AASAL POWER

JAVED SOLAR PARK (PVT) LTD

Ref: [JSPL/NEPRA/001/18]

Date: 08th November, 2018

THE REGISTRAR,
NATIONAL ELECTRICAL POWER REGULATORY AUTHORITY,
NEPRA Tower, Attaturk Avenue (East)
G-5/1, Islamabad

SUBJECT: **APPLICATION FOR GRANT OF GENERATION LICENSE TO JAVED SOLAR PARK PRIVATE LIMITED FOR ITS 49.5 MW SOLAR POWER GENERATION PROJECT TO BE LOCATED AT LUNI, KULACHI, DISTRICT DERA ISMAIL KHAN, PROVINCE OF KHYBER PAKHTUNKHWA**

Dear Sir,

1. Pursuant to Rule 3 of the National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, JAVED SOLAR PARK PRIVATE LIMITED hereby submits for NEPRA's kind consideration and approval, the Generation License Application (together with the information and annexures attached thereto).

2. The Generation License Application (including its annexures) are submitted in triplicate, together with:
   (a) A Pay Order No. **11886399** dated 30 October 2018 of Habib Metropolitan Bank Ltd amounting to PKR 318,160 /- (Pakistani Rupees [Three Hundred And Eighteen Thousand One Hundred And Sixty Only]) drawn in favor of NEPRA, as the application fee for the Generation License Application;

   (b) Extract of Board Resolution of JAVED SOLAR PARK PRIVATE LIMITED; and

   (c) Statement of Authorized Representative of JAVED SOLAR PARK PRIVATE LIMITED, Mr. Abdul Basit Javed.

3. In light of the submissions set out in the Generation License Application and the information attached to the same, NEPRA is kindly requested to process the Generation License Application at the earliest, thereby enabling JAVED SOLAR PARK PRIVATE LIMITED to proceed further with the development of the project.

Respectfully submitted for and on behalf of:
JAVED SOLAR PARK PRIVATE LIMITED

.....

MR. ABDUL BASIT JAVED
CHIEF EXECUTIVE OFFICER

JAVED SOLAR PARK (PVT) LTD. JSP

Board Resolution

The following resolutions were discussed in detail by the Board and approved unanimously on 06, November 2018:

"RESOLVED THAT JAVED SOLAR PARK PRIVATE LIMITED, a company incorporated under the laws of Pakistan with its registered office located at House 28, Street 2, Sector E11/1, MPCHS Islamabad, Pakistan, (the **"Company"**) be and is hereby authorized to file Generation License Application (including any modification) for submission to the National Electric Power Regulatory Authority (**"NEPRA"**) in respect of its [49.5 MWp] Solar Power Project to be located at town Luni in Kulachi, Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan (the **"Project"**) and in relation thereto, enter into and execute all required documents, make all filings and pay all applicable fees, in each case, of any nature whatsoever, as required."

"FURTHER RESOLVED THAT in respect of filing a Generation License Application (including any modification) for submission to NEPRA, Mr Abdul Basit Javed, CEO & Director be empowered and authorized for and on behalf of the Company to:

(i) review, execute, submit, and deliver the Generation License Application (including any modification) and any related documentation required by NEPRA including but not limited to filing, singing, presenting, modifying, amending, withdrawing application and other documents, responding to any queries of any nature whatsoever;

(ii) represent the Company in all negotiations, representations, presentations, hearings, conferences and /or meetings of any nature whatsoever with any entity (including, but in no manner 2-limited to NEPRA, any private parties, companies, partnerships, individuals, governmental and /or semi-governmental authorities and agencies, ministries, boards, departments, regulatory authorities and /or any other entity of any nature whatsoever);

(iii) appoint or nominate any one or more officers of the Company or any other person or persons, singly or jointly, in its discretion to communicate with, make presentations to and attend NEPRA hearings;

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

"AND FURTHER RESOLVED THAT Mr Abdul Basit Javed, CEO & Director, be and is hereby authorized to delegate all or any of the above powers in respect of the forgoing to any other officials of the Company as deemed appropriate.

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JAVED SOLAR PARK (PVT) LTD

Mr. Abdul Basit Javed
Chief Executive Officer

Mr. Muhammad Salim Javed
Director

IN WITNESS THEREOF, I hereunder set my hands as such Secretary / Chief Executive and affixed the corporate seal of said company.

Mr. Salman-Alam
Company Secretary

JAVED SOLAR PARK (PVT) LTD. JSP

House # 28, Street # 2, Sector E-11/1, MPCHS, Islamabad
t: +92 51 873 4203;f: +92 51 873 4204; e: info@javed-group.com; w: www.javed-group.com

Prospectus

Introduction to the Sponsors

The Project is an initiative of AASAL Solar Power (Private) Limited whose major shareholder (95%) is Mr. Abdul Basit Javed, a qualified Chartered Accountant, with net worth of 40 million USD. Mr. Abdul Basit owns and manages family properties of agricultural and commercial nature; measuring about 4,000 acres (directly owned by Mr. Abdul Basit) in the province of KPK.

Abdul Basit Javed has played major role in bringing FAS Power Trading Company of Saudi Arabia into Pakistan which is establishing a 50 MWp Solar Power Plant in KPK. Similarly in the past he advised Target Group in developing 50 MWp Kulachi Solar Power Project (Private) Limited.

He has also made his footprints in the energy sector of the country through substantial investment in hydropower sector. His company AASAL owns two hydropower Projects of 6.6 MW and 20.6 MW with approved feasibilities by PEDO where as other four projects of 45 MW, 65 MW, 100 MW and 100 MW respectively are in the LOI stage. The company is therefore successfully managing and developing more than 400 MW with different partners. In solar power industry AASAL has successfully completed bidding in numerous projects of United Nations for Solarization of different units in entire KPK. AASAL has also successfully won the project of Solarization of Quaid E Azam University Islamabad having capacity of 12 MWp.

Introduction to the Project

The Applicant obtained the Letter of Intent (LOI) from Pakhtunkhwa Energy Development Board (PEDO), Government of Khyber Pakhtunkhwa on July 21, 2016 for 3.5 MWp Solar PV Power Generation Project at Kulachi, Dera Ismail Khan, Khyber Pakhtunkhwa (the "**Project**"). Based on technical studies and further deliberations, PEDO enhanced the project capacity to 49.5 MW through an Addendum to LOI No: 2260-62/PEDO/DREPP dated October 24, 2018 (annexed).

The project site is near Luni village, approximately 17 km from Kulachi City. It is located at 31°93'N 70°28'E at an altitude of 238 meters having a distance of approximately 448 km from Islamabad.

The Project site consists of approximately 250 acres of land, which is acquired by the project company. The site selected for the project is generally flat, with a minor slope towards the southeast, with the slope increasing towards the southern end of the site boundary.

The complete feasibility study was submitted to PEDO which has been approved on November 7, 2018.

The Electrical and Grid Interconnection Studies was conducted by ARCO Energy Pakistan, and approved by PESCO on February 21, 2018.

Initial Environmental Examination (IEE) Report was submitted to Environmental Protection Agency (EPA), Khyber Pakhtunkhwa and approved by the authority on January 22, 2018.

The Project shall have an installed capacity of 49.5 MWp. The scheme of interconnection with PESCO grid has been determined in the Grid interconnection studies.

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Salient Feature of the Facility for which license is sought

Project Capacity	49.5 MWp
Type of generation Facility	Solar PV Power Plant
Type of Technology	Crystalline Silicon
Module	JAP6(T)- JA Solar
Inverter	TBEA TC500KH
Purposed Interconnection Scheme	2.5 KM In/Out arrangement with 132 kV Grid Station Kulachi

The Project has applied for the tariff simultaneously with this application. Upon issuance of the Generation License and determination of tariff, the applicant would execute Energy Purchase Agreements (EPA) with the power purchaser and aims to reach financial close by June 2019 the expected commercial operation date of the Project by April 2020, subject to award of tariff, execution of concession agreements and availability of Grid.

Proposed investment

The total cost of the project is approximately US$ 49.27 million with the proposed capital structure comprising of 80% debt and 20% equity as per recently issued National Electric Power Regulatory Authority (Benchmarks for Tariff Determination) Guidelines, 2018. Total debt component is estimated at US$ 39.41 million while total equity component is estimated at US$ 9.8 million. Debt funding mix is assumed at 50:50 foreign and local debt. An LOI from the Bank has also been issued in favor of the project which is attached herewith as Annex – B. Whole equity component will be provided by the project sponsors.

Social and Environmental Impact of the Proposed Facility

A detailed Initial Environmental Examination ("IEE") Report has been prepared Nasir Absar Consulting (Pvt.) Limited, on behalf of the Sponsors, which has been approved by the Directorate of Environmental Protection Agency, Southern Region, D.I. Khan, Forestry, Environment and Wildlife Department, Government of Khyber Pakhtunkhwa ("KP-EPA").

As per the IEE Report, the Project has no significant adverse impacts and shall contribute positively to the environment and socioeconomic development of the area. Further, the Project land is marginal in nature with no endangered flora or fauna species in the area. Appropriate measures for environmental monitoring and mitigation have been proposed in the approval issued by the KP-EPA.

This document is submitted pursuant to Section - 5 of Article - 3 of NEPRA Licensing (Application & Modification Procedure) Regulation, 1999 (the "**Regulations**"); and list of documents required are attached as Annexure as mentioned in Document Structure.

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SCHEDULE-I

The Location, Size (i.e. Capacity in MW), Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facilities of the Licensee are described in this Schedule.

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

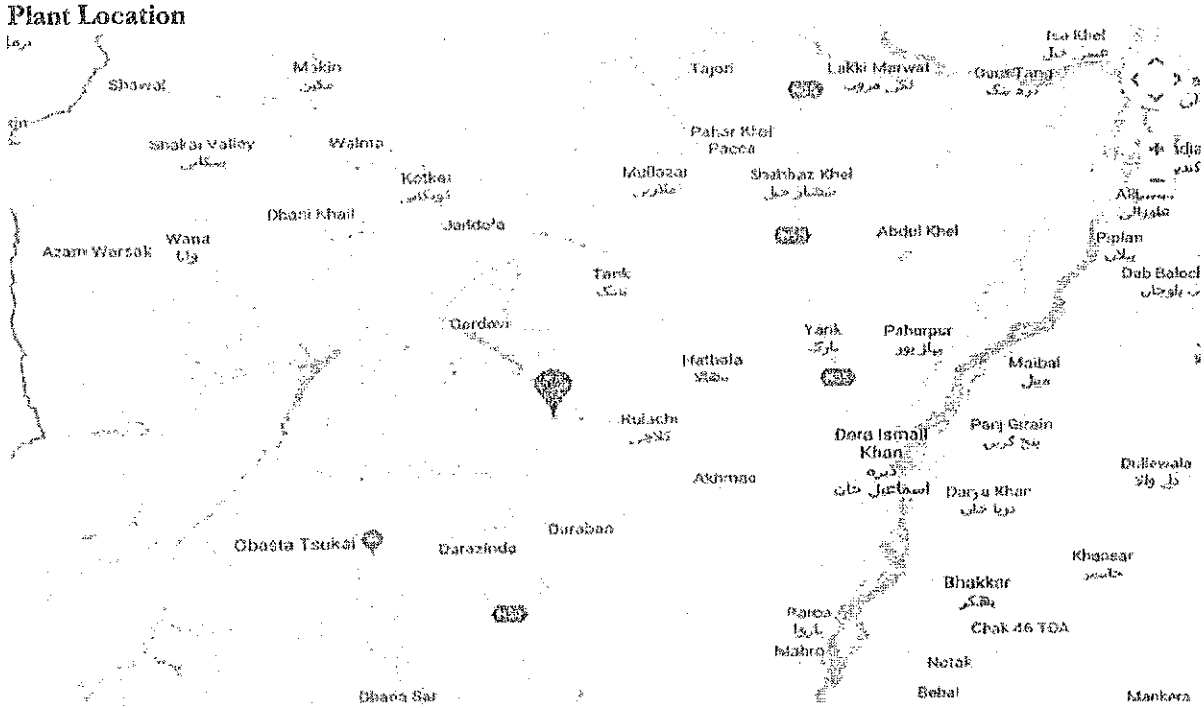
Project Site

The project site is accessible through Rawalpindi-Jand-Kohat Road (N-55) at the distance of approximately 430 km from Islamabad and Mianwali-Talagang-Dera Ismail Khan Road at the distance of approximately 440 km from Islamabad. The project area runs through northern central Indus basin. Central Indus Platform Basin (CIPB) rests on the continental margin of Indo-Pakistani Plate. CIPB is bounded in south by Jaisalmer-Mari-Kandhkot High, while Sulaiman Range defines the western boundary. Sargodha Ridge (Kirana Hills) marks the north-eastern boundary. The Punjab Platform dips westward into the Sulaiman Foredeep. The structural style of the Central Indus Platform Basin is obscured at surface by thick alluvial cover.

Relevant site details are summarized in the following table;

Particulars	Description
Project Site	Moza Luni
Tehsil	Hathala
District	D.I. Khan
Province	Khyber Pakhtunkhwa
Latitude	31°56'49.48"N
Longitude	70°16'47.45"E
Road Access	Asphalt road attached to the site
Project Site Area (Assessed)	375 Acres

Plant Location



SOLAR PARK (PVT) LTD.

Location Coordinates of the Generation Facility/

Solar Power Plant/Solar Farm

Land Coordinates of the Project site	31°56'49.48"N	70°16'47.45"E
	31°56'50.81"N	70°17'30.54"E
	31°56'20.85"N	70°17'30.42"E
	31°56'18. 97"N	70°16'51.61"E

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Interconnection Arrangement/Transmission Facilities for Dispersal of Power from the Generation Facility/Solar Power Plant /Solar Farm of the Licensee

The project will be connected by making an In/Out on 132kV Rail Single circuit between the Project and Kulachi Substation by a feed length of 2.5km of Rail conductor Steady state power flow assessment has been performed using the base case provided by PESCO. Pre-project power flow study was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Post project power flow analysis has also been performed after the interconnection of the proposed project with the PESCO transmission system. The power flow results for the system intact and for the contingency conditions shows that the power flows on all the transmission line branches are within their normal thermal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area. Dynamic stability analysis has been performed to access the dynamic impact of the Solar power plant on national grid system due to disturbances at the power plant and vice versa. The results of dynamic stability analysis indicate that the power system is stable for the interconnection proposal and it also fulfils all the criteria for generation connection with the power system. Short circuit analysis has been performed to evaluate the contribution of the proposed project in fault current levels of substations in its electrical locality. Fault currents have been computed based on simulation of three-phase and single-line-to-ground faults by applying the criteria as mentioned in the IEC-60909 standard.

Result of the analysis shows that the calculated fault currents are below the circuit-breaker interrupt ratings of existing grid stations located in locality of the project. Based on the study results, it is concluded that proposed generation interconnection assessment for 49.5MW (AC) Solar PV Power Generation project meets the NEPRA grid code planning criteria.

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Detail of

Generation Facility/Solar Power Plant/Solar Farm

(A). General Information

(i).	Name of Company/ Licensee	Javed Solar Park Private Limited
(ii).	Registered/Business Office	House no. 28, Street No. 2, Sector E-11/1, MPCHS, Islamabad
(iii).	Plants Location	Luni village, Kulachi Tehsil, D I Khan, KPK
(iv).	Type of Generation Facility	Solar Photovoltaic (PV) Power Plant

(B). Solar Technology & Capacity

(i).	Type of Technology	PV Cell
(ii).	System Type	Grid Connected
(iii).	Installed Capacity[1] of the Generation Facility/Solar Power Plant/Solar Farm (MW)	49.50 MW_p

(C). Technical Details of Equipment

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	PV Modules crystalline silicon
(ii).	Type of Cell	60-cell Poly-crystalline silicon
(iii).	Dimension of each Module	Dimensions (L×W×H) (mm) 1646×987×21/23

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(iv).	Module Surface Area	1646x987 (mm)
(v).	No. of Panel /Modules	215,220 Solar PV modules
(vi).	Total Module Area	351,917 sq. m
(vii).	Total Land Area Used	375 acres
(viii).	Panel's Frame	Combination of anodized aluminium channels, purlins and raceways are used to form the supporting frame. The frame is for 5 modules in width and 6 modules in length. These modules have 60-cell in total.
(ix).	Weight of one Module	15.5 kg with traditional aluminium frame
(x).	Module Output Warranty	10 year product warranty
		25 years Linear power output warranty
(xi).	Number of Solar Cells in each module	60-cell
(xii).	Efficiency of module	14.16%
(xiii).	Environment Protection System	The first solar company in China to complete Intertek's carbon footprint evaluation program and receive green leaf mark verification products.
(xiv).	Nominal Maximum Power (Pmax) at STC	230W
(xv).	Power Tolerance at STC	0 - +5 W
(xvi).	Open circuit voltage (Voc) at STC	37.11 V
(xvii).	Short circuit current (Isc) at STC	8.33 A
(xviii).	Maximum system Voltage at STC	DC 1000 V
(b).	**PV Array**	
(i).	No. of PV modules	215,200
(ii).	Modules in a string	20 module
(iii).	Total number of strings	10761
(c).	**PV Capacity**	

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(i).	Total	49.5 MWp	
(d).	**Inverters**		
(i).	Max. DC power Input	567 kW	
(ii).	Inverter Model	TC500KH-M	
(iv).	Minimum Input Voltage	480 V	
(v).	Number of Inverters	95	
(vi).	Efficiency	99%	
(vii).	Max. Allowable Input voltage	1000V	
(viii).	Max. Input Current	1134 A	
(ix).	Output electrical system	0.5MW (AC)	
(x).	Nominal Output Voltage (AC)	315 V	
(xi).	Rated Frequency	50 Hz	
(xii).	Power Factor	0.9 lead - .09 lag	
(xii).	Environmental Enclosures	Operating Temperature Range	-25C - +60C (above 55C, derating)
		Relative Humidity	5% - 95% (non-condensing)
		Audible Noise	
		Operating Elevation	Without derating ≤ 3000m (above 3,000m, derating according to GB/T3859.2)
(xiv).	Grid Operation Protection	(a).	Over-voltage/undervoltage protection
		(b).	Over-frequency/under frequency protection
		(c).	Anti-island protection strategy
		(d).	Over-current protection
		(e).	Anti-discharge protection
		(f).	Overload protection
		(g).	Low voltage ride through

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		(h).	Lightning protection
(e).	**Step-up Transformer**		
(i).	Rating	400V // 33kV step-up	
(ii).	Type of Transformer	Oil and Natural Air	
(iii).	Input voltage	430V	
(iv).	Output Voltage	33kV	
(v).	Purpose of Transformer	Step-up	

(D). **Other Details**

(i).	Expected COD of the Generation Facility/Solar Power Plant/Solar Farm (Anticipated)	December 30, 2019
(ii).	Expected Useful Life of the the Generation Facility from COD	25 Years

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SCHEDULE-II

The Total Installed Gross ISO Capacity of the Generation Facility/Power Plant/Solar Plant (MW), Total Annual Full Load (Hours), Average Sun Availability, Total Gross Generation of the Generation Facility/Solar Farm (in kWh), Annual Energy Generation (25 years Equivalent Net Annual Production-AEP) KWh and Net Capacity Factor of the Generation Facility/Power Plant/Solar Farm of Licensee is given in this Schedule.

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SCHEDULE-II

(1).	Total PV Installed Capacity of Generation Facility	49.50 MW_p
(2).	Days per Year	365 days
(3).	PV Plant Generating Capacity Annually (As Per Simulation)	84,724 MWh
(4).	Expected Total Generation in 25 years Life Span	2,118,100
(5).	Generation per Year from plant keeping 24 Hours Working	433,620
(6).	Net Capacity Factor (3/5)	19.54% at P50

Note

All the above figures are indicative as provided by the Licensee. The Net energy available to the Power Purchaser for dispatch will be determined through procedures contained in the Energy Purchase Agreement.

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Profile of Experience of the Applicant, Management, Staff and its members in the electricity industry

The Project is an initiative of AASAL Solar Power (Private) limited "AASAL", whose major shareholder (95%) is Mr. Abdul Basit Javed, a qualified Chartered Accountant, with net worth of 40 million USD. Mr. Abdul Basit owns and manages family properties of agricultural and commercial nature; measuring about 4,000 acres (directly owned by Mr. Abdul Basit) in the province of KPK.. Abdul Basit Javed has played major role in bringing FAS Power Trading Company of Saudi Arabia into Pakistan which is establishing a 50 MWp Solar Power Plant in KPK. Similarly in the past he advised Target Group in developing 50 MWp Kulachi Solar Power Project (Private) Limited. AASAL owns two hydropower Projects of 6.6 MW and 20.6 MW. The feasibility study of both the projects have been completed by Lahmeyer Germany and the same are approved by panel of expert (POE) of PEDO where as other four projects of 45 MW, 65 MW, 100 MW and 100 MW are in the LOI stage. The company is therefore successfully managing and developing more than 400 MW with different partners. In solar power industry AASAL has successfully completed bidding in numerous projects of United Nations for Solarization of different units in entire KPK. AASAL has also successfully won the project of Solarization of Quaid E Azam University Islamabad having capacity of 12 MWp.

The Project Company, Javed Solar Park Private Limited is going to be one of the primary IPP (Independent Power Producer) in Solar Energy in KPK province.

JAVED SOLAR PARK (PVT) LTD. JSP

Certificate of incorporation

JAVED SOLAR PARK (PVT) LTD.
JSP

AO42073

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. 0119701 (Two Zero One)

I hereby certify that JAVED SOLAR PARK (PRIVATE) LIMITED is this day incorporated under the Companies Act, 2017 (XIX of 2017) and that the company is limited by shares.

Given under my hand at Islamabad this Sixteenth day of May, Two Thousand and Eighteen

CERTIFIED TO BE TRUE COPY

Incorporation fee Rs. 1000.0/= only

(Khalida Perveen)
Joint Registrar
Islamabad

No. ADL 52418

Dated 24/5/18

No. ADL 52418

Dated 24/05/18

Memorandum of Association / Article of Association

JAVED SOLAR PARK (PVT) LTD. JSP

THE COMPANIES ACT, 2017 (XIX of 2017)

(A Private Company Limited by Shares)

MEMORANDUM OF ASSOCIATION

JAVED SOLAR PARK (PRIVATE) LIMITED

THE COMPANIES ACT, 2017 (XIX of 2017)

(PRIVATE COMPANY LIMITED BY SHARES)

Memorandum of Association

of

JAVED SOLAR PARK (PRIVATE) LIMITED

1. The name of the Company is **JAVED SOLAR PARK (PRIVATE) LIMITED.**
2. The Registered Office of the Company will be situated in the Islamabad Capital Territory.

3. (i) The principal line of business of the company shall be to carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply, subject to permission of concerned authorities; and to locate, establish, construct, equip, operate, use, manage and maintain thermal power plants, coal fired power plants, hydal power plants, alternate energy, solar energy, wind mills, power grid station, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops and necessary devices, showrooms, depots, factories, workshops, plants and to provide transforming, switching, conversion and transmission facilities, subject to permission of relevant authorities.

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

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

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

a) Engage in any of the business mentioned in sub-clause (3) (iii) above or any unlawful operation.

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

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

4. The liability of the members is limited.

5. The Authorized Share Capital of the Company is Rs. Rs. 100,000/- (Rupees one hundred thousand only) divided into 10,000 (Ten thousand only) ordinary shares of Rs. 10/- (Rupees ten only) each with powers to the Company from time to time to increase or reduce its capital subject to any permission required under the law.

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

Serial No.	Name	CNIC No. (in case of foreigner, Passport No)	Father's / Husband's Name in full	Nationality with any former Nationality	Occupation	Residential Address in full	Number of shares taken by each subscriber	Signatures
1	*ABDUL BASIT JAVED*	*17301-6755057-7*	*MUHAMMAD SALIM JAVED GANDAPUR*	*PAKISTANI*	*BUSINESS*	*HOUSE NO. 69 A, STREET NO. 3, SECTOR E-11/1, MPCHS, ISLAMABAD*	800 (Eight hundred only)	
2	*AASAL SOLAR POWER (PRIVATE) LIMITED* *Through Nominee Director Mr. Salman Alam*	*0094876* *61101-5525076-3*	*N/A* *ALAM ZEB*	*PAKISTANI* *PAKISTANI*	*N/A* *BUSINESS*	*HOUSE NO. 28, STREET NO. 2, SECTOR E-11/1, MPCHS, ISLAMABAD* *VILLAGE KANDI MIANA MATRA, PESHAWAR*	200 (Two hundred only)	
Total number of shares taken							1,000 (One Thousand Only)	

Dated 15th day of May 2018

THE COMPANIES ACT, 2017 (XIX of 2017)

(PRIVATE COMPANY LIMITED BY SHARES)

Articles of Association

of

JAVED SOLAR PARK (Private) Limited

Section - D - Company subscribers, directors, chief executive officer and in case of sinlge member company, nominee

2.7 State Number of directors fixed by subscribers:
[Please note that as per law a company must have minimum director as follows:]

		No. of proposed directors
Single Member Company	01	
Private Limited Company	02	2
Public Limited Company	03	

2.8 Details of subscribers, directors and chief executive officer *

Name	Father/Husband Name	NIC/Passport No/NICOP	**Incorporation/Registration No	Nationality	***Occupation	Residential/Registered office address	NTN	DESIGNATION	No of shares subscribed	****Date of Appointment
Abdul Basit Javed	S/O Muhammad Salim Javed Gandapur	1730167550577		Pakistan	Business	HOUSE NO. 69 A, STREET NO. 3, SECTOR E-11/1, MPCH S, ISLAMABAD		Chief Executive		Since incorporation.
Salman Alam	S/O ALAM ZEB	6110155250763		Pakistan	Business	VILLAGE KANDI MIANA MATRA, PESHAWAR PESHAWAR Khyber		Director		Since incorporation.
AASAL SOLAR POWER (PRIVATE) LIMITED through	S/O ALAM ZEB	6110155250763	0094876	Pakistan	Business	VILLAGE KANDI MIANA MATRA, PESHAWAR PESHAWAR Khyber		Subscriber (Company)	200	Since incorporation.
Abdul Basit Javed	S/O Muhammad Salim Javed Gandapur	1730167550577		Pakistan	Business	HOUSE NO. 69 A, STREET NO. 3, SECTOR E-11/1, MPCH S, ISLAMABAD		Director And Subscriber	800	Since incorporation.

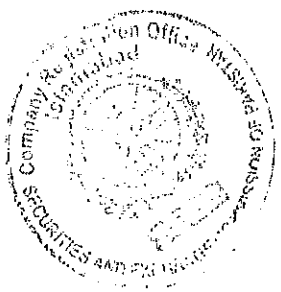
Add details as applicable
** Applicable on subscribers other than natural persons
***Please also mention names of other companies where directorship is held.
**** Signature of subscribers and consent to act as director or chief executive as the case may be. In case of online submission, the document will be signed electronically

2.9 Details of Nominee (only in case of single member company- Nominee shall not be a person other than relatives of the member- namely, a spouse, father, mother, brother, sister and son or daughter)

Name of Nominee

NIC of Nominee

Company Registration Office Islamabad SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN



Section - E - If the company intends to adopt tables contained in First Schedule to the Companies Act, 2017 (XIX of 2017) as its articles of association

[✓] Table A- Part I (Articles of association of company limited by shares)

[ ] Table A- Part II (Articles of association of single member company limited by shares)

Section - F - The company limited by shares in case it has not adopted articles contained in First Schedule to the Act company limited by guarantee and unlimited company shall attach the articles of association.

PART- III

Declaration under section 16

3.1 Declarant's Name	Mr Abdul Basit Javed
3.2 Declarant Profession / Designation	[ ] Authorized Intermediary [✓] a person named in the articles as Director of the proposed company
3.3 Declaration	I do hearby solemnly and sincerely declare that: a) I have been authorized as declarant by the subscribers; b) all the requirements of the Companies Act, 2017, and the regulations made there under in respect of matters precedent to the registration of the said Company and incidental thereto have been complied with c) I make this solemn declaration conscientiously believing the same to be true.
3.4 Declarant Signature	
3.5 Registration No of authorized intermediary, if applicable	
3.6 Date(dd/mm/yyyy)	16/05/2018

ENCLOSURES

(i) Original paid bank challan evidencing payment of fee;
(ii) Memorandum of Association;
(iii) Articles of Association, where applicable;
(iv) Copies of valid CNIC/NICOP of the subscribers/directors/chief executive officer or copy of Passport in case of a foreigner;
(v) Copy of valid CNIC/NICOP of Nominee only in case of single member company or copy of Passport in case of a foreigner;
(vi) Copy of valid CNIC of witness in case of physical filing;
(vii) NOC/Letter of Intent/ License (if any) of the relevant regulatory authority in case of specialized business;
(viii) Authority letter for filling of documents for the proposed company on behalf of the subscribers as per requirement of clause (vi) of sub-regulation (2) of regulation 5.
(ix) Copy of valid CNIC/Passport of person duly authorized by the Board of directors of a body corporate which is a subscriber. Further, along with copy of Board resolution along with and attendance sheet duly authorizing the representative. In case of a subscriber which is a limited liability partnership, copy of valid NIC/ Passport of designated partner empowered to act as such, along with copy of instrument empowering him;
(x) In case the subscriber is a foreign company or a foreign body corporate, the profile of the company, detail of its directors, their nationality and country of origin, certified copy of its charter, statute or memorandum and articles etc.
(xi) In case of foreign subscriber/ officer, an undertaking on stamp paper of requisite value duly signed , notarized and witnessed to the effect that in case name of subscriber/officer is not security cleared by MoI, the subscriber/officer and the company, shall take immediate steps for replacement and shall transfer shares if any, held by the subscriber.

No. ADL _____

Dated _____

Safety plans, emergency plans

Fire Protection

The solar PV module, inverter and structure installation shall be Class-A certified. Fire-resistant cables shall be used and, especially on the DC-side, TUV-certified DC cables shall be used. Fire extinguishers shall be located at regular spacing at the project site, as there is no fire station in the near vicinity.

Environment Management

As renewable energy projects are generally considered environmentally friendly, there are a few aspects that should be closely monitored and managed as they could otherwise have adverse impacts. The measure to be adopted by the Project include:

1. Oil-leaking transformers. There will be 16 MV transformers and two HV transformers installed at the Project, and dry type will be used.
2. Preserving the agricultural land utilized for solar project installation. Native plant species which do not intervene with solar PV performance shall be managed and retained.
3. Adequate recycling program for broken or damaged solar PV modules. The O & M Contractor will be required adhere to a recycling plan to reduce the environmental impact of disposing of solar PV modules.
4. Some solar PV modules, such as thin film modules (CdTe), can also leak hazardous substances. A proper containment mechanism shall be devised for such hazards.
5. A total of 79,345 MWh of energy will be produced by the fixed tilt system on an annual basis at P50. The generated energy would be 84,724 MWh for a single-axis tracking system at P50. All energy is to be offtake by the local power utility, PESCO, and would displace a proportionate amount of fossil fuel-fired thermal generation. This would correspond to an annual maximum carbon footprint reduction of 37,434 metric tonnes of CO2efora49.5 MWp fixed tilt system and 41,298 metric tonnes for a tracking system. For more details on the plant's environmental monitoring program (EMP), see Vol. 4 of the Project Feasibility Study.

Health & Safety Management

An adequately designed solar system is one which caters to all safety considerations in its design. There are several codes and standards relating to safety practices, particularly in solar PV equipment manufacture and installation. Agencies with codes and standards relevant to solar PV systems include:

- National Fire Protection Agency (NFPA)
- Underwriters Laboratory (UL)
- Institute of electrical and electronics engineers (IEEE)
- International Electrotechnical Commission (IEC), and
- CEC (California Energy Commission)

The NFPA's 70 NEC (National Electric Code), Chapter 6, has been particularly developed for sizing and installing solar PV systems. NESC (National Electric Safety Code), updated by IEEE every five years, is another valuable source of information for devising health and Safety protocols for the Project. EPC contractors shall be advised to conform to the relevant industry-standard safety codes, such as those mentioned above, and detailed guidelines shall be developed by the owners' engineer.

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Infrastructure: Roads, rail, staff colony, amenities

Roads

In order to successfully move all project related equipment from sea port to the point of installation at the project site, a series of existing roads are available. The project will use the existing roads to the extent possible. Unpaved road of approximately 4.5 km will be used to access the project site. This road needs to be developed enough so to enable travel of containers carrying trucks/trailers and low bed trailers for transporting substation transformers and other equipment's. Local government will be briefed on the importance of this road connecting to the project site, particularly highlighting the establishment of other solar projects at the adjacent sites as well. Internal roads with in the power plant facility are within the scope of the project.

Colony for Staff

During the construction phase a staff colony will be constructed as part of the project. The colony will all the basic amenities for laborers and other staff working on the project. After the construction phase, a part of the staff colony will be used for the O&M staff of the project.

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Control, Metering, Instrumentation and Protection

Power Station Control System

A SCADA system will be an integral part of the project EPC scope and would be accessible to the sponsor, O&M operator, grid operator and asset manager. This operating system will help monitor energy generation in detail, report and troubleshoot faults, and help evaluate asset performance, component degradation and other important variables that need to be regularly assessed for ensuring effective solar PV and plant performance. The SCADA interface will also be accessible to local operator at the plant's control room for operational command and control purposes. All ancillary services and functions which the inverter is capable of will be operable through the control system. In case of a tracking system, the control system will also allow changing panel orientations based on specific requirements, if and when required.

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Training and development plan

The Operations & Management (O&M) of the Project shall be managed by the EPC Contractor for initial 2 years post-COD as Warranty Period O&M under the EPC Contract. The O&M for years 3 – 8 shall be carried out by the same contractor under the O&M Contract. Throughout the O&M period, the Contractor shall be responsible for On Job Training (OJT) of the local team, which shall remain part of the O&M and gradually take over after completion of O&M tenure.

The EPC and O&M Contracts shall mention in detail the training requirements for the operation of the Solar project and the Project Company's personnel. As per the Contracts, the Contractors shall be required to provide details of how training will be carried out, including the number of days of training outside Pakistan, and the number of people who will be trained under their offer. The Contractor will ensure that the personnel working on the solar project during the construction and the operation period are correctly trained and qualified for the roles that they are performing and that a record of their training is maintained.

The Contractors shall be required to provide special emphasis to the Health & Safety (H&S) aspects of the Project construction and operations, for which specific training will be provided by the Contractors to all of the operations and maintenance personnel, including the regulatory requirements for the use of any special safety equipment required for the undertaking of such functions. Such training will be in addition to any other training provided and will continue, for each individual, until each said individual can be certified by the Contractors as having attended the full H&S training, thus gaining sufficient appreciation of the H&S requirements to operate the Project.

Although the content of training modules will be finalized between the Contractors and the Project Company prior to COD, some specific training needs that will be covered include the following:

a) Procedures for operation and maintenance of the solar project and its associated equipment.
b) Awareness and application of safe systems of work and responsibilities of all staff involved in operations and maintenance duties.
c) Fire control and prevention (including equipment maintenance and management and 'emergency plan').
d) First-aid provision (including 'emergency plan').
e) Working at heights (including 'emergency plan').
f) Working on, at or near rotating plant.
g) Working on, at or near high and low voltage AC and DC apparatus (HV & LV) and the differences between live, not live and dead circuits.
h) Working on, at or near energized systems (such as pressure vessels, accumulators, springs, gearing, torque arms, unearthed electrical systems and dampers).
i) Working on, at or near hazardous substances (oils, chemicals, insulators and gases).
j) Confined space works and requirements therein.

The Contractors shall provide or procure the provision of these training needs for all O&M personnel in order that the O&M services may be performed in accordance with the Project Agreements and Prudent Industry Practices.

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Project Commencement and Completion Schedule

Activity/Milestone	2016	2017				2018				2019				2020			
	Q3	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Issuance of LOI																	
Project Feasibility, IEE and GIA Studies																	
IEE Submission																	
Feasibility Study Submission																	
Grid Study Submission																	
IEE Approval																	
Grid Study Approval																	
Project Development Consultations																	
Issuance of LOI Extension																	
Feasibility Study Approval																	
Submission of Tariff Petition																	
Tariff Determination																	
Signing of EPA																	
Signing of IA																	
Financial Close																	
Project Construction																	
COD																	

Completed	
Proposed	

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P E D O

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION

Government of Khyber Pakhtunkhwa Peshawar

No. 2196-09/PEDO/CEO/LOI
Dated Peshawar the 21/07/2016

To,

M/s AASAL Solar Power,
Office 6-7, AGTC office,
Golden Plaza, Blue Area Islamabad

Subject: **LETTER OF INTEREST (LOI) FOR DEVELOPMENT OF [3.5] MW JAVED SOLAR POWER PARK, TEHSIL PAHARPUR DISTRICT DI KHAN KPK.**
Reference. ***NOC No.2020-24/. PEDO/PP/ASP Dated 23.06.2016. Proposal submitted dated 15.03.2016***

In terms of the Policy for Development of Renewable Energy for Power Generation 2006 ("Policy"), the Energy and Power Department / Pakhtunkhwa Energy Development Organization (PEDO) hereby confirms its interest in your proposal for establishing a 3.5 MW solar PV power generation project in Khyber Pakhtunkhwa province. The Sponsor(s) is responsible for arranging the land for the project. PEDO may facilitate the Sponsor(s) in arranging the land for the project; however, PEDO has no obligation to provide land to the Sponsor(s) for the project. PEDO acknowledges receipt of the bank draft No. **BBB 12690709 dated 12.07.2016** in the sum of **US Dollar 1750/- (US $ Seventeen Hundred Fifty Only.**

2. The Sponsor(s) is required to complete the feasibility study and achieve the milestones listed at the **Annex-I** to this LOI ("LOI Milestones") for the subject project, at no risk and at no cost to, and without any obligation on the part of the PEDO, the Government of Pakistan, any Provincial Government or their respective agencies, within a period of Eighteen (18) months from the date of issuance of this Letter of Intent ("LOI").

3. The Sponsor(s) is required to carry out and complete the feasibility study at internationally acceptable standards and in accordance with the terms and conditions stipulated in the Policy and this LOI. The feasibility study must include, inter alia, Solar PV Plant equipment site details, detailed power production estimates based on solar irradiance data of project site, soil tests reports, technical details pertaining to solar PV panels and other allied equipment to be used in the Solar PV Plant, grid tied solar PV project, electrical studies (including but not limited to short-circuit study, power quality study, load flow study and stability study), environmental study, project costing, financing plan, carbon credits, financing terms, tariff calculations and assumptions for financial calculations including economic/financial analysis. The Sponsor is also advised to liaise with the power purchaser while determining the site, project layout, sub-station design and layout, the transmission line, interconnection arrangements, and other related matters.

4. The validity of this LOI is not more than 18 months from the date of its issue, where after it will automatically lapse immediately (unless extended pursuant to clauses 5 or 6), being the **15.01.2018** (the "**Expiry Date**"). Issuance of this LOI or the lapsing of its validity, or your conducting a feasibility study there under, cannot form the basis of any claim for compensation or damages by the Sponsor(s) or the project company or any party claiming through or under them against the Government of Pakistan, the Provincial Government, PEDO or any of their agencies, employees or consultants on any grounds whatsoever, during or after the expiry of the validity of the LOI.

5. The Sponsor(s) is therefore required to complete the feasibility study and achieve the LOI Milestones for the subject project within the validity of this LOI. The Sponsor(s) is also required to submit quarterly progress reports. Provided the Sponsor(s) meets the LOI Milestones on the stated dates, the Expiry Date of this LOI shall be extended on a day-for-day basis for the number of days of delay by which the approval or review by the relevant public sector entity listed in the LOI Milestones is delayed beyond the corresponding period stated in the LOI Milestones. In case there is a delay in completion of the feasibility study within the validity of this LOI for reasons not attributable to a public sector entity, a one-time extension may be granted up to a maximum period of one hundred eighty (180) days if PEDO is satisfied that the feasibility study is being conducted in a satisfactory manner and is likely to be completed shortly, and provided the Sponsor(s) enhance the amount of the bank guarantee to twice its original amount and extend its validity for a period six (6) months beyond the extended Expiry Date. Furthermore, if the said feasibility study is technically approved by the Panel of Experts and later the tariff awarded by NEPRA is not agreed by the Sponsor(s) (such decision to be made within thirty (30) days of the award of the tariff, and in any event within the validity of the LOI), the bank guarantee less 10% deduction for administrative and ancillary charges, would be returned to the Sponsor(s).

6. The Sponsor(s) shall apply to NEPRA for award of tariff within the period of validity of this LOI. Upon tariff being given, the Sponsor(s) shall forthwith submit a new Performance Guarantee in the sum of **US Dollars 8750 (USD Eight Thousand Seven Hundred Fifty Only)** and obtain the Tripartite Letter of Support ("LOS") from AEDB within the validity period of this LOI, provided, if the award of the tariff is delayed beyond the initial validity of the LOI, the Sponsor(s) shall extend the bank guarantee for a further period of six (6) months and the Expiry Date shall be extended *ipso facto* for a further period of six (6) months, and the Sponsor(s) shall obtain the LOS and submit the Performance Guarantee within the extended period afore-said. For the avoidance of doubt, the afore-said extension process may be repeated if the tariff is not announced (including on any review petition filed by the Sponsor(s), such review (if any) to be filed within the period prescribed in the NEPRA (Tariff Procedures and Standards) Rules) up to fifteen (15) days before the then prevailing Expiry Date.

7. In case the Sponsor(s) fails to meet the LOI Milestones or perform any other obligations set forth in the Policy and this LOI, including the extension of the date of expiry of bank guarantee as provided herein, PEDO will terminate this LOI and encash the bank guarantee.

8. (A) Pending the nomination of the Main Sponsor per sub-clause (B), the CEO, Javed Solar Power Park is liable for all obligations and liabilities of and on behalf of all other shareholders/ Sponsor(s) (without relieving the other shareholders/Sponsor(s) of their obligations and liabilities under this LOI). Accordingly CEO, Javed Solar Power Park shall not transfer or assign its shareholding (or other participatory interest, if the project company is not formed by the date of issue of the LOI) in the project or the project company without the prior written approval of PEDO, which approval may be declined by PEDO in its discretion if the proposed transferee's financial and other relevant credentials are found unsatisfactory.

(B) The Sponsor(s) is advised to nominate the Main Sponsor *(being the individual or group holding at least 20% equity or participatory interest in the IPP project)* no later than the Expiry Date of the LOI. In default of nomination as aforesaid, the CEO, Javed Solar Power Park will be deemed the Main Sponsor for all intents and purposes. The Main Sponsor, together with other initial project shareholders/Sponsor(s) (which shall, subject in each case to sub-clause (A) above, be firmly settled and announced to PEDO by the Expiry Date of the LOI), must hold 51% of the project equity for a period up to the project's Commercial Operations Date (COD).

(C) Any actual or purported transfer or assignment of the shares or other participatory interests by the Sponsor(s) / shareholders in contravention of the foregoing restrictions without prior written consent of the PEDO shall render this LOI void and the bank guarantee will be enchased in such case by PEDO.

9. This LOI is not assignable and non-transferable. This LOI shall be void upon any actual or purported assignment or transfer hereof without the prior written consent of PEDO.

10. This LOI is issued subject to the grant of a generation license and award of tariff by the National Electric Power Regulatory Authority ("NEPRA") to the subject project under the provisions of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1996 (the "NEPRA Act"). While PEDO shall extend its offices to support applications by the subject project before NEPRA under the current or any amended policy framework, by granting this LOI, PEDO does not make any representation or warranty on behalf of itself or the Government of Khyber Pakhtunkhwa that the subject project will be granted a generation license or a tariff acceptable to the subject project or at all.

11. This LOI is issued in duplicate on the date hereof, and it shall come into effect when one copy is received by PEDO after being duly countersigned by you. Nevertheless, this LOI shall lapse if the countersigned copy is not received at PEDO within 15 days of its issuance.

For and on behalf of
(Name & Signature of CEO, Javed Solar Power Park)

Khurram Javed

Chief Executive Officer
PEDO

CC.

1. PS to Secretary, Energy & Power Department, Peshawar.
2. Chief Executive Officer, AEDB, Islamabad.
3. PS to GM (Hydel), PEDO Peshawar.

Chief Executive Officer
PEDO

P E D O

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION

Government of Khyber Pakhtunkhwa Peshawar

Room # 332, Plot # 38 / B-2, PEDO House, Phase-5, Hayatabad, Peshawar, Tel: 091-9217331

No. 2260-62/PEDO/DREPP

Date: 24.10.2018

To

Mr. Abdul Basit Javed
M/s AASAL Solar Power (Pvt) Ltd.
House No. 28, Street No. 2, Sector E-11/1, Islamabad

Subject: **Addendum to LOI – Enhancement in Capacity from 3.5 MW to 49.5 MW of AASAL Solar PV Project in Kulachi, D.I. Khan**

Kindly refer to your request for enhancement in the capacity from 3.5 MW to 49.5 MW, in this regard, the competent authority is pleased to accord approval for the enhancement in the capacity upon recommendation of the Penal of Experts (PoE) of PEDO.

This letter is issued to act as an addendum to the LOI No. 2106-09/PEDO/CEO/LOI dated 21st July 2016, wherein the Project capacity in the LOI shall now be read as 49.5 MW instead of 3.5 MW.

Furthermore, it is advised to kindly submit a valid Bank Guarantee for the enhanced capacity of 46 MW @ US$ 500 per MW.

Director (Renewable Energy Projects)
Private Power

Copy to:

1. PS to Chief Executive Officer, PEDO Peshawar.
2. Dr. Irfan Yousaf (Director CDM/Solar), AEDB, Islamabad.

Director (Renewable Energy Projects)
Private Power

P E D O

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION

Government of Khyber Pakhtunkhwa Peshawar

No. 2366-69/PEDO/DRE/AASAL/Kulachi
Dated: 7/11/2018

To

Mr. Abdul Basit Javed
M/s AASAL Solar Power (Pvt) Ltd.
House No. 28, Street No. 2, Sector E-11/1, Islamabad

Subject: **Extension of Letter of Intent (LOI) for 49.5 MW Solar PV Project in Kulachi, D.I. Khan**

This is with reference to your letter No. Nil dated 2nd January 2018 on the subject cited above.

PEDO is pleased to inform that, in pursuant to clause 5 of the LOI, a day-to-day extension in the validity of LOI No. 2106-09/PEDO/CEO/LOI dated 21st July 2016 from its expiry i.e. 15th January 2018 is granted till the time the Grid Interconnection Study is approved by NTDCL and subsequently obtain Letter of Support (LOS) from AEDB after completing all procedural requirements as per RE Policy and accomplishing milestones as per LOI, within two months after approval of Grid Interconnection Study.

Manager (Renewable Energy Projects)
(Private Power)

Copy for information to:

1. PS to CEO, PEDO Peshawar.
2. PS to GM (Hydel), PEDO Peshawar.
3. PS to CE (Dev.), PEDO Peshawar.

Manager (Renewable Energy Projects)
(Private Power)

Feasibility study and its approval

JAVED SOLAR PARK (PVT) LTD. JSP

PEDO

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION
Government of Khyber Pakhtunkhwa Peshawar

No. 2361-65/PEDO/DREPP/AASAL
Dated: 07/11/2018

Mr. Abdul Basit Javed
M/s AASAL Solar Power (Pvt) Ltd.
House No. 28, Street No. 2, Sector E-11/1, Islamabad.

Subject: **Approval of Technical Feasibility Study submitted by M/s AASAL Solar Power (Pvt.) Ltd. for 49.5 MW Solar PV Project at Kulachi, District DI Khan, KP**

This is with reference to Panel of Expert (PoE) meeting held on June 13, 2018 at PEDO House Peshawar to review the revised draft feasibility study, submitted by M/s AASAL Solar Power (Pvt.) Ltd. for their 49.5 MW Solar PV Project, under RE Policy 2006.

PEDO is pleased to inform that the Technical Feasibility Study of M/s AASAL Solar Power (Pvt.) Ltd. for 49.5 MW Solar PV Project in Kulachi, D.I. Khan has been reviewed and approved by the Panel of Experts (PoE).

Furthermore, you are advised to complete all the codal formalities including approval of Grid Interconnection Study from concerned department before approaching NEPRA.

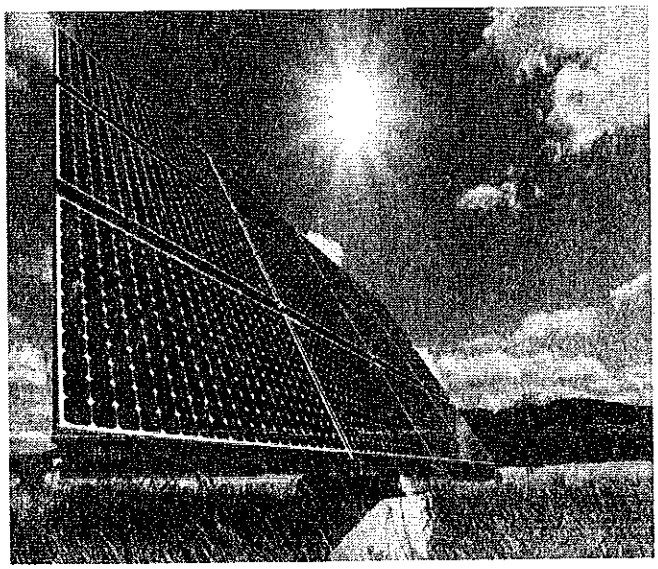
Manager Renewable Energy Projects
(Private Power)

Copy for information to:

1. PS to Secretary to GoKP, E&P Department, Peshawar.
2. PS to CEO, PEDO, Peshawar.
3. Mr. Irfan Yousuf, Director (CDM/IC/Solar), AEDB, Islamabad.
4. Mr. Salman Nazir Raja (PEDO PoE Member)

Manager Renewable Energy Projects
(Private Power)

Room No. 329, PEDO House,38/B-2, Phase-V, Hayatabad, Peshawar. Tel: (+92-91) 9217331, Fax (+92-91) 9217489



49.5 MW JAVED SOLAR PV IPP FEASIBILITY STUDY

PROJECT:
The Project is located near the town of Luni in Kulachi in Dera Ismail Khan district of the Khyber Pakhtunkhwa province.

Volume 4 of Feasibility Study Report

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Appendix C: **Inverter and Transformer Datasheet**
Appendix D: **Conceptual Plant Single Line Diagram**
Appendix E: **PVsyst Simulation Report for Fixed Tilt System**

Abbreviations and Acronyms

AC	Alternating current
ADB	Asian Development Bank
AEDB	Alternative Energy Development Board
amsl	Above mean sea level
a-Si	Amorphous silicon
BOS	Balance of system BSF (Back surface field)
CAGR	Compound annual growth rate
CdTe	Cadmium telluride
CEC	California Energy Commission
CIGS	Copper indium gallium (di) selenide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COD	Commercial operations date
CPM	Carbon pricing mechanism
CPPA-G	Central Power Purchase Agency Guarantee c-Si Crystalline silicon
CUF	Capacity utilization factor
DAS	Data acquisition system
DC	Direct current
eBOS	Electrical balance of system
EMP	Environmental monitoring program
EPA	Energy Purchase Agreement
EPC	Engineering, procurement and construction
ESMAP	Energy Sector Management Assistance Program
FIT	Feed-in tariff
GHG	Greenhouse gas
GIS	Geographical information system
h	Hour
HV	High voltage
IA	Implementation Agreement
IDC	Interest during construction
IEC	International Electro technical Commission
IEEE	Institute of Electrical and Electronics Engineers
ILR	Inverter load ratio
IPP	Independent power producer
IRR	Internal rate of return
km	Kilometer
KP-EPA	Khyber Pakhtunkhwa Environmental Protection Agency
kV	Kilovolt

LCOE	Levelized cost of electricity
LID	Light induced degradation
LoI	Letter of Interest
LoS	Letter of Support
LV	Low voltage
m	Meter
MENA	Middle East and North Africa
MPPT	Maximum power point tracking
ms	Millisecond
MV	Medium voltage
MW	Megawatt
MW_p	Megawatt peak
NASA	National Aeronautics and Space Administration
NEC	National Electric Code
NEPRA	National Electric Power Regulatory Authority
NESC	National Electric Safety Code
NFPA	National Fire Protection Agency
NOC	No objection certificate
NREL	National Renewable Energy Laboratory
N-S	North-south
NTDC	National Transmission & Despatch Company
O&M	Operation and maintenance
OEM	Original equipment manufacturer
PEC	Pakistan Engineering Council
PERC	Passivated emitter rear cell
PESCO	Peshawar Electric Supply Company
PF	Power factor
PFC	Power factor correction or control
PID	Potential induced degradation
POE	Panel of Experts
POI	Point of interconnection
PV	Photovoltaic
Px	x% outcome probability (e.g., P90)
RFP	Request for proposals
RMU	Ring main unit
ROE	Return on equity
ROEDC	Return on equity during construction
Rs	Pakistan rupee
s	Second
SBP	State Bank of Pakistan
SCADA	Supervisory control and data acquisition
SECP	Securities & Exchange Commission of Pakistan

SLD	Single line diagram
SPV	Special purpose vehicle
STC	Standard testing conditions
TDS	Total dissolved solids
TEL	Target Energy (Pvt.) Ltd.
ToR	Terms of reference
TUV	Techischer Überwachungsverein (Technical Inspection Association)
UL	Underwriters Laboratory
V	Volt
VAR	Volt-ampere reactive
W	Watt
W_p	Watt peak

1. Introduction

49.5 MW Javed Solar Park is an initiative of AASAL Solar Power (Private) limited "AASAL", incorporated under the Companies Act, in Pakistan. AASAL is a well-capitalized, listed group company Subsidiary of AASAL Hydrotech (Pvt) Ltd., established to develop, construct and operate power projects, nationally. AASAL Hydrotech owns two hydropower Projects of 6.6 MW and 20.6 MW The feasibility study of both the projects have been completed by Lahmeyer Germany and they are currently with panel of expert (POE) of PEDO.

The Project Company, M/s AASAL Solar Power Pvt Ltd was formed in 2016, primarily to become the first IPP (Independent Power Producer) in Solar Energy in KPK. After obtaining the first LOI from Pakhtunkhwa Energy Development Organization (PEDO) KPK it has successfully completed bidding in numerous projects of United Nations for Solarization of different units in entire KPK. With that, it has successfully won the project of Solarization of Quaid E Azam University Islamabad which is a 12 MW in-house project. AASAL Solar Power Pvt Ltd endeavors to become the first IPP in Solar Energy and then enhance its existing project to at least 50 MW in stage first and then move on further. Along with this, the sponsors hold two registered Hydropower Projects in KPK of more than 100 MW each.

The Solar project is located near Luni village, about 13 km from Kulachi town in Kulachi Tehsil. The project has assessed 300 acres of land in Moza Luni. The project shall be developed as an Independent Power Producer "IPP", to be connected with the Peshawar Electric Supply Company "PESCO" at 132 kV grid connection at Tehsil Kulachi, which is 16 KM away from the project site. Sale of the Power shall be made to the Central Power Purchasing Agency (Guarantee) Limited "CPPA (G)".

2. Project Overview

2.1 Project Location and Capacity

The Project is located near the town of Kulachi in Dera Ismail Khan District of the Khyber Pakhtunkhwa province. The project site is located approximately 20 km from the center of Kulachi town at 31.93° N, 70.28° E and an elevation of 238 masl (**Exhibit 2.1**). The site selected for the project is generally flat, with a minor slope towards the southeast, with the slope increasing towards the southern end of the site boundary. The site area is approximately 151 hectares (300 acres). The land at the location and its surroundings is semi-arid agricultural, with a small village situated some 165 m north of the site's northwestern corner. The power plant under consideration is a grid-connected solar PV powered generation plant. The project capacity is 49.5 MW_p (DC) at standard testing conditions (STC) and will be feeding grid-compatible electricity at 132 kV at PESCO's Kulachi substation.

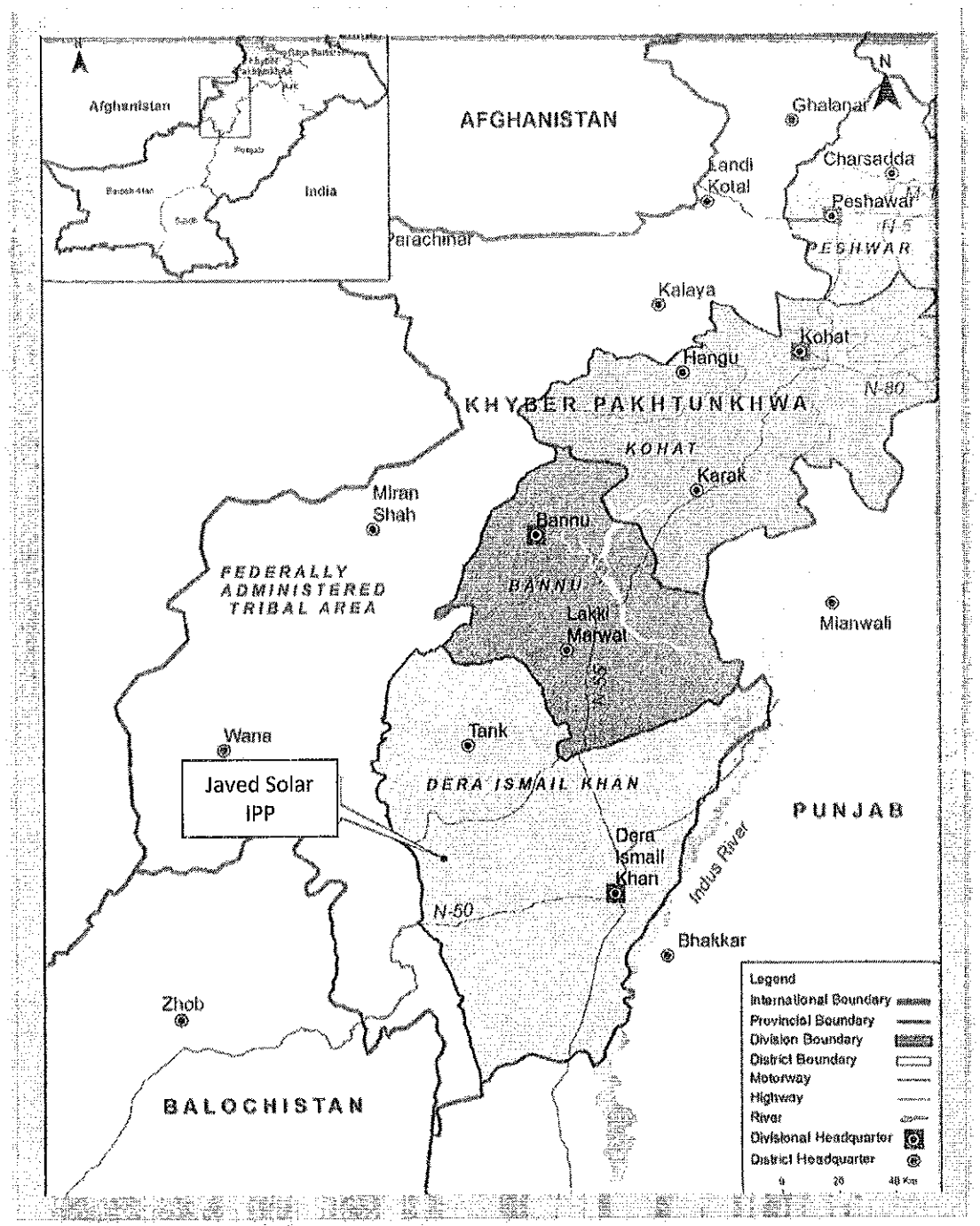
2.2 Plant Layout and Configuration

There are several configurations in which a grid-connected solar PV system can be designed, based on different site-specific variables and depending on the size of the project. The Project is intended to be close to the 49.5 MW_p (DC) capacity mark and is categorized as a commercial utility-scale IPP project. Based on the preliminary design, the Project uses centralized inverter skids of 0.5 MW (AC) rated output capacity and each of these 95 central inverters. The total project capacity is thus 49.5 MW_p (DC). The solar PV modules selected as generators are standard 4-busbar 60-cell crystalline silicon (c-Si) modules. There will be a total of 215,220 solar PV modules of 230 W_p each, with 20 modules in series and 10761 strings in parallel having module area 351917 meter square. Therefore, there will 20 modules in series and 10761 strings in parallel having module area 351917 meter square making up a total plant capacity of 49.5 MW_p (DC). For every 20 strings (also known as 'home runs'), there will be one combiner box and disconnect, and 17 DC combiner boxes of different capacities for every block. DC cables from each one of them terminate at the inverter. The inverters will produce three-phase 400V AC output, which will be then stepped up to 33 kV by a step-up transformer and transferred to the 132- k V substation through underground trenches. The objective of this configuration is to minimize the EPC cost for the sponsor while maintaining the 17% CUF benchmark at P90 that is determined by the national electricity regulator (NEPRA) for that location/region.

While there are other configurations and/or design modifications that can improve the eventual IRR for the project owners, the design configuration recommended for this opportunity is that of a standard utility-type grid-connected system typically employed in emerging solar markets, such as Pakistan's. All such IRR kickers have been listed, however along with their merits and demerits, in the following sections to enable the sponsor to make an appropriate final determination.

See **Appendix A** for the basic plant layout details.

Exhibit 2.1: Project Location



2.3 Site Geological Conditions

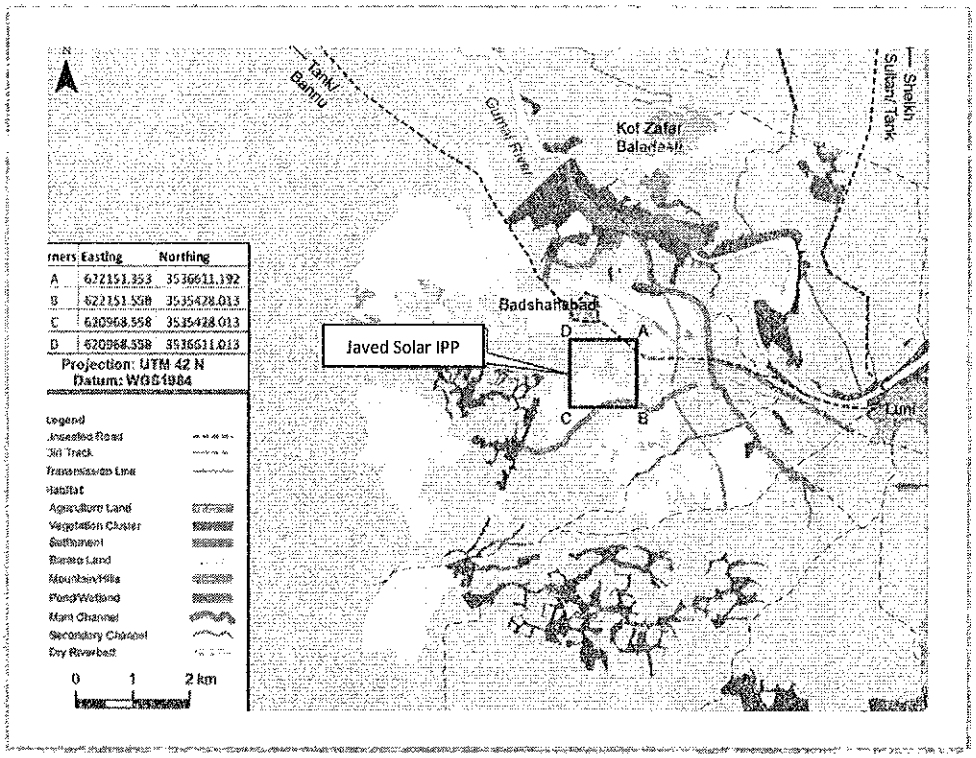
Site-specific geological details are an important consideration for determining the technical feasibility, reliability and longevity of a utility-scale solar project. One of the main design considerations and components of such a solar PV project is the metal structure used to support the solar PV modules. There are number of key considerations that go into the reliable design of this supporting structure, such as:

- Moisture content in the soil and the associated impact on metals.
- Understanding and predicting annual variation of the soil's water content due to water logging and temperatures to determine the long-term effects of moisture on metal.
- Gradients at the site area need to be determined for the design of the supporting structure. Also, since the land experiences seasonal surface water flows due to precipitation and rainwater runoff from adjoining areas, it is critical to determine flow patterns and directions, and if any local ponding can occur within the construction site.
- Soil composition, classification and load bearing capacity, based on which it can be determined whether any special design considerations would be required in selecting the pile type and supporting frame specifications.
- Project-specific seismic zone needs to be specified for the design of the supporting structure and foundations.

These parameters directly impact the cost of installing the mounting structure and, hence, the project itself, as well as its commercial feasibility. Relevant information on these considerations has been obtained as part of the geotechnical and topographic investigations of the site and is included in **Volume 2** (Site Topography & Geotechnical Study) of the Project Feasibility Study. A summary of the relevant information is given below (in the order of the parameters listed above):

- The site area is generally flat, having a slope of 0.17% to 0.21% over the entire area as evident in the topographic survey. The maximum gradient is around 5% near Corner B of the plot (**Exhibit 2.2**). Another part of the site with rising undulations has been avoided for the placement of solar modules.
- The soil is classified as clayey sand (CS) and poorly graded clayey sand (SP-SC) up to 4.2 m. Soil cohesion, c, ranges from 663 psf (3,219 kg/m^2) to 1,432 psf (6,998 kg/m^2) and angle of internal friction, Φ, varies from 19.8° to 29°.
- The Project site is located at Luni, which falls under Seismic Zone 2B as per the Pakistan Building Code. This zone is categorized as a 'minor to intermediate damage' zone. This is a low-risk technical design aspect for the structure and generally all solar PV supporting structures, procured locally or internationally, will comply with this requirement. No additional cost repercussion is expected in order to meet this design requirement.

Exhibit 2.2: Project Site and Environments



2.4 Solar Power Plant Equipment

There are three main components that make up a grid-connected utility-scale solar PV plant that need to be specified:

- ☐ Solar PV generator
- ☐ Inverter
- ☐ Supporting structure and arrangement.

Apart from these three main components, selection of the power transmission equipment and associated protection at the designated voltage also needs to be determined in the preliminary design stage of the solar project. The following sections list the range of components and equipment that will be evaluated and appropriate ones selected for the proposed Project based on technical and commercial considerations.

2.4.1 Solar PV Generator

Photovoltaic manufacturing is a fast-growing industry, with a compound annual growth rate (CAGR) of 42% between 2000 to 2015.There are two main types of solar photovoltaic technology that dominate the commercial solar PV market. Wafer-based crystalline silicone (c-Si) modules accounted for 93% of the global solar PV manufacturing capacity in 2015. These c-Si modules are further classified into mono and poly (multi) crystalline solar PV modules, where multicrystalline solar PV modules make up 68% of total production. The remaining market share is taken up by thin film modules an

approximately 7% of worldwide sales, which include cadmium telluride (CdTe), copper indium gallium (di)selenide (CIGS) and amorphous silicon (a-Si) solar modules. A brief technical comparison of the three types of PV technologies is given below.

Mono and polycrystalline solar PV modules differ by cell manufacturing process and technology. While monocrystalline solar PV cells require a more expensive manufacturing process owing to the need for higher purity levels and single-cell grain structure, which result in more efficient solar cells, polycrystalline solar cells are cheaper to manufacture but are slightly less efficient. The difference in efficiency is usually not more than 1% to 2% for standard high-efficiency 60-cell c-Si modules. This small efficiency difference does not impact the yield of the solar system appreciably, but does affect the space occupied by the solar PV plant. Owing to the minor difference in efficiencies, the difference in space requirements is also small, and given that sufficient land is available for the Project, this efficiency gain at a higher cost does not appear to warrant consideration.

The technical parameter of a solar PV module that directly impacts the energy yield of a solar plant is the correlation and dependence of module output wattage with module temperature. This is represented by the term 'temperature coefficient of power'. The lower this temperature coefficient is, the higher is the resistance of the solar PV module output against high temperatures and, therefore, the higher the expected yield of the solar PV plant. This becomes an even more relevant concern in high temperature zones, such as the Kulachi region. It has been generally observed that for 60-cell, Tier 1 Chinese solar manufacturers, polycrystalline cells demonstrate slightly better characteristics when it comes to temperature resistance. However, this is not true for all solar PV module manufacturers, as for some brands the temperature resistance profile is the same for their mono and polycrystalline PV cells.

Most importantly, polycrystalline modules are cheaper by 5% to 10% compared to monocrystalline modules, based on current solar PV market prices as they are simpler to manufacture.

The thin film PV market has a 7 to 8% share of the global solar module sales, and is primarily dominated by the American manufacturer First Solar with its Series 4 module, which is considered the industry benchmark. The efficiency of the Series 4 module ranges from 16% to 17% and like what is currently offered by polycrystalline modules; monocrystalline modules, on the other hand, are slightly more efficient. However, an advantage of thin film modules is their improved resistance to heat and, hence, better performance in high temperature zones. Thin film modules also have an improved spectral response compared to conventional c-Si modules in areas with high relative humidity. The advantage ranges from 5% to 7%, depending on site-specific temperature profiles. These modules also offer more resistance to drop in output due to shading by landscape features. However, since nearby shading structures is not a concern at the Project site, this advantage would not be of much relevance.

The downside of thin film modules is their higher output voltage, because of which the number of strings increases, leading to an increase in associated parts and accessories

(jumpers, connectors, etc.) and balance of system (BOS)[1] cost for a few components. Since the maximum wattage of each module is not more than 123 W_p, the cost of structural accessories also increases. In fact, this is one of the major considerations because of which First Solar is releasing their new Series 6, which is expected to be close to 400 W_p per module.

Thin film modules, despite using less silicon material, are more expensive to make due to the encapsulation and lamination cost that they incur. The cost of thin film modules from First Solar are also more expensive compared to conventional polycrystalline modules, but the relevant factor is by how much? Since the objective here is to reach the lowest levelized cost of electricity (LCOE). There have been some solar auctions in the MENA region (desert type locations) where developers have come up with extremely low tariffs using First Solar's thin film modules. Thus, it is important to determine what sort of cost per watt First Solar can offer for a 49.5 MW_p capacity project in northwestern Pakistan.

Selecting a solar PV module supplier is not only about evaluating technical parameters on offer, but also about the bankability of the manufacturer in question and the supply and timelines of delivery risks, especially if the company ceases production and support at some point in the future. There need to be other suppliers in the market who can step in with a similar standard product, so that plant operations are not affected.

Considering all of the above factors, conventional high-efficiency 60-cell polycrystalline solar PV modules have been selected for this feasibility study, and the following critical steps are recommended for the Project sponsor to evaluate carefully during the RFP stage

- ☐ PID (potential induced degradation[2])-resistant modules should be preferred, since they reduce the degradation involved and, hence, improve LCOE. Cost impact in $/W to be determined.
- ☐ 1,500 V solar PV modules should be preferred since they reduce the amount of source circuits by 33%, hence resulting in reduced electrical balance of system (eBOS) cost. The increased voltage increases string sizes and hence reduce other eBOS accessory requirements. More details on this later in this volume.
- ☐ Double-glass modules offer increased degradation protection in the absence of a back sheet and improved strength and durability of the solar module. Modules become PID-free without the frame. However, there is a requirement of unorthodox mounting structures for these frameless solar modules. There is also no requirement of grounding the solar module frames in this case.
- ☐ PERC (passivated emitter rear cell) polycrystalline solar modules have reflectors at the rear of the cells which reflect back the longer wavelength (i.e., infrared) light which is missed out during the first pass, increasing electron capture and therefore producing

[1] Balance of system (BOS) encompasses all components of a photovoltaic system other than the photovoltaic panels. This includes wiring, switches, mounting systems, inverters, control instruments, batteries, chargers, etc.

[2] Potential induced degradation (PID) is an electric potential-induced (i.e., difference in electric potential between the encapsulated solar cells and the frame of the module) performance degradation in crystalline photovoltaic modules caused by so-called 'stray' currents. This effect may cause power loss of up to 30%.

more energy. Generally, conventional solar PV modules have a BSF (back surface field) and charge carriers are lost to the metallization of the rear cell. PERC solar PV modules therefore operate well even in diffused sunlight and low light conditions. However, PERC-based modules are associated with higher degradation because of the presence of more material, and hence must be evaluated carefully.

Apart from these technical parameters, it is particularly important to assess the bankability of the solar PV manufacturer and to comprehensively understand the warranty and guarantee terms and claim processes and policies offered by different vendors. Bloomberg's quarterly *New Energy Finance* publishes a list of the most bankable solar PV manufacturers and is a reliable source for such information, as would be the recommendations of the EPC contractors employed for the Project.

JA Solar polycrystalline 60-cell, 4 busbar, PID-resistant, 230 W_p solar modules will be used for purposes of this feasibility study analysis (see **Appendix B**). However, it is strongly recommended that the technology options listed above are explored further during the RFP phase to determine the lowest possible LCOE possible for the sponsor.

2.4.2 Inverters

One of the key components of the solar PV system is the inverter. The function of a utility-scale inverter is to convert the DC power coming from the solar modules through the combiner boxes to three-phase AC power at 500kW (ac) and to make sure that the AC output is in phase and synchronized with the grid supply at the given output point with unity power factor at the rated output. In terms of utility-scale grid-connected solar inverters, two types of inverters were evaluated for the 49.5 MW_p solar plant:

- ☐ Central inverters
- ☐ String inverters.

Features based on which the inverter type for the Project should be selected include the following:

- ☐ 450-820 V DC-side input option with wide maximum power point tracking (MPPT)[3] range.
- ☐ Integrated anti-PID function
- ☐ Inverter load (or DC/AC) ratio (ILR)
- ☐ Should be mounted on easily installable skids, along with MV switchgear and transformer, in a transportable 20-ft. (6-m) container
- ☐ Should be outdoors-rated and include integrated ventilation
- ☐ Should incorporate measures for reducing downtime
- ☐ The number of DC inputs required

[3] An MPPT, or maximum power point tracker is an electronic DC-to-DC converter that optimizes the match between the solar array (PV panels) and the battery bank or utility grid. Simply stated, it converts a higher voltage DC output from the solar panels down to a lower voltage required to maximize power extraction under all conditions.

- The extent to which the inverter offers grid support functions, such as LVRT, HVRT, anti-islanding and power factor control,[4] and
- Cost per watt of the inverter.

Based on these technical and commercial parameters and considering the size of the Project, central inverters are deemed the most suitable option. The fundamental basis for selecting central inverters over string inverters is the 450-820 V input capability. A few string inverters also have this feature, but their availability is limited. Central inverters also result in reduced AC cabling, with an integrated MV transformer and switchgear on a skid right next to the inverter. Most importantly, there should be integrated mechanisms present for reducing downtime (i.e., maintaining plant availability, hence securing plant yield). Since there are no nearby sources of shade at the site, the advantage of having multiple MPPT points is also reduced. Integrated anti-PID function is also another advantage of using central inverters.

As per Pakistan Grid Code requirements,[5] the following mandatory features are required in a grid-connected utility-scale solar PV inverter:

- Data of voltage, current, frequency, active and reactive power and power quality-related issues of harmonics, flicker and unbalance should be available.
- Exempted from 'black start' and islanded operation for the span of the energy purchase agreement (EPA).
- In case of blackout, PV power plants will be required to be disconnected from the grid, i.e., should have anti-islanding protection built into the inverter.
- The inverter should inject small pulses slightly out of phase with the AC electrical system in order to cancel out any stray resonances when the grid shuts down.
- The inverter should be able to smoothly synchronize and de-synchronize from the grid.
- The inverter should be capable of increasing or decreasing active power output in steps of 10% of the rated plant installed power capacity per minute, i.e., ramp rate of 5 MW/min.
- There are can be four or five set points agreed with NTDC, such as 100%, 70%, 50%, 30% and 0%, etc., which the inverter must achieve from any instantaneous operating point in any operational mode. This will depend on the incidence of radiation required to reach that operating point.

[4] LVRT, or low-voltage ride through, is the capability of electric generators to stay connected during short periods of lower electric network voltage (i.e., voltage dips). Similarly, HVRT, of high-voltage ride through, is the capability of a generator to stay connected during short periods of high electric network voltage (i.e., voltage surges). Anti-islanding protection is essential to ensure that grid-tied energy harvesting systems cut their connection to the grid when the grid itself loses power. Power factor control or correction brings the power factor of an AC power circuit closer to 1 by supplying or absorbing reactive power, adding capacitors or inductors that act to cancel the inductive or capacitive effects of the load, respectively.

[5] NEPRA, 2014. *Grid Code Addendum No. II for Grid Integration of Photovoltaic (PV) and Concentrated Solar Power Plants*, June 2014.

- Reactive power control to maintain the power factor within the range of 0.95 (lagging) to 0.95 (leading) at full active power output according to dispatch instructions/voltage adjustment requirements.
- Power quality parameters of power output will be governed by relevant IEC standards, such as IEC 60904 and 61850.
- Harmonic emissions shall comply with IEC standards.
- LVRT capability up to 30% voltage dip for 100 ms.
- Should be able to manage active power restoration after voltage recovery at a rate of least 20% of nominal output per second.

2.4.3 Inverter Sizing

While selecting the inverter, the objective is to reduce the number of inverters and transformer skids while coming as close as possible to the 49.5 MW_p gross output mark, while maintaining the DC/AC ratio. Reducing the number of skids helps reduce eBOS cost and helps achieve a competitive EPC project cost ($/W).

The most common central inverter sizes in the market have been analyzed with a load factor of 1.25 to see which inverter size would result in the highest plant capacity. The inverter size selected was 500 kW (AC). A total of 95 of these blocks therefore give a total solar plant capacity of 49.5 MW_p (DC). As is the case with all components of a PV IPP, the bankability and reputation of the OEM is critical in the final brand selection.

Overload Losses

Determining the actual overload losses strongly depends on the granularity of data intervals and the quality of measurement. One of the advantages of using the selected TBEA inverter is that its output can go up to 550KW at 40 °C. Variation of solar irradiance can happen in the span of seconds, with clear bright sun conditions providing considerable direct irradiance changing instantaneously to those with cloud cover and diffuse irradiance. Access to minute-wise data values can drastically improve the calculation of inverter overload losses, and hence help in getting to an optimum DC/AC ratio. Despite having access to 10-min interval data through World Bank data packages and Meteonorm 7.2 interpolated minute values, the limitation of the PVsyst software used to simulate plant yield is that it relies only on hourly data values (Exhibit **2.5**).

Exhibit 2.5: Power Sizing Characteristics

PV Array P_{NOM} (STC)	49501 kW_p
PV Array (50 °C)	44325 kWp (DC)
Inverter P_{NOM} (AC)	47,500 kW (AC)
Overload Losses	108 kWh
P_{NOM} Array/Inv. Ratio	1.25
P_{NOM} Ratio at 40 °C	1.13

2.4.4 Support Structure

The function of a supporting structure for the solar PV modules is to bear the drag, lift and distributed loads of winds and gusts, snow and seismic loads. Apart from this, the structure has to be designed to bear the weight of the solar PV modules. Several variables go into the design of the support structure, which include the weight of the solar PV modules, average and maximum local wind speeds, dead load of snow on the modules (if applicable) and potential seismic loads. Other important features which need to be incorporated into the structure include DC wire cable raceways for better cable management, corrosion protection, electrical grounding of structure, and orienting the solar modules at a certain designed tilt and azimuth. Properly sized raceways allows for DC cable management and eliminate the use of separate conduits and cable ties.

The structure comprises of two important elements: the ground pile and the frame supporting the solar modules. There are three different type of piles that are commonly used for different type of soils:

- Earth screw (required in areas with high refusal rates)
- Driven piles (generally for locations having good soil cohesion, e.g., dense sand, clay and gravel; installed in locations which offer good pullout resistance)
- Helical pile (generally for locations with poor soil cohesion, higher water tables, little pullout resistance)
- Ballasted (where penetration into the ground is not possible)

A structural engineer's recommendation is a prerequisite to finalizing the type of pile to be used.

2.5 Power Transmission Schematic

The proposed 49.5 MW solar plant has been divided into 95 power generating blocks. Each block has a DC capacity of 0.52 MW, taking the total maximum plant output to 49.5 MW (DC). Each block's AC generating capacity is 521 kW, with a DC/AC ratio of 1.248.

The single-line diagram (SLD) for this IPP has been divided into four parts:

2.5.1 DC-side SLD

Polycrystalline 230 W_p solar panels have been chosen as energy generating units for the plant. Strings, comprises of 20 solar panels each, are consolidated into a single PV combiner. A total of 50 combiners per block is repeated in all 95 blocks. Power collected through the combiners is terminated on the DC side of the inverters and converted into AC for onward transmission of power to the grid. The load flow of the circuit is from strings of solar panels to the DC portion of the inverters via combiner boxes.

2.5.2 AC-side SLD

Inverters used in the system are of central type and convert DC power into AC power at 0.315 kV voltage level. Output of the inverter is directly connected (via busbars) to the low voltage side of transformer. Output of inverters is in delta configuration, which eliminates the risks of harmonics travelling to the medium voltage side of transmission. Prepackaged skid-type Inverters are used in the system with built-in transformers and MV switchgear to reduce losses due to long cable lengths by immediately stepping up output voltage to the design level.

2.5.3 MV-side SLD

Medium voltage transformer is used for boxed type inverter packs. Oil and natural air ventilation has been adopted in the transformer design. The transformer steps up low voltage output of the system to 33 kV, within adjustable range from 10-35 kV. The reason for using a 33 kV intermediate voltage level is to reduce the size of long distance AC cables, and reduced Ferranti effect[8] (which can be even more pronounced in underground power cables). Blocks 1-4 are stepped up to 33 kV separately at their inverter skids and flow towards a centralized 4-way ring main unit (RMU) with 33 kV switchgear, terminated to a combined 33 kV, 0.16 kA busbar. There are a total of four 4-Way RMUs that are terminated at two separate buses of the 33 kV substation. RMUs 1 and 2 terminate at Busbar 1 and RMUs 3 and R4 at Busbar 2. These busbars are connected via a bus coupler to be able to completely shift loads to one bus in contingencies.

2.5.4 HV-side SLD

Plant 33 kV voltage levels are stepped up to 132 kV transmission required to connect to the utility grid. Here, the N + 1 configuration is adopted, as per the Pakistan Grid Code. The 33 kV Busbar 1 is connected to Main Transformer 1 and Busbar 2 is connected to Main Transformer 2. Both transformers have a capacity of 50 MVA and either can be used as a complete single unit, in case of failure or during maintenance of the other transformer. Outputs of the transformers are finally connected to the grid point of inter-connection (POI) via an air-insulated switchyard. A 132 kV double-circuit transmission line is proposed for the evacuation of power generated by the Project.

2.6 Electromechanical Design

System voltage

Considering the advantages of 820 V inverter voltage compared to 1,000 V in utility-scale solar PV systems for reducing eBOS cost and improving energy generation, the former was selected for this study. However, during the detailed engineering phase of the

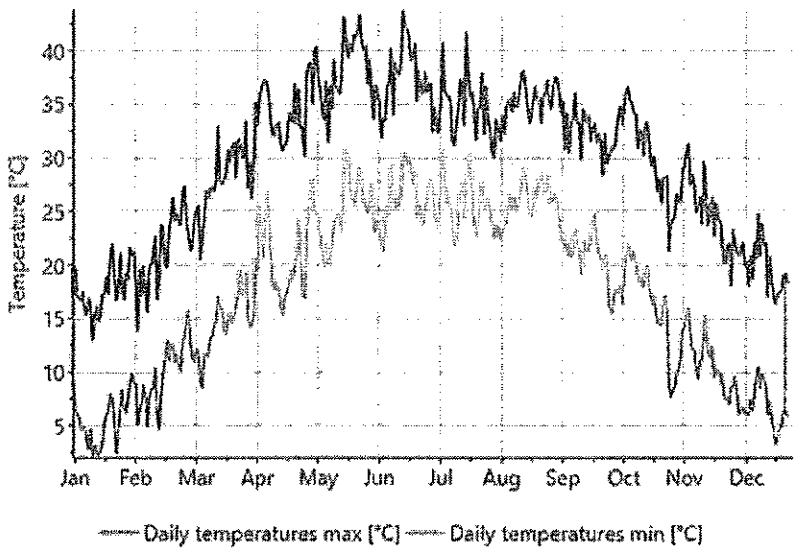
[8] The Ferranti effect is an increase in voltage occurring at the receiving end of a long transmission line, above the voltage at the sending end. This occurs when the line is energized, but there is a very light load or the load is disconnected.

Project, 1,000 V central inverters could also be considered, in light of the cost and availability of various inverter options.

Stringing

There are 50 modules in a string, given the average minimum temperature through the year in Kulachi, as temperature and irradiance are two factors which determine the maximum open-circuit voltage of a string. **Exhibit 2.6** shows the range of monthly temperature variation at the Project site.

Exhibit 2.6: Temperature Variation across a Year at the Project Site



Inter-row spacing and solar angles

The solar PV modules face south at zero azimuth, and the tilt angle considering the Project's location is 30°. The inter-row distance is 5.7 m.

Arrangement of solar PV modules

Each table array has an arrangement of five modules across its width and six modules along its length for the fixed tilt tracking system. The modules are arranged in a landscape orientation, making it easier to manage the DC cables as there are 50 modules in a string. One table array would thus represent one string (see detailed structure drawing in **Appendix C**). There is one solar PV module per row in landscape orientation. The number of motors used and their energy consumption depends significantly on the tracking system vendor selected.

Inverter placement and combiner boxes

There is one central inverter of 0.5 MW_p (AC) for every block of 0.55 MW (DC) located in the block's center to reduce DC cable lengths. There is one combiner box with 20 inputs for every array (one complete row) right next to a DC cable trench, which would take the

DC cables directly to the inverter skid (see **Appendix D** for inverter and transformer details).

Power cable management

The DC cable connecting the modules together will run through the cable raceways integrated into the 5x6 structure (**Appendix C**). All DC cables will end at the combiner box. Each DC combiner box will have 20 inputs and a single output DC cable, which will run through an underground trench to the inverter skid. The output from the inverter will go directly to the MV transformer located right next to the central inverter on the same skid. The stepped-up power after the transformer will then move through underground armored cables connecting four different blocks via a ring main unit and terminating at a busbar of suitable rating.

Supervisory control and data acquisition (SCADA)

The SCADA is an important control interface between the solar PV system and the personnel operating it. Functions such as condition monitoring, evaluating generation performance, VAR control, and frequency regulation can be carried out remotely, as per grid requirement. Access to the SCADA system will be with the asset manager, O&M service provider, the power off taker and the project sponsors. The DAS (data acquisition system) single line will be illustrated during the detailed engineering phase by the EPC contractor. One of the important prerequisites of this system will be the high level of security that it must offer against cyber-attacks or interventions.

Preliminary SLD

Refer to **Appendix E** for the preliminary single-line diagram (SLD) of the power plant.

Technical IRR kickers

Single-axis N-S Tracking

Tracking is the process of moving the solar PV modules to follow the sun on its diurnal path across the sky, which results in increased power generation from the solar plant. A tracking mechanism which results in the highest generation is the north-south arrangement, where the solar PV modules follow the sun on its east-west path. For this, the single-axis support structure would need to include a tracking mechanism and therefore its design would be more complex and include moving parts, which would increase the O&M cost for the structure. Project generation increases to 86,950 MWh at P50 with single-axis tracking. The cost of the EPC installation goes up by US¢ 10/W and the cost of O&M is estimated to go up by 30%.

DC Optimizers

DC power optimizer with MPPT and output voltage and current limits acts to optimize system design and maximize performance. The DC optimizer doubles the string size, hence reduces combiner boxes and by 50% and reduces DC/AC cabling by 30%, improves energy generation of the system by increasing the number of MPPT points and reducing mismatch losses. String level performance monitoring is possible because of the DC optimizers, and this helps improve plant O&M. The number of inverters required will also

decrease, resulting in better cost per wattage. One of the challenges of using DC optimizers is that the inverter must now work on a narrower MPPT range which requires special capability, and hence a different inverter design. There are only a handful of inverter manufacturers that can offer this feature, including:

- Bonfiglioli
- KACO
- LRI RE Energy, and
- Satcon.

One DC optimizer manufacturer, Ampt, which specializes in DC optimizers for utility-scale systems, should be further explored.

Passivated emitter rear cells (PERC)

PERC technology refers to a design where a dielectric passive layer is added at the back of the solar cell to improve performance and hence increase generation. The additional layer reduces electron recombination and improves light absorption as well. There are some experts who have also raised the issue of additional LID experienced by PERC-based solar PV modules, but this should be covered under the module's linear output production guarantee.

2.7 Preliminary Design of Civil Works

There are multiple aspects for a civil engineer/contractor to consider for the successful execution of a solar PV system. These are listed below:

Grading of solar field

It is imperative that water is not allowed to stand at the foundations of the modules' supporting structures. To ensure this, the site is graded to provide sloping sufficient to discharge precipitation runoff into a properly designed drainage system. Maximum effort should be made to use the existing slope/contours of the field to minimize cost. Some isolated trenches and elevations were identified at the site, which also need to be graded/filled in if they are to be utilized for solar PV panel placement. While placing the solar modules, it should be made certain that no such trenches and elevations exist below an array or near any foundation, which could later become a risk for water accumulation.

Power cable trenching

DC and AC power cable trenches are to be excavated and backfilled. Maximum effort should be made to minimize the length and width of the trenches. Cable sizes and runs should be kept in mind while sizing the trenches to avoid possible rework during the installation phase of the project.

Skid platform

The skid platform that holds the central inverter, the transformer and the MV protection will be of considerable weight. A concrete mounting pad should be constructed upon

compacted soil in order to avoid settlement of the installation into the ground.

Pile foundations

A piling machine should be used to geo-locate the coordinates of the pile positions as per the design layout and penetrate them into the ground to support the frame. The type of piles employed will be determined by a structural engineer, based on site soil conditions. The piles will be hot dip galvanized in order to protect them from the long-term effects of corrosion.

Supporting frame

A combination of anodized aluminum channels, purlins and raceways are used to form the supporting frame. The supporting frame is in contact with the solar PV modules and hence it is important that the metals are same, as dissimilar metals with time can experience galvanic corrosion. All nuts and screws are either stainless steel or hot dip galvanized. The frame is for 5 modules in width and 6 modules in length. These modules have 60-cell in total. **Appendix C** provides a conceptual illustration of the supporting structure for a fixed tilt system.

Perimeter fencing

In order to maintain a secure perimeter around the solar PV project a wire mesh fence would have to be installed which would not only be grounded but would also be piled to the ground. This would depend on the proximity of the fence from the solar PV modules.

2.8 Construction Management

2.8.1 Project Construction

For effective construction management, it is a good practice to engage and get feedback from all related stakeholders as early as possible during the project development stake, including:

- EPC contractor
- O&M contractor
- Owner's engineer
- Asset manager, and
- Regulator/offtaker.

Though all inputs are locked in before the construction of the solar PV plant starts, it is important to keep all stakeholders in the loop during the construction phase. The EPC contractor will be sharing the detailed construction documents of the solar PV plant and a comprehensive timeline breakup of activities involved. The owners engineer will make sure all activities are preplanned by the contractors and subcontractors. Necessary flags will be raised to the sponsors when the contractor falls behind timelines, equipment specs are not met, equipment quality tests/ benchmarks are not met or if installation is not carried out as per construction documents.

Any of the above reasons can result in delays in project execution and timely delivery. The owners engineer and EPC contractor play a key role in the timely delivery of the project. A term of reference document on quality levels, checks, standards and compliances should be agreed between the EPC contractor and the owners engineer to avoid surprises

during project execution. These terms of references should be reflected in the EPC contractor's contract.

2.8.2 Power Transmission Construction

Renewable energy projects have the option to sell energy to the off taker even before the COD for the project is reached. This option has been available for all wind projects in Pakistan. Similarly, for all solar projects the construction planning should be such that the commissioning of the high voltage interconnection AC-side of the power plant should be prioritized along with the SCADA system of the power plant. The inverter blocks once installed can immediately start selling electricity to the grid. As the project execution progresses more inverter blocks would be expected to come online and hence deliver more energy to the grid. This will overall improve the cash flow of the project.

2.8.3 Roads and Infrastructure Construction

In order to successfully move all project related equipment from the sea port to the point of installation at the project site, a series of roads need to be available. Internal roads within the power plant facility are within the scope of the project, however the availability and condition of roads connecting the project site to the nearby city and to the port of Karachi would be important for the safe logistics of all equipment. The central inverters skids which include the transformer and the MV switchgear are collectively considerably heavy and would preferentially require flat, load bearing roads. Local government or AHJ should be briefed on the importance of these road connecting the solar project to nearby cities. Though national highways and motorways present in the country are capable enough for allowing the safe transportation of goods across the country, the roads connecting the city of Kulachi with the project site is of concern and should be improved if possible.

The construction of internal roads and project fencing will also be amongst the first construction activities that would be necessary before any other equipment can be moved to the site.

2.9 Firefighting Facilities

The solar PV module, inverter and structure installation should be Class-A certified. Fire-resistant cables should be used and, especially on the DC-side, TUV-certified DC cables should be used. Fire extinguishers should be located at regular spacing at the project site, as there is no fire station in the near vicinity.

2.10 Operation and Maintenance (O&M) Management

The biggest factor differentiating a successful project which completes its design life and delivers the expected energy output and an underperforming project which is prone to equipment failure issues is how effectively the plant's O&M needs are managed. The international solar market is flooded with reputable O&M service providers with experience of a reasonably large portfolio of solar PV projects. There has been considerable research in the area of solar PV asset management and the costs for such contracts have gone down considerably in the last few years. Considering the incipient capability and capacity of local O&M firms with respect to such installations, the most effective model for such contracts would involve an international supervisory firm, with sufficient solar PV plant maintenance qualifications, as the main contractor and a local subcontractor to assist with daily supervision and onsite activities, thus providing a cost-effective O&M solution.

The owners' engineer and the O&M contractor will be the two main parties involved in successful project operation and maintenance management. The owners' engineer and the O&M contractor should agree to their mutual terms of reference well before the project execution and installation starts. The ToR should reflect all relevant activities, including:

- ☐ Solar PV module cleaning.
- ☐ Vegetation management at the project field.
- ☐ Water drainage management.
- ☐ Condition monitoring of the plant, which would involve monitoring factors such as PID, hotspots, micro cracks and delamination of solar PV modules. Condition monitoring of inverter performance will also need to be checked on a regular basis, including all other eBOS equipment.
- ☐ Transformer maintenance
- ☐ Grounding checks and power cable tests
- ☐ Monitoring corrosion buildup in the supporting structure piles and monitoring their load bearing integrity.
- ☐ Remotely executed control checks of voltage and frequency regulation.
- ☐ LID after project COD.
- ☐ Performance Ratio tests.

Cleaning schedules should be maintained and logged for these and all other activities that are necessary as per the O&M ToR, and a weekly log should be generated for the owners' engineer to validate on behalf of the project sponsors.

2.11 Environmental Management

While renewable energy projects are generally considered environmentally friendly, there are a few aspects that should be closely monitored and managed as they could otherwise have adverse impacts. These include:

- Oil-leaking transformers. There will be 16 MV transformers and two HV transformers installed at the Project, and dry type should be preferred.
- Preserving the agricultural land utilized for solar project installation. Native plant species which do not intervene with solar PV performance should be managed and retained.
- Adequate recycling program for broken or damaged solar PV modules. The manufacture should adhere to a recycling plan to reduce the environmental impact of disposing of solar PV modules.
- Some solar PV modules, such as thin film modules (CdTe), can also leak hazardous substances. A proper containment mechanism should be devised if such materials are used at site.
- A total of 79,405 MWh of energy will be produced by the fixed tilt system on an annual basis at P50. The generated energy would be 79,888 MWh for a single-axis tracking system at P50. All energy is to be offtake by the local power utility, PESCO, and would displace a proportionate amount of fossil fuel-fired thermal generation. This would correspond to an annual maximum carbon footprint reduction of 37,434 metric tonnes of CO_2e for a 49.5 MW_p fixed tilt system and 39,944 metric tonnes for a tracking system.

For more details on the plant's environmental monitoring program (EMP), see **Vol. 4** of the Project Feasibility Study.

2.12 Health and Safety Management

An adequately designed solar system is one which caters to all safety considerations in its design. There are several codes and standards relating to safety practices, particularly in solar PV equipment manufacture and installation. Agencies with codes and standards relevant to solar PV systems include:

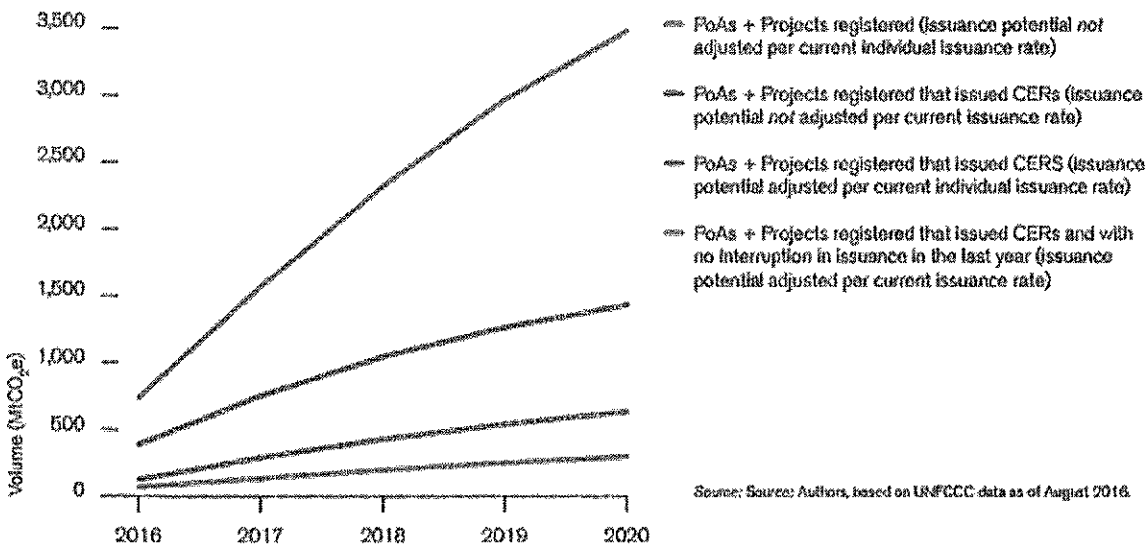
- National Fire Protection Agency (NFPA)
- Underwriters Laboratory (UL)
- Institute of electrical and electronics engineers (IEEE)
- International Electrotechnical Commission (IEC), and
- CEC (California Energy Commission)

The NFPA's 70 NEC (National Electric Code), Chapter 6, has been particularly developed for sizing and installing solar PV systems. NESC (National Electric Safety Code), updated by IEEE every five years, is another valuable source of information for devising health and Safety protocols for the Javed solar PV project. All EPC contractors should be advised to conform to the relevant industry-standard safety codes, such as those mentioned above, and detailed guidelines should be developed by the owners' engineer.

2.13 Carbon Credits

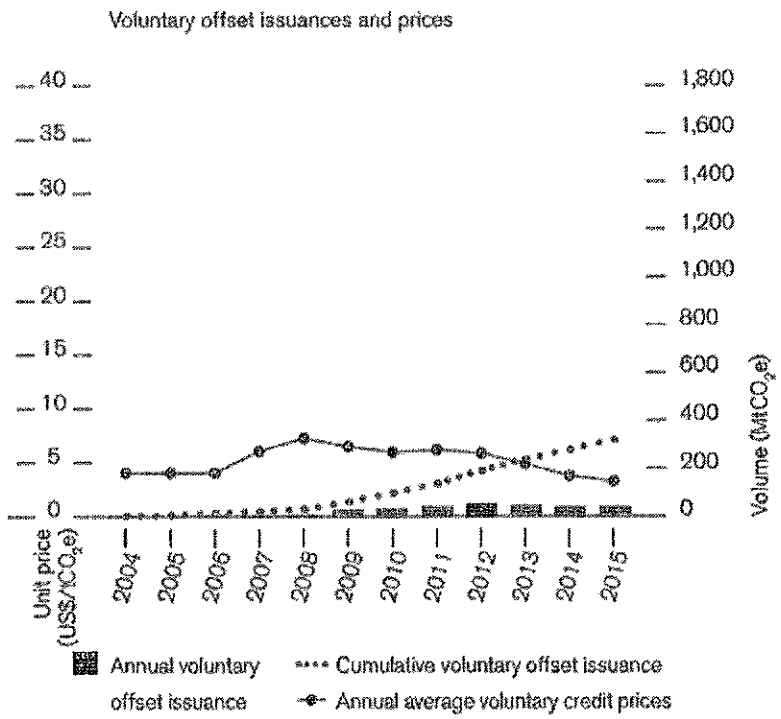
A 'carbon credit' is a generic term for any certificate that is tradable and represents one tonne of carbon dioxide emission. The formation of this tradable credit represents a global initiative by economists to mitigate the production of greenhouse gases such as CO_2. Greenhouse gas (GHG) emissions are capped to a certain threshold based on the type of industry and then markets are used to allocate allowable emissions amongst the group of regulated sources. Since renewable energy projects, such as solar PV-based power generation, are GHG mitigation sources, they add credits to the market that are bought by investment funds or carbon development companies and then sold on to carbon off-setters at market-determined prices (**Exhibit 2.7**). It is the job of the investment fund or carbon development company to ensure and confirm the authenticity of the traded carbon credit.

Exhibit 2.7: Volume of Carbon Credits Traded Globally



The price for carbon credits vary from country to country and different markets, depending on their carbon management plans. The price for credits has come down considerably in the last couple of years globally; however, it has been provided with a lifeline in the wake of the recent Paris Agreement on climate change. Carbon credit prices fluctuate, depending on the type of project involved and the supply of these credits in the open market at any given time (**Exhibit 2.8**)

Exhibit 2.8: Carbon Credits Price Trends

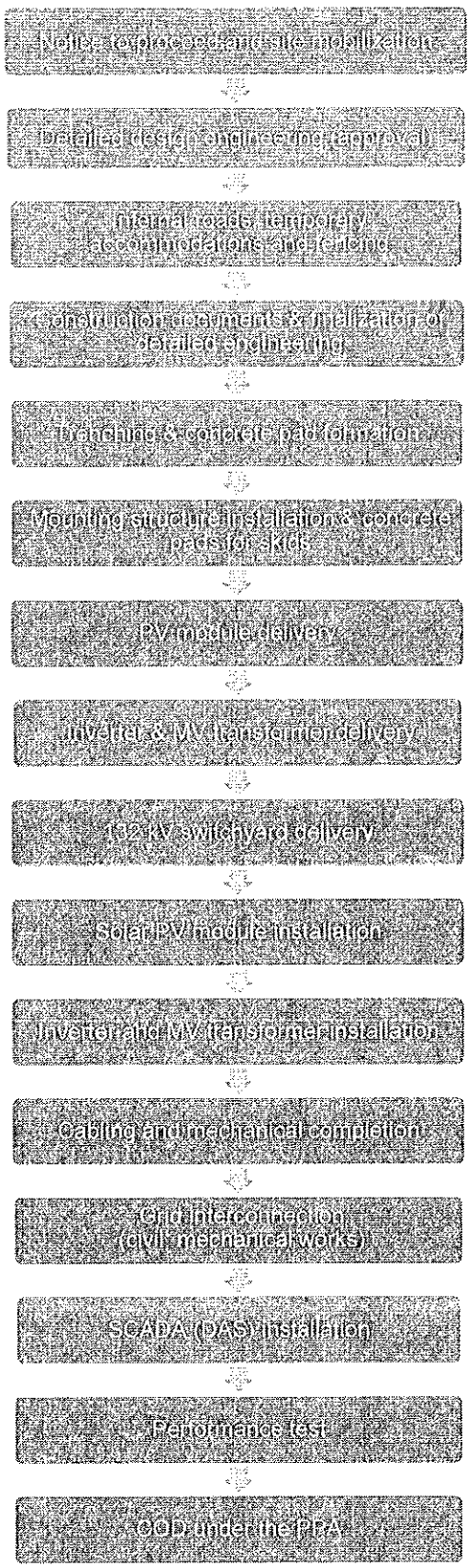


Source: UNFCCC for CDM and JI data on issuances, Intercontinental Exchange ICE for CDM data on prices, Forest Trends' Ecosystem Marketplace for data on voluntary offsets.

2.14 Project Execution Milestones and Schedule

A detailed schedule of the installation and execution plant for the Project will be prepared in a comprehensive manner by the EPC contractor after thorough site investigations and logistical planning. The diagram in **Exhibit 2.9** below represents a general outline of the flow of activities typically involved in the installation and commissioning of a utility-scale solar PV power generation project. Specific activities can vary depending on site conditions and timelines provided by the OEMs for the delivery of plant equipment. The timeline for the execution of the project is taken to be 12 calendar months.

Exhibit 2.9: Solar PV IPP Project Execution Milestones



2.15 Project Risk Identification and Mitigation

Identifying risks is one of the foremost activities that need to be determined as part of a project's technical and commercial feasibility study. **Exhibit 2.10** details the main risks, their level of impact on the project and possible mitigation measures relevant to the proposed Javed solar PV IPP Project.

Exhibit 2.10: Project Risk Identification and Mitigation

Deal breaker: high risk not possible to solve
High risk, possible to solve
Medium risk, possible to solve
Low risk, possible to solve
No risk

No	Topic	Risk	Risk Impact Level	Mitigation Measures
1	Land-related parameters	Water logging at site near foundations during the monsoon season	Medium	The need of drainage channels at lower depression points close to expected foundations to be evaluated; natural slope at site of 0.18% to 0.22% reduces risk impact
2	Weather conditions	High-temperature zone; dust and sand resistant filters to be utilized to avoid abrasion	Low	Component selection and detailed engineering to incorporate local/weather site conditions
3	Foundations	Varying soil chemistry and types across the property may warrant different pile types; refusal of piles may occur	Low	Structural engineer to finalize pile types based on geotechnical study of the site; preferably, one pile type to be selected throughout the project to minimize cost and for convenience of installation
4	Solar resource potential	Variation in measured solar data through different models.	Medium	It is suggested that P75 or P90 figures be used to determine returns in the Project's financial model; selection to be based on level of security the sponsor's require
5	Water supply	Water supply needed for solar PV modules cleaning; water quality risk	Low	Water-less and water-efficient PV module cleaning option to be explored; since the water table is also low, submersible pumps would require power to lift it; groundwater TDS would need to be monitored since high TDS can affect the longevity of the solar modules

No.	Topic	Risk	Risk Impact Level	Mitigation Measures
6	Grid access/ offtake risk	The nearest substation is a 66 kV overloaded PESCO grid station which pose availability issues for the solar PV project	Low	The substation is expected to be upgraded to 132 kV this year, which will substantially mitigate this risk; supply of power from the Project will thus be at 132 kV; substation upgrade timelines to be monitored closely
7	Site access	Access to basic facilities, e.g., hospital, police station, fire station, etc.; properly constructed road to the project site.	Low	Basic services and facilities available in Kulachi town located 20 km from Project site; fire safety equipment should be installed at site and should be included in the project EPC scope; site access route from Kulachi town does not have a permanent asphalt road, hence logistics need to be planned accordingly
8	Agricultural land	Cultivable land and vegetation to be removed	Low	All vegetation which is high enough to affect solar PV performance to be removed; this will be an ongoing exercise for the O&M contractor; agricultural land is generally avoided for solar PV projects
9	Site security	Equipment damage by animals and humans	Low	Wire mesh fence and security lighting to be installed, along with CCTV cameras at certain locations
10	Government Policy	Change in tax policy for IPPs; solar PV equipment duties	Low	Change in govt. policy on contracted RE IPP projects not expected; however, any such changes should be closely followed with the AEDB and provincial govt., especially with respect to tariffs
11	Site contours	Excessive slopes at the project site	None	Slopes less than 0.18% to 0.22%; gentle enough even for tracking systems.
12	Solar PV equipment Supply	Delivery timelines	None	Solar PV market is currently in an oversupply state; supply timeline constraints not expected

3. Solar Resource Assessment and Energy Yield

3.1 Irradiance Conditions at Site

3.1.1 Data Sources

The primary data source used for the Project's detailed energy simulation using PVsyst is Meteonorm 7.2 and SolarGIS (attached). Data variables imported into PVsyst included:

- Global horizontal radiation (hourly)
- Diffused radiation (hourly)
- Ambient temperature (hourly), and
- Fill factors (hourly).

The SolarGIS irradiance data ranged from 1999 to 2018 and temperature data from 1999 to 2018.

The results obtained by the simulation were validated using PV yields reported in World Bank data from a recent exercise undertaken the Bank to map solar data in Pakistan using ground-level measurements. The World Bank data[9] were produced by measurement stations located in Lahore, Islamabad, Peshawar, Karachi, Khuzdar, Multan, Hyderabad and Quetta. The datasets represent 10 min interval values of PV output, global horizontal radiation, direct normal irradiance, diffused horizontal irradiance, temperature and elevation. Conditions at locations situated between measurement sites can be interpolated to determine an appropriate local data set (using both the real-time ground data and satellite-based data to obtain the interpolated data set). The World Bank dataset is from 2015 to 2017 (further data collection is ongoing).

The nearest weather stations of the Pakistan Meteorological Department to the Project site are listed in **Exhibit 3.1.**

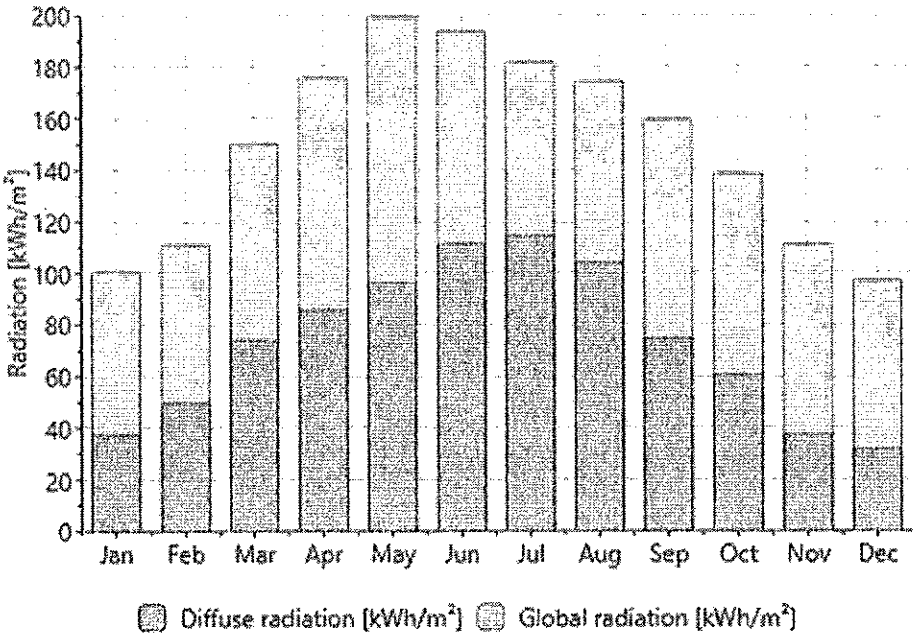
Exhibit 3.1: Meteorological Stations Close to the Project Site

Station	Distance from Station in	Delta Elevation in	Data/ Equipment Quality
Peshawar	270	112	Tier 1
Islamabad	325	351	Tier 2
Multan	220	94	Tier 2

[9] For details, see the World Bank's Global Solar Atlas website at http://globalsolaratlas.info.

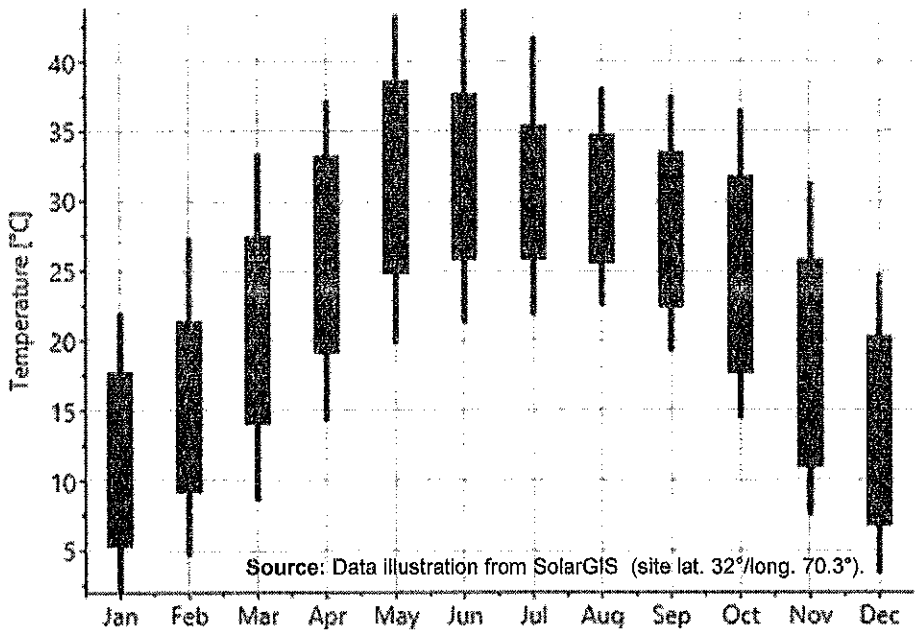
An illustration of the breakup of direct and diffused radiation for the Kulachi site is given in **Exhibit 3.2**, while **Exhibit 3.3** provides monthly temperature ranges and **Exhibit 3.4** shows daily hours of sunshine.

Exhibit 3.2: Breakup of Global and Diffused Radiation at the Project Site



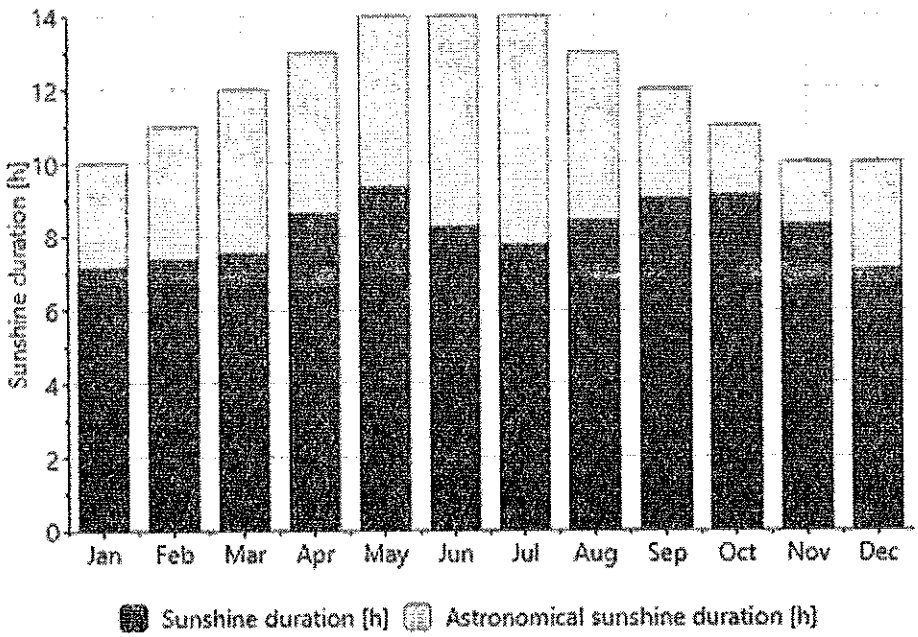
Source: Data illustration from SolarGIS (site lat. 32°/long. 70.3°).

Exhibit 3.3: Ranged Temperature Variation across the Year at the Project Site



Source: Data illustration from SolarGIS (site lat. 32°/long. 70.3°).

Exhibit 3.4: Month-wise Daily Sunshine Hours at the Project Site



Source: Data illustration from SolarGIS (site lat. 32°/long. 70.3°).

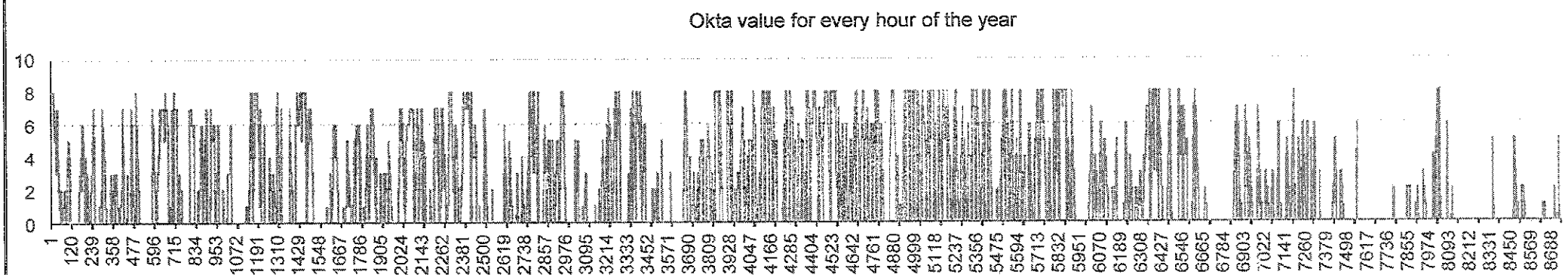
3.1.2 Cloud Cover/Okta Scale

Exhibit 3.5 shows Okta values for every hour of the year for the Kulachi Project site. Okta value (N) represents the fraction of the sky that is covered with clouds. The scale varies from 0 to 8, where 0 represents a completely clear sky and 8 represents completely overcast conditions.

The output of a solar PV system is strongly dependent on the fraction of the sky that is covered with clouds, i.e., the proportion of direct and diffuse irradiance reaching the modules. It can be observed that the clearest days are experienced during November-December and February-March.

In general, selecting solar modules which operate well in low light, diffused radiation condition improves the performance of a solar PV system. Maximum irradiance at any instant is experienced between 4 to 6 on the Okta scale, where direct irradiance is incident on the solar PV modules and there is diffused irradiance from nearby clouds as well. However, overall generation (kWh) is lower in this Okta range compared to 0 Okta, but there are more power peaks experienced.

Exhibit 3.5: Hourly Okta Values for the Year at the Project Site



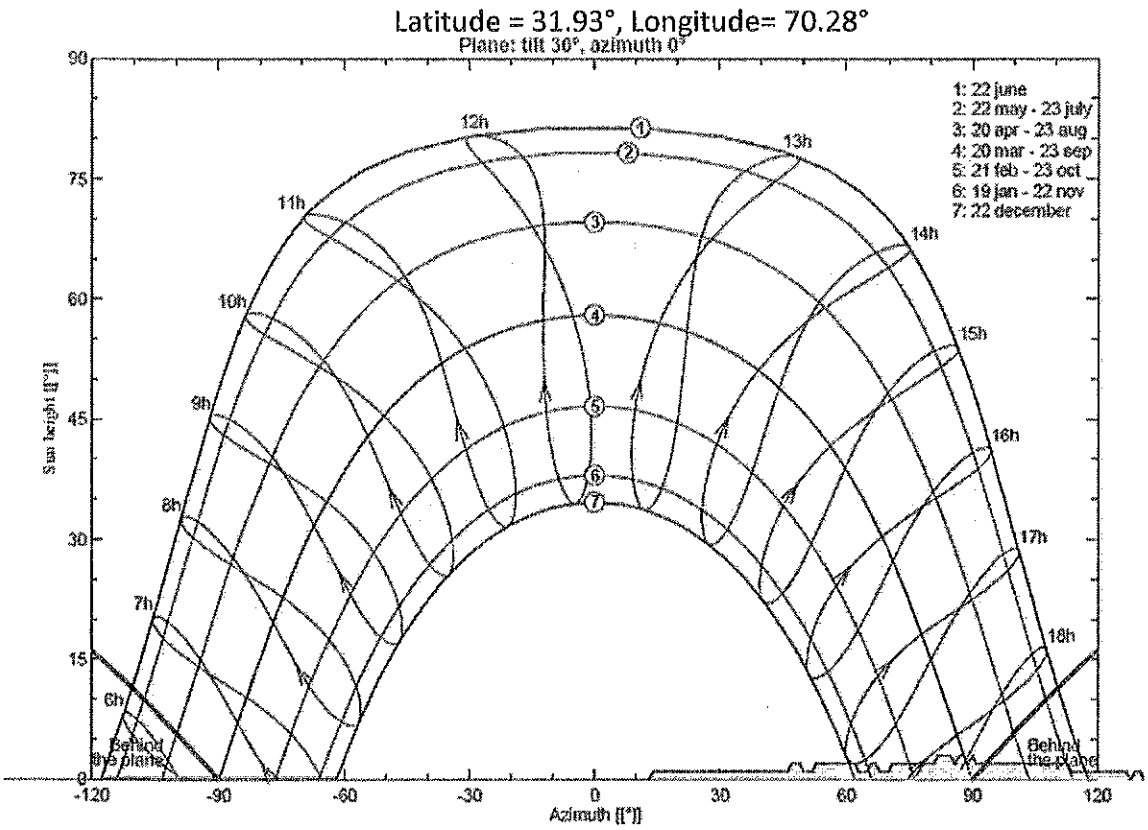
3.1.1 Shading at Site

There are two types of shading of the solar modules that have been considered in the plant's energy simulation:

Horizon Losses

Horizon losses are the same for fixed and tracking systems (**Exhibit 3.6**).

Exhibit 3.6: Sun Path Diagram Illustrating Horizon Losses

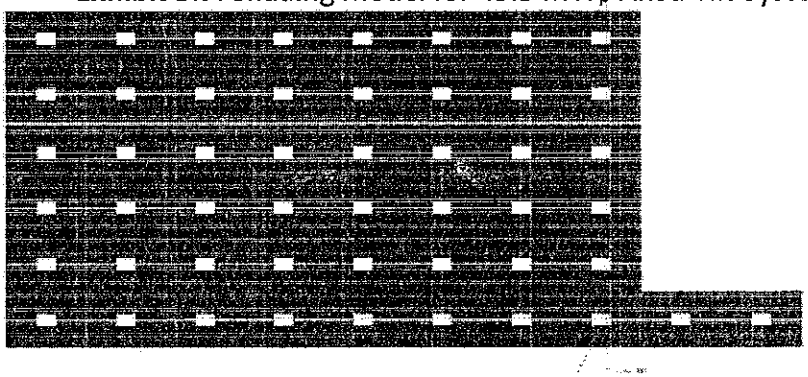


Source: Obtained from Meteonorm 7.2 for the site location.

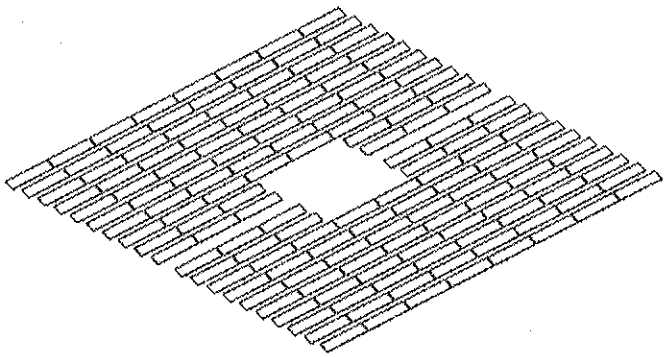
Near Shading Losses

Near shading losses primarily include inter-row shading losses. It is assumed that there are no other nearby obstructions, such as trees or buildings, which will result in near shading on the solar PV modules at the Kulachi site. A near shading model was also developed for a single-axis tracking system under the same site conditions. All near shading was simulated in PVsyst 6.3.9 for both types of systems (**Exhibit 3.7** & **Exhibit 3.8**).

Exhibit 3.7: Shading Model for 49.5 MW_p Fixed Tilt System

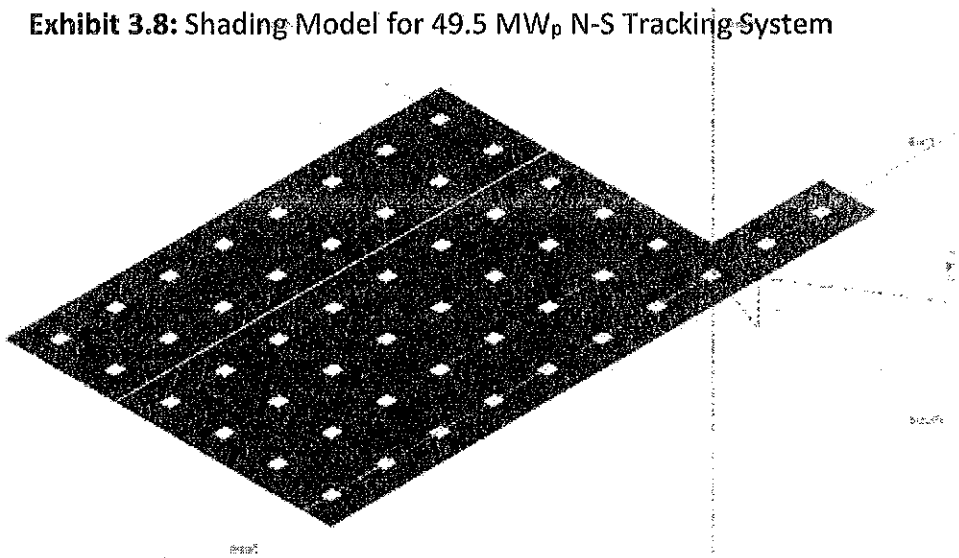


Plant view in PVsyst 6.3.9, all 50 blocks shown.



Block View in PVsyst 6.3.9, single block shown.

Exhibit 3.8: Shading Model for 49.5 MW_p N-S Tracking System



Plant view in PVsyst 6.3.9, all 50 blocks shown.

3.2 Resource Data Variation

There are a number of different data sources and models available that combine measurements from ground stations and satellite-based interpolated data for the final data set. These include:

- Meteonorm
- Solar GIS
- NASA
- PVGIS 4
- Swera SUNY, and
- Swera NREL.

Two models, Meteonorm and Solar GIS, gave results which were closest to actual solar PV output results for Karachi, Islamabad, Lahore and Islamabad. Therefore, the latest version of Meteonorm 7.2 dataset for the Kulachi site was used for the Project simulation study and the results obtained from the simulated plant yield was validated against the World Bank's solar atlas and other solar PV projects in the region. In addition, the variances shown in **Exhibit 3.10** were observed based on terrain types.

Exhibit 3.10: Variation of Data in Different Terrain Conditions

Model Uncertainty Yearly Estimates	Region	GHI %	GTI %	DNI %
Low	Lowlands and monotonous terrain	±4 to ±4.5	±5.5	±6 to ±8
Medium	Mountains and western Pakistan, large urban areas	<±6	<±7	<14
High (exceptional)	High mountains	±8+	±9+	±18+

3.3 PV System Simulation Basis and Assumptions

The basis of assumptions used for the plant energy yield simulations can be found in the PVsyst report in **Appendix F & G** for fixed tilt and tracked systems, respectively. **Exhibit 3.11** and **Exhibit 3.12** summarize the basis of assumptions for the fixed tilt system and N-S tracking system, respectively.

Exhibit 3.11: Assumptions Used in Fixed Tilt System Simulation

Parameter	Assumptions	Basis
Site & meteo	Meteonorm 7.2 was used for data at lat. 32° and long. 70.3°	One of the more elaborate weather data sources commercially available
Albedo	0.2	For land with grass, albedo varies from 0.15 to 0.25
Transposition model	Perez	The Perez model is considered somewhat more accurate than the classic Hay model (in terms of root mean square differences), even with synthetic data[10]
Orientation		
Tilt	30°	Optimum tilt for the location
Azimuth	0° (true south-facing)	South-facing solar PV modules produce maximum energy
System definition	5,120 strings, 16 inverters, 325 W modules, DC/AC ratio of 1.24	Optimum DC/AC ratio, the added energy generation not worth the extra inverter costs and increased O&M; overload losses less than 0.1%

[10] Note that the Perez model usually gives yearly averages higher than the Hay model, of the order of 0% to 2%, depending on climate and plane orientation (P. Ineichen. 2011. *Global Irradiance on Tilted and Oriented Planes: Model Validations*. Research report of the Institute of Environmental Sciences, University of Geneva).

Parameter	Assumptions	Basis
Detailed Losses		
Thermal and wind loss factor	29 W/m²k and 0 W/m²k	Free-mounted modules with air circulation
Wiring ohmic loss	2% DC-side and 2% AC-side	Maximum allowable NEC values; actual sizing should yield reduced % of losses
Module quality loss	-0.8%	Positive tolerance solar PV modules on average have 0.8% STC rating, confirmed from flash test report
Light induced degradation (LID)	2%	First year drop in power due to absorption of light on the cells, as represented by manufacturers in datasheets
Module mismatch losses	2%	Difference in solar PV output in different strings; this can be due to ongoing cleaning of solar PV modules, hotspots, change in orientation of few strings due to mechanical failure, etc.
Soiling loss	Jan. 2%, Feb. 2%, Mar. 3%, Apr. 3%, May 3%, Jun. 1%, Jul. 1%, Aug. 2%, Sep. 2%, Oct. 3%, Nov. 3%, Dec. 3%	Losses evaluated based on precipitation cycle for the Project site
Incidence angle modifier (IAM) loss	$b_o = 0.04$	Based on novel antireflection coatings currently used by manufacturers
Auxiliary losses	Inverter loss continuous 67.8 kW; from threshold 37.8 kW	Based on inverter specification sheet
Night loss	5,000 W	Basic control room and perimeter lights
Transformer loss	Iron loss 0.1% and inductive losses at 1%	Transformer specification sheet of commonly used transformers
Unavailability loss	0.8% of the year divided into three intervals across the year	O&M-related activities or repairs
Horizon Loss		
Average height	0.5%	Obtained from Meteonorm for the Project site; see simulation report for more information

Exhibit 3.12: Assumptions Used in Single-Axis Tracked System Simulation

Parameter	Assumptions	Basis
Site & meteo	Meteonorm 7.2 was used for data at lat. 32° and long. 70.3°	One of the more elaborate weather data sources commercially available
Albedo	0.2	For land with grass, albedo varies from 0.15 to 0.25
Transposition model	Perez	The Perez model is considered somewhat more accurate than the classic Hay model (in terms of root mean square differences), even with synthetic data
Orientation		
Axis tilt	0°	Axis tilt
Rotational angles	–60° and +60°	Backtracking enabled
Pitch	6.5 m	In order to maximize generation.
Azimuth	0° (true south-facing)	South-facing solar PV modules produce maximum energy
System definition	5,120 strings, 16 inverters, 325 W modules, DC/AC ratio of 1.24	Optimum DC/AC ratio, the added energy generation not worth the extra inverter costs and increased O&M; overload losses less than 0.1%
Detailed Losses		
Thermal and wind loss factor	29 W/m²k and 0 W/m²k	Free-mounted modules with air circulation
Wiring ohmic loss	2% DC-side and 2% AC-side	Max allowable NEC values. Actual sizing should yield reduced % of losses.
Module Quality loss	–0.8%	Positive tolerance solar PV modules on average have 0.8% STC rating, confirmed from flash test report
Light induced degradation (LID)	2%	First year drop in power due to absorption of light on the cells, as represented by manufacturers in Datasheets
Module mismatch losses	2%	Difference in solar PV output in different strings; this can be due to ongoing cleaning of solar PV modules, hotspots, change in orientation of few strings due to mechanical failure, etc.
Soiling loss	Jan. 2%, Feb. 2%, Mar. 3%, Apr. 3%, May 3%, Jun. 1%, Jul. 1%, Aug. 2%, Sep. 2%, Oct. 3%, Nov. 3%, Dec. 3%	Losses evaluated based on precipitation cycle for the Project site
Incidence angle	$b_0 = 0.04$	Based on novel antireflection coatings

Parameter	Assumptions	Basis
modifier (IAM) loss		currently used by manufacturers
Auxiliary loss	Inverter loss continuous 67.8 kW. From threshold 37.8 kW	Based on inverter specification sheet
Night loss	5,000 W	Basic control room and perimeter lights
Transformer loss	Iron loss 0.1% and inductive losses at 1%	Transformer specification sheet of commonly used transformers
Unavailability loss	0.8% of the year divided into three intervals across the year	O&M-related activities or repairs
Horizon Loss		
Average height	0.5%	Obtained from Meteonorm for the Project site; see simulation report for more information

3.4 Selected Main Solar PV Components

The main data sources utilized for the selection of the solar PV power plant components for this feasibility study are listed in **Exhibit 3.13**.

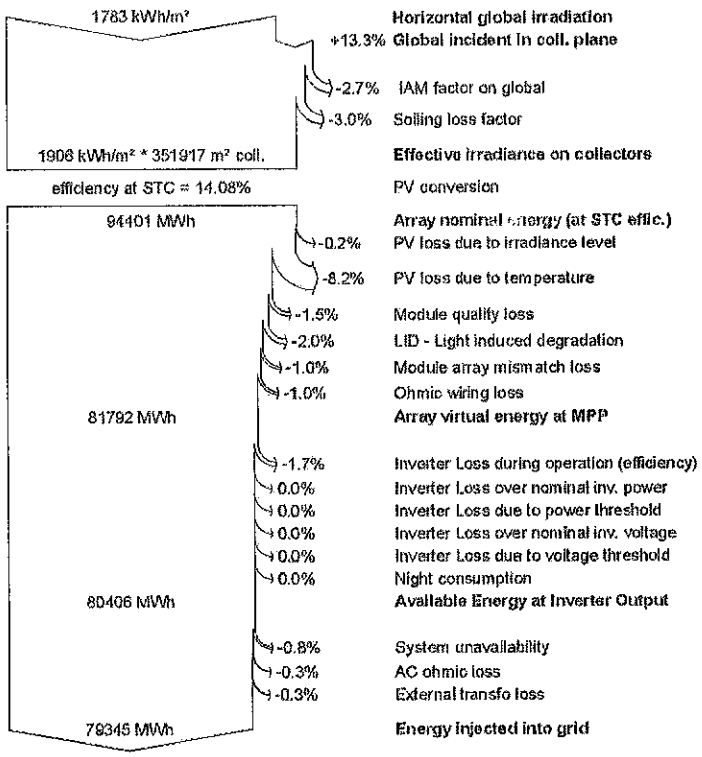
Exhibit 3.13: Data Sources Used for Component Specifications

Component	Data Source
Solar PV module	http://www.jasolar.com/uploads/JAP6(BK)%2060%20240-
Central inverter	http://en.tbeapower.com/show.php?id=8929
Combiner box	http://www.cooperindustries.com/content/dam/public/crousehinds/resources/pdfs/literature/solar-combiner-1,500v.pdf

3.5 Auxiliary Consumption and System Losses

Loss flow charts for a fixed tilt and single-axis tracked solar PV system are shown in **Exhibit 3.14** & **Exhibit 3.15**, respectively.

Loss diagram over the whole year



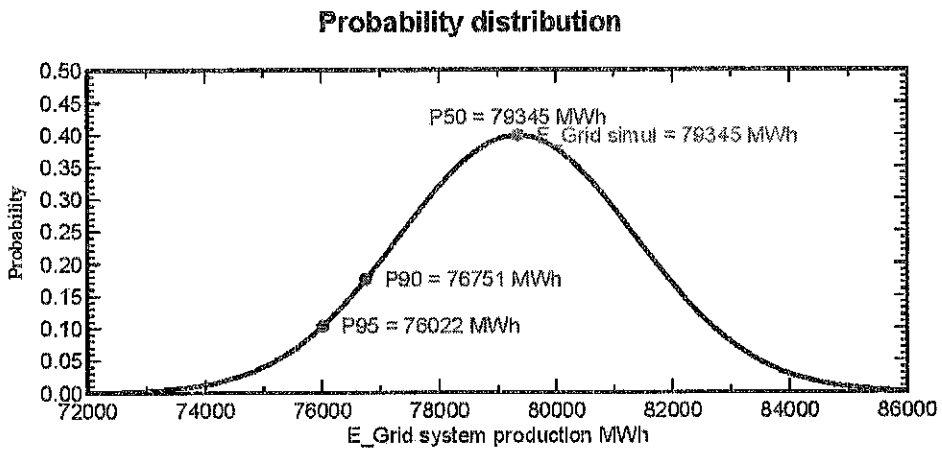
3.6 Plant Electricity Generation Profile

3.6.1 Probability Distribution for Annual Energy Generation

Fixed Tilt System

The computed energy yield probability curve for a 49.5 MW_P fixed tilt solar PV system at the Kulachi site is illustrated in **Exhibit 3.16**

Exhibit 3.16: Yield Probability Distribution Curve for Fixed Tilt System at Kulachi



The energy generation numbers for a 49.5 MW_p fixed tilt system installed at the Kulachi site and corresponding capacity utilization factors (CUF) are shown in **Exhibit 3.17.**

Exhibit 3.17: Yield and Capacity Utilization for Fixed Tilt System at Kulachi

Case	Generation MWh	CUF
P50	79,405	18.05%
P90	77,205	17.09%
P95	76,877	16.90%

Single-Axis N-S Tracked System

The computed energy yield probability curve for a 49.5 MW_p single-axis tracked solar PV system at the Kulachi site is illustrated in **Exhibit 3.18.**

Exhibit 3.18: Yield Probability Distribution Curve for Single-Axis Tracked System at Kulachi

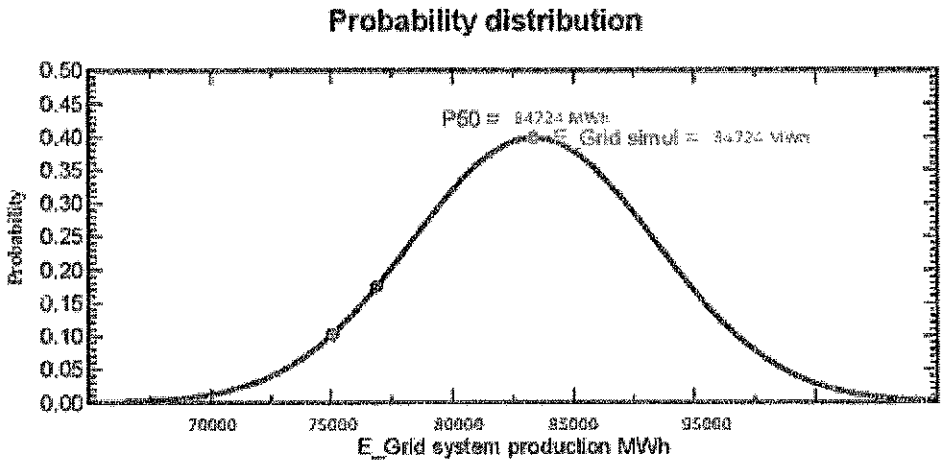


Exhibit 3.19: Yield and Capacity Utilization for Single-Axis Tracked System at Kulachi

Case	Generation MWh	CUF
P50	84724	19.54%
P75	81694	18.85%
P90	78968	18.22%

3.6.2 Plant Energy Yield and Expected Availability

For a solar PV system, the term 'performance ratio' refers to the relationship between the system's actual and target yields:

Performance Ratio (PR) of a plant for a period of time =
Energy Measured (kWh)/[Irradiance (kWh/m^2) on the Panel
x Active Area of PV Module (m^2) x PV Module Efficiency]

Fixed Tilt System

Monthly performance ratios for a 49.5 MW_p fixed tilt solar PV system at the Kulachi site are shown in **Exhibit 3.20**.

Exhibit 3.20: Monthly Performance Ratio for Fixed Tilt System at Kulachi

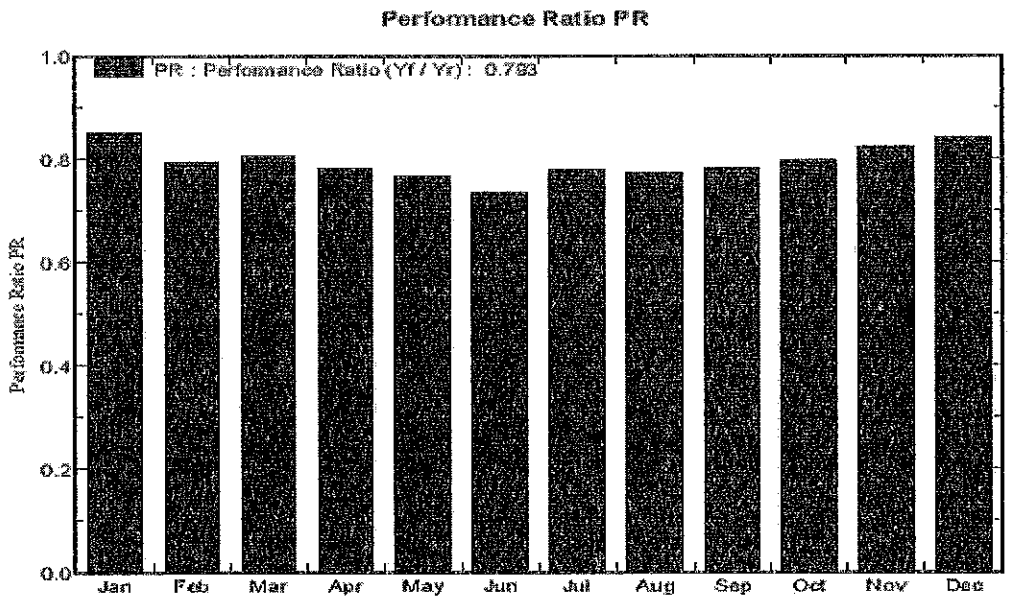


Exhibit 3.21: Normalized Monthly Average Production for Fixed Tilt System at Kulachi

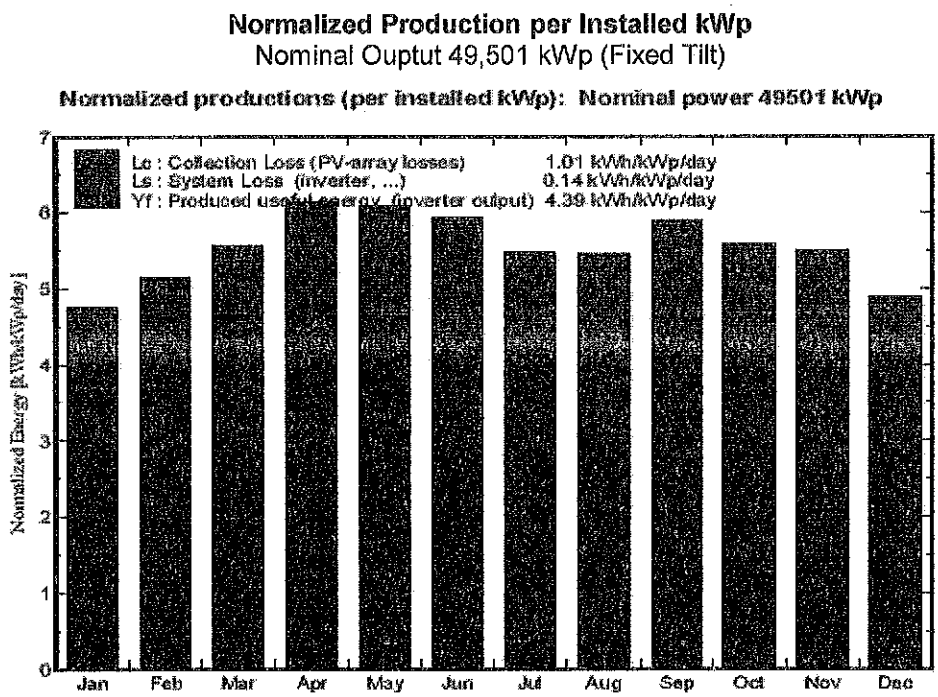
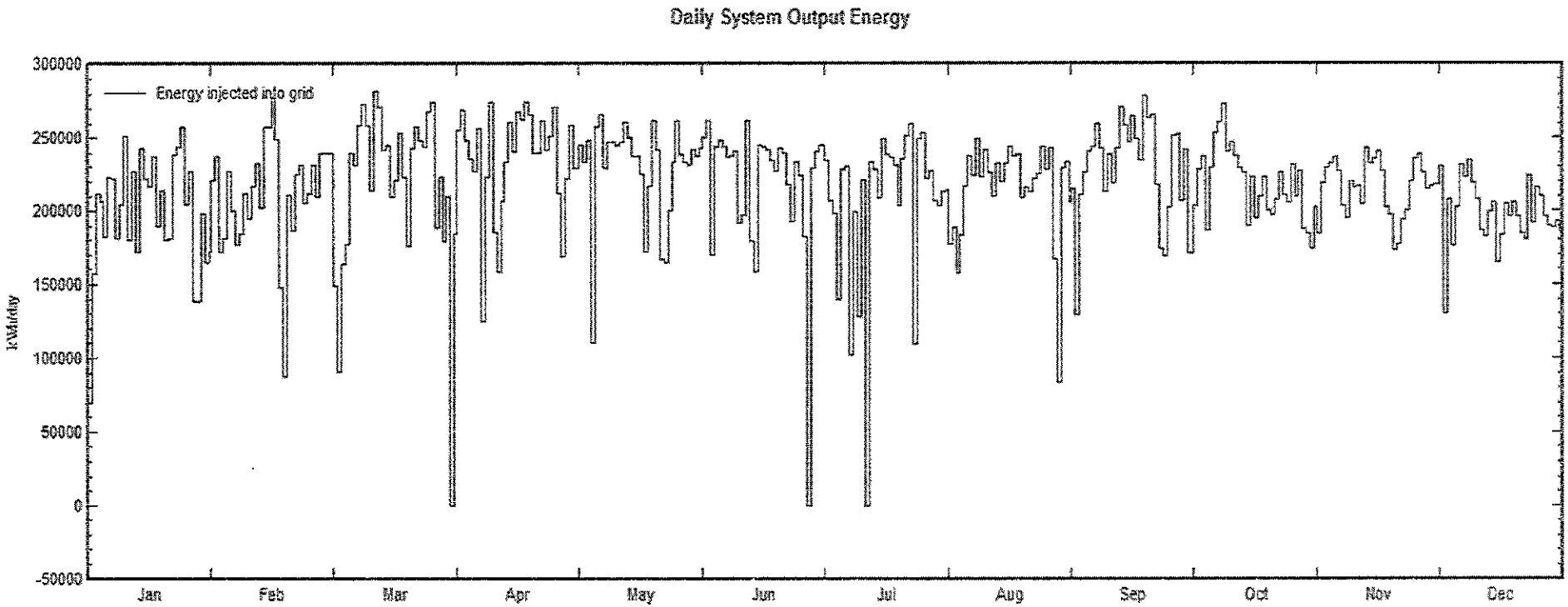


Exhibit 3.22: Daily System Output for Fixed Tilt System at Kulachi



4. Project Implementation

4.1 Power Station Control System

A SCADA system will be an integral part of the project EPC scope and would be accessible to the sponsor, O&M operator, grid operator and asset manager. This operating system will help monitor energy generation in detail, report and troubleshoot faults, and help evaluate asset performance, component degradation and other important variables that need to be regularly assessed for ensuring effective solar PV and plant performance. The SCADA interface will also be accessible to local operator at the plant's control room for operational command and control purposes. All ancillary services and functions which the inverter is capable of will be operable through the control system. In case of a tracking system, the control system will also allow changing panel orientations based on specific requirements, if and when required.

4.2 Project Implementation Plan

A detailed breakdown of activities will be sought from the EPC contractor. The plan should be organized such that the sponsor could gain advantage from selling extra energy before the Project COD. Contractual clauses should be incorporated to reward or penalize the EPC contractor for early or delayed completion, respectively, of the solar PV plant installation, testing and commissioning. These could be percentage-based, tied to weekly and monthly work plan milestones.

4.3 Implementation Schedule

The timeline for the Project commissioning is estimated to be twelve months from initial ground breaking. A detailed construction and commissioning Gantt chart will be developed by the EPC contractor which would list the sequence and duration of each activity and phase. The owners' engineer shall make sure that project implementation activities can run in parallel as much as possible and equipment and material delivery schedules are closely synchronized with on-site construction needs. **Exhibit 4.1** shows the sequence of main project implementation activities and tentative timeline for completion of each. Some of these activities would overlap each other. Total project execution will take from 230 to 250 days, or a maximum of 9 calendar months, which will be clearly defined in the EPC implementation agreement.

Exhibit 4.1: Project Implementation Timeline

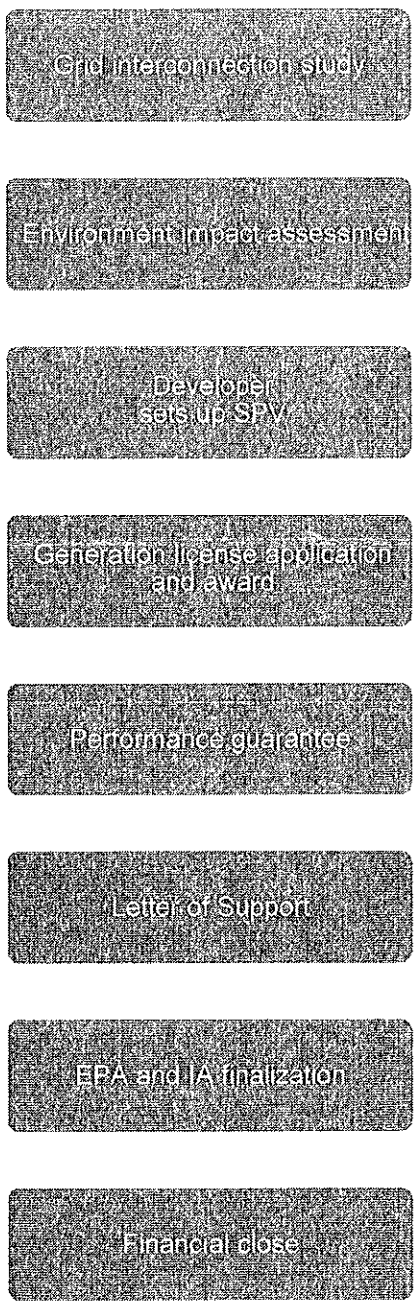
Activity	Duration (Days)
Site investigations and preliminary studies	20
Detailed design	20
Supplies and long-lead items	65
Site mobilization	60
Civil works	90
SCADA and security	30
Electrical and mechanical	130
Commissioning	50
Total implementation period	230 to 250

5. Licensing, Permitting and Security

5.1. Project Development Milestones

The flowchart in **Exhibit 6.1** summarizes key development milestones and their sequence required for the implementation of the Project on which various regulatory licenses, permits and consents will depend.

Exhibit 6.1: Project Permitting Milestones



5.2. Company Registration

AASAL Solar Power Pvt Ltd shall make a project company as per Power Policy under which AASAL Solar shall at least retain 20% of the shareholding and rest of the shareholding can be held again by AASAL Solar or by one of its shareholders in the individual capacity.

5.3. Acquisition of Land

Land has been identified in Mauza Luni, Tehsil Kulachi in Dera Ismail Khan district of the Khyber Pakhtunkhwa province of Pakistan and is owned by shareholders of AASAL Solar Power. At the same time GoKPK also owns wasteland in the respective Khasras of the Moza Luni. We have already made a written request of GoKPK Land and Revenue Department to switch the title of land with AASAL Solar Power so as to convert the project location into the ownership of GoKPK whereas shareholders of AASAL Solar gets the land of GoKPK. The GoKPK has already agreed to it and they are only finalizing the lease amount to be notified to us for a 30 years lease period. Thus the project location is not going to move from its existing location. For the purpose of submission of FSR we shall provide the actual ownership documents of shareholders of AASAL Solar Power for the respective project land.

5.4. Regulatory Requirements

The following main regulatory consents will be required for the Project before the LoS can be issued:

5.4.1 Building Permissions

The EPC contractor will need to be registered with the Pakistan Engineering Council (PEC) and certified under the relevant professional and project size (based on the monetary value of the contract) categories necessary for to engage in the engineering design and construction of the Project.

5.4.2 Generation License

An application will be filed by AASAL Solar Power with the National Electric Power Regulatory Authority (NEPRA) for the Project's generation license after obtaining the consent of the power off-taker, the Central Power Purchase Agency Guarantee (CPPA-G), and transmission system operators, the Peshawar Electric Supply Company (PESCO) and the National Transmission & Despatch Company (NTDC), as well as issuance of the LOS by PEDO.

[12] https://www.secp.gov.pk/document/companies-act-2017/?wpdmdl=28472.

5.4.3 Tariff Determination

A petition for a cost-plus tariff determination for the Project's bulk power sale to CPPA-G will be filed with NEPRA and a final tariff will be negotiated via relevant public hearings to be arranged by the regulator, once the Project's Energy Purchase Agreement (EPA) and Implementation Agreement (IA) have been signed and generation license obtained.

5.4.4 Environmental Approvals

The Project IEE has been submitted in September, 2017 on behalf of AASAL Solar Power to the Khyber Pakhtunkhwa Environmental Protection Agency (KP-EPA) for the necessary environmental 'no objection certificate' (NOC).

5.5. Security Package

The following security documents are required for the Project before plant construction can commence. These legally binding agreements specify the terms, fees and conditions under which project development approval and subsequent operation must take place, while providing protection against various risk factors over the project's lifetime backed up by a sovereign government guarantee. Standard approved formats for these legal documents can be obtained from the Alternative Energy Development Board (AEDB):

5.5.1 Letter of Interest

A Letter of Interest (LoI), valid for 18 months, has been issued to AASAL Solar Power by PEDO on July 21, 2016 (Ref. No. 2106-09/PEDO/CEO/LOI) for setting up a 3.5 MW solar PV IPP in the Khyber Pakhtunkhwa province. However the approval of PESCO is expected to be on 49.5 MW therefore AASAL Solar Power shall request to PEDO to kindly approve the Feasibility Study on 49.5 MW

5.5.2 Letter of Support

Within the validity period of the LoI, a tripartite Letter of Support (LoS) will be issued by AEDB and PEDO to AASAL Solar Power Pvt Ltd once the Project tariff has been determined by NEPRA, the Project's feasibility study has been approved by PEDO's Panel of Experts (POE), and the relevant performance guarantee deposited by the sponsors. The LoS shall govern the Project until achievement of financial close. In case of delay in tariff determination by NEPRA beyond the original LOI expiry date, the validity of the LOI (and the performance guarantee) may be extended by a period of six calendar months.

5.5.3 Energy Purchase Agreement

An energy Purchase Agreement (EPA) will be signed with the Central Power Purchase Agency Guarantee (CPPA-G) guaranteeing power evacuation and bulk sale of power by AASAL Solar Power Pvt Ltd at the NEPRA-determined tariff, subject to the Project achieving financial close.

5.5.4 Implementation Agreement

AASAL Solar Power Pvt Ltd will sign the Project's tripartite Implementation Agreement (IA) with PEDO and AEDB, which will guarantee power purchase and payments, as well as provide cover against specific political risks, currency exchange variation, taxes and duties, inflation, repatriation of profits, force majeure, etc. The IA will be backed up by a sovereign guarantee of the Government of Pakistan, and shall govern the Project over its operational lifetime.

Environmental study and its approval

JAVED SOLAR PARK (PVT) LTD. JSP

DIRECTORATE
OF ENVIRONMENTAL PROTECTION AGENCY
SOUTHERN REGION D.I.KHAN.
FORESTRY, ENVIRONMENT & WILDLIFE DEPARTMENT
GOVT.OF KHYBER PAKHTUNKHWA.

NO. EPA/IEE/49.5MWSolar-Aasal/ 706 Dated: D. I. Khan the 22/01/2018.

To,

Mr. Abdul Basit Javed,
CEO, AASAL Solar Power Pvt. Ltd,
House Nol. 28, Street No. 2, E-11-1,
MPCHS Islamabad, Pakistan,
Phone No. 03468885500.

Subject: **SUBMISSION OF INITIAL ENVIRONMENTAL EXAMINATION REPORT FOR "CONSTRUCTION & OPERATION OF AASAL SOLAR POWER PVT LTD FOR SOLAR POWER PROJECT OF 49.5 MW BY AASAL SOLAR POWER PVT LTD LOCATED AT KULACHI, D.I.KHAN KPK.**

I am directed to refer to the subject cited above and to enclosed herewith Environmental Protection Approval/Decision Note on IEE Report of "49.5MW Solar Power Project at Badshahabad village, Mosa Luni, Tehsil Kulachi, District D. I. Khan" for your information and further implementation.

Moreover, Shedule VII must be submitted to this Agency within a month on Stamp Paper as an undertaking for the compliance of terms and conditions as mentioned in the Environmental Approval as well as mitigation measures in the IEE Report. (Copy enclosed).

M. Irfan Ghoh

Assistant Director

Copy for information to;

- PA to Director General, EPA, Govt. of Khyber Pakhtunkhwa, Peshawar.
- PA to Director, EPA, Govt. of Khyber Pakhtunkhwa, Peshawar.

HOUSE# 2, KARIM ABAD, DIYAL ROAD OPP: QUAID-E-AZAM SCHOOL SYSTEM D.I.KHAN.
PHONE NO.0966-740171 FAX NO. 0966-740171

SCHEDULE-V
Decision on IEE

1. **Name & address of Proponent:** Mr. Abdul Basit Javed,
CEO, Aasal Solar Power,
House No. 28, St. No.2, Sector E-11/1,
Islamabad

2. **Description of Project:**

AASAL solar power (Pvt) Ltd has planned to construct 49.5MW Javed Solar Park project at Badshahabad village, moza Luni, Tehsil Kulachi, District D.I.Khan. The total 375 acres land has been assessed for the proposed project. The proposed project will be connected to Daraban gird station (18km). The estimated construction period of the proposed project is 12-18 Months and operational life is 20 Years. Total estimated Cost of the project is Rs. 5821,200,000.

3. **Location of Project:** The project site is located at District D.I.Khan

4. **Date of Filing of IEE:** 27.09.2017 Ref. EPA Diary No 392

5. After careful review, the Environmental Protection Agency , Regional Office D.I.Khan has decided to accord approval of the Initial Environmental Examination for "49.5MW Javed Solar Park project at Badshahabad village, moza Luni, Tehsil Kulachi, District D.I.Khan" in line with the guidelines issued by Khyber Pakhtunkhwa Environmental Protection Act, 2014 and IEE/EIA Regulations, 2000, subject to the following terms & conditions:-

a) The proponent will adopt all precautionary and mitigation measures identified in IEE Report as well as any un-anticipated impacts during the construction and operation phase of project.
b) The proponent shall ensure to avoid dumping of debris into down slope. A proper area should be identified for disposal of debris.
c) Land ownership documents/acquisition/lease agreements duly verified shall be provided to EPA before commencement of construction activities.
d) Existing traffic route must not be disturbed and proper signboards should be installed to avoid any inconvenience in the existing Right of Way (RoW).
e) The proponent should ensure the strict and efficient health and safety measures for the protection of workers and passersby.
f) Mature Trees on the project area shall be protected. Moreover Plantation should be carried out in the available open spaces of the proposed project area.
g) Proper security/fences shall be installed around the project area.
h) Drinking Water Tube well shall be provided to the nearby community.

i) the proponent shall submit the detail of project/activities for the befit of the surrounding community as per CSR guideline.

j) Safety of the social & cultural life of the local community shall be ensured.

k) Non-technical jobs must be provided to local community.

l) All conflicting issues regarding compensation, lease agreement etc if any to be settled down before executing or commencing of the project activities and a certificate in this regard should be submitted to EPA.

m) This approval is only issued for the construction activities of the project and not for any other kind of activities.

n) No extension would be permitted in the future in the existing project without prior approval of the EPA/Govt. of Khyber Pakhtunkhwa.

o) The proponent shall provide the copy of this approval and IEE report to the contractor for information and compliance.

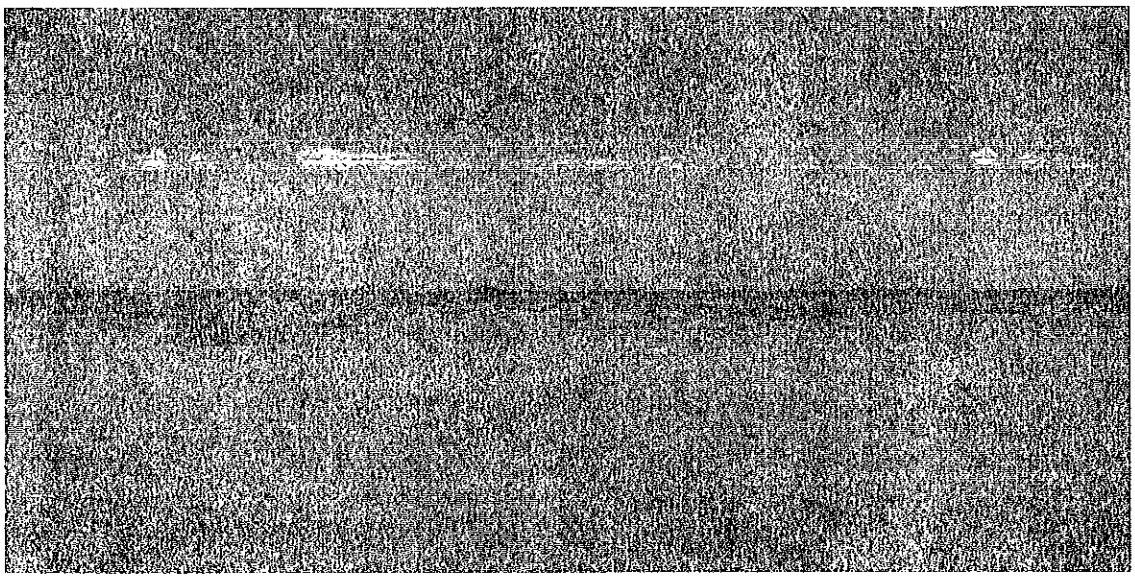
p). Ambient air report must be submitted to EPA on monthly basis.

6. The proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.
7. The proponent shall be liable for compliance of Regulations 13, 14, 17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.
8. This approval is accorded only for the installation/ construction phase of the project. The proponent will obtain approval for operation of the Solar Park project in accordance with the Regulations 13 (2) (b) and 18 of the IEE/EIA Regulations, 2000.
9. Any change in the approved project shall be communicated to EPA, Regional Office D.I.Khan and shall be commenced after obtaining the approval.
10. This approval shall be treated as null and void if all or any of the conditions mentioned above is/are not complied with.
11. This approval does not absolve the proponent of the duty to obtain any other approval or clearance that may be required under any law in force.
12. There shall be no legal case pending in the courts against the project.
13. In exercise of the power under Section 13 of the Khyber Pakhtunkhwa Environmental Protection Act, 2014, the undersigned is pleased to approve the IEE Report for construction phase of the project with above mentioned terms and conditions.

Dated: 22-01-2018
Tracking/File.No. EPA/IEE/49.5MWSolar-Aasal/706

17/1/2018

DIRECTOR
Environmental Protection Agency
Regional Office, D.I.Khan



49.5 MW Javed Solar Park

INITIAL ENVIRONMENTAL EXAMINATION

LUNI – KULACHI, DERA ISMAIL KHAN

VOLUME 5 OF FEASIBILITY STUDY REPORT

Proponent:
AASAL Solar Power (Pvt.) Ltd.
Office 28, Street 2, Sector E-11/1,
MPCHS, Islamabad
Contact: 051-8734203

Consultant:
Nasir Absar Consulting (Pvt.) Ltd.
Office No 1, Second Florr, VIP Square,
I-8 Markaz, Islamabad
Contact: 051-4861322-24
Email: consulting@nasirabsar.com

Contents

EXECUTIVE SUMMARY

A. INTRODUCTION

49.5 MW Javed Solar Park is an initiative of AASAL Solar Power (Private) limited "AASAL", incorporated under the Companies Act, in Pakistan. AASAL is a well-capitalized, listed group company Subsidiary of AASAL Hydrotech (Pvt) Ltd., established to develop, construct and operate power projects, nationally. AASAL Hydrotech owns two hydropower Projects of 6.6 MW and 20.6 MW The feasibility study of both the projects have been completed by Lahmeyer Germany and they are currently with panel of expert (POE) of PEDO.

The Project Company, M/s AASAL Solar Power Pvt Ltd was formed in 2016, primarily to become the first IPP (Independent Power Producer) in Solar Energy in KPK. After obtaining the first LOI from Pakhtunkhwa Energy Development Organization (PEDO) KPK it has successfully completed bidding in numerous projects of United Nations for Solarization of different units in entire KPK. With that, it has successfully won the project of Solarization of Quaid E Azam University Islamabad which is a 12 MW in-house project. AASAL Solar Power Pvt Ltd endeavors to become the first IPP in Solar Energy and then enhance its existing project to at least 50 MW in stage first and then move on further. Along with this, the sponsors hold two registered Hydropower Projects in KPK of more than 100 MW each.

The Solar project is located near Luni village, about 13 km from Kulachi town in Kulachi Tehsil. The project has assessed 375 acres of land in Moza Luni. The project shall be developed as an Independent Power Producer "IPP", to be connected with the Peshawar Electric Supply Company "PESCO" at 132 kV grid connection at Tehsil Kulachi, which is 14 KM away from the project site. Sale of the Power shall be made to the Central Power Purchasing Agency (Guarantee) Limited "CPPA (G)".

PROJECT AT A GLANCE

Particulars	Descriptions
Project site	Village-Moza Luni
Tehsil	Hathala
District Name	D.I.Khan
Name of the Province	Khyber Pakhtun Khawa
Latitude:	31°56'49.48"N
Longitude:	70°16'47.45"E
Road Accessibility:	Asphalt Motor able road is attached to the Site. Motor able Asphalt road is 2 km away from the site.
Nearest airport:	70 KM of D.I Khan
Nearest City:	Dera Ismail Khan – 55 km
Land available:	375 Acre.

Water Requirement:	Low Level
Daily Global Solar Irradiance	5.65 kWh/m^2
Daily Diffuse Solar Irradiance	2.01 kWh/m^2
Annual Global Solar Irradiance	2063 kWh/m^2
Annual Diffuse Solar Irradiance Land availability Type of system	732 kWh/m2 375 Acre Fixed tilt (30 degree)
Type of PV modules	Poly crystalline
Proposed capacity	49.5 MW
Capacity of each module proposed	230 Wp / any other compatible size
Model of solar PV module	JAP6
Total number of PV Modules	215220
Inverter Model	Power One PVI 500 TL
Annual electricity supplied to grid	79345 MWh
Plant load factor (%)-First Year	18.6%
Project Cost	Rs 5,821,200,000

PROJECT OBJECTIVE

The overall objectives of the project are;

- Provision of much-needed electricity to the National Grid.
- By using indigenous renewable resources of power generation, avoid depletion of natural resources for future generation and environmental stability.
- Employment generation for local skilled and unskilled labor during construction and operation of the Project.
- Improve efficiency of the power sector by reducing fossil fuel usage.
- Reduce greenhouse gas emissions from power generation and contribute to negligible emission, effluent, and solid waste intensity of power generation in the system.
- Improve the local physical infrastructure such as roads and transmission network in the project area.

OBJECTIVE OF IEE STUDY

The objective of Initial Environmental Examination (IEE) is to prepare a document based on anticipated Environmental Impact due to setting up of 49.5MW Solar Power Project and to applicable local and national regulations.

The proposal is for PV based solar power project and there are no potentially significant adverse and irreversible social and environmental impacts. Therefore, according to the findings of the environmental and social impact assessment study conducted with respect to the establishment of the Project and a review of the broad Equator Principles of project due to limited adverse social or environmental impacts and these are limited to site-specific, largely reversible and readily addressed through mitigation measures.

B. PROJECT DESCRIPTION

The plot size for the proposed project site is approximately 375 acres. The site is located at approximately 65 KM, north-west of D. I. Khan city. The route to access the site from D. I. Khan starts from the Tank-Kulachi road, which connects to Kulachi road at Hathala Tehsil. The route continues along Kulachi road to Kulachi city. There is a bypass which connects to Daraban road from this by-pass. Along the Daraban road, there is a turn, called "Luni-Daraban Turning" at approximately 5.1 KM from Daraban road starting point. Access to site is available from this turning and along the Daraban-Luni Road. The access road is partly black bituminous approximately 10.5 KM and partly Katcha Track (Jeep able Track) approximately 4.5 KM. Site Access for the proposed site along the Katcha Track (Jeep able Track) intercepts 2 waterways which were observed at approximately 2.9 KM for drain crossing Point 1 & approximately 3.6 KM for drain crossing Point 2 from start of Katcha Track (Jeep able Track).

ROAD ACCESS

The route to access the site from D. I. Khan starts from the Tank-Kulachi road, which connects to Kulachi road at approximately 42.5 KM from Tank-Kulachi road at Hathala Tehsil. The route continues along Kulachi road to Kulachi city. There is a by-pass which connects to Daraban road at approximately 15.3 KM from Kulachi by-pass. Along the Daraban road, there is a turn, called "Luni- Daraban Turning" at approximately 5.1 KM from Daraban road which is joining to Daraban & Kulachi Road.

PROJECT JUSTIFICATION

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

C. LEGAL POLICIES & INSTITUTIONAL FRAMEWORK

This chapter describes the relevant:

i. national and international policies;

ii. legal and administrative framework; and

iii. institutional setup, in respect of the environmental and social assessment of the proposed Project.

Several laws exist in Pakistan containing a number of clauses concerning protection of the environment. However, the first legislation on environmental protection was issued in 1983.

The Pakistan Environment Protection Ordinance, 1983 was the first legislation promulgated for the protection of environment. Pakistan Environment Protection Agency was established in 1984. No significant environmental policy, guidelines and regulations were made till early 1990s. The National Conservation Strategy was developed and approved by the federal cabinet in 1992. Provincial Environment Protection Agencies were also

established in 1992-93. National Environmental Quality Standards (NEQS) were established in 1993. Detailed environmental guidelines were issued in 1996. The National Assembly and the Senate conferred Pakistan Environment Protection Act in 1997.

National Environmental Laws

The most important Pakistani environmental legislation is the PEPA, 1997 and the PIEE-EIA Regulations, 2000. After devolution through the 18th Constitutional Amendment 2010, the provinces have sole authority and responsibility to legislate on 'environment and ecology'.

In this respect Khyber Pakhtunkhwa Environmental Protection Act (KP Act), enforced in 2014, is the relevant environmental act that will apply to this Project. Under the Act, all decisions made under PEPA, 1997 are protected and applicable (Section 40(2)). Hence the environmental approval and conditions of approval which were conferred before the enforcement of this Act are fully valid and applicable and refer to the same regulations for determining whether projects require an IEE or an EIA.

Khyber Pakhutnkhwa Environmental Protection Act, 2014

The KP Act, 2014 is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, and noise pollution, as well as to the handling of hazardous wastes. The articles of KP Act, 2014 that have a direct bearing on the proposed Project are listed below and discussed further in the following sections:

- Article 11 deals with the KPEQS and their application.
- Article 11 deals with discharges, emissions and waste disposal
    i. *no person shall discharge or emit or allow the discharge or emission of any effluent or wastes or air pollutant or noise, load, concentration or level which is in excess of the Khyber Pakhtunkhwa Environmental Quality Standards or, where applicable, the standards established under sub clause (vii) and (viii) of sub-section (1) of section 6; and*
    ii. *no person shall discharge effluents, emissions or wastes in excess of load permitted in the conditions of environmental permit or environmental approval or license.*
- Article 12 deals with Strategic Environmental Assessment
- Article 13 deals with the IEE and EIA review and approval process

    "No proponent of a project shall commence construction and operation unless he has filed with the Agency an initial environmental examination or where the project is likely to cause an adverse environmental effect, an environmental impact assessment, and has obtained from the Agency, environmental approval in respect thereof."

National Environmental Quality Standards

KP-EPA has yet to formulate Khyber Pakhtunkhwa Environmental Quality Standards (KPEQS), as per Article 6 (v) of the KP Act, 2014.

> *"prepare, revise and establish the Khyber Pakhtunkhwa Environmental Quality Standards with the approval of the Council:*

Provided that before seeking approval of the Council, the Agency shall publish the proposed Khyber Pakhtunkhwa Environmental Quality Standards for public opinion in accordance with the prescribed procedure;"

ENVIRONMENT INSTITUTIONS AND ADMINISTRATION

The Constitution of Pakistan distributes the legislative powers between the federal and the provincial governments through Federal and Concurrent Lists. The Federal list depicts the areas and subjects on which the Federal government has exclusive powers. The second, concurrent list contains areas and subjects on which both Federal and Provincial governments can enact laws.

The Ministry of Climate Change, Local Government and Rural Development is responsible for environmental issues at federal level. The NCS unit within the Ministry ensures implementation of the National Conservation Strategy.

The Pakistan Environment Protection Agency at the federal level is responsible for administering the provisions of the Environment Protection Act. It is responsible to ensure compliance with the NEQS, develop monitoring and evaluation systems and initiate legislation when necessary.

The provincial Environment Protection Agencies are responsible for environmental planning and development, approval of Initial Environmental Examination (IEE) and Environmental Impact Assessments (EIA) of new projects at provincial level.

LAWS, REGULATIONS AND GUIDELINES

Pakistan Environment Protection Act, 1997 is the basic law that empowers the Government of Pakistan to develop policies and guidelines for the protection of the country's natural environment. A brief description of the laws is given below;

PAKISTAN ENVIRONMENT PROTECTION ACT, 1997

The PEPA, 1997 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes.

The key features of the law that have a direct bearing on the proposed project relate to the requirement for an initial environmental examination (IEE) and EIA for development projects. Section 12(1) requires that: "No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an initial environmental examination or, where the project is likely to cause an adverse environmental effect, an environmental impact assessment, and has obtained from the Federal Agency approval in respect thereof." The Pak-EPA has delegated the power of review and approval of environmental assessments to the provincial environmental protection agencies.

PAKISTAN ENVIRONMENT PROTECTION AGENCY REVIEW OF IEE AND EIA REGULATIONS, 2000

The Pakistan Environment Protection Agency Review of IEE and EIA Regulations provide the necessary details on preparation, submission and review of the IEE and EIA. Categorization of projects of IEE and EIA is one of the main components of the Regulations.

The IEE-EIA Regulations, 2000 also provide the necessary details on the preparation, submission, and review of IEEs and EIAs.

The following is a brief step-wise description of the approval process:

- A project is categorized as requiring an IEE or EIA using the two schedules attached to the Regulations.
- An EIA or IEE is conducted as per the requirement and following the Pak-EPA guidelines.
- The EIA or IEE is submitted to the concerned EPA—provincial EPAs if the project is located in the provinces or the Pak-EPA if it is located in Islamabad.
- A fee, depending on the cost of the project and the type of the report, is submitted along with the document.
- The submittal is also accompanied by an application in the format prescribed in Schedule IV of the Regulations.
- The EPA conducts a preliminary scrutiny and replies within 10 days of the submittal of a report, a) confirming completeness, or b) asking for additional information, if needed, or c) returning the report requiring additional studies, if necessary.
- The EPA is required to make every effort to complete the IEE and EIA review process within 45 and 90 days, respectively, of the issue of confirmation of completeness.
- If the EPAs accord their approval subject to certain condition, then before commencing construction of the project, the proponent is required to submit an undertaking accepting the conditions as per mentioned in schedule VII.
- Before commencing operation of the project, the proponent is required to obtain from the EPA a written confirmation of compliance with the approval conditions and requirements of the EIA.
- An Environment Management Plan (EMP) is to be submitted with a request for obtaining confirmation of compliance.
- The EPAs are required to issue confirmation of compliance within 15 days of the receipt of request and complete documentation.
- The EIA approval is valid for three years from the date of accord.

D. EXISTING ENVIRONMENTAL & SOCIAL CONDITION

General

Dera Ismail Khan situated on the right bank of the River Indus is the divisional headquarters of the southern districts of KP. It borders Punjab and Baluchistan provinces. Total area of D.I Khan district is 7,326 (sq km), with population density of 181 persons per sq km. While the total population of D.I Khan district is 1,329,456 in 2011-12. Using average population growth estimations the map below provides an overview of estimated population in 2015.

Study Area

An area with in 2 km around the project can be considered as influence zone and hence it has been taken as study area to understand even setting in the vicinity of the proposed

project. However, as the environmental setting is arrived based on secondary data, all available data has been used for the purpose of Environmental understanding.

SOIL

The soils of the Arid Zone are generally sandy to sandy-loam in texture. The consistency and depth vary according to the topographical features. The low-lying loams are heavier and may have a hard pan of clay, calcium carbonate (CaCO3) or gypsum. The pH varies between 7 and 9.5. The soils improve in fertility from west and northwest to east and northeast. Desert soils are Regosols of windblown sand and sandy fluiratile deposits, derived from the disintegration of rock in the subjacent areas and blown in from the coastal region and the Indus Valley.

LAND USE

The proposed project area is Government wasteland. There are few shrub thickets near the project site. There are no settlements near project site. Within the 2 Km survey area, there are some houses, some temporary huts and agricultural fields as shown there. The soil is sandy which is porous comprising of more of gravel and less silt and clay content. There are some sand dunes in small area. Overall the area is plain with gentle slope.

E. ENVIROMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

The proposed project may have impact on the environment during construction & operation phases. During the construction phase, the impacts may be regarded as temporary or short-term; while long term impacts may be observed during the operation stage. Spatially the impacts have been assessed over the study area of 2 km radius of the project site.

The project has overall positive impacts by providing a competitive, cost-effective, pollution free reliable mode of Solar PV power. It will certainly meet the ever increasing Demand of Power and to bridge the Gap between Demand and Supply of Power.

The environmental impact during construction phase is localized and of short term magnitude. However, as this project land shall be govt. barren land, the change in land use will be minimum.

Identification Of Activities & Probable Impacts (Construction Phase)		
Construction Activities	**Environment Attribute**	**Probable Impacts**
Land Acquisition	Land	✓ No significant impact on land-use is expected.
	Socio-economics	✓ No Impact due to Rehabilitation & Resettlement issues is expected as govt. wasteland is being acquired for the project.
Site clearing and Leveling (cutting, stripping, excavation, earth movement, compaction)	Air	✓ Fugitive Dust Emissions ✓ Air Emissions from construction equipment and machinery
	Water	✓ Run-off from construction area

	Land	✓ Loss of top soil
	Ecology	✓ Minimal loss of vegetation / habitat as the site is has barren land with almost no vegetation.
Transportation and Storage of Construction Material/ Equipment	Air	✓ Air Emissions from vehicles ✓ Fugitive Dust Emissions due to traffic movement
	Water	✓ Run-off from Storage Areas of construction ✓ Material
	Public Utilities	✓ Increased flow of traffic
Civil Construction Activities	Air	✓ Air Emissions from construction machinery ✓ Fugitive Dust Emissions
	Water	✓ Run-off from Construction Areas
Mech. and Elec. Erection Activities	Air	✓ Air Emissions from Machines / activities
Influx of Labour and construction of temporary houses	Socio-economics	✓ Employment opportunities shall increase ✓ tress on infrastructure
	Land	✓ Change in land use pattern of the area
	Water	✓ Sanitary effluents from labour colonies
Transportation and Disposal of Construction Debris	Air	✓ Air Emissions from Transport Vehicles ✓ Fugitive Dust Emissions due to Movement of Traffic ✓ Spillage and fugitive emissions of debris materials
Transportation and Disposal of Construction Debris	Water	✓ Run-off from Disposal Areas
	Soil	✓ No Conversion of land into waste land as already barren land.

F. ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN

Environmental & Social Management Plan is an implementation plan to mitigate and offset the potential adverse environmental & social impacts of the project and enhance the positive impacts. Based on the environmental baseline conditions, planned project activities and impacts assessed earlier, this section enumerates the set of measures to be adopted to minimize the adverse impacts. Process of implementing mitigation and compensatory measures, execution, agencies responsible for their implementation and indicative costs is discussed in this chapter.

The project has overall positive impacts by providing a competitive, cost-effective, pollution free reliable mode of Solar PV power. It will certainly meet the ever increasing Demand of Power and to bridge the Gap between Demand and Supply of Power.

ENVIRONMENTAL AND SOCIAL MANAGEMENT PROCESS

The ESMP has been designed within the framework of requirement under Pakistan's legislation and ADB's SPS on environmental and socio-economic aspects.

The mitigation measures to be adopted for the implementation of the proposed project include the following:

- Environmental Management Plan;
- Rainwater Harvesting
- Clean Development Mechanism;
- Occupational Health and Safety;
- Labour Working Conditions;
- Construction Labour Management;
- Environmental Action and Monitoring Plan;
- Community Development Plan;
- Public Consultation and Information Disclosure Plan;
- Grievance Redressal Mechanism;
- Disaster Management Plan

G. CONSULTATION, PARTICIPATION AND DISCLOSURE

The need for public consultation and disclosure arises from the universal belief that transparency and accountability are fundamental to fulfilling any development mandate and in strengthening public involvement in the decision making process.

For all Categories "A" and "B" projects the project proponent or third party experts must have consulted with project affected communities in a structured and culturally appropriate manner. The public consultation should involve affected communities; the process must ensure their free, prior and informed consultation (FPIC) and facilitate their informed participation. .

H. CONCLUSION AND RECOMMENDATION

Impacts are manageable and can be managed cost effectively - Environmental impacts are likely to result from the proposed transmission system development. Careful mitigation and monitoring, specific selection criteria and review/assessment procedures for sub-projects have been specified to ensure that minimal impacts take place. The detailed design would ensure inclusion of any such environmental impacts that could not be specified or identified at this stage are taken into account and mitigated where necessary. Those impacts can be reduced through the use of mitigation measures such as correction in work practices at the construction sites, or through the careful selection of sites and access routes.

The proposed project will have number of positive impacts and negative impacts to the existing environment as follows:

- Significantly improvement in the economic activities in the surrounding areas due to generation of direct and indirect employment opportunities.
- There is negligible removal of trees for the transmission line, which is the main positive impact to the proposed project area. Compensatory afforestation will take place where tree removal is unavoidable.
- Environment pollution due to cut and fill operations, transportation of construction materials, disposal of debris, nuisance from dust, noise, vehicle fumes, black smoke, vibration are the short term negative impacts due to proposed project.

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

CONCLUSION

An environment and social analysis has been carried out looking at various criteria such as topology, air, noise, water resources and water quality, ecology, demography of the area, climate and natural habitat, community and employee health and safety etc. The impact analysis, found that due to careful consideration of environmental and social aspects during route and site selection by proponent, no major adverse impacts are expected. There is no adverse impact on the migration of habitat, any natural existing land resources and effect in the regular life of people. The environment and social impact associated with transmission line project is limited to the extent of construction phase and can be mitigated through a set of recommended measures and adequate provision for environment and social impacts which cover monitoring, measuring and mitigation.

EMP has been prepared. Most impacts are expected to occur during the construction phase and are considered to be of a temporary nature. The transmission corridor was carefully selected after undergoing an options assessment. This enabled the right of way alignment to bypass villages and important water supplies and resources. The main project impacts are associated with clearing of shrub vegetation, waste management and excavation and movement of soils.

From this perspective, the project is expected to have a small "environmental footprint". No endangered or protected species of flora or fauna are reported at any of the subproject sites. Adequate provisions have been made for the environmental mitigation and monitoring of predicted impacts, along with their associated costs.

1 INTRODUCTION

49.5 MW Javed Solar Park is an initiative of AASAL Solar Power (Private) limited "AASAL", incorporated under the Companies Act, in Pakistan. AASAL is a well-capitalized, listed group company Subsidiary of AASAL Hydrotech (Pvt) Ltd., established to develop, construct and operate power projects, nationally. AASAL Hydrotech owns two hydropower Projects of 6.6 MW and 20.6 MW The feasibility study of both the projects have been completed by Lahmeyer Germany and they are currently with panel of expert (POE) of PEDO.

The sponsors of AASAL Hydrotech Pvt Ltd are the sons of soil and they belong to Khyber Pakhtun Khwa Province. The sponsors belong to Dera Ismail Khan and are land lords since 5 decades. The chairman of the board Muhammad Salim Javed Gandapur is a retired Government Officials from Health Department KPK. The CEO of the company, Mr Abdul Basit Javed Gandapur is a Chartered Accountant by profession and is in the energy sector since four years. The other members include Mr. Salman Alam, Mr Faisal Ahmad, Mr Samiullah Khan and Mr Khurram Javed Gandapur.

The Project Company, M/s AASAL Solar Power Pvt Ltd was formed in 2016, primarily to become the first IPP (Independent Power Producer) in Solar Energy in KPK. After obtaining the first LOI from Pakhtunkhwa Energy Development Organization (PEDO) KPK it has successfully completed bidding in numerous projects of United Nations for Solarization of different units in entire KPK. With that, it has successfully won the project of Solarization of Quaid E Azam University Islamabad which is a 12 MW in-house project. AASAL Solar Power Pvt Ltd endeavors to become the first IPP in Solar Energy and then enhance its existing project to at least 50 MW in stage first and then move on further.

AASAL Solar Power Pvt Ltd engaged the services of M/S Nasir Absar Consulting (Pvt.) Ltd. "NACL" for the conduction of the environmental study of the project area. NACL has been involved in the power sector since many years providing consultancy services in all phases of projects. The services include the conduction of feasibility studies, environmental studies, detail designs, tariff, generation license, project financing and others.

1.1 THE PROJECT

The project is located near Luni village, about 13 km from Kulachi town in Kulachi Tehsil. The project has assessed 375 acres of land in Moza Luni. The project shall be developed as an Independent Power Producer "IPP", to be connected with the Peshawar Electric Supply Company "PESCO" at 132 kV grid connection at Tehsil Kulachi, which is 14 KM away from the project site. Sale of the Power shall be made to the Central Power Purchasing Agency (Guarantee) Limited "CPPA (G)".

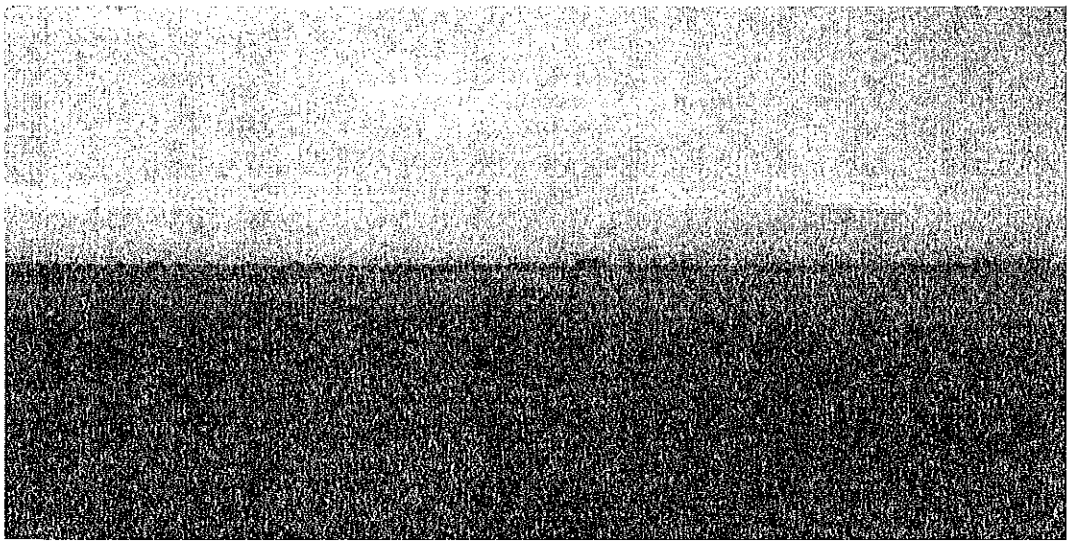


Figure: Project Area

Following are key features of proposed 49.5 MW Solar Power Project:

- The location falls under the 'Hot and Dry' climatic zone of the area and comprises extreme weather conditions of hot desert.
- The project location comprises well accessibility as the motorable/jeepable asphalt road is 2 km away from the site.
- There are no shading elements like mountains, large sand dunes, trees available on the site. Entire area is shadow free.
- NHA is located on 27 km from selected project location. After 27 km the road links with newly asphalt road from D.I.Khan to Tank
- Nearest Airport is in D.I.Khan which is about 70 km from the projected location.
- Nearest City to the site is D.I.Khan which is 55 km away the project location.
- Tank is the nearest railway station from the location which is 20 km away from the project location. However railway is not the most used-for transport system in that part of the province
- Soil condition at site is hard sandy and surface is almost flat; hence limited land work is needed to make land flat as per the requirements of solar PV power plant.
- Three Grid stations are nearby from the project site. One is Tank 132 KV Grid station, which is 23 km from project location, second is Draban 132 KV Grid Station, which is 18 km away from project location and third is Kulachi 132 KV Grid Station, which is 14 km away from project location. AASAL Solar shall be doing the power evacuation in the Kulachi 132 KV Grid station.

1.2 PROJECT JUSTIFICATION

Pakistan's major electricity sources are thermal and hydro generation, meeting approximately 65.5% and 28% (respectively) of the country's annual electricity demand. The primary thermal generation fuels employed are furnace oil and gas. While both are

produced domestically, demand already outstrips supply by a considerable amount. Oil import is a significant burden on the national exchequer and the increasing import bill continues to exert further pressure on the foreign exchange reserves. Electricity mix of Pakistan (2013-2014) is presented in Figure 1.1

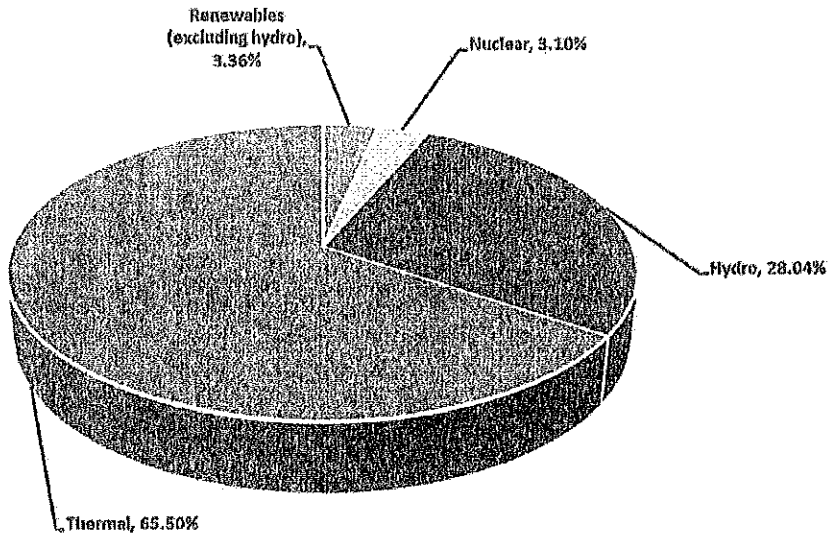


Figure: Electricity Mix of Pakistan

Import of gas could be seen as a viable option to overcome the depleting domestic reserves. However, 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 burdens. 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 production of domestic coal, generation from hydro-electric power, or other renewable sources, such as wind and solar power. These options will assist in reducing Pakistan's reliance on imported oil and protect against resulting vulnerability to changes in global oil prices, which will in turn also have a positive effect on the current trade deficit and inflating import bill.

As with gas, securing future supplies of domestic coal and hydro-electric power would require significant spending on infrastructure. While Pakistan has domestic reserves of coal, it currently makes up a very small proportion of the country's total power generation. This is due, in part, to the fact that most of the reserves are located in the remote Thar Desert region. Exploiting the coal reserves would require significant upfront investment in local infrastructure (including provision of water supplies), development of mines, housing and related infrastructure, and investment in transmission lines, as a pre-requisite to any power plant development. Hydro-electric power already supplies almost 30% of the domestic electricity that is generated, and numerous sites for future investment exist. However, due to their locations, this would also require significant investment in transmission and other infrastructure.

In light of the prevailing circumstances at how the country's future electricity needs might be in a way that supports the environmental objectives of the Government of Pakistan; solar power generation appears to be a viable and environmental friendly alternative for meeting Pakistan's urgent electricity demands. The development of solar power generation projects could reduce dependence on oil based thermal power generation, increase diversity in Pakistan's electricity generation mix, and reduce greenhouse gas (GHG) emissions, all of which will contribute towards projecting a positive image of Pakistan within the international community.

1.2.1 Solar Energy in Pakistan

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

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

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

A quick idea for the potential of solar energy in Pakistan can be obtained from the satellite map of solar radiation released by National Renewable Energy Lab (NREL) of USA shown in Figure 2-2.

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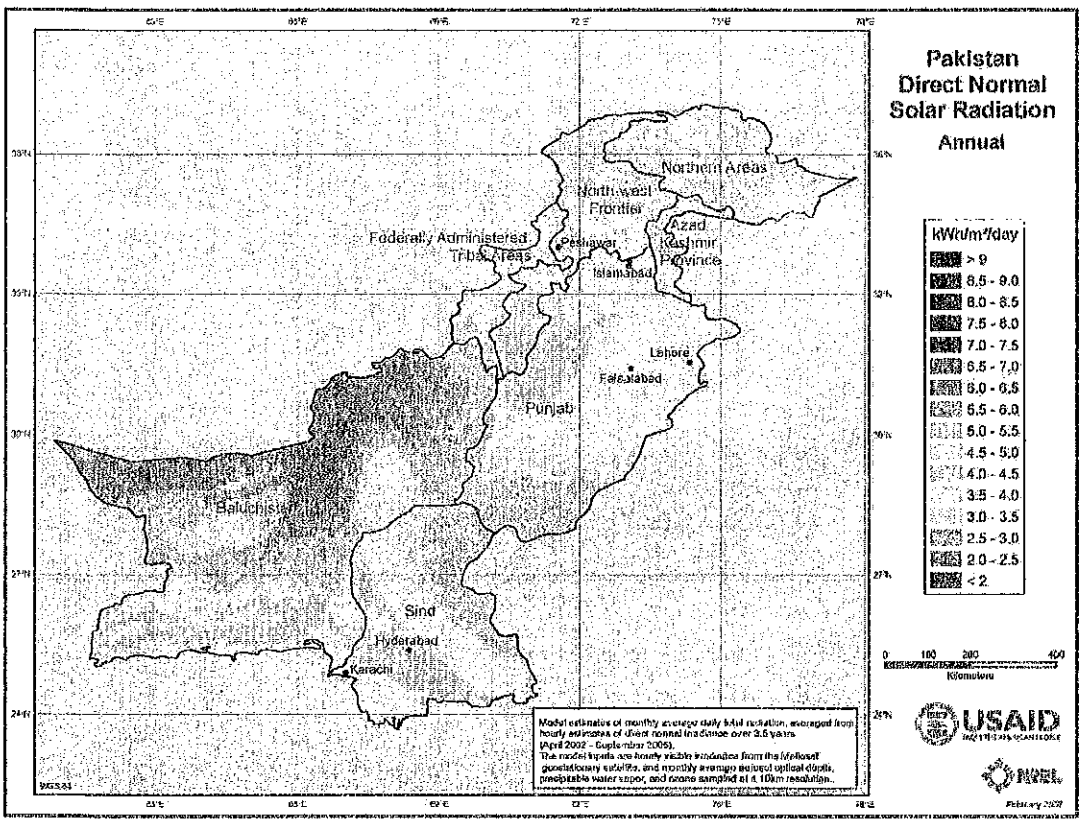

Figure: NREL Solar Map of Pakistan[1]

1.3 PROJECT OBJECTIVES

The overall objectives of the project are;

- Provision of much-needed electricity to the National Grid.
- By using indigenous renewable resources of power generation, avoid depletion of natural resources for future generation and environmental stability.
- Employment generation for local skilled and unskilled labor during construction and operation of the Project.
- Improve efficiency of the power sector by reducing fossil fuel usage.
- Reduce greenhouse gas emissions from power generation and contribute to negligible emission, effluent, and solid waste intensity of power generation in the system.
- Improve the local physical infrastructure such as roads and transmission network in the project area.

1.4 OBJECTIVE OF INITIAL ENVIRONMENTAL EXAMINATION STUDY

This report has been prepared to meet the following key requirement of KP-EPA:

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1 2 http://www.nrel.gov/international/ra_pakistan.html

Complying with the Section 13 of KP- Environmental Protection Act, 2014, which enunciates that; "no proponent of a project shall commence construction or operation unless he has filed with the Agency, an Initial Environmental Examination (IEE) or where the project is likely to cause an adverse environmental effect, an Environmental Impact Assessment (EIA), and has obtained from the Agency approval in respect thereof".

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

The ***IEE/EIA Regulations 2000 issued under PEPA 1997*** provides separate lists for the projects requiring IEE or EIA. Since the total power generation capacity of proposed project is less than 200 MW, therefore IEE study is performed. Also in various meeting organized by AEDB, EPA, UNEP, it was agreed to follow the same criteria for IEE or EIA as stipulated for thermal and hydro projects.

Both guidelines provide separate lists for the projects requiring IEE or EIA. This Initial Environmental Examination (IEE) report has been prepared in accordance with the provisions in the ***Pakistan Environmental Protection Agency (Review of IEE and EIA) Regulations, 2000.*** According to these regulations, an IEE is required for projects falling in any category listed in Schedule-I of the regulations, and an EIA is required for projects listed in Schedule-II of the regulations.

The document has been prepared to considering the requirements of ***ADB's Safeguard Policy Statement 2009*** as well as local and national standards. To comply with other lender's requirement, the IEE report also addresses ***IFC's and World Bank group performance standards.***

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

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

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

1.5 PROJECT CATEGORY

Pakistan Environment Protection Act:

In Pakistan, under the Pakistan Environmental Protection Act, 1997 (PEPA, 1997), the Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations (IEE-EIA Regulations 2000) provide the pertinent project categorization. The IEE-EIA Regulations 2000 are silent on solar power plants specifically; these are included neither in Schedule I nor in Schedule II of the regulations. In addition, the same regulations also state that irrespective of the nature or size of the project, a project located in an environmentally sensitive area—areas protected under wildlife laws, areas near cultural heritage sites and ecological sensitive areas—require an EIA.

For the purpose of the proposed Project, the environmental assessment study recommended is an initial environmental examination (IEE). This is because the proposed Project is not located in an environmentally sensitive area and the fact that the expected impacts from the Project will most likely be site-specific; few, if any of them, will be irreversible; and the proposed mitigation measures are expected to have a high rate of effectiveness.

International Finance Corporation:

IFC employs an environmental and social categorization scheme to appropriately reflect the magnitude of potential risks and impacts. Projects are assigned category A, B or C, in descending order of environmental and social sensitivity.[2]

These categories are:

Category A: Business activities with potential significant adverse environmental or social risks and/or impacts that are diverse, irreversible, or unprecedented.

Category B: Business activities with potential limited adverse environmental or social risks and/or impacts that are few in number, generally site-specific, largely reversible, and readily addressed through mitigation measures.

Category C: Business activities with minimal or no adverse environmental or social risks and/or impacts.

Based on environmental and social review summaries and project information for solar power projects available on the IFC website, solar power projects are categorized as Category B projects. The projects were assigned this category because of the limited number of specific associated environmental and social impacts, which can be avoided or mitigated by adhering to the generally recognized IFC performance standards, guidelines or design criteria.

[2] *Policy on Environmental and Social Sustainability*. January 2012, International Finance Corporation (IFC). www.ifc.org/wps/wcm/connect/7540778049a792dcb87efaa8c6a8312a/SP_English_2012.pdf?MOD=AJPERES (accessed: June 2, 2017)

4.4 CLIMATOLOGY

The climate in the Dera Ismail Khan district is "desert." There is virtually no rainfall during the year. This climate is considered to be BWh according to the Köppen-Geiger climate classification. The average annual temperature in Dera Ismail Khan is 24.5 °C. The average annual rainfall is 249 mm. The driest month is November, with 3 mm of rain. In July, the precipitation reaches its peak, with an average of 63 mm. June is the warmest month of the year. The temperature in June averages 34.4 °C. At 12.1 °C on average, January is the coldest month of the year. There is a difference of 60 mm of precipitation between the driest and wettest months. The variation in annual temperature is around 22.3 °C.

Figure: Historical average weather data for Dera Ismail Khan district

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	12.1	15										13.7
Min. Temperature (°C)	4.5	7.6	13.2								10.4	5.4
Max. Temperature (°C)												
Avg. Temperature (°F)	53.8	59.0										56.7
Min. Temperature (°F)	40.1	45.7	55.8								50.7	41.7
Max. Temperature (°F)												
Precipitation / Rainfall (mm)	12	16	29	21	15	15	63	46	18	4	3	7

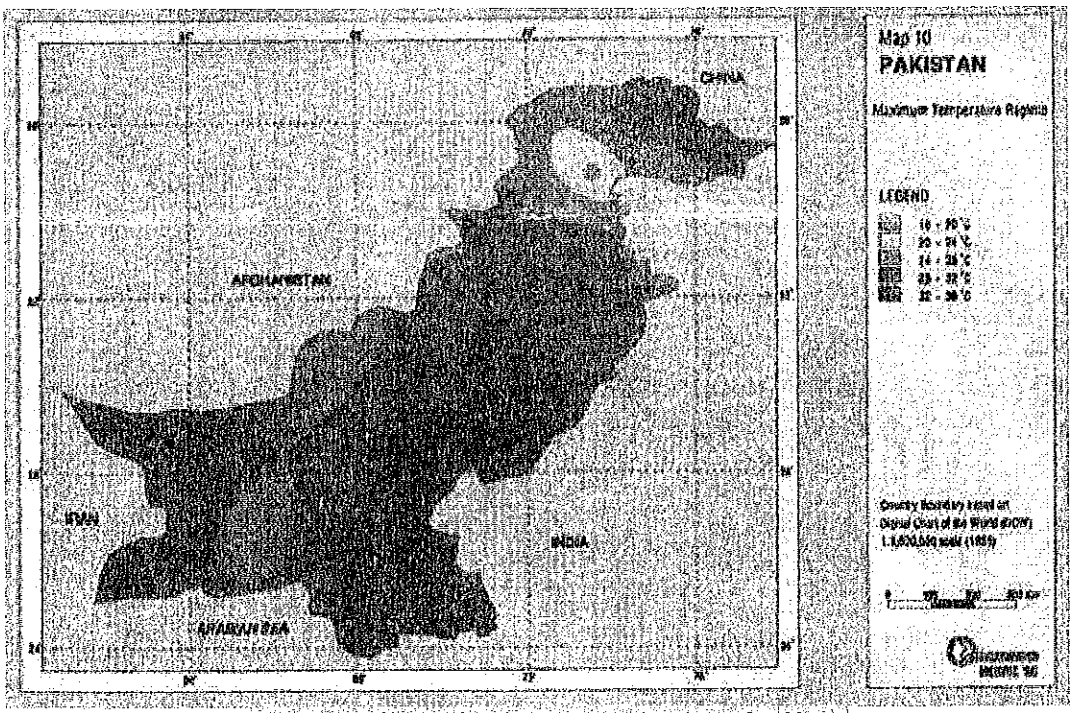


Figure: Maximum Temperature Regime Map of Pakistan

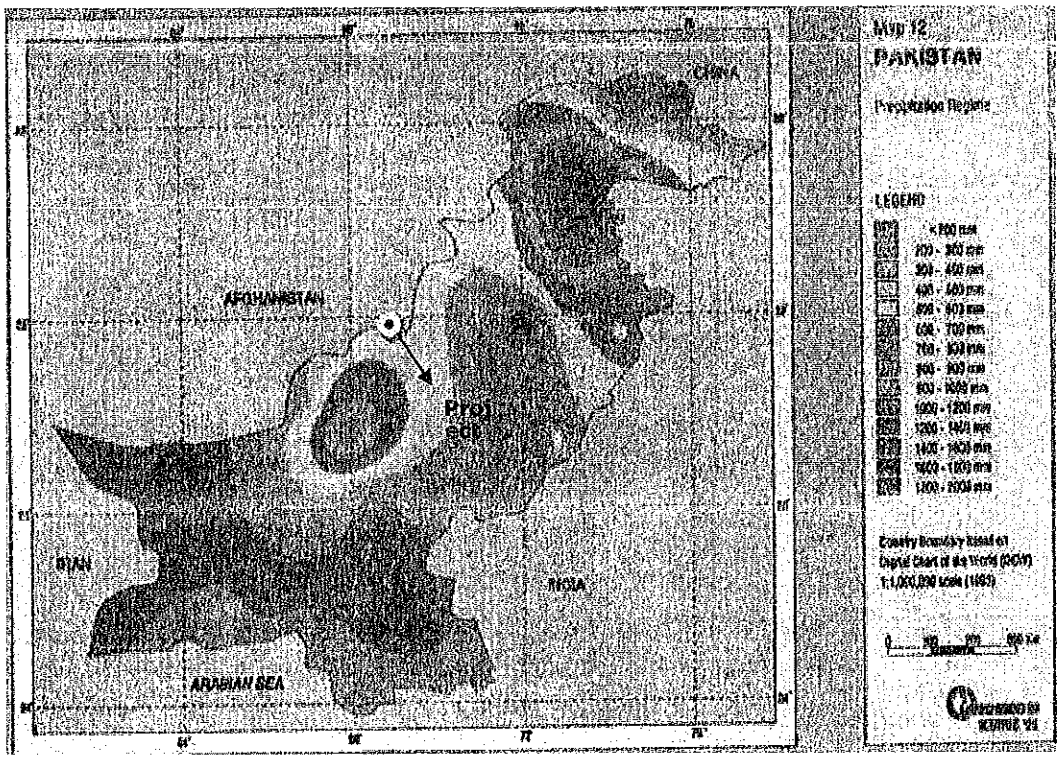
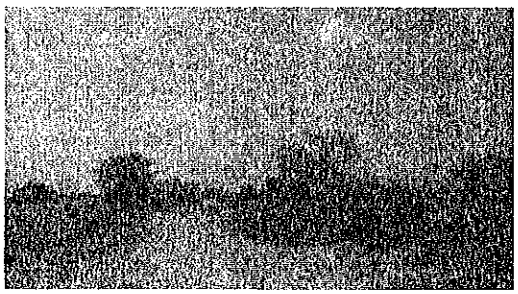


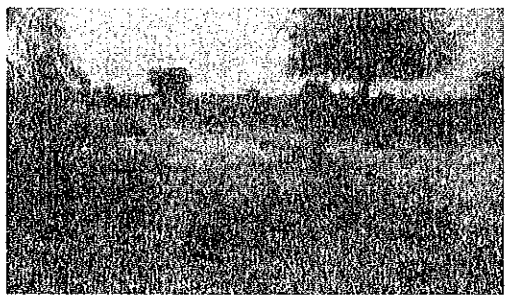
Figure: Rainfall Map of Pakistan

4.5 BIOLOGICAL ENVIRONMENT

4.5.1 FLORA

The physiographic diversity of Khyber Pakhtunkhwa attributes the province a unique status in the country with respect to its wildlife resources. Due to great physiographic diversity and climatic conditions, Khyber Pakhtunkhwa hosts 11 major habitat types with over 4,000 species of plants. Dera Ismail Khan is a desert with a mean annual rainfall of 230 mm and maximum summer temperature of 50 oC, the lowest elevations (174 m to 600 m) of D. I. Khan support xerophytic vegetation.30 Studies of the flora of D. I. Khan are currently limited; however, studies have been carried out in the neighboring district of Tank.





The site does not have any protected flora. Only few bushes and trees were found of 0.5m to 6m height, scattered from each other. There is no such threatening or endangers species exist as indicated by IUCN red list of the species. There is not any environmentally sensitive area located in or near to the buffer zone of the project. There is no impact of project activity on environmental sensitive area.

The plant species recorded in the Study Area are:

- Acacia Modesta
- Acacia Nilotica
- Calotropis Procera
- Centaurea Moschata
- Chenopodium album
- Haloxylon spp.
- periploca aphylla
- Prosopis juliflora
- Tamarix aphylla
- Solanum surrattense
- Withania somnifera

4.5.2 FAUNA

During the site visit there was cattle and livestock (cows and goats) found resting at the area. Apart from that there are other species present in the area like diversified lizards and snakes.

- Canis aureus
- Vulpes vulpes
- Herpestes javanicus
- Hystrix indica
- Hemiechinus collaris
- Funambulus pennantii
- Corvus spelendens
- Passer domesticus
- Pavo cristatus
- Francolinus pondicarinus
- Pycnonotus cafer

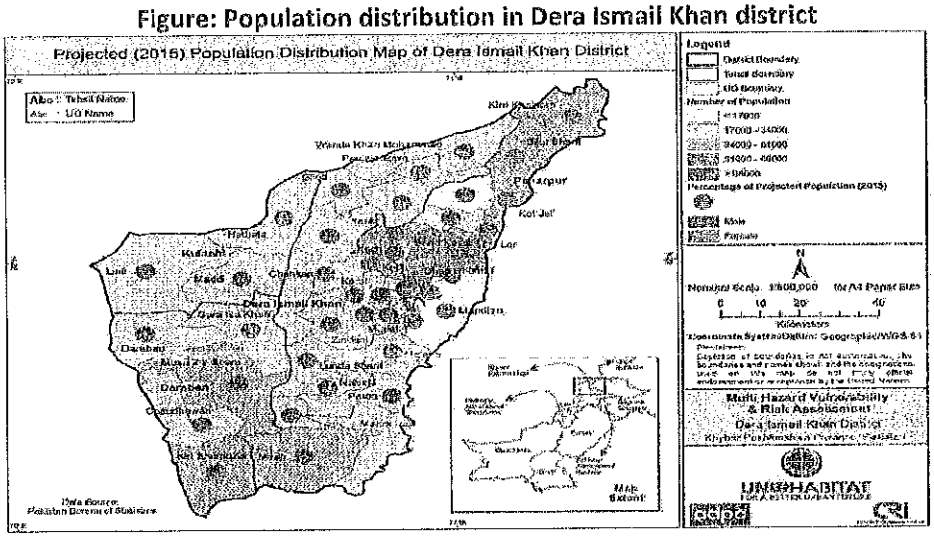
Endangered Flora & Fauna:

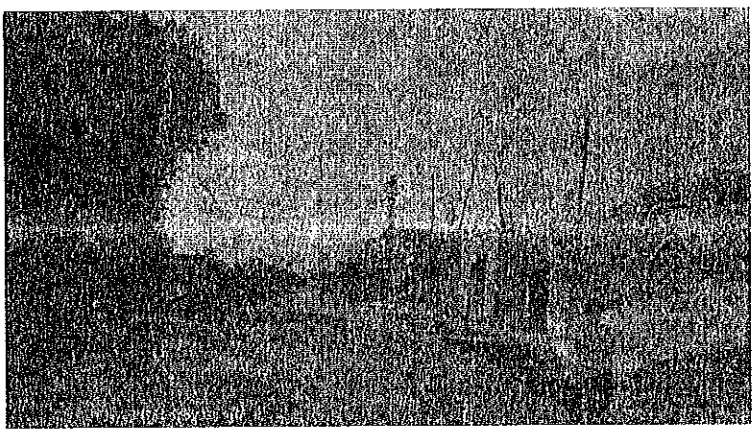
With reference to the list of endangered species prepared by Botanical Survey of Pakistan (BSP) and Zoological Survey of Pakistan (ZSP), Ministry of Environment and Forests, Government of Pakistan, none of the species present in the study area belonged to the endangered flora & fauna.

4.6 HUMAN SETTLEMENT PATTERN

Dera Ismail Khan situated on the right bank of the River Indus is the divisional headquarters of the southern districts of KP. It borders Punjab and Baluchistan provinces. Total area of D.I Khan district is 7,326 (sq km), with population density of 181 persons per sq km. While the total population of D.I Khan district is 1,329,456 in 2011-12. Using average population growth estimations the map below provides an overview of estimated population in 2015.

Figure: Population distribution in Dera Ismail Khan district





Agriculture and fisheries are the main sources of livelihood of the rural population. The total cultivated area in Dera Ismail Khan district is 246,802 hectares.

There is no human activity within the site limits. The nearest community "Luni village" is located 0.21km from the site area. The community consist of mostly Batcha Abad Residence & Frontier Constabulary (F.C) Qila (Fort) (Pakistan Government Security Department at the northwest side. The biggest town "Kulachi" is located around 15 km from site.

4.7 Land Use

The proposed project area is Government wasteland. There are few shrub thickets near the project site. There are no settlements near project site. Within the 5 Km survey area, there are some houses, some temporary huts and agricultural fields. The soil is sandy which is porous comprising of more of gravel and less silt and clay content. There are some sand dunes in small area. Overall the area is plain with gentle slope.

Derra Ismail comprises maximum wasteland which is essentially desert area in the country as well as highest solar radiation. Vicinity of project area is almost sandy & barren.

The Land points of project area are:

31°56'49.48"N 70°16'47.45"E
31°56'50.81"N 70°17'30.54"E
31°56'20.85"N 70°17'30.42"E
31°56'18.97"N 70°16'51.61"E

4.8 Socio-Economic Environment

4.8.1 Occupational Pattern

Agriculture and fisheries are the main sources of livelihood of the rural population. The total cultivated area in Dera Ismail Khan district is 246,802 hectares. Dates are grown here in abundance and are one of the major exports. The key occupational activity for Batcha Abad residents is primarily agriculture i.e. cattle. Additionally, as mentioned the Frontier Constabulary (F.C) Qila (Fort) (Pakistan Government Security Department) is also located at vicinity of the site.

The most important crop in the district for this period in terms of production was sugarcane, with a production of about 11,163,000 tonnes, followed by wheat with 100,000 tonnes as a far second. Cash crops such as fruits (including mangoes and dates) were produced at 34,000 tonnes; vegetables, 17,000 tonnes; maize, 3,000 tonnes; and canola, 2,000 tonnes.

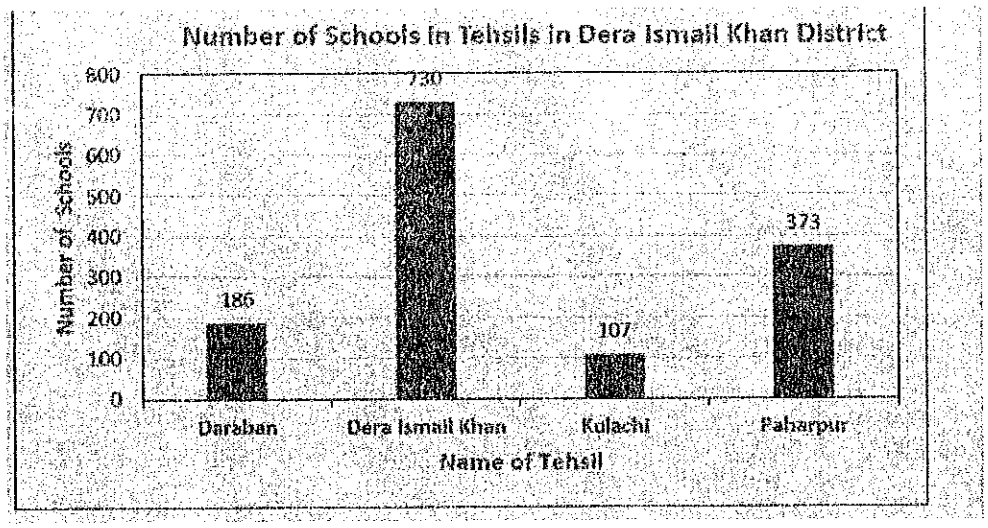
CRBC Canal is the major canal that provides water for irrigation. Of the total land area planted to crops, about 13% were sown more than once.

The district also produces peas, rice, and a famous variety of mango called the "langra." A popular product from Dera Ismail Khan is the "Dhakki Date," which is exported to the Middle East, United States, and Europe. This date is grown in the nearby village of Dhakki. Dera Ismail Khan is increasingly exporting another type of dried date called "chooara." The majority of chooara are produced in Dhakki, Mitrah Abad, Kathgarh, and Saidu Wali. In terms of land area, according to the Land Use Map of Dera Ismail Khan , a total of 5,875 sq. km. was planted to crops, while 67 sq.km. were classified as being with forest cover.

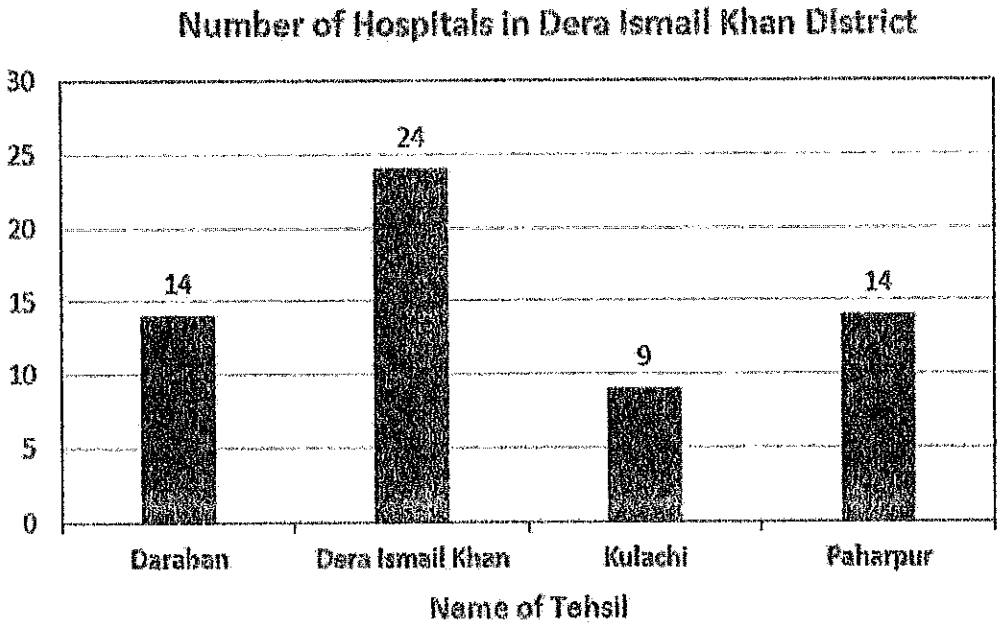
Coal mining is also present in Dera Ismail Khan particularly in the village of Kathgarh.

4.8.2 EDUCATION AND HEALTH FACILITIES

Educational and health facilities are available in Kulachi tribe community which is located 15km from the site.



The district has literacy rate of 31.3% (1998 census) with male literacy rate at 43.19% and female at 17.86%. Looking across regions, the region has 14.75% of urban population and 85.25% rural population.



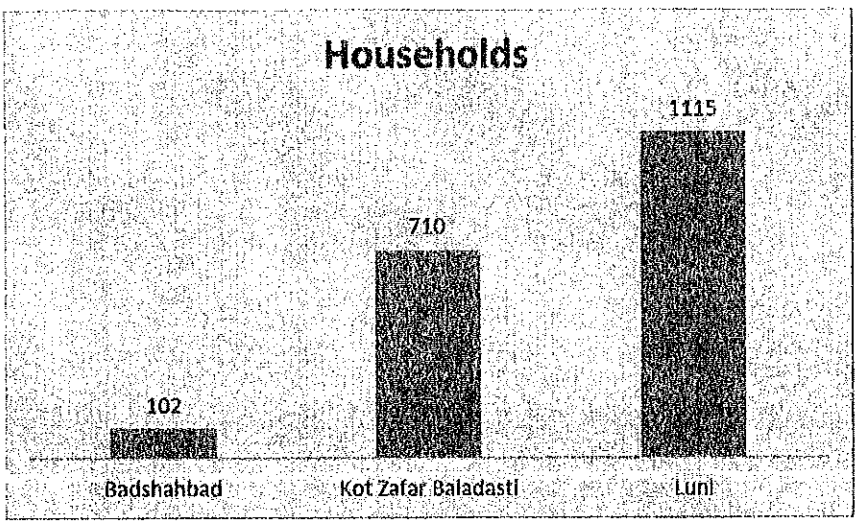
The critical facilities considered are hospitals and schools. Hospital database in GIS format is collected from the World Health Organisation (WHO), and the type of attributed data available is health facility type and name, Province, District, health facility id, latitude and longitude. School database in GIS format is collected from the Education Management Information System (EMIS), Khyber Pakhtunkwha.

4.8.3 DEMOGRAPHICS

The D. I. Khan district had a population of 852,995 in 1998 and 1,167,317 in 2008.92 According to a recent assessment, 93 the total population of D. I. Khan district is currently 1,300,000 million. Of the total population 20% is urban and 80% is rural. The results of the 2017 national population census have not yet been compiled and made public.

Settlement Size

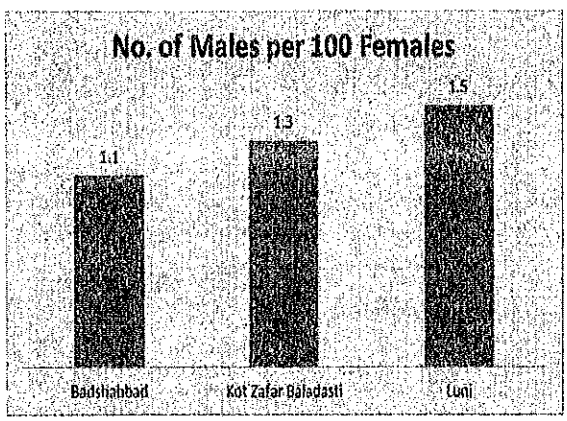
The size of the surveyed settlements within the Study Area varied, ranging from 100 households in the smallest settlement, Badshahabad, to 1,100 households in the largest, Luni.



Luni village is surrounded by agricultural land and is much larger in size for this reason as compared with Badshahabad, which is surrounded by barren land. The population of the Badshahabad, Kot Zafar Baladasti and Luni villages is 900, 5,500 and 7,300, respectively. On an average, there are 4,200 to 6,500 persons inhabiting per square kilometer of area in this region (Exhibit 5.38). The typical rural household size in D. I. Khan is 7.5[3]. Household sizes within the Study Area range from 6 to 8.

Sex Ratio

Sex ratio is defined as the number of males per 100 females. The sex ratio worldwide is approximately 1:1, although deviations occur within population subsets which are often attributed to environmental, social and economic factors. The sex ratio in D. I. Khan district is 1.1:1, 95 but within the settlements it ranges to a high of 1.5:1[4].



[3] Profile of District Dera Ismail Khan. South Asia-Partnership Pakistan. December 2009.
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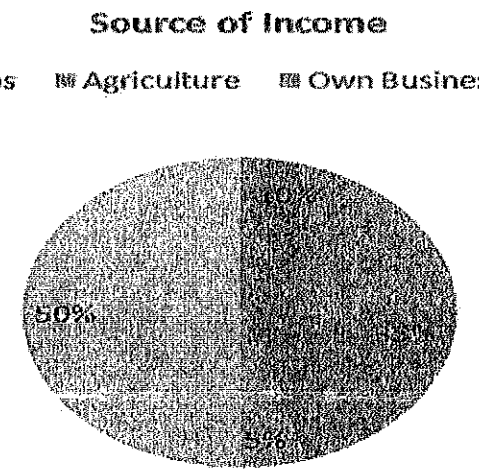
Ethnicity

The major ethnic groups are *Ghandapur* and *Niazi*. However, there are various other groups also present within the Study Area:

- Saidaan
- Tharkan
- Maral
- Isra

Local Economy

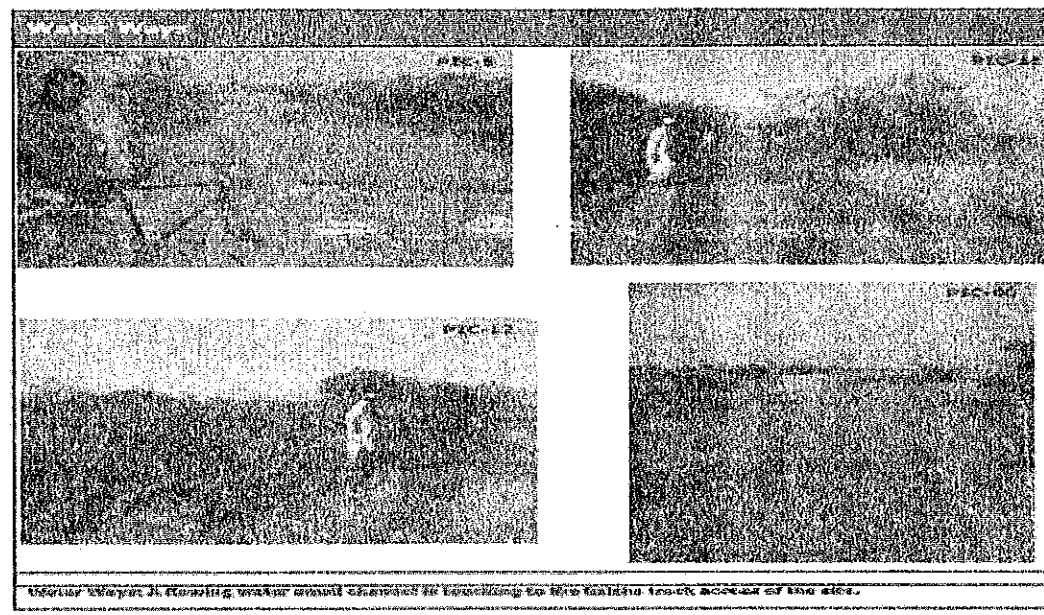
Key livelihood sources reported by the surveyed households are wage labor and agriculture.



4.9 WATER RESOURCES

Water is scares in the Dera Ismail Khan district. CRBC Canal is the major canal that provides water for irrigation. Most of the town is served with water supply system whereas rest of the area is without it and people have their own sources of water mostly hand pumps / power pumps. The district is estimated to have around 78% of water network supply coverage in 2014.

During the site visit it was noticed that there are water resources near the project area.



4.9.1 Surface Water

The Gomal River passes in the northeast of the Project site. The river originates in Afghanistan and enters into the Project area from South Waziristan agency. The river then passes through the Damaan Plains in Kulachi tehsil and later falls into the Indus River near the city of D. I. Khan. The riverbed was dry at the time of the study field visit. According to the locals, it remains dry all year, except during the monsoon season.

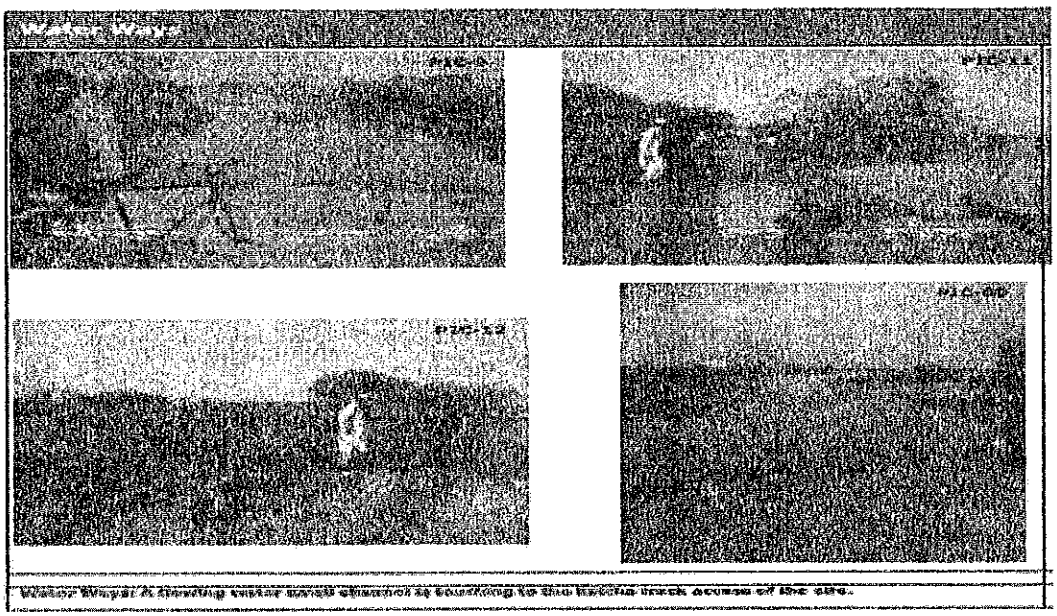
There are some main channels (channels diverting water directly from the river) and some secondary channels (fed by the main channels) that are used to divert water from the river to the agricultural fields. As water flows through the channels, it is diverted to the adjacent fields. Once a field pools up, there are two possibilities—either further water intake is manually blocked at the inlet, or the pooled water at the field is further diverted to other adjacent fields located at lower elevations. The natural gradient of the land is from the northwest to the southeast.

4.9.2 Ground Water

The Study Area has very limited groundwater yield prospects because of several hundred meters thick unconsolidated deposits. The groundwater table is reported to be at 36 m below the surface. Clay is the dominant component, with presence of appreciable amounts of gravels, clayey silts, and minor sand. No groundwater extraction well was found in the Study Area.

4.10 Air Quality

There are no major anthropogenic sources of gaseous emissions in the Study Area other than cookstoves in villages that use wood as a fuel and that produce insignificant emissions of sulfur dioxide (SO^2) and nitrogen dioxide (NO^2). The dry, desert conditions in the area result in significant amounts of windblown dust.



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Air quality monitoring results for the Project Site is:

Parameter	Averaging Time	NEQS	Unit	*Avg. Conc.
Carbon Monoxide (CO)	24 h	5	mg/m^3	1.530
Sulfur Dioxide (SO_2)	24 h	120	$\mu g/m^3$	103.45
Ozone (O_3)	24 h	130	$\mu g/m^3$	101.68
Nitrogen Dioxide (NO_2)	24 h	80	$\mu g/m^3$	62.14
Nitric Oxide (NO)	24 h	40	$\mu g/m^3$	20.39
Oxides of Nitrogen (NOx)	24 h	120	$\mu g/m^3$	99.54
Particulate Matter (PM_{10})	24 h	150	$\mu g/m^3$	105.7

4.11 Noise Level

The project area is a quite area. There is no traffic or industrial activity in the vicinity of the project, except for the north-west site perimeter where the Luni village is located. It is recommended to maintain the noise quality in the project area within the permissible levels.

The results of the noise sampling are:

Parameter	Averaging Time		NEQS	Unit	*Avg. Conc.	Methodology
Noise	Day-time	12h.53 m	65	dB (A)	44.21	Noise Logger
	Night-time	11h.7m	55		32.25	Noise Logger

4.12 Water Resources

The Project site is located in a rain-fed agricultural farming area. Other than rain, the main source of water is precipitation runoff from the hills west of the Project area. Torrential flows from the Luni or Gomal rivers during the rainy season are diverted for agricultural use through a system of man-made earthen channels running through cultivated plots, and retained on farmland by shallow dirt berms lining the periphery of each plot.

5 ENVIROMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

5.1 INTRODUCTION

The proposed project may have impact on the environment during construction & operation phases. During the construction phase, the impacts may be regarded as temporary or short-term; while long term impacts may be observed during the operation stage. Spatially the impacts have been assessed over the study area of 2 km radius of the project site.

The project has overall positive impacts by providing a competitive, cost-effective, pollution free reliable mode of Solar PV power. It will certainly meet the ever increasing Demand of Power and to bridge the Gap between Demand and Supply of Power.

5.2 POTENTIAL IMPACT GENERATION ACTIVITIES

The construction and operation phase of the proposed project comprises various activities each of which may have an impact on environmental parameters.

During the construction phase, the following activities may have impacts on environment:

- Site preparation
- Minor excavation and leveling
- Hauling of earth materials and wastes
- Cutting and drilling
- Erection of concrete and steel structures
- Road construction
- Painting and finishing
- Clean up operations
- Landscaping and afforestation

The activities can be divided into two categories, viz. sub-structural and super-structural work. Moreover, construction work will involve cutting of trenches, excavation, concreting etc. All these activities attribute to dust pollution. The super-structural work will involve steel work, concrete work, masonry work etc. and will involve operation of large construction equipment like cranes, concrete mixers, hoists, welding sets etc. There may be emission of dust and gases as well as noise pollution from these activities.

Mechanical erection work involves extensive use of mechanical equipment for storage, transportation, erection and on-site fabrication work. These activities may generate some air contaminants and noise pollution. The electrical activities are less polluting in general. Potential Impacts and Mitigation Measures (for construction and operation phase) is given in Appendix V.

5.3 IMPACTS DURING CONSTRUCTION PHASE

The environmental impact during construction phase is localized and of short term magnitude. However, as this project land shall be govt. barren land, the change in land use will be minimum.

Impact is primarily related to the civil works and some intensive impact due to erection of the equipment. The details of the activities and probable impact are brought out in table below:

Identification Of Activities & Probable Impacts (Construction Phase)		
Construction Activities	**Environment Attribute**	**Probable Impacts**
Land Acquisition	Land	✓ No significant impact on land-use is expected.
	Socio-economics	✓ No Impact due to Rehabilitation & Resettlement issues is expected as govt. wasteland is being acquired for the project.
Site clearing and Leveling (cutting, stripping, excavation, earth movement, compaction)	Air	✓ Fugitive Dust Emissions ✓ Air Emissions from construction equipment and machinery
	Water	✓ Run-off from construction area
	Land	✓ Loss of top soil
	Ecology	✓ Minimal loss of vegetation / habitat as the site is has barren land with almost no vegetation.
Transportation and Storage of Construction Material/ Equipment	Air	✓ Air Emissions from vehicles ✓ Fugitive Dust Emissions due to traffic movement
	Water	✓ Run-off from Storage Areas of construction ✓ Material
	Public Utilities	✓ Increased flow of traffic
Civil Construction Activities	Air	✓ Air Emissions from construction machinery ✓ Fugitive Dust Emissions
	Water	✓ Run-off from Construction Areas
Mech. and Elec. Erection Activities	Air	✓ Air Emissions from Machines / activities
Influx of Labour and construction of temporary houses	Socio-economics	✓ Employment opportunities shall increase ✓ tress on infrastructure
	Land	✓ Change in land use pattern of the area
	Water	✓ Sanitary effluents from labour colonies
Transportation and Disposal of Construction Debris	Air	✓ Air Emissions from Transport Vehicles ✓ Fugitive Dust Emissions due to Movement of Traffic ✓ Spillage and fugitive emissions of debris materials

	Water	✓ Run-off from Disposal Areas
	Soil	✓ No Conversion of land into waste land as already barren land.

5.3.1 Impact on Land use

The land required for the proposed expansion project will be about 375 acre. The construction activities attract a sizeable population and the influx of population is likely to be associated with construction of temporary hutments for construction work force, having an effect on land use pattern of the areas surrounding the project. However, this impact is envisaged to be insignificant due to following reasons.

- Temporary labour colonies shall be situated in the areas already acquired for the project.
- It will be only a temporary change (restricted to construction period). After construction phase, the areas acquired by labour colonies shall be reverted back similar to preconstruction stage

Further, AASAL shall also be in the process to improve the infrastructure of the area such as roads, schools, hospitals, etc. The project would add to the economic development of the area through allied business, which will be set-up along with the plant.

5.3.2 Impact on Soil Cover

As the construction activities for the main plant units of project would be confined in the wasteland, the impact on soil will be minimal and confined. Only cutting and filling is required during construction. The construction activities result in loss of vegetation cover (grass and shrubs) and topsoil in the plant area. No adverse impact on soil in the surrounding area is anticipated. However, in order to minimize such impacts, appropriate soil erosion control measures would be undertaken by AASAL to appease the chances of soil erosion. Completion of excavation and foundation work in limited time schedule would also reduce / minimize the chances of soil erosion

5.3.3 Impact of Solid Waste

Solid waste during the construction phase consists primarily of scrapped building materials, excess concrete and cement, rejected components and materials, packing and shipping materials (pallets, crates, Styrofoam, plastics etc.) and human waste. During the construction there will be generation of garbage, for which designated practices of solid waste disposal shall be followed.

5.3.4 Air Impact

As the proposed project is Solar PV Project, the impact during construction of is expected to be minimal as a Greenfield Project plant.

Particulate matter in the form of dust would be the predominant pollutant affecting the air quality during the construction phase. Dust will be generated mainly during excavation, back filling and hauling operations along with transportation activities. However, a high boundary wall will prevent the dust generated due to construction activities going outside the project area.

The main source of gaseous emission during the construction phase is movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO2, NOX, and particulate matter. The impact is reversible, marginal and temporary in nature.

5.3.5 Noise Impact

The major noise generating sources during the construction phase are vehicular traffic, construction equipment like dozer, scrapers, concrete mixers, cranes, generators, pumps, compressors, rock drills, pneumatic tools, vibrators etc. The operation of this equipment will generate noise ranging between 75 – 90 dB (A).

To minimize the impact on nearby communities, construction schedules have been optimized. Also the noise level is substantially lower near the plant boundary due to attenuation caused over the distance. Overall, the impact of generated noise on the environment during construction period is insignificant, reversible and localized in nature.

5.3.6 Impact on Water Environment

The construction personnel would be housed in temporary settlements. These settlements would discharge considerable amount of domestic wastewater. Stagnant pools of water would increase breeding of mosquitoes and generally create insanitary conditions. Contractor will provide Soak pit with a depth of 2 meter to dispose liquid waste so that such waters do not form stagnant pools nor aggravate soil erosion. The main pollutants are organic components and microorganisms with the potential to cause contamination of water quality. To address potential impacts on water quality, disinfected latrines (e.g., through regular liming) will be used as main component of the sanitation system.

Construction processes include fabrication of concrete and related water usage. Wastewater from construction activities would mostly contain suspended impurities. The waste water will be arrested before discharge, to prevent solids buildup in the existing drains. Thus, the construction site wastewaters would be led to sedimentation basins, allowing a hydraulic retention time of 1 ½ to 2 hours, where excess suspended solids would be settled out and relatively clear supernatant would be discharged to the plant drain. Generally, Surface run-off water is not there in dry months during construction. Also, since the area is arid, there will not be any considerable surface runoff as it shall be lost due to evaporative losses. However, during monsoon, surface run-off including effluents may cause load of suspended solids.

5.3.7 Ecological Impact

The project site is mainly barren land and there are no settlements near the site. The impact of the construction activities would be primarily confined to the project site. Since, the entire land is barren land with some xerophytic plants, shrubs. Thus, the site development works would not lead to any significant loss of important species.

5.4 Impact During Operation Phase

Various activities of operation and maintenance phase and their probable impacts on various sectors of environment are presented in table below.

Identification Of Activities And Probable Impacts (O&M)		
O&M Activities	**Sector**	**Probable Impacts**
Transportation	Air	✓ Air Emissions from Vehicles ✓ Fugitive Dust Emissions due to Traffic Movement
	Public Utilities	✓ Increased flow of traffic
	Water	✓ Effluents from Oil Storage Areas
Burning of Fuel	Air	✓ No Stack emissions from solar Project
Water Treatment for various uses	Water	✓ Generation of Wastewater due to PV Cleaning Modules
Equipment Cooling	Water/ Ecology	✓ Discharge of Hot Water containing chemicals
Operation of Transformers and Switchyard	Water	✓ Generation of effluents containing oil

5.4.1 Impact on Land use

The proposed project will be set up on government wasteland. The site, after completion of its development, would consist of built structures, landscaped to give a pleasing outlook.

Following the construction phase, the temporarily modified land use pattern, such as construction of temporary tents to accommodate some construction personnel will be totally removed during the operation stage. Land released from the construction activities would be put to economic and aesthetic use to hasten recovery from adverse impacts.

5.4.2 Impact on Soil Cover

Most impacts of Solar PV project on soil are restricted to the construction phase, which will get stabilized during operation phase.

The soil conditions of the project site would be allowed to stabilize during this period after the impacts of the construction phase. The topsoil in non-built up areas would be restored and such portions of the site would be subjected to plantations, which would help in bonding of the soil, thus increasing its strength. During operation of a project, no appreciable adverse changes in the soils are anticipated.

5.4.3 Air Impact

Plant operation would affect the air quality, as solar green field project & no any gaseous emission by the project.

5.4.4 Noise Impact

Work Zone Noise Levels

Protective instruments will be provided to the operators and workers working near the high noise generating machinery. As per Occupational Safety and Health Administration (OSHA) Standards, the maximum allowable noise level for the workers is 90 dB (A) for 8 hours

exposure a day. Therefore, adequate protective measures in the form of ear mufflers/ear plugs to the workers working in high noise areas will be provided.

In addition, reduction in noise levels in the high noise machinery areas will be achieved by adoption of suitable preventive measures such as adding sound barriers, use of enclosures with suitable absorption material, etc.

5.4.5 Impact On Water Environment

Impact on Ground Water

No ground water due to plant operation will be drawn during operation phase for any purpose. So lowering of groundwater table will not be an issue. In addition, Rainwater Harvesting will be implemented at proposed plant to conserve storm water and help in recharge of ground water.

Impact on Surface Water Impact due to Discharge

There shall be minimal discharge of wastewater from cleaning of Solar PV modules. The wastewater emanating from cleaning operations shall be recycled for plantation and greenbelt development around the plant. The rest of the wastewater will be deposited in rain water harvesting pond.

Terrestrial Ecology

There is no sensitive ecological area / protected forest area such as national wildlife park, bird sanctuary crossing the proposed route alignment. The removal of herbaceous vegetation from the soil and loosening of the top soil generally causes soil erosion. However, such impacts would be primarily confined to the project site during initial periods of the construction phase and would be minimized through adoption of mitigation measures like paving and surface treatment and water sprinkling.

5.5 Social Impacts

5.5.1 Traffic Congestion

No overburden on the local transportation system is envisaged due to the proposed Project.

5.5.2 Labor Influence

Construction Phase

During construction activities, there will be a sizeable influx of population and labor colony is being constructed with basic amenities for the laborers working on the project. This will have an effect on social fabrics of the areas surrounding the project. However, this impact is envisaged to be insignificant due to the following reasons:

- Temporary labour colonies shall be situated in the areas already acquired for the project.
- It will be only a temporary change (restricted to construction period). After construction phase, the areas acquired by labour colonies shall be reverted back similar to preconstruction stage

AASAL has a Human Resources Policy, which specifies the terms of employment and working conditions. These include procedures for hiring and recruiting, probation, training, performance review, promotion, insurance, salary and compensation, resignation, lay-off and retrenchment, leave and vacation, and superannuation, which follow Pakistann labour law. All the employees will have access to the human resources policy and procedures. Labour inspections are done annually by the relevant government agency, which reviews wages, working hours, benefits, etc.

Most of the construction labor will be on contractual basis. Separate labour camps shall be made within the plant premises for the construction labors. Therefore, conflict of the migrating labor with locals, will not take place during the construction phase. Regarding monitoring of diseases corresponding to labor influx, regular health status monitoring of labors and its surrounding population will be carried out with the mobile health care facilities shall be developed and operated by AASAL in this area. The health areas and issues that requires attention by AASAL is as follows:

Labour Health Management

Environmental Health Areas	**Influx camp followers, job seekers, family, service workers**	**Resettlement; relocation**	**Water management including creation of new water bodies; altering existing water bodies and changes in drainage pattern**	**Linear features Roadways; transportation routes;**	**Hazardous materials control and disposal**	**Changes in income & expenditure consumption including food/ housing inflation**
Vector Related	Increasing human parasite	Movement to different prevalence area	Creation and movement of breeding grounds	Improper drainage, temporary water pool	Creation of breeding sites with drums at household level	
Respiratory & Housing	Crowded housing, both work camps and community	Number of occupants per room; mix of occupants children/elderly / adults (different vulnerability)		Facilitating mixing/interaction of different groups		Housing inflation triggered crowding
Veterinary Medicine	Movement and migration of stock	Movement and migration of livestock due to influx of new groups	Creation and/or movement of livestock watering locations		Inadvertent water source contamination, of streams/ rivers	

Sexually Transmitted Infections; HIV / AIDS	//			Facilitating movement of high risk groups into rural settings		Men with money mixing with vulnerable women
Soil, Water & sanitation	Overburdenin g existing services/syste ms; explosive food-borne epidemics	Failure to anticipate extended family influx in initial design	Changes in surface water flows/quality, potential groundwater drawdown		Releases into surface water; long-term impacts to ground water	
Food & Nutrition	influx of extended family more	Shift from subsistence agriculture to	Changes in crop/garden selection and	Changes in access to gardens or		Food inflation further
	mouths to feed	peri-urban living/petty trading	planting cycle	local markets		marginalizin g vulnerable groups
Accidents & Injuries	Overcrowding, falls, burns, road traffic//			Road traffic, increased pedestrian activity	Unplanned releases/em issions	

Hazardous Materials Exposure	Squatter developments adjacent to industrial facilities with unplanned releases			Movement via trucks of hazardous materials across communities to project areas	Use of Project drums and containers for water and food storage; Inadequate incinerators design	
Psychosocial; Gender Issues	Cultural shock due to rapid societal change	Transformation of rural to peri urban/urban lifestyle		Greater ease of mixing social/ ethnic groups		Sudden money influx in a barter economic structure
Cultural Health Practices	Introduction of new practices and / or elimination of existing practices	Introduction of new practices and/or elimination of existing practices				Shift to western medicine
Health Services Infrastructure & Capacity	Increased visits for out and inpatient services	Increased visits for out and inpatient services if access improves		Changes in access		Attraction of additional private providers/ increase in insurance enrollment

Noncommunicable; hypertension, diabetes	Changes in diet	urban living versus high intensity subsistence farming				Shift from physical activity to sedentary lifestyle

Operation Phase

The operation & maintenance staff will be accommodated in the AASAL Township, which will be located at Luni Town. Therefore no impact on the local life pattern is envisaged due to operational worker of the project.

5.5.3 R&R Issue

The proposed project will be set-up on public barren land. Therefore there is no R & R issue for the proposed project.

Change in Socio-economic Condition

Employment: The project will generate employment opportunities for the local population. Even indirect job opportunities will be created outside the project boundary. Many people will find employment in service sector and marketing of day-to-day needs viz. poultry and other agricultural products. The project will improve the basic infrastructure and the people of nearby villages can also use these amenities. .

- Provision in project contracts to provide priority in employment
- Training for skills up-gradation
- Encouraging labour co-operative of displaced families and giving priority to labour cooperatives of displaced families for award of miscellaneous contracts
- Reservation of shops for displaced families in employee township
- Efforts to employ educated unemployed youth

Overall there will be marginal impact on the socio-economic condition of the locality and the impact will be mostly positive.

Development of Infrastructure: The job opportunities in non-agricultural sector are likely to increase. The installation of the power plant is expected to further increase the prospects by bringing in direct and indirect employment opportunities.

As the project and consequent activities are expected to generate additional employment and income opportunities for the local population, market expansion supported by infrastructural development will foster economic growth in the area. Flow of reliable and adequate power from the proposed plant will not only enhance growth in the region, but will also bring about a change in energy consumption pattern by switching over from other sources of energy. This will ease off burden on the existing biomass.

6 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

6.1 INTRODUCTION

Environmental & Social Management Plan is an implementation plan to mitigate and offset the potential adverse environmental & social impacts of the project and enhance the positive impacts. Based on the environmental baseline conditions, planned project activities and impacts assessed earlier, this section enumerates the set of measures to be adopted to minimize the adverse impacts. Process of implementing mitigation and compensatory measures, execution, agencies responsible for their implementation and indicative costs is discussed in this chapter.

The project has overall positive impacts by providing a competitive, cost-effective, pollution free reliable mode of Solar PV power. It will certainly meet the ever increasing Demand of Power and to bridge the Gap between Demand and Supply of Power.

6.2 ENVIRONMENTAL & SOCIAL MANAGEMENT PROCESS

The ESMP has been designed within the framework of requirement under Pakistann legislation and ADB's SPS on environmental and socio-economic aspects.

The mitigation measures to be adopted for the implementation of the proposed project include the following:

- Environmental Management Plan;
- Rainwater Harvesting
- Clean Development Mechanism;
- Occupational Health and Safety;
- Labour Working Conditions;
- Construction Labour Management;
- Environmental Action and Monitoring Plan;
- Community Development Plan;
- Public Consultation and Information Disclosure Plan;
- Grievance Redressal Mechanism;
- Disaster Management Plan

The ESMP has been prepared considering life cycle approach of the project that Dahanu Solar Power Limited will own and operate.

The Project will develop and implement following management action plans under the ESMP: **a) During Design Phase:**

- Design of Clean Development Mechanism

b) During Construction Phase:

- Construction Labour Management Plan;

- Health and Safety Management Plan (Construction Phase);

The ESMC is responsible for processing and implementing all subproject(s). Subprojects will be monitored by qualified technical staff/experts (e.g., design and technical reports, feasibility studies, environmental and/or social assessments, and associated EMP's and budgets), who will also ensure and monitor compliance with ADB and Government safeguard requirements. Summary appraisal reports will be submitted to the ADB subsequent to obtaining the ESMC's approval and clearance(s) from the GoR during operation phase. The ESMC will prepare and submit performance monitoring reports to the ADB twice yearly. Activities to be monitored include: all planning, coordination and management activities related to the implementation of safeguard issues; the identification of corrective and preventive actions; records of health and safety matters and training activities; consultations with project affected peoples (as and when needed, particularly during the implementation); feedback, trouble shooting and project related grievances (per the project grievance redress mechanism); preparation of progress and monitoring reports as required by the ADB; and verifying the projects overall compliance with safeguard measures and its progress towards achieving the intended loan outcomes. ADB will continue to monitor project compliance with ADB safeguard plans and requirements on an on-going basis throughout the duration of the contract.

The ESMC comprises of a team of qualified and experienced environmental engineers, analytical chemists, horticulturists, safety engineers and well trained personnel for environmental monitoring. The EMC also conducts regular training programs for the other personnel in the areas of environment, air quality and water quality aspects, energy and water conservation measures, safety and health aspects etc.

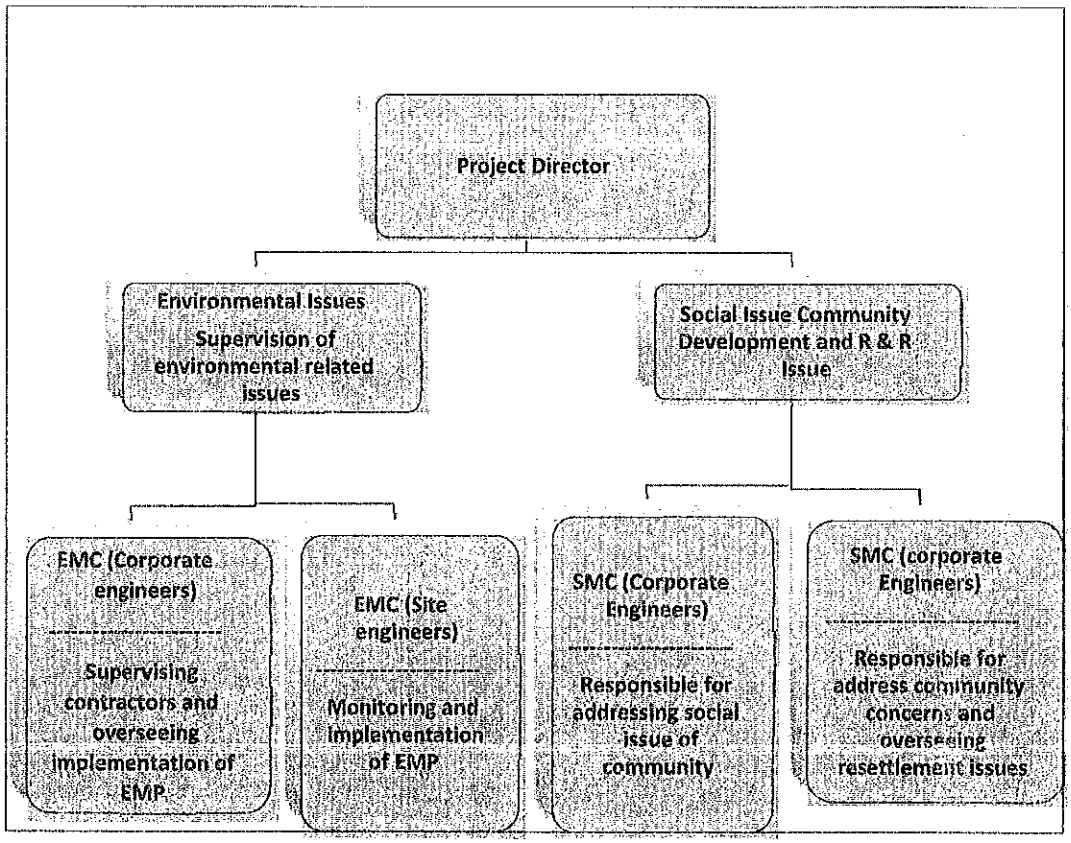
The ESMC is supported by well-equipped testing laboratory and other facilities to facilitate effective working.

The responsibilities of the various members of the environment management cell are presented in table below

Key Responsibilities of Environmental & Social Management Cell

S. No.	Designation	Responsibility
1.	Project Director (1 no.)	Environmental and Social policy and directions
2.	Head-Operations (1 no.)	Overall in-charge of operation of environment & social management facilities; Ensuring legal compliance by properly undertaking activities as laid down by various regulatory agencies from time to time and interacting with the same.
3.	General Manager (2 no.)	Secondary responsibility for environment & social management and decision making for all environmental issues including Safety and Occupational Health

Framework of Environment & Social Management Cell



Corporate Social Responsibility Plan (Community Development Plan)

Corporate social responsibility is AASAL's self-regulation integrated into a business model. CSR policy functions is built-in, self-regulating mechanism whereby business monitors and ensures its active compliance with the spirit of the law, ethical standards, and international norms. The goal of CSR is to embrace responsibility for the company's actions and encourage a positive impact through its activities on the environment, consumers, employees, communities, stakeholders and all other members of the public sphere.

- The objective is to communicate to the local community, the nature, importance and impact of the project on the local community, the state and the country. The initiatives are being designed, to create a positive impact on the lives of the local people and improve their living conditions. Monetary and short term initiatives are kept to the minimum. Major focus is to initiate activities which are sustainable and will help to build lasting relationship with the local community. This would also help in creating inter-dependencies with local community, so that they also have a sense of responsibility towards the well-being of the project.
- The proposed action plan will serve as a preliminary framework and would be modified based on results of such initiatives and feedback from community and stakeholders.

Identifying CSR initiatives in line with local requirements

Based on site visits by AASAL Power team and discussions with local people, following issues have been highlighted

Area	Community Need
Health	- Non-availability of adequate health related infrastructure; women and children are most affected - Low awareness on hygiene, sanitation and dietary issues
Education	- Facilities for higher secondary education are inadequate and distant - Higher education and counseling for youth missing - Technical skill building institutions far and few and have poor infrastructure
Employment / Livelihood	- Scope of employment for unskilled or semi-skilled laborers
Financial literacy	- Lack of information/ about long term fiscal planning needs. Very important to prevent misuse of compensation package

Keeping in mind the above mentioned issues, AASAL's CSR initiatives would focus on the following areas:

- Improving medical facilities in the villages around the project area.
- Improving awareness and providing sufficient training in hygiene, sanitation and proper diet
- Encouraging people to send children to school and also educate themselves through adult literacy programs
- Improving education infrastructure by providing better teaching aid and training for teaching faculty.
- Building skills among villagers as per skills requirements of the project during construction as well as during the operations phase.
- Encouraging entrepreneurial spirit among people and supporting such initiatives by conducting training programmes to acquire and enhance skills. Creating awareness about long term financial planning

6.3 ESMP During Construction and Operation

The project activities will be executed in phased manner, Pre-construction Phase, Construction Phase and Operation phase. The major activities to be undertaken are described below.

6.3.1 Construction Phase

The environmental issues during construction stage generally involve safety and public health issue. The Contractor is required to comply with the laws with respect to environment protection, pollution prevention, safety and other applicable law. Environmental pollution during the construction phase will be less but control of pollution

during this phase is of considerable importance. The EMP is an executable part of Project, and the activities are to be guided, controlled, monitored and managed as per the provision provided. Following activities require attention during construction phase.

6.3.2 Construction/Labour Camp Management

- The labor camp construction, upkeep and maintenance at the 49.5 MW Solar PV project site is under the scope of the contractor.

  400-450 laborers are likely to be working on the project area. Local community shall be preferred at all levels, reducing the influx substantially, A proper Construction Camp Development Plan has to be formulated to control degradation of the surrounding landscape due to the location of the proposed construction camp. Although, it is the responsibility of EPC contractor to implement, AASAL shall ensure that it is strictly followed.

- Sufficient supply of potable water will be provided at camps and working sites. If the drinking water is obtained from the intermittent public water supply then storage tanks will be provided. All water supply storage may be at least 15m away from the toilets or drains.

- It is the responsibility of EPC contractor to fulfill the water requirement during construction period. AASAL will ensure that water will be supplied through water tanker from nearby area, where sufficient water is available.

- Adequate sanitation facility, Septic tank, will be provided.

- Health check-up will be conducted. These activities may be provided by the construction contractor.

- At every Camp first aid facility will be provided. Suitable transport will be provided to take injured or ill person to the nearest hospital.

- Adequate supply of fuel in the form of kerosene or LPG will be provided to construction labours to avoid felling of trees for cooking and other household activities.

- All the construction workers will be provided with proper training to handle potential occupational hazards and on safety and health, which include the following:

- Environmental Awareness program

- Medical surveillance

- Engineering controls, work practices and protective equipment

- Handling of raw and processed material

- Emergency response

6.4 Labor and Working Conditions

Through a constructive employee-management relationship, and by treating the employees fairly and providing them with safe and healthy conditions, tangible benefits may be

created, such as enhancement of the efficiency and productivity of their operations. The basic objectives are to ensure following.

- To establish, maintain and improve the employee-management relationship
- To promote fair treatment, non-discrimination and equal opportunity of employee, and compliance with national labor and employment laws
- To protect the employee by addressing child labor and forced labor
- To promote safe and healthy working conditions, and to protect and promote the health of workers by evolving safe working practices.
- To respect the worker's rights to freedom of association and the effective recognition of the right to collective bargaining, as per the relevant conventions of the International Labor Organization

The organization shall work to achieve these objectives, all relevant provisions of employee laws will be complied.

Working Relationship

All employees and workers directly engaged by the contracting agencies will be communicated their working conditions and terms of employment, including their entitlement to wages and any other benefits.

Workers Organizations

The company will not discourage workers from collective bargaining in a positive manner for mutual benefit.

Equal Opportunities

The company will base the employment relationship on the principle of equal opportunities and fair treatment and will not discriminate with respect to aspects of the employment relationship including recruitments and hiring, compensation, working conditions and terms of employment, access to training, promotion, termination of employment or retirement and discipline except on the basis of merit.

Equal Opportunities for Women

The Company will base the employment relationship on the principle of equal opportunities and fair treatment and will not discriminate on gender. Instead, the company will encourage the women participation and will frame appropriate policies to achieve the same.

Child Labour

The company will not employ children in any manner i.e. economically exploitative or is likely to be hazardous or to interfere with the child education or to be harmful to the child's health or physical, mental, spiritual, moral or social development. Children below the age of 18 years will not be employed in dangerous work. The company in fact discourages child labour & encourages them to go to School by providing free education facilities & also providing education stipend for attending school.

Occupational Health and Safety

The company will provide the employees with a safe and healthy work environment taking into account inherent risks in its particular sector and specific classes of hazards in the works premises, including physical, chemical and biological hazards. The company will take steps to prevent accidents, injuries and disease arising from, associated with or occurring in the course of work by minimizing as far as reasonably practicable the causes of hazards.

Major Environmental Mitigation Measures during Construction Phase

Mitigation Measure	Purpose	Failure consequence	Responsible Organization
Water sprinkling	Control of fugitive dust during construction and transportation activity	Increment in ambient SPM concentration	- Contractor - AASAL Management - Environment Consultant
Transportation of construction material in covered trucks	Control of fugitive dust	Increase in dust emission	- AASAL Management - Environment Consultant
Regular maintenance of transport vehicle and provision of acoustic cover on construction machinery	Control of Noise	Increase the noise level of surrounding area	- Contractor - AASAL Management
Provision of environmentally safe camping area for laborers	To provide a clean and healthy living condition for labours	Unhealthy living condition and spread of disease	- Contractor - AASAL Management

6.5 Operation Phase

During operation phase of the proposed project pollution impacts are minimum. However, in order to limit within predicted impact levels and to further mitigate the impacts wherever possible on individual environment components, the following mitigation measures are recommended: Environment Impact and Mitigation Measure

Possible Impact	Mitigation during planning and design	Mitigation during operation
Air Impact	Incorporate consultant and engineers advice	- No Air Pollution
Soil Quality Degradation	Consider strategies to avoid soil quality degradation	
Occupational health hazard		- Periodic health check-up
Possible Impact	**Mitigation during planning and design**	**Mitigation during operation**
Safety of workers		- Workers would be provided with hand gloves ear muffs, safety boots, safety Goggles, helmets etc. - Workers should be trained to follow safe working practices
Transmission line	Avoid, as far as practicable, operations in environmentally Sensitive Areas, Eco-Sensitive Zones, Wetlands, Wildlife Sanctuaries, National Parks and Biosphere Reserves. If it is inevitable, AASAL should obtain approvals as required under the relevant laws.	- Abate pollution in all its activities and operations. It should adopt the good practices of the sector. - Take due precautions to avoid disturbance to human habitations, tribal areas and places of cultural significance and minimize the same wherever inevitable.

Note: AASAL management shall have the responsibility to implement mitigation measures during operation

Air Environment

Dust generated as a result of clearing, leveling and site grading operations should be suppressed using water sprinklers. It should be ensured that the construction machinery using diesel driven prime movers are properly maintained to minimize exhaust emissions of CO, SPM and Hydrocarbons. Further, the construction activity should be restricted to daytime as far as possible to avoid disturbance to surrounding areas.

Noise Environment

All noise generating equipment used during the construction phase should be provided with noise control devices and properly maintained. Wherever required, personal protective equipment such as ear plugs, earmuffs etc. should be provided to the persons working in high noise areas, to minimize their exposure to noise.

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Air Impact	Incorporate consultant and engineers advice	- No Air Pollution
Soil Quality Degradation	Consider strategies to avoid soil quality degradation	
Occupational health hazard		- Periodic health check-up
Possible Impact	**Mitigation during planning and design**	**Mitigation during operation**
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Storage of Hazardous Materials

The hazardous materials stored at the construction site like acetylene cylinders, petroleum, spirit, diesel, lubricating oil, paints etc. should be stored as per the statutory provisions of Manufactures, Storage and Import of Hazardous Chemicals Rules. 1989 under the Environment (Protection) Act, 1986

Safety Measures

The site should have necessary security arrangements to prevent entry of unauthorized personnel and proper control of hazardous materials on site. All the employees as well as contractor's labour should be trained in safety aspects related to their job, with a special emphasis on safe handling of material, safety in welding and fabrication, working at heights etc. All the personnel should be provided with safety appliances such as face shields, helmets, safety Goggles, safety shoes, hand gloves etc., as per the job requirement.

To ensure that the local inhabitants are not exposed to these hazards, the site should be secured by fencing and manned at entry points.

Labour Deployment and Labour Camp Management Plan

AASAL shall draw a Labour Deployment & Welfare Management Plan for the proposed Solar PV project. The EPC Contractor and the sub-contractor shall ensure the compliance of the labour welfare arrangement plan:

- Accommodation for Labour – Provision of Military Tents for accommodating outstation labours
- Accommodation for Women Labour- Separate provision of Military Tents for accommodating women labours
- Prevention from Insects/Snakes – Carbolic Acid bottles will be buried under the ground surrounding the perimeter of the Labour accommodation area to prevent them from the risk of Snakes/Insects
- Sanitation for Labour – Portable Toilets/WC will be provided for Labour. Waste water will be disposed in septic tanks/ soak pits.
- Sanitation for Women Labour- Separate Toilets/ WC will be provided for women labour. Waste water will be disposed in septic tanks/ soak pits.
- Water Arrangements – Treated Water will be made available at Site for Labour drinking purpose.
- Health arrangements - Tying up with Local Doctor for any exigencies at site. Also the doctor will make occasional visits to site for Health check-up of labour
- Strict adherence to the Labour Laws applicable in the area of work will be ensured through robust Time Office department at Site.

6.6 Operation and Maintenance Phase

The problems envisaged during the operation and maintenance phase are accident, exposure to heat, noise, arc lights, chemicals etc. Suitable personnel protective equipment

should be provided to all employees, likely to be exposed to these situations. The working personnel should be given the following personnel protective equipment:

- Industrial safety helmet.
- Crash helmets.
- Face shield with replacement acrylic vision.
- Zero power plain Goggles with cut type filters on both ends.
- Welder's equipment for eye & face protection.
- Cylindrical type ear Plugs.
- Earmuffs.
- Canister gas mask.
- Self-contained breathing apparatus.
- Leather apron.
- Aluminised fibreglass fix proximity suit with hood and gloves.
- Safety belt/line man's safety belt.
- Leather hand gloves.
- Canvas cum leather hand gloves with leather palm.
- Electrical safety shoes with and without steel tie.
- Gum boots.

In addition, medical facilities should be made available round the clock for attending any medical emergency during construction & operation phases.

6.7 Waste Management Plan

Scope & Purpose of the Plan

This Waste Management Plan "WMP" identifies the wastes that are likely to be generated during the construction and operation of the proposed Plant and documents cradle to grave waste management practices to be employed for their collection, storage, treatment and/or disposal.

Specifically, the waste covered by this WMP includes the following sources:

- Construction and commissioning of plant and the associated facilities
- Operation of plant and the associated facilities throughout the project life-cycle.
- Temporary accommodation during construction phase for the workers.
- Other operations like equipment maintenance, road construction, site preparation etc. Operation and maintenance of infrastructures both during construction and operation phase.

WMP is intended to serve as a guideline for the project proponent & the contractor(s) to manage wastes effectively during construction and operation phase. The contractor(s)

should prepare their own WMP in compliance with this WMP and implement the same during the construction phase. AASAL should implement the WMP throughout the operational phase.

The WMP describes how wastes will be managed during the construction and operation phase of the project and how the project will:

- Minimize the potential to cause harm to human health and the environment.
- Comply with ADB's social safeguards policy statement and with Pakistan Environmental Regulations.
- Reduce operational costs and any potential liabilities which may arise from waste handling operations.

This plan also ensures that every waste stream and solid waste materials from the main plant site and the associated facilities will be managed effectively.

Solid and Hazardous Waste Management

The mitigation measures with respect to waste treatment, storage, handling and disposal during both phases of the project have been discussed below:

Construction Phase

- A waste inventory of various waste generated will be prepared and periodically updated. The excavated material generated will be reused for site filling and leveling operation to the maximum extent possible.
- The scrap metal waste generated from erection of structures and related construction activities will be collected and stored separately in a stack yard and sold to local recyclers. Food waste and recyclables viz. paper, plastic, glass etc will be properly segregated and stored in designated waste bins/containers. The recyclables will be periodically sold to local recyclers while food waste will be disposed through waste handling agency.
- Hazardous waste viz. waste oil etc will be collected and stored in paved and bundled area and subsequently sold to authorized recyclers. Necessary manifest for the same will be maintained.

Operational Phase

There should be no solid wastes likely to be generated during operation phase

6.8 Road Safety & Traffic Management Plan

The plan encompasses the addresses of community safety related impacts that may arise from the increased vehicular traffic due to movement of equipment/machineries and vehicles along the site access and approach roads particularly during construction phase. The plan will be regularly reviewed and as vehicle movement requirements are identified in detail.

During Construction Phase

The following mitigation measures will be implemented during this phase:

- Project vehicular movement will be restricted to defined access routes.
- Proper signage will be displayed at important traffic junctions along the vehicular access routes to be used by construction phase traffic. The signage will serve to prevent any diversion from designated routes and ensure proper speed limits are maintained near residential areas. Any road diversions and closures will be informed in advance to the project vehicles accessing the above route. Usage of horns by project vehicles will be restricted near sensitive receptors viz. schools, settlements etc.
- Traffic flows will be timed wherever practicable during period of increased commuter movement in the day.
- Temporary parking facilities should be provided within the work areas and the construction sites to avoid road congestion.
- Vehicular movement to be controlled near sensitive locations viz. schools, colleges, hospitals identified along designated vehicular transportation routes.
- Routine maintenance of project vehicles will be ensured to prevent any abnormal emissions and high noise generation.
- Adequate training on traffic and road safety operations will be imparted to the drivers of project vehicles. Road safety awareness programs will be organized in coordination with local authorities to sensitize target groups viz. school children, commuters on traffic safety rules and signage.

During Operational Phase

Since limited vehicular movement is anticipated during operational phase considering only the daily movement of project personnel any impacts arising from the same can be effectively addressed through implementation of mitigation measures as discussed during the construction phase.

6.9 Environmental Impacts Associated With Construction and Operation Stage

Environment Impacts due to Project Location and Design

Potential adverse environment impacts associated with transmission lines have been avoided or minimized through careful route selection. The alignment is sited away from major settlements, whenever possible, Forests areas and vegetation areas are avoided wherever possible; however, the route alignment passes through shrub lands, cultivated and abandoned fields. Alignment in this project has avoided geologically unstable areas, which can also pose foundation related problems. No land acquisition is required for placing transmission towers on private land.

Environmental Impacts Associated with Pre-Construction Stage

Acquisition of Cultivable and Non cultivable lands

There may be loss of agricultural productivity due to obstructions and reduced land availability. Thus the following measures will have to be taken prior to the project activities:

Protect /preserve topsoil and reinstate after construction is completed,

- Repair /reinstate damaged bunds after construction is completed, and
- Compensation for temporary loss in agricultural production.

Impact on Climate

The Transmission lines area consists of barren uncultivated lands. Also, there will be few removals of trees therefore there will be no impact on the climate conditions from the transmission lines during the construction and operation phases.

Impact on Air Quality

During the construction phase, the activity would involve excavation for the tower erection, movement of vehicles carrying the construction materials along the haul road (through un-built roads, which are not maintained).

All these activities would give rise to emission of dust particles thereby affecting air quality marginally at the site. The impact will be temporary in nature and therefore is assessed as of low significance. Covering of stockpiles and sprinkling of water during excavation will reduce the dust emission to a great extent. The construction of transmission line and the substation will not have any negative impact on the air quality of the region during the operation phase.

Impact on Noise Levels

During the construction phase, the major sources of noise pollution are movement of vehicles carrying the construction material and equipment to the site. Most of the access roads along the alignment are motor able and project traffic would be negligible. The major work of the construction is expected to be carried out during the day time. Apart from vehicles bringing in materials to the nearest road, construction works for the transmission line will require minimal powered equipment. As such, noise emissions will be minor. As the predominant land use along most part of the alignment is barren and inhabitated, there will be few residential areas exposed to noise generated during the construction phase and the noise produced during the construction period will have negligible impact on residents.

During the operation phase of the project, there may be corona noise from the conductors which will be felt only up to 15 to 30 m area, hence the ambient noise level will meet the CPCB standard for residential areas : 55 dB(A) during daytime and 45 dB(A) during night time

Impact on Surface Water Quality

There are no any major surface water bodies in the area. The construction and operation of the transmission lines will not have any major impact on the surface and ground water quality in the area.

Impact on Water Resources

Water needs during construction of the Project would be limited to sanitary water and minimal amounts of water for construction (such as spraying for dust prevention). This would be a negligible impact on water resources. Operation of the lines would not require any water.

Impact on Ground Water Quality

In Transmission line construction activity, no chemical substance or oil is used hence there is no impact on ground water quality

Impact on Terrestrial Ecology

There is no sensitive ecological area / protected forest area such as national wildlife park, bird sanctuary crossing the proposed route alignment. The removal of herbaceous vegetation from the soil and loosening of the top soil generally causes soil erosion. However, such impacts would be primarily confined to the project site during initial periods of the construction phase and would be minimized through adoption of mitigation measures like paving and surface treatment and water sprinkling.

Removal of Trees

As per the preliminary survey hardly any trees shall be removed during the line construction. The initial construction works along the alignment involving land clearance, cutting, filling, and leveling that may cause loss of vegetation. Appropriate compensation will be governed by the Resettlement Framework.

Effect on Local Road Network

Transformers, tower material, substation equipment, iron bars, concrete materials, piling equipment, will be transported through the provincial and local road network to the project site. This may impact local traffic temporarily. Appropriate maintenance all road sections, which will be utilized for the construction related activities shall be carried.

Disposal of Debris

As a result of construction related activities, spoil and debris will be generated during the construction stage. Proper disposal of the debris shall be ensured to minimize the impact on the surrounding ecology, public health and scenic beauty.

Impact on Human Environment

Project activities could impact the health and safety of the work force and of the general public, in particular, in terms of risk of accidents and exposure to electromagnetic fields along the alignment. The accidents may be caused due to electro-cutting, lightening, fires and explosions. Necessary training regarding safety aspects to the personnel working at the line will be provided by the contractor. Personal protective equipment like safety gloves, helmet, harness, Goggles, mufflers will be provided during construction period and during the maintenance work. First aid facilities will be made available with the labor gangs and doctors called in from nearby towns when necessary. Workers are also covered by the statutory Workmen Compensation as per GoP laws by the contractor.

Socio-Economics

Construction of transmission line will generate local employment, as number of unskilled labors will be required at the time of construction activities. Local employment during this period will increase socio-economic standards.

Resettlement and Rehabilitation

For the construction of transmission line, involuntary resettlement impacts is yet to be determined as some minor changes in transmission line route shall not be ruled out till AASAL obtains RoW permission for the transmission line. The land acquisition will not be done as far as possible. But, if AASAL has to do it under inevitable circumstances then AASAL will adopt and implement a Resettlement Framework consistent with the ADB Safeguard Policy Statement

Cultural sites

There are no archaeological, historical or cultural important sites along the route alignment, hence no impact on these sites is envisaged. In the case of discovery of archaeological features during excavation/construction works, a chance find procedure to notify relevant authorities will be put in place by AASAL.

Solid Waste Disposal

The solid waste generation will be at the location of the tower erection site which will include metal scraps, wooden packing material. Waste will be minimized and recycled wherever possible. Final waste will be collected and disposed of in compliance with applicable regulations and rules.

Liquid Waste Disposal

There will be no oil or chemical waste generated during the construction of transmission line, hence no mitigation is required.

Thus following measures are needed to protect and enhance the quality of environment during the construction stage:

- A better way to overcome garbage disposal as mentioned above by reducing or avoiding the need to construct labour camps, thus the selection of the majority of skilled and unskilled workers from the project area of influence will be a proper measure in this regard.
- Contractor shall provide adequate facilities, soak pits to manage liquid waste
- Provision of the solid waste disposal, sanitation and sewage facilities at all site of the construction/labour camps to avoid or minimize health hazards and environmental pollution.
- Contractor should handle and manage waste generated from the construction/labour camps without contamination to natural environment and it will reduce risk to general public who stay close to sites. Also contractor should be responsible to enhance the quality of environment.
- Adequate supply of water should be provided to the urinals, toilets and wash rooms of the workers' accommodation.

- Contractor shall provide garbage bins to all workers' accommodation and construction sites, for dumping wastes regularly in a hygienic manner in the area.

6.10 Safety and Emergency Plan

Safety of both men and material during construction and operation stages are of concern to industries. Keeping in view the safety requirements during construction and operation and maintenance phases, a safety policy will be formulated for the present Solar PV project. Separate safety rules should be prepared for each type of occupation / processes involved in the project in consultation with manufacturer / supplier of equipment and materials and regular safety inspection should be ensured by a competent person of all buildings, equipment, work places and operations.

6.10.1 Safety Organization

Organization already has a Safety Department headed by Senior Manager and having qualified and experienced supporting staff. The responsibilities of Safety Department include identification of the hazardous conditions and unsafe acts of workers and advise on corrective action, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of Safety Rules/Statutory provisions. Safety Department has prepared.

6.10.2 Safety Awareness Among Workers/Employees

Training programmes in safety and accident prevention should be organized at all levels of employees with a view to familiarize them with the general safety rules, safety procedures in various operational activities and to update their knowledge in safety and accident prevention, industrial hygiene and emergency equipment. These training programmes should be conducted periodically in a planned manner to refresh their knowledge.

6.10.3 First Aid Training

First aid training programmes should also be conducted for all employees with the help of qualified medical and para-medical staff. This programme may be conducted in batches. The programme should include basic first-aid techniques and should be repeated periodically to refresh knowledge

6.11 Accident Reporting

Whenever accidents or dangerous events occur such incidents should be reported as notified in the sections 88 and 88A of Factories Act 1948, amended from time to time and also as per the schedule 6 of the Manufacture, Storage and Import of Hazardous Chemicals (MSIHC) Rules, 1989.

6.12 Safety Review Check List

A checklist is one of the very useful tools for hazard identification. A checklist should be prepared and used as a final check that nothing has been neglected.

6.13 Fire Fighting Arrangement

Plant should be well equipped with fire protection systems and it has a fully-fledged fire station operated by Central Industrial Security Force (Fire Wing). The fire station is headed by Asstt. Commandant and has supporting staff at various levels. The fire control room is manned in 3 shifts round the clock.

6.14 Clean Development Mechanism

The Clean Development Mechanism (CDM) is one of the three mechanisms under the Kyoto Protocol (KP), 1997 that enables developing countries to assist developed countries in meeting their greenhouse gas (GHG) emission reduction targets.

Being a renewable energy source with zero (GHG) emissions, solar energy becomes eligible under various GHG reduction and climate change mitigation programs. The entire proceeds of carbon credit from approved CDM project, if any, should be retained by the generating company.

6.15 Environmental Monitoring Plan

Regular monitoring of critical environmental parameters is of immense importance to assess the status of environment during plant operation. The monitored data can serve as an indicator for any change in environmental quality due to operation of the plant with respect to baseline environmental conditions, so that suitable mitigatory steps could be taken in time to safeguard the environment.

Monitoring indicators have been developed for each of the activity considering the mitigation measures proposed.

6.16 Resettlement Budget and Financing Plan

Proponent plans to procure 375 acres of Government barren land for the project. The project would not result in physical and displacement as these lands are all barren and vacant. However AASAL will adopt a Resettlement Framework. Some provisions of the RF are described below:

- Procedure for damage tree compensation is in place with standard format. For damage of trees, horticulture department circular will be used for calculation and based on assessment of Tehsildar the amount will be paid. Additionally, the budget includes costs relating to the hiring of the staff, coordination, site visits by the expert and other logistic support for the disbursement of compensation to the APs. AASAL will ensure that the budget outlined in the assessment should be kept ready in advance for the timely payment of compensation. A contingency of 10% additional costs has been kept as a provision to meet any variation in the cost during implementation. A tentative budget has been calculated for the project and details for the same are given in table.

Resettlement Budget

Item	Unit Rate Rs	Amount (Rs)
A. Compensation for loss of trees	Lump sum	250,000
B. Provision for unanticipated impact due to construction of transmission line towers	Lump sum	2,500,000
Total (A+B)		2,750,000
Contingency (10% of the Compensation)		275,000
Grand Total (PKR)		3,025,000

6.17 Community Development Plan

Any company, along with active support from government, has a role to play in development of an area in which it works. In most cases, it is difficult to operate and do business without the cooperation of the local communities and other stakeholders. To build a good rapport with the local communities, it is essential to engage the local community along with the administrative machinery to develop an ongoing process of development of the villages surrounding the plant involving the kind of joint initiatives

The community development plan would initially be targeted nearby villages. But should be expanded to other areas. The various areas where involvement can be made are discussed below.

Health Care Facilities: Project proponent can help villagers by arranging the health care support in form of bi weekly clinics, family planning camps, eye camps, Mother – Child care camps, etc. and ambulance service can also support the developments of permanent health care facility in the project affected villages in consultation with the district administration. The centre should be equipped to handle primary level emergencies throughout the day and should be accessible to the villagers. It should also have the infrastructure and expertise required to handle delivery patients.

Drinking Water: At present people are dependent on the tube wells for the drinking water. Scarcity of water during summer months due the drop is water table has observed in the region. Proponent can undertake repair work of old tube wells and sinking of new tube wells or supply of low voltage electric motors as per the needs of the villagers.

6.18 Environmental Management Plan

Issue	Impact category (not significant, minor, moderate, major)	Mitigation Summary	Residual Impact
Construction Phase			
1- Ambient Air Quality			
• Fuel combustion Emissions from Diesel generator; • Dust emissions during construction activities	Minor	• Use vehicles in good running condition with emissions within the permissible limits as per National Environmental Quality Standards (NEQs) • Maintenance of equipment and vehicles; • Speed limit restrictions will be implemented on site • Dust suppression methods will be adopted where applicable • Water will be sprinkled daily or when there is obvious dust problem, on all exposed surface. • Excavated materials will be covered, as feasible, to reduce potential for windblown matter	Not significant / negligible
2- Ambient Noise			
• Machinery and equipment • Earth works	Minor	• Equipment and machinery will be maintained in good working conditions, • Proper design, maintenance and repair of construction machinery and equipment; • Use of proper silencers, mufflers and personal protective equipment's; • Nighttime traffic will be avoided near the	Not significant / negligible

		communities • Use of further reduction measures (e.g. mufflers) may be assessed. • If necessary a grievance mechanism will be adopted for assessing complaints associated with construction noise, if any.	
3- Soil			
• Clearing of small bushes and trees • Civil works • Septic tanks • Oil leaks and fuel spills	Moderate	• Land update to keep to a minimum • Proper domestic wastewater and waste management • Proper management of fuels used on to minimize release to soils • At decommissioning develop a re-instatement plan	Not significant
4- Biological Environment			
• Terrestrial biodiversity	Not significant	• Implement and update a solid waste management plan to include waste collection, storage, transport and disposal in an environmentally sustainable manner to avoid attraction of vermin • Hunting, trapping or harassment of wild life will be strictly prohibited and monitored • Personnel working during operational phase of the project will be strictly prohibited to hunting and trapping of wild life	Not Significant
5- Labor and workplace health and safety			
• Work environment health and safety	Moderate	• A health and safety policy will be applied throughout the project and among all project contractors.	

		◦ Abide by all national occupational health and safety regulations ◦ Provision of suitable PPE, training and ongoing safety checks ◦ Equipment periodic maintenance according to manufacturers' schedule ◦ Plan temporary traffic arrangements during construction within the construction area. Review the plan periodically with respect to site conditions. ◦ Give special consideration to local traffic management for the safety of pedestrians, especially near villages. ◦ The project will create employment opportunities for the nearby areas. All the precautionary measures as required for the safety of workers are applicable ◦ Take adequate precautions to prevent danger from electrical equipment ◦ Provide a readily available first aid unit including an adequate supply of sterilized dressing material and appliances. ◦ Ensure workers exposed to loud noise wear Ear plugs/ear muffs. ◦ As there is no road facing the solar PV project, therefore reflection of PV panels will not be a problem for traffic ◦ The project will not only provide electricity to the area but also create awareness of local	

		people to the solar PV technology. • Workers accommodation complies with IFC standards • AASAL, its contractors and sub-contractors comply with the national labor law	
6- Socio-economic			
• Employment	Positive	• work opportunities for local communities mostly during construction phase	Positive
• Water resources used during construction activities	Minor	• Water from the nearby facility will be used after getting approval from the concerned authority • Water contamination during construction will be avoided through proper waste disposal arrangement • Proper drainage system and waste disposal system will be implemented for guard room for domestic use • Excess water wastage will be avoided and monitored in routine.	• Minor • If using ready mix concrete the impact would be not significant
• Waste Management	Minor	• Septic tanks and soak pits will be used • Use of covered bins • Use separate Bins for recyclable material and other type of solid waste • Move waste from site on daily basis to avoid odour • Approved contractors will be hired for the recyclable waste material. • A separate waste area will be allocated for the project waste material as per the mentioned in	Minor

		the guidelines • Debris, Waste generated from construction material will be properly stored during the construction phase and will be removed from the site, once the construction is completed • Maintenance of vehicle and machinery will only be carried out at designated places to avoid any fuel spill	
• Waste water	Minor	• Conduct daily inspections at the construction site to ensure removal of construction debris. • Provide an adequate treatment facility to treat the sewage generated from toilets before discharge. • Store construction material containing fine particles in an enclosure so that sediment laden water does not drain into nearby water drains.	Minor
• Traffic: Impacts resulting from increased traffic movements	Moderate	• Transportation for individual project is estimated to be 60 or more vehicles/day in total during peak construction. • International standard of EHS will be followed • Personal Protective equipment will be provided during construction and operation phase to the workers • First Aid kits will be provided on site • Road Sign board will be fixed at appropriate places to reduce safety hazards associated with project related vehicular traffic • Project drivers will be trained on defensive driving	

		• Strict code of conduct will be followed • Also make safety precautions and display on the notice board of entry gate in both national and local language	
Operations			
1-Ambient Noise Impacts			
• Machinery and equipment	• Not significant	• Potential noise generating machines and equipment are designed to meet statutory regulations concerning noise. • Acoustic enclosures are installed for noise generating equipment, wherever possible such as inverters and transformers • Workers at noise generating machinery and equipment will be provided with the suitable personal protective equipment (PPEs) • If necessary a grievance mechanism will be adopted for assessing complaints associated with operation noise, if any.	• Not significant
2- Soil			
• Septic tanks • Oil leaks	Minor	• Proper domestic wastewater and waste management Proper management of fuels used on to minimize release to soils • At decommissioning develop a re-instatement plan • Septic tank integrity checking • Good house-keeping measures; and, • Emergency response plan to include response to spill scenarios.	Not significant

3. Impact on Biological Environment			
◦ Terrestrial biodiversity	Minor	◦ Implement and update a solid waste management plan to include waste collection, storage, transport and disposal in an environmentally sustainable manner to avoid attraction of vermin	Not significant/negligible
4. Labor and workplace health and safety			
◦ Work environment health and safety	Minor	◦ A health and safety policy will be applied throughout the project and among all project contractors. ◦ Abide by all national occupational health and safety regulations ◦ Provision of suitable PPE, training and ongoing safety checks ◦ Installing fire detection and fighting system ◦ Equipment periodic maintenance according to manufacturers' schedule	Not significant
5. Socio-economic			
◦ Employment	Positive	◦ Work opportunities for local communities mostly during construction phase	Positive
◦ Traffic: impacts resulting from increased traffic movements	Minor	◦ Transportation for individual project is estimated to be 10 vehicles/day during normal operation. ◦ Local workers in charge of O&M will be provided with decent sleeping amenities ◦ AASAL Power, its contractors and sub-contractors comply with the national labor law	not significant

7 CONSULTATION, PARTICIPATION AND DISCLOSURE

7.1 INTRODUCTION

The need for public consultation and disclosure arises from the universal belief that transparency and accountability are fundamental to fulfilling any development mandate and in strengthening public involvement in the decision making process.

For all Categories "A" and "B" projects the project proponent or third party experts must have consulted with project affected communities in a structured and culturally appropriate manner. The public consultation should involve affected communities; the process must ensure their free, prior and informed consultation (FPIC) and facilitate their informed participation.

7.2 CATEGORIZATION OF PROJECTS AND ACTIVITIES

- All projects and activities are broadly categorized in to two categories - Category A and Category B, based on the spatial extent of potential impacts and potential impacts on human health and natural and man-made resources.
- All projects or activities included as Category 'A' in the Schedule, including expansion and modernization of existing projects or activities and change in product mix, shall require prior environmental clearance from the Central Government in the Ministry of Environment and Forests (MoEF) on the recommendations of an Expert Appraisal Committee (EAC)
- All projects or activities included as Category 'B' in the Schedule will require prior

7.3 ADB'S SAFEGUARD POLICY STATEMENT:

As per the Safeguard Policy Statement (SPS) of ADB, a Public Consultation and participation plan needs to be included in the Report for all stages of the project (project design, construction and operations phase) for categories "A" and "B". Also, a documentation of meaningful consultation with affected local communities especially project affected persons needs to be carried out.

7.4 PARTICIPANTS OF DISCUSSION

The venue for the consultation was a primary school located in the village closest to the Project site. 45 persons attended the consultation, Community participants included people from different walk of the society. Participants include Numberdar (Village head), State revenue department officials, Teachers, equipment suppliers, employees and local villagers. It was attended by some prominent people of the locality as well as common villagers also.

List of attendees:

Sr No	Name of Stakeholder	Organization & Address
1	Mr. Shah Behram	Tehsil Dar Kulachi
2	Mr. Hazrat Sherdad Khan	Patwari Tehsil Luni
3	Mr. Abdul Ghaffar Khan	Girdawar, Tehsil Office
4	Mr. Daud Khan	District Counsellor, Union Council Luni
5	Mr. Habib Ullah	General Counsellor, Union Council Luni
6	Mr. SamiUllah Khan	Ex-Nazim, Union Council Luni
Villagers		
7	Mr. Surat Khan	
8	Mr. Ghulam Qasim.	
9	Mr. Abdul Wahab Khan, Msc Chemistry	
10	Mr. Barkat Ullah Khan	
11	Mr. Asif Khan Gandapur, Civil Engineer	
12	Mr. Abdul Hannan, Shop keeper	
13	Mr. Gul Zaman	
14	Mr. Taj Muhammad	

7.5 PUBLIC CONSULTATIONS (FIELD CONSULTATION)

To make the discussion unbiased and fruitful, prominent people from local community (Namberdar) were given the authority to conduct the local stakeholders' consultation process. It was decided to conduct the consultation process in the, local vernacular language and National language of Pakistan, so that the language barrier should not prove a hindrance in taking the process to its logical conclusion. Pamphlet and summary of projects were distributed among the public. The meeting started with the presentation made by officials about the company followed by the process of electricity generation using Solar Photovoltaic technology. Local stakeholders' were informed about the project execution, social and environment impact due to project especially during construction phase and utilization of local resources by company during construction phase. The local stakeholders were informed about the benefits of the project along with environment and social impact especially during construction phase.

During the interactive session, questions were raised by local community on various aspects such as impact of project on their economic conditions, future expansion plans of the project in the same locality, employment of local community in the project etc. which were answered satisfactory by the concerned person. Some of the issue raised by local stakeholders regarding additional economic activities, use of local resources by project company especially during construction phase is listed below. Initially, people have apprehension about their land being acquired for the project.

8 CONCLUSION AND RECOMMENDATIONS

Impacts are manageable and can be managed cost effectively - Environmental impacts are likely to result from the proposed transmission system development. Careful mitigation and monitoring, specific selection criteria and review/assessment procedures for sub-projects have been specified to ensure that minimal impacts take place. The detailed design would ensure inclusion of any such environmental impacts that could not be specified or identified at this stage are taken into account and mitigated where necessary. Those impacts can be reduced through the use of mitigation measures such as correction in work practices at the construction sites, or through the careful selection of sites and access routes.

The selected land is located within the government land. Thus acquisition of land will not be required from the surrounding communities. Since proposed land is covered with shrubs and weed plants, thus there is no need for removal of trees for the construction of the Solar PV project.

The proposed project will have number of positive impacts and negative impacts to the existing environment as follows:

- Significantly improvement in the economic activities in the surrounding areas due to generation of direct and indirect employment opportunities.
- There is negligible removal of trees for the transmission line, which is the main positive impact to the proposed project area. Compensatory afforestation will take place where tree removal is unavoidable.
- Environment pollution due to cut and fill operations, transportation of construction materials, disposal of debris, nuisance from dust, noise, vehicle fumes, black smoke, vibration are the short term negative impacts due to proposed project.

No reliable baseline information of water, air and noise / vibration exists with respect to transmission line and substation locations.

Proper GRM will have to be implemented by proponent to overcome public inconvenience during the proposed project activities. It is highly recommended to establish a tree replanting programme which would be undertaken as per the directives/requirements of the Forest Department, and financed by company where ever trees will be planted for corresponding number of trees that are cut.

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

8.1 CONCLUSION

An environment and social analysis has been carried out looking at various criteria such as topology, air, noise, water resources and water quality, ecology, demography of the area, climate and natural habitat, community and employee health and safety etc. The impact analysis, found that due to careful consideration of environmental and social aspects during route and site selection by proponent, no major adverse impacts are expected. There is no adverse impact on the migration of habitat, any natural existing land resources and effect in the regular life of people. The environment and social impact associated with transmission line project is limited to the extent of construction phase and can be mitigated through a set of recommended measures and adequate provision for environment and social impacts which cover monitoring, measuring and mitigation.

EMP has been prepared. Most impacts are expected to occur during the construction phase and are considered to be of a temporary nature. The transmission corridor was carefully selected after undergoing an options assessment. This enabled the right of way alignment to bypass villages and important water supplies and resources. The main project impacts are associated with clearing of shrub vegetation, waste management and excavation and movement of soils.

From this perspective, the project is expected to have a small "environmental footprint". No endangered or protected species of flora or fauna are reported at any of the subproject sites. Adequate provisions have been made for the environmental mitigation and monitoring of predicted impacts, along with their associated costs.

Grid connectivity study and its approval

JAVED SOLAR PARK (PVT) LTD. JSP

PESHAWAR ELECTRIC SUPPLY COMPANY

PROJECT MANAGEMENT UNIT PESCO PESHAWAR

Phone # 091-9210987, Fax # 091-9213018

No. CE (Dev)/ 933-34 / Dated 21 /02/2018

Chief Commercial Officer
PESCO Peshawar

Subject: **GRID INTERCONNECTION ASSESSMENT (GIA) OF JAVED SOLAR PARK 49.5 MW SOLAR POWER PROJECT BY AASAL SOLAR POWER PVT LTD. AT KULACHI, D.I.KHAN, KPK, PAKISTAN**

Reference (1) your officer letter No. CCO/M(PPC)Solar/Javed 2027-32 dated 24.11.2017
(2) This office letter No. CE (Dev)/258-61 dated 16.01.2018.
(3) CEO Javed Solar Power Project letter No. Nil dated 06.02.2018.

The site has already been visited by the representatives of PMU office, GSO office and GSC office. The observation raised by this office vide letter referred at S.No. 2 have been incorporated in the revised study received vide letter referred at S.No.3 above.

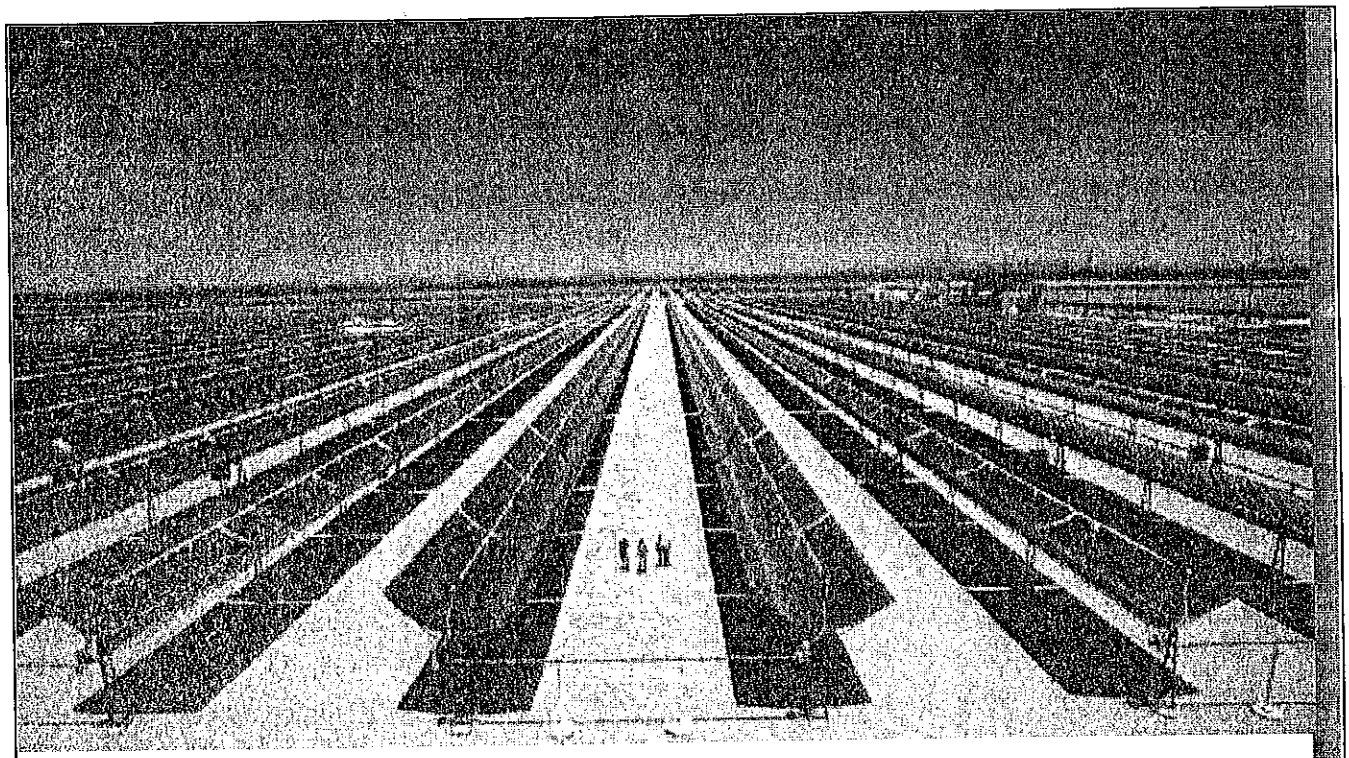
The revised Grid Interconnection Study has been vetted for Load Flow, Contingency, Short Circuit and Stability analysis. The proposed interconnection scheme through 2.5 km In/Out arrangement from 132 KV FAS Solar Power - 132 kV Grid Station Kulachi S/Circuit Transmission Line using Rail conductor for connecting the said Power Project is found technically feasible and approved.

Chief Engineer (Development)
PMU PESCO Peshawar

Copy to:

1. Mr. Abdul Basit Javed, CEO Javed Solar Power Project House No. 28, Street No.2, Sector E-11/1 Islamabad.

Received 21/2/18



GRID INTERCONNECTION ASSESSMENT OF 49.5MW JAVED SOLAR PV POWER PLANT

ARCO Energy

Final Report
January, 2018

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CONTENTS

EXECUTIVE SUMMARY

This Grid Interconnection Assessment (GIA) report provides the documentation of an assessment that has been performed for the connection of a 49.5MW (AC) Solar PV Power Generation project by JAVED Solar Park to the Peshawar Electric Supply Company (PESCO) transmission system at 132kV. The '49.5MW (AC) Solar PV Power Generation project' located in Tehsil DI Khan, KPK, Pakistan and has a commercial operation date of September 2019. The project will be connected by making an In/Out on 132kV Rail Single circuit between FAS Solar and Kulachi Substation by a feed length of 2.5km of Rail conductor.

Steady state power flow assessment has been performed using the base case provided by PESCO. Pre-project power flow study was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Post project power flow analysis has also been performed after the interconnection of the proposed project with the PESCO transmission system. The power flow results for the system intact and for the contingency conditions shows that the power flows on all the transmission line branches are within their normal thermal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

Dynamic stability analysis has been performed to access the dynamic impact of the Solar power plant on national grid system due to disturbances at the power plant and vice versa. The results of dynamic stability analysis indicate that the power system is stable for the interconnection proposal and it also fulfils all the criteria for generation connection with the power system.

Short circuit analysis has been performed to evaluate the contribution of the proposed project in fault current levels of substations in its electrical locality. Fault currents have been computed based on simulation of three-phase and single-line-to-ground faults by applying the criteria as mentioned in the IEC-60909 standard. Result of the analysis shows that the calculated fault currents are below the circuit-breaker interrupt ratings of existing grid stations located in locality of the project.

Based on the study results, it is concluded that proposed generation interconnection assessment for 49.5MW (AC) Solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This Grid Interconnection Assessment (GIA) report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by JAVED Solar Park "Project Owner" or "PO") for the connection of a 49.5MW (AC) Solar PV Power Generation project ("Project") to the Peshawar Electric Supply Company (PESCO) transmission System at 132kV. The PO has proposed a commercial operation date of September 2019 for the Project.

The project is located in Tehsil DI Khan, KPK. Figure 1.1 shows Google site map of the project. The pre-project and post-project geographical representation of power plant is shown in Figure 1.2 and Figure 1.3.

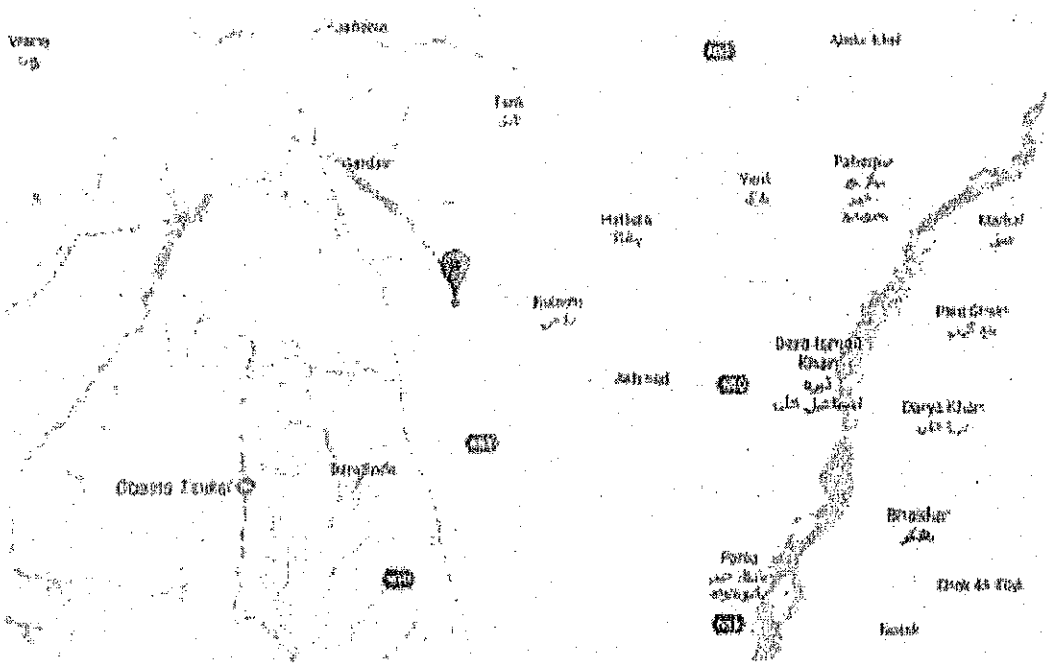

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Grid Interconnection Arrangement

The project will be connected by making an In/Out on 132kV Rail circuit between FAS Solar and Kulachi Substation by a feed length of 2.5Km of Rail conductor. The objective of the GIA is to evaluate the impact of the proposed solar power plant on the PESCO transmission system.

1.3 Study Components

GIA includes the following three types of analyses to evaluate the impact of interconnecting the proposed project:

i) Steady state analysis.

ii) Dynamic stability analysis.

iii) Short circuit analysis.

This report documents the results of the steady state, dynamic stability, short circuit and power quality analysis. The steady state analysis includes pre-project and post project power flow assessment. Dynamic stability analysis includes the post project dynamic stability assessment during occurrence of any fault. Short circuit analysis includes pre-project and post project short circuit current levels assessment at different buses in the vicinity of the project.

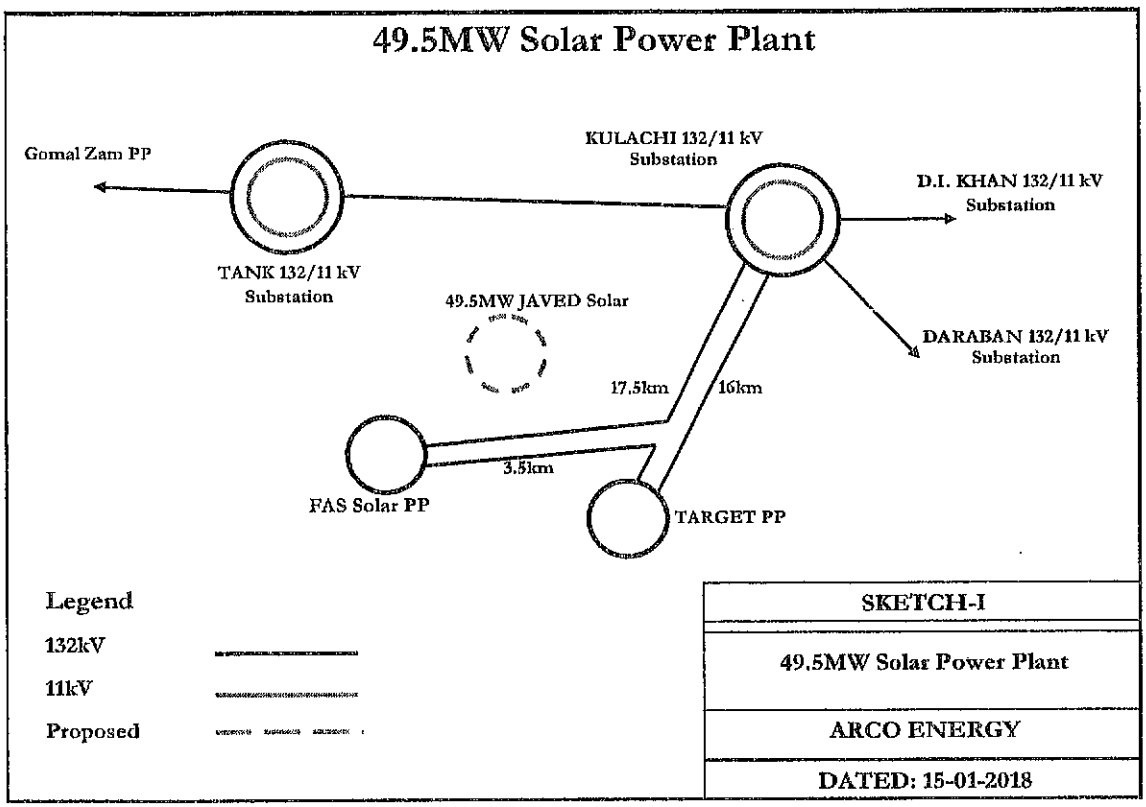

Figure 1.2: Existing Network around JAVED Solar Park.

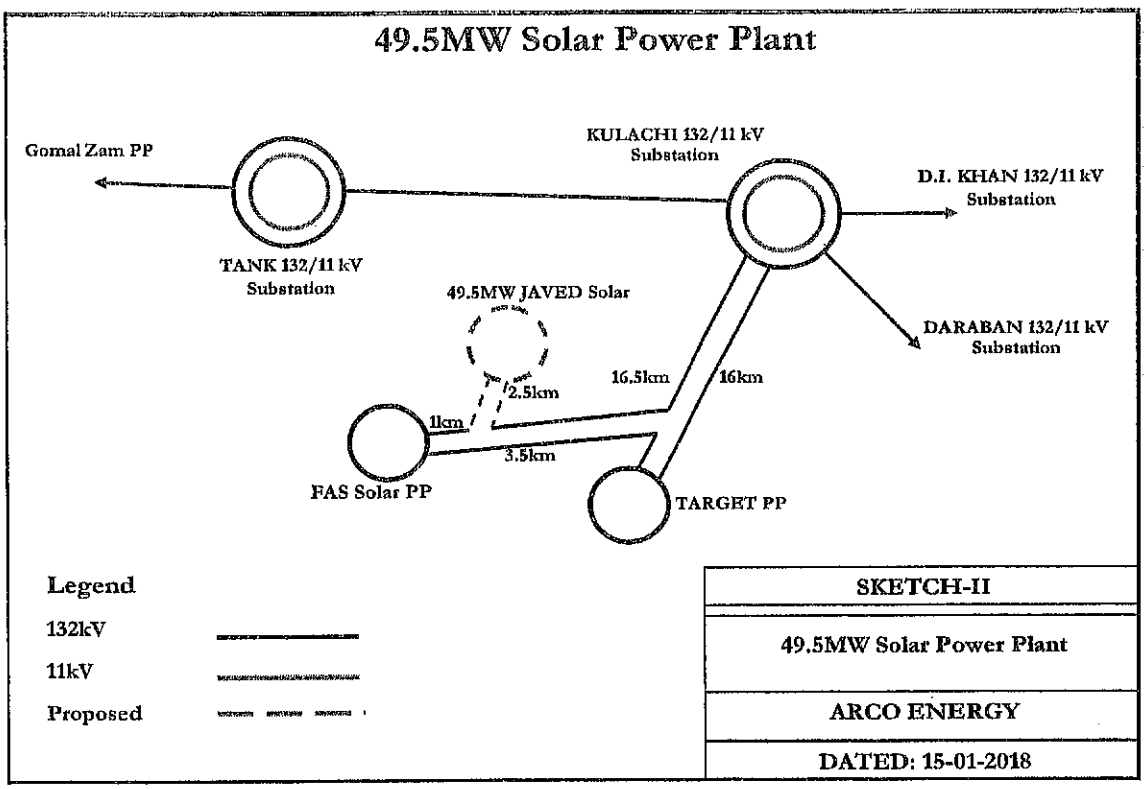

Figure 1.3: Interconnection Proposal of JAVED Solar Park.

2 STUDY METHODOLOGY

2.1 Study Criteria

GIA has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage	System Intact	±5 % p.u at load grids +8%,-5% p.u at generation switchyards
	Contingency	±10 % p.u
Thermal loading	System Intact	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Steady State Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95
Breaker Short Circuit Rating	132 kV	40kA
	11 kV	25kA

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on transmission system facilities under steady-state conditions. It involves two distinct analyses: thermal loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest which includes the following areas within PESCO:

- DARABAN
- DI KHAN
- KULACHI
- TANK
- CHASHMA

2.2.1 System Intact Analysis

The incremental impact of the project on thermal loading of transmission facilities under system intact conditions was evaluated by comparing transmission system power flows without and with the proposed project. Loadings of the transmission facilities without and with the project were tabulated and compared. The criteria to flag thermal overloads are 100% of continuous facility rating (Rate A in the power flow model).

2.2.2 Contingency Analysis

The contingency analysis for this study consists of single branch (N-1) outage in the study area.

2.2.3 Thermal Loading Analysis

132kV and 11kV rated transmission facilities in the study area have been monitored for thermal loadings.

2.2.4 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible pre and post project voltage violations in accordance with NEPRA Grid Code guidelines. In accordance with these guidelines, those buses that have a voltage change of more than ±5 %p.u (System Intact condition) and ±10%p.u (contingency condition) are considered affected.

2.3 Dynamic Stability Analysis

The purpose of dynamic stability analysis is to analyse the impact of the proposed solar power plant on transmission system facilities under transient conditions. The system is considered to be stable if the system recovers with good damping after the transients die out and the synchronism is retained.

Fault clearing time for different voltage levels in accordance with NEPRA Grid Code guidelines is presented in table below.

Voltage Level	Fault Type	Fault Clearing Time
132kV	3-Phase	5 Cycles (100 msec)
132kV (Stuck Breaker)	3-Phase	9 Cycles (180 msec)

2.4 Short Circuit Analysis

The purpose of short-circuit analysis is to investigate the fault current levels at nearby substations without and with the proposed project online. And to check whether the calculated pre-project and post-project fault currents are within the circuit breaker interrupt ratings. Short

circuit analysis has been carried out by applying the criteria as mentioned in the IEC-60909 standard.

Key assumptions in IEC-60909 are given below.

- Tap ratios to unity
- Line charging to zero
- Shunts are set to zero in positive sequence
- Desired voltage magnitude at bus bars is set to 1.1p.u.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in Annexure-A. The steady state model of the power plant is presented in table below:

Generator		
No. of Collector Units	4	1
Generation size of each collector (MVA)	10	9.5
Active Power of each collector Pgen. (MW)	9.5	8.55
Power Factor	0.95 lagging, 0.95 leading	
Qmin, Qmax (MVAR)	-3.1225,3.1225	2.8102,-2.8102
Rated Frequency	50 Hz	
Generation Voltage	0.4kV	
Xsource	∞	
Switchyard Transformer		
No. of Transformer units	2	
MVA Capacity of each GSU	50	
Rating	33/132kV	
% Reactance (X)	13%	
(X+ve) = (Xzero) At 100MVA system base.	0.26 p.u	
Generation Step Up (GSU) Transformer		
No. of Transformer units	5	
MVA Capacity of each GSU	12.5	
Rating	0.4/33kV	
% Reactance (X)	9%	
(X+ve) = (Xzero) At 100MVA system base.	0.72 p.u	

Steady state power flow assessment has been performed using the already available network data of PESCO.

3.2 Pre Project Power Flow Assessment

A pre-project power flow study was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The results of the pre-project power flow analysis are in **Annexure-C**.

3.2.1 Base Year 2019: Peak Loading Summer

Power flow analysis has been performed on the peak loading summer (September) case of PESCO network. This base case included a detailed representation of the PESCO transmission system in the study area.

The power flow results for the system intact conditions show that the power flows on all the transmission line branches are within their normal thermal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area. The results of the pre-project power flow analysis are plotted in **Annexure-C.**

3.3 Post Project Power Flow Assessment

Post project power flow study was conducted to determine the reliability impact of the proposed 49.5MW JAVED Solar Park project on the PESCO transmission system. This includes the performance of a contingency analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the post project power flow analysis are plotted in **Annexure-D.**

3.3.1 Base Year 2019: Peak Loading Summer

A base case has been developed for peak loading summer (September) 2019 that allow us to judge the maximum impact of JAVED Solar Park project on the PESCO network, using the network data supplied by PESCO.

Post-project power flow analysis has been performed after the interconnection of the proposed project with the PESCO transmission system. This includes the detailed representation of the power plant. A simulation of all possible contingencies within the NEPRA Grid Code planning criteria has also been carried out.

The steady state results for the system intact and contingency conditions depicts that the power flows on all the transmission line branches are within their normal thermal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Results from the power flow analysis are presented in table below.

Condition	Contingent Branch	Figure No.	Steady State Result
System Intact	-N.A-	Figure D-1	No overloading
Contingency	JAVED Solar to FAS Solar PP line out	Figure D-1.1	No overloading
Contingency	JAVED Solar PP to KULACHI line out	Figure D-1.2	No overloading
Contingency	KULACHI to TANK line out	Figure D-1.3	No overloading
Contingency	KULACHI to D.I KHAN line out	Figure D-1.4	No overloading

3.3.2 Base Year 2020: Peak Loading Winter

A base case has been developed for peak loading winter (January) 2020 that allow us to judge the maximum impact of JAVED Solar Park project on the PESCO network, using the network data supplied by PESCO.

Post-project power flow analysis has been performed after the interconnection of the proposed project with the PESCO transmission system. This includes the detailed representation of the power plant. A simulation of all possible contingencies within the NEPRA Grid Code planning criteria has also been carried out.

The steady state results for the system intact and contingency conditions depicts that the power flows on all the transmission line branches are within their normal thermal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Results from the power flow analysis are presented in table below.

Condition	Contingent Branch	Figure No.	Steady State Result
System Intact	-N.A-	Figure D-2	No overloading
Contingency	JAVED Solar to FAS Solar PP line out	Figure D-2.1	No overloading
Contingency	JAVED Solar PP to KULACHI line out	Figure D-2.2	No overloading
Contingency	KULACHI to TANK line out	Figure D-2.3	No overloading
Contingency	KULACHI to D.I KHAN line out	Figure D-2.4	No overloading

3.3.3 Future Year 2023: Peak Loading Summer

A base case has been developed for peak loading summer (September) 2023 that allow us to judge the maximum impact of JAVED Solar Park project on the PESCO network, using the network data supplied by PESCO.

Post-project power flow analysis has been performed after the interconnection of the proposed project with the PESCO transmission system. This includes the detailed representation of the power plant. A simulation of all possible contingencies within the NEPRA Grid Code planning criteria has also been carried out.

The steady state results for the system intact and contingency conditions depicts that the power flows on all the transmission line branches are within their normal thermal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Results from the power flow analysis are presented in table below.

Condition	Contingent Branch	Figure No.	Steady State Result
System Intact	-N.A-	Figure D-3	No overloading
Contingency	JAVED Solar to FAS Solar PP line out	Figure D-3.1	No overloading
Contingency	JAVED Solar PP to KULACHI line out	Figure D-3.2	No overloading
Contingency	KULACHI to TANK line out	Figure D-3.3	No overloading
Contingency	KULACHI to D.I KHAN line out	Figure D-3.4	No overloading

4 Power and Energy Loss Calculations

Power and energy loss calculations are analysed on both connection arrangements. Each one is discussed in detail below.

4.1 System Intact Conditions

Refer to Figure D-1 for system intact conditions, the power loss and energy loss is calculated as under;

$$\text{Power Loss} = \frac{Power\ sent(MW) - Power\ received(MW)}{Power\ sent(MW)}$$

$$\%\ \text{Power Loss} = \frac{46.55 - 46.23}{46.55} \text{ x } 100$$

% Power Loss = 0.5747%

$$\text{Energy Loss} = \frac{Energy\ sent(MWh) - Energy\ received(MWh)}{Energy\ sent(MWh)}$$

$$\%\ \text{Energy Loss} = \frac{407778 - 405439.08}{407778} \text{ x } 100$$

% Energy Loss = 0.5747%

4.2 N-1 Contingency Conditions

Refer to Figure D-1.1 for N-1 contingency conditions, the power loss and energy loss is calculated as under;

$$\text{Power Loss} = \frac{Power\ sent(MW) - Power\ received(MW)}{Power\ sent(MW)}$$

$$\%\ \text{Power Loss} = \frac{46.55 - 46.386}{46.55} \text{ x } 100$$

% Power Loss = 0.352%

$$\text{Energy Loss} = \frac{Energy\ sent(MWh) - Energy\ received(MWh)}{Energy\ sent(MWh)}$$

$$\%\ \text{Energy Loss} = = \frac{407778 - 406341}{407778} \text{ x } 100$$

% Energy Loss = 0.352%

5 DYNAMIC STABILITY ANALYSIS

Dynamic stability analysis has been performed to access the dynamic impact of the solar power plant on national grid system due to disturbances at the power plant and vice versa.

5.1 Dynamic Model Development

Generic dynamic models, available in the PSSE model library, for the solar power plant have been used to develop the dynamic model of the power plant. Dynamic model of the power plant is presented in table below;

Component	Model
Generator	PVGU1
Electrical	PVEU1
Mechanical	PANELU1
Pitch	IRRADU1

5.2 Post-Project Dynamic Stability Assessment

5.2.1 Base Year 2019: Peak Loading Summer

Dynamic stability analysis has been carried out for the Base Year 2019 peak loading summer conditions. To access the dynamic behavior of power plant and system towards the disturbances, simulations have been carried out of 3 Phase fault at JAVED Solar Park cleared in 5 cycles.

Each simulation has been performed for one second to depict steady state condition. Then fault is applied and system has been simulated for the fault clearance time. Post-fault condition has been simulated, from clearance of fault followed by a certain contingency, till fifteen seconds.

5.2.2 3 Phase fault at JAVED Solar Park cleared in 5 cycles

Three phase fault has been applied at JAVED Solar Park, fault has been cleared in 100msec (5 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-1: 3 Phase fault at 132kV JAVED Solar Park bus cleared in 5cycles (Standard Opening in 100msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-1.1	132kV line from JAVED Solar to FAS Solar	Bus Voltages of (i) 0.4kV JAVED LV (ii) 132kV JAVED Solar (iii) 132kV FAS Solar (iv) 132kV Target (v) 132kV Kulachi	E-1.1A	Stable
		Frequency of (i) 132kV JAVED Solar Bus	E-1.1B	Stable
		MW and MVAR of one collector group of JAVED Solar PP.	E-1.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam (ii) Chashma (iii) Tarbela	E-1.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) JAVED Solar to FAS Solar Bus (ii) JAVED Solar to Tank Bus	E-1.1E	Stable
E-1.2	132kV line from JAVED Solar PP to KULACHI	Bus Voltages of (i) 0.4kV JAVED LV (ii) 132kV JAVED Solar (iii) 132kV FAS Solar (iv) 132kV Target (v) 132kV Kulachi	E-1.2A	Stable

No.	Contingency	Monitored Element	Figure No.	System Response
		Frequency of (i) 132kV JAVED Solar Bus	E-1.2B	Stable
		MW and MVAR of one collector group of JAVED Solar PP.	E-1.2C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam (ii) Chashma (iii) Tarbela	E-1.2D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) JAVED Solar to FAS Solar Bus (ii) JAVED Solar to Tank Bus	E-1.2E	Stable

5.2.3 3 Phase fault at FAS Solar Park cleared in 5 cycles

Three phase fault has been applied at FAS Solar Park, fault has been cleared in 100msec (5 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-2: 3 Phase fault at 132kV FAS Solar Park bus cleared in 5cycles (Standard Opening in 100msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-2.1	132kV line from JAVED Solar to FAS Solar	Bus Voltages of (i) 0.4kV JAVED LV (ii) 132kV JAVED Solar (iii) 132kV FAS Solar (iv) 132kV Target (v) 132kV Kulachi	E-2.1A	Stable
		Frequency of (i) 132kV JAVED Solar Bus	E-2.1B	Stable
		MW and MVAR of one collector group of JAVED Solar PP.	E-2.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam (ii) Chashma (iii) Tarbela	E-2.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) JAVED Solar to FAS Solar Bus (ii) JAVED Solar to KULACHI Bus	E-2.1E	Stable

5.2.4 3 Phase fault at KULACHI cleared in 5 cycles

Three phase fault has been applied at KULACHI, fault has been cleared in 100msec (5 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-3: 3 Phase fault at 132kV KULACHI bus cleared in 5cycles (Standard Opening in 100msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-3.1	132kV line from JAVED Solar to KULACHI	Bus Voltages of (i) 0.4kV JAVED LV (ii) 132kV JAVED Solar (iii) 132kV FAS Solar (iv) 132kV Target (v) 132kV Kulachi	E-3.1A	Stable
		Frequency of (i) 132kV JAVED Solar Bus	E-3.1B	Stable
		MW and MVAR of one collector group of JAVED Solar PP.	E-3.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam (ii) Chashma (iii) Tarbela	E-3.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) JAVED Solar to FAS Solar Bus (ii) JAVED Solar to KULACHI Bus	E-3.1E	Stable

5.2.5 3 Phase fault at JAVED Solar Park cleared in 9 cycles

Three phase fault has been applied at JAVED Solar Park, fault has been cleared in 180msec (9 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-4: 3 Phase fault at 132kV JAVED Solar Park bus cleared in 9cycles (Standard Opening in 180msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-4.1	132kV line from JAVED Solar to FAS Solar	Bus Voltages of (i) 0.4kV JAVED LV (ii) 132kV JAVED Solar (iii) 132kV FAS Solar (iv) 132kV Target (v) 132kV Kulachi	E-4.1A	Stable
		Frequency of (i) 132kV JAVED Solar Bus	E-4.1B	Stable
		MW and MVAR of one collector group of JAVED Solar PP.	E-4.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam (ii) Chashma (iii) Tarbela	E-4.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) JAVED Solar to FAS Solar Bus (ii) JAVED Solar to KULACHI Bus	E-4.1E	Stable
E-4.2	132kV line from JAVED Solar PP to KULACHI	Bus Voltages of (i) 0.4kV JAVED LV (ii) 132kV JAVED Solar (iii) 132kV FAS Solar (iv) 132kV Target (v) 132kV Kulachi	E-4.2A	Stable

No.	Contingency	Monitored Element	Figure No.	System Response
		Frequency of (i) 132kV JAVED Solar Bus	E-4.2B	Stable
		MW and MVAR of one collector group of JAVED Solar PP.	E-4.2C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam (ii) Chashma (iii) Tarbela	E-4.2D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) JAVED Solar to FAS Solar Bus (ii) JAVED Solar to KULACHI Bus	E-4.2E	Stable

5.2.6 3 Phase fault at FAS Solar Park cleared in 9 cycles

Three phase fault has been applied at FAS Solar Park, fault has been cleared in 180msec (9 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-5: 3 Phase fault at 132kV FAS Solar Park bus cleared in 9cycles (Standard Opening in 180msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-5.1	132kV line from JAVED Solar to FAS Solar	Bus Voltages of (i) 0.4kV JAVED LV (ii) 132kV JAVED Solar (iii) 132kV FAS Solar (iv) 132kV Target (v) 132kV Kulachi	E-5.1A	Stable
		Frequency of (i) 132kV JAVED Solar Bus	E-5.1B	Stable
		MW and MVAR of one collector group of JAVED Solar PP.	E-5.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam (ii) Chashma (iii) Tarbela	E-5.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) JAVED Solar to FAS Solar Bus (ii) JAVED Solar to KULACHI Bus	E-5.1E	Stable

5.2.7 3 Phase fault at KULACHI cleared in 9 cycles

Three phase fault has been applied at KULACHI, fault has been cleared in 180msec (9 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-6: 3 Phase fault at 132kV KULACHI bus cleared in 9cycles (Standard Opening in 180msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-6.1	132kV line from JAVED Solar to KULACHI	Bus Voltages of (i) 0.4kV JAVED LV (ii) 132kV JAVED Solar (iii) 132kV FAS Solar (iv) 132kV Target (v) 132kV Kulachi	E-6.1A	Stable
		Frequency of (i) 132kV JAVED Solar Bus	E-6.1B	Stable
		MW and MVAR of one collector group of JAVED Solar PP.	E-6.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam (ii) Chashma (iii) Tarbela	E-6.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) JAVED Solar to FAS Solar Bus (ii) JAVED Solar to KULACHI Bus	E-6.1E	Stable

Dynamic Stability Analysis Results are attached in **Annexure-E**.

6 SHORT CIRCUIT ANALYSIS

Short circuit analysis has been performed to determine the need for any breaker replacements due to impacts of the solar power plant project. Single-line-to-ground and three-phase fault current values have been calculated for buses in the vicinity of the solar power plant project. The calculated fault currents observed at these buses were compared with the interrupting current capabilities of corresponding circuit breakers to determine need for upgrading existing circuit breakers.

6.1 Short Circuit Model Development

Short circuit database provided by PESCO has been used as a base case to perform short circuit assessment. The study project has been added to the base case to develop the post-project case. The short circuit model of the power plant is presented in table below.

Generator Data	
X (+ve)	∞
X (-ve)	∞
X (zero)	∞

6.2 Post-Project Short Circuit Assessment

With the addition of power plant, short circuit current at each bur bar is increased, so the circuit breaker capacity has analysed. Post-project short circuit assessment has been performed to evaluate the contribution of the proposed project in fault current levels of substations in its electrical locality and to compute the fault levels at JAVED Solar Park.

6.2.1 Maximum Short Circuit: Year 2019

The maximum short circuit levels have been computed according to IEC-60909 standard. Pre and Post project maximum short circuit levels at the buses within the study area in the year 2019 have been presented in table below.

Bus Name	Bus kV	Pre-Project		Post Project	
		1-Φ Fault Level (kA)	3-Φ Fault Level (kA)	1-Φ Fault Level (kA)	3-Φ Fault Level (kA)
Javed Solar MV	33	-N.A-	-N.A-	0	6.282
Javed Solar PP	132	-N.A-	-N.A-	1.877	3.009
FAS Solar PP	132	1.866	2.959	1.877	3.009
TARGET	132	1.872	2.977	1.894	3.034
KULACHI	132	2.218	3.503	2.269	3.583
D.I. Khan	132	3.464	5.447	3.494	5.495

Pre and Post project maximum short circuit analysis summary for the future year 2019 are attached in **Appendix F-1 and F-2** respectively.

Note:

In the attached short circuit study reports, both three phase and single phase fault currents with polar coordinates and detailed output showing contribution from adjoining sources (i.e. lines and transformers connected to the bus bar) to the fault currents are included.

7 CONCLUSIONS

7.1 Steady State Assessment

Steady state power flow assessment has been performed using the already available network data of PESCO. Pre-project power flow study was conducted to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Post project power flow analysis has also been performed after the interconnection of the proposed project with the PESCO transmission system. The power flow results for the system intact and for the contingency conditions showed that the power flows on all the transmission line branches are within their normal thermal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The Solar power plant will connect to 132kV Rail single circuit KULACHI – FAS Solar PP transmission line by making In/Out connection at JAVED Solar 132kV switch yard with feed length of 2.5Km Rail Conductor.

The steady state results found no capacity constraint in terms of power flow and voltage ranges. Both options are further analysed and investigated under the influence of power & energy losses, cost of equipment installed, cost of augmentation required at substation.

7.2 Dynamic Stability Assessment

Dynamic stability analysis has been performed to access the dynamic impact of the solar power plant on national grid system due to disturbances at the power plant and vice versa. The results of dynamic stability analysis indicate that the power system is stable for the interconnection proposal and it also fulfils all the criteria for generation connection with the power system.

7.3 Short Circuit Assessment

Short circuit analysis has been performed to evaluate the contribution of the proposed project in fault current levels of substations in its electrical locality. Fault currents have been computed based on simulation of three-phase and single-line-to-ground faults by applying the criteria as mentioned in the IEC-60909 standard. Result of the analysis shows that the calculated fault currents are below the circuit-breaker interrupt ratings of existing grid stations located in locality of the project.

Hence, it is concluded that based on the study results the proposed generation interconnection assessment for 49.5MW JAVED Solar Park meets the NEPRA grid code planning criteria.