SAFE
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(Pvt)Ltd

Date: 08.10.2015

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

Subject: **Application for Modification to Generation License**

Dear Sir,

Safe Solar Power (Private) Limited (the "**Company**") was granted a Generation License No SPGL/07/2014 on 12.09.2014 ("**Generation License**") by the National Electric Power Regulatory Authority ("**NEPRA**" or "**Authority**") under Section 15 of the NEPRA Regulation of Generation Transmission and Distribution of Electric Power Act, 1997 ("**NEPRA Act**") for its solar generation facility of installed capacity of 10.2816MWp (Gross ISO) ("**Project**") to be located at Quaid-e-Azam Solar Park, Lal Sohanra in Cholistan District Bahawalpur in the Province of Punjab ("**QASP Site**").

As your good office is aware, the Project was originally proposed to be established at the QASP Site in light of Government of Punjab's Energy Department's allotment of subject land at QASP Site to the Company *vide* letter dated 07.02.2014 (bearing Ref. No. S.O. (C)(ED)4-5/2014) (*enclosed herewith*). However, the land was allocated only *provisionally* to the Company, subject to the finalization of master plan of QASP, and upon introduction/approval of an evaluation criteria for allocation of land in QASP Site by the Government of Punjab, it was found that the Company, despite being a holder of a Letter of Interest dated 13.01.2014, was not eligible for placement of its Project at the QASP Site. As a result of these series of events, more detailed in **Annex E** hereto, the foregoing delays prompted the Company to purchase the Project's land privately at Dharanwala, District Bahawalnagar Punjab ("**New Site**"), as further identified in the enclosed annexures.

Furthermore, the Authority has kindly: (a) granted an extension to the deadline date of Financial Close to the Company from 31.03.2015 to 31.12.2015 *vide* its "*Decision of the Authority in the matter of Extension in Date of Financial Close for Solar Power Projects under Upfront Solar Tariff*" dated 04.12.2014; and (b) corrected the Plant Capacity Factor in the solar upfront tariff of the Company from 16.78% to 17.50% *vide* the "*Corrigendum Approval of National Electric Power Regulatory Authority in the Matter of Application of Safe Solar Power (Private) Limited for Unconditional Acceptance of Upfront Solar Tariff for 10 MW Solar Power Plant [Case No. NEPRA TRF-261/SSPPL-2014]*" communicated through letter dated 22.05.2014 bearing Ref. No. NEPRA/TRF-261/SSPPL-2014/5275-80, both of which changes are not currently reflected in the Generation License.

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In view of the foregoing, pursuant to Regulation 10(2) of the NEPRA Licensing (Application and Modification Procedure) Regulations, 1999 (the **"Regulations"**), I, *Mrs. Afshan Hamid Mir, Chief Executive Officer*, being the duly authorized representative of the Company by virtue of Board Resolution dated *07.10.2015*, hereby apply to NEPRA on behalf of the Company for the Proposed Modification of the Generation License to cater for the change in: (i) the Project's land from QASP Site to the New Site; (ii) the extension in the date of Financial Close/Project Commissioning Date; and (iii) the correction to the Net Capacity Factor.

I have attached supporting documentation as annexures to this application in order to provide relevant justification on the continued technical and operational feasibility of the Project. In relation hereto, I certify that the documents-in-support enclosed with this modification application are prepared and submitted in conformity with the provisions of the Regulations, and that the Company undertakes to abide by the terms and provisions of the Regulations. The Company further undertakes and confirms that the information provided in the enclosed documents-in-support is true and correct to the best of knowledge and belief.

A ~~Pay Order~~ check # 00193362 in the sum of Rs. 140,272, being the modification fee calculated in accordance with Schedule II to the Regulations (as amended), is also enclosed herewith.

In light of this application and its enclosures, you are kindly requested to proceed in accepting our application for the Proposed Modification of the Generation License.

Sincerely,

Afshan Asghar

Mrs. Afshan Hamid Mir
Chief Executive Officer

SAFE SOLAR POWER (Pvt) Ltd

Enclosures:

Annexures as provided in table of content on next page

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TEXT OF THE PROPOSED MODIFICATION

The proposed modifications to the Generation License are laid out as follows ("**Proposed Modification**")[1]:

1. **Cover Page of the Generation License**

   The underlined portion on the cover page of the Generation License, which provides that the Generation License has been granted "*for its Solar Generation Facility/Solar Power Plant/Solar Farm Located at Quaid-E-Azam Solar Park, Lal Sohanra in Cholistan District Bhawalpur in the Province of Punjab*" may be amended to read as follows:

   "*for its Solar Generation Facility/Solar Power Plant/Solar Farm Located at Chak 140, Dharanwala District, Bhawalnagar, Punjab*"

2. **Schedule 1: Location of the Generation Facility/Solar Power Plant/Solar Farm**

   It is requested that diagram provided in Schedule 1, Section titled "*Location of the Generation Facility/Solar Power Plant/Solar Farm*" be replaced with the diagram enclosed herewith as **Annex D-1**.

3. **Schedule 1: Access of the Generation Facility/Solar Power Plant/Solar Farm**

   It is requested that the diagram provided in Schedule 1, Section titled "*Access of the Generation Facility/Solar Power Plant/Solar Farm*" be replaced with the diagram enclosed herewith as **Annex D -2.**

4. **Schedule 1: Location Coordinates of the Generation Facility/Solar Power Plant/Solar Farm**

   It is requested that the diagram provided in Schedule 1, Section titled "*Location Coordinates of the Generation Facility/Solar Power Plant/Solar Farm*" be replaced with the diagram enclosed herewith as **Annex D -3.**

5. **Schedule 1: Schematic Diagram for Interconnection Arrangement/Transmission Facilities**

   It is requested that the diagram provided in Schedule 1, Section titled "*Schematic Diagram for Interconnection Arrangement/Transmission Facilities*" be replaced with the diagram enclosed herewith as **Annex D-4.**

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6. **Schedule 1: Interconnection Arrangement/Transmission Facilities for Dispersal of Power from the Generation Facility/Solar Power Plant/Solar Farm of Safe Solar Power (Private) Limited (SSPPL)**

Paragraph 2 of Schedule 1, Section titled "*Interconnection Arrangement/Transmission Facilities for Dispersal of Power from the Generation Facility/Solar Power Plant/Solar Farm of Safe Solar Power (Private.) Limited (SSPPL)*" may be amended altogether to read as under:

"*The proposed Interconnection Arrangement/Transmission Facilities for dispersal of electric power for the project will be consisting of 11 KV Feeders (on ACSR OSPREY Conductor) connecting the Generation Facility/Power Plant/Solar Farm of SSPPL with 132/11 KV Collector Sub-Station (Grid) located at, Dharanwala, Bhawalnagar District, Punjab.*"

7. **Schedule 1: Detail of Generation Facility/Solar Power Plant/Solar Plant/ Solar Farm**

In Schedule 1, Section titled "*Detail of Generation Facility/Solar Power Plant/Solar Plant/ Solar Farm*", the following amendments are proposed:

(i) The information against "*Plant Location*" under Section (A) (*General Information*), currently provided as "*Quaid-E-Azam Solar Park, Lal Sohanra in Cholistan, District Bahawalpur, in the Province of Punjab*" may be replaced with "*Chak 140, Dharanwala, District Bhawalnagar, in the Province of Punjab.*"

(ii) The information against "*Project Commissioning Date (Anticipated)*" under Section (D) (*Other Details*), currently provided as "*November 30, 2015*" may be replaced with "*August 31, 2016*"

8. **Schedule 2: Net Capacity Factor (4/6)**

In Schedule 2, the information against the "*Net Capacity Factor (4/6)*" currently provided as "16.89%" may be amended to read "17.50%".

9. **Header of Generation License**

We note that the header of the Generation License on every page mentions the old location i.e. "*Quaid-E-Azam Solar Park, Lal Sohanra in Cholistan, District Bahawalpur in the Province of Punjab*" therein. It is requested that the same may be amended to read "*Chak 140, Dharanwala District, Bhawalnagar, Punjab*" instead.

Afshan Asghar

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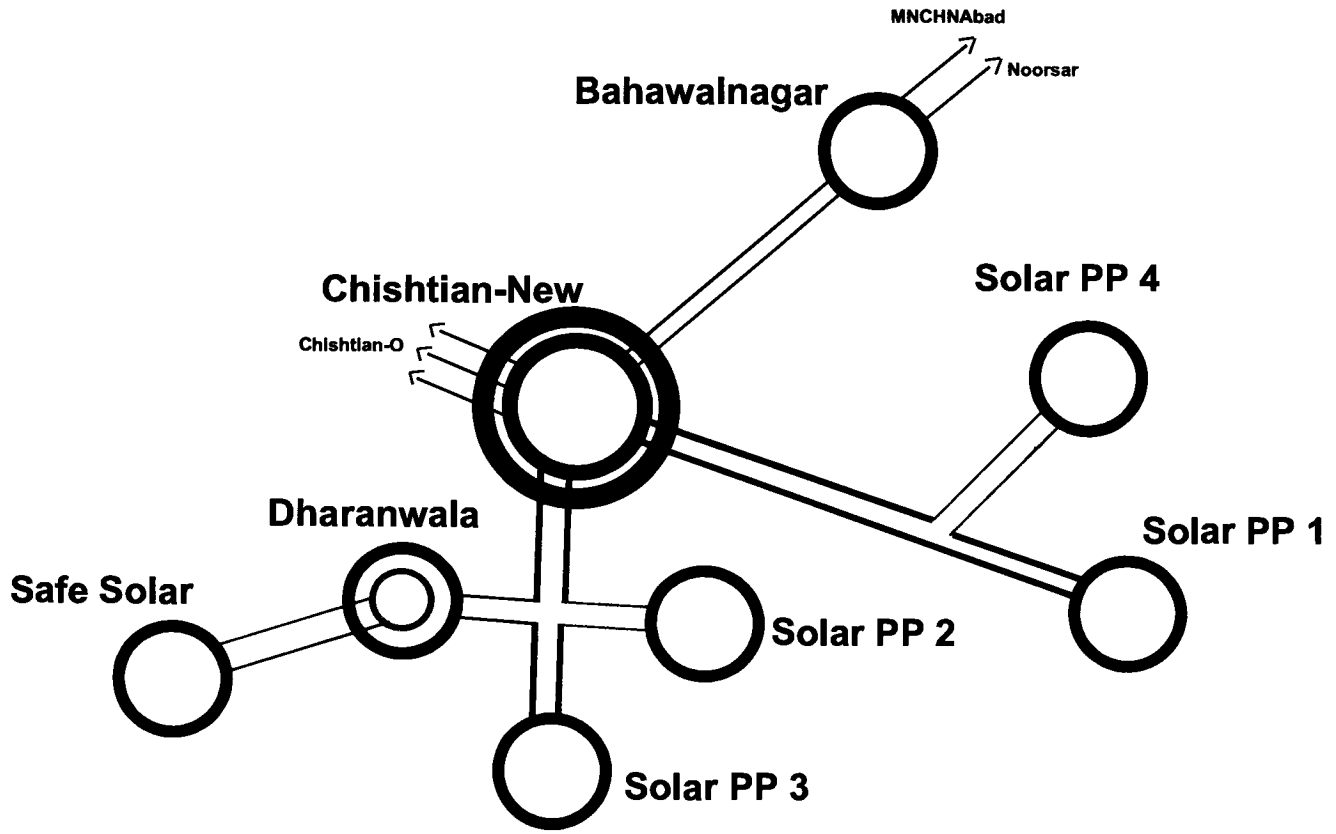
Annexure D -4 Schematic Diagram for Interconnection Arrangement/ Transmission Facilities

132kV Network Near Chishtian-New
With Safe Solar Power Plant, September 2016



Legend

220 kV	———
132 kV	———
11 kV	- - - -
Proposed 132 kV	———
Proposed 11 kV	———

Sketch-2			
Interconnection Study of Safe Solar PP			
Power Planners International			
DATE 2015	SHEET 1	DWG NO Safe Solar Sketch-2.DWG	REV

Generation Licence

Safe Solar Power (Pvt.) Limited

Chak 140/M, Dharanwala

District Bhawalnagar

In the Province of Punjab

Location Coordinates of the Generation Facility/Solar Power Plant/Solar Farm

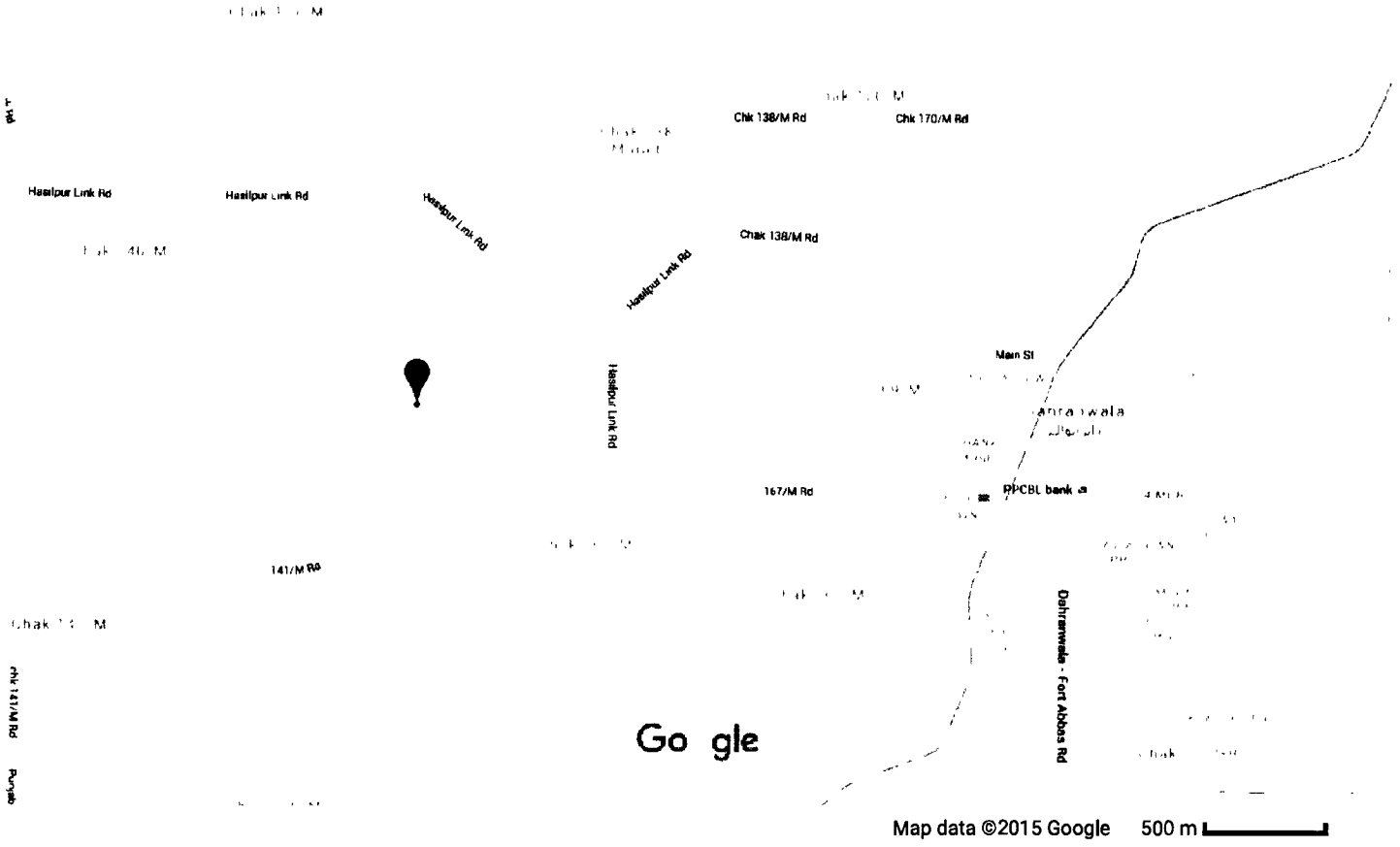
Node	Longitude (East)	Latitude (North)
1	E 72° 47.536	N 29° 36.073

Annexure D -3 Location Coordinates of the Generation facility/Solar Power Plant/Solar farm

Go gle Maps

29°36'07.0"N 72°47'53.0"E

SSPPL Solar Generation Facility - Location Close-Up



29°36'07.0"N 72°47'53.0"E

29.601944, 72.798056

Annexure D -2 Access of the generation facility/Solar Power Plant/Solar farm

Annexure D -1 Location of Generation facility /Solar Power Plant/Solar farm

Google Maps

29°36'07.0"N 72°47'53.0"E

SSPPL Solar Generation Facility - Google Earth

Imagery ©2015 DigitalGlobe, Map data ©2015 Google 500 m

29°36'07.0"N 72°47'53.0"E

29.601944, 72.798056

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STATEMENT OF REASONS IN SUPPORT OF THE PROPOSED MODIFICATION

1. **Stage of the Project:**

The Project is currently at the planning stage, therefore, the Generation License can be updated and developed with an inherent flexibility, and the Proposed Modification can be seamlessly made to the same.

2. **Location of the Project:**

It is respectfully submitted that the following series of events led to a change in the location of the Project from the QASP Site to the New Site:

(a) The Project was originally proposed to be established at QASP Site in light of the Government of Punjab's, Energy Department's, letter dated 07.02.2014 (bearing Ref. No. S.O.(C)(ED)4-5/2014) (enclosed as **Annex E-1**) whereby it was communicated to Cholistan Development Authority that the Company is allowed to conduct the feasibility study on the QASP Site as per the coordinates allocated to the Company *provisionally*, subject to the finalization of master plan of QASP and that it may be reallocated on the finalization of the master plan.

(b) Through Alternative Energy Development Board's ("**AEDB**") letter dated 05.12.2014 bearing Ref. No. B/3/2/SPV/GC (enclosed as **Annex E-2**) with subject title "*Land Allocation for Solar Power Projects (SPP) in Quid-e-Azam Solar Park, Lal Shoanra, Bahawalpur*", the Company was informed that the Government of Punjab has approved the evaluation criteria for allocation of land for development of solar power projects in QASP, and that the subject land will be allocated to the evaluated and eligible Letter of Interest holders of Punjab Power Development Board and AEDB.

(c) The aforesaid letter of AEDB also enclosed the relevant advertisements published in daily *Nawai-e-Waqt* (Lahore Edition) and *Daily Ausaad* (Islamabad Edition) dated 27.11.2014 (enclosed as **Annex E-2**) whereby the holders of Letters of Interests by PPDB and AEDB were invited to file applications/acceptance for placement of their respective projects in QASP as per the evaluation criteria.

(d) In response to the foregoing, the Company filed a letter of reservations dated 28.11.2014 to provide its reservations for the site (Enclosed as **Annex E-3**).

(e) A committee was formed to evaluate the received applications against the advertisement and make its recommendations; as per the committee's evaluation report, it was communicated to the Company by PPDB, Energy Department, through its letter dated 02.03.2015 bearing Ref No. PPDB/198/2015 (enclosed as **Annex E-4**) the application of the Company has not been recommended for placement of the Project in QASP Site.

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(f) To address any objections of the Company to the foregoing, a Grievance Redressal Committee ("**GRC**") was convened on 05.03.2015 at the Energy Department, 8th Floor, EFU Building, Jail Road Lahore at 10.00am (Minutes of the Meeting are enclosed as **Annex E–5)** wherein the following was discussed:

(i) It was decided that the Company is not recommended for allocation of land in QASP, Bahawalpur being non-compliant to the Evaluation Criteria;

(ii) The Representative of the Company/sponsor informed the GRC that they have already been granted a Generation License specifically for the QASP Site and that their acceptance of upfront tariff by NEPRA was based on the provisional land coordinated to them before initiation of the current land allocation process by the Punjab Government.

(iii) The GRC, considering the plea taken by the Sponsor of the Company, endorsed their viewpoint and recommended allocation of land to them at any adjacent land to them at any adjacent place of QASP on the premise that the Sponsor does not conform with the statement of conditions for land allocation in QASP.

(g) It is regrettably noted that up till the date of this Application, the Government of Punjab has not yet identified, assisted or allocated any land for the Company's Project. Due to the foregoing delay, the Company had no option but to proceed with acquiring private land of approximately 50 Acres at Dharanwala, District Bahwalpur, Punjab to ensure the completion of the Project before the expiry of its solar upfront tariff approved by NEPRA (enclosed as **Annex E-6)** and the Letter of Support dated 01.07.2015 issued to the Company by the AEDB (enclosed as **Annex E-7**). The arrangements for the Project land have been based on availability of evacuation and good solar resources.

Furthermore, kindly note that the Company also made a request for a change to the location of the Project from QASP to the New Site provided in its Letter of Support, which was approved by AEDB *vide* letter dated 03.08.2015 bearing Ref. No. B/3/2/SPV/SSPPL/14 (enclosed as **Annex H**). In view of the foregoing, the Authority is kindly requested to accept the Application and the Proposed Modification herein.

3. Project Commissioning Date:

As you are aware and as provided in the "*Decision of the Authority in the matter of Extension in Date of Financial Close for Solar Power Projects under Upfront Solar Tariff*" dated 04.12.2014 ("**Decision**") (enclosed as **Annex E-8**), the following series of events led to an extension to the deadline date of Financial Close from 31.03.2015 to 31.12.2015 by the Authority:

(a) The Authority determined the upfront tariff for solar PV power projects *vide* its decision dated 21.01.2014 whereby, the applicant opting for the upfront tariff was required to

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achieve financial close by 31.03.2015, provided that in case the applicant fails to achieve financial close by 31.03.2015 or generation license is declined to the applicant, the approved upfront tariff will no longer remain valid.

(b) Along with six other companies, the afore-said upfront tariff was also awarded to the applicant Company vide "*Approval of National Electric Power Regulatory Authority in the matter of Application of Safe Solar Power (Private) Limited for Unconditional Acceptance of Upfront Solar Tariff for 10 MW Solar Power Plant*" [Case No. NEPRA/TRF-261/SSPPL-2014], notified through letter dated 22.04.2014 bearing Ref. No. NEPRA/TRF-261/SSPPL-2014/3993-3995 ("**SSPPL Approved Upfront Tariff**") (enclosed as **Annex E-9**).

(c) Access Solar (Private) Limited ("**ASPL**"), being one of the companies that were awarded the afore-said upfront tariff, *vide* its letter dated 14.04.2014 submitted that: (i) in order to meet the financial close & commercial operations deadlines, it requires the Energy Purchase Agreement ("**EPA**") and Implementation Agreement ("**IA**") from AEDB; (ii) the EPA/IA are still under development, thus are not available to any solar project developer; and (iii) the deadline for financial close, in the aforesaid upfront tariff should be adjusted for the delay in finalization of the IA and EPA; and (iv) the countdown for financial close should begin only once the finalized EPA and IA have been provided by AEDB. Similar request was also lodged by Access Electric (Private) Limited.

(d) AEDB vide its letter dated 28.08.2014 bearing Ref. No. U.O.No. B/3/2/SPV/GC/14-9630 submitted that NEPRA may consider a suitable extension in deadline of Financial Close in order to provide sufficient time to the independent power producers to achieve the same.

(e) The Authority considered the request of ASPL and decided to initiate review proceedings in terms of section 7(2)(g) of the NEPRA Act, 1997 read with Regulation 3(1) of NEPRA (Review Procedure) Regulations, 2009, and hold a public hearing in the matter, notice of which was published in newspapers on 13.09.2014 and 19.09.2014.

(f) Issues were framed for consideration in the hearing and comments were received from a few entities. A public hearing was held on 29.09.2014 in NEPRA Tower and was participated by the representatives from ASPL, Sanjwal Solar Power (Private) Limited, RIAA Law (now RIAA Barker Gillette), Asia Petroleum, IESCO, PPDB and MEPCO.

(g) After consideration of ASPL's and AEDB's request and the comments submitted by the stakeholders, the Authority was of the following opinion:

(i) The purpose of announcement of the upfront tariff (i.e. to reduce the time in processing and implementing of the project and availability of the much needed electricity in the shortest period of time) had been defeated due to one or the other reason;

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(ii) The IA and EPA are essential documents for achieving the financial close by any company and in the absence of these documents, it would be unjustified to expect from the companies who opted for upfront tariff to achieve their financial close within the deadline given in the upfront tariff determination.

(iii) Since there is no default on the part of companies who opted for upfront tariff and they could not achieve financial close due to failure of AEDB to finalize the IA & EPA within the stipulated time, the Authority has decided to review the paragraph 21(V)(ix) of its solar upfront tariff determination and has decided to extend the period of financial close by nine (9) months i.e. **till 31.12.2015**.

Reference is specifically made to paragraph 8.1 (*Order*) of the Decision which reads as under:

> *"The deadline for financial close of 31st March 2015 in the Upfront Solar Tariff notified vide SRO No. 158(1)/2014 dated 5th March 2014 is being extended till 31st December 2015. The extension in date of financial close will be applicable to the following companies whose tariffs have been approved under the upfront solar tariff:*
>
> - *Access Solar (Private) Limited;*
> - *Access Electric (Private) Limited;*
> - *Sanjwal Solar Power (Private) Limited;*
> - *Safe Solar Power (Private) Limited;*
> - *Bukhsh Solar (Private) Limited;*
> - *Blue Star Hydro (Pvt) Limited."*

In view of the foregoing, since the Authority has granted an extension to the deadline for financial close till 31.12.2015, acceptance of the Proposed Modification shall ensure that the Generation License is up to date in all aspects of the Project. Therefore, it is requested that the Application be accepted by the Authority.

4. NET Capacity Factor:

Reference is made to the "*Corrigendum Approval of National Electric Power Regulatory Authority in the matter of Application of Safe Solar Power (Private) Limited for Unconditional Acceptance of Upfront Solar Tariff for 10 Mw Solar Power Plant*" [Case No. NEPRA/TRF-261/SSPPL-2014] communicated *vide* letter dated 22.05.2014 bearing Ref. No. NEPRA/TRF-261/SSPPL-2014/5275-80 ("**Corrigendum**") (enclosed as **Annex E-10**), whereby a number of corrections were made to the SSPPL Approved Upfront Tariff.

The Net Plant Capacity Factor was originally approved in the SSPPL Approved Upfront Tariff as 16.89%, however pursuant to the Corrigendum, the same was amended by the Authority to read 17.50% instead. The Proposed Modification, therefore, aims in ensuring that the Generation License is updated and reflects this change.

Usman Asghar

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5. **Public Interest:** The Proposed Modification shall ensure that the Generation License, available on NEPRA's website, is up-to-date and reflects the current arrangement of the Company in relation to the Project. Therefore, it is submitted that the Proposed Modification is not against public interest.

6. **Compliance with Applicable Laws:** Please also note that the Proposed Modification is in compliance with the applicable laws, in particular Regulation 10(5) of the Regulations, and:

(a) Does not adversely affect the performance by the Company of its obligations;
(b) Does not cause the Authority to act or acquiesce in any act or omission of the Company in a manner contrary to the provisions of the NEPRA Act or the rules or regulations made pursuant to the NEPRA Act;
(c) Is or is likely to be beneficial to the consumers;
(d) Is reasonably necessary for the Company to effectively and efficiently perform its obligations under the Generation License; and
(e) Is reasonably necessary to ensure the continuous, safe and reliable supply of electric power to the consumers keeping in view the financial and technical viability of the Company.

Ehsan Sehgal

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Annexure E -1 Government of Punjab's Energy Department letter dated 07.02.2014

NO S O(C)(ED) 4-5/2014
GOVERNMENT OF THE PUNJAB
ENERGY DEPARTMENT
Dated Lahore the 7th February, 2014

To

ATIF SALMAN MAZHAR

The Managing Director
Cholistan Development Authority
District Bahawalpur

SUBJECT - **ALLOCATION /EARMARKING OF LAND FOR 10 MW SOLAR PROJECT IN QA SOLAR PARK, BAHAWALPUR**

I am directed to refer to this department's letter of even No dated 29.01.2014 on the above noted subject

2 It is informed that M/s Safe Solar Power (Pvt.) Ltd. holder of LOI from AEDB to develop 10-MW Solar PV Power Project in Cholistan Bahawalpur The said Company is hereby alloweo to conduct the feasibility study as per following coordinates (Copy of marked map is attached):

(Sqr No. 4, 8 &12 of Block No. 371) & (Sqr No. 1, 5 & 9 of Block No. 372)

3 Further, these coordinates are allocated provisionally subject to the finalization of master plan of QASP and may be reallocated on the finalization of master plan

SECTION OFFICER (Conservation)

C.C.

1. The Director (Solar) Alternative Energy Development Board (AEDB) Government of Pakistan Ministry of Water and Power Islamabad
2. M/s Safe Solar Power (Pvt.) Limited, 28-Street 24 F-8/2 Islamabad
3. The Managing Director Punjab Power Development Board, Energy Department
4. PS to Additional Chief Secretary (Energy), Energy Department.

letter not available with me.

Annexure E -2 Alternative Energy Development's board letter dated 05.12.2014

[illegible] of PAKISTAN
[illegible] Energy Development Board ([illegible])
Ministry of Water and Power
[illegible] Foundation Building
[illegible]
[illegible]

[illegible] [illegible]

[illegible]

Government of Punjab has approved the evaluation criteria for allocation [illegible] development of solar power [illegible] in Quaid e Azam Solar Park (the [illegible] Bahawalpur (Punjab). Land will be allocated to the evaluated [illegible] of Punjab Power Development Board (PPDB) and Alternative [illegible]

[illegible] herewith the advertisements published [illegible] daily [illegible] (Islamabad edition) dated [illegible] [illegible] Department [illegible]).

[illegible] information please.

[illegible]
Director [illegible]

[illegible]

i. [illegible] Director, M/s [illegible] (Pvt) Ltd, Almas Tower, Buksh [illegible] [illegible] Road, Gulberg [illegible]
ii. [illegible] President, M/s [illegible] Energy, H No. 3, Street No. [illegible] Islamabad.
iii. Ahmed [illegible] Gulzar, Director, M/s [illegible] Pakistan Pvt Ltd, Suite No. 803 [illegible] Floor, City Towers, Gulberg II, Lahore. Mr. Douglas C. [illegible] Executive Officer, M/s Table Rock Associates 1450 Candleridge Drive, Boise Idaho 83712 USA
iv. Afshan Meer, CEO, M/s Safe Solar Power (Pvt.) Ltd. House No.28, Street No 24
v. F-8/2, Islamabad
vi. Mr Kumayl Khaleeli, Managing Director, M/s R E Solar (Pvt.) Ltd 68 B, Sindhi Muslim Housing Society, Karachi.

viii. [illegible]

ix. [illegible]

x. Mr. Jean-Marc Otero del Val, President (Chairman), M/s TOTAL E[illegible] Nouvelles Ventures 24 Cours Michelet La Defense 10, 92069 Paris La Defense Cedex France

Cc:

- PS to CEO, AFDB
- APS to DG (F&A)

245 161 16 UAN 111-222-007 74

POWER PROJECTS (SPP) IN QUAID-E-AZAM SOLAR PARK, LAL SOHANRA, BAHAWALPUR, CHOLISHTAN (PUNJAB)

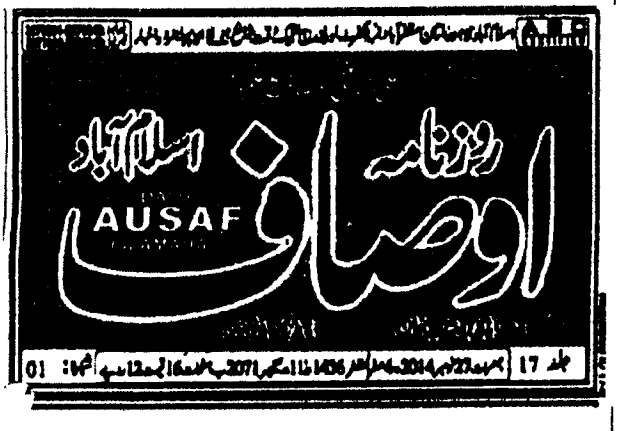
Government of the Punjab Energy Department invites applications from LOI holders of Punjab Power Development Board (PPDB) and Alternative Energy Development Board (AEDB) for placement of their respective projects in Quaid-e-Azam Solar Park, Lal Sohanra, Bahawalpur, Cholistan (the "Park") as per the evaluation criteria under Para 6(c) of Statement of Conditions (No. 1475-2014/694-CWS.111 dated May 09, 2014) to lay down a fair, transparent and open regime for allocation of space in the Park.

Interested LOI holder(s) are required to submit their letter(s) of acceptance for placement of project(s) in the Park, as per above referred evaluation criteria, to the office of undersigned within 15 days of this Advertisement.

The evaluation criteria is available at the Energy Department's Website (www.energy.punjab.gov.pk).

Additional Chief Secretary (Energy)
Energy Department,
Government of the Punjab,
8th Floor, EFU House, Jail Road, Lahore.
Ph # 042-99268017 & 99268019

(PL-1525)



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LAND ALLOCATION FOR SOLAR POWER PROJECTS (SPP)

IN QUAID-E-AZAM SOLAR PARK, LAL SOHANRA, BAHAWALPUR, CHOLISHTAN (PUNJAB)

Government of the Punjab Energy Department invites applications from LOI holders of Punjab Power Development Board (PPDB) and Alternative Energy Development Board (AEDB) for placement of their respective projects in Quaid-e-Azam Solar Park, Lal Sohanra, Bahawalpur, Cholistan (the "Park") as per the evaluation criteria under Para 6(c) of Statement of Conditions (No. 1475-2014/694-CWS. 111 dated May 09, 2014) to lay down a fair, transparent and open regime for allocation of space in the Park.

Interested LOI holder(s) are required to submit their letter(s) of acceptance for placement of project(s) in the Park, as per above referred evaluation criteria, to the office of undersigned within 15 days of this Advertisement.

The evaluation criteria is available at the Energy Department's Website (www.energy.punjab.gov.pk).

Annexure E -3 SSPL letter of Reservations dated 28.11.2014

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OFFICE COPY

No: PPDB/SSPPL/SOC/2014 01

Date. - 28th November 2014

Mr. Mohammad Jehanzeb Khan,
Additional Chief Secretary,
Energy Department,
Government of Punjab,
Lahore.

Subject: - **RESERVATIONS REGARDING EVALUATION CRITERIA UNDER PARA-6 (C) OF STATEMENT OF CONDITIONS (SOC) FOR PLACEMENT OF SOLAR POWER PROJECTS IN QUAID-E-AZAM SOLAR PARK, LAL SOHANRA, BHAWALPUR, CHOLISTAN (THE "PARK")**

Dear Sir,

With reference to the 10 MW Safe Solar Power Project being developed under **LOI No**: B/3/2/SPV/SSP/28 **issued by** the Alternative Energy Development Board (AEDB) **dated** January 13, 2014 with tariff determination by NEPRA as per the upfront solar tariff mechanism vide **Determination No:** NEPRA/TRF-261/SSPPL-2014/3996 dated April 22, 2014, Subject: - Approval of National Electric Power Regulatory Authority in the matter of application of Safe Solar Power (Pvt) Ltd for unconditional Acceptance of upfront solar tariff for 10 MW Solar Power Plant [Case No. NEPRA/TRF-261/SSPPL-2014], we would like to express our grave concerns regarding the **Evaluation Criteria Under Para-6 (C) Of Statement Of Conditions (SOC) For Placement Of Solar Power Projects In Quaid-E-Azam Solar Park, Lal Sohanra, Bhawalpur, Cholistan (The "Park).**

While we are ready to comply with all other terms and conditions of the SOC, including the Development Duration of fifteen months (15) and furnishing of a Bank Guarantee amounting to US 3000$/MW under the Project Commitment Agreement, it would not be possible for us to accept section "(iii) b" regarding an undertaking for ensuring a tariff application of 14 USD Cents/KwH, and section "(v)" requiring an tariff determination application to be submitted to NEPRA within three (03) months of issuance of the Letter of Allotment (LOA) *as we have already made such application and would be in direct violation of the Tariff Determination already made by NEPRA as cited above.*

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The terms and conditions of the SOC besides being strict seem to be prohibitive in nature towards both national and international investors.

We would therefore kindly request the competent authority to please revise and reconsider the above mentioned terms and conditions stipulated in the SOC as they may have the undesired effect of delaying and discouraging investment/development in the already troubled Energy Sector of Pakistan.

Looking forward to a favorable response and your kind support on the subject.

Best Regards,

Raja Naseer Ahmed
Diretor

C.C: Mrs. Saniya Awais, Managing Director, PPDB, Lahore.

Annexure E -4 PPDB – Energy department letter dated 02.03.2015

Put proper copy

No. 1758 /2015
PUNJAB POWER DEVELOPMENT BOARD
ENERGY DEPARTMENT
[illegible] Irrigation Secretariat
[illegible] Lahore
[illegible] Fax [illegible]
Dated 2-03-2015

M/s. Safe Solar Power (Pvt.) Ltd.
House No 28, Street No 24, F-8/2
Islamabad
(Tel: 051-8358477 Fax: 8358499)

Subject: **REQUEST FOR ALLOCATION OF LAND FOR DEVELOPMENT OF SOLAR POWER PROJECTAT THE QUID-E-AZAM SOLAR PARK CHOLISTAN BAHAWALPUR**

Please refer to the advertisement published in Daily "Nawa-e-Waqt" Lahore dated 27.11.2014 for inviting applications from LOI holders of PPDB & AEDB for land allocation in Quaid-e-Azam Solar Park Cholistan Bahawalpur Punjab (the "Park") on prescribed terms & conditions. Subsequent to the referenced advertisement, a Committee was formed to evaluate the received applications and make its recommendations. As per the Evaluation Report of the Committee, the application of M/s. Safe Solar Power (Pvt.) Ltd. has not been recommended for placement of subject project in the Park.

In context of the above, the Grievance Redressal Committee (GRC) has been convened on March 5, 2015 at Energy Department 8th Floor, EFU Building Jail Road Lahore at 10.00 am. If you have any objection regarding the subject matter, you may appear before the above cited Committee at given time and venue.

With Regards,

Managing Director
Punjab Power Development Board (PPDB)

C.C:

1) P.S. to Additional Chief Secretary (Energy), 8th Floor EFU Building, Jail Road, Lahore.

Annexure E-5 Minutes of meetings of the Grievance Redressal Committee convened on 05.03.2015

GOVERNMENT OF THE PUNJAB
ENERGY DEPARTMENT

Subject. **MINUTES OF MEETING OF GRIEVANCE REDRESSAL COMMITTEE (GRC) REGARDING EVALUATION FOR ALLOCATION OF LAND IN QUAID-E-AZAM SOLAR PARK, LAL SOHANRA, BAHAWALPUR " DATED 05-03-2015 AT 10.00AM**

A meeting of Grievance Redressal Committee (GRC) constituted vide No. SO (EC) (ED) 04-5/2014 was held on 05-03-2015 at 10.00 AM under the Chairmanship of Additional Secretary (I) in the Committee room of Energy Department EFU house Jail road, Lahore to consider the grievances of the Sponsors of PPDB / AEDB against evaluation for allocation of land in Quaid-e-Azam Solar Park (QASP) Bahawalpur for placement of their solar power plants at the said Park

2 The Chair welcomed the participants and in his opening remarks briefed the participants about the purpose of the meeting. The issues discussed, points raised and the decisions arrived at during the meeting are as under.

Sr. No.	Name of Sponsor	Remarks of Evaluation Committee	Grievances / Contentions of Sponsor	Discussion & Decision of GRC
1	Associated Technologies (PVT) Ltd.	Not recommended for allocation of land in QASP Bahawalpur being non-compliant to the conditions (iii-a), (iii-b) and (vi) of Evaluation Criteria. Also the validity of LOI has not been confirmed by the AEDB	The representative of the Sponsor reiterated its conditional stance as conveyed earlier in their letter of acceptance	After hearing the sponsor at length, the GRC unanimously upheld the recommendations of Evaluation Committee, by virtue of conditional acceptance letter from the Sponsor.
2.	Total Energies Nouvelles Ventures	Not recommended for allocation of land in QASP Bahawalpur being non-compliant fully to the conditions (iii-a) & (iii-b) of Evaluation Criteria.	The representative of the Sponsor reiterated its conditional stance as conveyed earlier in their letter of acceptance	After hearing the sponsor at length, the GRC unanimously upheld the recommendations of Evaluation Committee, by virtue of conditional acceptance letter from the Sponsor

3	Welt Konnect (Pvt) Ltd/ (M/S CWE & WK Consortium)	Not recommended for allocation of land in QASP Bahawalpur being non-compliant to the conditions (iii-b) of Evaluation Criteria.	The Sponsor's representative was of the view that letters communicated by them to the Energy Department have been misconstrued by the Evaluation Committee. As a matter of fact, they have given unconditional acceptance letter	After hearing the sponsor at length, the GRC was of unanimous view that the Sponsor has given acceptance in line with the requirement of SOC. Therefore may be considered for allocation of land in QASP
4	DACC Power Generation	Recommended subject to clear commitment by sponsor, for all conditions of evaluation criteria	Representative of the Sponsor took the plea that AEDB has conveyed provision of extended period LOI shortly However, there is no firm commitment on part of AEDB in this regard.	After hearing the sponsor at length, the GRC unanimously upheld the recommendations of Evaluation Committee considering no firm commitment on part of AEDB, thus making it non-compliant.
5	Safe Solar Power (Pvt.) Ltd.	Not recommended for allocation of land in QASP Bahawalpur being non-compliant to the conditions (iii-b) of Evaluation Criteria.	Representative of the Sponsor informed the GRC meeting that they have already been granted Generation License specifically for QASP and acceptance of Upfront Tariff by NEPRA based on provision of provisional land coordinates to them before initiation of current land allocation process by Punjab Government. Consequently, their case is required to be reviewed separately.	The GRC considering the plea taken by the Sponsor endorses their viewpoint and recommends allocation of land to them at any adjacent place of QASP on the premise that the Sponsor does not conform with the Clause 6 (b) (iii) of the Statement of Conditions for land allocation in QASP specifically.
6	Storm Harbour	Not recommended for allocation of land in QASP Bahawalpur being non-compliant to the conditions (iii-b) and (vi) of Evaluation Criteria.	The Sponsor's representative was of the view that letters communicated by them with the Energy Department have been misconstrued by the Evaluation Committee As a matter of fact, they have given unconditional acceptance letter.	After hearing the sponsor at length, the GRC was of unanimous view that the Sponsor has given acceptance with some suggestions and not pre-conditions Therefore may be considered for allocation of land in QASP

7	Nizam Power (11.3 MW)	Not recommended for allocation of land in QASP Bahawalpur as LOI relates to Balochistan	The representative of the Sponsor reconfirmed issuance of Letter of Interest to them by AEDB for location of the project in the Baluchistan Province. However, was of the view that they are persuading AEDB for change of LOI from Baluchistan to Punjab.	After hearing the sponsor at length, the GRC unanimously upheld the recommendation of Evaluation Committee by virtue of issuance of LOI to them by AEDB for location of the project in Baluchistan Province instead of QASP.
8	Engro Power Gen.	Not recommended for allocation of land in QASP Bahawalpur as Bank Guarantee withdrawn by sponsor vide letter dated 23-12-2014.	The representative of the Sponsor conveyed that their letter of acceptance was based on Statement of Conditions dated May 09, 2014 for allocation of land prior to amendment made therein vide Section 6 (c). As such, they did not participate in the prevalent process for allocation of land in QASP	After hearing the sponsor at length, the GRC unanimously upheld the recommendation of Evaluation Committee by virtue of withdrawal of LOI's Bank Guarantee by them and nonparticipation in the prevalent land allocation process as conveyed by the Sponsor's representative in the GRC meeting
9	Nizam Energy (5.65 MW)	Not recommended for allocation of land in QASP Bahawalpur as LOI relates to Balochistan.	The representative of the Sponsor reconfirmed issuance of Letter of Interest to them by AEDB for location of the project in the Baluchistan Province However, was of the view that they are persuading AEDB for change of LOI from Baluchistan to Punjab.	After hearing the sponsor at length, the GRC unanimously upheld the recommendation of Evaluation Committee by virtue of issuance of LOI to them by AEDB for location of the project in Baluchistan Province instead of QASP
10	Trans Tech Pakistan	Orders of AEDB suspended by additional distnct and session judge, Islamabad till 5.1.15, decision awaited. Recommended subject to final decision of court and recommendation of AEDB	Representative of the Sponsor took the plea that they are endeavoring for out of court settlement with AEDB regarding status of their LOI	After hearing the Representative of the Sponsor at length, the GRC unanimously upheld the recommendations of Evaluation Committee by virtue of undecided status of LOI of the Sponsor being subjudice
11	Table Rock Association	Recommended in view of general acceptance of the criteria subject to clear commitment by sponsor, for all conditions of evaluation criteria and also subject to performance certificate by AEDB, if LOI is valid.	Representative of the Sponsor took the plea that AEDB has conveyed provision of extended period LOI shortly However, there is no firm commitment on part of AEDB in this regard.	After hearing the Representative of the Sponsor at length, the GRC unanimously upheld the recommendations of Evaluation Committee considering no firm commitment on part of AEDB, thus

				making it non-compliant
12	Hecate Energy	Recommended in line with condition vi(b) of evaluation criteria subject to validation of LOI by AEDB	Representative of the Sponsor took the plea that AEDB has conveyed provision of extended period LOI shortly However, there is no firm commitment on part of AEDB in this regard.	After hearing the Representative of the Sponsor at length, the GRC unanimously upheld the recommendations of Evaluation Committee considering no firm commitment on part of AEDB, thus making it non-compliant
13	Hecate Energy	Recommended subject to validation of LOI by AEDB	Representative of the Sponsor took the plea that AEDB has conveyed provision of extended period LOI shortly However, there is no firm commitment on part of AEDB in this regard.	After hearing the Representative of the Sponsor at length, the GRC unanimously upheld the recommendations of Evaluation Committee considering no firm commitment on part of AEDB, thus making it non-compliant

Note: M/S Forte despite intimation about convening of GRC Meeting did not appear.

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

5/3/15

Additional Secretary (I),
Energy Department
(Chairman)

5/3/15

Manager Finance
PPDB, Energy Department
(Member)

5.3.15

Deputy Secretary (Energy Council),
Energy Department
(Member)

5/3/2015

Manager Renewable Energy,
PPDB, Energy Department
(Member)

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STATEMENT OF THE IMPACT ON THE TARIFF, QUALITY OF SERVICE AND THE PERFORMANCE BY THE LICENSEE/COMPANY AND ITS OBLIGATIONS UNDER THE GENERATION LICENSE

Impact on Tariff: The Company is of the view that there will not be any adverse impact on the SSPPL Approved Upfront Tariff on acceptance of this application by the Authority for the Proposed Modification of the Generation License.

Impact on Quality of Service and the Performance by the Company/Licensee:

The Company certifies that the quality of service and the performance by the Company under the Generation License shall not be negatively affected on acceptance by NEPRA of this application for the Proposed Modification of the Generation License. Furthermore, it is kindly submitted as under:

Diminished Grid Line Losses: The Company expects that the change of location to the New Site will lead to a better quality of service as the interconnection study of the 132KV/11KV grid (Sub-Station) at Dharanwala reveals limited line losses. Furthermore, it is anticipated that the close accessibility of the Project to the grid will also prove beneficial in providing uninterrupted service to the power distributor.

Irradiation Levels: Geotechnical surveys and radiation tests of the New Site confirm that the level of solar radiation (irradiation levels) at the New Site is comparable to the levels observed at the QASP Site, therefore, the Company's power produced from the solar Project will be in line with the original Generation License.

Impact on Obligations:

It is anticipated that the obligations of the Company under the Generation License shall not be adversely affected on acceptance by the Authority of this application for the Proposed Modification of the Generation License.

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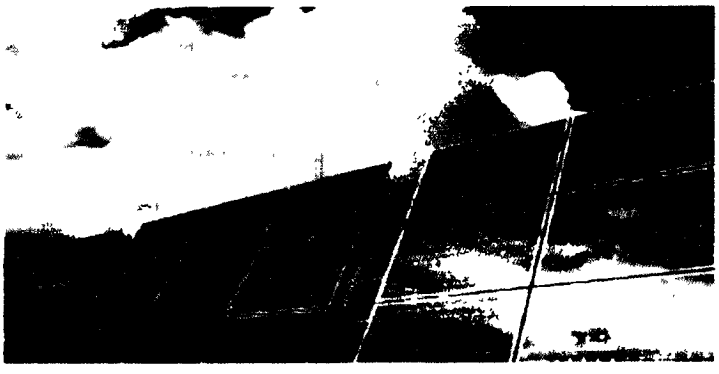
Report No. PPI-85.2-Draft/15

INTERCONNECTION STUDY

For

10 MW Solar Power Project by Safe Solar Pvt. Ltd near Dharanwala, Punjab



Draft Report
(September 2015)

POWER PLANNERS INTERNATIONAL LTD.

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Executive Summary

- ❖ The study objective, approach and methodology have been described and the plant's data received from the client Safe Solar Pvt. Ltd has been validated.
- ❖ The expected COD of the project is in the year 2016. Therefore the month of September 2016 have been selected to carry out the study as it will help determine the maximum impact of the project.
- ❖ The MEPCO system data as available with PPI for other studies have been used.
- ❖ The nearest substation of MEPCO is Dharanwala 132/11 kV. The following scheme of interconnection of Solar Power Plant by Safe Solar to evacuate maximum power of 10 MW is envisaged and studied in detail:
    - A direct 11 kV double circuit of 1.5 km length using Osprey conductor to be laid from 11 kV Bus Bar of Safe Solar to each one of the two 11 kV bus bars of Dharanwala 132/11 kV substation.
    - In this context two 11 kV breaker/line bays need to be added in the 11 kV switchgear hall of Dharanwala 132/11 kV Substation.
- ❖ The following new additions have been proposed at 132 kV
    - Two loops with two 100 MW solar power plants each have been proposed to be connected to Chishtian-New.
    - The first loop comprises of two 100 MW Solar Power Plants each (named Solar-PP-1 and Solar-PP-4 for future reference).
    - The second loop comprises of two 100 MW Solar Power Plants each (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 kV grid station.
- ❖ Detailed load flow studies have been carried out for the peak load conditions of September 2016 for the proposed scheme under normal and N-1 contingency conditions for the scenarios considered in this study to meet the reliability criteria.
- ❖ Steady state analysis by load flow reveals that proposed scheme is 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 Safe Solar Power Plant at 11 kV, and the substations of 132/11kV in its vicinity. We find that the fault currents for the proposed scheme are much less

than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from the Safe Solar Power Plant.

The maximum short circuit level of 11 kV bus bar of Safe Solar Power Plant 11 kV is 8.23 kA and 10.36 kA for 3-phase and 1-phase faults respectively for the year September 2016. Therefore industry standard switchgear of the short circuit rating of 25 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.

- The dynamic stability analysis of proposed scheme of interconnection has been carried out for September 2016. The stability check for the worst case of three phase fault on the 11 kV bus bar of the Safe Solar power plant substation followed by the final trip of 11 kV circuit connected to this substation has been performed for fault clearing of 9 cycles (180 ms) as understood to be the maximum fault clearing time of 11 kV protection system. The system is found to retain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Dharanwala 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

Report Contents

1. Introduction

1.1 Background

Safe Solar (Private) Limited is setting up a 10 MW solar power plant near Dharanwala, Punjab. The site of the proposed project is located in the concession area of Multan Electric Power Company Limited (MEPCO). The peak AC net output planned to be generated from the project is about 10 MW which will start commercial operations by the year 2016. The electricity generated from this project will be supplied locally to the Dharanwala Grid Station and to the MEPCO network through the 132/11 kV grid located in the vicinity of this project.

1.2 Objectives

The overall objective of the Study is to develop an interconnection scheme between Safe Solar Power Project and MEPCO 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 a scheme of interconnections at 11 kV 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 and that voltage levels are within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at the Safe 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	0.95 Lagging; 0.95 Leading (for conventional synchronous generators but would not be applicable to solar PP)

Dynamic/Transient:

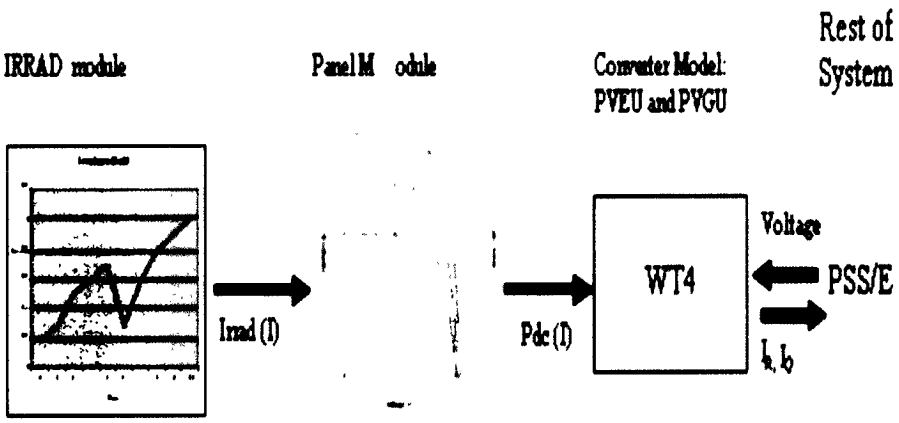
- The system should revert back to normal condition after the transients have died down without losing synchronism with good damping. For 11 kV the total maximum fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 180 ms (9 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

Voltage sensor time constant = 1.1 s

2.2 Network data

The 11 kV and 132 kV networks available for interconnection to Safe Solar Power Plant are as shown in Sketches 1 and 2 in Appendix-A.

The PEPCO/MEPCO system data of National Grid have been assumed in the study as already available to PPI.

3. Study Approach and Methodology

3.1 Understanding of the Problem

The 10 MW Solar Power Plant by Safe Solar (Pvt.) Limited is going to be a Photovoltaic (PV) based solar project embedded in the 11kV distribution network of Dharanwala. It would run almost all the months of the year though with some variation in its output due to variation in the intensity of light during winter and rainy season.

The existing nearest grid station available for interconnection is Dharanwala 132/11 kV Substation. The addition of this source of power generation embedded in local distribution network of this area shall provide relief to Dharanwala 132/11kV substation feeding the local network and also help 11 kV network in terms of improving line losses and voltage profile. The 11 kV network surrounding Dharanwala has significant load demand, therefore most of the power from the Safe Solar Power Plant will be utilized locally in meeting this load demand.

The adequacy of MEPCO network of 132 kV in and around the proposed site of Safe Solar Power Plant has been analysed 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 September 2016 considering maximum AC out of 10 MW for the solar plant by Safe Solar (Pvt.) Limited, comprising all 500 kV, 220 kV and 132 kV system and envisaging the load forecast, the generation additions and transmission expansions for that year particularly in MEPCO.
- The project is expected to be completed by 2016 Therefore the month of September 2016 has been selected to carry out the study as it will allow the maximum impact of the project to be judged.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, has been developed.

- 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, transient stability study and power quality analysis to check the strength of the plant and the proposed interconnection scheme under disturbed conditions.
- Determine the appropriate 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 MEPCO interconnection facilities at the time of commissioning of Safe Solar Power Project would be Dharanwala 132/11 kV Substation.

The existing 132 kV network available around these 132 kV grid station is shown in Sketch-1 in Appendix-A.

Given the physical proximity of Dharanwala to Safe Solar power plant and the fact that the other facilities are at a considerable distance from the plant, the most feasible interconnection of the Safe Solar Power Plant will be with Dharanwala 132/11 kV substation.

4.2 The Scheme of Interconnection of Solar Power Plant

Keeping in view the above mentioned 11 kV and 132 kV network available in the vicinity of the site of the Safe Solar Power Plant, the interconnection scheme has been developed as shown in Sketch-2 in Appendix A by laying down direct 11 kV double circuit of 1.5 km length using Osprey conductor from 11 kV Bus Bar of Safe Solar to each one of the two 11 kV bus bars of Dharanwala 132/11 kV substation.

4.3 Proposed additions at 11 kV in Dharanwala 132/11 kV Substation

Two breaker/panels of 11 kV along with respective protection equipment would be required to be added in 11 kV switchgear hall of Dharanwala 132/11kV substation to provide connection to direct 11 kV circuits from this Solar Power Plant.

5. Detailed Load Flow Studies

5.1 Load Flow without Safe Solar Power Plant, September 2016

A base case has been developed for the peak load case of September 2016, using the network data of Safe Solar PP and MEPCO network.

The results of load flow for this case are shown in Exhibit 0.0 of Appendix-B. The system plotted in this Exhibit shows 132 kV network feeding Dharanwala connected to its surrounding substations through Chistian-New. Also the 11 kV network connected to Dharanwala has been modeled showing each substation as an 11 kV bus bar 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.

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

Exhibit 0.0	Solar-PP-1 to Chishtian-N 132 kV Single Circuit Out
Exhibit 0.1	Solar-PP-2 to Chishtian-N 132 kV Single Circuit Out
Exhibit 0.2	Solar-PP-2 to Solar-PP-3 132 kV Single Circuit Out
Exhibit 0.3	Solar-PP-3 to Dharawala 132 kV Single Circuit Out
Exhibit 0.4	Dharawala to Chishtian-N 132 kV Single Circuit Out
Exhibit 0.5	Chishtian-N to Bhawalnagar 132 kV Single Circuit Out
Exhibit 0.6	Chishtian-N to Chishtian-O 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 the MW or MVAR flows in the 11 kV or 132 kV network available in the vicinity of Safe Solar Power Plant for its connectivity under normal and contingency conditions prior to its connection.

5.2 Load Flow with Safe Solar Power Plant, September 2016

The scheme of interconnection modeled in the load flow for Safe Solar Power Plant consists of a direct 11 kV double circuit of 1.5 km length using Osprey conductor from 11 kV Bus Bar of Safe Solar to each one of the two 11 kV bus bars of Dharanwala 132/11 kV substation. The results of load flow with Safe Solar Power Plant interconnected as per the proposed scheme are shown in Exhibit 1.0 in Appendix-B. The power flows on the circuits are 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.

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

Exhibit 1.1	Safe Solar to Dharanwala T-1 11 kV Single Circuit Out
Exhibit 1.2	Safe Solar to Dharanwala T-2 11 kV Single Circuit Out
Exhibit 1.3	Safe Solar to Dharanwala T-1 132/11 kV Single Transformer Out
Exhibit 1.4	Solar-PP-1 to Chishtian-N 132 kV Single Circuit Out
Exhibit 1.5	Solar-PP-2 to Chishtian-N 132 kV Single Circuit Out
Exhibit 1.6	Solar-PP-2 to Solar-PP-3 132 kV Single Circuit Out
Exhibit 1.7	Solar-PP-3 to Dharawala 132 kV Single Circuit Out
Exhibit 1.8	Dharawala to Chishtian-N 132 kV Single Circuit Out
Exhibit 1.9	Chishtian-N to Bhawalnagar 132 kV Single Circuit Out
Exhibit 1.10	Chishtian-N to Chishtian-O 132 kV Single Circuit Out

5.4 Conclusion of Load Flow Analysis

From the analysis carried out above, we conclude that the proposed interconnection scheme of a direct 11 kV double circuit of 1.5 km length using Osprey conductor from 11 kV Bus Bar of Safe Solar to each one of the two 11 kV bus bars of Dharanwala 132/11 kV substation ensures its reliability and availability under all events of contingencies considered in this study i.e. planned or forced outages.

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been adopted 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 2016 i.e. all the generating units have been assumed on-bar in fault calculation simulations.

6.2 Fault Current Calculations without Safe Solar Power Plant, September 2016

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 MEPCO in the vicinity of the site of the Plant near Dharanwala, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will not only give us an idea of the fault levels without Safe 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 we are also able to assess 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 11 kV and 132 kV along with fault current contributions from the incoming circuits, which are shown in the Exhibit 2.0 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 Dharanwala. 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 are normally 20 kA, 25 kA.

Table - 6.1
Maximum Short Circuit Levels without Safe Solar PP

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Dharanwala T1-11kV	**5.87**	**8.37**
Dharanwala T2-11kV	**5.87**	**8.37**
Chishtian-New 132kV	**9.78**	**10.53**
Solar PP-1 132kV	**5.70**	**4.52**
Solar PP-2 132kV	**4.73**	**3.89**
Solar PP-3 132kV	**4.74**	**4.41**
Solar PP-4 132kV	**5.70**	**4.52**
Dharawala 132kV	**4.96**	**4.91**
Bhawalnagar 132kV	**8.00**	**8.72**
Hota 132kV	**6.06**	**5.94**
Noorsar 132kV	**6.03**	**5.74**
Chishtian-Old 132kV	**8.70**	**9.61**

6.3 Fault Current Calculations with Safe Solar Power Plant, September 2016

Fault currents have been calculated for the electrical interconnection of the proposed scheme. Fault types applied are three phase and single-phase at 11 kV bus bars of Safe Solar Power Plant itself and other bus bars of the 132 kV substations in the electrical vicinity of Dharanwala. The graphic results are shown in Exhibit 2.1.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV and 11 kV bus bars of the network in the electrical vicinity of Safe 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.

Comparison of Tables 6.1 and 6.2 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 and 11 kV bus bars in its vicinity. This increase is limited considering 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. The maximum short circuit level of 11 kV bus bar of Safe Solar Power Plant 11 kV is 8.23 kA and 10.36 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 11 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contributions from any future reinforcements taking place in that area.

Table-6.2
Maximum Short Circuit Levels with Safe Solar PP, September 2016

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Safe Solar 11Kv	**8.23**	**10.36**
Dharanwala T1-11kV	**8.73**	**12.17**
Dharanwala T2-11kV	**8.73**	**12.17**
Chishtian-New 132kV	**9.79**	**10.53**
Solar PP-1 132kV	**5.70**	**4.52**

Solar PP-2 132kV	**4.73**	**3.89**
Solar PP-3 132kV	**4.74**	**4.42**
Solar PP-4 132kV	**5.70**	**4.52**
Dharawala 132kV	**4.98**	**4.92**
Bhawalnagar 132kV	**8.00**	**8.72**
Hota 132kV	**6.06**	**5.94**
Noorsar 132kV	**6.03**	**5.75**
Chishtian-Old 132kV	**8.71**	**9.62**

6.5 Conclusion of Short Circuit Analysis

The short circuit analyses results show that for the proposed scheme of interconnection of Safe Solar Power Plant with the Dharanwala 11 kV distribution network, we don't see any violations of short circuit ratings of the already installed equipment on the 132 kV and 11 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 or single phase faults.

The maximum short circuit level of 11 kV bus bar of Safe Solar Power Plant 11 kV is 8.23 kA and 10.36 kA for 3-phase and 1-phase faults respectively for September 2016. Therefore an industry standard switchgear of the short circuit rating of 25 kA should be installed at 11 kV switchyard of Safe 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

We have done studies with the inverter which has reactive support capability of ± 0.95 PF.

7.1.2 System Conditions

We have used the system conditions of September 2016 given the COD of the subject Solar Power Plant in the year 2016.

The interconnection scheme of a direct 11 kV double circuit of 1.5 km length using Osprey conductor from 11 kV Bus Bar of Safe Solar to each one of the two 11 kV bus bars of Dharanwala 132/11 kV substation has been proposed.

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

7.1.3 Presentation of Results

The plotted results of the simulations are placed in Appendix - D. Each simulation has been run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish that the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for ten seconds. Usually all the transients due to non-linearity die down within 2-3 seconds after disturbance is cleared in the system.

7.1.4 Worst Fault Cases

Three phase faults are considered to be the worst disturbance in the system. We have considered 3-phase fault in the immediate vicinity of the Solar Power Plant i.e. right at the 11 kV bus bar of the solar power plant substation, cleared in 9 cycles, as normal clearing time for 11 kV i.e. 180 ms, followed by permanent trip of 11 kV single circuit connected to this substation.

7.2 Transient Stability Simulation Results, September 2016

7.2.1 Fault at 11 kV Safe Solar

We applied three-phase fault on 11 kV bus bar of Safe Solar PP 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 11 kV systems, followed by a trip of the Safe Solar to Dharanwala T-1 11 kV circuit. We monitored different variables for one second pre-fault and ten seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 11 kV bus bars of Safe Solar, Dharanwala T-1, Dharanwala T-2 and 132 kV bus bars of Dharanwala, Chistian-New and Solar-PP-2 have been plotted. The results show quick recovery of the voltages after clearing of the fault.

Fig. 1.2 Frequency

We see the system frequency recovers normalcy quickly after clearance of the fault.

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 reverts to its pre-fault value after the fault clears.

Fig. 1.5 MW /MVAR Flow on Safe Solar to Dharanwala T-2 11 kV Single Circuit

Followed by clearing of fault, the trip of the Safe Solar to Dharanwala T-1 11 kV Single Circuit causes the entire load of that circuit to flow through the intact Safe Solar to Dharanwala T-2 11 kV Single Circuit. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attain steady state with power swings damping down fast.

Fig. 1.6 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 85 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. 1.7 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Guddu 220 kV, Engro-P 220 kV and Foundation-P 220 kV have been plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles get back to their normal state after the first swing and damp down quickly. The system is stable and strong enough to dampen the post fault oscillations.

7.2.2 Fault at 11 kV Safe Solar (Stuck Breaker)

We applied three-phase fault on 11 kV bus bar of Safe Solar PP 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) as standard clearing time for Stuck Breaker case of 11 kV systems, followed by a trip of the Safe Solar to Dharanwala T-1 11 kV circuit. We monitored different variables for one second pre-fault and ten seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 11 kV bus bars of Safe Solar, Dharanwala T-1, Dharanwala T-2 and 132 kV bus bars of Dharanwala, Chistian-New and Solar-PP-2 have been plotted. The results show quick recovery of the voltages after clearing of the fault.

Fig. 2.2 Frequency

We see the system frequency recovers normalcy quickly after clearance of the fault.

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 reverts to its pre-fault value after the fault clears.

Fig. 2.5 MW /MVAR Flow on Safe Solar to Dharanwala T-2 11 kV Single Circuit

Followed by clearing of fault, the trip of the Safe Solar to Dharanwala T-1 11 kV Single Circuit causes the entire load of that circuit to flow through the intact Safe Solar to Dharanwala T-2 11 kV Single Circuit. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attain steady state with power swings damping down fast.

Fig. 2.6 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 85 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. 2.7 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Guddu 220 kV, Engro-P 220 kV and Foundation-P 220 kV have been plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles get back to their normal state after the first swing and damp down quickly. The system is stable and strong enough to dampen the post fault oscillations.

7.2.3 Fault at 132 kV Dharanwala (Far-End Fault - Stuck Breaker Case)

We applied three-phase fault on far-end 132 kV bus bar of Dharanwala 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) as standard clearing time for stuck breaker case of 132 kV systems, followed by trip of one of the two Dharanwala 132/11 kV transformers. We monitored different variables for one second pre-fault and ten seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 11 kV bus bars of Safe Solar, Dharanwala T-1, Dharanwala T-2 and 132 kV bus bars of Dharanwala, Chistian-New and Solar-PP-2 have been plotted. The results show quick recovery of the voltages after clearing of the fault.

Fig. 3.2 Frequency

We see the system frequency recovers normalcy quickly after clearance of the fault.

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 reverts to its pre-fault value after the fault clears.

Fig. 3.5 MW /MVAR Flow on Safe Solar to Dharanwala T-2 11 kV Single Circuit

Followed by clearing of fault, the trip of the Safe Solar to Dharanwala T-1 11 kV Single Circuit causes the entire load of that circuit to flow through the intact Safe Solar to Dharanwala T-2 11 kV Single Circuit We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attain steady state with power swings damping down fast.

Fig. 3.6 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 85 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. 3.7 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Guddu 220 kV, Engro-P 220 kV and Foundation-P 220 kV have been plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles get back to their normal state after the first swing and damp down quickly. The system is stable and strong enough to dampen the post fault oscillations. .

7.4 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed scheme for the severest possible faults of 11 kV and 132 kV systems near and far away from the Solar Power Plant of Safe Solar. Therefore there are no issues 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.

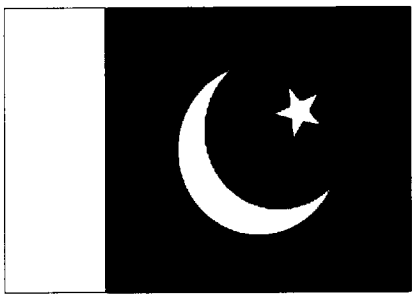
8. Conclusions

- The study objective, approach and methodology have been described and the plant's data received from the client Safe Solar Pvt. Ltd has been validated.
- The expected COD of the project is in the year 2016. Therefore the month of September 2016 has been selected to carry out the study as it will help determine the maximum impact of the project.
- The MEPCO system data as available with PPI for other studies have been used.
- The nearest substation of MEPCO is Dharanwala 132/11 kV. The following scheme of interconnection of Solar Power Plant by Safe Solar to evacuate maximum power of 10 MW is envisaged and studied in detail:
    - A direct 11 kV double circuit of 1.5 km length using Osprey conductor to be laid from 11 kV Bus Bar of Safe Solar to each one of the two 11 kV bus bars of Dharanwala 132/11 kV substation.
    - In this context two 11 kV breaker/line bays need to be added in the 11 kV switchgear hall of Dharanwala 132/11 kV Substation.
- The following new additions have been proposed at 132 kV
    - Two loops with two 100 MW solar power plants each have been proposed to be connected to Chishtian-New.
    - The first loop comprises of two 100 MW Solar Power Plants each (named Solar-PP-1 and Solar-PP-4 for future reference).
    - The second loop comprises of two 100 MW Solar Power Plants each (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 kV grid station.
- Detailed load flow studies have been carried out for the peak load conditions of September 2016 for the proposed scheme under normal and N-1 contingency conditions for the scenarios considered in this study to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed scheme is 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 Safe Solar Power Plant at 11 kV, and the substations of 132/11kV in its

vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from the Safe Solar Power Plant.

The maximum short circuit level of 11 kV bus bar of Safe Solar Power Plant 11 kV is 8.23 kA and 10.36 kA for 3-phase and 1-phase faults respectively for the year September 2016. Therefore industry standard switchgear of the short circuit rating of 25 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.

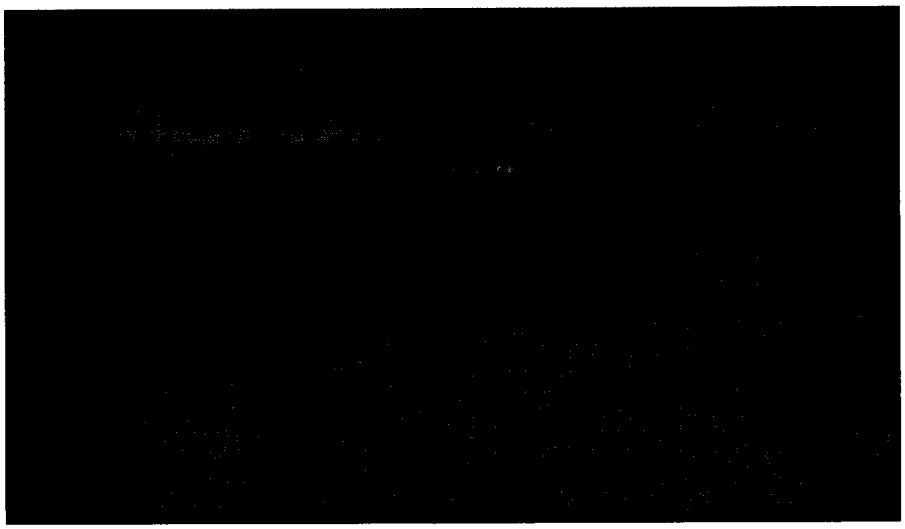
- The dynamic stability analysis of proposed scheme of interconnection has been carried out for September 2016. The stability check for the worst case of three phase fault on the 11 kV bus bar of the Safe Solar power plant substation followed by the final trip of 11 kV circuit connected to this substation has been performed for fault clearing of 9 cycles (180 ms) as understood to be the maximum fault clearing time of 11 kV protection system. The system is found to retain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Dharanwala 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.



Feasibility Study Report

10 MW Solar PV Power Project in Dharanwala Bahawalnagar

May, 2015



Volume 5

Environmental Studies: IEE & EIA

by

WELT KONNECT (PVT) LTD

WELT KONNECT

Driving You Into The Future

EXECUTIVE SUMMARY OF THE PROJECT

The Government of Pakistan has developed a Renewable Energy Policy to encourage the private sector investments towards development of renewable energy solutions in the country. The Alternative Energy Development Board (AEDB) has been established within the Government to facilitate the implementation of such renewable energy projects.

Whereas Safe Solar Power (Pvt.) Ltd. ("Safe Solar Power" or the "Project Sponsor") has been established with the purpose of setting up a 10 MW Solar Power Plant as an IPP under the Government of Pakistan Renewable Energy Policy. Safe Solar Power is incorporated under the laws of Pakistan under the Companies Ordinance, with its head office in Islamabad.

Safe Solar intends to enter into an Engineering, Procurement and Construction ("EPC") agreement for the construction and installation of the equipment on a turnkey basis. The Project Company also intends to enter into Operations and Maintenance ("O&M") agreement to manage the Project on a day to day basis.

Safe Solar Power intends to enter into a 25-year Power Purchase Agreement ("PPA") with National Transmission & Dispatch Company Limited ("NDTC"). The PPA is expected to be signed under the Alternative Energy Development Board's Renewable Energy Policy of 2006 extended in 2012. Tariff for generation based incentive is expected to be negotiated with National Electric Power Regulatory Authority ("NEPRA"), as an upfront tariff.

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

Whereas the Project Site which was earlier located in the Lal-Suhanara Quaid-E-Aza, Solar Park, has now been relocated to Dharanwala, District Bhawalnagar, with nearest city of Bahawalpur and will have an installed capacity of 10MWp

Photovoltaic Panels and will function as an Independent Power Producer (IPP) under the rules and regulations of Pakistan.

The project pre-feasibility study was completed by end of 2013. Subsequently after submission of the Pre-Qualification Documents, to the Alternative Energy Development Board (AEDB) along with the Project Proposal, the required Bank Guarantees of 5'000.USD (five thousand) and the requisite fees, the sponsor successfully obtained an LOI (Letter of Intent) from the Board.

Teams were then immediately deployed to initiate work on the feasibility analysis of the project, and competent teams of Engineers & Specialists were deployed for conducting the various requisite studies.

The Project Sponsor is now submitting this Volume 5 which is a part of the final Feasibility Study, for approval by the Environmental Protection Agency (EPA) of Punjab. After sanctioning of which further development of the project shall be commenced, and after approval of the FSR by the Panel of Experts of the Alternative Energy Development Board, competent companies in the field of Solar Photovoltaic's will be selected through a Short Listing Criteria based on Experience, Financial And Technical Competencies of such firms in development & construction of Power Projects and Project Management, which shall be advertised in the News Papers & other relevant media. Consequently the Request for Proposal (RFP) shall be circulated and shared amongst the qualifying companies for finalization of the Engineering Procurement & Construction (EPC) Contract after which a petition for Generation License and a petition for Feed In Tariff would simultaneously be filed with the National Electric Power Regulatory Authority (NEPRA) as allowed under their policy, before issuance of the LOS (Letter Of support) by AEDB. This is intended to save time and cut through avoidable red tape in the development of Independent Power Producers (IPP's) in Pakistan.

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

1 INTRODUCTION AND ENVIRONMENTAL APPROVAL FOR THE PROJECT

One of the most important feature of solar PV systems is that there are no emissions of carbon dioxide - the main gas responsible for global climate change - during their operation. Although indirect emissions of CO2 occur at other stages of the lifecycle, these are significantly lower than the avoided emissions. PV does not involve any other polluting emissions or the type of environmental safety concerns associated with conventional generation technologies. There is no pollution in the form of exhaust fumes or noise.

Decommissioning a system is unproblematic. Although there are no CO2 emissions during operation, a small amount does result from the production stage. PV only emits 21.65 grams CO2/kWh, however, depending on the PV technology. The average emissions for thermal power, on the other hand, are 900g CO2/kWh. By substituting PV for thermal power, a saving of 835879 g/kWh is achieved.

The benefit to be obtained from carbon dioxide reductions in a country's energy mix is dependent on which other generation method, or energy use, solar power is replacing. Where off-grid systems replace diesel generators, they will achieve CO2 savings of about 1 kg per kilowatt-hour. Due to their tremendous inefficiency, the replacement of a kerosene lamp will lead to even larger savings, of up to 350 kg per year from a single 40 Wp module, equal to 25kg CO2/kWh. For consumer applications and remote industrial markets, on the other hand, it is very difficult to identify exact CO2 savings per kilowatt-hour.

Recycling of PV modules is possible and raw materials can be reused. As a result, the energy input associated with PV will be further reduced. If governments adopt a wider use of PV in their national energy generation, solar power can therefore make a substantial contribution towards international commitments to reduce emissions of greenhouse gases and their contribution to climate change. Natural gas is the most environmentally sound of the fossil fuels, because it produces roughly half as much carbon dioxide as coal, and less of other polluting gases. Nuclear power produces very little CO2, but has other major safety, security, proliferation and pollution problems associated with its operation and waste products.

Exemption from EIA or IEE

In addition virtue of the appropriate research, concrete reasons and paperwork, Please be informed that the matter of IEE and EIA reports for the 10MW Solar PV Power Project, was taken up with the Federal Government Ministry of Water and

Power, with respect to the Exemption of the said Solar Power Project from either of EIA And IEE Studies, under the Pakistan Environmental Protection Act, 1997 (which primarily deals with the creation of EPA's and their ambit of functioning with general guidelines) and the PAKISTAN ENVIRONMENTAL PROTECTION AGENCY (REVIEW OF IEE AND EIA) REGULATIONS, 2000 (the only document dealing in detail with IEE and EIA Studies.), ***As a result of which we a conditional No Object Certificate (NOC) has already been issued and is below.***

You will find below a more detailed explanation to the above synopsis.

As can be seen in the language of article 12 of the Pakistan Environmental Protection Act, 1997, provided below and its relevant portion quoted here:

> "No proponent of a project shall commence construction or operation unless he has filed with the Government Agency designated by Federal Environmental Protection Agency or Provincial Environmental Protection Agencies, ***as the case may be***, or, ***where the project is likely to cause an adverse environmental effects an environmental impact assessment, and has obtained from the Government Agency approval in respect thereof***."

the proponent is Not required to do the IEE or EIA if that is not required as the case may be and/or the project does not have an adverse effect on the Environment. We are very well aware that Solar Power Project particularly Photovoltaic's has no such effect.

Now coming to the PAKISTAN ENVIRONMENTAL PROTECTION AGENCY (REVIEW OF IEE AND EIA) REGULATIONS, 2000 whose relevant sections 3. **Projects requiring an IEE**, 4 . **Projects requiring an EIA** and 5 **Projects not requiring an IEE or EIA,** are provided below. It can clearly be seen that We neither fall in Schedule 1 or Schedule II of the Regulations Governing the functioning of the EPA's with respect to the IEE and EIA reports.

3. Projects requiring an IEE
A proponent of a project falling in any category listed in Schedule I shall file an IEE with the Federal Agency, and the provisions of section 12 shall apply to such project.

4. Projects requiring an EIA
A proponent of a project falling in any category listed in Schedule II shall file an EIA with the Federal Agency, and the provisions of section 12 shall apply to such project.

5. Projects not requiring an IEE or EIA

(1) A proponent of a project not falling in any category listed in Schedules I and II shall not be required to file an IEE or EIA:
Provided that the proponent shall file –
(a) an EIA, if the project is likely to cause an adverse environmental effect;
(b) for projects not listed in Schedules I and II in respect of which the Federal Agency has issued guidelines for construction and operation, an application for approval accompanied by an undertaking and an affidavit that the aforesaid guidelines shall be fully complied with.

(2) Notwithstanding anything contained in sub-regulation (1), the Federal Agency may direct the proponent of a project, whether or not listed in Schedule I or II, to file an IEE or EIA, for reasons to be recorded in such direction: Provided that no such direction shall be issued without the recommendation in writing of the Environmental Assessment Advisory Committee constituted under Regulation 23.

(3) The provisions of section 12 shall apply to a project in respect of which an IEE or EIA is filed under sub-regulation (1) or (2)."

12. Initial environmental examination and environmental impact assessment.—(1) No proponent of a project shall commence construction or operation unless he has filed with the Government Agency designated by Federal Environmental Protection Agency or Provincial Environmental Protection Agencies, as the case may be, or, where the project is likely to cause an adverse environmental effects an environmental impact assessment, and has obtained from the Government Agency approval in respect thereof.

(2) The Government Agency shall subject to standards fixed by the Federal Environmental Protection Agency—

(a) review the initial environmental examination and accord its approval, or require submission of an environmental impact assessment by the proponent; or
(b) review the environmental impact assessment and accord its approval subject to such conditions as it may deem fit to impose, require that the environmental impact assessment be re-submitted after such modifications as may be stipulated or reject the project as being contrary to environmental objectives.

(3) Every review of an environmental impact assessment shall be carried out with public participation and no information will be disclosed during the course of such public participation which relates to—

(i) trade, manufacturing or business activities, processes or techniques of a proprietary nature, or financial, commercial, scientific or technical matters which the

proponent has requested should remain confidential, unless for reasons to be recorded in writing, the Director General of the Federal Agency is of the opinion that the request for confidentiality is not well- founded or the public interest in the disclosure outweighs the possible prejudice to the competitive position of the project or its proponent; or
(ii) international relations, national security or maintenance of law and order, except with the consent of the Federal Government; or
(iii) matters covered by legal professional privilege.

(4) The Government Agency shall communicate its approval or otherwise within a period of four months from the date the initial environmental examination or environmental impact assessment is filed complete in all respects in accordance with the prescribed procedure, failing which the initial environmental examination or, as the case may be, the environmental impact assessment shall be deemed to have been approved, to the extent to which it does not contravene the provisions of this Act and the rules and regulations.

(5) Subject to sub-section (4) the appropriate Government may in a particular case extend the aforementioned period of four months if the nature of the project so warrants.

(6) The provisions of sub-sections (1), (2), (3), (4) and (5) shall apply to such categories of projects and in such manner as may be prescribed.

(7) The Government Agency shall maintain separate registers for initial environmental examination and environmental impact assessment projects, which shall contain brief particulars of each project and a summary of decisions taken thereon, and which shall be open to inspection by the public at all reasonable hours and the disclosure of information in such registers shall be subject to the restrictions specified in sub-section (3)."

Hence the project is exempt from the IEE and EIA studies and an NOC in this regard has already been issued.

Initial Environment Examination (IEE) and Environmental Impact Assessment (EIA)

However on advice of the concerned departments both the IEE and EIA studies were conducted and have been submitted for the relevant No Object Certificate/Approval to the Environmental Protection Agency (EPA) of Punjab, provided below. The IEE and EIA are provided below in Section 2 and 3 respectively late in the booklet.

2 INITIAL ENVIRONMENT EXAMINATION (IEE)

I. Application Form (As per Schedule IV in PEPRA 2000)

1	Name and Address of Proponent	**Safe Solar (Pvt) Ltd House 28, Street 24, F-8/2 Islamabad.**	Phones: Fax: Telex:	**92-(5 1)-8358477 92-(5 1)-8358499**
2	Description of Project	10MWp Solar Photovoltaic Power Project		
3	Location of Project	Dharanwala, Bahawalnagar		
4	Objectives of Project	Production of electricity and connection to the National Grid		
5	IEE/EIA attached?	**IEE** / EIA:	Yes/No:	
6	Have alternatives been considered and reported in IEE or EIA		Yes / No	
7	Existing Land Use	Barren Land	Land Requirement	75 Acres
8	Is the basic Site data available or has it been measured?	(only tick yes if the data is reported in the IEE/EIA) Meteorology (including rainfall) Ambient Air Quality Ambient Water Quality Ground Water Quality	**Available** Yes/No Yes/No Yes/No Yes/No	**Measured** Yes/No Yes/No Yes/No Yes/No
9	Have estimates of the following been reported?	Water Balance Solid Waste Liquid Waste treatment	**Estimated** Yes/No Yes/No Yes/No	**Reported** Yes/**Not Applicable** Yes/**Not Applicable** Yes/**Not Applicable**
10	Source of Power	Solar/Sunlight	Power Requirement	Not Applicable
11	Labor Force (number)	Construction: 600 Operation: 50		

Verification

I do solemnly affirm and declare that the information given above and contained in the attached IEE/EIA is true and correct to the best of my knowledge and belief.

Date 25th May 2015

Signature, name and designation of proponent (with official stamp/seal)

II. Policy Legal and Administrative Framework

As per the general criteria the project should be consistent with the national laws and sustainable development policies, strategies and plans including:

- **Pakistan Environmental Protection Act- 1997**

The project is in compliance with the PEPA 1997, and as mentioned in Para 12 of the said act, this project being a solar PV project in a desert with almost no population or wildlife or plantation, does not have any adverse effect on the environment whatsoever. However an Environment studies have been filed with the relevant authorities for their consideration.

- **National Energy Conservation Strategy**

The project complies with the three explicit objectives of the NECS: conservation of natural resources, promotion of sustainable development, and improvement of efficiency in the use and management of resources; and would also abide by policies outlined for pollution control as in s.no 4, 8, 10, 12 and 13 of the 14 core programme areas.

- **National Environment Policy**

The project is in unison and support of the NEP, particularly contents of 3.4, 3.4(h), 3.6, 3.7, 3.9, 4.1, 4.3, 4.4, 5.4, 5.5 and 5.6.

- **National Forestry Policy**

The project is in harmony with the National Forestry Policy and although being situated in a desert namely Cholistan it will contribute to the national grid and hence meet the objectives of Para 1.2 by generating power from solar energy which will indirectly hinder cutting of mountain trees for firewood. It also supports Para 7, 10.2, and 10.3.

- **National Renewable Energy Policy**

The project complies with NREP, articles 4 (4.4), 8.1, and 8.3 (8.3.3)

- **Medium-term Development Framework**

  The project supports Medium term Development Framework objectives such as poverty reduction, upgrading of physical infrastructure, energy security, accelerated development of lesser developed areas, and environment.

- **Pakistan Environmental Protection Agency Regulations 2000**

  Environmental impact assessment or Initial Environment Examination is not required for solar power projects in Pakistan as per section 3 and 4 of the Pakistan Environmental Protection Agency's Regulations 2000. However a complete IEE Document has been prepared for the project.

- **Other Relevant Policies and Plans of the Government**

  The project complies and is in harmony with all relevant concerned policies of the government of Pakistan. Not result in any obligation towards the investor country other than Certified Emission Reduction (CER) authorization. The project will not result in any obligation towards the investor country other than CER authorization.

III. Description of the Project

Project Location

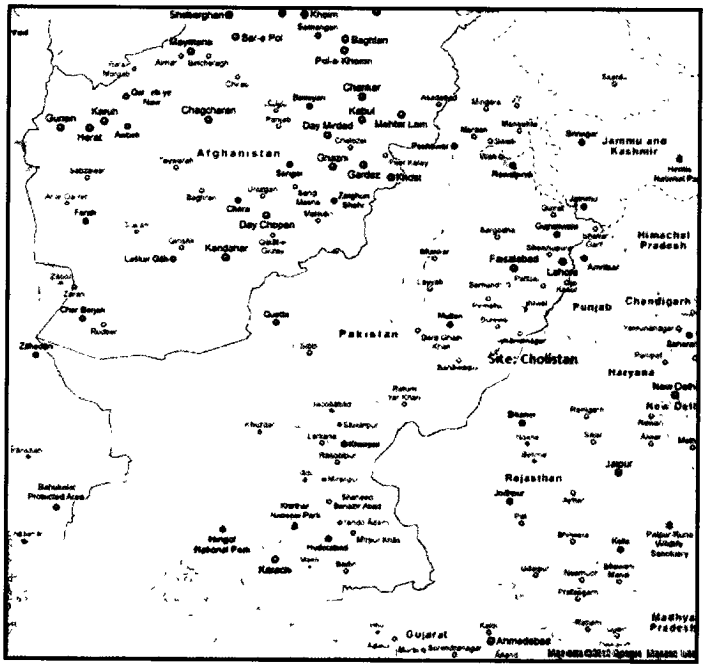
Comprehensive due diligence was carried out by experts and representatives from all stakeholders of the project, which was followed by a review and selection procedure. The site selected encompasses an area of 75 Acres E 71°47.209 N 29°36.277 which is approximately 50 km from Bahawalpur (the nearest urban city). **Extract 1** shows the Coordinates of the project, while **Extract 2** shows the geographical location of the project.

Extract 1: Coordinates of the project

[redacted]

Node	Longitude (East)	Latitude (North)
1	E 72.785223	N 29.604100
2	E 72.787998	N 29.604100
3	E 72.788472	N 29.601762
4	E 72.785095	N 29.601931

Extract 2: Geographical location of the project



Scope and Layout

After review of the equipment which would need to be utilized to ensure optimized performance and maximum yield generation, the Project Layout has been designed to utilize 6 of "1.6 MW Inverter" combined units of SMA 800 CP Series Inverters (Actual power output at test conditions is 1.76 MW for each unit) which are further connected to 28 SMA Low to Medium range voltage transformers at approximately 360V AC, one for each 1.6 MW unit respectively, leading finally to the switch gear or transformer from medium to high voltage range for connection to the Grid Station at 132KV . Each unit of 1.6 MW will consist of 7480 panels, 2 inverters and 1 transformer.

A string concept is being used with 22 modules connected to a string, and 17 strings connected on a Bus leading to the SMA Inverters connection in parallel with a total of 10 such connections. The total number of PV modules used in this arrangement would be 3356 units per 1.6 MW with a total of approximately 6 such units for the complete 10 MW setup.

Extract 3 Technical specifications of the modules

Generation	1st	2nd
Market Shares (2008)	84 %	16 %
Data Availability	Old Technology; Data is available for analysis	Relatively Newer Technology; Data is scant for reliability analysis
Efficiency	Mono crystalline: 17 % Poly crystalline: 13.5	9 %
Lowest Retail Price ($/watt)	High Mono Crystalline: 1.20 Poly Crystalline: 1.08	Low 0.81
Weight to Power Ratio	Small	Large
Module Size	Large range 65 – 240 W	Small Range 65 – 130 W

The modules to be selected for the project should have in built features for extreme weather conditions to be suitable for the project site. The modules would be subject to conditions such as temperatures exceeding 50 C, wind speeds exceeding 5 m/s, and precipitation on panels in case of rare occasional occurrence of a sand-storm. Therefore, modules should consist of materials that have high tolerance to these conditions and more, meaning a high factor of safety and resilience. Additionally, the modules should allow for easy and fast maintenance along with cleaning operations.

Construction

The land acquired consists primarily of flat ground and sand dunes. Construction of the solar farm will be focused on the flat areas. Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading. The panels would be mounted on racks, facing due south, at an angle of 30 degrees above horizontal to maximize the system for annual energy production. The mounting racks would be aligned in rows along an east-west axis across the entire area defined for the project. Depending on the height of the panels off the ground, it is estimated that approximately five to six feet of spacing between rows would be required to prevent shading from one row of modules onto the other.

A single string of 224 PV modules require approximately 8 meters x 21 meters where as a single inverter (3740 units of PV modules) requires 50 meters x 60 meters. The total requirement for construction of 41,888 units of PV modules is approximately 150,000 m^2 (37.5 acres) which is clearly within the value of the acquired land. There are three options that can be utilized when setting the tracking system of a photo-voltaic powered power plant namely single axis, dual axis or no tracking system.

Design optimization shows that for such a large number of panels, a tracking system would require a large initial investment as well as yearly maintenance for a relatively lower amount of increase in yield. Therefore the company has opted to utilize no tracking system

The modules would be clamped to a long term resistant mounting structure (details of which are provided in subsequent sections). The mountings will be made with considerations of stress analysis in weight and wind conditions.

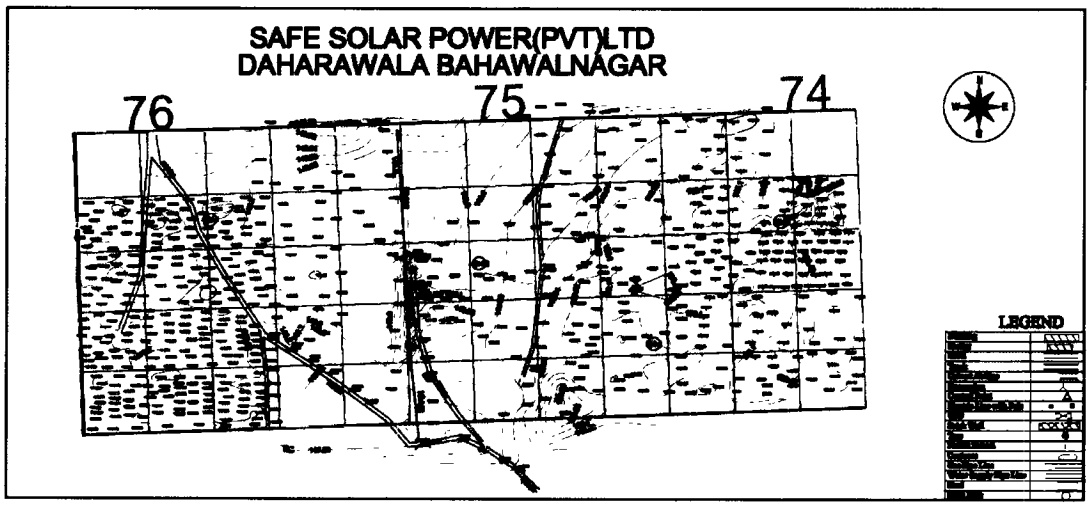
IV. Description of Environment

Site Condition

The land acquired by the Joint Venture consists primarily of flat ground and scarce sand dunes at the peripheral of the site. Construction of the solar farm will be focused on the flat areas.

Cholistan has very low propensity towards natural disasters or similar risks. Till date the nearest area to the Project Site which has faced the effects of a flood is Bahawalpur and that too only once in history. Cholistan and nearby areas for a significant radius are not prone to earth quakes (as per past records). The Project is strategically positioned between the Farm Lands being irrigated by man made canals taken out from the Indus River passing through Punjab on its way to Sindh which cover it on 3 sides and on the other hand the Marot Fort with its high elevation. **Extract 4** represents the topographic survey of the project site.

Extract 4: Topographic Survey of the Site



Micro Climate Effects

The Pakistan Meteorological Department is both a scientific and a service department, and functions under the Ministry of Defense. It is responsible for providing meteorological service throughout Pakistan to wide variety of interest and for numerous public activities and projects which require weather information.

In its services to aviation the department's responsibility goes to some extent beyond national boundaries in fulfillment of accepted international agreements and obligations which include, among other things, the collection and rebroadcast of meteorological data.

Apart from meteorology, the department is also concerned with Agro meteorology, Hydrology, Astronomy and Astrophysics (including solar physics), Seismology, Geomagnetism, Atmospheric Electricity and studies of the Ionosphere and Cosmic Rays. Pakistan Meteorological Department shoulders the responsibility to investigate the factors responsible for global warming, climate change its impact assessment and adaptation strategies in various sectors of human activities.

Microclimate effects of Cholistan and nearby area are characterized by low and rare sporadic rain. The mean annual rainfall varies from less than 100 mm in the west to 200 mm in the east and as per collected Synthetic Data, installed SRA equipment on site and information gathered from Locals, it rains only 1 to 3 times a years.

Rain usually falls during monsoon (July through September), winter and spring (January through March). Aridity is the most striking feature of the Cholistan desert with wet and dry years occurring in clusters. Cholistan is one of the hottest regions of Pakistan. Temperatures are high in summer and mild in winter. The mean summer temperature (May, June) is 34 °C with the highest reaching above 51 °C. **Extract 5** gives us the meteorological details of the site.

Extract 5 The meteorological details of the site

Months	Min	Max		Mean
Jan	6.95	19.9	45.3	0.30
Feb	9.19	22.9	38.2	0.61
Mar	15.1	29.3	29.3	0.66
Apr	20.8	34.2	27.4	0.52
May	25.3	37.9	30.3	0.54
Jun	28.2	38.2	43.4	1.22
Jul	28.0	35.1	61.8	3.63
Aug	26.9	33.4	67.7	2.95
Sep	24.8	33.8	55.4	1.22
Oct	19.3	32.6	33.5	0.40
Nov	13.8	27.8	31.6	0.09
Dec	8.99	22.2	39.1	0.23

Soil, Water and Vegetation Condition

The investigated site is located in District Bhawalnagar. The area is mainly underlain by Sandy Silty Clay up to the maximum explored depth.

Soil

The onsite material is generally classified as SANDY SILTY CLAY (CL-ML) group of Unified Soil Classification System. Prior to any construction activity, the site must be cleared of all debris and surface vegetation. The leveling and grading can be carried out by normal earth moving machine. It is recommended that immediately after excavation for construction of foundation or other substructures, the excavation bottoms and slopes are cleared of all debris, proof rolled and covered by a 5 cm thick blinding concrete layer.

Water

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

Vegetation

Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading. The panels would be mounted on racks, facing due south, at an angle of 30 degrees above horizontal to maximize the system for annual energy production.

V. Anticipated Impacts and Mitigation Measures

Impacts during Construction

The civil, mechanical and electrical works will be minor and will spread over the large project site. Considering the nature and magnitude of construction works and the ecological insensitivity of the project site, it is certain that the construction would create only minor and manageable environmental disturbances such as noise from trucks and excavation equipment, which are insignificant impacts due to the absence of communities in the area. No toxic and hazardous materials will be used in the construction apart from diesel oils for vehicles, which will be properly stored. The construction contracts will require the EPC contractors to be responsible for undertaking effective measures for environmental impact mitigation. Environmental performance of the EPC contractors will be monitored by the joint on site project management team, specifically the personnel of HSE Department.

Impacts during Operation

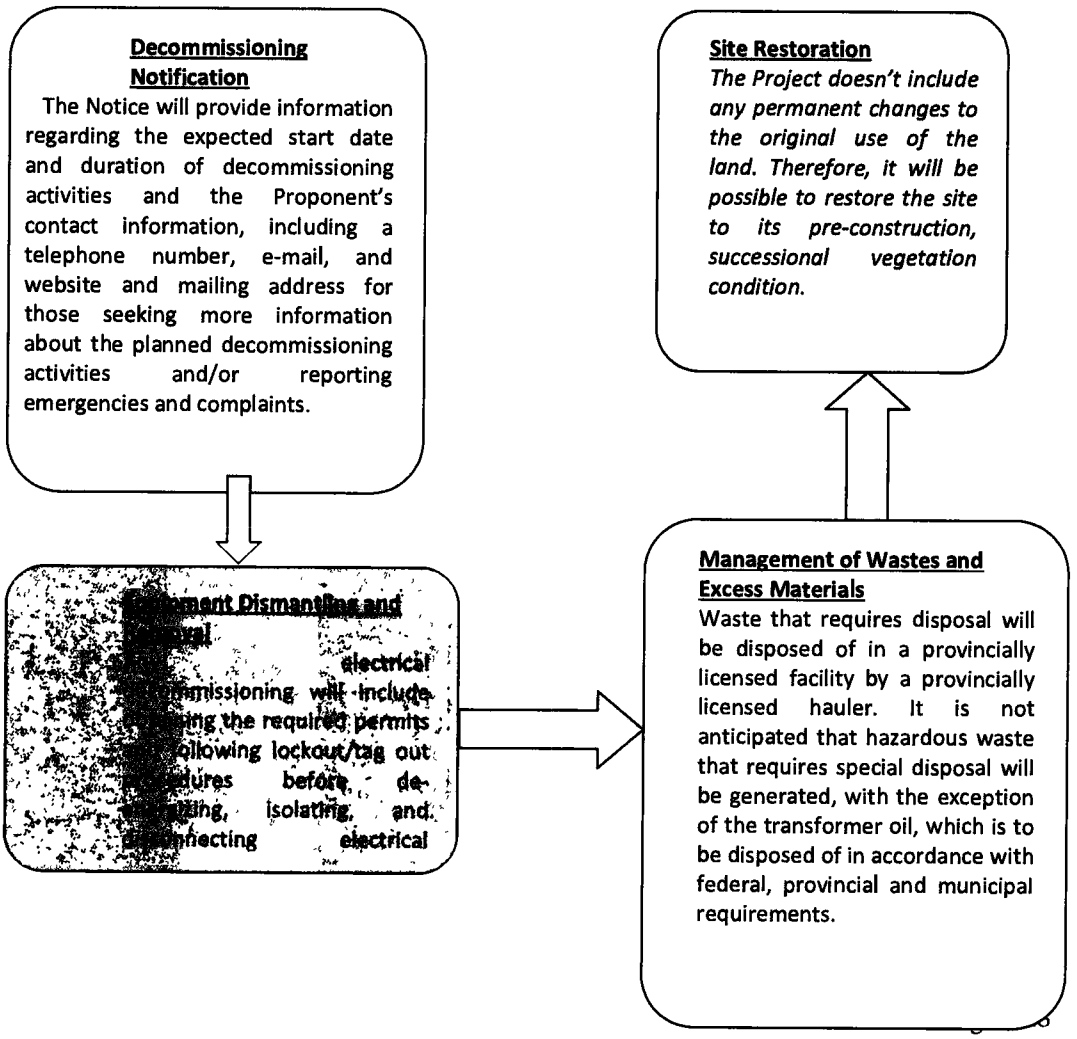
The solar power plant does not create noise and gaseous emissions during operation. A small volume of wastewater would be daily generated from washing dust from surface of the solar panels. This wastewater contains only suspended solids and will be drained into the storm drainage basin. Not more than 10 staff for operation and for maintenance such as PV surface cleaning; Domestic wastes generated by this small number of people could be readily handled by a septic tank system.

The potential impacts could be visual and reflection. However, as the project site and the surrounding areas provide no significant aesthetic value, the sights of a large area covered with solar PV panels will have no visual impact. With the old design of solar PV arrays, reflected sunlight may cause problems if the system is close to a road and is facing in a direction which the reflected sunlight may cause problems. This problem will not occur in this Project as its surface of solar PV panels is designed to absorb sunlight and minimize sunlight reflections. Though the reflection problem will not occur because the panels are designed to absorb sunlight, the project team will plant trees along the road as green belt.

Decommissioning

Safe Solar Pvt Ltd will ensure that the entire Project Location is restored back to its pre-construction condition (successional vegetation land use or as may be appropriate at that time) and that the decommissioning is conducted in accordance with the applicable local (Bahawalnagar and Cholistan bodies), provincial (Punjab Government) and federal requirements. In addition, potential effects and mitigation pertaining to significant natural features on and/or in proximity to the Project Location will documented. Overall, no significant adverse impacts to the environment are expected as a result of decommissioning the Project. **The Flow Chart below (Extract 6: From Feasibility Report)** shows the flow chart of the decommissioning procedure.

Extract 6: Decommissioning Plan



Social Impacts

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

VI. Analysis of Alternatives

Alternative Sites

With the help of the Punjab Government, 4 sites were short listed and identified in Cholistan, towards Southern Punjab with presence of the required minimum infrastructure, high irradiation levels and solar potential. After due scrutiny and deliberation by Experts over the sites; the 75 Acres strip of land located approximately 50 km from Bahawalpur, the nearest urban city, was selected and finalized. The location enjoys a flat terrain with innocuous sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself a technically and logistically feasible location for the setup of a large solar power station.

Alternative Measures

The Project's feasibility study reviewed the technical aspects and conceptual designs of multiple potential PV suppliers that would meet the requirements as set by the Safe Solar (Pvt.) Ltd. The winning EPC contractor will be chosen based on the following general criteria, apart from the selection criteria as will be mentioned in the pre-qualification documents:

- Displays understanding and skills to develop optimum design for the PV system for the selected site
- Has used best engineering principles in the conceptual design
- Demonstrates engineering ingenuity that will help reduce the projects capital and operation and maintenance costs
- Has over two years of experience in project management with a well developed and trained department for
    - Health
    - Safety and
    - Environment

The EPC contractors selected during the pre-qualification phase will be required to develop a complete environment management plan as part of their bidding documents.

VII. Grievance Redress Mechanism

At least 2 channels for environmental complaints will be created. These would comprise of complaints using emails, and telephone. The details of both these channels would be mentioned on all direction and site boards for the project. The most effective channel for response is by telephone because the contact can be made anytime and is two-way communication. No matter which channel is used, the responders from the HSE (Health, Safety and Environment) team will firstly obtain the information from the complainer as much as possible to identify source of the problem and inform the operations or maintenance departments. When the operations or maintenance department receives the information from HSE, they will find out if the complaint is caused from their operation. In case "yes", they will fix the problem or stop their operation.

A follow up will be carried out when the operation will call back HSE staff for the situation so that HSE staff can communicate to the complainer as soon as possible. Moreover, HSE staff will also meet the complainer, if required and possible, at site for better understanding and curing his/their feelings and inform them the progress of mitigation measures from time to time until the problem has been solved.

VIII. Environmental Management Plan

Management System

After the completion of this 10MW Solar PV Project, a joint management organization will be established with the principle of requiring "few on-duty staff". After the electrical equipment and machinery have entered their stable operation mode, the PV plant shall be managed with "no on-call staff and few on-guard staff".

The 10 MW PV Plant is divided into the production area and the utility area. The production area includes facilities such as Solar PV panels, etc. The complex will have multiple functions of administration, living, and production. The offices of the building will consist of relay protection room (including the DC panel room), central control room, communication room, and general purpose offices. The control room, the room for distributing high and low voltage electricity, and power distribution will be arranged conveniently so as to reduce the total length of cable laying and save construction cost. The other section is for daily lives including dormitories, dining room, and kitchen.

Housekeeping of Facility

OEMs for Solar panels are responsible for providing the generic maintenance plans for solar panels which include cleaning. The joint management between Safe Solar Pvt Ltd and EPC Contractor will be required to further determine the suitable cleaning requirements for the panel. This would be done by sharing complete site information (dust, dirt, pollen and/or pollution in the site environment; the frequency of rain or snow) with the OEMs for Solar panel, and ask them for site specific cleaning plans and details for the solar panels. Innovative methods for different maintenance and operation aspects are being employed all over the globe.

Safety and Security Concerns

Responsibility for security concerns before the construction of the project will lie with the EPC Contractor with monitoring authority of Safe Solar Pvt Ltd. Post-construction the responsibility will lie with the joint management to develop a team and an SOP mentioning the number of personnel required for the security purpose of the facility.

Responsibility for security concerns before the construction of the project will lie with the EPC Contractor with monitoring authority of Safe Solar Pvt ltd. Post-construction the responsibility will lie with the joint management to develop a team and an SOP mentioning the number of personnel required for the security purpose of the facility.

Risk Management

The risk management plan, documents the procedures that will be used to manage risk throughout the project. In addition to documenting the results of the risk identification, it also covers who will be responsible for managing various areas of risk, how risks will be tracked throughout the project, and how plans of action will be implemented.

Risk management plan is an assessment tool that may is used in the project oversight process. For the 10 MW Solar PV Power Project in Cholistan, the RMP includes at least the following information:

- Purpose and scope
- Risk management methodology
- Overview or summary of risk
- Risk identification
- Risk analysis
- Risk response planning
- Risk monitoring and controls

Emergency Response Processes

During the construction and operation of the project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personnel safety of the workers. The safety and health supervision department will provide appropriate inspection equipment, as well as necessary public education service for production safety.

HSE personnel will be required to draft emergency shutdown procedures for the plant in collaboration with the maintenance and project department during the detailed design phase of the Project. These would include all procedures in case of

fire, lightning, flood, other natural disasters, etc. The procedures would be based on the guidelines from OSHA Standards (29 CFR 1910).

Social Development

For the purpose of measuring Social Development the "**JEDI** - Jobs and Economic Development Impact" model of evaluating socio economic factors has been employed. The (JEDI) models are user-friendly tools that estimate the economic impacts of constructing and operating power generation and biofuel plants at the local level. Based on project-specific and default inputs (derived from industry norms), JEDI estimates the number of jobs and economic impacts to a local area (usually a state) that could reasonably be supported by a power generation project.

For example, JEDI estimates the number of in-state construction jobs from a new solar project. JEDI models are input-output models designed to provide reasonable estimates, not exact numbers. JEDI also provides estimates on land lease and property tax revenues, when appropriate.

Various ownership and financing structures can be incorporated by the user as well. Results obtained for the impact of this project on the local employment can be represented by empirical changes on employer payroll. This can be seen in **Extract 7:** Empirical results of Using JEDI with Cost estimates on employer payroll.

	Cost	Local Share	Locally (Y or N)
Labor			
Technicians	$27,333	100%	
Subtotal	$27,333		
Materials and Services			
Materials & Equipment	$22,666	100%	N
Services	$0	100%	
Subtotal	$22,666		
Sales Tax (Materials & Equipment Purchases)	$1,870	100%	
Average Annual Payment (Interest and Principal)	$301,600	0%	
Property Taxes	$0	100%	
Total	$353,470		
Other Parameters			
Financial Parameters			
Debt Financing			
Percentage financed	80%	0%	
Years financed (term)	10		
Interest rate	6%		

Tax Parameters			
Local Property Tax (percent of taxable value)	0%		
Assessed Value (percent of construction cost)	0%		
Taxable Value (percent of assessed value)	0%		
Taxable Value	$0		
Property Tax Exemption (percent of local taxes)	100%		
Local Property Taxes	$0	100%	
Local Sales Tax Rate	8.25%	100%	
Sales Tax Exemption (percent of local taxes)	0%		
Payroll Parameters	**Wage per hour**	**Employer Payroll Overhead**	
Construction and Installation Labor			
Construction Workers / Installers	**$21.39**	**45.6%**	
O&M Labor			
Technicians	**$21.39**	**45.6%**	

Extract 7: Empirical results of Using JEDI with Cost estimates on employer payroll

The current recession being faced by the globe has shifted the attention towards major socio-economic disasters such as inflation, industries crashing, unemployment rise, and standards of living reducing dramatically. Pakistan and the nearby region has been a victim of these conditions prior to recessions and is expected to keep facing similar situations in the aftermath of recess.

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

- Immediate employment
- Cheap energy and comfort

Some indirect and important benefits are:

- A Creation of a local market and/or of a local industry for PV products and services
- Security of energy supply
- Poverty alleviation, Creation of education facilities (need of skilled personnel)
- Recovery of vegetation due to improved irrigation / improved access to safe drinking water due to solar water purification

All methods employed during the engineering, procurement and construction phase have not only been screened to develop opportunities in Pakistan but also to cater to important requirements such as providing a healthy environment to the community. This project will also play a crucial role in improving awareness on renewable energy and in turn on the right consumption pattern of power for consumers.

The project holds complete compliance to every law and rule set down by the Government of Pakistan, Provincial government of Punjab, regulatory bodies for power, and regulatory bodies for Economics such as SECP and regulatory requirements of Environment.

At an early stage of PV power development it is not likely that PV modules or cells for large power plants will be produced in Pakistan, so the creation of local industry should not be overestimated in beginning of the development of a the national PV market.

Environmental Impacts Mitigation

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

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

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

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

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

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

The Project Site is not used for agriculture farming due to very arid climate and undulating topography. Neither is livestock grazing an option due to the limiting weather conditions of the Land There is scarcity of drinking water both for humans and scarce livestock. As a result livestock production is less than its potential.
Groundwater is never the less available less than 20 meters below the surface however in some locations it is too saline to drink. The main method of keeping animals in areas further away from this hyper-arid region is a free availability of forage and monsoon rains which leave water stored in the pools dug in past by their owners.

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

The 10 MW Cholistan Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under the schedule II classified by Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. The project has also been planned to fulfill all requirements of Clean Development.

IX. Conclusions And Recommendations

Environmental impact assessment or Initial Environment Examination is not required for solar power projects in Pakistan as per section 3 and 4 of the Pakistan Environmental Protection Agency's Regulations 2000. However a complete IEE Document has been prepared for the project. This step has been taken to document all the reasons that are in line with all policies and regulations mentioned in this report; based on which the project has already obtained a No Objection Certificate.

The project site is not used for agriculture, is not located in a sensitive ecosystem, and has no historical and cultural value. This nature of the project site coupled with the clean nature of solar power generation ensures that the Project will not cause any significant, lasting environmental and social impacts during construction, operation and decommissioning. Only minor and transient environmental disturbances would be experienced at the project site during construction and operation, and they will be minimized through implementation of the Environment Management Procedures. It is then recommended that the Project be considered environmentally and socially feasible, and that this IEE is adequate to justify environmental and social feasibility of the Project. There is no need for further analysis and the environmental and social assessment of the Project is considered complete.

Project owners are fully committed to their environmental and social responsibility and discharge this responsibility in adherence to principles of good corporate governance. In their daily business operations, the Project Sponsors will fully meet the environmental, occupational health, and safety requirements and risk management within the basic framework of globally recognized environmental management system standard. Its staff and contractors are fully committed to their environmental responsibility and discharge their responsibility within the HSE policy and operational framework.

Safe Solar Pvt Ltd will discharge their social responsibility through: (i) fair treatment of its employees in full compliance with all applicable laws and regulations; and (ii) supporting community participation and development activities through its CSR program. Involuntary resettlement and indigenous peoples are not relevant issues in the operations of the project owners and are unlikely to become relevant issues in its future operations.

10 MW Solar PV Power Project in Dharanwala Bahawalnagar Feasibility Study Report

Volume 1
Main Report - Part 1

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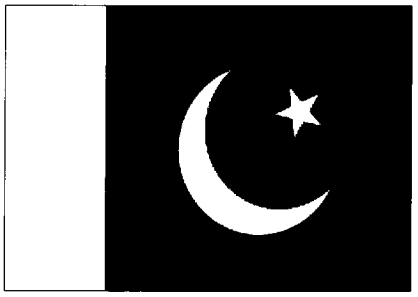

Feasibility Study Report
10 MW Solar PV Power Project in Dharanwala Bahawalnagar

July, 2015

Volume 1
Main Report - Part 1

by

WELT KONNECT (PVT) LTD

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APPROVAL SHEET

TITLE : Feasibility Report
10 MW Solar Power Project in Dharanwala Bahawalnagar

DOCUMENT NUMBER : 01-0786-02

CLASSIFICATION : **Un-Classified**

SYNOPSIS

This document is a feasibility study report of 10 MW Solar PV Power Project and is divided into 7 Volumes for ease of review and approvals.

Volume 1: Main Report Part 1: of this report contains detailed information regarding the geographic features of Pakistan, along with the insight to Pakistan's Energy and Electricity market. After discussing the solar energy industry and carbon credit details for information purposes, the volume focuses on mentioning the regulatory regime of the country that is applicable to the project and all legal requirements. The volume also summarizes the salient features of the project.

Volume 2: Main Report Part 2: of the report focuses entirely on the specific details of the project. It provides information on the selected site, the description of the technical equipment and the layout of plant. The report further includes the basis for calculations and designing, by giving details of the grid connections available and yield of power. Prior to conclusion, the report also gives details of the policies and procedures for O&M, Project Management, and tariff calculation. The report concludes with details of the ecological and socio-economic benefits of the project.

Volume 3: Geo-Technical Study Topographic Survey: of the Project Site, with detailed analysis.

Volume 4: Geo-Technical Investigation Report: for the Project Site, including Soil Testing

EXECUTIVE SUMMARY OF THE PROJECT

The Government of Pakistan has developed a Renewable Energy Policy to encourage the private sector investments towards development of renewable energy solutions in the country. The Alternative Energy Development Board (AEDB) has been established within the Government to facilitate the implementation of such renewable energy projects.

Whereas Safe Solar Power (Pvt.) Ltd. ("Safe Solar Power" or the "Project Sponsor") has been established with the purpose of setting up a 10 MW Solar Power Plant as an IPP under the Government of Pakistan Renewable Energy Policy. Safe Solar Power is incorporated under the laws of Pakistan under the Companies Ordinance, with its head office in Islamabad.

Safe Solar intends to enter into an Engineering, Procurement and Construction ("EPC") agreement for the construction and installation of the equipment on a turnkey basis. The Project also intends to enter into Operations and Maintenance ("O&M") agreement to manage the Project on a day to day basis.

Safe Solar Power intends to enter into a 25-year Power Purchase Agreement ("PPA") with National Transmission & Dispatch Company Limited ("NDTC"). The PPA is expected to be signed under the Alternative Energy Development Board's Renewable Energy Policy of 2006 extended in 2012. Tariff for generation based incentive is expected to be negotiated with National Electric Power Regulatory Authority ("NEPRA"), as an upfront tariff.

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

Whereas the Project Site originally located in Lal Suhanara, Quaid-E-Azam Solar Park, Bahawalpur has been relocated to Dharanwala, Bahawalnagar, near the Cholistan Desert, with nearest city of Bahawalpur and will have an installed capacity of

10MWp Photovoltaic Panels and will function as an Independent Power Producer (IPP) under the rules and regulations of Pakistan.

The project pre-feasibility study was completed by end of 2013. Subsequently after submission of the Pre-Qualification Documents, to the Alternative Energy Development Board (AEDB) along with the Project Proposal, the required Bank Guarantees of 5'000.USD (five thousand) and the requisite fees, the sponsor successfully obtained an LOI (Letter of Intent) from the Board.

Teams were then immediately deployed to initiate work on the feasibility analysis of the project, and competent teams of Engineers & Specialists were deployed for conducting the various requisite studies.

The final updated Feasibility Study Report after relocation has now been finalized along with this Volume 1, for further progress. The Sponsor has also completed substantial work on the financial modeling for the project. The Sponsor believes that keeping in view the recent improvement and trend in the viability of the technology, possibility of fast track implementation by virtue of the recently announced Feed In Tariff regime by NEPRA and current energy crises, this project is of paramount importance for Pakistan and will prove to be a pioneer in the Solar PV industry, paving the way for future progress in this ever growing field and at the same time provide a viable profitable investment opportunity to all stake holders of the country.

2 Introduction

Safe Solar Power (Pvt.) Ltd. ("Safe Solar Power" or the "Project Sponsor") has been established with the purpose of setting up a 10 MW Solar Power Plant as an IPP under the Government of Pakistan Renewable Energy Policy. Safe Solar Power is incorporated under the laws of Pakistan under the Companies Ordinance, with its head office in Islamabad.

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Safe Solar has the vision of being the one of the best clean energy groups of Pakistan specializing in solar power development, project management and operations; proactively developing Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

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

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

The Group has been working in Pakistan for the past 25 years and has targeted a number of projects including but not limited to the Infrastructure Sector: namely Construction of Roads, Bridges and Motorways, and The Power Sector; including

Hydro Projects, Coal Power Projects, and Wind Energy Projects, and is currently working with its valuable foreign partners in implementing large scale projects.

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

After due diligence the Joint Venture awarded WK Consultants the task to provide technical consultancy Services for conducting the Feasibility Study Report (FSR) in accordance with the requirements of the Letter of Intent (LOI) issued by Alternative Energy Development Board (AEDB) under the 2006-2009 Alternative Power Policy coupled with an energy yield assessment for the PV Plant of 10MW, located in the region of Cholistan Desert in the province of Punjab Pakistan. This report describes the results of the Feasibility Study performed for the 10MW PV Plant on the project site (Latitude N 29° 36.277; Longitude E 71° 47.209). The study also investigated solar power technology options that were appropriate for a large scale solar power facility in Cholistan Desert, Punjab and the economic viability of such a solar power facility

The plant consists of a rammed fixed mounted system with an installed module capacity of **10053 kWp** using Mono-crystalline Q-Cells module QC-C05 and 56 SMA Sunny Central inverters SMA SC 800 CP with a total AC capacity of 49,280 kVA.

The Project Layout has been designed to utilize 6 of "1.6 MW Inverter" combined units of two SMA 800 CP Series Inverters (Actual power output at test conditions is 1.76 MW for each unit) which are further connected to 6 SMA Low to Medium range voltage transformers at approximately 360V AC, one for each 1.6 MW unit respectively giving an output between 11 to 20KV range, leading finally to the switch gear or transformer from medium to high voltage range for connection to the Grid

Station at 132KV . Each unit of 1.6 MW will consist of 7480 panels, 2 inverters and 1 transformer.

A string concept is being used with 22 modules connected to a string, and 17 strings connected on a Bus leading to the SMA Inverters connection in parallel with a total of 10 such connections. The total number of PV modules used in this arrangement would be 694 units per 1.6 MW with a total of approximately 6 such units for the complete 10 MW setup.

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

2.1 Purpose of Study

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

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

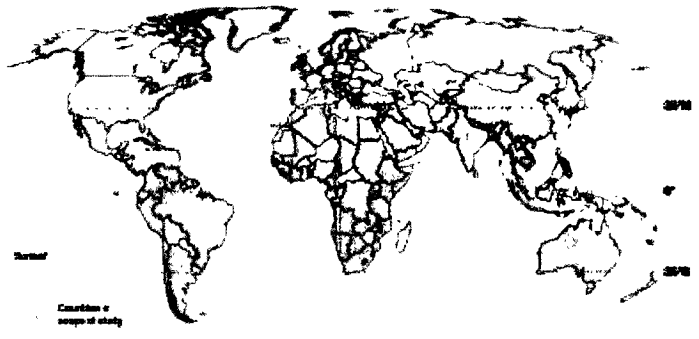
climatic conditions, shading situation, inverter failures, used PV technology and inverter type, external cabling and grid connection losses.

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

2.2 Background of Study

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

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



	Sunbelt countries in scope	All countries in Sunbelt	World
# countries (2006)	86	148	201
Population (2006)	5.0 billion	5.3 billion	6.7 billion
GDP (2006)	15.7 trillion	16.4 trillion	60.0 trillion
Electricity consumption (2007)	6,800 TWh	7,000 TWh	17,900 TWh

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

Figure 2.2.1: Sun Belt Countries Analysis

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

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

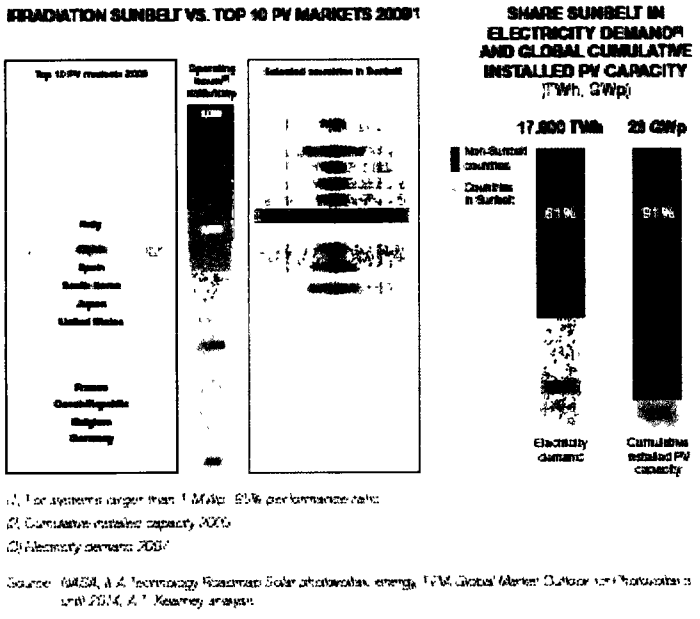
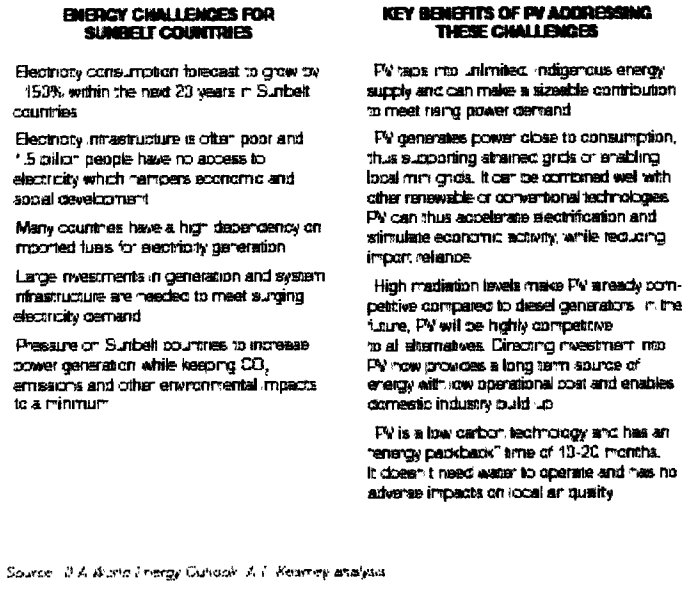


Figure 2.2.2: Comparison of Solar Irradiation, Share in Electricity Demand and Cumulative installed PV Capacity

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

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

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



ENERGY CHALLENGES FOR SUNBELT COUNTRIES

Electricity consumption forecast to grow by 150% within the next 20 years in Sunbelt countries

Electricity infrastructure is often poor and 1.5 billion people have no access to electricity which hampers economic and social development

Many countries have a high dependency on imported fuels for electricity generation

Large investments in generation and system infrastructure are needed to meet surging electricity demand

Pressure on Sunbelt countries to increase power generation while keeping CO_2 emissions and other environmental impacts to a minimum

KEY BENEFITS OF PV ADDRESSING THESE CHALLENGES

PV taps into unlimited, indigenous energy supply and can make a sizeable contribution to meet rising power demand

PV generates power close to consumption, thus supporting strained grids or enabling local mini grids. It can be combined well with other renewable or conventional technologies. PV can thus accelerate electrification and stimulate economic activity, while reducing import reliance

High radiation levels make PV already competitive compared to diesel generators. In the future, PV will be highly competitive to all alternatives. Directing investment into PV now provides a long term source of energy with low operational cost and enables domestic industry build up

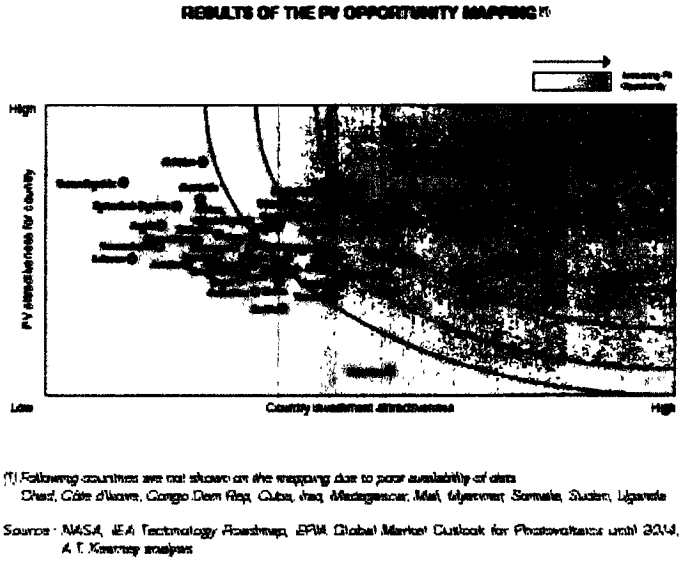
PV is a low carbon technology and has an "energy payback" time of 10-20 months. It doesn't need water to operate and has no adverse impacts on local air quality

Source: IEA World Energy Outlook; A.T. Kearney analysis

Figure 2.2.3: Benefits of PV for Sunbelt Countries

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

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

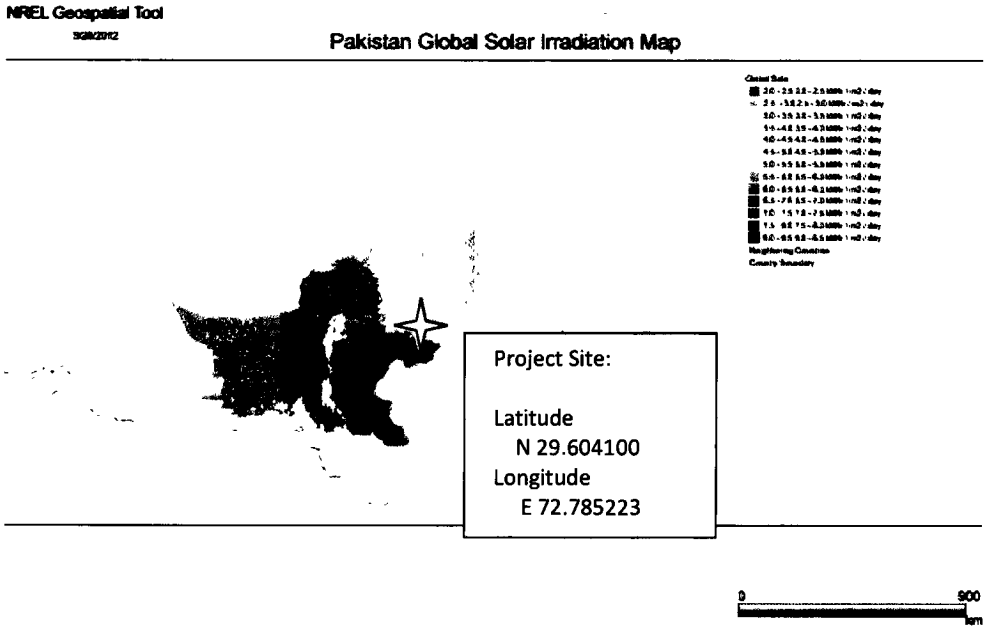


(1) Following countries are not shown on the mapping due to poor availability of data
Chad, Côte d'Ivoire, Congo Dem Rep, Cuba, Iraq, Madagascar, Mali, Myanmar, Somalia, Sudan, Uganda

Source: NASA, IEA Technology Roadmap, EPIA Global Market Outlook for Photovoltaics until 2014, A.T. Kearney analysis

Figure 2.2.4: PV Opportunity Attractiveness for Sunbelt Countries

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



Map 2.2.1: Pakistan Global Solar Irradiation Map

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

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

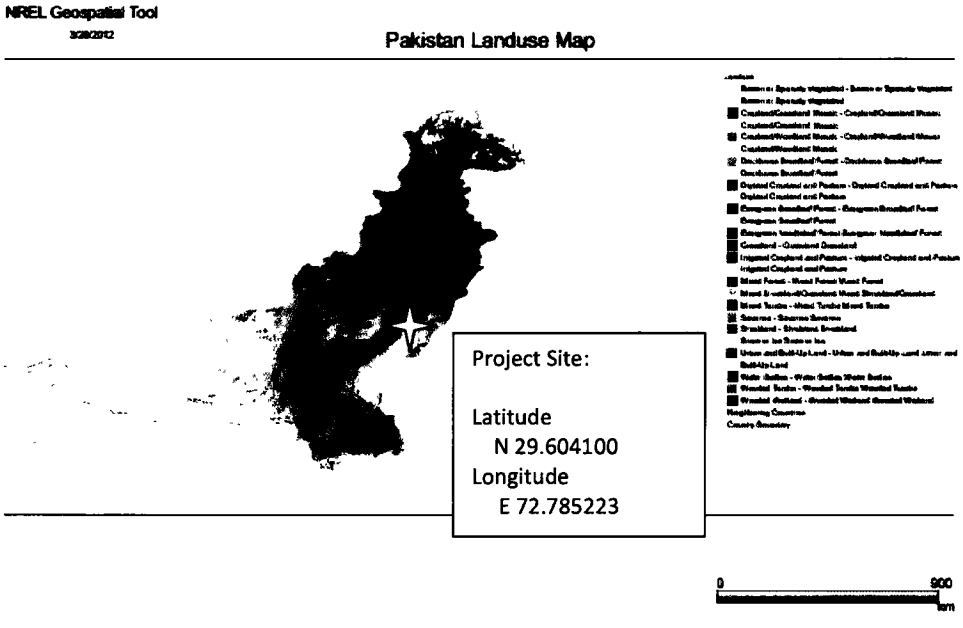
Also, about 70 per cent of the population lives in some 50,000 villages dispersed around the country. Many of these villages are far from the main transmission lines of the national grid and, because of their relatively small populations; it is usually not economically viable to connect these villages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

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

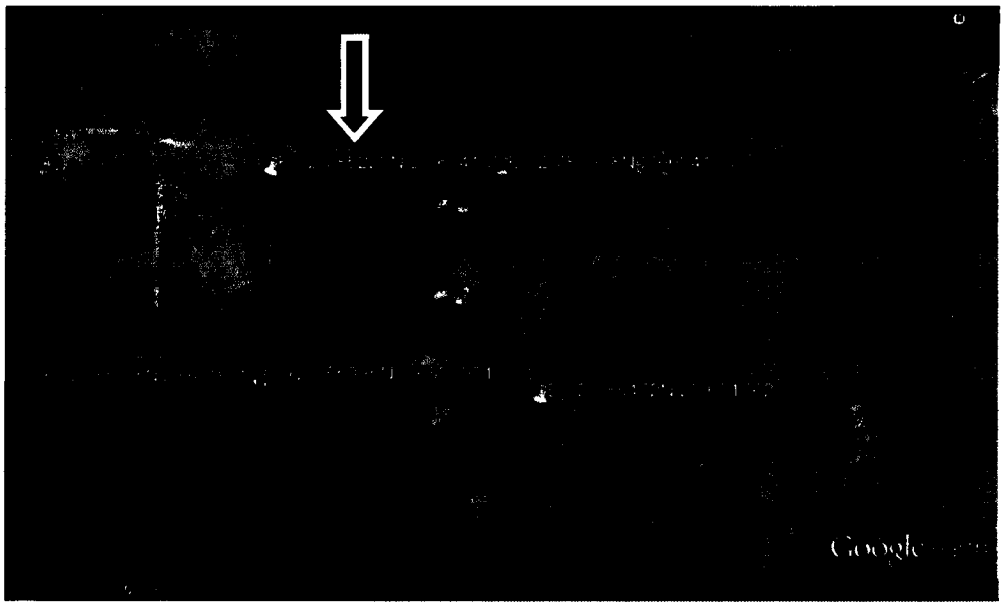
Development Board (AEDB) and respective Provincial Power Boards including the competent and highly esteemed Punjab Power Development Board (PPDB) have been established to facilitate the implementation of renewable energy projects. PPDB has been given a mandate, requisite resources and target to facilitate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

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

The site is located about 10 km from Bahawalpur, the nearest urban center. The locality enjoys a flat terrain, scarce plant cover, rich solar radiation, and availability of large area suitable for project expansion, accessibility and proximity to medium voltage transmission network, thus rendering itself an appropriate location for large Solar PV power stations.



Map 2.2.2: Project Site Coordinates



Map 2.2.3: Project Site Cholistan District, Punjab

The Project Sponsor has been following closely the Solar Power sector of Pakistan since 2005, and now registered as a member of AEDB in 2014 and obtained a preliminary qualification for solar power development. And consequently began development of the 10 MW Solar PV project in Cholistan Desert.

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

The 10 MW Solar PV Power project benefits include avoided fossil fuel costs and emissions reductions from the displaced conventional power generation, and the economic analysis based on the guaranteed 17% Internal Rate of Return demonstrates that the project is beneficial to the investors and project developers. The levelized cost of Energy comes out to be about 17.9 USD cents per KWh.

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

2.3 Project overview

The Project Site is located near the Cholistan Desert, District Bhawalnagar, with nearest city of Bahawalpur; which is one of the oldest cities of the region with a very rich historical heritage. The direct distance between the Project Site and Main Bahawalpur City is about 75km. Detailed information on the Cholistan Desert and Bahawalpur City can be found in **Annexure 4:** General Site information, however relevant and concise information is provided below.

Cholistan Desert sprawls thirty kilometers from Bahawalpur, Punjab, Pakistan and covers an area of 26,300 km^2. It adjoins the Thar Desert extending over to Sindh and into India.

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

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

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

In 2007, the city's population was recorded to have risen to 798,509 from 403,408 in 1998. Punjabi and Saraiki are the major languages of local people, while Urdu is well understood and English is the official languages used in various educational and government institutions. Bahawalpur is located south of the Sutlej River and lies in the Cholistan region near the Thar Desert. It is situated 90 km from Multan, 420 km from Lahore, and 270 km from Faisalabad.

The main crops for which Bahawalpur is recognized are cotton, sugarcane, wheat, sunflower seeds, rape/mustard seed and rice. Bahawalpur mangoes, citrus, dates and guavas are some of the fruits exported out of the country. Vegetables include

onions, tomatoes, cauliflower, potatoes and carrots. Being an expanding industrial city, the government has revolutionized and liberalized various markets, allowing the caustic soda, cotton ginning and pressing, flour mills, fruit juices, general engineering, iron and steel re-rolling mills, looms, oil mills, poultry feed, sugar, textile spinning, textile weaving, vegetable ghee and cooking oil industries to flourish.

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

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

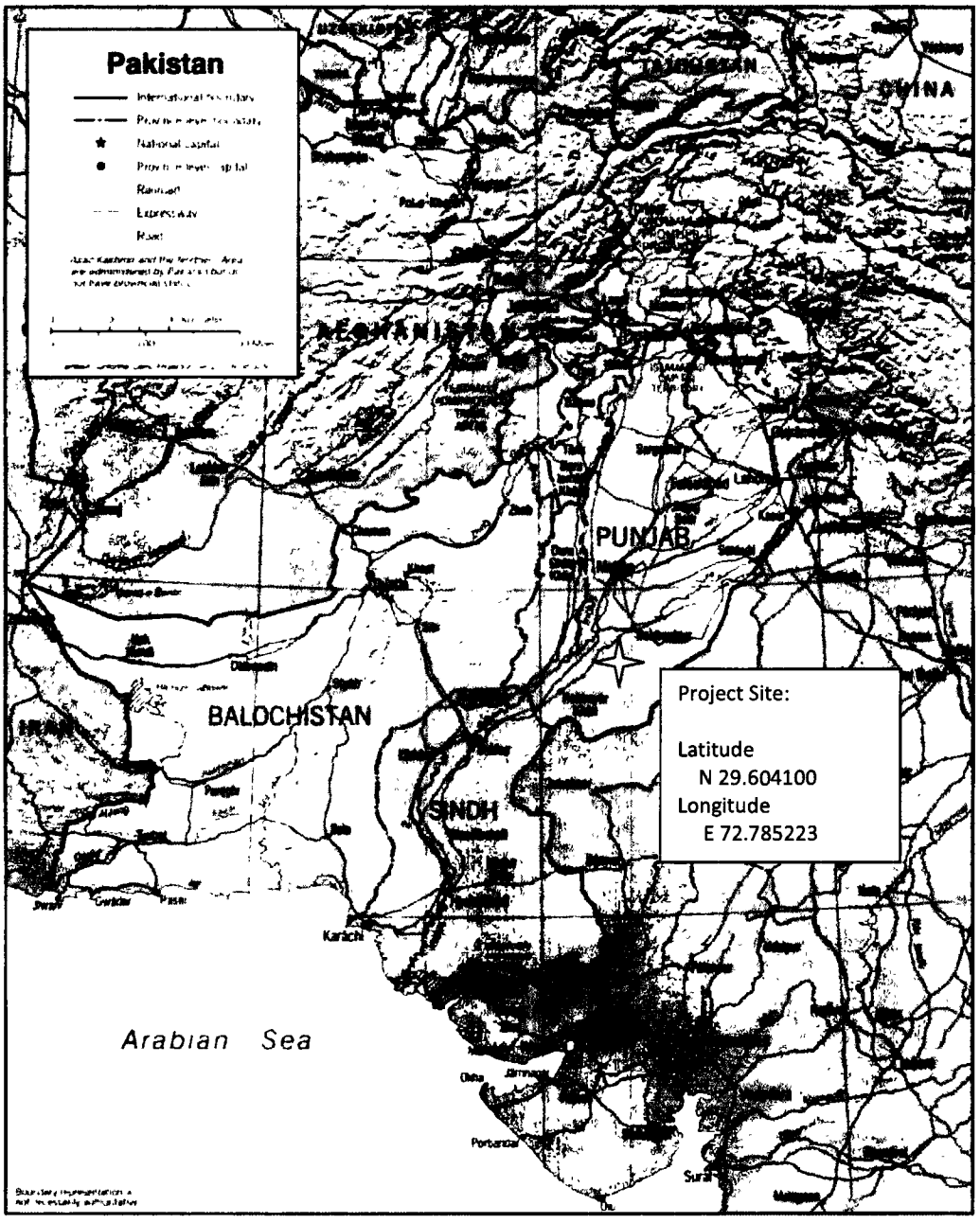
Demographics: Bahawalpur is one of the largest districts of Pakistan covering an area of 24,830 km^2. It has peculiar demographic, topographic and geographical characteristics. The district is situated almost in the center of the country at an elevation of 152 meters from the sea levels. The population of Bahawalpur district increased from 1.453 million in 1981 to 2.411 million in 1998, showing a growth rate of 3.88% per year and population density has increased from 59 in 1981 to 97 in 1998. The majority of Bahawalpur's residents speak Punjabi and Saraiki, while Urdu, and English are common languages used in various educational and government institutions

Transport: Bahawalpur is well connected with various cities in Pakistan. The city has its own airport built by the Dubai Civil Aviation Department and the CAA. Bahawalpur Airport links the city with various Pakistani cities such as Dera Ghazi Khan, Islamabad, Karachi and Lahore with the national flag carrier, Pakistan

International Airlines. The airline has launched international flights to Dubai, and plans to introduce more international destinations. There are daily trains and bus services from Multan, Lahore, Sukkur and Karachi to Bahawalpur, taxicabs and rickshaws are plentiful in the city. Cars are also available for hire in the city.

The distance between Project Site and the border between Pakistan and India is between 100 to 150Km. The Project covers an area of **50 Acres which is equivalent to 0.2134282112 Square Kilometers**. The latitudes and longitudes are provided in a table below. The altitude is 150m above sea level. The monsoon from the Indian Ocean, which is stable in its direction and high in its quality, brings rich wind energy resource to the Site.

The installed capacity of the Project is planned to be 10 MW. The geographical location of the project is shown in Map 2.3.1



Map 2.3.1: Regional Map showing Project Site in District Bhawalnagar, Cholistan Desert, Punjab

Map 2.3.2: Satellite Map of Project Site

10MW Project Coordinates

Node	Longitude (East)	Latitude (North)
1	E 72.785223	N 29.604100
2	E 72.787998	N 29.604100
3	E 72.788472	N 29.601762
4	E 72.785095	N 29.601931

Table 2.3.1: Geographical Coordinates of Project Site

The electric grid selected for connection with the PV power plant is MEPCO's Dharanwala 132/11 kV Substation due to a number of factors. Connection to this grid station is most feasible as per initial surveys and research. The grid station has the required capacity (and is going up-gradation) for receiving and distributing maximum load from the PV Power station. Operators at grid station have also demonstrated their confidence in being able to forecast required information.

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

The Project shall have an installed capacity of approximately 10.05 MW. There shall be a substation of 132KV, which shall dispatch electricity to MEPCO Grid through their station at Dharanwala, which is near to the Site which would be between 3.2 to 4.5 Km's from the Power Station depending on where the switch gear is finally positioned on the project site.

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

2.3.1 Project Size

The Project will install 41,888 Solar PV Modules of 240 Wp each, totaling 10.05 MWp approx., covering an area of almost 150 Meters square (37.5 acres).

2.3.2 Project Status and Calendar

The project has successfully achieved a number of milestones as outlined in the Executive Summary and Background of the Study provided above, and now the Comprehensive Feasibility Study Report is ready for onward progress. In parallel, the Project shall also pursue and continue work on signing of EPA/ IA.

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

2.3.3 Geological Conditions

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

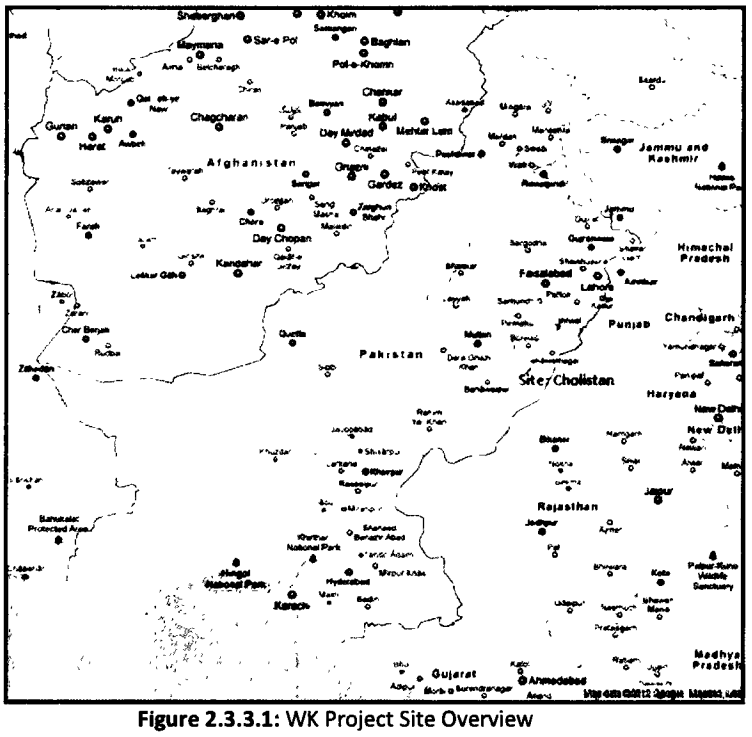


Figure 2.3.3.1: WK Project Site Overview

The Site encompasses an area of 50 Acres approximately 10 km from Bahawalpur (the nearest urban city). The location enjoys a flat terrain with sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself an appropriate location for the setup of a large solar power station

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

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

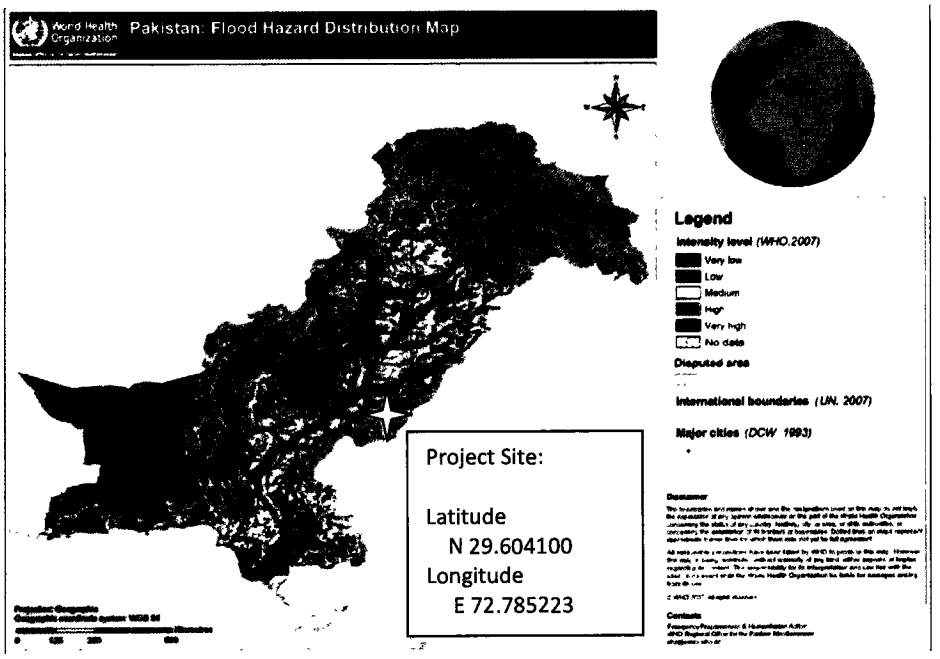


Figure 2.3.3.3: Shows the Flood hazard map of Pakistan

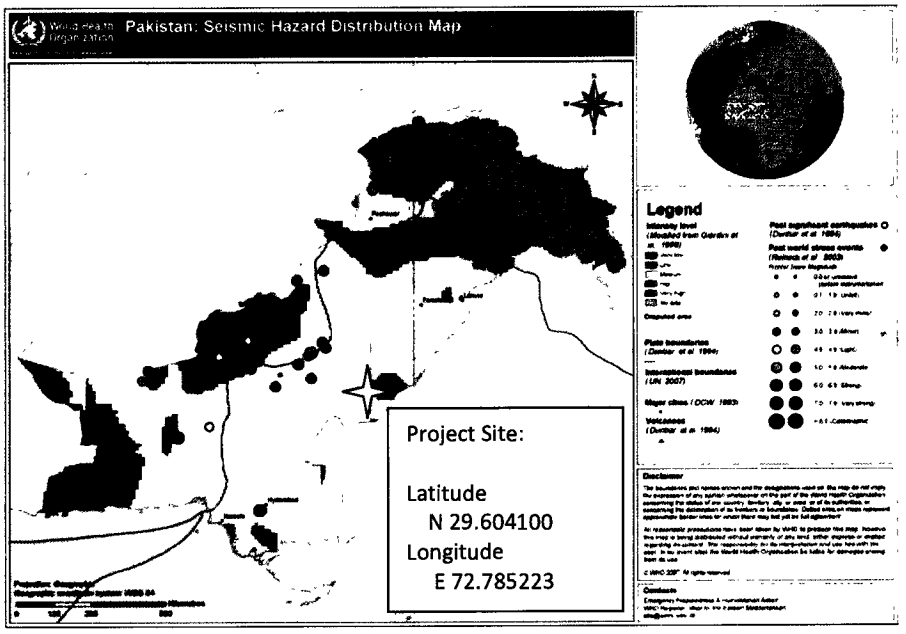


Figure 2.3.3.4: Shows the Natural Hazard map of Pakistan

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

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

2.3.4 Solar Resource Assessment

The SRA equipment installed at site has been manufactured by NRG, Vermont with Data Logger Model # 4941 (**Fig. 10.3.5** NRG Data Logger Installed and Connected). The Solar Resource Assessment System; NRG Systems SymphoniePLUS3™ data logger, iPackGPS communications modules (GSM, CDMA, and Satellite), SDR software, meteorological tower components, and reliable sensors from NRG Systems is designed for the professional solar PV developer looking for quick and repeatable deployment, easy and autonomous off grid operation, and bankable data. The system is comprised of proven products including the NRG Systems Symphonie*PLUS*3™ data logger, iPackGPS communications modules (GSM, CDMA, and Satellite), SDR software, meteorological tower components, and reliable sensors. NRG Systems resource assessment equipment is currently used on all continents and across 145 countries.

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

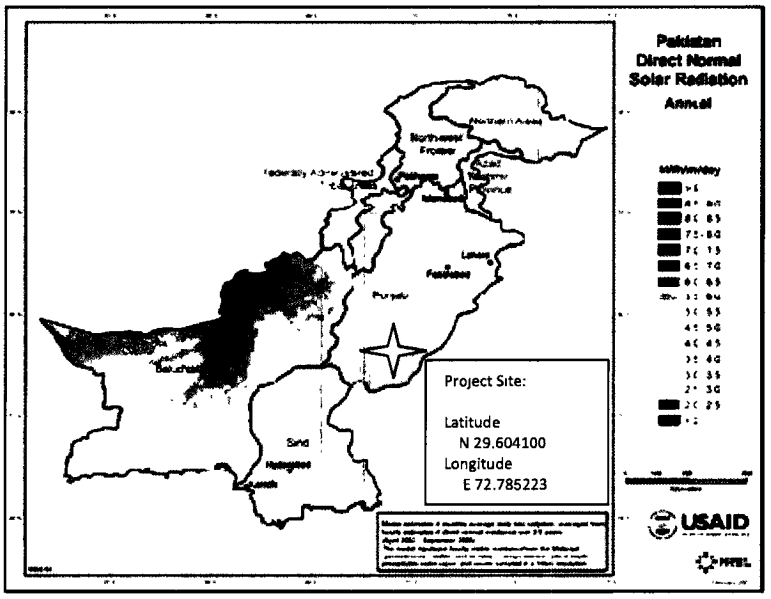


Figure 2.3.4.1: Solar Radiation Map of Pakistan

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

2.3.5 Solar Power Plant Equipment and Energy Yield Estimate

PV Modules

The modules used in the Feasibility Study have been selected after stringent analysis of technologies in the market. The product to be used is SW 240 Mono which is a 240 W solar panel manufactured by Solar World. The technology used in these panels is Mono-Crystalline silicone. It has the following specifications:

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

Table 2.3.5.1: Specifications of PV Modules

* Test conditions according to UL1703

** Performance at 800 W/m^2, NOCT (Nominal Operating Cell Temperature)

The total number of modules used is 209,440 units creating nominal power of 10.05 MW.

Inverters

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

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

Table 2.3.5.2: Specifications of Inverter

The modules are to be connected to the inverters in a sub-array concept. A string consists of 22 panels. 17 of these strings constitute a single connection. 10 such connections are connected to a single inverter. Therefore the total number of strings connected to an inverter is 170. The total number of inverters utilized is 12 units. The inverters are planted in close vicinity of the PV array

Transformers

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

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

Table 2.3.5.3: Specifications of Transformer

2 inverters could be connected to a single transformer. A total of 6 such transformers would be planted in close vicinity to the inverters. The transformers used in this layout are supplied by the manufacturers of the inverters thus allowing for optimum performance.

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

Model:	SFZ9-60000/11/132 STEP UP TRANSFORMER
Input Voltage:	11 kV
Output Voltage:	132 kV
Capacity:	12000 kVA

Computer generated simulations of the layout showed that the annual system production is 15,830 MWh/yr at an average of 43.4 MWh/day.

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

2.3.6 Design of Electrical Engineering

The Project has an Installed capacity of 10.05 MW, with 41,888 solar modules installed. The module to be used for power generation is the "SW240 Mono Model" which is a 240 W solar panel manufactured by Solar World, using Mono-crystalline silicon. The output lines carry medium voltage electricity to specially constructed switchgear which steps up the voltage from 11 kV to 132 kV and feeds the electricity to the gridline.

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

The modules are to be connected to the inverters in a sub-array concept. A string consists of 22 panels. 17 of these strings constitute a single connection. 10 such connections are connected to a single inverter. Therefore the total number of strings connected to an inverter is 170. The total number of inverters utilized is 12 units. The inverters are planted in close vicinity of the PV array.

A medium voltage transformer is used to step-up the voltage from 360V to 11 kV. 2 inverters could be connected to a single transformer. A total of 6 such transformers would be planted in close vicinity to the inverters. The transformers used in this layout are supplied by the manufacturers of the inverters thus allowing for optimum performance. The output lines carry medium voltage electricity to specially constructed switchgear which steps up the voltage from 11 kV to 132 kV and feeds the electricity to the gridline. Computer generated simulations of the layout showed that the annual system production is 15,830 MWh/yr at an average of 43.4 MWh/day.

2.3.7 Design of Civil Works

Prior to any construction activity, the site must be cleared of all debris and surface vegetation if any. The leveling and grading can be carried out by normal earth moving machine. It is recommended that immediately after excavation for construction of foundation or other substructures, the excavation bottoms and slopes are cleared of all debris, proof rolled and covered by a 5 cm thick blinding concrete layer. The onsite material is generally classified as SANDY SILTY CLAY (CL-ML) group of Unified Soil Classification System. Select fill material should consist only of inorganic material and shall have 5-20% passing the No. 200 sieve. Fill material should pass 100% the 50 mm sieve. Besides, that portion of material passing sieve No. 40 should not have liquid limit more than 35 and plasticity index of not more than 12. Atterberg limits are not required for select fill material with less than 15% passing sieve No. 200. Select fill material shall have a carbonate content of less than 25% by weight.

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

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

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

2.3.8 Fire Fighting Management

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

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

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

- Daytime = Danger;
- Nighttime = No Hazard
- Inform the IC that a PV system is present
- Securing the main electrical does not shut down the PV modules
- At night apparatus-mounted scene lighting does not produce enough light to generate an electrical hazard in the PV system
- Cover all PV modules with 100 percent light-blocking materials to stop electrical generation

- Do not break, remove, or walk on PV modules, and stay away from modules, components, and conduit

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

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

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

- Identify the existence of a solar power system
- locate rooftop panels
- clarify electrical disconnects
- obtain system information
- Identify the type of solar power system
- Solar Thermal System
- Photovoltaic System
- Isolate and shutdown as much of the system as possible
- Lock-out and tag-out all electrical disconnects
- Isolate the photovoltaic system at the inverter using reliable methods
- Work around all solar power system components

2.3.9 Construction Management

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

- Orientation and setting of the modules to take full advantage of sun as generators of energy
- Selection, delivery and handling of fragile, state-of-the-art components

- Expertise and qualifications of system installers such as roofers, electricians and glaziers.

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

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

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

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

Main soil types of Cholistan desert are sand dunes (44%), sandy soils (37%), loamy soils (2%) and saline-sodic clayey soils (17%). The 50 MW Cholistan Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under schedule II classified by the Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. However both studies were conducted and submitted to EPA Punjab which after its due diligence has issued a No Objection Certificate (NOC) to the Project. The site will be restored to the original landscape in the later phase of construction.

2.3.10 O & M Management

After the completion of its construction, the Project shall be jointly managed with the 132 kV Substation. A joint management organization will be established with the

principle of requiring "few on-duty staff". After the electrical equipment and machinery have entered their stable operation mode; the solar farm and substation shall be managed with "no on-call staff and few on-guard staff'.

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

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

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

2.3.11 Environmental Management

A separate environment study has been carried out. Please refer to Volume 5. There are no significant hazards. The minor adjustments required during construction phase have been addressed and mitigation plan provided. There are no settlements within 05-08 Km of the Project Site, which further supports the Project in this location. As mentioned above, the 10 MW Cholistan Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under the schedule II classified by Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. However both studies were conducted and submitted to EPA Punjab which after its due diligence has issued a No Objection Certificate (NOC) to the Project.

2.3.12 Health and Safety

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

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

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

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

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

2.3.13 CDM Aspect

Thorough work has been done to develop the Project under the Clean Development Mechanism of the UNFCCC. The Project is a power generation project with renewable resource and zero emission. When put into operation, the project can provide power supply to the southern Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. It can deliver good environmental and social benefits. It is also consistent with the spirit of the Kyoto Protocol and qualifies for the application of CDM projects', NEPRA is allowing almost the same return on

equity (RoE) to the thermal and the renewable energy projects. The Sponsors of the Project require CERs to bring the RoE at a level where they can invest in renewable energy projects in Pakistan in future as well. If the project is approved and registered as a CDM project, CERs can provide slightly extra financial resource for the project it encouraging project sponsors and lenders. Besides providing minutely more favorable conditions for the project financing, it will improve competitiveness of the project, and reduce investment risk during the project implementation process.

1	**Location of the Solar Farm**		
1.1	Elevation	m	135
1.2	Longitude (East)		071 49.291
1.3	Latitude (North)		029 18.836
2	Solar resource		
2.1	Annual Average Horizontal Radiation	kWh/m2/day	5.53
3	Major Equipment		
3.1	PV Modules		
(1)	Quantity	Ea	41,888
(2)	Technology		Mono Sllicone
(3)	No. of cells	Ea/panel	60
(4)	Impp	A	30.6
(5)	Vmpp	V	7.87
(6)	Rated Power	Wp	240
3.2	Inverters		
(1)	Quantity	Ea	12
(2)	Pmax	Wp	880
(3)	Input Voltage	V	673
(4)	Input Imax	A	1338
(5)	Output Voltage	V	363
(6)	Output Imax	A	1400
3.3	Medium Transformers		
(1)	Quantity	Ea	6
(2)	Pmax	Wp	1760
(3)	Input Voltage	V	363
(4)	Input Imax	A	2 X 1400
(5)	Output Voltage	kV	20
(6)	Output Imax	A	46.2
3.4	High Voltage Transformer		
(1)	Quantity	Ea	1

(2)	Capacity	kVA	12000
(3)	Input Voltage	kV	11
(4)	Output Voltage	kV	132
(5)	Frequency	Hz	50
(6)	Phase	Ea	3
4	Civil Engineering		
4.1	PV Module Mountings	Simple truss structures for immediate installation at site	
4.2	Foundation for High Voltage Substation		
5	Construction		
5.1	Construction Period	month	9
6	Production Analysis		
	Annual Benchmark Energy Yield	GWh/yr	15.83
7	Budgetary Estimates		
7.1	EPC Cost	Min US $	**16.927,083**
7.2	Total Project Cost	Min US $	**19.006,875**
7.3	O&M Cost for Year 01 – 02	Min US $	**1.05**
7.4	O&M Cost for Year 03 – 05	Min US $	**1.05**
7.5	O&M Cost for Year 06 – 20	Min US $	**1.05**
8	Referenced Levelized Tariff		-
8.1	Levelized Tariff (Excluding withholding Tax)	US Cents / KWh	-
8.2	Levelized Tariff (Including withholding Tax)	US Cents / KWh	**17.9**

Figure 2.3.13.1: Project Technical and Financial Summary

2.4 Rational for Solar power

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

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

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

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

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

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

2.5 Country overview

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

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