang	Oct 2010
79	Xinjiang 2010 Hami 3MW Golden Sun PV on-grid project	Xinjiang Yutian New Energy Investment Co.	3MW and step-up transformer network	Hami. Xinjiang	Nov 2010
80	Xinjiang 2009 Shihezi 5MW Golden Sun PV on-grid project	Xinjiang Yutian New Energy Investment Co.	5MW and step-up transformer network	Shihezi, Xinjiang	Nov 2010
81	500KW Independent PV Plant in Ruoqiang Town, Ruoqiang County	Power Company of Ruoqiang County Xinjiang	500KW PV off-grid Power Plant	Ruoqiang county Xinjiang	Mar 2010
82	The first phase of Taiyangshan PV grid connected power project, CECEP	Wuzhong Taiyangshan Solar Generating Co., Ltd of CECEP	5MW grid connected system integration project	Taiyangshan, Wuzhong, Ningxia province	Oct 2009
83	Wuhan Railway PV on-grid Project	EPC Project of Hubei power Survey and Design Group	2.2MW on-grid inverter	Wuhan Railway Station	Oct 2009
84	91 Group of No. 9 Agricultural Division Project	91 Group of No. 9 Agricultural Division	39.78KW on-grid power plant EPC	91 Group of No. 9 Agricultural Division Project	May 2009

PROSPECTUS

Roshan Power owned by Beaconhouse Group got Letter of Intent (LoI) from Punjab Power Development Board (PPDB) in May, 2011 for the development of 10 MW Solar Power Project in Kasur Punjab Pakistan.

The land area of about 315 acres is owned by the project owners, out of which area of 48.6 acres is selected for the implementation of 10 MW solar PV project.

The feasibility of the Project has been submitted to PPDB in March, 2012 vide letter No. RPL/12/I/2008 and approval is awaited.

Initial Environmental Examination (IEE) of the Project has been completed and NOC has been issued by Environmental Protection Department Punjab.

The Electrical and Grid Interconnection Studies were submitted to Lahore Electric Supply Company (LESCO) in March, 2012, which is revised based on LESCO comments and the final grid interconnection is submitted to LESCO in January, 2013. The approval from LESCO is awaited.

RFP was floated for the selection of EPC contractor and negotiations are at final stage with TBEA Sunoasis Company Limited, China.

The Project is now submitting application for unconditional acceptance of upfront tariff to NEPRA and for Generation License simultaneously.

The Project is expected to achieve Financial Close by 4th quarter of 2014 and Project COD is expected by 3rd quarter of 2015.

ANNEXURE-L: PROJECT INFORMATION IN PURSUANT TO SCHEDULE III [(REGULATION 3(6))] FOR GENERATION FACILITIES

Brief details of Project as required in pursuant to Schedule III [(Regulation 3 (6)] for Generation facilities is provided in this section. However, complete feasibility study of 10 MW Solar Power Project of Roshan Power including following Annexure is also submitted with the application of Generation License.

ANNEX – I
Site Selection and Access Study

ANNEX – II
Soil Investigation Report

ANNEX – III
Electrical and Grid Interconnection Studies

ANNEX – IV
Initial Environmental Examination

1 PROJECT LOCATION AND SITE MAP

The Project Site is acquired in village Kundian Khas, District Kasur-Punjab. The project site is located around 80 kilometers from Lahore in the south east direction.

The land area of about 315 acres is owned by the project owners, out of which area of 48.6 acres is selected for the implementation of 10 MW solar PV project.

The coordinates of Project Site are given in **Table 1** and shown in **Figure 1 and Figure 2**.

Table.1: Geographical Coordinates of Project Site

Boundary Point	Geodetic	
	Latitude	Longitude
1.	31.0234°	74.1154°
2.	31.0203°	74.1154°
3.	31.0203°	74.1214°
4.	31.0234°	74.1214°

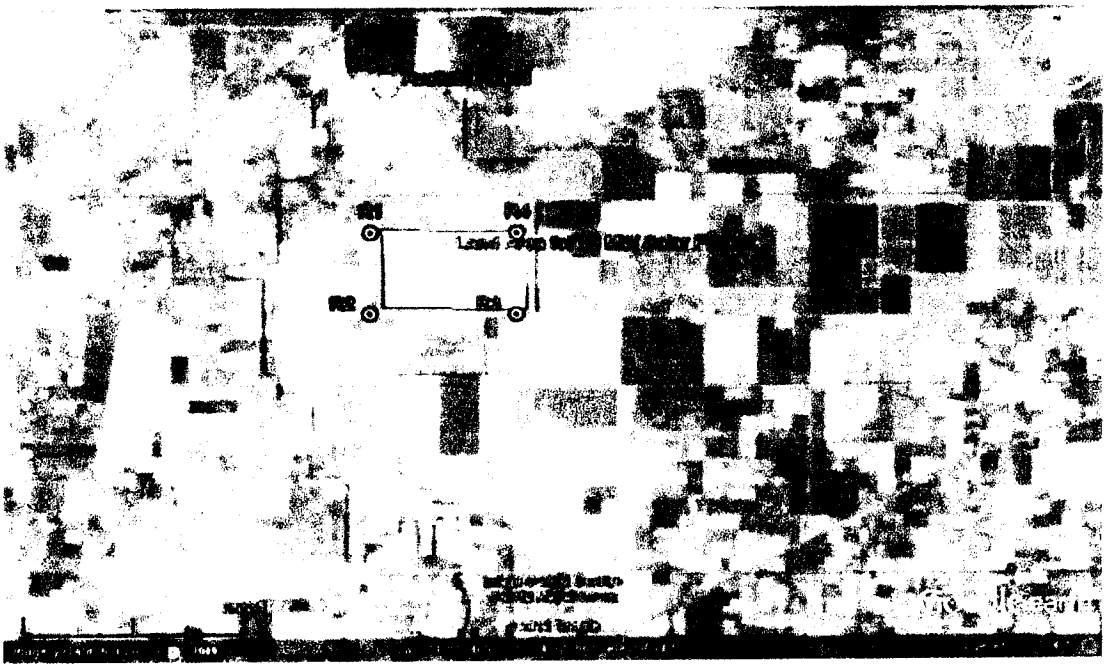


Figure.1: Project Site Overview

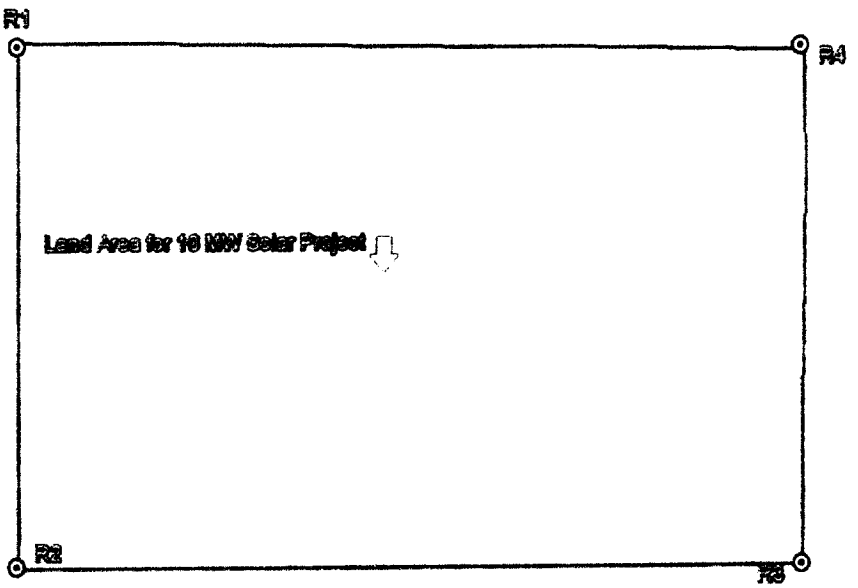


Figure.2: Project Site Coordinates

2 PLANT DETAILS

2.1 General Information

Name of Applicant/Company	Roshan Power (Pvt.) Ltd
Registered Office	4th Floor, Bahria Complex 1, M.T.Khan Road Karachi-Pakistan Tel: +92-21-35611194 Fax: +92-21-35610754
Plant Location	Kasur, Punjab pAKISTAN
Type of Generation Facility	Solar Power

2.2 Plant System Description

No of Modules in Series [Units]	22
Parallel Strings Per inverter [Units]	100
Modules per Inverter	2200
Designed Peak Power per Inverter [kW]	550
No. of Inverters	20
Total Modules [Units]	44000
Plant Capacity [kW]	11000

2.3 Specification of Solar Modules

Module Model	TBEA 3250
Manufacturer	TBEA
Nominal Power [W]	250.00
Efficiency [%]	15.30
Power Tolerance [%]	0/+2
Cell Type	Poly-Crystalline
Open Circuit Voltage [V]	37.60
Short Circuit Current [A]	8.70
MPP Voltage [V]	30.20
MPP Current [A]	8.28
Power Coefficient of Temperature [%/C]	-0.50
Nominal Operating Cell Temperature (NOCT)	45.00
Height X Width X Thickness [mm]	1667 X 1000 X 50

2.4 Specification of Inverter

Inverter Model	TBEA-GC-500KTL
Manufacturer	TBEA
Nominal AC Capacity	500 kW
Maximum DC input Power	550 kWp
MPP voltage range	500 V – 820 V
Maximum DC voltage	1000 V
Maximum DC current	1100 A
Nominal AC voltage	270 V – 350 V
Maximum Efficiency	0.99
European Efficiency	0.98
Operating temperature range	-30°C to +60°C
Power consumption	<50 W night time

2.5 Design and Manufacturing Standards

Solar Power Plant shall be design manufactured and tested according to the IEC standards or other equivalent standards. All plant and equipment used shall be new, un-used and of latest model.

2.6 Project Commissioning Date (Anticipated)

Project commissioning date (Anticipated)	March, 2015

2.7 Expected Life of the Project

Expected Life of the Project from COD	25 Years

2.8 Plant Characteristics (at Interconnection Point)

Voltage (kV)	±5% Normal Voltage Conditions ±10% Contingency Conditions
Frequency	50HZ, Continuous, ±1 variation state 49.2-50.5 Hz, Short Time
Power Factor	0.80 lagging, 0.9 Leading (for conventional synchronous generators but would not applicable to solar PP

3 EXECUTIVE SUMMARY OF ELECTRICAL AND GRID INTERCONNECTION

Executive summary of Electrical and Grid Interconnection Study is attached as Flag-A. Complete Electrical and Grid Interconnection study is provided to NEPRA along with Generation License Application.

Executive Summary

- Three Interconnection Schemes have been devised for the Interconnection of 10 MW Roshan Solar Power Plant. Two of these schemes, referred to as Alternative-I and Alternative-II in this report, propose evacuation of power on 11 kV while the third scheme, referred to as Alternative-III in this report, has been developed after incorporating the comments of LESCO and proposes evacuation of power on 132 kV. Alternative-III will incur the least line losses and is therefore the recommended Interconnection Scheme.
- The first interconnection scheme, referred to as Alternative-I in this report, aims to interconnect by making use of the nearby Marali Feeder. This would require:
  - Construction of about 0.8 km long circuit of 11 kV from Roshan Power switchyard to a Tee-Point on Marali 11kV feeder, about 20 km long emanating from Khudian Grid Station.
  - Two direct 11 kV single circuits of 20 km length, using Osprey conductor from Roshan Power till Khudian T-2 and T-3 11 kV Bus Bars.
  - The proposed direct circuits of 11 kV from Roshan PP to Khudian Grid Station shall require adding two line bays of 11 kV at Khudian Grid Station to connect this double circuit
- The second interconnection scheme, referred to as Alternative-II in this report, has been developed from the point of view of involving no direct connection to distribution feeders as it might affect the load-shedding scheme during the seasons of power shortage in the country or switching off these feeders for theft control if required. This alternative would require:
  - Three single circuits of 11 kV of 20 km length, using Osprey conductor, from Roshan Power to the existing Khudian Grid Station
  - The exiting substation of 132 kV at Khudian shall require adding of three line bays of 11 kV to connect to three circuits of 11 kV from Roshan Power
- The third interconnection scheme, referred to as Alternative-III in this report, has been developed for interconnection at 132 kV with Khudian Grid Station as per the comments of LESCO. This would require:
  - A double circuit of 132 kV of 20 km length, using Lynx conductor, from Roshan Power to the existing Khudian Grid Station

- The exiting substation of 132 kV at Khudian shall require adding of two line bays of 132 kV to connect to the double circuit of 132 kV from Roshan Power

❖ The study objective, approach and methodology have been described and the plant's data received from the client Roshan Power is validated.

❖ The LESCO system data as available with PPI for other studies have been used.

❖ The nearest substation of LESCO from the proposed site of Roshan Solar Power Plant is Khudian 132/11 kV. Considering the physical proximity of the grid to the power plant, interconnection options at 11 kV and 132 kV with Khudian 132/11 kV are considered. Two Alternatives have been envisaged to evacuate the maximum power of 10 MW of Roshan power at 11 kV and one Alternative has been considered to evacuate the maximum power of 10 MW of Roshan power at 132 kV and have been studied in detail.

❖ Detailed load flow studies have been carried out for the peak load conditions of 2013 for the three proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, under normal and N-1 contingency conditions to meet the reliability criteria.

❖ Steady state analysis by load flow reveals that all the proposed schemes are adequate to evacuate the maximum power of 10 MW of the plant under normal and contingency conditions.

❖ The short circuit analysis has been carried out to calculate maximum fault levels at the Solar Power Plant at 11 kV, and the substations of 11 kV and 132 kV in its vicinity. We find that the fault currents for all the proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from the Solar Power Plant.

❖ For Alternative-I, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.34 kA and 3.37 kA for 3-phase and 1-phase faults respectively. For Alternative-II, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.41 kA and 3.44 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 12.5 kA should be installed at 11 kV switchyard of the Solar Power Plant

leaving enough margin to accommodate fault current contribution from any future reinforcements in that area. For Alternative-III, the maximum short circuit levels of 132 kV bus bar of Roshan Solar Power Plant are 7.33 kA and 4.71 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 25 kA should be installed at 132 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements in that area

- The dynamic stability analysis of all the proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, has been carried out. The stability check for the worst case of three phase fault right on the 11 kV bus bar of the solar power plant substation followed by the final trip of 11 kV circuits emanating from this substation, has been performed for Alternative-I and Alternative-II. The stability check for the worst case of three phase fault right on the 132 kV bus bar of the solar power plant substation followed by the final trip of 132 kV circuits emanating from this substation, has been performed for Alternative-III including the stuck breaker case. The system is found strong enough to stay stable and recovered with fast damping. The stability of system for far end faults of 3-phase, including stuck breaker case, occurring at Khudian 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The results of load flow, short circuit and dynamic stability analysis have proved that all the three Alternatives are technically feasible. However Alternative-III would incur the least line losses.
- The proposed schemes of interconnection, i.e. Alternative-I, Alternative-II and Alternative-III, have no technical constraints or problems, fulfill all the criteria of reliability under steady state load flow, contingency load flows, short circuit currents ratings and dynamic stability analysis. However Alternative-III would result in the least line losses and is therefore recommended to be adopted.

4 EXECUTIVE SUMMARY OF INITIAL ENVIRONMENTAL EXAMINATION

Introduction:

Roshan Power (Pvt.) Ltd is a project company owned by Beaconhouse Group, for setting up Solar PV Power Projects of 10 MW in Kasur, Punjab Pakistan. Roshan Power got LOI in 2011 from Punjab Power Development Board as per Punjab Power Generation Policy year 2006, Revised 2009. Roshan Power (Pvt.) Ltd is owned by Beaconhouse Group, which is one of the largest school networks of its kind in the world. Beaconhouse Group is involved in a range of education, infrastructure and technology products.

The report prepared is ***Initial Environmental Examination (IEE)*** for submission to Environment Protection Agency (EPA)-Punjab as per Pakistan Environment Protection Act, 1997.

Sponsor's Introduction:

Roshan Power (Pvt.) Ltd is owned by Beaconhouse Group, which is one of the largest school networks of its kind in the world. Beaconhouse Group is involved in a range of education, infrastructure and technology products.

The Beaconhouse group has over 195,000 full-time students in nine countries, established in 1975, Beaconhouse has since grown into an international network of private schools imparting distinctive and meaningful learning to students all the way from birth –through its partnership with Gymboree play and music- to post graduation, through the Beaconhouse National University in Lahore.

The Beaconhouse of today is thus much more than just a stand-alone school. Through distinct and independent divisions in the UK, Malaysia, Indonesia, Thailand, Philippines, Oman, UAE, Pakistan and Bangladesh, it caters to the education and training needs of a large and diverse group of individuals of varying ages, socio-economic backgrounds, and nationalities, with its activities also extending beyond education in some countries. Beaconhouse Group owns Beaconhouse School Systems, The Educators, the Discovery Centre, Beaconhouse National University, TNS Beaconhouse, The early years, Beacon Energy Limited, Premier Trading Services, and Premier Bus Services.

Consultant's Introduction:

Renewable Resources Pvt. Ltd is the consultant of Roshan Power Pvt. Ltd for project development of this project. RE2 provides consultancy services in the fields of Renewable Energy (RE), Energy Efficiency (EE) and Environment. RE2 provides high quality energy engineering and management consulting services to enable rapid deployment of efficient, cost-effective, reliable, and environment-friendly renewable energy systems.

The consultant responsible for this assignment is well comprehended with the renewable energy power projects; including the environmental studies. So far so forth, the Consultant has achieved 05 approvals of IEE studies from the concerned EPAs for renewable energy power project.

Apart from above, the consultant already has a few projects under its credentials to have passed through various stages of development and requisite approvals including complete feasibility study and the security documents. It's a ONE STOP SHOP for the development of renewable energy projects including to act as Owner's Engineer as well as Lender's Advisor.

The Consultant has experience of working in projects of international stature with teams coming from multinational organizations.

Study Methodology:

The study was conducted using standard methodology prescribes by national and international agencies. The IEE comprises of baseline data on existing conditions on physical and biological environment, and social environment together with the anticipated environmental impacts and proposed mitigation measures. Detailed assessment of the social and biological environment of the area was conducted through field survey for the distance up to 10 Km radius of the project site, however the influence zone of the environmental impacts is considered as 5 Km.

Data was also collected through secondary sources such as published literature and internet to support the findings of the field survey.

The present document reports the finding of Initial Environmental Examination (IEE) carried out to identify potential environmental issues associates with the project and ensures appropriate mitigation measures to cope with those issues.

The IEE report stands on following strings:

- Relevant Project Information
- Project Alternatives
- Baseline Environmental Conditions
- Possible Impacts
- Mitigation Measures
- Environment Management Plan

Statutory Requirements:

The report fulfils the following regulatory requirements

- Guidelines published by Pakistan Environmental Protection Agency (Pak-EPA),
- Asian Development Bank Polices and Guidelines
- Performance Standards of IFC and World Bank group
- The best practices followed at international level.

Project Overview:

The Project Site is acquired at Khudian Khas, District Kasur-Punjab. The project site is located around 60 kilometers from Lahore in the south east direction.

The land area of about 315 acres is owned by the project owners, out of which area of 48.6 acres is selected for the implementation of 10 MW solar PV project. The proposed plan site located at latitude of 31.024"N and longitude of 74.1154"E with elevation of around 184 meters.

Description of Environment

A data collection survey that included investigations of geology, meteorology, hydrology, ambient air quality, water quality, soil characteristics, noise levels, flora and fauna, land use pattern, and socioeconomic conditions was undertaken in the vicinity of the site. Primary data was collected to establish baseline conditions for the soil, water (surface and ground) quality, flora and fauna, and noise. Secondary data was collected for land, ecology, climate, and socioeconomic factors.

The area of Kasur District is comprised of fluvial deposits of River Beas and Sutlej. The deposits are composed of flood plain mud, mixed with salt clay and fine to medium sandy point bars. Three flood plains two active and one remnant/extinct can be recognized. These are flood plains of River Ravi, flood plain of River Sutlej and remnant flood plain of extinct River Beas. The project area is agricultural land with variety of crops growing in the area.

The districts may be divided into two parts, a low lying or riverine area along the two bordering rivers and upland, away from the rivers. The riverine area is generally inundates during monsoon season. The water level in this area is higher than in the upland. The soil is sandy. The upland is flat plains sloping from north-west to south-west.

Two villages Khory and Sikandarabad is located at around 03 and 07 Km respectively from the project site. Local people of the villages have access to urban areas through link roads and public transport available. Electricity is available in the area. However, sui gas facility is yet not available in the villages and people are using wood as a source of fuel. PTCL telephones along with mobile services are available at village level also.

Primary and secondary schools are available for boys and girls in the villages. The nearest hospital is available in Khudian Khas.

The present main source of water supply system in the town is deep tube wells with a depth of 450-550 ft.

No authentic data is available regarding air quality measurements specifically of Khudian-Kasur. As the city is surrounded by agricultural land, a number of trees and vegetation is there to minimize the impacts of gaseous emissions.

The challenge posed by flood is two pronged in Kasur i.e River Sutlej and the inundation of low lying areas on the city due to Monsoon rains. Kasur has the history of floods of varying intensities during the monsoon.

Kasur is a plan agricultural fertile area and there is not any kind of minerals found in the district Kasur.

Stakeholder Consultation:

Stakeholder consultation was carried out as part of IEE study. The main objectives of the consultations were to apprise the stakeholders about the proposed project activities; obtain their views, concerns and recommendations; and address / incorporate them in the project design - thus enhancing the environmental and social performance of the project.

Impact Assessment and Mitigation

During the IEE, the project potential social and environmental impacts were identified. Each identified impact was then characterized with respect to its nature, reversibility, geographical extent, consequence-severity and likelihood. Based upon this characterization, the impacts were then assessed to be of high, medium or low significance. The key potential environmental and social issues identified during the study included contamination of soil and water, safety hazards, damage to infrastructure, air quality deterioration, noise emissions, threat to wildlife and habitat modification. Similar impacts during the plant operation were identified; these included soil and water contamination, safety hazards, species mortality, habitat modification, noise and vibration. The IEE has recommended appropriate mitigation measures to address the above concerns, and to keep the residual impacts within acceptable limits.

Environmental Management Plan

An Environmental Management Plan (EMP) had been developed to provide an implementation mechanism for the mitigation measures mentioned above and has been updated in the light of the EPA decision circumstances. The EMP provides the organization structure for the environmental and social management system during the project, and defines the roles and responsibilities of project players. The EMP includes a mitigation plan, a monitoring plan, the communication and documentation requirements, and training needs, in the context of the environmental and social management of the project.

Finding and Recommendation

The Project will not cause any significant lasting environmental and social impacts. The environmental disturbance normally associated with construction activities will be minimized through an EMP, implementation of which will continue during EPC and which includes monitoring arrangements. As solar PV technology is a clean energy source with no significant impacts on the environment and no GHG gas emissions after the construction phase, therefore, there will be no need for frequent environmental monitoring once the project is operational. If there will be any major negative environmental impact noticed during operation of the project, possible mitigation measures will be taken to reduce the impact.

5 INFRASTRUCTURE: ROADS, RAIL, COLONY AND AMENITIES

The information of road, rails, nearby settlements and colonies is provided in the survey report attached as Flag-B.

1.1 PROJECT AREA

The Project Site is acquired in Khudian Khas, District Kasur-Punjab. The project site is located around 60 kilometers from Lahore in the south east direction.

The land area of about 315 acres is owned by the project owners, out of which area of 48.6 acres is selected for the implementation of 10 MW solar PV project. Kasur is one of the oldest cities of Pakistan and is located at 55 km southeast of Lahore .It is adjacent to the Indo-Pak Border which is famous for its guard changing ceremony.

Khundian Khas and two villages Khory and Sikandarabad are located near the project Local people of the nearby villages of Khory and Sikandarabad have access to urban areas through link roads and public transport available. Electricity is available in the area. However, Sui gas facility is yet not available in the villages and people are using wood as a source of fuel. PTCL telephone along with mobile services is available at village level also.
The area adjacent to the Project site is shown in Figure-1

Figur.1: Project Site and its Adjacent Boundaries

1.2 TOPOGRAPHY

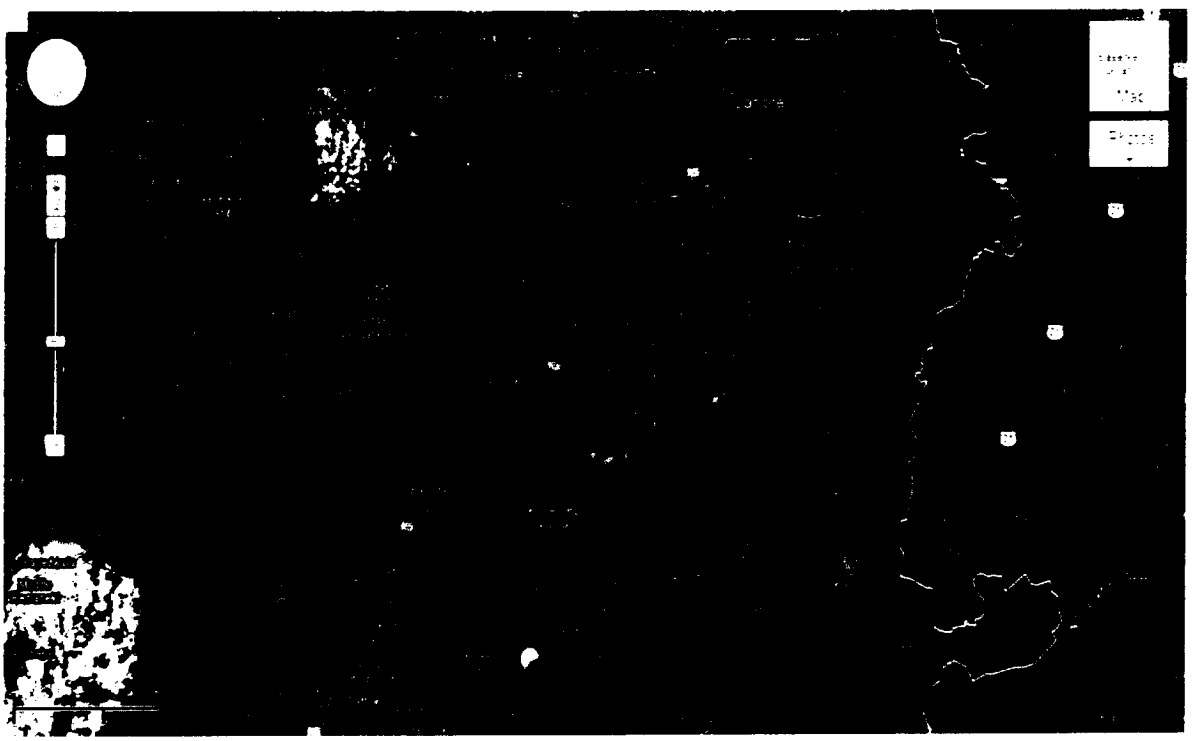
Topographically, Kasur District lies between the river Satluj which flows along its boundaries with India and river Ravi which flows its boundary with Sheikhupura District. The districts may be divided into two parts, a low lying or riverine area along the two bordering rivers and upland, away from the rivers. The riverine area is generally inundates during monsoon season. The water level in this area is higher than in the upland. The soil is sandy. The upland is flat plains sloping from north-west to south-west. The general height of the area is from 150 to 200 meters above the sea level. Topographic map of Kasur derived from satellite mapping is shown in **Figure 4.2.**

Figure.2: Topographic Map of Kasur District

1.3 ROAD ACCESS

The Project Site is easily accessible. Going from Lahore, there are two main roads towards Kasur.

One way from Lahore to the site is through Changa Manga Multan Road. Changa Manga Multan Road, slightly turn right lead to Changa Managa Chunian road. On this road, taking the first right to the Muqam road, there is unmetalled road towards Khudian Khas at around 2Km, where the project site is located. It took around two hour to reach on the site through this way from Lahore. The track towards the project site from Lahore through Changa Manga Multan Road is shown with blue path in **Figure-3.**



Figur.3: Road Access to Project Site through Lahore-Chanag Manga Multan Road

Another way, which is preferred over the previous track, is through Lahore-Kasur road. Going on the Lahore Kasur Road, at around 40 Km continue towards Kasur-Ganda Singh wala road and take a U turn towards Depal Pur Road. Continue towards the Depal pur road turn left at around 20-25 Km towards Khudian Khas through unmetalled road where the project site is located. It took around one and a half hour to reach on project site from Lahore through this track.

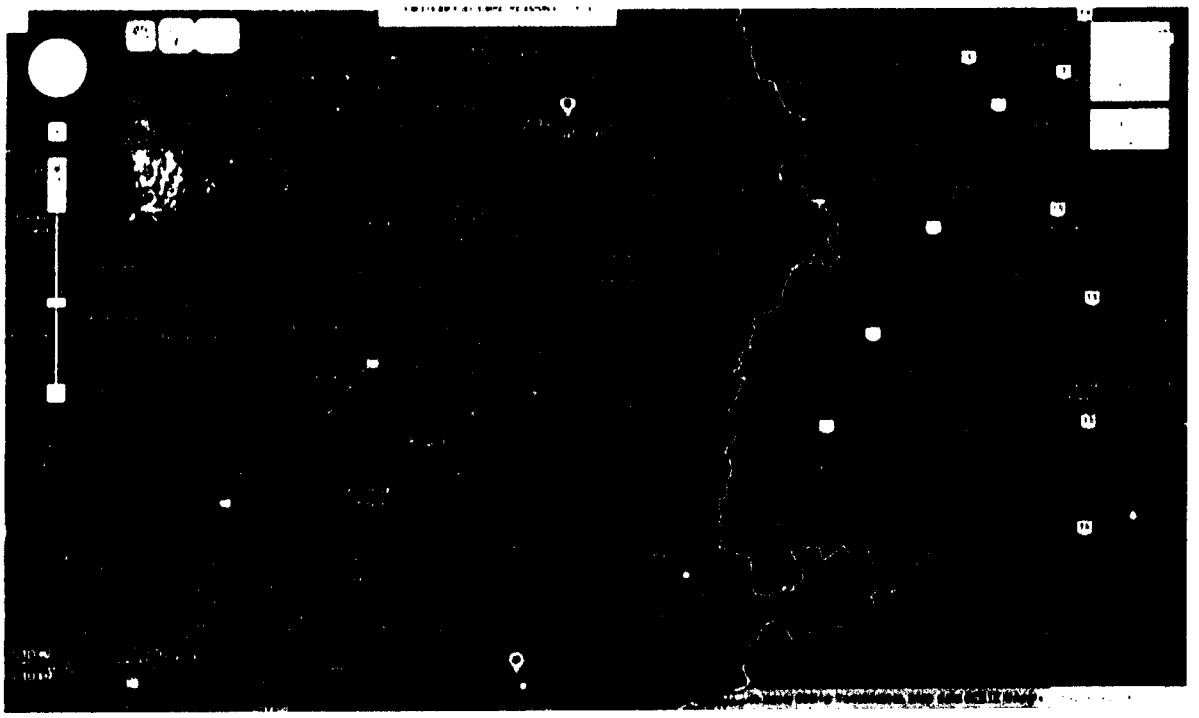


Figure.4: Road Access to Project Site through Lahore-Kasur Road

1.4 Rail Links

All the main towns of the district except Mustufabad and Bhaipheru are connected by rail. Kasur is connected with Lahore and Karachi and Pakpattan through rail network.

6 PROJECT COST INCLUDING DEBT AND EQUITY DETAILS

The required information is attached as Flag-C

Financial Analysis

Project Cost

The total project cost has preliminary estimated at USD 20.9 million (including interest during construction) for a capacity of 11 MWp, which is in line with the per MW project cost determined by NEPRA in the Upfront Tariff. Key components of the estimated project cost are shown in Table 1-1.

Table 1-1 Project Cost

Description	Total (USD m)
Total EPC Costs	18.62
Non-EPC Costs	1.38
Insurance	0.19
Other Financing Fees and Charges	0.55
Project Cost before Interest During Construction	20.73
Interest During Construction	0.15
Total Project Cost	20.88

Capital Structure

The Power Policy and State Bank of Pakistan guidelines allow a debt to equity ratio of 75:25 and the same has been assumed for purposes of the tariff. However the same may change based on lenders' requirements. For the purposes of the project tariff and financial model, 100% of the debt is assumed to be provided by international financial institutions. The financing parameters used in our assessment have been arrived at after consultations with the sponsors and reflect their expectations regarding the project's financing at this stage. However, in order to achieve the most cost-effective pricing, the sponsors plan to look for other, lower cost financing sources such as export/suppliers credit or loans from international financial institutions. The proposed financing plan is summarized in Table 1-2.

Table 1-1 Financing Structure

#	Funding Parameters	Funding Items	
		Loan	Equity
1	Funding Ratio	75%	25%
2	Funding Amount (USD m)	15.66	5.22

Table 1-2 Funding Parameters

Funding Parameters	
Total Loan	USD 15.66 million
Loan Tenor	10 years 8 months
Repayment Period	10 years
Grace Period	8 months
Repayment Frequency	Quarterly
Total Instalments	40
Margin over LIBOR	4.50%
Base LIBOR	0.31%
Total Lending Rate	4.81%

7 PROJECT COMMENCEMENT AND COMPLETION PLAN

Table.2: Project Status and Planned Milestones

-

Activity / Milestone	2013		2014				2015			
	3RDQTR	4THQTR	1STQTR	2NDQTR	3RDQTR	4THQTR	1STQTR	2NDQTR	3RDQTR	4THQTR
Submission of Feasibility Study										
Approval of Feasibility Study										
Generation License										
Upfront Tariff Approval										
Signing of EPA / IA										
Financial Close										
Project COD										

The project construction shall take 24 months from the date of start till the COD.

Table 3: Project Construction Scheduling

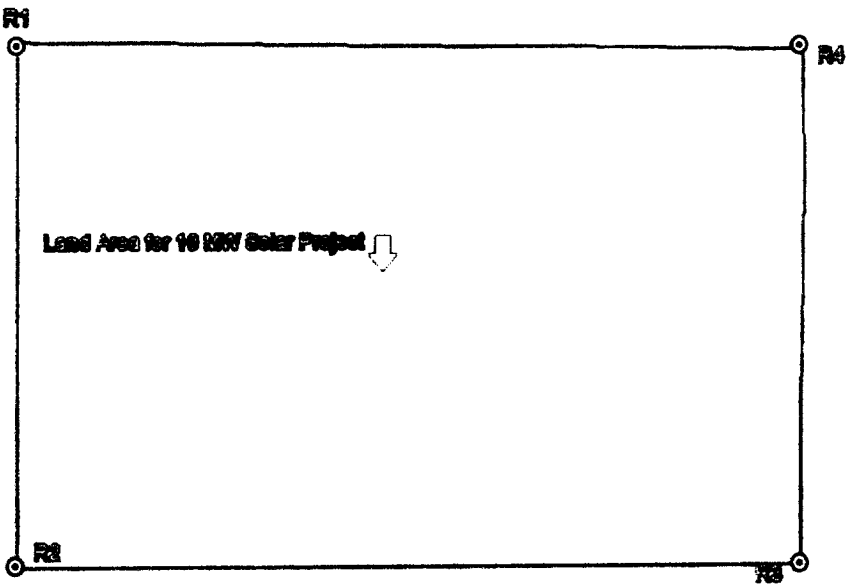
Activity / Month	1	2	3	4	5	6	7	8
Engineering Design and Mobilization								
Import of Hardware and Equipment								
Fabrication of Steel Structures								
Site Civil Works								
Installation of Solar Power Equipment								
Cables and Interconnections								
Grid Connectivity								
Commissioning and Testing								

ANNEXURE-M: INFORMATION FOR SCHEDULE-I OF LICENSE

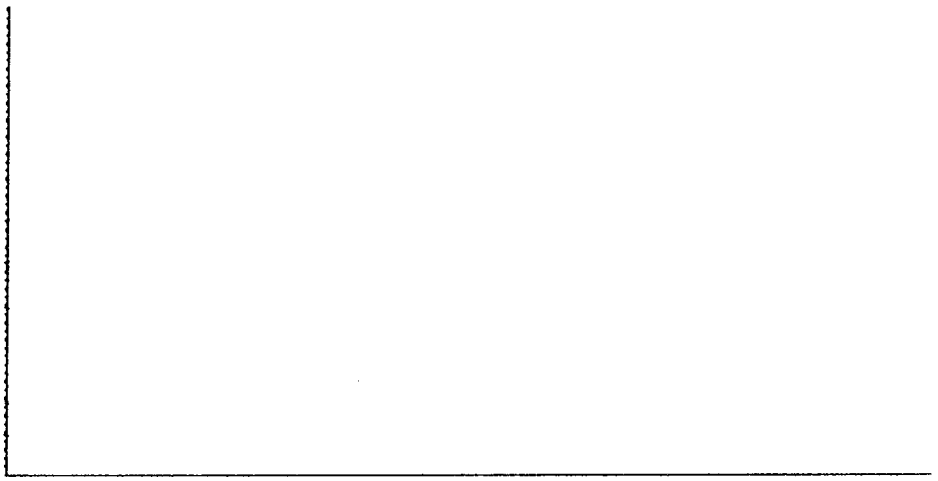
Solar Project Location Map

Boundary Point	Geodetic Coordinates	
	Latitude	Longitude
5.	31.0234°	74.1154°
6.	31.0203°	74.1154°
7.	31.0203°	74.1214°
8.	31.0234°	74.1214°

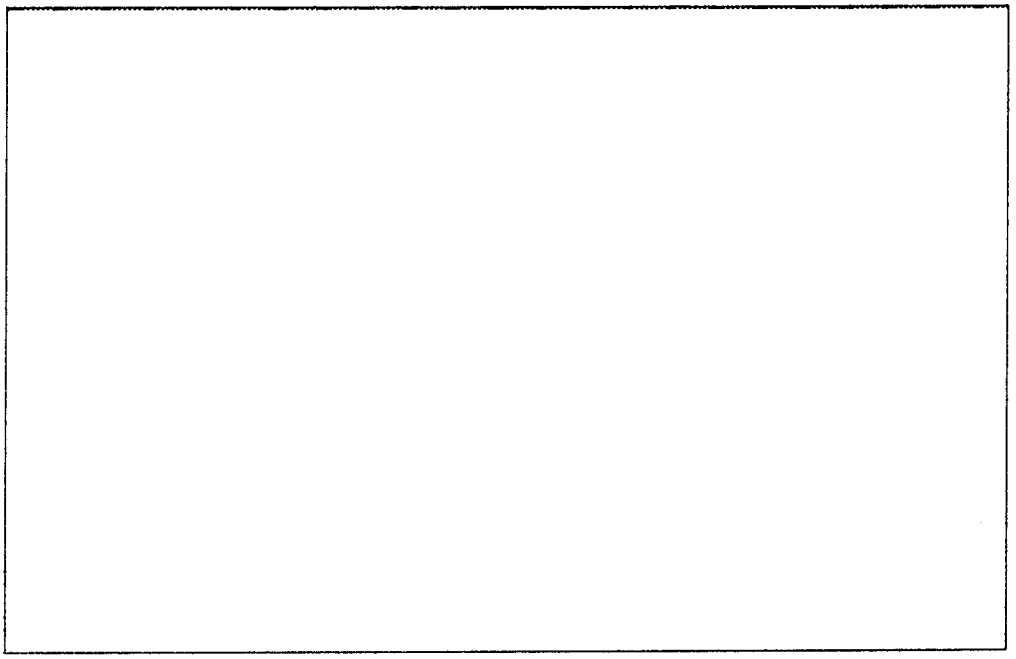

R1
R4
R2
R3

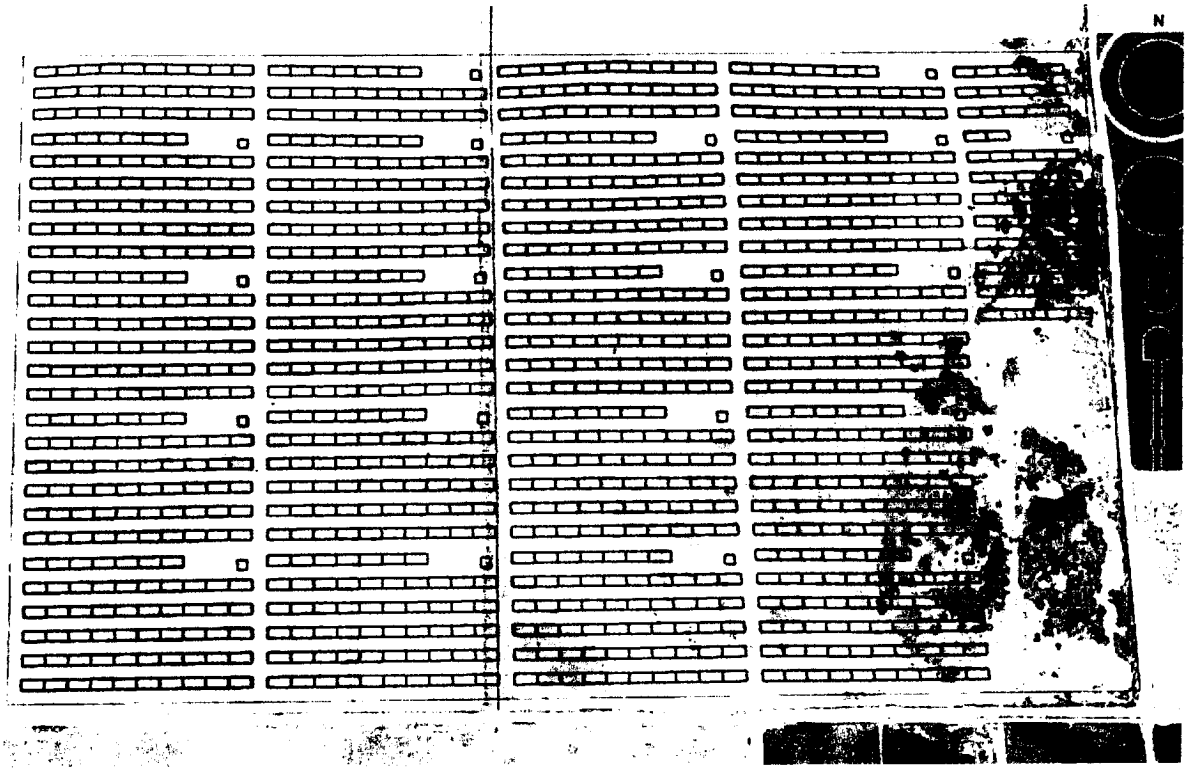

R1
R4
Land Area for 10 KW Solar Project
R2
R3

Solar Project Micrositing



Micrositing of Solar Modules – The Sector Layout (TBEA Sunoasis)



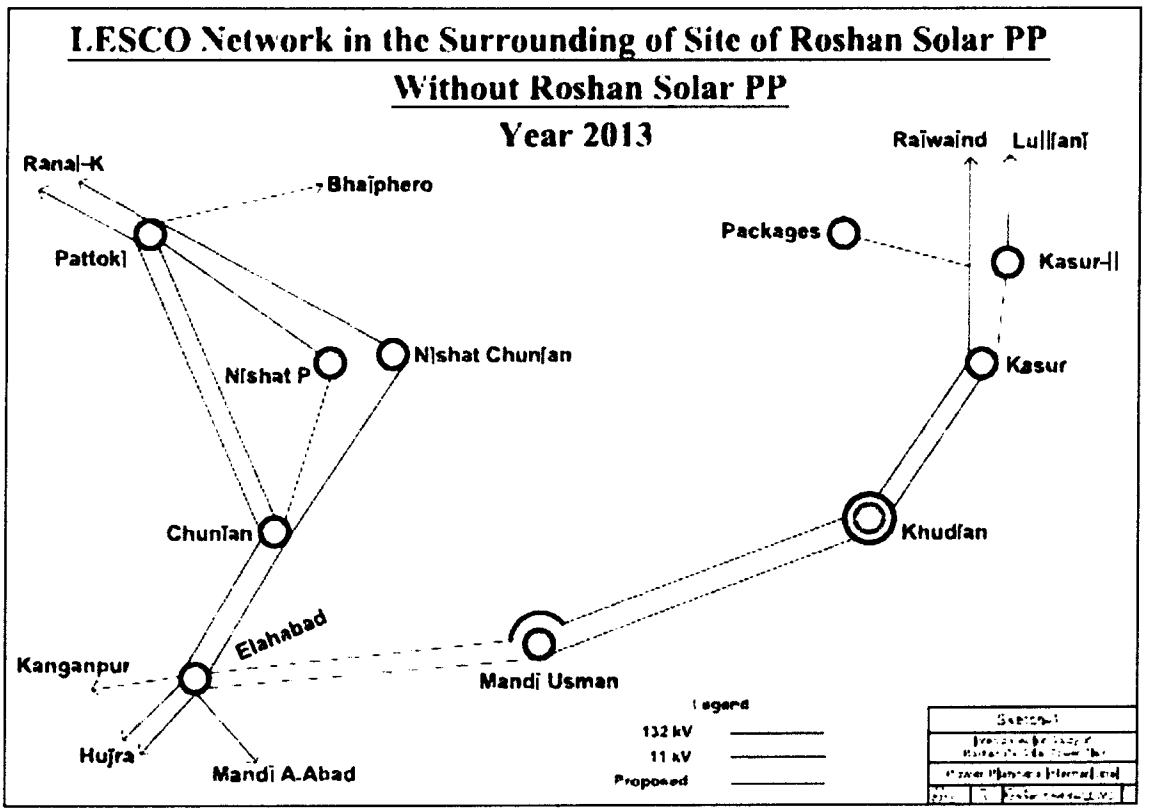


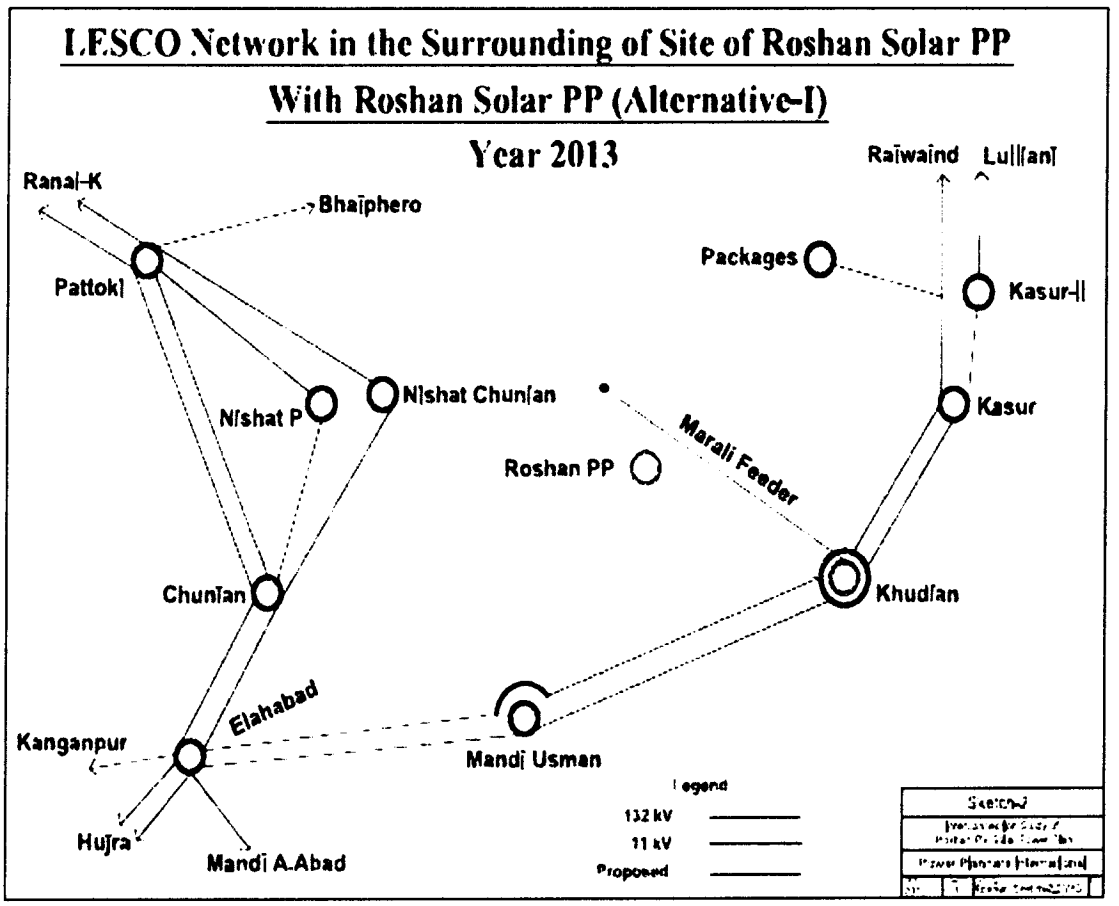
Micrositing of Solar Modules – The Plant Layout (TBEA Sunoasis)

INTERCONNECTION ARRANGEMENT FOR DISPERSAL OF POWER FROM THE SOLAR PROJECT

The electricity generated by the Project would be supplied locally to the Khundian 132/11 kV Grid and to the LESCO network through Khundian 132/11 kV.

Schematic Diagram
For Interconnection/Transmission Arrangement for Dispersal of Power from Roshan Power Pvt. Ltd




LESCO Network in the Surrounding of Site of Roshan Solar PP
With Roshan Solar PP (Alternative-I)
Year 2013
Raiwaind
Lullani
Ranal-K
Bhaiphero
Packages
Pattoki
Kasur-II
Nishat P
Nishat Chunian
Kasur
Roshan PP
Marali Feeder
Chunian
Khudian
Elahabad
Kanganpur
Mandi Usman
Hujra
Mandi A.Abad
Legend
132 kV
11 kV
Proposed

Solar project Details

(A). General Information

(i)	Name of Applicant/Company	Roshan Power (Pvt.) Ltd
(ii)	Registered Office	4th Floor, Bahria Complex 1, M.T.Khan Road Karachi-Pakistan Tel: +92-21-35611194 Fax: +92-21-35610754
(iii)	Plant Location	Kasur, Punjab pAKISTAN
(iv)	Type of Generation Facility	Solar Power

(B). Solar Power Project Capacity & Configuration

Plant Capacity (MW)	10
No of Modules in Series [Units]	22
Parallel Strings Per inverter [Units]	100
Modules per Inverter	2200
Designed Peak Power per Inverter [kW]	550
No. of Inverters	20
Total Modules [Units]	44000
Plant Capacity [kW]	11000

(C). Equipment Specifications

Solar Panel	
Module Model	TBEA 3250
Manufacturer	TBEA
Nominal Power [W]	250.00
Efficiency [%]	15.30
Power Tolerance [%]	0/+2
Cell Type	Poly-Crystalline
Open Circuit Voltage [V]	37.60
Short Circuit Current [A]	8.70
MPP Voltage [V]	30.20
MPP Current [A]	8.28
Power Coefficient of Temperature [%/C]	-0.50

Nominal Operating Cell Temperature (NOCT)	45.00
Height X Width X Thickness [mm]	1667 X 1000 X 50

Inverter Specifications	
Inverter Model	TBEA-GC-500KTL
Manufacturer	TBEA
Nominal AC Capacity	500 kW
Maximum DC input Power	550 kWp
MPP voltage range	500 V – 820 V
Maximum DC voltage	1000 V
Maximum DC current	1100 A
Nominal AC voltage	270 V – 350 V
Maximum Efficiency	0.99
European Efficiency	0.98
Operating temperature range	-30°C to +60°C
Power consumption	<50 W night time

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

(i).	Project Commissioning date (Anticipated)	March, 2015
(ii).	Expected Life of the Project from Commercial Operation date (COD)	25 Years

Total Installed Capacity of the plant (Gross ISO)	10 MW
De-rated Capacity	0.5 MW
Auxiliary Consumption	0.34 MW
Total Net Capacity of the Plant at Mean Site Conditions	9.16 MW

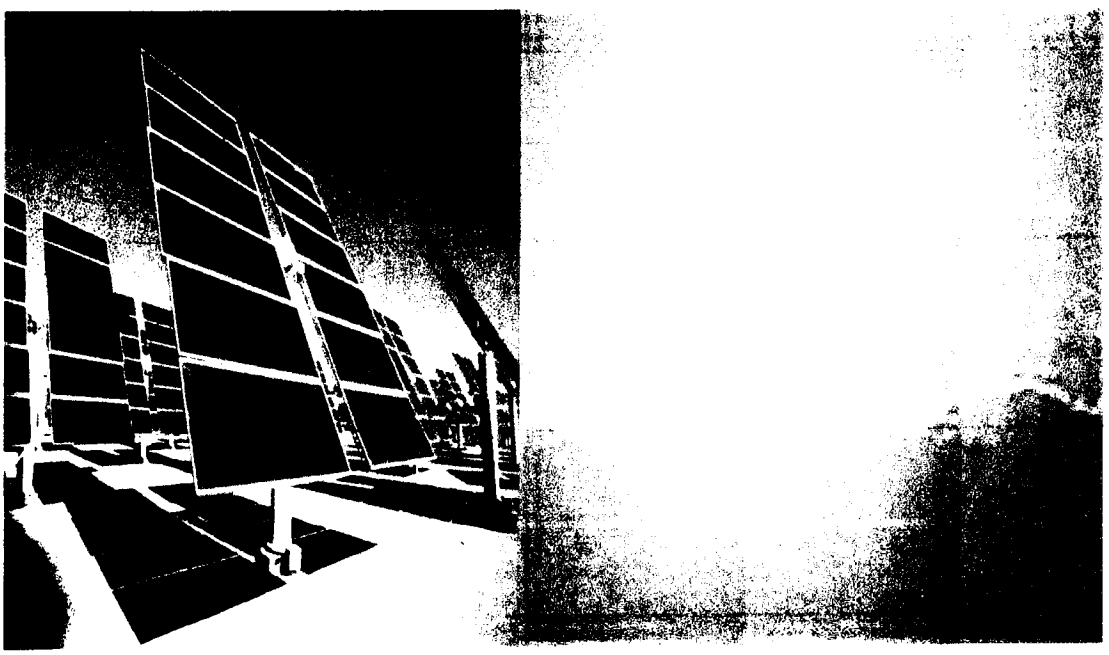
Note

All the above figures are indicative as provided by the Licensee. The Net Capacity available to NTDC for dispatch and provision to purchasers will be determined through procedures contained in the Agreements or Grid Code.

Beaconhouse School System

A PROJECT OF BEACON HOUSE GROUP

INITIAL ENVIRONMENT EXAMINATION (IEE) OF 10 MW SOLAR PV POWER PROJECT IN KASUR PUNJAB - PAKISTAN



Disclaimer Notice

The information contained in the report is meant for the purpose of Approval of project from Environment Protection Agency as per requirement of "Pakistan Environment Protection Act, 1997". Subsequently, Renewable Resources (Pvt.) Ltd (RE2) is not responsible for the contents of the report and any references therein except to the desired purpose of the report. While we have made every attempt to ensure that the information contained in the report has been obtained from reliable and up-to-date sources.

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Prepared in March, 2012

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www.renewableresources.com.pk

APPROVAL SHEET

TITLE	:	Initial Environmental Examination (IEE) of 10MW Solar PV Power Project in Kasur, Punjab-Pakistan
DOCUMENT NUMBER	:	RE2-131-113-001 Issue: 01
CLASSIFICATION	:	**UN CLASSIFIED**

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irfan@renewableresources.com.pk

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AEDB	Alternative Energy Development Board
CBD	Convention on Biological Diversity
CITES	Convention on Trade of Endangered Species
CLs	Core Labor Standards
DISCOs	Distribution Companies
db	decibel
DMC	Developing Member Countries
EIA	Environmental Impact Assessment
EHS	Environment Health and Safety
EMP	Environment Management Plan
ESMC	Environmental and Social Management Cell
EPA	Energy Purchase agreement
EMMP	Environment Monitoring and Management Plan
GAD	Gender and Development
GHG	Green house Gas Emissions
GRM	Grievance Redressal Mechanism
IA	Implementation Agreement
IEE	Initial Environmental Examination
IFC	International Finance Corporation
JICA	Japan International Cooperation Agency
Km	Kilometers
LAA	Land Acquisition Act

LOI	Letter of Intent
LOS	Law of Seas
MEA	Multilateral Environmental Agreements
MW	Mega Watt
MWh	Mega Watt Hour
MJ/sq.m	Mega Joule per square meter
NCS	National Conservation Strategy
NEP	National Environmental Policy
NEQS	National Environmental Quality Standards
NGO	Non Governmental Organization
NOx	Nitrate Oxides
NREL	National Renewable Energy Laboratories
NTDC	National Transmission and Dispatch Company
O & M	Operation and Maintenance
PEPA	Pakistan Environment Protection Act
POPs	Persistent Organic Pollutants
Pak-EPA	Pakistan Environment Protection Agency
PM	Particulate Matter
PPB	Parts Per Billion
PV	Photo Voltaic
RE2	Renewable Resources (Pvt.) Ltd
SCR	Social Complaint Register
SHEE	Safety Health Environment and Energy
SOx	Sulphate Oxides

UNFCC	United Nation Framework on Climate Change
WAPDA	Water And Power Development Authority
WHO	World Health Organization
WID	Women in Development

COMPANY CONTACT INFORMATION

Project Company	Roshan Power (Pvt.) Ltd
Sponsor / Holding Company	Beaconhouse Group
Address	10-11 Gurumangat Road Gulberg-III, Lahore Tel: +92-42-111 23 22 66 Fax: +92-42-35772027
Contact Person	Rao mahmud Ilahi, Director Energy Projects
Email	Mahmud_ilahi@hotmail.com

CONSULTANT CONTACT INFORMATION

Consultant Name	Renewable Resources (Pvt) Ltd
Address	10-11, VIP Square, I-8 Markaz, Islamabad 44000 – Pakistan
Telephone	0092 51-8358591
Fax	0092 51-8358592
Website	www.renewableresources.com.pk
Contact Person	Irfan Afzal Mirza, CEO
Email	irfanmirza@renewableresources.com.pk

EXECUTIVE SUMMARY

Introduction:

Roshan Power (Pvt.) Ltd is a project company owned by Beaconhouse Group, for setting up Solar PV Power Projects of 10 MW in Kasur, Punjab Pakistan. Roshan Power got LOI in 2011 from Punjab Power Development Board as per Punjab Power Generation Policy year 2006, Revised 2009. Roshan Power (Pvt.) Ltd is owned by Beaconhouse Group, which is one of the largest school networks of its kind in the world. Beaconhouse Group is involved in a range of education, infrastructure and technology products.

The report is ***Initial Environmental Examination (IEE)*** for submission to Environment Protection Agency (EPA)-Punjab as per Pakistan Environment Protection Act, 1997.

Sponsor's Introduction:

Roshan Power (Pvt.) Ltd is owned by Beaconhouse Group, which is one of the largest school networks of its kind in the world. Beaconhouse Group is involved in a range of education, infrastructure and technology products.

The Beaconhouse group has over 195,000 full-time students in nine countries, established in 1975, Beaconhouse has since grown into an international network of private schools imparting distinctive and meaningful learning to students all the way from birth –through its partnership with Gymboree play and music- to post graduation, through the Beaconhouse National University in Lahore.

The Beaconhouse of today is thus much more than just a stand-alone school. Through distinct and independent divisions in the UK, Malaysia, Indonesia, Thailand, Philippines, Oman, UAE, Pakistan and Bangladesh, it caters to the education and training needs of a large and diverse group of individuals of varying ages, socio-economic backgrounds, and nationalities, with its activities also extending beyond education in some countries. Beaconhouse Group owns Beaconhouse School Systems, The Educators, the Discovery Centre, Beaconhouse National University, TNS Beaconhouse, The early years, Beacon Energy Limited, Premier Trading Services, and Premier Bus Services.

Consultant's Introduction:

Renewable Resources Pvt. Ltd is the consultant of Roshan Power Pvt. Ltd for project development of this project. RE2 provides consultancy services in the fields of Renewable Energy (RE), Energy Efficiency (EE) and Environment. RE2 provides high quality energy engineering and management consulting services to enable rapid deployment of efficient, cost-effective, reliable, and environment-friendly renewable energy systems.

The consultant responsible for this assignment is well comprehended with the renewable energy power projects; including the environmental studies. So far so forth, the Consultant has achieved 05 approvals of IEE studies from the concerned EPAs for renewable energy power project.

Apart from above, the consultant already has a few projects under its credentials to have passed through various stages of development and requisite approvals including complete feasibility study and the security documents. It's a ONE STOP SHOP for the development of renewable energy projects including to act as Owner's Engineer as well as Lender's Advisor.

The Consultant has experience of working in projects of international stature with teams coming from multinational organizations.

Study Methodology:

The study was conducted using standard methodology prescribes by national and international agencies. The IEE comprises of baseline data on existing conditions on physical and biological environment, and social environment together with the anticipated environmental impacts and proposed mitigation measures. Detailed assessment of the social and biological environment of the area was conducted through field survey for the distance up to 10 Km radius of the project site, however the influence zone of the environmental impacts is considered as 5 Km.

Data was also collected through secondary sources such as published literature and internet to support the findings of the field survey.

The present document reports the finding of Initial Environmental Examination (IEE) carried out to identify potential environmental issues associates with the project and ensures appropriate mitigation measures to cope with those issues.

The IEE report stands on following strings:

- Relevant Project Information
- Project Alternatives
- Baseline Environmental Conditions
- Possible Impacts
- Mitigation Measures
- Environment Management Plan

Statutory Requirements:

The report fulfils the following regulatory requirements

- Guidelines published by Pakistan Environmental Protection Agency (Pak-EPA),
- Asian Development Bank Polices and Guidelines
- Performance Standards of IFC and World Bank group
- The best practices followed at international level.

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During the IEE, the project potential social and environmental impacts were identified. Each identified impact was then characterized with respect to its nature, reversibility, geographical extent, consequence-severity and likelihood. Based upon this characterization, the impacts were then assessed to be of high, medium or low significance. The key potential environmental and social issues identified during the study included contamination of soil and water, safety hazards, damage to infrastructure, air quality deterioration, noise emissions, threat to wildlife and habitat modification. Similar impacts during the plant operation were identified; these included soil and water contamination, safety hazards, species mortality, habitat modification, noise and vibration. The IEE has recommended appropriate mitigation measures to address the above concerns, and to keep the residual impacts within acceptable limits.

Environmental Management Plan

An Environmental Management Plan (EMP) had been developed to provide an implementation mechanism for the mitigation measures mentioned above and has been updated in the light of the EPA decision circumstances. The EMP provides the organization structure for the environmental and social management system during the project, and defines the roles and responsibilities of project players. The EMP includes a mitigation plan, a monitoring plan, the communication and documentation requirements, and training needs, in the context of the environmental and social management of the project.

Finding and Recommendation

The Project will not cause any significant lasting environmental and social impacts. The environmental disturbance normally associated with construction activities will be minimized through an EMP, implementation of which will continue during EPC and which includes monitoring arrangements. As solar PV technology is a clean energy source with no significant impacts on the environment and no GHG gas emissions after the construction phase, therefore, there will be no need for frequent environmental monitoring once the project is operational. If

there will be any major negative environmental impact noticed during operation of the project, possible mitigation measures will be taken to reduce the impact.

SECTION 1

INTRODUCTION AND PURPOSE OF STUDY

1 INTRODUCTION AND PURPOSE OF STUDY

1.1 PROJECT PROPONENT

Roshan Power (Pvt.) Ltd is owned by Beaconhouse Group, which is one of the largest school networks of its kind in the world. Beaconhouse Group is involved in a range of education, infrastructure and technology products.

The Beaconhouse group has over 195,000 full-time students in nine countries, established in 1975, Beaconhouse has since grown into an international network of private schools imparting distinctive and meaningful learning to students all the way from birth –through its partnership with Gymboree play and music- to post graduation, through the Beaconhouse National University in Lahore.

The Beaconhouse of today is thus much more than just a stand-alone school. Through distinct and independent divisions in the UK, Malaysia, Indonesia, Thailand, Philippines, Oman, UAE, Pakistan and Bangladesh, it caters to the education and training needs of a large and diverse group of individuals of varying ages, socio-economic backgrounds, and nationalities, with its activities also extending beyond education in some countries. Beaconhouse Group owns Beaconhouse School Systems, The Educators, the Discovery Centre, Beaconhouse National University, TNS Beaconhouse, The early years, Beacon Energy Limited, Premier Trading Services, and Premier Bus Services.

1.2 PROJECT BACKGROUND AND JUSTIFICATION

Pakistan's major electricity sources are thermal and hydro generation, meeting approximately 70% and 28% (respectively) of the country's annual electricity demand. The primary thermal generation fuels employed are furnace oil and gas. While both are produced domestically, demand already outstrips supply by a considerable amount. Oil import is a significant burden on the national exchequer and the increasing import bill continues to exert further pressure on the foreign exchange reserves. Electricity mix of Pakistan (2009-2010 is presented in **Figure 1.1**.

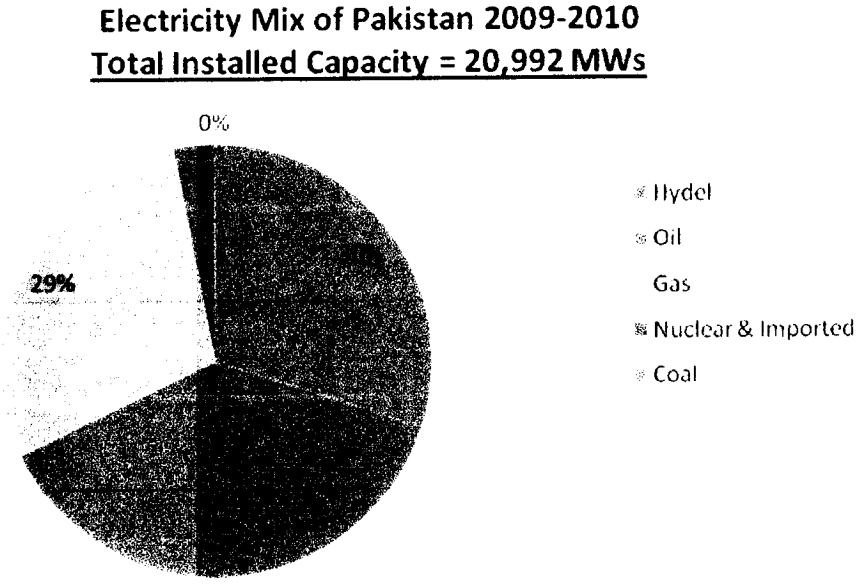

Figure 1.1: Electricity Mix of Pakistan by Source[1]

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

[1] Energy Year Book of Pakistan 2010

Alternatives to further fuel imports for electricity generation are the use of domestic coal, or generation from hydro-electric or other renewable sources, such as wind and solar power.

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

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

Solar energy, on the other hand, has excellent potential in areas of Pakistan that receive high levels of solar radiation throughout the year. Every day, for example, the country receives an average of about 19 Mega Joules per square meter of solar energy

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

To summarize, the sun shines for 250-300 days per years in Pakistan with an average sun shine hours of 8-10 per day. This gives huge amount of energy to be used for electricity generation by solar thermal power plants.

A quick idea for the potential of solar energy in Pakistan can be obtained from the satellite map of solar radiation released by National Renewable Energy Lab (NREL) of USA shown in **Figure 1.2.**

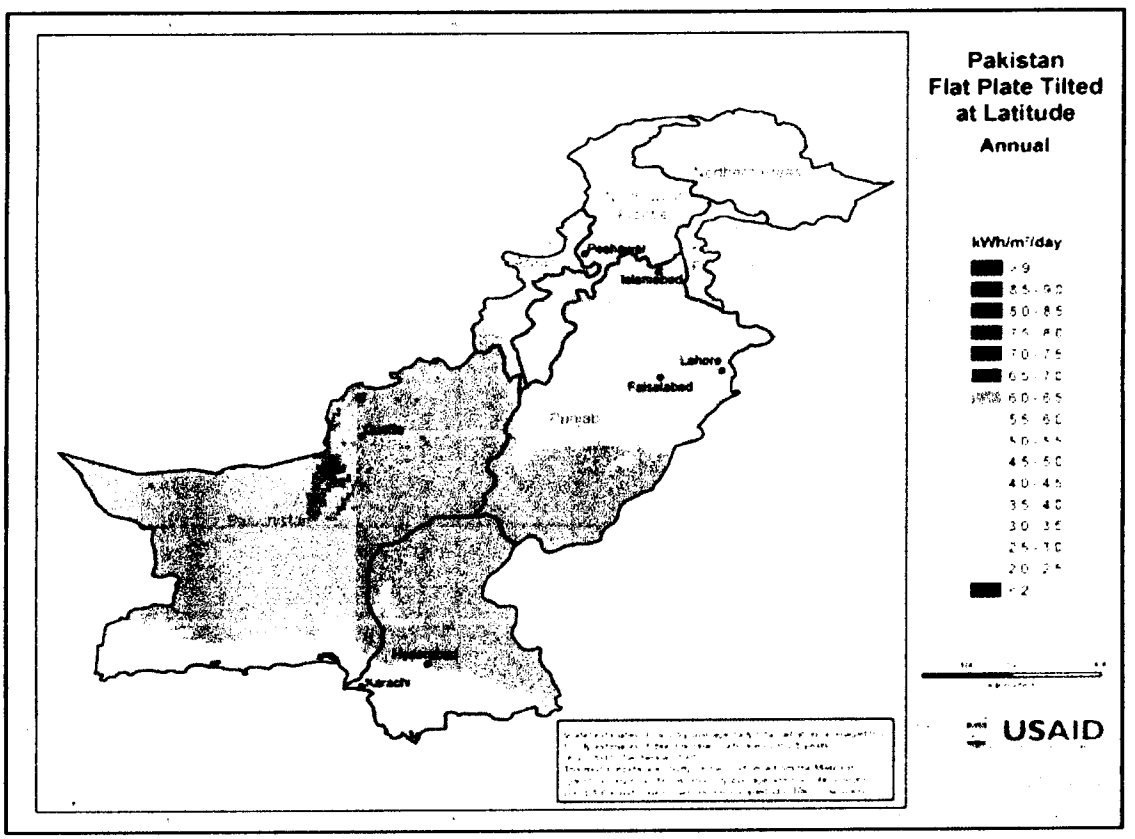

Figure 1.2: NREL Solar Map Of Pakistan

1.3 PROJECT OVERVIEW AND OBJECTIVES

Roshan Power got LOI from PPDB in year 2011 to develop 10 MW solar PV power project in the area of Khudian Khas, Kasur Punjab Pakistan.

The land area of about 315 acres is owned by the project owners, out of which area of 48.6 acres is selected for the implementation of 10 MW solar PV project.

The proposed project brings in multifold advantages. Not only does it produce clean, pollution free energy, it also has the capacity to provide employment to the people living around the area. It has the capacity of turning the area into clean energy producing hub which will be emulated in other areas of the country.

The brief overview of project is summarized in **Table 1.1** below;

Table 1.1: Project at a Glance

S. No	Particulars	Description
1	Project Site	Kasur, Province Punjab-Pakistan
2	Land Available for project	48.6 Hectares
3	Project Capacity	10MW
4	Total number of Solar PV modules to be installed	35000-40000
6	Estimated Project Cost (PKR)	33,771,137

The overall objectives of the project are;

i. Contribute to meeting the electricity supply deficit in project area in particular; and country in general.

ii. By using indigenous renewable resources of power generation, avoid depletion of natural resources for future generation and environmental stability.

iii. Contribute to improved electricity supply service delivery to a limited extent specifically having a wide rural outreach.

iv. Improve microeconomic efficiency of the power sector by reducing fossil fuel usage.

v. Reduce greenhouse gas emissions from power generation and contribute to negligible emission, effluent, and solid waste intensity of power generation in the system.

vi. Conserve natural resources including land, forests, minerals, water, and ecosystems.

vii. Develop the local economy and create employment, particularly in rural areas and in a district that is designated a backward area, a priority concern of the Government of Pakistan.

1.4 NEED AND OBJECTIVES OF IEE STUDY

Pakistan Environmental Protection Act 1997 (PEPA 1997) requires the proponents of every development project in the country to submit either an Initial Environmental Examination or Environmental Impact Assessment to the concerned environmental protection agency.

The IEE/EIA Regulations 2000 issued under PEPA 1997 provides separate lists for the projects requiring IEE or EIA. Since the total power generation capacity of proposed project is less than 50 MW, therefore IEE study is performed. Also in various meeting organized by AEDB, EPA, UNEP, it was agreed to follow the same criteria for IEE or EIA as stipulated for thermal and hydro projects.

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

In the context of the scope of the project, the IEE report has addresses the following objectives, where applicable;

The purpose of Initial Environmental Examination (IEE) is to identify the reasonably foreseeable environmental effects of the activities that will be conducted under this project;

- Category of the project consistent with Pakistan Environmental Protection Act, 1997
- Highlight baseline environmental and social conditions of the project area along with identification of environmentally sensitive area and concerned stakeholders
- Relevant host country laws, regulations, applicable treaties and agreements
- Protection of human health, cultural properties and biodiversity including endangered species and sensitive ecosystems
- Major hazards; Occupational health and safety; Fire prevention and life safety
- Socio-economic impacts; Land use: Land acquisition; Involuntary resettlement
- Impacts on indigenous peoples and communities; if applicable
- Cumulative impacts of existing, proposed and anticipated future projects
- Efficient production, delivery and use of energy; and
- Pollution prevention and waste minimization, pollution controls (liquid effluent and air emissions) and solid and chemical waste management
- GHG reduction potential

1.5 APPROACH AND METHODOLOGY

The IEE comprises of baseline data on existing conditions on physical and biological environment, and social environment together with the anticipated environmental impacts and proposed mitigation measures. Detailed assessment of the social and biological environment of the area was conducted through field survey for the distance up to 10 Km radius of the project site, however the influence zone of the environmental impacts is considered as 5 Km.

Data was also collected through secondary sources such as published literature and internet to support the findings of the field survey.

The overall methodology and main phases of the IEE are briefly given below;.

1.5.1 Scoping

The key activities of this phase included:

Project Data Compilation: A generic description of the proposed activities relevant to environmental assessment was compiled. A list of potential environmental well as social issues was developed. A stakeholder analysis was carried out for the consultation carried out subsequently.

Published Literature Review: Secondary data on weather, soil, water resources, wildlife, and vegetation were collected from internet, published literature and books. The data was then reviewed and compiled.

Legislative Review: Information on relevant legislation, regulations, guidelines, and standards was reviewed and compiled.

Identification of Potential Impacts: The information collected in the previous steps was reviewed and potential environmental and social issues identified.

Baseline Data Collection: A considerable amount of baseline information on the project area was available from existing literature and other studies conducted close to the project area. A field visit was conducted to verify and collect primary data on the site alternatives.

A questionnaire was developed and views of local inhabitants were taken about the solar power project.

3.3 Impact Assessment

The environmental, socioeconomic, and project information collected was used to assess the potential impacts of the proposed activities. The issues studied included potential project impacts on:

- Geomorphology
- Groundwater and surface water quality, with particular reference to the coast
- Ambient air quality and ambient noise levels
- Ecology of area, including flora and fauna
- Local communities
- Noise impact
- Visual Impact

Wherever possible and applicable, the discussion covers the following aspects:

- The present baseline conditions
- The potential change in environmental parameters likely to be effected by project related activities
- The identification of potential impacts
- The evaluation of the likelihood and significance of potential impacts
- The defining of mitigation measures to reduce impacts to as low as practicable
- The prediction of any residual impacts, including all long-term and short-term; direct and indirect; beneficial and adverse impacts
- The monitoring of residual impacts
- An Environment Management Plan (EMP) for the mitigation measures identified during the project

3.4 Documentation

This report documenting the IEE process and results is prepared according to the relevant guidelines set by the Pakistan Environment Protection Agency (Pak-EPA).

Chapter 1 gives the overview of project introduction and purpose of the IEE study. **Chapter 2** discusses the ADB policies and standards, as well as the regulatory, legislative and institutional setup in the country, relevant to the environmental and social assessment. **Chapter 3** provides a simplified description of the proposed project and its components. The project alternatives are discussed in **Chapter 4**. The environmental and social baseline conditions of the project area are presented in **Chapter 5**. The stakeholder consultation has been covered in **Chapter 6**. The environmental and socioeconomic impacts of the project are assessed and their respective mitigations recommended in **Chapter 7**. **Chapter 8** outlines the implementation mechanism for the mitigation measures, in the form of an environmental management plan. Finally, **Chapter 9** presents the findings and conclusion of the study.

1.6 METHOD FOR EVALUATING IMPACT

The description of baseline conditions represents the basis for evaluating the impacts of the project. The description and evaluation of the environmental impacts and proposals for measures to be taken to mitigate and compensate for any determined environmental impacts during construction and operation phase are presented in Environment Management Plan (EMP) (Annexure-I). In the interest of transparent presentation and evaluation, tabulated evaluation procedures have been applied. On the basis of a point system, the severity of a particular environmental impact together with its general trends i.e. negative or positive is described. The evaluation scale applied is as follows


=High


=Medium


=Low


=No Impact


=Locally Favorable


=Regionally Favorable

For this judgment, international and national standard like those of the World Bank, WHO, etc are used. According to these standards, impacts are evaluated as follows;

High	International and national standards are exceeded.
Medium	Between international and national standards
Low	International and national standards are met

Beaconhouse School System

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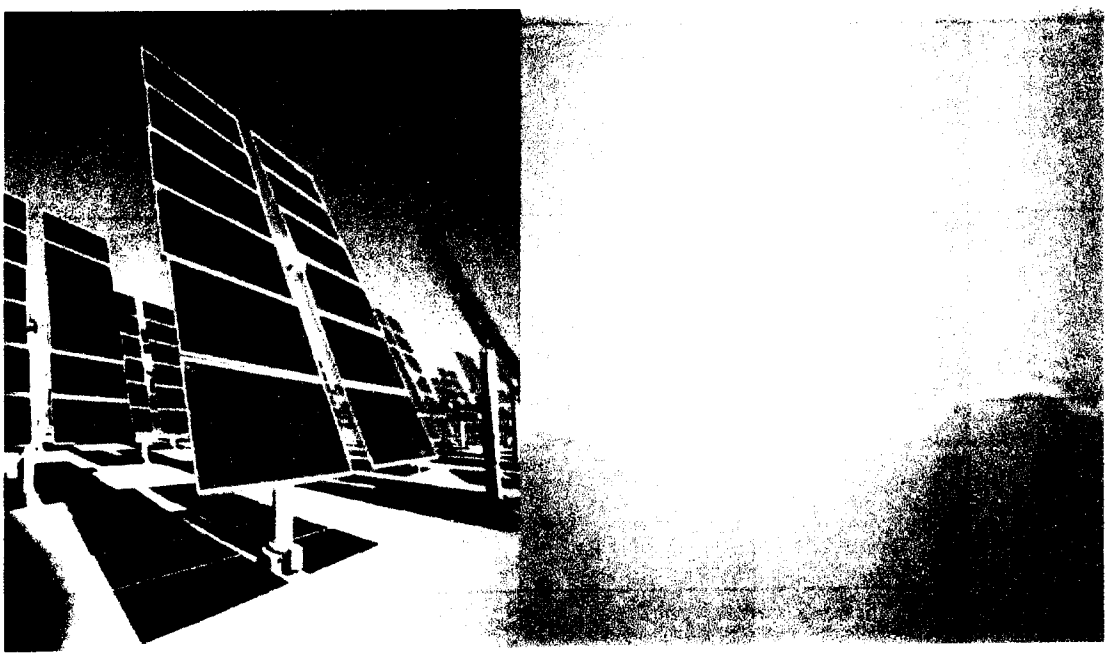
RE

A PROJECT OF BEACON HOUSE GROUP

FEASIBILITY STUDY OF 10 MW SOLAR PV POWER PROJECT IN KASUR PUNJAB - PAKISTAN



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APPROVAL SHEET

TITLE : Feasibility Study of 10 MW Solar PV Power Project In Kasur-Punjab, Pakistan

DOCUMENT NUMBER : RE2-141-113-001 Issue: 01A

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LIST OF ABBREVIATIONS

AC	Alternate Current
AEDB	Alternative Energy Development Board
BOM	Bill of Material
CDM	Clean Development Mechanism
CERs	Carbon Emission Reduction
CFCs	Chloro Fluoro Carbons
cm	Centimeter
CO2	Carbon dioxide
COD	Commercial Operation Date
COP	Conference of Parties
CPPA	Central Power Purchasing Agency
DC	Direct Current
DISCOs	Distribution Companies
EE	Energy Efficiency
EMP	Environment Management Plan
EPA	Energy Purchase Agreement
EPC	Engineering Procurement Construction
EPRI	Electric Power Research Institute
EU	European Union
GDP	Gross Domestic Product
GHG	Green House Gas
GIS	Geographic Information System
GWh	Giga Watt Hour
GoP	Government of Pakistan

HESCO	Hyderabad Electric Supply Company
HSD	High Speed Diesel
HSE	Health Safety and Environment
IA	Implementation Agreement
ICB	International Competitive Bidding
IEE	Initial Environmental Examination
IPPs	Independent Power Producers
JI	Joint Implementation
KESC	Karachi Electric Supply Company
km	Kilometer
kV	Kilovolt
KWh	Kilowatt Hour
LOI	Letter of Intent
LPG	Liquified Petroleum Gas
LOS	Letter of Support
m^2	Meter square
MTDF	Medium Term Development Framework
MW	Megawatt
N_2O	Nitrous Oxide
NCS	National Conservation Strategy
NEPRA	National Electricity Power Regulatory Authority
NEQS	National Environmental Quality Standards
NOCs	No Objection Certificates
NREL	National Renewable Energy Laboratories
NTDC	National Transmission and Dispatch Company
O & M	Operation & Management
PAEC	Pakistan Atomic Energy Commission

PEPA	Pakistan Environment Protection Act
PMD	Pakistan Meteorological Department
PPDB	Punjab Power Development Board
PPI	Power Planners International
PSCAD	Power System Computer Aided Design
RE	Renewable Energy
RE2	Renewable Resources (Pvt) Ltd
RFP	Request for Proposal
SEC/SCECO	Saudia Electric Company
WAPDA	Water And Power Development Authority
TSML	Tawairqui Steel Mills Limited
TL	Transmission License

ACKNOWLEDGEMENTS

The management of Roshan Power is thankful to Punjab Power Development Board (PPDB) for generous support at all stages of project development and looks forward to get the same support in future milestones.

The management also recognizes the cooperation of Government of Punjab and other Government departments (NEPRA, NTDC / LESCO) which shall be required at further stages of project.

DISCLAIMERS

This document is intended for use for effective decision making regarding this Project. Reliance on this document for any other purpose would not be suitable. The Company and the Sponsors are not responsible for any decision made by the intended users for any other purpose. The Company and the Sponsors are also not responsible for any decision made by any other person or party not being an intended user of this document whether related to this project or not without written consent of the Company or Sponsors in this regard. Further, this is not intended to be a business or operational plan for the project. Also, RE2 shall take responsibility of this report in its original form and contents "as a whole" only; and shall not be responsible for any kind of modification of this report and any text, photograph or illustrations which are extracted from this report.

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DOCUMENT INFORMATION

Purpose and Scope:

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

Structure of the Document:

This document has been divided into following main parts:

- Part 1: Executive Summary
- Part 2: Country and Industry Overview
- Part 3: Technical Feasibility

Each part is further sub-divided into chapters. Information in the document is supplemented by Annexes.

PART 1

EXECUTIVE SUMMARY

1 EXECUTIVE SUMMARY

Located on the western stretch of the South Asian Continent, Islamic Republic of Pakistan is largely under the influence of tropical desert climate.

Government of Pakistan has formulated a policy to standardize and encourage the participation of private sector in the development and application of renewable energies. A Government organization, called Alternative Energy Development Board (AEDB), is established to facilitate the implementation of renewable energy projects. Likewise, the provincial governments are also standing upto the objective with Punjab making significant efforts through Punjab Power Development Board (PPDB).

Punjab Government has announced its policy called "Punjab Power Generation Policy, 2006 (Revised, 2009)" and PPDB has issued several Letter of Intents (LOIs) under the policy. The LOI to Roshan Power was issued on 23rd May, 2011.

Roshan Power has opted to invest in the project of 10 MW installed capacity. The Site is located in District Kasur at approx 80 Km from Lahore. The site of 48 acres of flat piece is inside an agricultural land owned by the Project Company and is perfectly suitable for solar installation.

At present, this is going to be the first bankable feasibility study of a Solar IPP submitted to PPDB.

This document is the complete feasibility study of the project including but not limited to technical feasibility having main components such as soil investigations, transportation and access, solar resource assessment, energy yield estimates, initial environment examinations, electrical and grid interconnection studies. An earlier version of the document was developed using the EPC costs based on the proposals received from the bidders. This particular version of the document has been prepared using the EPC offer of TBEA SunOasis and the subsequent MoU signed with the client.

1.1 PROJECT OVERVIEW

1.1.1 Project Size

The project is of 10 MW capacity and shall deploy crystalline PV modules.

1.1.2 Project Status and Calendar

The project has completed following milestones till now:

Table 1-1: Milestones achieved by the Project

Item	Status	Remarks
Site Acquisition	Done	Self Owned Land
Installation of Solar Mast	Done	International Standard
Hiring of Consultants	Done	NIL
Hiring of Legal Counsel	Done	NIL
Site Selection and Access Studies	Done	NIL
Solar Resource Assessment	Done	NIL
Energy Yield Estimates	Done	03 EPC Offers
Soil Investigations	Done	NIL
Electrical and Grid Interconnection Studies	Done	NIL
Initial Environmental Examination	Done	NIL
RFP for EPC and Receiving of Bids	Done	NIL
EPC Selection	Done	NIL
Submission of Feasibility Study	Done	Being Submitted
Tariff Determination	Pending	Stage not reached
EPA and IA	Pending	Stage not reached
Financial Close	Pending	Stage not reached

The complete feasibility study is being submitted. From here onwards, the Project shall pursue approval of feasibility and its all parts from the concerned stakeholders. In parallel, the Project shall also pursue determination of tariff and signing of EPA / IA.

Table 1-2: Project Planned Milestones

Activity / Milestone	2012				2013				2014			
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1ST QTR	2ND QTR	3RD QTR	4TH QTR
Submission of Feasibility Study												
Approval of Feasibility Study												
Approval of Grid Studies												
Tariff Determination												
Signing of EPA												
Signing of IA												
Financial Close												
Project Construction												
Project COD												

The project construction shall take 12 months from the date of financial close till the COD.

Table 1-3: Project Construction Scheduling

Activity / Month	1	2	3	4	5	6	7	8	9	10	11	12
Engineering Design and Mobilization												
Import of Hardware and Equipment												
Fabrication of Steel Structures												
Site Civil Works												
Installation of Solar Power Equipment												
Cables and Interconnections												
Grid Connectivity												
Commissioning and Testing												

1.1.3 Project Site

The Project Site is located in the self owned land of Sponsors in district Kasur at approx 80 Km from Lahore.

The details of Site are given in **Section 10** of the feasibility study. The site selection and access study is attached as **Annex I** of the feasibility study.

1.1.4 Solar Resource Assessment

The solar resource assessment is explained in **Section 11** of the feasibility study.

1.1.5 Selection of EPC Contractor

The information of EPC contractor is given in **Section 12** of the feasibility study.

1.1.6 Geological Conditions

The information of geological conditions is given in **Section 13** of the feasibility study.

1.1.7 Civil Engineering Design

The information of civil engineering design is given in **Section 14** of the feasibility study.

A complete soil investigations report is attached as **Annex II** of the feasibility study.

1.1.8 Electrical Engineering Design

The information of electrical engineering design is given in **Section 15** of the feasibility study.

A complete electrical and grid interconnection study is attached as **Annex III** of the feasibility study.

1.1.9 Mechanical Engineering Design

The information of mechanical engineering design is given in **Section 16** of the feasibility study.

1.1.10 Construction Management

The information of construction management and schedules is given in **Section 17** of the feasibility study.

1.1.11 O&M Management

The information of O&M management is given in **Section 18** of the feasibility study.

1.1.12 Environmental Management

The information of environmental management is given in **Section 19** of the feasibility study.

A complete Initial Environmental Examination (IEE) report is attached as **Annex IV** of the feasibility study.

1.1.13 Key Project Figures

Table 1-4: Key Project Figures

Item	Value	Remarks
Project Site	Kasur	Self Owned Land
Debt to Equity Ratio	75:25	NIL
Debt Term	10 + 08 years	NIL
Debt Repayment	Quarterly	NIL

1.2 LIST OF ANNEX

ANNEX – I: **Site Selection and Access Study**
ANNEX – II: **Soil Investigation Report**
ANNEX – III: **Electrical and Grid Interconnection Study**
ANNEX – IV: **Initial Environmental Examination**

1.3 PROJECT TEAM

1.3.1 Roshan Power (Pvt) Ltd – Project Company

Roshan power (Pvt.) Ltd is owned by Beaconhouse Group (BHG), which is one of the largest school networks of its kind in the world. BHG is involved in a range of education, infrastructure and technology products.

Since its inception in 1975, BHG has been a market leader in non-traditional businesses. At a time when the education sector was just opening up to private enterprise, BHG was the pioneer in setting up private schools, and is now the market leader. Its educational network, starting in 1975 as a Montessori for small children, is now the largest of its kind anywhere in the world. Beaconhouse received international recognition in 1996 when the International Finance Corporation (IFC) made a $10million loan to the company.

The Beaconhouse group has over 195,000 full-time students in nine countries. Beaconhouse has since grown into an international network of private schools imparting distinctive and meaningful learning to students through its partnership with Gymboree play and music to post graduation, through the Beaconhouse National University in Lahore.

The Beaconhouse of today is thus much more than just a stand-alone school. Through distinct and independent divisions in the UK, Malaysia, Indonesia, Thailand, Philippines, Oman, UAE, Pakistan and Bangladesh, it caters to the education and training needs of a large and diverse group of individuals of varying ages, socio-economic backgrounds, and nationalities, with its activities also extending beyond education in some countries. Beaconhouse Group owns Beaconhouse School Systems, The Educators, the Discovery Centre, Beaconhouse National University, TNS Beaconhouse, the early years, Beacon Energy Limited, Premier Trading Services, and Premier Bus Services.

The group also has a history of successfully developing a 50 MW wind power project in Sindh, which the group ultimately sold to Fauji Foundation. The group is also developing a 10 MW Solar PV Power Plant in Punjab.

1.3.2 Renewable Resource (Pvt) Ltd – Owner's Engineer

(www.renewableresources.com.pk)

Renewable REsources(RE2) is the overall Project Consultant and the Owner's Engineer to coordinate all the project development activities. The scope of work for RE2 in Project includes the feasibility study (including resource studies and energy yield estimates), tariff approval and technical negotiations of EPA / IA.

RE2 provides consultancy services in the fields of Renewable Energy (RE), Energy Efficiency (EE) and Environment. RE2 offers services for "green" business innovation, customer education, project appraisal, project planning, design and management, development of feasibility studies and environmental studies, as well as client-specific research & surveys. The company has been incorporated as a private limited company in Pakistan under Companies Ordinance 1984.

RE2 provides high quality energy engineering and management consulting services to enable rapid deployment of efficient, cost-effective, reliable, and environment-friendly renewable energy systems. Our customized technical solutions and services are dedicated to investment firms, energy groups, industries, financing institutions and public authorities involved in the development and/or acquisition of renewable and thermal power plants.

In the area of project development, RE2 possesses the entire, necessary expertise including power production analysis, selection of technology / power equipment, comprehensive bankable feasibility, government approvals, overseeing / monitoring the EPC activities etc. For conducting feasibility studies, RE2 has the capabilities to conduct site based investigations like soil analysis, surface contouring, grid evaluation etc.In addition to planning, RE2 also covers the economics, i.e. the project financial model and subsequent generation cost of leading upto tariff in terms of value per kWh.

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

The RE2 team also has the expertise to deal with the legal aspects of power projects including Generation License, Tariff Application & justification, Energy Purchase Agreement and Implementation Agreement. The professional team of RE2 is well acquainted with the policies, regulations, methodologies and standards of the complete power projects cycle.

1.3.3 Power Planner International (PPI) – Electrical and Grid Studies

(www.powerplannersint.com)

PPI performed the electrical and grid interconnection studies of the project.

PPI has the honor to undertake electrical studies of all the renewable power projects in Pakistan. PPI has a team of highly skilled and experienced professionals having worked in WAPDA, Pakistan; and Saudi Electricity Company (SEC or SCECO) in Saudi Arabia in the fields of Power System Analysis, Transmission Planning, Load-Forecasting and Generation Planning. The professional experience spreads over the whole range of operating voltages viz. 765 kV, 500 kV, 380 kV, 220 kV, 132 kV, 110 kV, 66kV and 33kV.

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

The professionals of PPI possess thorough hands-on experience on the latest, state-of-the-art tools of power system analysis including PSS/E of Siemens-PTI, PSCAD/EMTDC of EPRI and Manitoba HVDC Research Center.

1.3.4 Geo Research – Soil Investigations and Topographic Map

Geo Research is a Pakistani based company located in Lahore and has undertaken the Geo Technical Studies for this Project.

1.3.5 Orr, Dignam & Co – Legal Counsel

(www.orrdignam.com)

Orr, Dignam and Co is one of the oldest and largest corporate commercial law firm in Pakistan and has been hired as the legal counsel of the project.

PART 2

COUNTRY AND INDUSTRY OVERVIEW

2 COUNTRY PROFILE

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

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

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

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

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

The country has a total area of 796,940 km^2 and is nearly four times the size of the United Kingdom. From Gwadar Bay in south-eastern corner, the country extends more than 1,800 km to the Khunjerab Pass on China's border.

3 PAKISTAN ENERGY MARKET[1]

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

Production of crude oil per day has decreased to 64,948 barrels during 2009-10 from 65,845 barrels per day during the same period last year, showing a decline of 1.36 percent. The overall production of crude oil has decreased to 23.7 million barrels during July-March 2009-10 from 24 million barrels during the corresponding period last year, showing a decline of 1.25 percent. On an average, the transport sector consumes 46.3% of the petroleum products, followed by power sector (46.1%), industry (5.1%), household (0.5%), other government (1.7%), and agriculture (0.3%) in the year 2009-10.

The average production of natural gas per day stood at 4,063 million cubic feet during July-March, 2009-10, as compared to 4,002 million cubic feet over the same period last year, showing an increase of 1.52%. The overall production of gas has increased to 1,482,847 million cubic feet during July-March 2009-10 as compared to 1,460,679 million cubic feet daily in the same period last year, showing an increase of 1.5%. On average, the power sector consumes 28.7% of gas, followed by fertilizer (17.2%), industrial sector (26.1%), household (17.2%), commercial sector (2.9%) and cement (0.2%) during period 2009-10. Total installed capacity of electricity (WAPDA, KESC, KANUPP AND IPPs) stood at 20,922 MW during July-March 2009-10, compared to 19,786 MW during July-March 2008-09. Total installed capacity of WAPDA stood at 11,344 MW as of June 2010, of which, hydel accounts for 6,481 MW, thermal accounts for 43.1 percent or 4,900 MW.

[1] Pakistan Energy Year Book, 2010

Primary energy supply by sources is shown below:

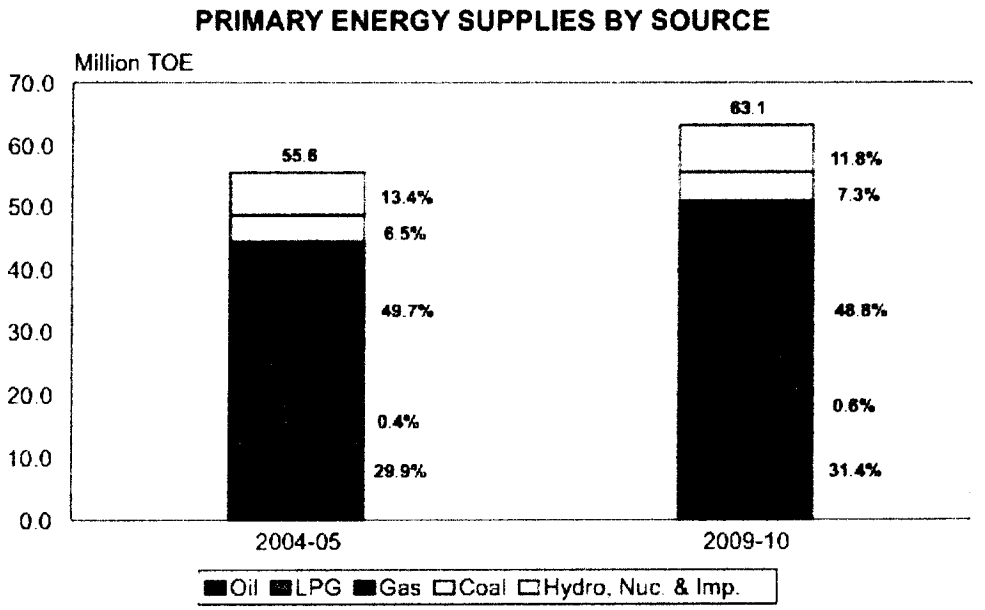


Figure 3-1: Primary Energy Supplies by Source[2]

[2] Pakistan Energy Yearbook, 2010

Punjab is the most populous province of Pakistan with highest energy consumption among all provinces. In the current political scenario of Pakistan, where the concept of provinces sovereignty is emerging, each province must be independent to fulfill the energy requirements of its own. It is the need of the hour that the hidden potentials of renewable energy technologies must be explored and utilized.

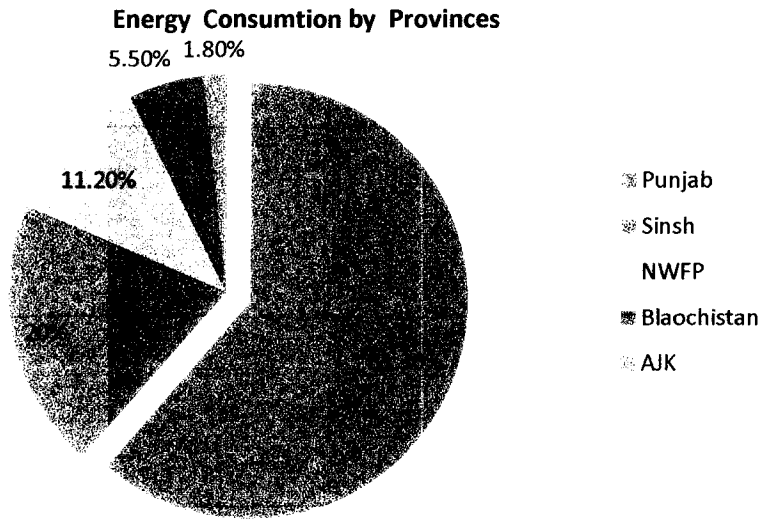


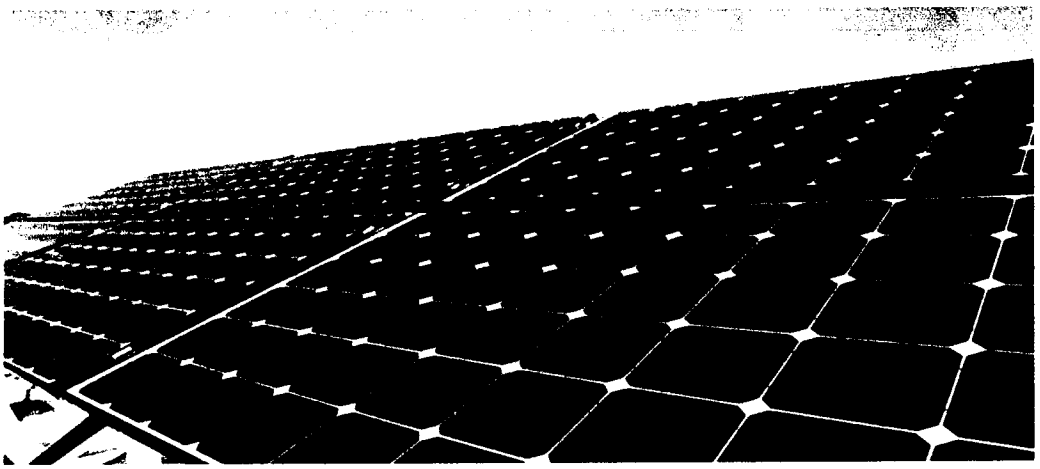
Figure 3-2: Energy Consumption by Province

Report No. PPI-38.3-Final/13

INTERCONNECTION STUDY

For

10 MW Solar PV Power Project by Roshan Power at Kasur, Punjab



Final Report
(24-1-2013)

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Executive Summary

- Three Interconnection Schemes have been devised for the Interconnection of 10 MW Roshan Solar Power Plant. Two of these schemes, referred to as Alternative-I and Alternative-II in this report, propose evacuation of power on 11 kV while the third scheme, referred to as Alternative-III in this report, has been developed after incorporating the comments of LESCO and proposes evacuation of power on 132 kV. Alternative-III will incur the least line losses and is therefore the recommended Interconnection Scheme.
- The first interconnection scheme, referred to as Alternative-I in this report, aims to interconnect by making use of the nearby Marali Feeder. This would require:
  - Construction of about 0.8 km long circuit of 11 kV from Roshan Power switchyard to a Tee-Point on Marali 11kV feeder, about 20 km long emanating from Khudian Grid Station.
  - Two direct 11 kV single circuits of 20 km length, using Osprey conductor from Roshan Power till Khudian T-2 and T-3 11 kV Bus Bars.
  - The proposed direct circuits of 11 kV from Roshan PP to Khudian Grid Station shall require adding two line bays of 11 kV at Khudian Grid Station to connect this double circuit
- The second interconnection scheme, referred to as Alternative-II in this report, has been developed from the point of view of involving no direct connection to distribution feeders as it might affect the load-shedding scheme during the seasons of power shortage in the country or switching off these feeders for theft control if required. This alternative would require:
  - Three single circuits of 11 kV of 20 km length, using Osprey conductor, from Roshan Power to the existing Khudian Grid Station
  - The exiting substation of 132 kV at Khudian shall require adding of three line bays of 11 kV to connect to three circuits of 11 kV from Roshan Power
- The third interconnection scheme, referred to as Alternative-III in this report, has been developed for interconnection at 132 kV with Khudian Grid Station as per the comments of LESCO. This would require:
  - A double circuit of 132 kV of 20 km length, using Lynx conductor, from Roshan Power to the existing Khudian Grid Station

- The exiting substation of 132 kV at Khudian shall require adding of two line bays of 132 kV to connect to the double circuit of 132 kV from Roshan Power

❖ The study objective, approach and methodology have been described and the plant's data received from the client Roshan Power is validated.

❖ The LESCO system data as available with PPI for other studies have been used.

❖ The nearest substation of LESCO from the proposed site of Roshan Solar Power Plant is Khudian 132/11 kV. Considering the physical proximity of the grid to the power plant, interconnection options at 11 kV and 132 kV with Khudian 132/11 kV are considered. Two Alternatives have been envisaged to evacuate the maximum power of 10 MW of Roshan power at 11 kV and one Alternative has been considered to evacuate the maximum power of 10 MW of Roshan power at 132 kV and have been studied in detail.

❖ Detailed load flow studies have been carried out for the peak load conditions of 2013 for the three proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, under normal and N-1 contingency conditions to meet the reliability criteria.

❖ Steady state analysis by load flow reveals that all the proposed schemes are adequate to evacuate the maximum power of 10 MW of the plant under normal and contingency conditions.

❖ The short circuit analysis has been carried out to calculate maximum fault levels at the Solar Power Plant at 11 kV, and the substations of 11 kV and 132 kV in its vicinity. We find that the fault currents for all the proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from the Solar Power Plant.

❖ For Alternative-I, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.34 kA and 3.37 kA for 3-phase and 1-phase faults respectively. For Alternative-II, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.41 kA and 3.44 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 12.5 kA should be installed at 11 kV switchyard of the Solar Power Plant

leaving enough margin to accommodate fault current contribution from any future reinforcements in that area. For Alternative-III, the maximum short circuit levels of 132 kV bus bar of Roshan Solar Power Plant are 7.33 kA and 4.71 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 25 kA should be installed at 132 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements in that area

- The dynamic stability analysis of all the proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, has been carried out. The stability check for the worst case of three phase fault right on the 11 kV bus bar of the solar power plant substation followed by the final trip of 11 kV circuits emanating from this substation, has been performed for Alternative-I and Alternative-II. The stability check for the worst case of three phase fault right on the 132 kV bus bar of the solar power plant substation followed by the final trip of 132 kV circuits emanating from this substation, has been performed for Alternative-III including the stuck breaker case. The system is found strong enough to stay stable and recovered with fast damping. The stability of system for far end faults of 3-phase, including stuck breaker case, occurring at Khudian 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The results of load flow, short circuit and dynamic stability analysis have proved that all the three Alternatives are technically feasible. However Alternative-III would incur the least line losses.
- The proposed schemes of interconnection, i.e. Alternative-I, Alternative-II and Alternative-III, have no technical constraints or problems, fulfill all the criteria of reliability under steady state load flow, contingency load flows, short circuit currents ratings and dynamic stability analysis. However Alternative-III would result in the least line losses and is therefore recommended to be adopted.

Report Contents

1. Introduction

1.1 Background

The site of proposed project is near Khudian in Punjab in the concession area of Lahore Electricity Supply Company (LESCO). The net output planned to be generated from the site is about 10 MW of electrical. The electricity generated from this project would be supplied locally to the Khudian 132/11 kV Grid and to the LESCO network through Khudian 132/11 kV grid located in the vicinity of this project.

1.2 Objectives

The overall objective of the Study is to evolve an interconnection scheme between Roshan Power Solar Power Project and LESCO network, for stable and reliable evacuation of 10 MW of electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives are:

1. To develop scheme of interconnections at 132 kV and 11kV for which right of way (ROW) and space at the terminal substations would be available.
2. To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
3. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 11kV and 132 kV voltage levels to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at the Solar Power Plant.
4. To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping after 3-phase faults on the system.

1.3 Planning Criteria

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

Steady State:

Voltage	± 5 %, Normal Operating Condition ± 10 %, Contingency Conditions
Frequency	50 Hz, Continuous, ± 1% variation steady state 49.2 - 50.5 Hz, Short Time
Power Factor	0.80 Lagging; 0.9 Leading (for conventional synchronous generators but would not be applicable to solar PP)

Dynamic/Transient:

- The system should revert back to normal condition after dying out of transients without losing synchronism with good damping. For 11 kV the total maximum fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 200 ms (10 cycles).

- For the systems of 132 kV and above the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles).

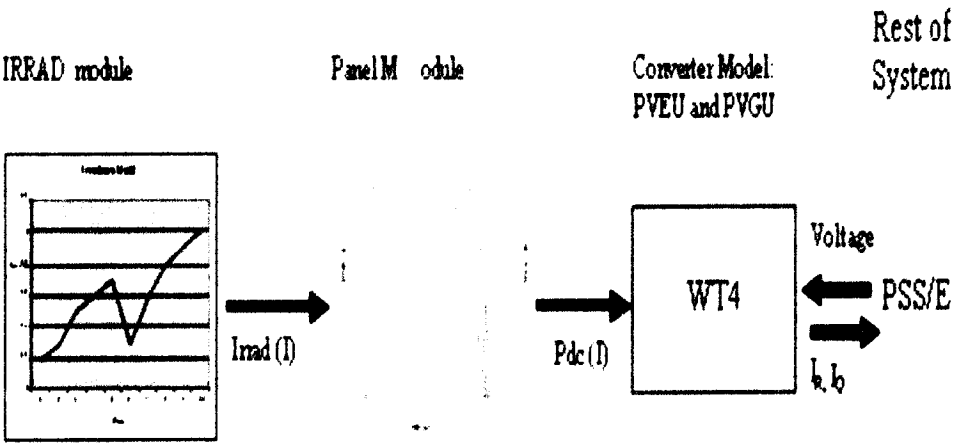
- For the systems of 132 kV and above, in case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles).

2. Assumptions of Data

The detailed electrical parameters would be designed at the EPC stage. However for the purposes of this study, following assumptions have been made:

2.1 Solar Power Plant data

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



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

Due to the presence of the inverter module, from the point of view of the network, the solar power plant is considered a voltage source convertor.

Dynamic Data:

Converter time constant for IQcmd seconds = 0.02 s

Converter time constant for IQcmd seconds = 0.02 s

Voltage sensor for LVACR time constants = 0.02 s

Max Power from PV Plant = 10 MW

Voltage sensor time constant = 1.1 s

2.2 Network data

The 11 kV and 132 kV network available for interconnection to Roshan Power is described in this section. The data of equipment at Khudian 132/ 11 kV Grid Station and 11 kV feeders emanating from here was collected by site visit to. Following are the salient features of the network:

- 132/11 kV Grid Station of Khudian at 20 kM from the site of Roshan Power
- There are 3 transformers of 132/11 kV at Khudian as follows;
    - T1 = 20/26 MVA (Max load recorded = 1100 Amps)
    - T2 = 20/26 MVA (Max load recorded = 1090 Amps)
    - T3 = 20/26 MVA (Max load recorded = 1300 Amps)
- The 11 kV feeder nearest to the site of Roshan Power is Marali Feeder which passes about 0.8 km away from the site of Roshan Power. The main branch of this feeder uses Dog conductor whereas the branch laying close to the site of the plant uses Rabbit conductor.
- Maximum load recorded at the Marali feeder is 330 Amps.
- Ampacity of Dog conductor = 346 Amps at 40° C with wind speed of 0.6 m/s which gives rating of 6.5 MVA for 11 kV feeders using Dog conductors.
- 11 kV switchgear's ratings at Khudian 132/11 kV Grid station:
    - Breakers For T1, T2 and T3
        - 2500 A nominal; 25 kA short circuit
    - Breakers For Marali
        - 2500 A nominal; 25 kA short circuit
    - Bus bar
        - 2500 A nominal; 25 kA short circuit
- The network data of LESCO have been assumed in the study as already available with PPI for similar other studies.
- The normal continuous thermal rating of single conductor Lynx for 132 kV overhead lines is 112 MVA as per data provided by LESCO.

The 11 kV and 132 kV networks available for interconnection to Roshan Solar Power Plant near Khudian and Kasur are as shown in Sketches 1in Appendix-A.

3. Study Approach and Methodology

3.1 Understanding of the Problem

The 10 MW Solar Power Plant by Roshan Power is going to be a Photovoltaic (PV) based solar project embedded in the network of LESCO around Khudian. It would run almost all the months of the year though with some variation in its output due to variation in the strength of light in winter and in rainy season.

The existing nearest grid station available for interconnection is Khudian 132/11 kV substation. The addition of this source of power generation embedded in local network of this area shall provide relief to Khudian 132 / 11 kV substation feeding the local loads of that area. The 11 kV network surrounding Khudian has significantly high load demand as the existing 3x26 MVA transformers are running at almost full load presently. LESCO is planning to add a 4th transformer here. Therefore all of the power from the Roshan Power Solar Power Plant will be utilized locally in meeting this rising load demand.

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

3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for the year 2013, which is the completion year of 10 MW Solar PV Plant by Roshan Power, comprising all 500kV, 220kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year particularly.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, have been identified.
- Performed technical system studies for peak load conditions to confirm technical feasibility of the interconnections. The scheme has been subjected to standard analysis like load flow and short circuit, and transient stability study

to check the strength of the plant and the proposed interconnection scheme under disturbed conditions.

- Determine the relevant equipment for the proposed technically feasible scheme.
- Recommend the technically most feasible scheme of interconnection.

4. Development of Scheme of Interconnection

4.1 The Existing Network

The nearest existing LESCO interconnection facilities at the time of commissioning of Roshan Power Solar Power Project would be as follows:

- Khudian 132/11 kV Substation
- Kasur 132/11 kV Substation

The Marali feeder emanating from T-1 of Khudian 132/11 kV substation passes just 0.8 km from the site of Roshan-PP.

Given the physical proximity of Khudian to the solar power plant and that fact that the other facilities are at a considerable distance from the plant, the most feasible interconnection of the Roshan Power Solar Power Plant will be with Khudian 132/11 kV substation. Keeping this in view, three interconnection alternatives are developed.

The presence of Roshan Power Plant will provide relief to the source substations of Nishat-Power, Nishat-Chunian, Saif P/H and KEL which are located further away.

4.2 The Schemes of Interconnection of Roshan PV Solar PP :

Alternative I: One Tee Connections of Roshan PP to Marali Feeder and a direct double circuit of11 kV with Khudian Grid Station

This alternative has been developed from the point of view of dispersal of power direct on the distribution feeders from the source of supply as near to the load as possible. The nearest and quick option for interconnection may seem to be making Tee-connection of Roshan Power with Marali 11 kV rural feeder which is built using Dog conductor whose capacity is about 6 MVA Therefore the single Tee connection will not be adequate and more outlets would be required for the dispersal of 10 MW to also ensure N-1 contingency criteria. Therefore two direct 11 kV single circuits from Roshan Power to Khudian T-2 and T-3 would also be laid down to make it a reliable alternative. This scheme is shown in Sketch-2 in Appendix-A and it would require as follows;

- Construction of about 0.8 km long circuit of 11 kV from Roshan Power switchyard to a Tee-Point on Marali 11kV feeder, about 20 km long emanating from Khudian Grid Station.
- Two direct 11 kV single circuits of 20 km length, using Osprey conductor from Roshan Power till Khudian T-2 and T-3 11 kV Bus Bars.
- The proposed direct circuits of 11 kV from Roshan PP to Khudian Grid Station shall require adding two line bays of 11 kV at Khudian Grid Station to connect this double circuit.

The capacity adequacy will be checked in the load flow analysis.

Alternative-II: Three Circuits of 11 kV from Roshan Power to Khudian Grid Station

This alternative has been developed from the point of view of involving no direct connection to distribution feeders as it might affect the load-shedding scheme during the seasons of power shortage in the country or switching off these feeders for theft control if required.

This scheme is shown in Sketch-3 in Appendix-A and it would involve construction of:

- Three single circuits of 11 kV of 20 km length, using Osprey conductor, from Roshan Power to the existing Khudian Grid Station.
- The exiting substation of 132 kV at Khudian shall require adding of three line bays of 11 kV to connect to three circuits of 11 kV from Roshan Power.

This would apparently be slightly expensive alternative but it would ensure more functional flexibility under load-shedding.

Alternative-III: Direct Double Circuit of 132 kV from Roshan Power to Khudian Grid Station

This alternative has been developed based on the comments of LESCO. This scheme is shown in Sketch-4 in Appendix-A and it would involve construction of:

- One Direct Double Circuit of 132 kV of 20 km length, using Lynx conductor, from Roshan Power to the existing Khudian Grid Station.
- The exiting substation of 132 kV at Khudian shall require adding of two line bays of 132 kV to connect to a direct double circuit of 132 kV from Roshan Power.

This Alternative would have the least line losses.

4.3 Proposed additions at Khudian 132/11 kV Grid Station

4.3.1 For Alternative-I

Additional two breaker bays of 11 kV will be required for the interconnection of two 11 kV circuits to be built direct from Roshan Power to Khudian Grid Station as per scheme of Alternative-I.

Total additional 11 kV breaker bays required = 2

4.3.2 For Alternative-II

An additional three breaker bays of 11 kV required for the interconnection of three circuits of 11kV to be built direct from Roshan Power to Khudian Grid Station as per scheme of Alternative-II.

Total additional 11 kV breaker bays required = 3

4.3.3 For Alternative-III

Two additional breaker bays of 132 kV required for the interconnection of a direct double circuit of 132 kV to be built direct from Roshan Power to Khudian Grid Station as per scheme of Alternative-III.

Total additional 132 kV breaker bays required = 2

5. Detailed Load Flow Studies

5.1 Base Case 2013, Without Solar Power Plant

A base case has been developed for the peak load of 2013 which, using the network data of Roshan Power Plant and LESCO network.

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-B. The system plotted in this Exhibit shows 132 kV network feeding Khudian connected to its surrounding substations through Kasur, Mandi Usman and Elahbad. Also the 11 kV network emanating from Khudian has been modeled showing each substation as 11 kV bus bars with loads connected to each bus.

The load flow results show that the power flows on all circuits are within their specified normal current carrying rating. The voltages are also within the permissible limits. We see that about 40.8 MW flows towards Khudian from Mandi Usman and about 48 MW flows towards Khudain directly from Elahabad. About 12.1 MW per circuit flows from Khudian to Kasur.

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

Exhibit 0.1	Mandi Usman to Khudian 132 kV Single Circuit Out
Exhibit 0.2	Khudian to Kasur 132 kV Single Circuit Out
Exhibit 0.3	Elahbad to Khudian 132 kV Single Circuit Out

In both cases the power flows on all circuits remain within their ratings. Thus we find that there are no capacity constraints in terms of MW or MVA flow in the 11 kV or 132 kV network available in the vicinity of the Solar Power Plant for its connectivity under normal and contingency conditions prior to its connection.

5.2 Load Flow with Roshan Power Solar Power Plant : Alternative-I

We have considered the scenario of peak 2013 when the 10 MW Roshan Power Solar Power Project has been completed so that we can judge the maximum impact of the project on the system.

The scheme of interconnection modeled in the load flow for Solar Power Plant is developed as follows:

- Construction of about 0.8 km long circuit of 11 kV from Roshan Power switchyard to a Tee-Point on Marali 11kV feeder, about 20 km long emanating from Khudian Grid Station.
- Two direct 11 kV single circuits of 20 km length, using Osprey conductor from Roshan Power till Khudian T-2 and T-3 11 kV Bus Bars.

The results of load flow with the Solar Power Plant interconnected as per proposed scheme are shown in Exhibit 1.0 in Appendix-B. The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

We find no capacity constraints on 11 kV or 132 kV circuits under normal conditions i.e. without any outages of circuits.

With part of the load at Khudian fed by Roshan Power Plant locally, the flow from Mandi Usman to Khudian is reduced to 38.3 MW and from Elahbad to Khudian to 45.4 MW.

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

Exhibit 1.1	Mandi Usman to Khudian 132 kV Single Circuit Out
Exhibit 1.2	Khudian to Kasur 132 kV Single Circuit Out
Exhibit 1.3	Elahbad to Khudian 132 kV Single Circuit Out
Exhibit 1.4	Roshan-PP to Khudian T-2 11 kV Single Circuit Out
Exhibit 1.5	Roshan-PP to Khudian T-3 11 kV Single Circuit Out

In all the above contingency cases, we find that in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the rated limits in all the contingency events. Thus there are no constraints in this scheme.

5.3 Load Flow with Roshan Power Solar Power Plant : Alternative-II

We have considered the scenario of peak 2013 when the 10 MW Roshan Power Solar Power Project has been completed so that we can judge the maximum impact of the project on the system.

The scheme of interconnection modeled in the load flow for Solar Power Plant is developed by laying down a double circuit and an additional single circuit of length 20 km using Osprey conductor from 11 kV Bus Bar of Roshan Power Plant till Khudian 132/11 kV substation. One circuit is to be connected to each at Khudian 132/11 kV T-1, T-2 and T-3. The results of load flow with the Solar Power Plant interconnected as per proposed scheme are shown in Exhibit 2.0 in Appendix-B. The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

We find no capacity constraints on 11 kV or 132 kV circuits under normal conditions i.e. without any outages of circuits.

With part of the load at Khudian fed by Roshan Power Plant locally, the flow from Mandi Usman to Khudian is reduced to 38.3 MW and from Elahbad to Khudian to 45.5 MW.

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

Exhibit 2.1	Mandi Usman to Khudian 132 kV Single Circuit Out
Exhibit 2.2	Khudian to Kasur 132 kV Single Circuit Out
Exhibit 2.3	Elahbad to Khudian 132 kV Single Circuit Out

Exhibit 2.4	Roshan-PP to Khudian T-1 11 kV Single Circuit Out
Exhibit 2.5	Roshan-PP to Khudian T-2 11 kV Single Circuit Out
Exhibit 2.6	Roshan-PP to Khudian T-3 11 kV Single Circuit Out

In all the above contingency cases, we find that in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the rated limits in all the contingency events. Thus there are no constraints in this scheme.

5.4 Load Flow with Roshan Power Solar Power Plant : Alternative-III

We have considered the scenario of peak 2013 when the 10 MW Roshan Power Solar Power Project has been completed so that we can judge the maximum impact of the project on the system.

The scheme of interconnection modeled in the load flow for Solar Power Plant is developed by laying down a direct double circuit of length 20 km using Lynx conductor from 132 kV Bus Bar of Roshan Power Plant till Khudian 132/11 kV substation. The results of load flow with the Solar Power Plant interconnected as per proposed scheme are shown in Exhibit 3.0 in Appendix-B. The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

We find no capacity constraints on 11 kV or 132 kV circuits under normal conditions i.e. without any outages of circuits.

With part of the load at Khudian fed by Roshan Power Plant locally, the flow from Mandi Usman to Khudian is reduced to 38.2 MW and from Elahbad to Khudian to 45.3 MW.

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

Exhibit 3.1	Mandi Usman to Khudian 132 kV Single Circuit Out
Exhibit 3.2	Khudian to Kasur 132 kV Single Circuit Out
Exhibit 3.3	Elahabad to Khudian 132 kV Single Circuit Out
Exhibit 3.4	Roshan-PP to Khudian 132 kV Single Circuit out
Exhibit 3.5	Kasur to Kasur-II 132 kV Single Circuit out

In all the above contingency cases, we find that in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the rated limits in all the contingency events. Thus there are no constraints in this scheme.

5.5 Conclusion of Load Flow Analysis

From the analysis discussed above, we conclude all the three alternatives i.e. Alternative-I, Alternative-II and Alternative-III are technically feasible. However compared to the other Interconnection Alternatives, the line losses will be the least in Alternative-III and is therefore the recommended Alternative.

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies. .

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

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2013 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

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

6.2 Fault Current Calculations without Solar Power Plant

In order to assess the short circuit strength of the network of 11 kV and 132 kV without the Solar Power Plant for the grid of LESCO in the vicinity of the site of the Plant near Khudian, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will not only give us the idea of the fault levels without the Solar Power Plant and later on how much the contribution of fault current from the Solar Power Plant may add to the existing levels, but also we get a feel of the strength of the proposed node to connect this Power Plant depending on its relative short circuit strength.

The results are attached in Appendix – C.

The short circuit levels have been represented graphically on the bus bars of 11kV and 132 kV along with fault current contributions from the incoming circuits, which are shown in the Exhibit 4.0 attached in Appendix-C.

Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-C for the 11 kV and 132 kV bus bars of our interest i.e. 11 kV and 132 kV circuits lying close to Khudian. The tabular output is the detailed output showing the contribution to the fault current from the adjoining sources i.e. the lines and transformers connected to that bus. The phase currents, the sequence currents and the sequence impedances are shown in detail for each faulted bus bar.

The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 6.1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 11 kV and 132 kV substations which normally are 20 kA, 25 kA.

Table-6.1
Maximum Short Circuit Levels without Roshan Solar PP

Substation	kV	3-Phase Fault Current, kA	1-Phase Fault Current, kA
Elahabad	132	17.20	12.44
Mandi Usman	132	11.42	7.59
Khudian	132	11.60	7.66
Chunian	132	21.53	17.01
Kasur	132	9.99	6.50
Khudian T-1	11	11.02	11.31
Khudian T-2	11	11.02	11.31
Khudian T-3	11	11.01	11.31

6.3 Fault Current Calculations with Solar Power Plant interconnected

Fault currents have been calculated for both the proposed electrical interconnection schemes. Fault types applied are three phase and single-phase at 11 kV bus bars of Solar Power Plant itself and other bus bars of the 11 kV and 132 kV substations in the electrical vicinity of Roshan Solar Power Plant and Khudian. The graphic results are indicated in Exhibit 4.1 for Alternative-I, Exhibit 4.2 for Alternative-II and in Exhibit 4.3 for Alternative-III.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV bus bars of the network in the electrical vicinity of Solar Power Plant are placed in Appendix-C. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.2 for Alternative-I, Table 6.3 for Alternative-II and Table 6.4 for Alternative-III.

Comparison of Tables 6.1 with Table 6.2, Table 6.3 and Table 6.4 shows slight increase in short circuit levels for three-phase and single – phase faults due to connection of Solar Power Plant on the 132 kV bus bars in its vicinity. This increase is limited from the point of view of the fact that the Solar Power Plant is a voltage source convertor. We find that even after some increase, these fault levels are much below the rated short circuit values of the equipment installed on these substations. For Alternative-I, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.34 kA and 3.37 kA for 3-phase and 1-phase faults respectively. For Alternative-II, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.41 kA and 3.44 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 12.5 kA should be installed at 11 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements taking place in that area.

For Alternative-III, the maximum short circuit levels of 132 kV bus bar of Roshan Solar Power Plant are 7.33 kA and 4.72 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 25 kA should be installed at 132 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements taking place in that area.

Table-6.2
Maximum Short Circuit Levels with Roshan Solar PP – Alternative I

Substation	kV	3-Phase Fault Current, kA	1-Phase Fault Current, kA
Elahabad	132	17.22	12.45
Mandi Usman	132	11.44	7.60
Khudian	132	11.62	7.68
Chunian	132	21.54	17.06

Kasur	132	10.01	6.50
Khudian T-1	11	11.57	11.89
Khudian T-2	11	11.69	12.02
Khudian T-3	11	11.69	12.02
Roshan-PP	11	3.34	3.37

Table-6.3
Maximum Short Circuit Levels with Roshan Solar PP – Alternative II

Substation	kV	3-Phase Fault Current, kA	1-Phase Fault Current, kA
Elahabad	132	17.22	12.45
Mandi Usman	132	11.44	7.60
Khudian	132	11.62	7.68
Chunian	132	21.54	17.03
Kasur	132	10.01	6.50
Khudian T-1	11	11.69	12.03
Khudian T-2	11	11.69	12.03
Khudian T-3	11	11.69	12.03
Roshan-PP	11	3.41	3.44

Table-6.3
Maximum Short Circuit Levels with Roshan Solar PP – Alternative III

Substation	kV	3-Phase Fault Current, kA	1-Phase Fault Current, kA
Elahabad	132	17.22	12.45
Mandi Usman	132	11.44	7.60
Khudian	132	11.62	7.68
Chunian	132	21.54	17.03
Kasur	132	10.01	6.50
Khudian T-1	11	11.04	11.33
Khudian T-2	11	11.04	11.33
Khudian T-3	11	11.04	11.33
Roshan-PP	132	7.33	4.72

6.4 Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of the Solar Power Plant with the Khudian 132kV network, we don't find any problem of violations of short circuit ratings of the already installed equipment on the 132 kV equipment of substations in the vicinity of the Solar Power

Plant due to fault current contributions from this plant due to three-phase faults as well as single phase faults.

For Alternative-I, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.34 kA and 3.37 kA for 3-phase and 1-phase faults respectively. For Alternative-II, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.41 kA and 3.44 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 12.5 kA should be installed at 11 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements.
For Alternative-III, the maximum short circuit levels of 132 kV bus bar of Roshan Solar Power Plant are 7.33 kA and 4.72 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 25 kA should be installed at 132 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements taking place in that area.

7. Transient Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Stability Models

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

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

Generator	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1

7.1.2 System Conditions

We have used the system conditions of 2013 as per the COD provided by the client and have kept the output of Roshan Solar-PP at full to judge the maximum impact of the plant.

We have tested both the proposed interconnection schemes in and they have been separately modeled in the stability analysis.

All the power plants of WAPDA /NTDC from Tarbela to HubCo have been dynamically represented in the simulation model.

One of the aspects of solar power plants is inverter selection. Although typically inverters did not provide any reactive support to the system, recent advances in inverter technology have allowed inverters not only to provide reactive support to the system but also features like Low Voltage Ride Through (LVRT), Zero Voltage Ride Through (ZVRT) and High Voltage Ride Through (HVRT) which are deemed desirable. We have done studies with the inverter specified by the client which has reactive support capability of ± 0.8 PF.

7.1.3 Presentation of Results

The plotted results of the simulations runs are placed in Appendix-D. Each simulation is run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been

monitored for nine seconds. Usually all the transients due to non-linearity die out within 2-3 seconds after disturbance is cleared in the system.

7.1.4 Worst Fault Cases

Three phase faults are considered as the worst disturbance in the system. We have considered 3-phase fault in the closest vicinity of the Solar Power Plant i.e. right at the 11 kV bus bars of the solar power plant substation, cleared in 10 cycles respectively as well as the faults and stuck breaker case on 132 kV level in which the fault is cleared in 5 and 9 cycles respectively, followed by permanent trip of relevant single circuit emanating from this substation.

7.2 Transient Stability Simulations' Results – Alternative -I

7.2.1 Fault at 11 kV Near Solar Power Plant

We applied three-phase fault on the Solar Power Plant 11 kV bus bar, cleared fault in 10 cycles (200 ms) followed by trip of 11 kV circuit between the Solar Power Plant and Khudian T-2. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 11 kV bus bars of Roshan Solar-PP, Khudian T-1, Khudian T-2 and 132 kV Bus Bars of Khudian, Mandi-Usman, and Elahabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

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

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Voltage Sensor For LVACR

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

Fig. 1.5 MW /MVAR Flow from Roshan-Solar Power Plant to Khudian T-3

Followed by clearing of fault, the trip of 11 kV circuit between the power plant and Khudian T-2 caused the part load of that circuit to flow through the intact 11 kV

circuit between the Solar-PP and Khudian T-3. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.2 Fault at Khudian 132 kV – (Far End Fault)

We applied three-phase fault on far-end 132 kV bus bar of Khudian to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 132 kV systems, followed by trip of a single circuit of 132 kV between Elahabad and Khudian. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 11 kV bus bars of Roshan Solar-PP, Khudian T-1, Khudian T-2 and 132 kV Bus Bars of Khudian, Mandi-Usman, and Elahabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

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

Fig. 2.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Voltage Sensor For LVACR

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

Fig. 2.5 MW /MVAR Flow from Mandi-Usman to Khudian 132 kV

Followed by clearing of fault, the trip of 132 kV circuit Elahabad and Khudian caused the part load of that circuit to flow through the 132 kV circuit between the Mandi-Usman and Khudian. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.3 Fault at Khudian 132 kV – (Far End Fault with Stuck Breaker)

We applied three-phase fault on far-end 132 kV bus bar of Khudian to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 9 cycles (180 ms) to simulate the case in which there was a failure of the primary protection(stuck breaker case), followed by trip of a single circuit of 132 kV between Elahabad and Khudian. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 11 kV bus bars of Roshan Solar-PP, Khudian T-1, Khudian T-2 and 132 kV Bus Bars of Khudian, Mandi-Usman, and Elahabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

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

Fig. 3.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 3.4 Voltage Sensor For LVACR

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

Fig. 3.5 MW /MVAR Flow from Mandi-Usman to Khudian 132 kV

Followed by clearing of fault, the trip of 132 kV circuit Elahabad and Khudian caused the part load of that circuit to flow through the 132 kV circuit between the Mandi-Usman and Khudian. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3 Transient Stability Simulations' Results – Alternative -II

7.3.1 Fault at 11 kV Near Solar Power Plant

We applied three-phase fault on the Solar Power Plant 11 kV bus bar, cleared fault in 10 cycles (200 ms) followed by trip of 11 kV circuit between the Solar Power Plant and Khudian T-2. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 11 kV bus bars of Roshan Solar-PP, Khudian T-2 and 132 kV Bus Bars of Khudian, Mandi-Usman, Kasur and Elahabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

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

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Voltage Sensor For LVACR

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

Fig. 1.5 MW /MVAR Flow from Roshan-Solar Power Plant to Khudian T-3

Followed by clearing of fault, the trip of 11 kV circuit between the power plant and Khudian T-2 caused the part load of that circuit to flow through the intact 11 kV circuit between the Solar-PP and Khudian T-3. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.2 Fault at Khudian 132 kV – (Far End Fault)

We applied three-phase fault on far-end 132 kV bus bar of Khudian to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 132 kV systems, followed by trip of a single circuit of 132 kV between Elahabad and Khudian. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 11 kV bus bars of Roshan Solar-PP, Khudian T-1 and 132 kV Bus Bars of Khudian, Mandi-Usman, Kasur and Elahabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

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

Fig. 2.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Voltage Sensor For LVACR

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

Fig. 2.5 MW /MVAR Flow from Mandi-Usman to Khudian 132 kV

Followed by clearing of fault, the trip of 132 kV circuit Elahabad and Khudian caused the part load of that circuit to flow through the 132 kV circuit between the Mandi-Usman and Khudian. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.3.3 Fault at Khudian 132 kV – (Far End Fault with Stuck Breaker)

We applied three-phase fault on far-end 132 kV bus bar of Khudian to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 9 cycles (180 ms) to simulate the case in which there was a failure of the primary protection(stuck breaker case), followed by trip of a single circuit of 132 kV between Elahabad and Khudian. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 11 kV bus bars of Roshan Solar-PP, Khudian T-1 and 132 kV Bus Bars of Khudian, Mandi-Usman, Kasur and Elahabad are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

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

Fig. 3.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 3.4 Voltage Sensor For LVACR

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

Fig. 3.5 MW /MVAR Flow from Mandi-Usman to Khudian 132 kV

Followed by clearing of fault, the trip of 132 kV circuit Elahabad and Khudian caused the part load of that circuit to flow through the 132 kV circuit between the Mandi-Usman and Khudian. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.4 Transient Stability Simulations' Results – Alternative -III

7.4.1 Fault at 132 kV Near Solar Power Plant

We applied three-phase fault on the Solar Power Plant 132 kV bus bar, cleared fault in 5 cycles (180 ms) followed by trip of 132 kV circuit between the Solar Power Plant and Khudian. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 132 kV bus bars of Roshan Solar-PP, Khudian, Mandi Usman and Elahabad as well as 11 kV bus bars of Khudian T-1 and T-2 are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

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

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Voltage Sensor For LVACR

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

Fig. 1.5 MW /MVAR Flow from Roshan-Solar Power Plant to Khudian 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the power plant and Khudian caused the entire load of that circuit to flow through the intact 132 kV circuit between the Solar-PP and Khudian. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.4.2 Fault at 132 kV Near Solar Power Plant – (Stuck Breaker)

We applied three-phase fault on the Solar Power Plant 132 kV bus bar to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 9 cycles (180 ms) to simulate the case in which there was a failure of the primary protection(stuck breaker case), followed by trip of a single circuit of 132 kV between the Solar Power Plant and Khudian. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 132 kV bus bars of Roshan Solar-PP, Khudian, Mandi Usman and Elahabad as well as 11 kV bus bars of Khudian T-1 and T-2 are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

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

Fig. 2.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Voltage Sensor For LVACR

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

Fig. 2.5 MW /MVAR Flow from Roshan-Solar Power Plant to Khudian 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the power plant and Khudian caused the entire load of that circuit to flow through the intact 132 kV circuit between the Solar-PP and Khudian. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.4.3 Fault at Khudian 132 kV – (Far End Fault)

We applied three-phase fault on far-end 132 kV bus bar of Khudian to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 132 kV systems, followed by trip of a single circuit of 132 kV between Elahabad and Khudian. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D:Alternative-I and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 132 kV bus bars of Roshan Solar-PP, Khudian, Mandi Usman and Elahabad as well as 11 kV bus bars of Khudian T-1 and T-2 are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

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

Fig. 3.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 10 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 3.4 Voltage Sensor For LVACR

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

Fig. 3.5 MW /MVAR Flow from Mandi-Usman to Khudian 132 kV

Followed by clearing of fault, the trip of 132 kV circuit Elahabad and Khudian caused the part load of that circuit to flow through the 132 kV circuit between the Mandi-Usman and Khudian. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of Nishat-Chunian 132 kV, Nishat-Power 132 kV, Saif P/H 132 kV and Japan-Power 132 kV are plotted relative to machines at Japan Power 132 kV. The results show that the rotor angles get back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

7.5 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that for all three Alternatives, Alternative-I, Alternative-II and Alternative-III the system is very strong and stable for the proposed scheme for the severest possible faults of 11 kV and 132 kV systems near to and far of the Solar Power Plant of Roshan Power. Therefore there is no problem of dynamic stability for interconnection of this Solar Power Plant; it fulfils all the criteria of transient stability. The reactive support from the inverter also helps the system stability.

8. Conclusions

- Three Interconnection Schemes have been devised for the Interconnection of 10 MW Roshan Solar Power Plant. Two of these schemes, referred to as Alternative-I and Alternative-II in this report, propose evacuation of power on 11 kV while the third scheme, referred to as Alternative-III in this report, has been developed after incorporating the comments of LESCO and proposes evacuation of power on 132 kV. Alternative-III will incur the least line losses and is therefore the recommended Interconnection Scheme.
- The first interconnection scheme, referred to as Alternative-I in this report, aims to interconnect by making use of the nearby Marali Feeder. This would require:
  - Construction of about 0.8 km long circuit of 11 kV from Roshan Power switchyard to a Tee-Point on Marali 11kV feeder, about 20 km long emanating from Khudian Grid Station.
  - Two direct 11 kV single circuits of 20 km length, using Osprey conductor from Roshan Power till Khudian T-2 and T-3 11 kV Bus Bars.
  - The proposed direct circuits of 11 kV from Roshan PP to Khudian Grid Station shall require adding two line bays of 11 kV at Khudian Grid Station to connect this double circuit
- The second interconnection scheme, referred to as Alternative-II in this report, has been developed from the point of view of involving no direct connection to distribution feeders as it might affect the load-shedding scheme during the seasons of power shortage in the country or switching off these feeders for theft control if required. This alternative would require:
  - Three single circuits of 11 kV of 20 km length, using Osprey conductor, from Roshan Power to the existing Khudian Grid Station
  - The exiting substation of 132 kV at Khudian shall require adding of three line bays of 11 kV to connect to three circuits of 11 kV from Roshan Power
- The third interconnection scheme, referred to as Alternative-III in this report, has been developed for interconnection at 132 kV with Khudian Grid Station as per the comments of LESCO. This would require:

- A double circuit of 132 kV of 20 km length, using Lynx conductor, from Roshan Power to the existing Khudian Grid Station
- The exiting substation of 132 kV at Khudian shall require adding of two line bays of 132 kV to connect to the double circuit of 132 kV from Roshan Power

❖ The study objective, approach and methodology have been described and the plant's data received from the client Roshan Power is validated.

❖ The LESCO system data as available with PPI for other studies have been used.

❖ The nearest substation of LESCO from the proposed site of Roshan Solar Power Plant is Khudian 132/11 kV. Considering the physical proximity of the grid to the power plant, interconnection options at 11 kV and 132 kV with Khudian 132/11 kV are considered. Two Alternatives have been envisaged to evacuate the maximum power of 10 MW of Roshan power at 11 kV and one Alternative has been considered to evacuate the maximum power of 10 MW of Roshan power at 132 kV and have been studied in detail.

❖ Detailed load flow studies have been carried out for the peak load conditions of 2013 for the three proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, under normal and N-1 contingency conditions to meet the reliability criteria.

❖ Steady state analysis by load flow reveals that all the proposed schemes are adequate to evacuate the maximum power of 10 MW of the plant under normal and contingency conditions.

❖ The short circuit analysis has been carried out to calculate maximum fault levels at the Solar Power Plant at 11 kV, and the substations of 11 kV and 132 kV in its vicinity. We find that the fault currents for all the proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from the Solar Power Plant.

❖ For Alternative-I, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.34 kA and 3.37 kA for 3-phase and 1-phase faults respectively. For Alternative-II, the maximum short circuit levels of 11 kV bus bar of Roshan Solar Power Plant are 3.41 kA and 3.44 kA for 3-phase and 1-phase

faults respectively. Therefore an industry standard switchgear of the short circuit rating of 12.5 kA should be installed at 11 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements in that area. For Alternative-III, the maximum short circuit levels of 132 kV bus bar of Roshan Solar Power Plant are 7.33 kA and 4.71 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 25 kA should be installed at 132 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements in that area

- The dynamic stability analysis of all the proposed schemes, i.e. Alternative-I, Alternative-II and Alternative-III, has been carried out. The stability check for the worst case of three phase fault right on the 11 kV bus bar of the solar power plant substation followed by the final trip of 11 kV circuits emanating from this substation, has been performed for Alternative-I and Alternative-II. The stability check for the worst case of three phase fault right on the 132 kV bus bar of the solar power plant substation followed by the final trip of 132 kV circuits emanating from this substation, has been performed for Alternative-III including the stuck breaker case. The system is found strong enough to stay stable and recovered with fast damping. The stability of system for far end faults of 3-phase, including stuck breaker case, occurring at Khudian 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The results of load flow, short circuit and dynamic stability analysis have proved that all the three Alternatives are technically feasible. However Alternative-III would incur the least line losses.
- The proposed schemes of interconnection, i.e. Alternative-I, Alternative-II and Alternative-III, have no technical constraints or problems, fulfill all the criteria of reliability under steady state load flow, contingency load flows, short circuit currents ratings and dynamic stability analysis. However Alternative-III would result in the least line losses and is therefore recommended to be adopted.