FAS ENERGY PAKISTAN

(SMC - PRIVATE) LIMITED

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

Date: July 23, 2018

Subject: **Application for a Generation License for 50MWp Solar Power Plant located at Kulachi, District Dera Ismail Khan, Province of Khyber Pakhtunkhwa**

Dear Sir,

I, Tariq Ahmad Khan, Director, being the duly authorized representative of FAS Energy Pakistan (SMC-Private) Limited by virtue of board resolution dated 2nd July 2018, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to FAS Energy Pakistan (SMC-Private) Limited pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of the above-said regulations. 1 further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

A BANK DRAFT/ PAY ORDER No. **00312826** dated 17/07/2018 of United Bank Limited amounting to PKR 314,752 /- (Pakistani Rupees Three Hundred Fourteen Thousand Seven Hundred Fifty-Two Rupees Only), being the nonrefundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations 1999 is also attached herewith.

Yours faithfully,

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

Tariq Ahmad Khan
Director and Authorized Representative
FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

FAS ENERGY PAKISTAN

(SMC - PRIVATE) LIMITED

Board Resolution

Extract of resolutions passed unanimously by the board of directors of FAS Energy Pakistan (SMC -Private) Limited on 2nd July 2018:

"RESOLVED THAT FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED, a company incorporated under the laws of Pakistan with registration number 0119912 and having its registered office located at First floor, Boquival Tower, Plot No 80, Street 27A, Crimson Road, Sector H, D.H.A. Phase 2, 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 50 MWp Solar Power Project to be located at 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. Tariq Ahmad Khan, Director be and is hereby empowered and authorized for and on behalf of the Company to:

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

(ii) represent the Company in all negotiations, representations, presentations, hearings, proceedings, conferences and /or meetings of any nature whatsoever with any entity (including, but in no manner 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 his sole and absolute discretion to communicate with, make presentations

to and attend NEPRA hearings and to appear before NEPRA or any other relevant regulatory or governmental authority in any proceedings, hearings or representations pertaining to the Company or the Project;

(iv) do all such acts, matters and things as may be necessary for carrying out the aforesaid purposes and to give full effect to each of the matters approved in the above resolutions."

"**AND FURTHER RESOLVED THAT** Mr. Tariq Ahmad Khan, CEO and 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 he may deem appropriate.

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

Mr.Tariq Ahmad Khan
Chief Executive Officer

Mr. Adnan Khan
Company Secretary

First Floor, Boquival Tower, Plot # 80, Street # 27A, Crimson Road, Sector H
DHA-Phase 2, Islamabad, Pakistan.
Landline: +92 (51) 5418644

Prospectus

Introduction to the Sponsors

The sponsor of the Project is FAS Power Trading Company KSA ("FAS Energy") which owns 100% shares of the company. FAS ENERGY is the renewable energy development arm of FAWAZ AL HOKAIR group based out of Saudi Arabia. Fawaz Abdulaziz Al Hokair Co (known as: Al Hokair Group) is a public company, listed on Saudi Stock Exchange "Tadawul" (TDWL) since December 2006. Al Hokair Group, one of the largest group of companies in the Kingdom of Saudi Arabia involved in energy, retail, hotels and real estate business sectors, operates across Southern and Central Asia, Northern Africa, Middle East and Southern Europe. Al Hokair Group is based in Riyadh, Saudi Arabia and was established in March 1990.

FAS Energy is a leading provider of utility-scale, commercial and industrial solar photovoltaic (PV) for utilities and other business interested in renewable energy. In recent times FAS Energy has signed two Power Purchase Agreements (PPAs) for 50 MWp Solar Power Projects each with the Egyptian and Jordanian Governments.

Introduction to the Project

The Applicant obtained the Letter of Intent (LOI) from Pakhtunkhwa Energy Development Board (PEDO), Government of Khyber Pakhtunkhwa on September 29, 2016 for 50 MWp Solar PV Power Generation Project at Kulachi, Dera Ismail Khan, Khyber Pakhtunkhwa.

The project site is near Badshahabad village, Mosa Luni, Tehsil Kulachi; approximately 65 KM north-west of Dera Ismail Khan and about 17 km from Kulachi City. It is located at 31°55'49"N 70°27'31"E at an altitude of 209 meters having a distance of approximately 444 km from Islamabad.

The Project site consists of approximately 250 acres of land area. The Project Company has entered into an "Agreement to Sell" with the owners of the project land. Till issuance of Letter of Support, the project land remains under lease arrangement between the Project Company and the owners. Immediately upon issuance of Letter of Support, ownership of the land shall be transferred to the Project Company. As per terms of the executed agreement, land owners cannot terminate the agreement". A copy of the executed Agreement to Sell between Land Owners and the Project Company is attached herewith as Annex-A.

The complete feasibility study, carried out by DNV GL Energy Advisory UAE; was submitted to PEDO which was approved on June 29, 2018. The Electrical and Grid Interconnection Studies was conducted by ARCO Energy, and approved by PESCO on 21st February 2018. Initial Environmental Examination (IEE) Report of the project has been approved by Directorate of Environmental Protection Agency, Southern Region D.I Khan of Forestry, Environment & Wildlife Department-Government of Khyber Pakhtunkhwa on 22nd January 2018.

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

Salient Feature of the Facility for which license is sought

Project Capacity	50MWp
Type of generation Facility	Solar PV Power Plant
Type of Technology	Crystalline Silicon
Module	p-Si - Jinko Solar
Inverter	Huawei 2000-36KTL
Purposed Interconnection Scheme	2.5 KM In/Out arrangement with 132 kV Grid Station Kulachi

The Project will apply 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 is March 2020, subject to award of tariff and execution of concession agreements.

Proposed investment

The total cost of the project is approximately US$ 47.8 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$ 38.2 million while total equity component is estimated at US$ 9.6 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 by DNV GL AS, Dubai Branch, United Arab Emirates, on behalf of FAS, 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.

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

SCHEDULE - I

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

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

The Location

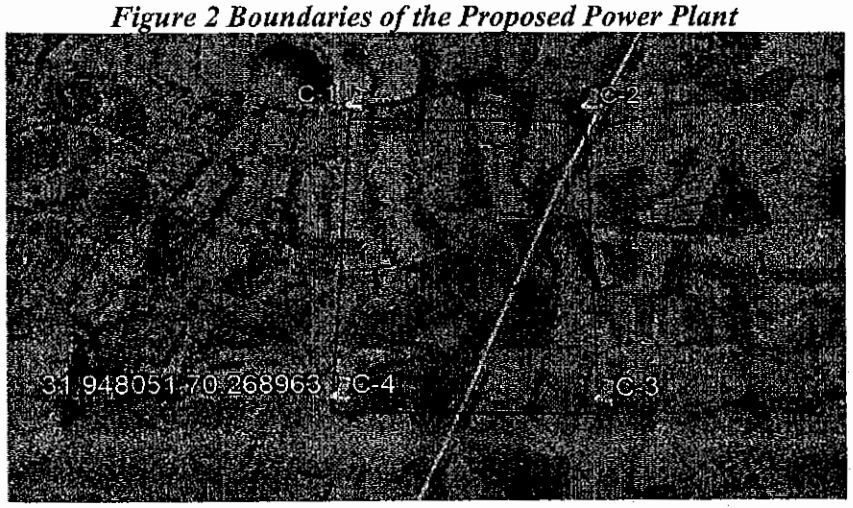
The project site is near Badshahabad village, Mosa Luni, Tehsil Kulachi; approximately 65 KM north-west of Dera Ismail Khan and about 17 km from Kulachi City.

Figure 1: Location of the proposed Solar PV Power Project

Location Coordinates of the Proposed Project Location

Point	Latitude (N)	Longitude (E)
C 1	31.958981	70.269122
C 2	31.958897	70.278165
C 3	31.947916	70.278007
C 4	31.948051	70.268963

Figure 2 Boundaries of the Proposed Power Plant

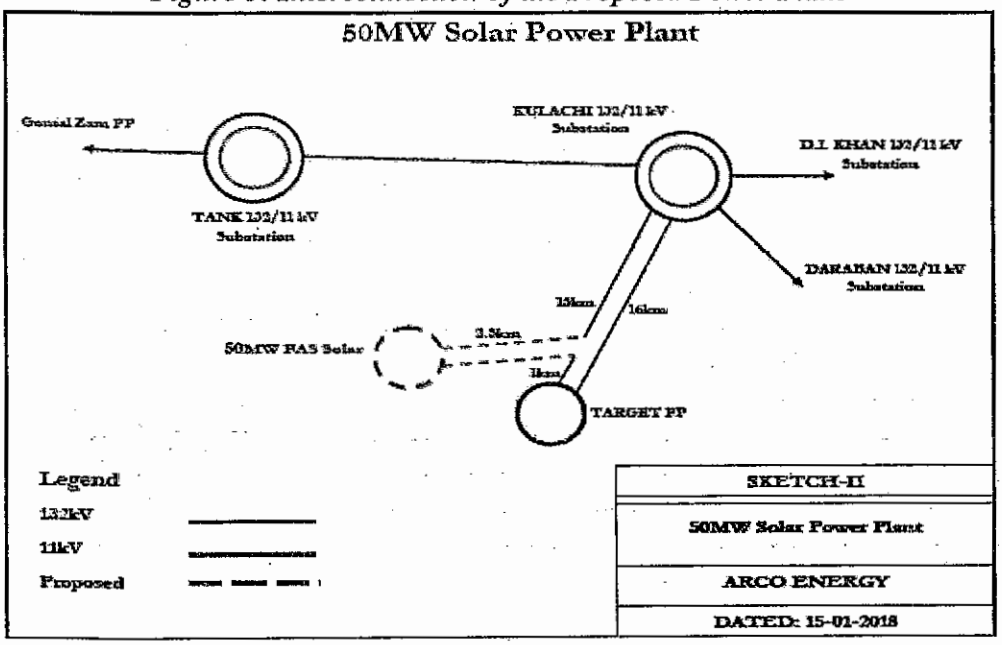


FAS ENERGY, PAKISTAN (SMC-PRIVATE) LIMITED.

Interconnection Arrangement / Transmission Facilities for Dispersal of Power from the Generation Facility

The electric power generated from the Generation Facility/Power Plant shall be sold to Central Power Purchasing Agency Project Management Unit (PMU) of PESCO has vetted the Grid Interconnection Study of the project for Load Flow, Contingencies, Short Circuit and Stability Analysis and approved the interconnection scheme through 2.5 km (feed length of Lynx Conductor) In/Out arrangement from single circuit of 132 KV Kulachi Solar Power – 132 kV Grid Station Kulachi D/C Circuit Transmission Line using Rail Conductor for connecting the proposed generation facility.

Figure 3: Interconnection of the Proposed Power Plant



FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

Details of Generation Facility

A. Solar Power Generation Technology and Capacity

I	Type of Technology	Photovoltaic (PV) with single-axis tracking
ii	System Type	Grid Connected
iii	Installed Capacity of Solar Farm (MW)	50 MWp

B. Technical Details of Equipment

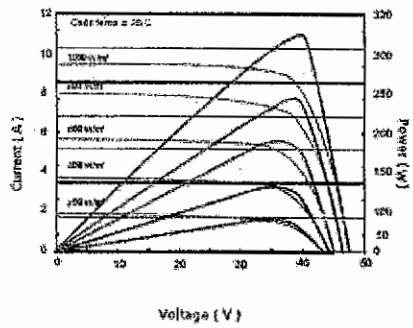
Solar Panels – PV Modules

i.	Type of Module	Jinko Solar (JKM 325PP-72-V)
ii.	Type of Cell	Poly-crystalline 156×156mm (6 inch)
iii.	Number of Cells	72 (6×12)
iv.	Dimension of each Module	1956mmx992mm
v.	Module Surface Area	1.94 m^2
vi.	Weight	26.5 kg (58.4 lbs.)
vii.	Panel's Frame	Anodized Aluminum Alloy
viii.	Junction Box	IP67 Rated
ix.	Linear Performance Warranty	10 Year product Warranty 25 Year Linear Power Warranty
x.	Maximum Power (Pmax)	325Wp
xi.	Maximum Power Voltage (Vmp)	37.6V
xii.	Maximum Power Current (Imp)	8.66 A
xiii.	Open-Circuit Voltage (Voc)	46.7V
xiv.	Short-Circuit Current (Isc)	9.10A
xv.	Module Efficiency	16.75%
xvi.	Maximum System Voltage	1500VDC (IEC)
xvii.	Maximum Series Fuse rating	15A
xviii.	Power Tolerance	0~+3%
xix.	Compliance	ISO 9001:2008, ISO 14001:2004, OHSAS18001 certified factory IEC 61215, IEC 61730 certified product

Figure 4: V-I Curve of Solar Cell

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

Current-Voltage & Power-Voltage Curves (315W)



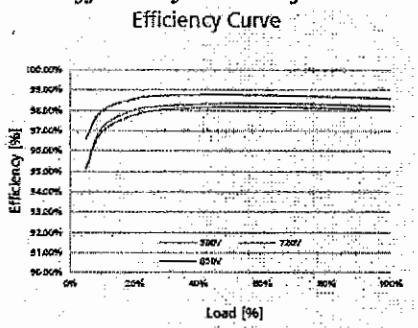
PV Inverter

i.	Inverter Type	String Inverter Configuration (Huawei 2000-36KTL)
ii.	Number of Inverters	1000
Efficiency		
iii.	Max. Efficiency	98.8%
iv.	European Efficiency	98.6%
Input		
v.	Max. DC Usable Power	40,800 W
vi.	Max. Input Voltage	1,100 V
vii.	Max. Current per MPPT	22 A
viii.	Max. Short Circuit Current per MPPT	30A
ix.	Min. Operating Voltage / Start Input Voltage	200 V / 250 V
x.	Full Power MPPT Voltage Range	480 V ~ 850 V @380Vac/ 400Vac 580V~850V@480Vac
xi.	MPPT Operating Voltage Range	200 V ~ 1000 V
xii.	Rated Input Voltage	620 V @380Vac / 400Vac 720V@480Vac
xiii.	Max. Number of Inputs	8
xiv.	Number of MPP Trackers	4
Output		
xv.	Rated AC Active Power	36,000 W
xvi.	Max. AC Apparent Power	40,000 VA
xvii.	Max. AC Active Power (cosφ=1)	Default 40,000W; 36,000W optional in settings
	Rated Output Voltage	220V / 380V, 230V / 400V, default 3W+N+PE; 3W+PE optional in settings 277V/480V, 3W+PE
xviii.	Rated AC Grid Frequency	50 Hz / 60 Hz
xix.	Max. Output	60.8 A/57.8A/48.2A

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

	Current(@380V/400V/480V)	
General		
xx.	Dimensions (W×H×D)	930 × 550 × 260 mm (36.6 x 21.7 x 10.2 inches)
xxi.	Weight	55 kg (121 lb.)
xxii.	Max. Operating Altitude Without Derating	4,000 m (13,123 ft.)
xxiii.	Relative Humidity	0 ~ 100%
xxiv.	Protection Rating	IP65

Figure 5: Efficiency Curve of PV Inverters



Single Axis Trackers

i.	Tracker Type	Exosun
ii.	Tracked Area	Up to 1200m²
iii.	Structure	Maintenance-free movement transmission HDG/Galvanized Steel/Stainless Steel/Composite
iv.	DC string management	Cable trays or raceways
v.	Drive Type	Brushless gear motor, 3 phase, 400 VAC (CE) or 460 VAC (UL)

Preliminary Design arrangement of the proposed Solar Power Project

Design Assumption	
Plant Arrangement	Single Axis solar tracker
Tracker Rotation	± 50
PV Module Technology	p-Si
Pitch E/W [m]	5.8
PV module rated power [Wp]	325

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

Ratio Modules/string	20
Ratio Strings/Inverter	8/7
Number of Inverters	1000
Inverter rated AC power [kW]	40
Total rated power $P_{DC\,[MWp]}$	50.0
Total rated power $P_{AC[MW]}$	40.0
Ratio P_{DC}/ P_{AC}	1.25
Plant availability area [ha]	103
Plant area ratio [ha/MWp]	2.05

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.

SCHEDULE-II

(1).	Total PV Installed Capacity of Generation Facility	50 MW_p
(2).	Days per Year	365 days
(3).	PV Plant Generating Capacity Annually (As Per Simulation)	85,626 MWh
(4).	Expected Total Generation in 25 years Life Span	2,140,650 MWh
(5).	Generation per Year from plant keeping 24 Hours Working	438,000
(6).	Net Capacity Factor (4/6)	19.55 % 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.

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

FAS ENERGY PAKISTAN
(SMC - PRIVATE) LIMITED

Mr. Iftikhar Ali
Director
Registrar Office
National Electric Power Regulatory Authority
NEPRA Tower Attaturk Avenue (East)
Sector G-5/1
Islamabad

Date: 10th August 2018
Ref No. Re-NEPRA/02

Subject: **RE- APPLICATION OF FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED (FESPSPL) FOR GRANT OF GENERATION LICENSE IN RESPECT OF 50.0 MW SOLAR POWER GENERATION FACILITY AT DISTRICT DERA ISMAIL KHAN IN THE PROVINCE OF KPK**

Dear Sir,

Reference to your telephonic enquiry dated August 10th, 2018 requiring technical information /documents for the subject application under Regulation 3 of NEPRA Licensing (Application & Modification Procedure) Regulation, 1999; please find below the response of FESPSPL:

Manufacturer	Jinko Solar
Type	Poly-crystalline
Model	JKM 325PP-72-V
Number of Modules	153,846 pcs
Total Installed Capacity	50 MWp

Please note that the stated information was provided in application for tariff petition.

In case there is any further observation/query regarding the application, including information/documents provided with the application; please feel free to contact us.

Yours sincerely,

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

Tariq Ahmad Khan
Chief Executive
FAS Energy Pakistan (SMC-Private) Limited

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

The sponsor of the Project is FAS Power Trading Company KSA ("FAS Energy") which owns 100% shares of the company. FAS ENERGY is the renewable energy development arm of FAWAZ AL HOKAIR group based out of Saudi Arabia. Fawaz Abdulaziz Al Hokair Co (known as: Al Hokair Group) is a public company, listed on Saudi Stock Exchange "Tadawul" (TDWL) since December 2006. Al Hokair Group, one of the largest group of companies in the Kingdom of Saudi Arabia involved in energy, retail, hotels and real estate business sectors, operates across Southern and Central Asia, Northern Africa, Middle East and Southern Europe. Al Hokair Group is based in Riyadh, Saudi Arabia and was established in March 1990.

FAS Energy is a leading provider of utility-scale, commercial and industrial solar photovoltaic (PV) for utilities and other business interested in renewable energy. FAS Energy approach to solar energy generation is supported through its vertically integrated divisions that include development, procurement, construction, operations and maintenance services. FAS Energy is committed to provide renewable energy solutions in the Middle East and beyond, with a focus on developing alternative energy capacity. With its branches in MENA region, namely Jordan, Egypt and Morocco and Gulf Cooperation Council, FAS Energy presently has 300 MWp of solar power projects in various stages of development.

In recent times FAS Energy has signed two Power Purchase Agreements (PPAs) for 50 MWp Solar Power Projects each with the Egyptian and Jordanian Governments.

FAS Energy has also remained involved in advising government agencies, in affiliation with one of the leading construction companies in the Middle East, on building industry-leading solar parks.

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

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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: 0119972

I hereby certify that **EAS ENERGY PAKISTAN (SMC-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 **Twenty Second** day of **May, Two Thousand and Eighteen**

Incorporation fee Rs. **25500.0/-** only

(Khalida Perveen)
Joint Registrar
Islamabad

No. ACL-37285

Dated 22-5-18

CERTIFIED TO BE TRUE COPY

(Muhammad Tariq Rasheed)
Assistant Registrar
Company Registration Office Islamabad

THE COMPANIES ACT, 2017 (XIX of 2017)

(PRIVATE COMPANY LIMITED BY SHARES)

Memorandum of Association

of

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED

1. The name of the Company is **FAS ENERGY PAKISTAN (SMC-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, 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 member is limited.

5. The Authorized Share Capital of the Company is Rs. Rs. 5,000,000 (Rupees five million only) divided into 500,000 (Five hundred 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.

I, whose name and address is subscribed below, am desirous of forming a company in pursuance of this memorandum of association and agree to take the number of shares in the capital of the company as set opposite my name:

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	*FAS POWER TRADING COMPANY* *Through Mr. Tariq Ahmad Khan*	*1010391414* *16202-3463357-1*	*NIL* *KHANIM ULLAH KHAN*	*SAUDI* *PAKISTANI*	*NA* *BUSINESS*	*RIYADH, AL SHIMAISI, CENTRAL HOSPITAL SQUARE, SAUDI ARABIA* *PO KHAS, BOQA, DISTRICT SWABI, PAKISTAN*	10,000 (Ten Thousand Only)	
Total number of shares taken							10,000 (Ten Thousand Only)	

Dated 23rd day of April 2018

CERTIFIED TO BE TRUE COPY
(Muhammad Tariq Rasheed)
Assistant Registrar
Company Registration Office, Islamabad

THE COMPANIES ACT, 2017 (XIX of 2017)

(Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED

INTERPRETATION

1. In the interpretation of these articles the following expressions shall have the following meanings unless repugnant to or inconsistent with the subject articles–

(a) "company" or "this company" means FAS ENERGY PAKISTAN (SMC-Private) Limited;

(b) "directors" or "board of directors" means board of directors consist of only the sole director or more than one directors if so appointed under the relevant provisions of the Act;

(c) "member director" means a director who is a member of the company;

(d) "non-member director" means an individual who is not a member, but has been nominated under the provisions of the Act;

(e) "private company" means a private company having two more members;

(f) "sole member" means the single member of the company; and

(g) "sole director" means the director of the company who is for the time being the only director and includes a non-member director of the company.

2. Unless the context otherwise requires, words or expressions contained in these regulations shall have the same meaning as in the Act; and words importing the singular shall include the plural, and *vice versa*, and words importing the masculine gender shall include feminine, and words importing persons shall include bodies corporate.

PRELIMINARY

3. Any provision of the Act or rules and regulations made thereunder which apply in relation to a private company limited by shares incorporated under the Act shall, in the absence of any express provision to the contrary, apply in relation to a single member company as it applies in relation to such a company which is formed by two or more persons or which has two or more persons as members and the provisions contained in part I of Table A of First Schedule in the Act shall be deemed part of these articles of association in so far as these are not inconsistent with or repugnant to the provisions contained herein below.

SINGLE MEMBER COMPANY

4. The company is a single member company and as such being a private company limited by shares—

(a) it shall not invite the public to subscribe for any shares of the company;

(b) the company shall not register any share(s) in the name of two or more persons to hold one or more shares jointly; and

(c) number of the members of the company shall be limited to one.

SHARES

5. The company may alter its share capital in accordance with section 85.

6. Share certificate shall be issued under the seal of the Company and shall be signed by the member director or the non-member director, as the case may be.

TRANSFER AND TRANSMISSION OF SHARES

7. The company shall not transfer all of the shares of a single member to two or more persons or part of shares of single member to other person(s) or allot further shares to any person other than the single member or, at any time, allow transfer of shares or allotment of shares or both resulting in number of members to become two or more, except for change of status from single member company to private company and to alter its articles accordingly.

8. The single member may transfer all of his shares to a single person whereby the company shall remain a single member company as it was before such transfer.

9. The sole member shall nominate a person who, in the event of death of the sole member, shall be responsible to—

(a) transfer the shares to the legal heirs of the deceased subject to succession to be determined under the Islamic law of inheritance and in case of a non-Muslim members, as per their respective law; and

(b) manage the affairs of the company as a trustee, till such time the title of shares are transferred:

Provided that where the transfer by virtue of the above provision is made to more than one legal heir, the company shall cease to be a single member company and comply with the provisions of section 47 of the Act.

CHANGE OF STATUS

10. The company may convert itself from single member private company to a private company in accordance with the provisions of section 47.

MEETINGS, VOTES AND ELECTION OF DIRECTORS

11. All the requirements of the Act regarding calling of, holding and approval in general meeting, board meeting and election of directors in case of a single member company, shall be deemed complied with; if the decision is recorded in the relevant minutes book and signed by the sole member or sole director as the case may be.

DIRECTOR(S)

12. The company shall always have the sole member or in case it is not a natural person its nominee, as a director but it may have such number of other director(s) who fulfil the conditions as specified in section 153.

13. The board shall not have the power to remove the member director provided that where the sole member is not a natural person, it may change its nominee.

14. The sole member shall have the power to remove any director, chief executive or secretary through a resolution.

15. The director(s) shall appoint a chief executive in accordance with the provisions of sections 186 and 187.

16. The directors may hold their meetings through tele or video link provided that the minutes of such meeting are approved and signed subsequently by all the directors.

17. The directors shall cause records to be kept and minutes to be made in book or books with regard to–

(a) all resolutions and proceedings of the meeting(s) of directors and Committee(s) of directors, and every director present at any meeting of directors or Committee of directors shall put his signatures in a book to be kept for that purpose;

(b) recording the names of the persons present at each meeting of the directors and of any committee of the directors, and the general meeting; and

(c) all orders made by the directors and Committee(s) of directors:

Provided that all records related to proceedings through video-link shall be maintained in accordance with the relevant regulations specified by the Commission which shall be appropriately rendered into writing as part of the minute books according to the said regulations.

SECRETARY

18. The company may appoint a secretary who shall be responsible for discharge of duties and functions normally discharged by a secretary under the corporate laws and secretarial practice.

CONTRACTS WITH THE SINGLE MEMBER

19. Where a single member company enters into a contract with the single member of the company, the single member company shall, unless the contract is in writing, ensure that the terms of the contract are forthwith set out in a written memorandum or are recorded in the minutes of the first meeting of the directors of the company following the making of the contract.

DIVIDENDS AND RESERVES

20. The company may declare dividends and pay in accordance with the provisions of the Act.

ACCOUNTS

21. The director(s) shall cause to keep proper books of account in accordance with the provisions of section 220.

22. Auditors shall be appointed and their duties regulated in accordance with the provisions of sections 246 to 249.

THE SEAL

23. The director shall provide for safe custody of the seal and the seal shall not be affixed to any instrument except by the authority of a resolution of the board of directors or by a committee of directors authorized in that behalf by the member director or the non-member director and in the presence of at least member director or the non-member director and of the secretary or such other person as the directors may appoint for the purpose and the member director or the non-member director and the secretary or other person as aforesaid shall sign every instrument to which the seal of the company is affixed in their presence.

WINDING UP

24. The company shall follow, in case of its winding up, the relevant provisions of the Act.

INDEMNITY

25. Every officer or agent for the time being of the company may be indemnified out of the assets of the company against any liability incurred by him in defending any proceedings, whether civil or criminal arising out of his dealings in relation to the affairs of the company, except those brought by the company against him, in which judgment is given in his favour or in which he is acquitted, or in connection with any application under section 487 in which relief is granted to him by the Court.

I, whose name and address is subscribed below, am desirous of forming a company in pursuance of these articles of association and agree to take the number of shares in the capital of the company as set opposite my name:

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	*FAS POWER TRADING COMPANY* *Through Mr. Tariq Ahmad Khan*	*1010391414* *16202-3463357-1*	*NA* *KHANIM ULLAH KHAN*	*SAUDI* *PAKISTANI*	*NA* *BUSINESS*	*RIYADH, AL SHIMAISI, CENTRAL HOSPITAL SQUARE, SAUDI ARABIA* *PO KHAS, BOQA, DISTRICT SWABI, PAKISTAN*	10,000 (Ten Thousand Only)	
Total number of shares taken							10,000 (Ten Thousand Only)	

Dated 23rd day of April 2018

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

CERTIFIED TO BE TRUE COPY
(Muhammad Tariq Rasheed)
Assistant Registrar
Company Registration Office Islamabad

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

NO. EPA/IEE/50MWSolar-FAS/ 708 Dated: D. I. Khan the 22/01/2018.

To,

Mr. Tariq Ahmad Khan,
FAS Energy, 1st Floor,
Boquival Tower, Street # 27-A,
Crimson Road, Sector -H, DHA-Phase 2, Islamabad.
Phone: +92 (051)5418644.

Subject: **SUBMISSION OF INITIAL ENVIRONMENTAL EXAMINATION REPORT FOR SOLAR POWER PROJECT OF 50MW BY FAS ENERGY LOCATED AT KULACHI, DISTRICT D.I.KHAN.**

I am directed to refer to the subject cited above and to enclosed herewith Environmental Protection Approval/Decision Note on IEE Report of "50MW 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. Ilyas Khan

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. Tariq Ahmad Khan,
FAS Energy, 1st Floor, Boquival Tower,
Street No. 27, Crimson Road,
Sector –H, DHA, Phase-2, Islamabad

2. **Description of Project:** FAS Energy (Pvt) Ltd. has planned to construct 50MW Solar Power Project at Badshahabad village, Moza Luni, Tehsil Kulachi, District D.I.Khan. The total 200 hectares land has been assessed for the proposed project. The proposed project will be connected to Kulachi grid station (15km) or Tank grid station (29km) or Daraban grid station (21km).The estimated Construction period of the proposed project is 12-18 Months and operational life is 20 Years.

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

4. **Date of Filing of IEE:** 15.09.2017 (Ref: EPA Diary No. 389)

5. After careful review, the Environmental Protection Agency , Govt. of Khyber Pakhtunkhwa has decided to accord approval of the Initial Environmental Examination for "50MW Solar Power 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

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.

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 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/50MWSolar-FAS/ 708

17/1/2018

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

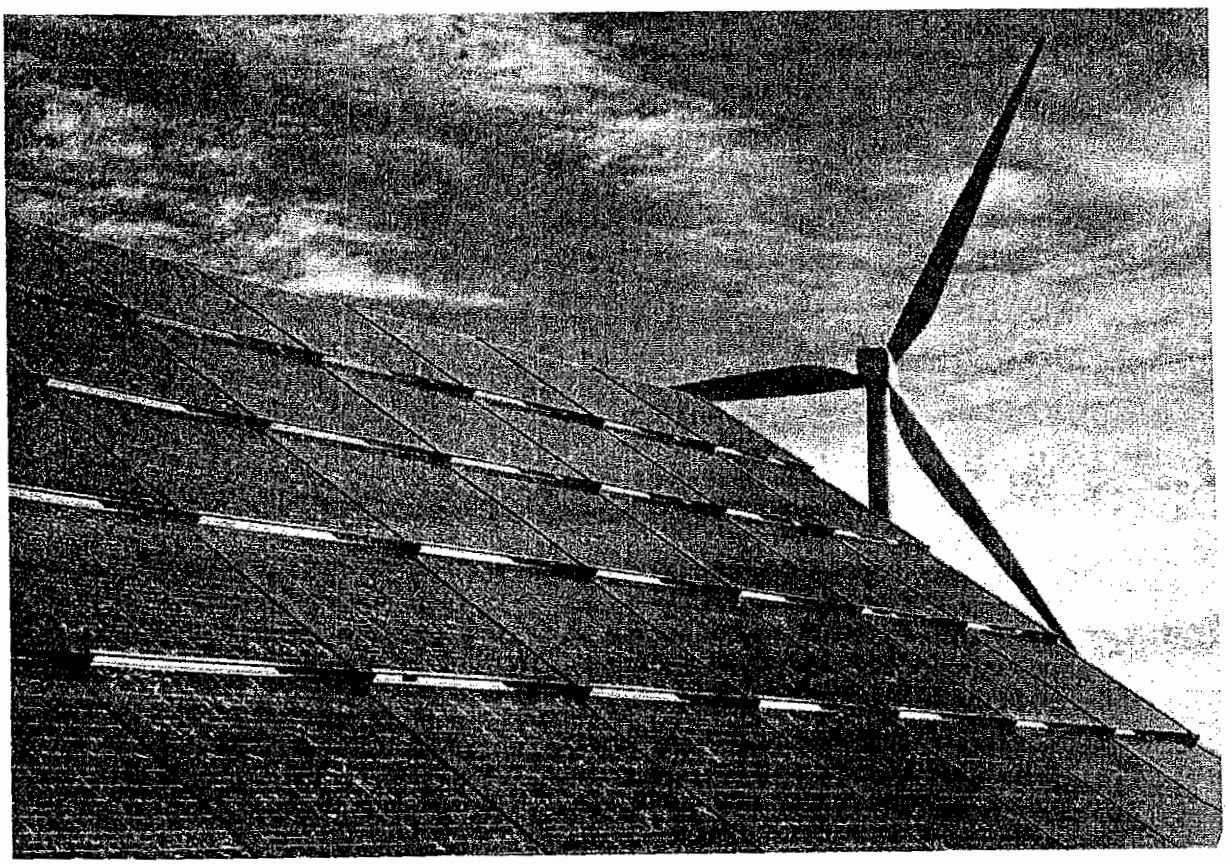
DNV·GL

FAS SOLAR PV PLANT

Initial Environmental Examination FAS Solar PV plant, Pakistan

FAS ENERGY

Final Report
Report No.: 17-0688 ME-R-02, Rev. A
Document No.: 17-0688-ME-R-02-A
Date: 2017-12-27



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Project name:	FAS Solar PV PLant	DNV GL - Energy Energy Advisory Burjuman Business Tower, 14th Floor Sheikh Khalifah Bin Zayed St. P.O. Box 28537, Dubai, UAE Tel: +971 4 352 6626
Report title:	Initial Environmental Examination FAS Solar PV plant, Pakistan	
Customer:	FAS Energy, P.O Box 341904, Riyadh 11333, KSA	
Contact person:	Sabri Asfour rsabri.asfour@fas-energy.com	
Date of issue:	2017-11-22	
Project No.:	TBD	
Report No.:	17-0688-ME-R-02, Rev. A	

Task and objective:
Initial Environmental Examination of the propsed Kulachi Solar PV plant.

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☐ Published

Keywords:
Initial Environmental Examination

A	2017-11-22	Draft version	Gemma D'Silva	Viktorija Namavira	Rakesh Raghav
B	2017-12-27	Final version	Viktorija Namavira	Rakesh Raghav	Rakesh Raghav

Table of contents

List of Figures

List of Tables

EXECUTIVE SUMMARY

1.1. Project overview

FAS Energy (the "Proponent") is proposing to develop the 50MW PV project located in Kulachi, Dera Ismail Khan District in Khyber Pakhtunkhwa Province, Pakistan.

The project area falls within 16km West of the town of Kulachi. The project area falls within the Dera Ismail Khan District in Khyber Pakhtunkhwa province of Pakistan.

1.2. IEE objective

This document is the Initial Environmental Examination (IEE) prepared to comply with the Khyber Pkhtunkhwa Environmental Protection Act, 2014.

The document addresses the following:

- Likely impacts arising from a proposal; and
- Provides mitigation measures for the potential impacts.

1.3. IEE methodology

The IEE study is focused at developing the environmental profile of the project area to evaluate the (baseline data) existing conditions on physical and biological environment, and social environment and identify the anticipated environmental impacts and propose mitigation measures.

This report has been prepared based on the existing and available information to date.

The following activities have been performed:

- Legislation was reviewed to ensure the report is prepared in line with the local legislation in Pakistan. Legislation reviewed is listed in Section 2.
- Site visit was performed to assess the site. Specifically, the following site visits were undertaken:
  - Environmental and Social assessment site visit – during this site visit environmental and social aspects were analysed;
  - Topographic study was undertaken – the report will be shared with the Authorities;
  - Geological study was undertaken – the report will be shared with the Authorities.
  - Grid interconnection study was undertaken – the report will be shared with the Authorities.

1.4. Conclusions and Recommendations

No major risks have been identified to be caused by the project. The project is going to be based on the desert land with few trees and bushes within the site perimeter.

The project site does not have any human settlements and hence will not require a resettlement. Project Land owners have been consulted with and they have agreed to sell the land.

The closest human settlement to the project is 500 meters away from the project site. The community has been consulted and they do not see any concerns about the project. The community, however, expressed an interest in potential job opportunities.

During the construction the project is expected to cause noise and air impact due to excavation activities and increased traffic, as well as waste creation.

During the operational stage, the project is not expected to have any impact apart from any potential waste management i.e. from broken panels.

Baseline activities shall be carried our prior to the commencement of the project, specifically:

- Air quality shall be recorded prior to the commencement of the project construction;
- Water quality shall be recorded in the nearby river prior to the commencement of the project;
- Noise levels shall be recorded prior to the commencement of the project construction.

A list of potential impacts and the recommended mitigation measures are provided below:

Table 1. Summary of identified impacts and recommended mitigation measures for the project

Component	Mitigation measure
Construction and Decommissioning Phase	
Air quality	• Use Traffic Management Plan (Section 7.3) to reduce vehicle use and minimize impacts, including optimize routes and speed limits, and ensure good maintenance. • Apply dust suppressors – water shall be sprinkled daily or when there is dust problem on the exposed surface. • Excavated soil shall be covered, including within the site and when transporting. • Advise nearby residents, as applicable, of significant truck transportation passing through nearby roads. • Utilise transportaiton and equipment in line with the KPK Quality legislation. • Air quality measurements shall be taken before the construction starts to establish a baseline; • Air quality shall be monitored every day and recordings logged.
Noise level	• Use Traffic Management Plan (Section 7.3) to reduce vehicle use and minimize impacts, including optimize routes and speed limits, and ensure good maintenance. • Depending on local feedback, limit construction activity during daylight hours to reduce the potential impact of construction noise. • Noise level shall be taken before the commencement of consutrction; and noise shall be monitored durign the consutrciton to ensure compliance with the requirements. • Noise level shall be in compliance with the KPK noise legislation on. • Use of proper silencers, mufflers and personal protective equipment's; • Any complaints regarding the nosie shall be logged and addressed. • Night-time traffic will be avoided near the communities.
Soil / Surface and Ground Water and Water consumption	• Use Water Management Plan (See Section 7.2) to ensure appropriate use of water. • Consider flooding aspects in the PV plant design. • Use Waste Management Plan (See Section 7.1) to ensure appropriate waste management. • No waste shall be stored within the nullah or within its proximity; • Equip personnel with emergency spill kits. • Train construction and maintenance crews in appropriate responses to accidental spills. • Maintain equipment throughout the construction/decommissioning period to minimize the potential for accidental releases of toxic fluids. • Ensure Contractors have an Emergency Response Plan (ERP) in place, in accordance with the environmental monitoring plan. Train construction staff in the proper implementation of these plans. • All the water plumbing shall be regularly inspected. Any identified leaks shall be repaired straight away; • Water efficiency devices such as self-closing taps, pressure reducing valves, low flow shower heads, toilets etc. shall be installed; • TBT talks shall be contacted on water efficiency by the HSE Manager; and • Cleaning of vehicles shall be minimised whilst still ensuring best maintenance practices. It is recommended to clean vehicles in urban areas instead of on site. • Appropriate approval shall be received from the authority to utilise ground water and river water for project purposes. • Proper drainage system shall be implemented. • Maintenance of vehicle and machinery will only be carried out at designated places to avoid any fuel spill.

Component	Mitigation measure
Waste Management	• Devel and implement Waste Management Plan (See Section 7.1) • 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. • 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.
Ecological and natural resources impacts (vegetation and fauna)	• Identify and delineate work zones prior to undertaking work to minimize the amount of vegetation that needs to be cleared. • Minimize the overall project footprint. • Prepare Site Restoration Plan once the consturction is finished the site is restored as much as possible. • Personnel working during operational phase of the project will be strictly prohibited to hunting and trapping of wild life
Traffic Management	• Implement Traffic Management Plan • There shall be clear separation between pedestrian road and vehicle roads within the site • Speed limits shall be followed at all times • Follow local driving rules • Road Sign board will be fixed at appropriate places to reduce safety hazards associated with project traffic • Project drivers will be trained on defensive driving • Follow strict code of conduct • Safety precautions and display on the notice board of entry gate in both national and local language
Economic and Community Setting and HSE	• Locals shall be prioritized for any job opprotunity. • Develop and implement program for training and job opportunities for the Project during construction for local populations. • Public involvement program • Provide local and regional authorities with Project Traffic Management Plan (or an equivalent document) to avoid any unexpected circulation problems. • Implementation of Health and Safety Incidents Plan (or an equivalent document) to reduce workplace safety risks. • Prepare Site Restoration Plan to restore construction activity consequences. • Any local cultural differences shall be considered. • Appropriate vaccinations shall be ensured. • Health checks shall be regularly performed on the workers. • First Aid shall be available. • Site shall be secured. • Implement Grievance Mechanism. • 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.

Component	Mitigation measure
	• Suitable PPE, training and ongoing safety checks shall be available. • Equipment periodic maintenance according to manufacturers' schedule. • Follow the Traffc Management Plan. • The project will create employment opportunities for the nearby areas. All the precautionary measures as required for the safety of workers shall apply • Take adequate precautions to prevent danger from electrical equipment. • Provide a first aid. • Ensure workers exposed to loud noise wear ear plugs/ear muffs. • Workers accommodation shall comply with the IFC / ADB standards. • FAS Energy, its contractors and sub contractors comply with the national labor law.
Operations Phase	
Soil / Surface and Ground Water	• Adhere to operational control procedures for the storage and handling of hazardous materials. • Train staff in the proper implementation of HSE procedures.
Waste Management	• Implement waste management plan

Overall the project is feasible and a sustanble option which will result in the following benefits for Pakistan:

- Cleaner Air in the long term – as the project will be using solar resource to generate elecitricyt;
- Creation of jobs during – the project will employ around 200 people during the peka consutrction. This will bring increased business to the area; and
- Better reputation for the country – as usage of solar power is very welcomed by all the communities.

EMP shall be constantly reviewed and updated as needed.

1 INTRODUCTION

1.1 Project overview

FAS Energy (the "Proponent") is proposing to develop the 50MW PV project located in Kulachi, Dera Ismail Khan District in Khyber Pakhtunkhwa Province, Pakistan.

The project area falls within 16km West of the town of Kulachi. The project area falls within the Dera Ismail Khan District in Khyber Pakhtunkhwa province of Pakistan.

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This report has been prepared based on the existing and available information to date.

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    - Geological study was undertaken – the report will be shared with the Authorities;
    - Grid Interconnection study was undertaken – the report will be shared with the Authorities.

1.4 Structure of the document

The overall structure of this report is in line presented below:

- **Section 2** – Legislative Requirements;
- **Section 3** – Project Description;
- **Section 4** – Analysis of Project Alternatives;
- **Section 5** – Project Costs and Benefits;
- **Section 6** – Anticipated Impacts and Mitigation Measures;

- **Section 7** – Environment and Social Management Plan;
- **Section 8** – Conclusion and Recommendation; and
- **Appendix A – Environmental Management Plan**

This report shall be read in conjunction with the following reports that are referenced in this study:

1. Topographic Study;
2. Geological Study;
3. Grid Interconnection Study; and
4. Permits received.

2 LEGISLATIVE REQUIREMENTS

The table below provides an overview of the environmental standards in Pakistan:

2.1 Khyber Pakhtunkhwa Environmental Protection Act 2014

The Act aims to ensure protection, conservation, rehabilitation and improvement of the environment, monitoring, prevention and control of pollution and promotion of sustainable development in the Province of the Khyber Pakhtunkhwa.

Initial Environmental Examination (IEE)

As per the Khyber Pakhtunkhwa Environmental Protection Act 2014 no proponent of a project shall commence construction and operation unless heh 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.

Environmental Impact Assessment (EIA)

As per the Khyber Pakhtunkhwa Environmental Protection Act 2014 an EIA is required for projects that are expected to have a significant environmental impact. The Act gives the following definition of the EIA: an environmental study comprising collection of data, prediction of qualitative and quantitative impacts of a proposed development activity, comparison of alternatives, evaluation of preventative mitigatory and compensatory measures, formulation of environmental management and training plans and monitoring arrangements, and, and framing of recommendations, measures and such other components as may be prescribed.

2.2 Khyber Pakhtunkhwa Environmental Quality Standards, 2010

The standards determine the functions of an environmental laboratory to test and analyse samples of air, water, soil, effluents and wastes, as well as noise to determine whether they comply with the set standards. The standard consists of the following requirements:

- **Ambient Air Standards;**
- **Drinking Water;**
- **Noise Levels;**
- **Waste management;**
- **Motor Vehicle Exhaust and Noise;**
- **Handling of Hazardous Substances.**

The above standards are available on the Pakistan Environmental Protection agency website here: http://epa.kp.gov.pk/page_type/rules

2.3 International Conventions applicable to Pakistan

As per Khyber Pakhtunkhwa Environmental Protection Act 2014, Pakistan is signatory to the following international conventions:

1. International Plant Protection Convention, Rome, 1951

2. Plant Protection Agreement for the South-East Asia and Pacific Region (as amended), Rome, 1956
3. Agreement for the Establishment of a Commission for controlling the Desert Locust in the Easter Region of its Distribution Area in South West Asia (as amended), Rome, 1963
4. Convention on Westlands of international Importance especially as Waterfowl Habitat, Ramsar, 1971 and its amending Protocol, Paris, 1982
5. Convention Concerning the Protection of World Cultural and Natural Heritage (World Heritage Convention), 1982
6. Convention on International Trade in Endangered Species of Wild Fauna and flora (CITES), Washington, 1973
7. Convention on the Conservation of Migratory Species of Wild Animals, Bonn, 1979.
8. Convention on the Law of the Sea, Montego Bay, 1982
9. Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985
10. Montreal Protocol on Substances that Deplete the ozone Layer, Montreal, 1987 and amendments thereto.
11. Agreement on the network of Agriculture Centres in Asia and the Pacific, Bangkok, 1988.
12. Convention on the Control of Tran boundary movements of Hazardous Waste and Their Disposal, Basel, 1989.
13. Convention on Biological Diversity, Rio de Janeiro, 1992
14. United Nations Framework Convention on Climate Change, Rio De Janeiro, 1992
15. United Nation Convention to Combat Desertification (UNCCD), Paris, 1994
16. Kyoto Protocol to UNFCC, Kyoto, 1997
17. Rotterdam Convention on Prior Informed Consent (PIC) for certain Hazardous Chemical and Pesticides in International Trade, Rotterdam, 1999
18. Stockholm Convention on Persistent Organic Pollutants (POPs), Stockholm, 2001.
19. Cartagena Protocol on Bio-Safety to the CBD, Cartagena, 2001.

3 PROJECT DESCRIPTION

3.1 Project Name and Project Proponent

The name of the Project is FAS Solar Power Plant and FAS Energy is the Proponent.

3.2 Project Objectives

The objective of the Project is to build a 50MW solar power plant to support Pakistan's renewable energy drive and reduce pollution.

3.3 Proposed Schedule for Implementation

It is scheduled to reach financial close in June 2018 and expected commercial operational date of the power plant is scheduled to be September 15th, 2019.

Table 3 provides an overview of the status of key permits (as of November 2017) required for the Project.

Table 2. Permitting Review

Approval / Permit	Authority / Consultation	Responsibility	Standards and requirements	Status
Letter of Interest (LOI)	KPEP	Sponsor	LOI is the official mandate to commence working on the Project and heralds the preparation of a feasibility study and acquisition of land.	Submitted
Acquisition of Land	Government the Khyber Pakhtunkhwa	Sponsor	Land needs to be allocated for the project development purposes.	Preliminary agreements from the land owners were obtained for the sale of land
Submission of Feasibility Study (including IEE)	KPEP	Sponsor	Feasibility study had to be completed within 3 months from the LOI date.	In progress
Interconnection study approval	PESCO, CPPA-G, NTDC	Sponsor	Permission to connect the plant to the grid is required.	Application for Grid Interconnection Assessment (GIA) was submitted to General Manager (Dev) PMU, Peshawar Electric Supply Company (PESCO). Grid interconnection study has been completed.
NOC related to fisheries	EPA	Sponsor	Non-objection certificate from fisheries department.	Request was submitted.

Approval	Authority	Responsibility	Conditions and Considerations	Status
NOC related to forest	EPA	Sponsor	Non-objection certificate from forest department.	Request was submitted.
NOC related to wildlife	EPA	Sponsor	Non-objection certificate from wildlife department.	Request was submitted.
NOC for IEE	KPEP	Sponsor	Non-objection certificate is issued in case no major critical findings that can prevent the power plant from construction.	In progress
Generation License	KPEP	Sponsor	Permit to generate electricity.	Not obtained yet
Tariff determination	NEPRA	Sponsor	Agreement on the tariff to be paid for the electricity generated by the plant.	Not obtained yet
Letter of Support (LOS)	KPEP	Sponsor	This is issued once the tariff has been approved.	Not obtained yet
Energy Purchase Agreement (EPA)	Central Power Purchasing Agency (Guarantee) Limited	Sponsor	Once LOS is issued this EPA can be signed.	Not signed yet
Implementation Agreement (IA)	GOP	Sponsor	IA is a guarantee in relation to the power purchaser operations, including any events of force majeure or default.	Not signed yet

3.4 Project Location

The Solar project is located near Batcha Abad village, about 13 km from Kulachi city, a city named after the Kulachi Baloch tribe and is the headquarters of Kulachi Tehsil (an administrative subdivision) of **Dera Ismail Khan District in Khyber-Pakhtunkhwa province of Pakistan.** It is located at 31°55'49"N 70°27'31"E at an altitude of 209 metres. The project site is approximately around 2km^2 (200 Ha).

Figure 3-1. FAS Project Location (Source: Google Earth image)

The area is an agricultural zone. It lies at the foot of the Sulaiman Range. There is no habitation within the plot limits; however, there is a small village with some houses at northernside, outside the plot limits. The site contains small bushes and trees at scattered location and are very thin in numbers. There is a low voltage transmission line passing at north – east corner side of the plot.

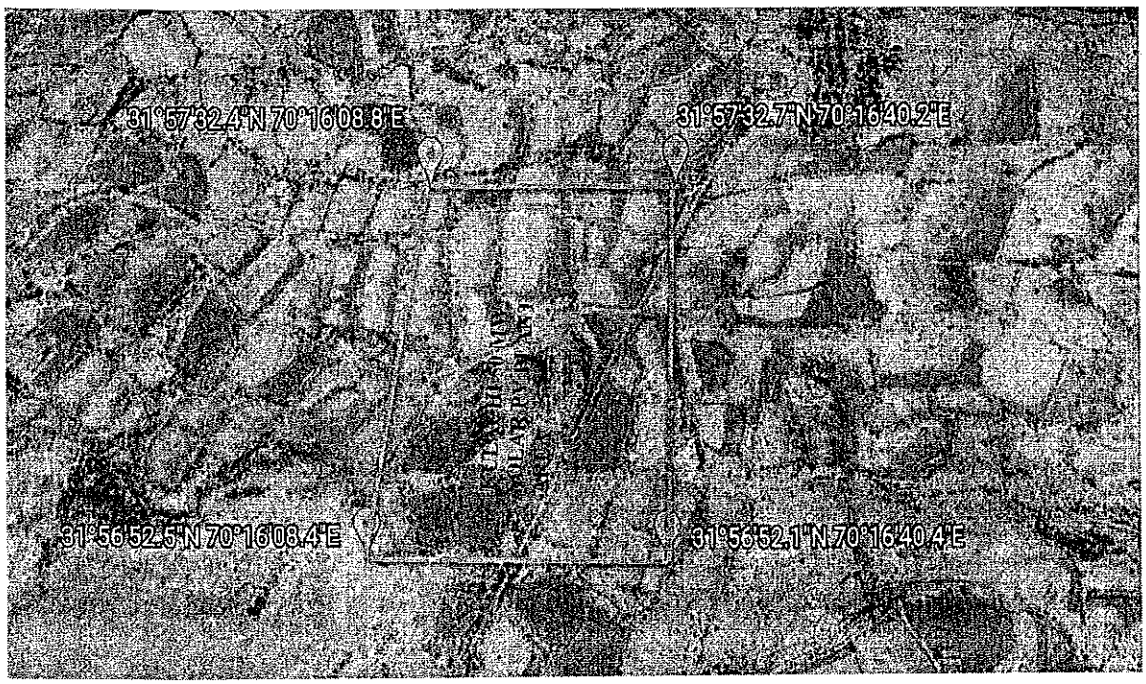


Figure 2. Zoomed in image of site location (Source: Extract from Site Visit report)

3.4.1 Project access

The site visit report indicated that the Project Site from Islamabad, Capital of Pakistan can be accessed through:

Kashmir Highway – Islamabad Motorway Link Road – Lahore-Islamabad Motorway M2 – Balkasar Interchange – Talagang-Chakwal Road – Talagang Bypass Road – Mianwali-Rawalpindi Road – Mianwali-Talagang Road – Sargodha-Mianwali Road – Mianwali-Muzafargarh Road – Dera Ismail Khan Road – Chashma Road – Dera Ismail Khan-Mianwali Road – Bannu Road – Indus Highway – Tank-D.I.Khan Road – Kulachi NH55 Link Road – Kulachi-Loni Road – Loni-Daraban Road - Loni Village – Batcha Abad Village – Project Site.

Total Distance of 443 km could be covered at a travel time of approx. 7 h.

The road is metal road all the way till Loni however, from Loni to Badshahbad village to Project site is rough track (Katachy road).

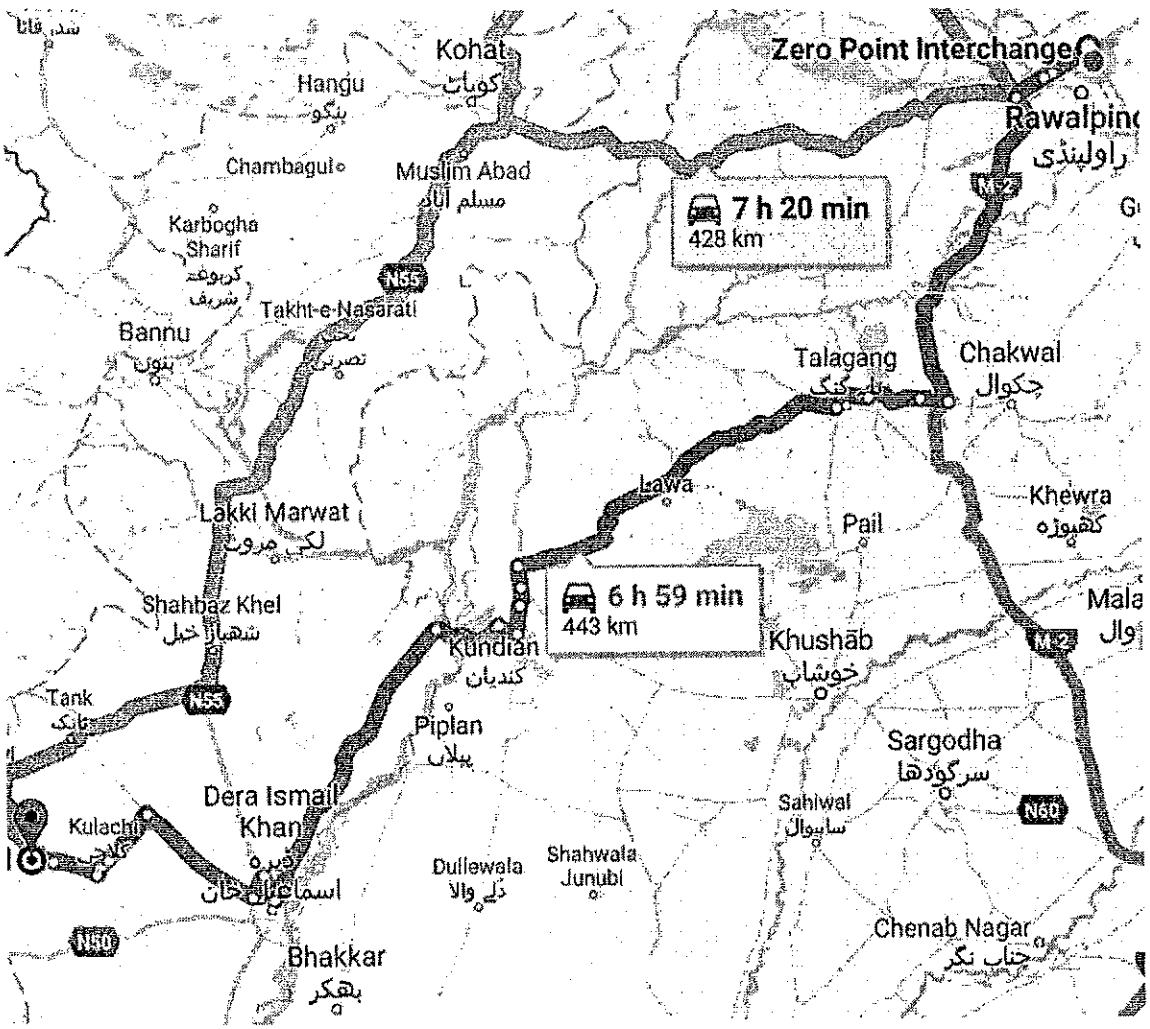


Figure 3. Project access from Islamabad (Source: Site Visit Report)

More detailed information regarding the route is available in the Site Visit Report.

3.4.2 Power Sources and Transmission

The project will be connected by making an In/Out of 132kV single circuit between Kulachi and Tank at FAS Solar Park with a feed length of 16km on Lynx conductor. Based on the Grid Interconnection study conducted by ARCO Energy 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. 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. Result of the short circuit analysis showed 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 grid interconnection study results, it is concluded that proposed generation interconnection assessment for 50MW (AC) Solar PV Power Generation project meets the NEPRA grid code planning criteria.

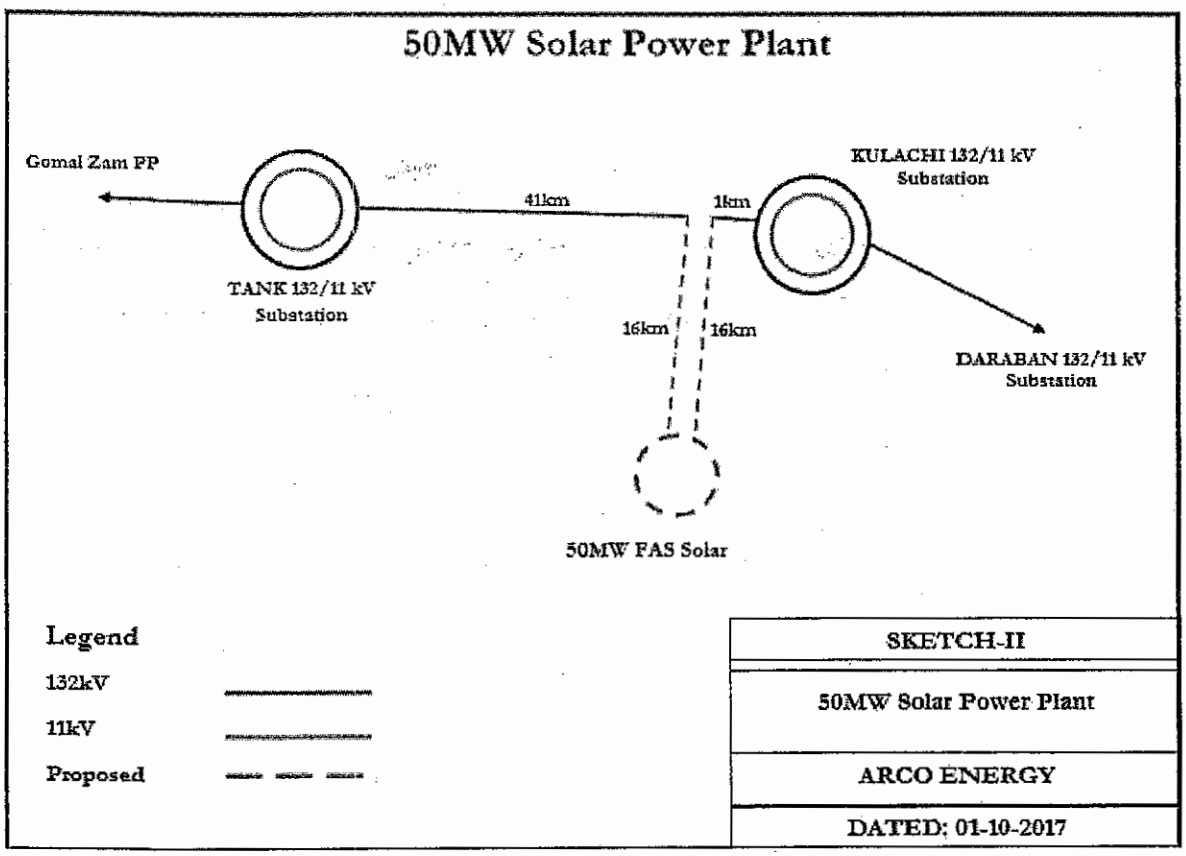


Figure 4. Proposed grid connection of the project (Source: Grid interconnection study)

3.5 Site selection criteria

The Site was selected in line with the Pakistan site selection principles. First three potential project locations were considered. The site was assess by the Sponsor's representative in Pakistan to consider the best site location based on the such site characteristics as topography, environmental considerations,

site closeness to the villages and other infrastructures. The site visit was performed also by Nasir Absar Consulting (site visit report is available), who analysed the site suitability considering whether the proposed land is prohibited (including environmental sensitivity considerations). The site was then selected due to the fact that the site is not within the protected area, the topography requires minimal levelling of land, land owners agreeing to sell the land.

3.6 Topographic study of the site

Topographic study was conducted on 16th of September 2017 by the Standard Land Surveyors. The Field area falls in zone 42N UTM. Soil is generally silty clay and in stable conditions and not in loose dust form. The Figure 3-5 shows the location of the pillars used for the topographic study.

Figure 3-5. Location of the Control Point Pillars used for the topographic study

The longitude and latitude of the pillars is available in Table 3.

Table 3. Latitude and longitude of pillars used for the topographic study.

[illegible]	[illegible] (Global)	Longitude (Global)	Elevation (above sea level)
BM1 (see Figure 3-6.	31° 57' 32.06851"	70° 16' 41.25215"	**239.469**

BM 1 Pillar point)			
BM14 (see Figure 3-7)	31° 57' 31.92050"	70° 16' 40.42834"	**239.721**
BM16 (see Figure 3-8)	31° 57' 1.52915"	70° 16' 20.88233"	**238.479**
BM17 (see Figure 3-9)	31° 57' 31.75437"	70° 16' 29.49675"	**239.155**

Elevation measured varied between 238 and 239 meters.

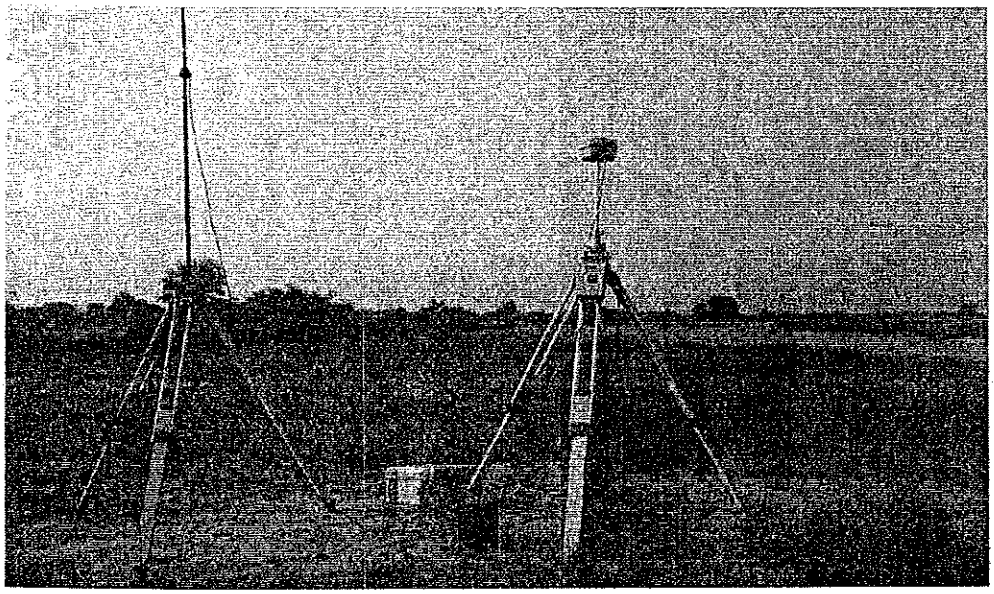


Figure 3-6. BM 1 Pillar point

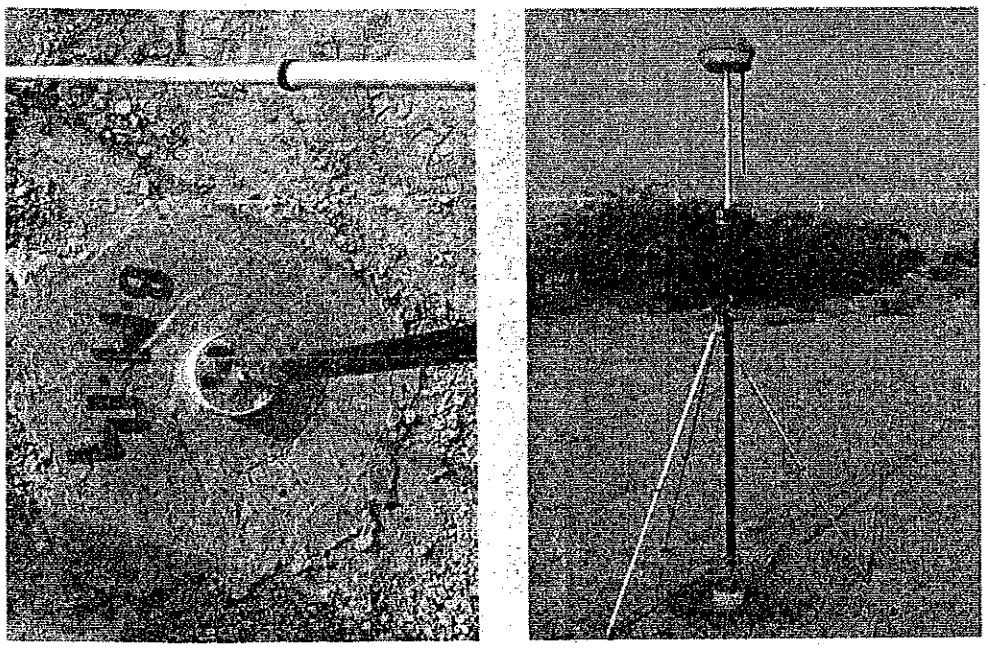


Figure 3-7. BM14 pillar point

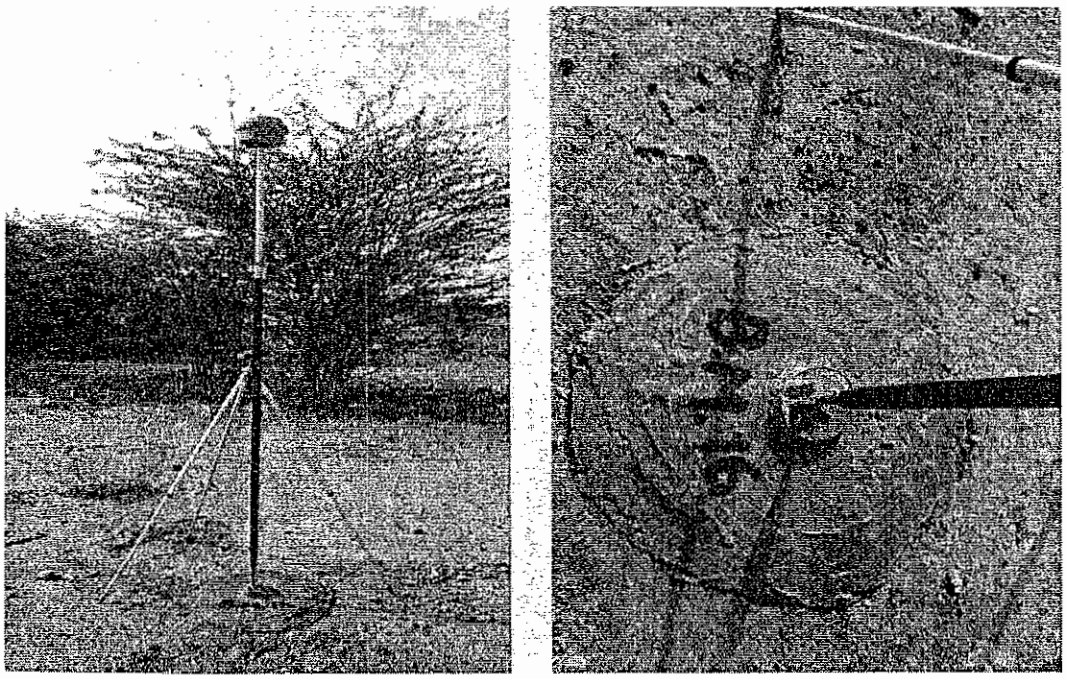


Figure 3-8. BM 16 Pillar point

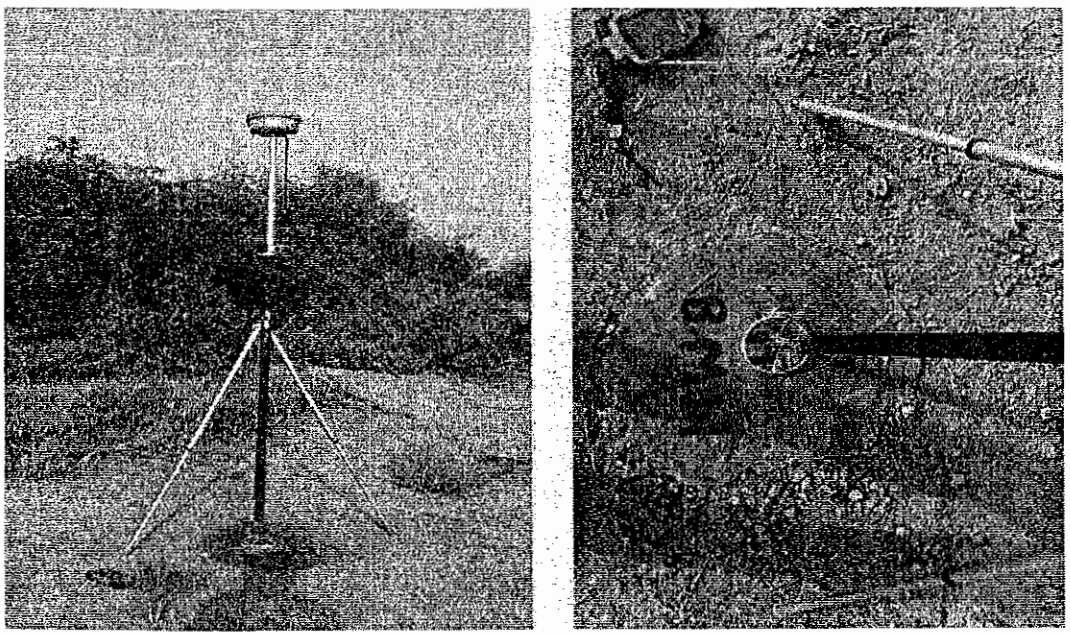


Figure 3-9. BM17 pillar point

3.7 Geological study

Geotechnical Study was conducted by GEOENGINEERS in September 2017 whereby 16 boreholes were drilled (see Figure 3-10).

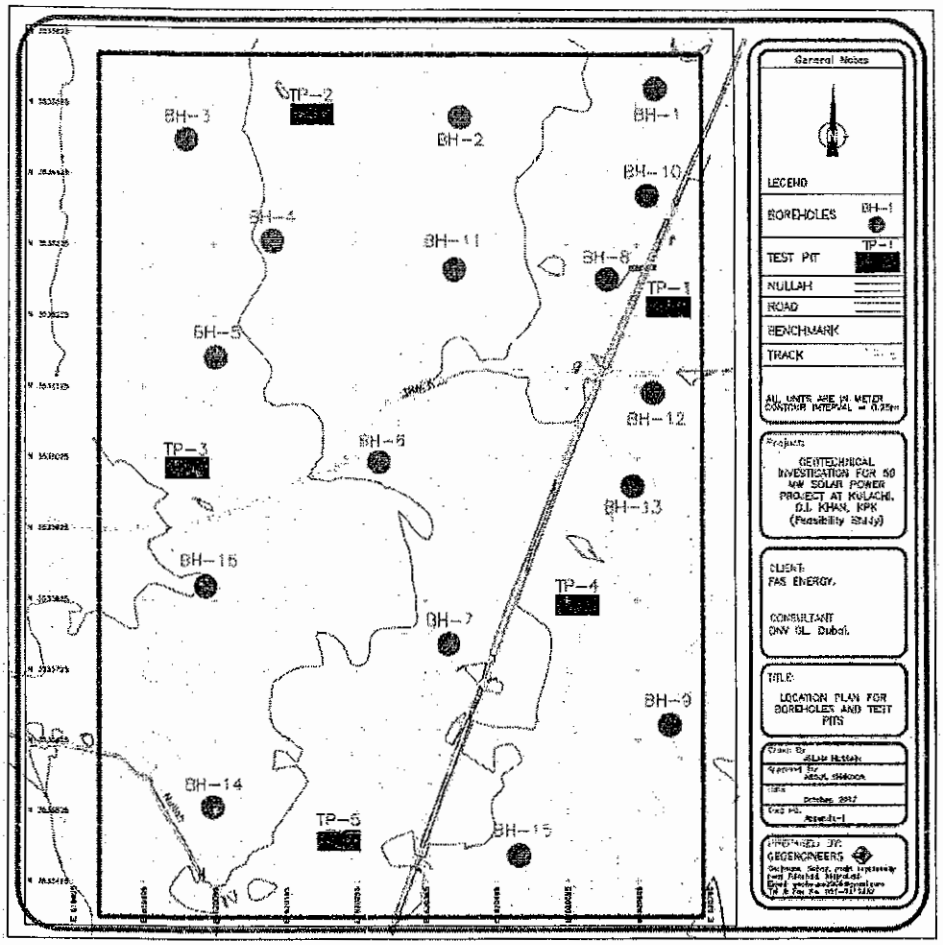


Figure 3-10. Geotechnical Investigation of the site (Source: Geotechnical Investigation Report)

Based on the findings of the report the project is located in the Northern Central Indus Basin (CIPB) comprising of alluvium (see Figure 3-11). According to the geotechnical investigation of 16 boreholes from 0 – 5 m depth each, the alluvium is mainly consisting of sandy clay and silty clayey sand.

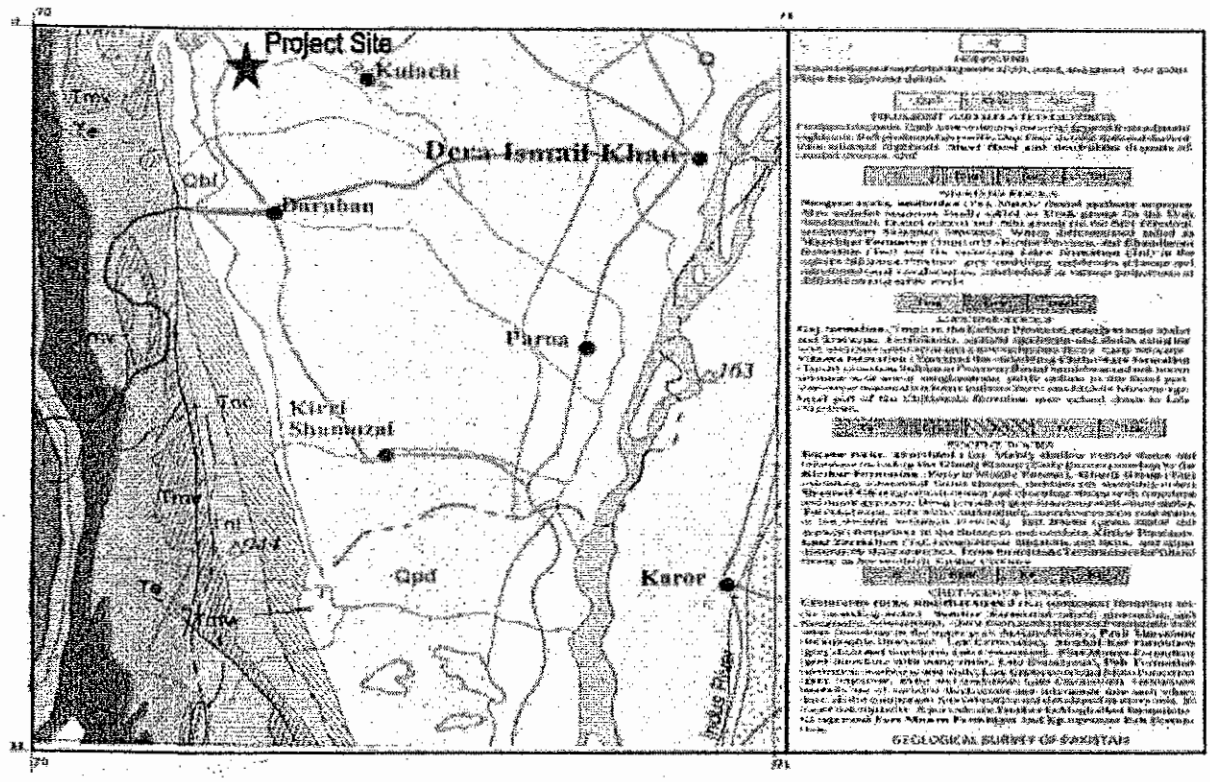


Figure 3-11. Central Indus Basin of Pakistan (Source: Geotechnical Investigation Report)

The seismic zoning of Pakistan is shown in Table 4.

Table 4. Seismic zoning map

[illegible]	[illegible]	[illegible]
1	0.05 to 0.08	Very low
2A	0.08 to 0.16	Low
2B	0.16 to 0.24	Moderate
3	0.24 to 0.32	High
4	>0.32	Very High

As noted in the Geotechnical report the **project area lies at the boundary of seismic zone 2B and 3**, this is shown further in Figure 3-12.

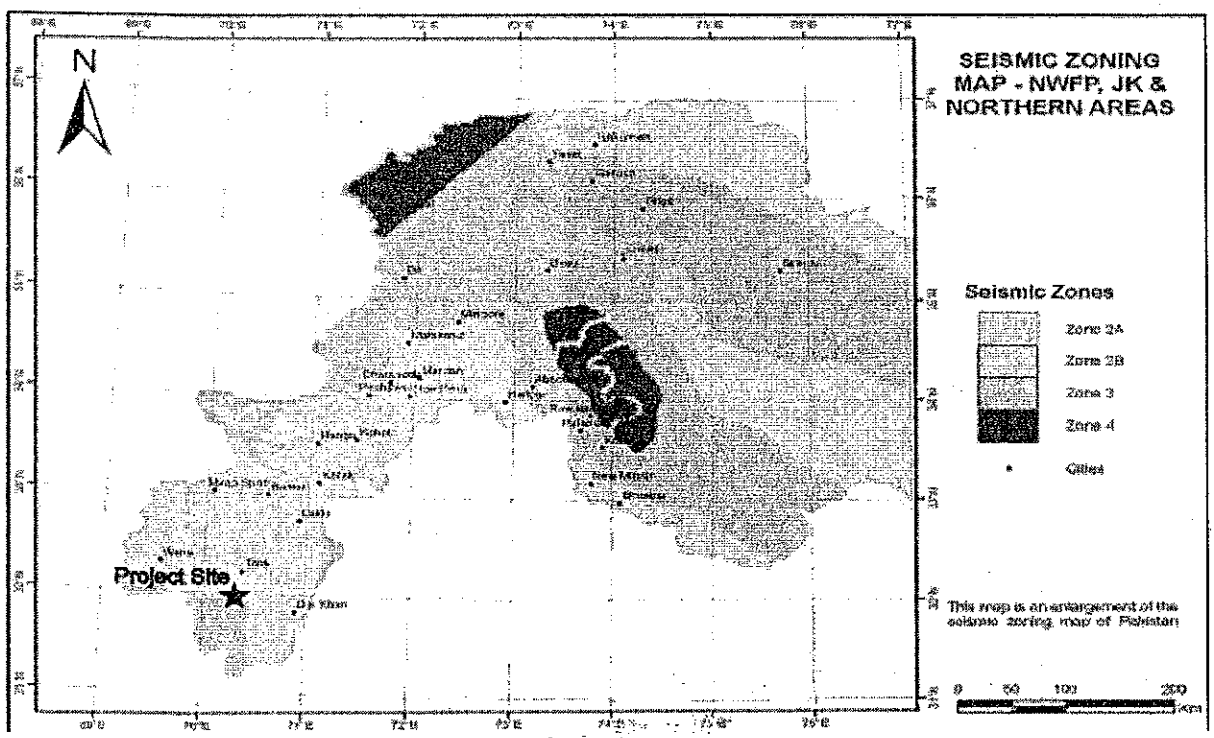


Figure 3-12. Seismic Zoning map and project location (Source: Geotechnical Investigation Report)

3.8 Climate

According to Climate Data Organisation, the climate in the Dera Ismail Khan district is "desert." 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 3-13. Historical average weather data for Dera Ismail Khan district (Source: Climate Data Org)

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	12.1	16	20.4	26.1	32.2	34.4	32	30.3	29.1	25.6	19.1	13.7
Min. Temperature (°C)	4.6	7.6	13.2	18.6	23.4	27.2	27.2	26.6	24.2	17.7	10.4	5.4
Max. Temperature (°C)	19.7	22.6	27.6	33.5	39.9	41.7	36.7	34.1	33.9	33.3	27.7	21.9
Avg. Temperature (°F)	53.8	60.8	68.7	79.0	90.0	93.9	89.6	86.5	84.4	78.1	66.4	56.7
Min. Temperature (°F)	40.1	45.7	55.8	65.5	74.1	81.0	81.0	79.9	75.6	63.9	50.7	41.7
Max. Temperature (°F)	67.5	72.5	81.7	92.3	103.8	107.1	97.7	93.4	93.0	91.9	81.8	71.6
Precipitation / Rainfall (mm)	12	16	29	21	15	15	63	46	18	4	3	7

3.9 Water (surface and groundwater)

Water is scarce in the Dera Ismail Khan district. CRBC Canal is the major canal that provides water for irrigation in the district. 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.

Within the proximity to site Badshad Abad village is using a well for water purposes.

Pit Latrine system is used for sewerage.

Additionally, during the site visit it was noticed that there are water ways (nullah) on the project area (see Figure 14).

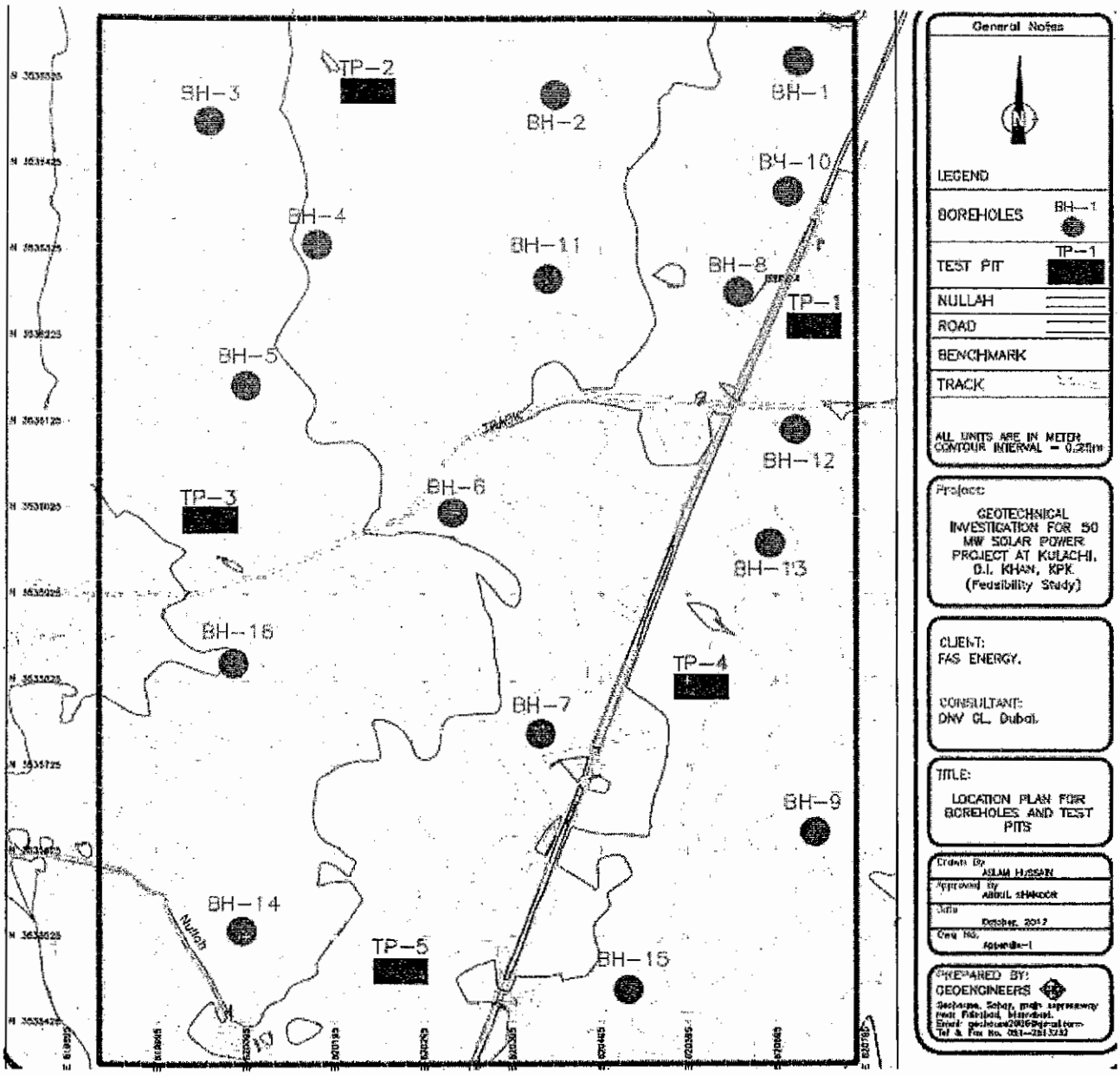


Figure 14. Topographical image of the area (Source: Geotechnical report)

Floods risks are very important to the solar PV plant development. The project is located in the Dera Ismail Khan district which is prone to flooding (see Figure 3-15).

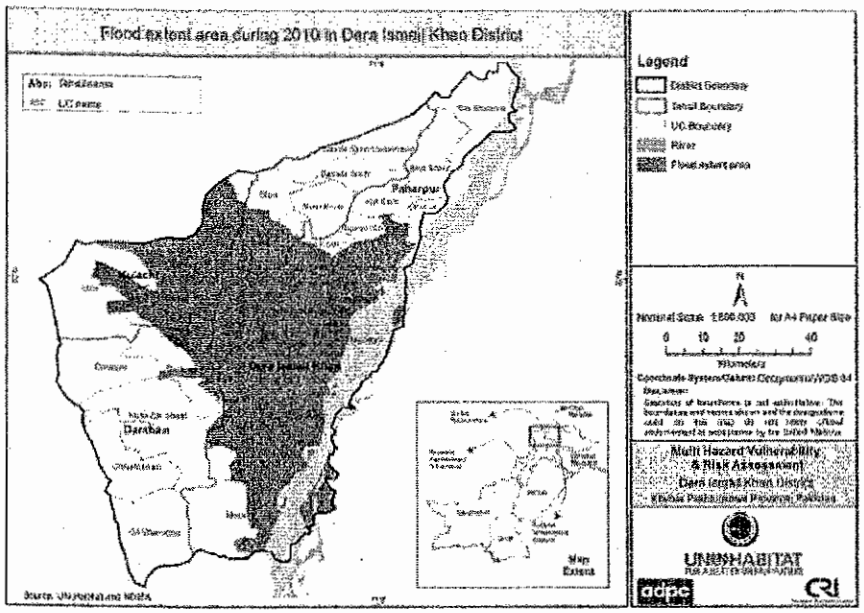


Figure 3-15. Flood extent in the Dera Ismail Khan district (Source: PDMA Report on Chitral and DI Khan District)

During the Geotechnical Investigation boreholes up to 5m depths were drilled. The ground water was not observed in the drilled boreholes. According to the report, the area contains the ground water at a depth of 100-200m.

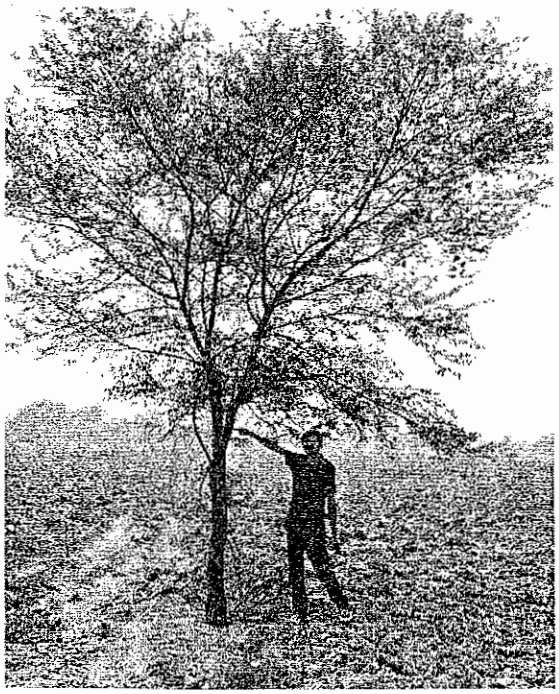
It is recommended to implement the flood measures when building the PV plant. These measures will be included as part of the Environmental Management Plan.

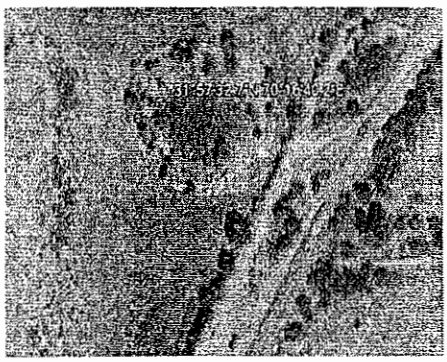
3.10 Ecological resources

3.10.1 Flora

The site does not have any protected flora. Only few bushes and trees were found of 0.5m to 6m height, including Vachellia, Nilotica, Calotropis, Procera, Centaurea, Moschata, Prosopis, Juliflora, Solanum, Surrattense, Tamarix, Aphylla, Acacia Modesta, Calotropis Procera, Haloxylon, scattered from each other (see Figure 3-16 and Figure 3-17). There are no threatening or endangered species as indicated by IUCN red list of the species. There is no 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.

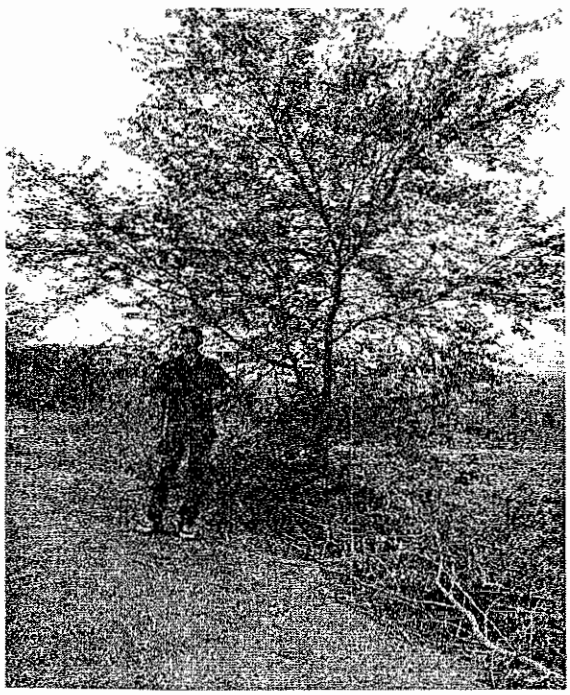
Figure 3-16. Plan of the Trees and Bushes on site

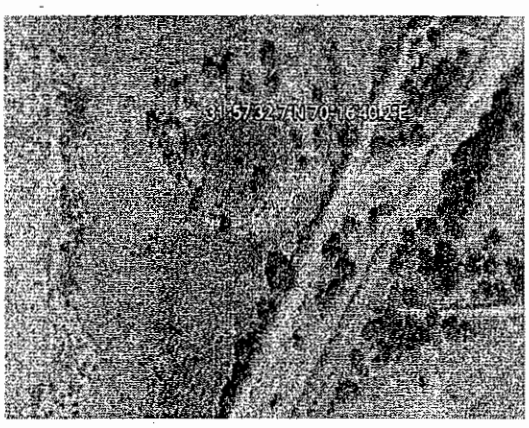




Coordinates	31°57'32.7"N 70°16'40.2"E	
Plot Corner 1	Height of Tree (approx.)	4.8 Meters
Tree:	Vachellia Nilotica (Kikar)	

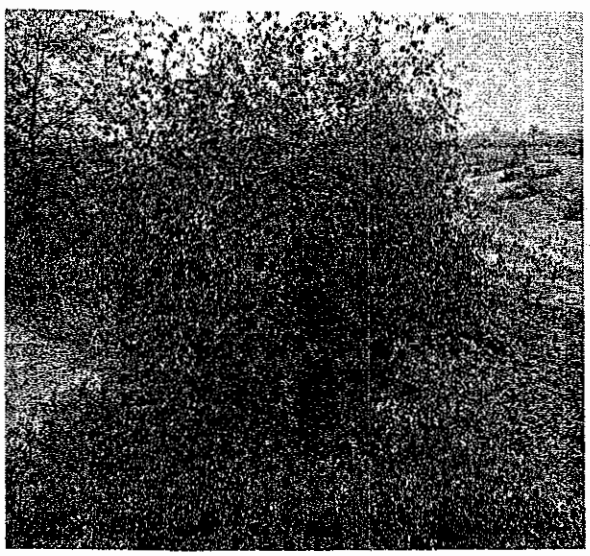
Figure 3-17. Trees and Bushes on the site perimeter

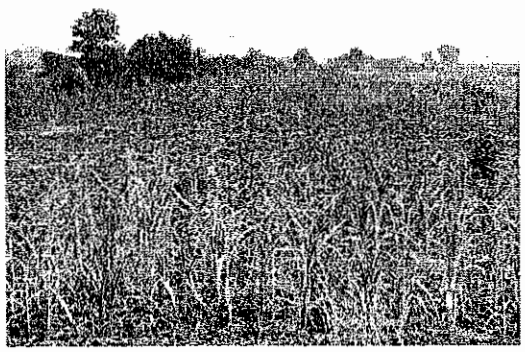


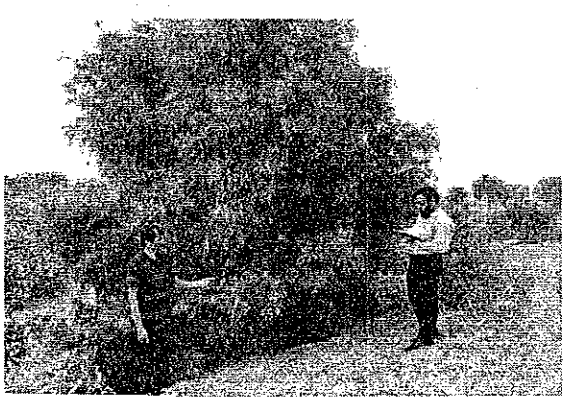


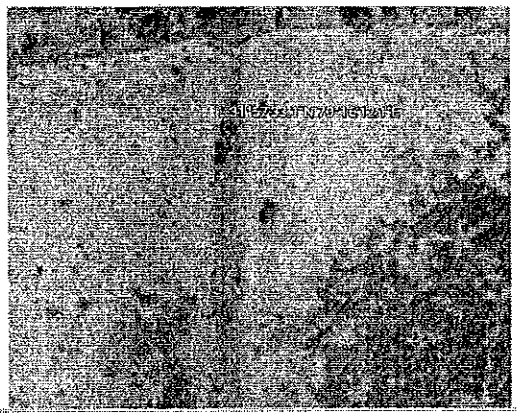
Coordinates 31°57'32.7"N 70°16'40.2"E

Plot Corner 1 Height of Tree (approx.) 3.048 Meters



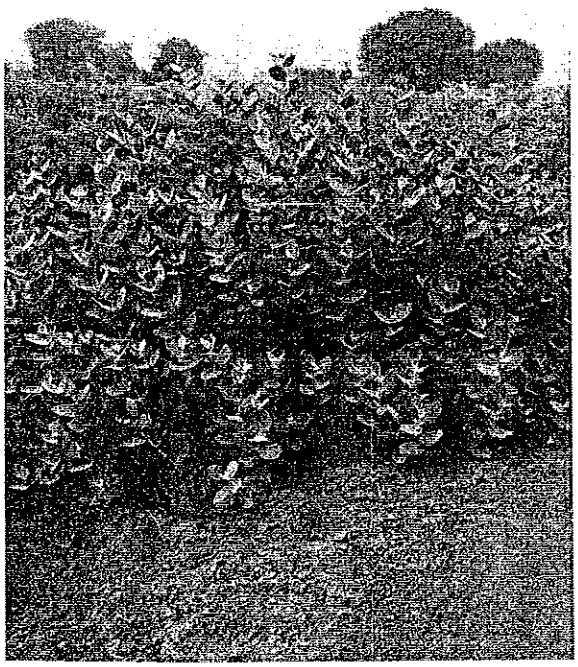


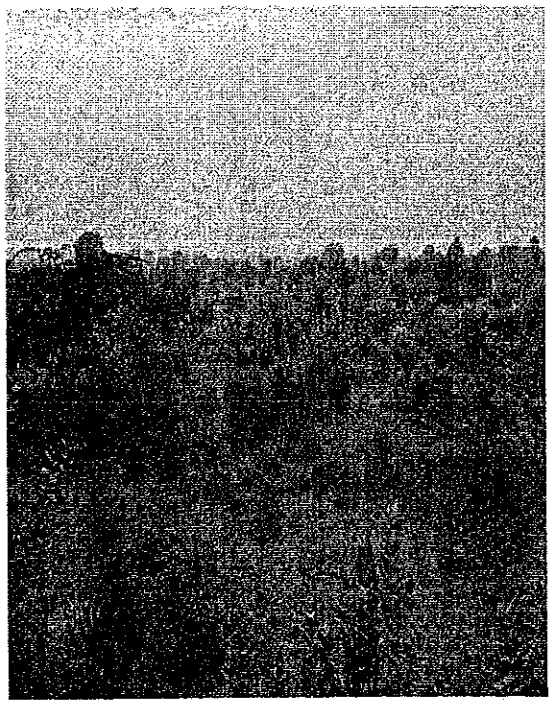




Coordinates	31°57'33.1"N 70°16'12.1"E
Height of Tree (approx.)	3m

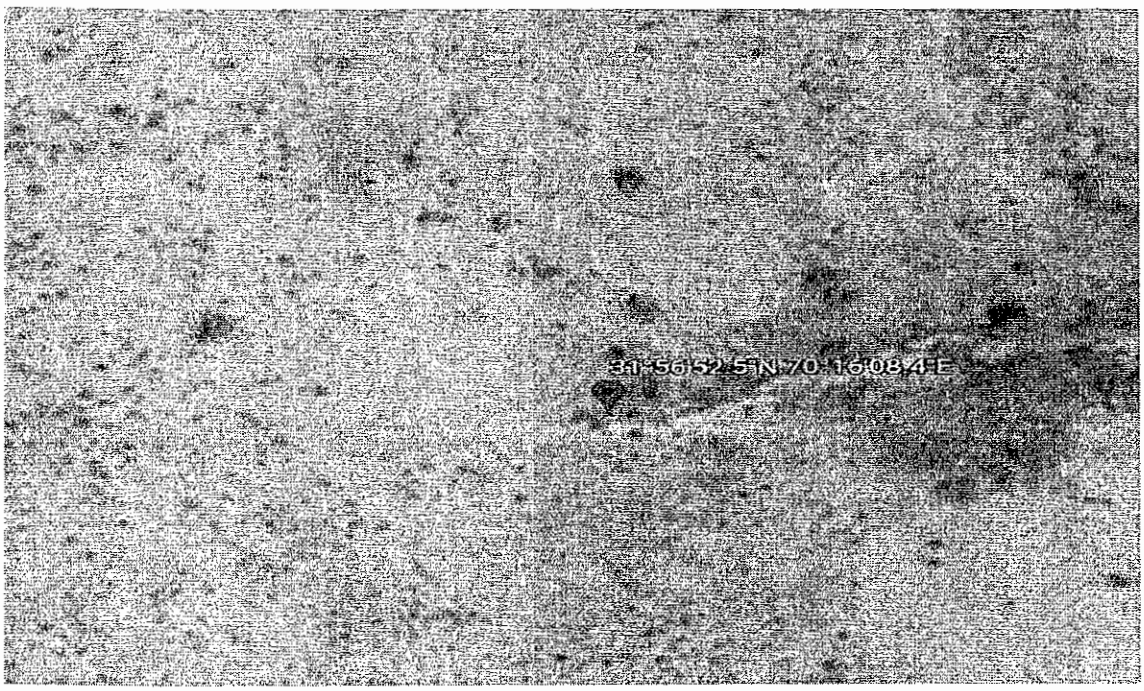
Figure 3-18. Tree on site





Vegetation around Plot Corner 3

Coordinates: 31°56'52.5"N 70°16'08.4"E



3.10.2 Fauna

Cattle and livestock (cows and goats) was observed during the site visit. Apart from that there are other species present in the area like diversified lizards and snakes.

3.10.3 Aquatic biology and fisheries

No aquatic biology or fisheries were observed within the site premises. The closest river is 3km away from the site.

3.11 Human and economic development

During the visit, no security force / squad escorted the visiting team. The local residents, when interviewed, also confirmed that there are no security issues in this area. Additionally, no surrounding residents disturbed the visiting team.

There is no human habitation inside the plot. However, there are residents belonging to Batcha Abad (500 meters from the PV plant location) found outside the plot at north-west side and there is also a Frontier Constabulary (paramilitary for providing security in the area) installation. The socio-economic profile of the village is summarised in the Table 5.

Table 5. Batcha Abad village socio economic situation

Village	Batcha Abad
Houses in a Village	70
Household Size	12-15 persons
Estimated Population of Village	1,000
Primary School	For Boys and Girls
Middle Secondary and High School	No. (Available in Loni)
Literacy Rate	Very Low (Most of the girls in village don't get education after primary)
Source of Income	Major source of income are selling animals and their by-products (Milk, Butter, eggs)
Average Income of Household	12000-15000
Animals	Goats: 30-40 per household Cow: 5-6 per house
Hospital/Basic Health Unit	No (Nearest dispensary is in Loni and Hospital is in Kulachi).
Diseases	Normal Fever, Malaria, Typhoid
Drinking Water	Available through tube well
Sewerage System	Pit Latrine
Cast	Gandapur
Communication	Mobile Service available
Nature of Houses	Made of mud (Katcha)
Electricity Availability	6-8 Hours

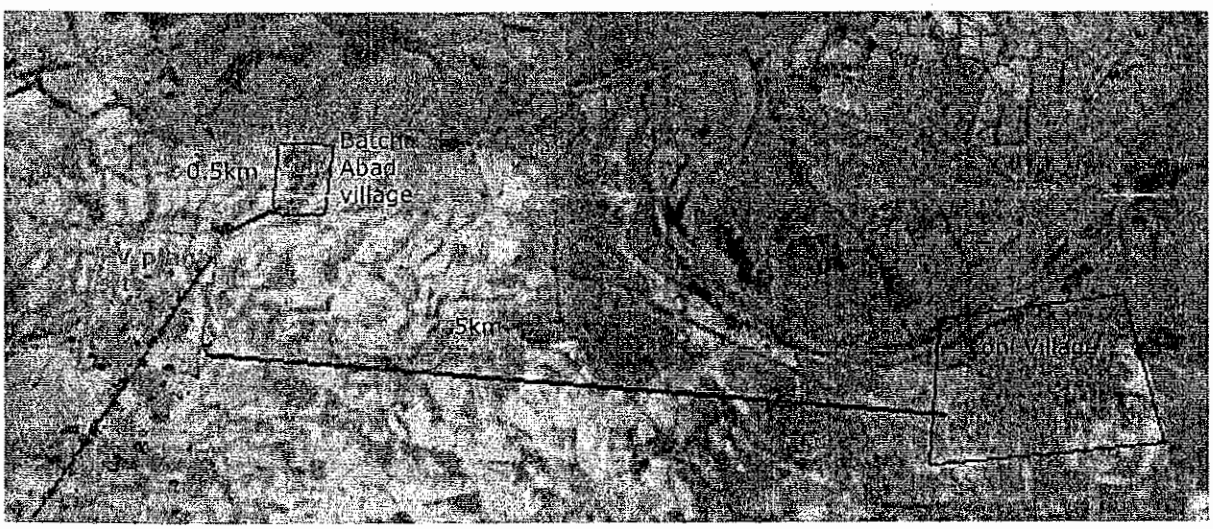
Issues:	Electricity
	No Road
	Drinking water of animals

3.11.1 Population and communities

Dera Ismail Khan situated on the right bank of the River Indus. 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. The total population of D.I Khan district is estimated at 1.6 million in 2017.

Based on the site visit report, there is no human activity within the site premises. The nearest community "Loni village" is located 5km from the site area (see Figure 3-19). The community consist of mostly "Batcha Abad Residence" (0.5km from the PV site) and Frontier Constabulary (F.C) Qila (Fort) (Pakistan Government Security Department at the northwest side. The biggest town "Kulachi" is located around 16 km from site.

Figure 3-19. Nearby community living near the site



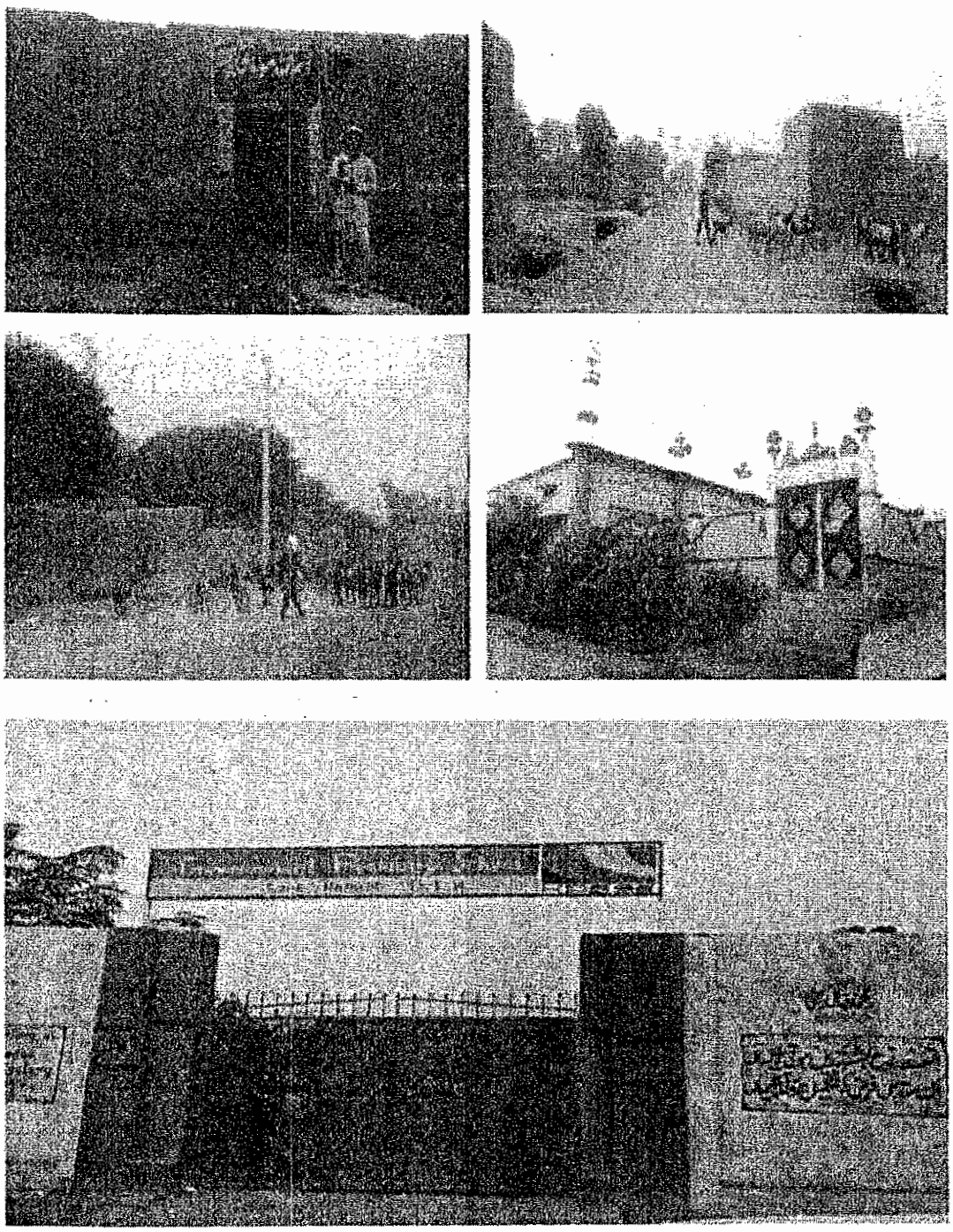


Figure 20. Loni Village

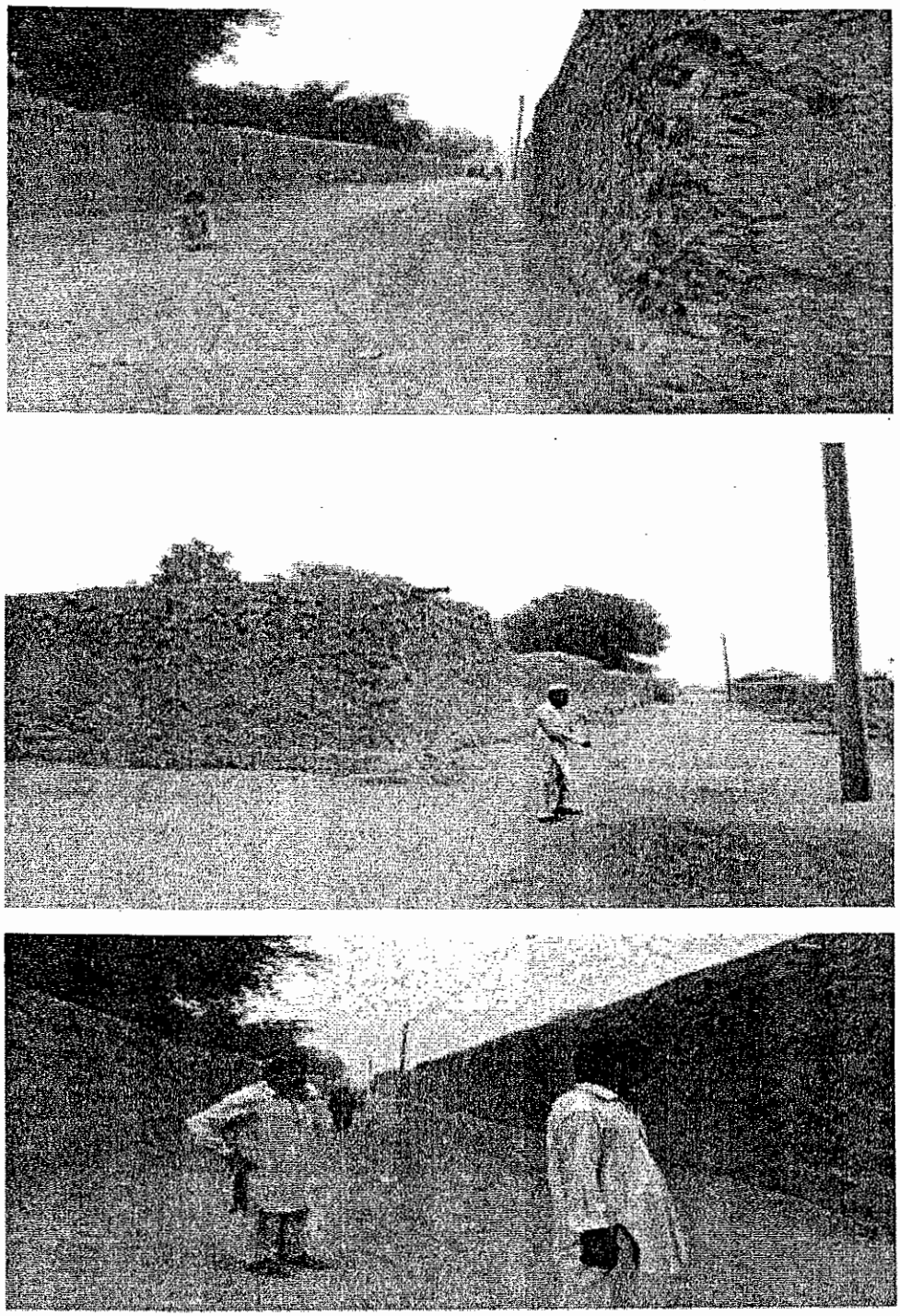


Figure 21. Batcha Abad village

3.11.2 Employment

Cattle, agriculture and fisheries are the main sources of livelihood of the rural population. Dates, sugarcane, mangoes, wheat, maze and cannola are one of the major crops grown in the area. The district also produces peas and rice.

3.11.3 Institutions

Local people of the nearby villages have access to urban areas through link roads and public transport available.

Educational and health facilities are available in Kulachi tribe community which is located 16km 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.

In Kulachi there are 9 hospitals available based on the World Health Organisation (WHO) analysis.

4 ANALYSIS OF PROJECT ALTERNATIVES

Based on the State of Industry Report 2016 produced by the National Electric Power Regulatory Authority, the total generation capacity of Pakistan in 2015 is 25GW, consisting of the following generation resources:

Table 6. Total Generation Capacity in Pakistan in 2015 (Source: NEPRA, 2016)

Type of generation	Installed Generation capacity (MW)	Share of total capacity (%)	Generated electricity (GWh)
Hydropower	7,116	28%	1,908
Thermal	16,619	66%	60,503
Nuclear	787	3%	3,854
Wind	306	1%	732
Solar	300	1%	230
Bagasse	146	0.6%	547
Total	**25,374**		67,774

Around 65.5% of thermal power plants use oil, natural gas and coal. Overall the consumption of fuel is as follows:

Type of fuel	Fuel Consumption (mTOE)
Gas	6.8
Furnace Oil	8.2
Diesel Oil	0.57
Coal	0.07
Total	**15.7**

The demand is driven by residential customers who consume around 45% of the total electricity consumption. Around 35% is consumed by industrial sector, whereas agricultural sector consumes 10% and commercial 6% of total electricity consumption. Electricity demand is growing year on year on average of about 4% in the least 4 years.

Table 7. Electricity Consumption in Pakistan

Type of customer	2011 - 12	2012-13	2013 - 14	2014-15	2015-16
Domestic (GWh)	34,767.29	35,404.35	38,811.30	40,327.90	43,537.00
Commercial (GWh)	5,690.00	5,940.00	6,299.50	6,437.89	7,096.43
Industrial (GWh)	21,741.28	22,086.44	24,118.80	24,917.32	24,977.75
Agricultural (GWh)	8,543.79	7,699.34	8,289.49	8,015.97	8,525.27
Public Lighting (GWh)	480.88	498.09	495.90	501.31	457.63
Bulk Supply (GWh)	3,404.33	4,095.95	4,263.55	4,256.07	3,550.90
Others	1,124.14	201.18	228.40	46.02	1,149.49
Supplied by PEPCO to K-EL	5,683.67	5,463.00	5,441.00	5,427.00	5,059.00
Total (GWh)	81,435.38	81,388.35	87,947.94	89,929.48	94,353.47
Growth		0%	8%	2%	5%

It is expected that the demand will continue to grow on average rate of around 6% each year. In order to meet the rapidly increase demand additional generation capacity needs to be added to the system. Pakistan already is experiencing a deficit of electricity supply of around 335MW.

4.1 "No Project" Option

This case is if the project would not go ahead, hence the potential 50MW of solar capacity would not be added to the system. Such a case would negatively influence electricity consumers and Pakistan would still be forced to import electricity. Shortages in electricity also negatively influence commercial and industrial services provides thus influencing negatively overall economy of the Pakistan. Hence, this option is not valid.

4.2 Alternative technologies

As shown in Table 6 the electricity generation is mostly provided by thermal power plants (66%) and hydropower (28%). Thermal power plants are highly dependent on polluting fuel such as oil and gas, which are not environmentally friendly and cause significant pollution. Meanwhile hydropower often causes significant environmental impact due to changes in water systems, soil degradation etc.

Nuclear power also is a very high risk generation source negatively viewed by the society due to the experienced nuclear accidents in the world.

Meanwhile, solar energy is an environmentally friendly electricity source. It is also in line with the Pakistan's Strategy to use more renewable energy sources.

5 PROJECT COSTS AND BENEFITS

As shown in DNV GL Economical feasibility report the following are the expected costs of the project:

Table 8: Breakdown of CAPEX costs (USD)

Cost item	Amount	Comment
EPC costs	55,250,000	0.85 USD/W_p
Project development & consultancy	1.500,000	Assumed fixed amount
Financing costs	1,657,500	3% of EPC costs
Insurance during construction	552,500	0.6% of EPC costs/year
Interest during construction	2,735,744	5.8% interest rate
Total CAPEX	**61,695,744**	

Table 9: Breakdown of annual OPEX costs (USD/year)

Cost item	Amount	% local	Comment
O&M Cost	780,000	10%	18 USD/kW/year
General & Administration Expenses	180,000	100%	Assumed fixed amount
Land Lease	0	100%	Not applicable
Insurance During Operation	138,125	100%	0.25% of EPC cost
Total OPEX	**1,488,125**		

For full calculations please see 17-0461-ME-R-01 report.

The benefits of the project are summarised in Table 10:

Table 10. PV Project Benefits

Benefits	Description
Employment creation	It is expected to employ between 150 and 300 people for the 1 year construction period.
Local business demand	During the construction, as well as operation there will be a need for food suppliers, other contractor, security and drivers who will further benefits from the project.
Taxes	Based on the amount of salaries and expenses to be spent on the project, there will be a revenue for the government.

Cleaner air due to less emissions (positive impact on health)	Electricity is one of the main drivers of the emissions in Pakistan. It is expected that the 50MW project will result in reduced need for thermal power plants and thus in lower emissions.
Positive image	Due to the solar power plant the area will gain more positive image.

6 ANTICIPATED IMPACTS AND MITIGATION MEASURES

6.1 Potential Impact Generation Activities

Site preparation and construction typically lasts for approximately one year and solar panels are expected to be operational for 30 to 40 years. DNV GL has prepared a list of impacts commonly associated with the development of solar PV projects that will be applicable to this Project. This list, separated by Project phase, is provided in Table 6-1 below. The detailed description of project impacts is provided in Section 6.3.

Table 6-1: Potential Project Impacts

Project Phase	Potential Project Impacts
Construction	• Degradation of air quality due to dust • Degradation of air quality due to the emission of greenhouse gases (i.e. by using machinery and traffic) • Erosion and soil compaction • Soil contamination due to accidental spills • Loss of plants on site • Habitat fragmentation • Surface and groundwater contamination due to accidental spills • Loss or modification of potential wildlife habitats • Disturbance of fauna due to noise and the presence of workers • Creation of temporary jobs and economic benefits • Site access and land use limitations • Increase in traffic • Modification of the ambient noise levels by activities and presence of workers • Accident and injury • Dewatering
Operations	• Erosion and soil compaction • Soil contamination due to accidental fuel spills • Creation of permanent jobs • Surface and groundwater contamination due to accidental spills • Site access and land use limitations • Visual impact • Accident and injury
Decommissioning	• Degradation of air quality due to dust • Degradation of air quality due to the emission of greenhouse gases • Erosion and soil compaction • Soil contamination due to accidental spills • Creation of temporary jobs and economic benefits • Site access and land use limitations • Surface and groundwater contamination due to accidental spills • Disturbance of fauna due to the noise and presence of workers • Loss of permanent jobs • Increases to traffic • Modification of the ambient noise levels by activities and presence of workers • Accident and injury

6.2 Possible Mitigation Measures

The typical approach taken to mitigate potential impacts is as follows:

- **Direct prevention** – Avoidance of sensitive areas or activities, as practicable;
- **Reduction** – Optimization of activities and work schedules, reduction of magnitude, frequency, extent and/or length through the application of appropriate mitigation measures;
- **Restoration and remediation measures** – Removal of temporary roads and work areas, replanting, site cleanup, etc.; and
- **Compensation** – Financial or in-kind payments to affected people to compensate for the loss of use or enjoyment. Protection, improvement or creation of replacement habitat, as applicable.

However, based on its experience, DNV GL has drafted a list of mitigation measures that are applicable to the Project in Table 2. Site specific mitigation measures are provided in Section 6.3.

Table 2. Possible Mitigation Measures for the FAS PV Project

Component	Mitigation measure
Construction and Decommissioning Phase	
Air quality / Noise level	• Prepare a Traffic Management Plan (or an equivalent document) to reduce vehicle use and minimize impacts, including optimize routes and speed limits. • Apply dust suppressors on unpaved roads. • Depending on local feedback, limit construction activity during daylight hours to reduce the potential impact of construction noise. • Advise nearby residents, as applicable, of significant truck transportation passing through nearby roads. • Ensure all internal combustion engines are fitted with appropriate muffler systems.
Soil / Surface and Ground Water	• Inspect trucks and heavy machinery on a regular basis. • Equip personnel with emergency spill kits. • Identify refuelling areas and maintenance (located away from vegetated areas). • Train construction and maintenance crews in appropriate responses to accidental spills. • Maintain equipment throughout the construction/decommissioning period to minimize the potential for accidental releases of toxic fluids. • Ensure Contractors have an Emergency Response Plan (ERP) in place, in accordance with the environmental monitoring plan. Train construction staff in the proper implementation of these plans.
Water consumption	• Prepare a Water Management Plan to redcue water consumption.
Vegetation	• Identify and delineate work zones prior to undertaking work to minimize the amount of vegetation that needs to be cleared. • Minimize the overall project footprint. • Prepare Site Restoration Plan once the consturction is finished the site is restored as much as possible.
Economic and Community Setting	• Develop and implement program for training and job opportunities for the Project during construction for local populations. • Public involvement program
Aesthetic / Visual	• Minimize scarring of the landscape during construction.
Land Use / Previous Site Use	• Provide local and regional authorities with Project Traffic Management Plan (or an equivalent document) to avoid any unexpected circulation problems. • Implementation of Safety Accidents and Malfunctions Plan (or an equivalent document) to reduce workplace safety risks. • Prepare Site Restoration Plan to restore consutrction activity consequences.
Operations Phase	
Air quality / Noise level	• Implement a complaint registry to analyze, follow up and remedy all valid complaints.
Soil / Surface and Ground Water	• Adhere to operational control procedures for the storage and handling of hazardous materials. • Train staff in the proper implementation of these procedures.

6.3 Project Impacts Analysis and Mitigation measures

Based on its experience in conducting Environmental Assessments (EAs) and the features identified in and around the Project region, DNV GL has prepared an overall evaluation of the Project's potential impacts on environmental components.

6.3.1 Air quality impacts

The project site is in remote area and hence does not have any industrial polluters or urban traffic. Nevertheless, the roads used in the closest populated village, Batcha Abad village, are unpaved roads. Construction-related activities, including stripping of topsoil, road construction and upgrading, installation of infrastructures and electrical lines, as well as restoration of the Project area, have potential to create dust emissions and temporarily increase particulate matter concentrations.

Additionally, transportation of the project equipment, as well as the traffic generated by workers may also create minor and local dust emissions, particularly on the unpaved roads that will be used to access the site. However, no significant concentrations of dust emissions that could affect air quality for a long period of time are anticipated.

The effect of these activities is also limited only to the Project area which is a largely deserted area with the closes populated area 500m away from the site, Batcha Abad village. It is expected that dust could affect construction workers, it is unlikely that it will affect the village.

Nevertheless, if not managed properly, dust could affect workers' health and safety by increasing Particulate Matter (PM) concentrations, reducing visibility and creating the potential for accidents.

Greenhouse gas (GHG) emissions associated with the construction, operation and decommissioning of solar energy projects are largely offset by the absence of emissions during the operational phase. As such, despite the temporary and minor dust emissions anticipated to be generated during the construction phase, the Project is expected to have an overall positive impact on air quality.

To reduce the effect of dust emissions during construction, the following **mitigation measures** shall be applied:

- Use Traffic Management Plan to limit vehicle speeds on unpaved roads (Section 7.3); and
- Utilize water or a water-based dust suppressor to control dust;
- It is recommended to limit construction activity during day light;
- Advising residents of increased transportation through the road;
- Utilise transportation that complies with the KPK Quality legislation;

In order to ensure compliance with the above measures, the following **reporting requirements** are suggested:

- Air quality measurements shall be taken by air quality monitoring devices (such as BAM stations or other certified devices that can be adjusted to provide the readings in reference to a trusted source such as Environmental Protection Agency approved monitor) before the construction starts to establish a baseline;
- Air quality shall be monitored every day and recordings logged.

The project is not expected to cause air pollution during the operational phase.

6.3.2 Soil, Surface and Ground Water quality impacts and Water Consumption

The Project is located entirely on desert land. Soil will be removed within the project site to prepare it for the installation of solar power panels. Most impacts to land use are expected to occur during the construction phase. During the construction, some spills can occur which can contaminate the land.

Land quality shall be ensured through the waste management plan. A Site Restoration Plan will ensure that temporary construction areas are restored. As a result, the overall impact to land use is expected to be non-significant.

During the project construction oil based substances and paint can spill onto the soil and with rain water can impact the quality of ground water and surface water. According to the study the groundwater is located at a depth of 100-200m. The site also contains nullah, which gets filled in during the rainy season. Nullah shall be preserved and no waste shall be stored in proximity of nullah.

The water is expected to be used for worker consumption such as drinking water, sanitary purposes, dust management and construction such as cleaning equipment.

The following water resources will be used for project purposes:

- Ground water can be used for sanitary purposes. Ground water shall not be used for construction purposes.
- Potable water can be used for human consumption. Water can be supplied by trucks.
- Nullah water and nearby river water can be used for construction purposes.

The project is expected to have around 200 workers during the peak construction. It is expected that per person around 50 litres per day is used. Thus, during peak construction up to $10m^3$ per day for 200 workers will be used.

For dust management it is also expected to use approximately $10m^3$ per day. Before PV plant operation, water will also be used to clean the newly installed PV panels before the plant commissioning and at plant handover, which for a 50MW PV plant is around 1,200 m^3.

During the PV plant operation, the water will be consumed by workers. Additionally, water will be used for PV panel cleaning.

As described in section 3.9, the Dera Ismail Khan district is a water scarce area and hence water management plan will be required to ensure appropriate utilisation of the water. For the Kulachi PV plan it is planned to supply the water via a water supply network or using ground wells.

The Project will comply with the following regulations and guidelines to minimize erosion and the impact on water resources during construction:

- Khyber Pakhtunkhwa Environmental Protection Act 2014; and
- Khyber Pakhtunkhwa Environmental Quality Standards.

Water management plan will be developed for the project to ensure sustainable water use.

Additionally, the area is under a risk of flooding. The project design shall consider the flooding risk.

Mitigation measure:

In order to ensure appropriate soil quality the following measures are recommended:

- As much as possible reuse the excavated soil.
- Ensure spill basins for the storage of liquids such as oil.
- Inspect trucks and heavy machinery on a regular basis for any spills.
- Equip personnel with emergency spill kits.
- Identify refuelling areas and maintenance (located away from vegetated areas).
- Train construction and maintenance crews in appropriate responses to accidental spills.
- Maintain equipment throughout the construction/decommissioning period to minimize the potential for accidental releases of toxic fluids.
- In case of oil spills:
    - Ensure contractor workforce is trained in handling of chemicals;
    - Ensure adequate ventilation;
    - The area shall be cleared of personnel;
    - Use PPE such as safety boots, gloves, eye protection, respiratory protection;
    - Sufficient number of spill kits shall be available at the site, including any fuel storage areas, maintenance areas and refuelling areas;
    - A spill kit shall contain (but not limited):
        - Absorbent material;
        - Shovels;
        - Empty bags for collecting contaminated material;
        - Absorbent sheets; and
        - Absorbent socks to stop the spilled material.
    - Do not use water or aqueous cleansing agents;
    - Identify the type of spill (Safety Data Sheets shall be available for any products being used during the construction and operation pf the plant);
    - Use spill kit to clean and remove the contaminated soil. Appropriate absorbent shall be used to neutralise the spill (refer to the product Safety Data Sheets to identify the absorbent to be used).

Ensure Contractors have an Emergency Response Plan (ERP) in place, in accordance with the environmental monitoring plan. Train construction staff in the proper implementation of these plans.

In order to ensure appropriate water quality the following measures are recommended:

- Develop and implement appropriate waste management plan (See Section 7.1);
- Inspect trucks and heavy machinery on a regular basis to prevent any oil leaks;
- No waste shall be stored within the nullah or within its proximity;
- Develop and implement water management plan (See Section 7.2);

- All the water plumbing shall be regularly inspected. Any identified leaks shall be repaired straight away;
- Water efficiency devices such as self-closing taps, pressure reducing valves, low flow shower heads, toilets etc. shall be installed;
- TBT talks shall be contacted on water efficiency by the HSE Manager; and
- Cleaning of vehicles shall be minimised whilst still ensuring best maintenance practices. It is recommended to clean vehicles in urban areas instead of on site.

Reporting requirements:

- Daily checks shall be performed to ensure appropriate waste management procedures are in place.
- Daily checks shall be performed to ensure appropriate water management procedures are in place.
- HSE Manager shall keep records of supplied water;
- Leak inspection results shall be recorded in the log;
- Quality checks of potable water shall be assessed.

6.3.3 Ecological and natural resources impacts

The majority of the Project area is deserted and there were no protected species identified.

Vegetation clearing is the activity that will impact ecological and natural resources during the Project's construction phase.

Mitigation measures:

To minimise the impacted area work zones shall be identified to minimise the amount of vegetation that needs to be cleared.

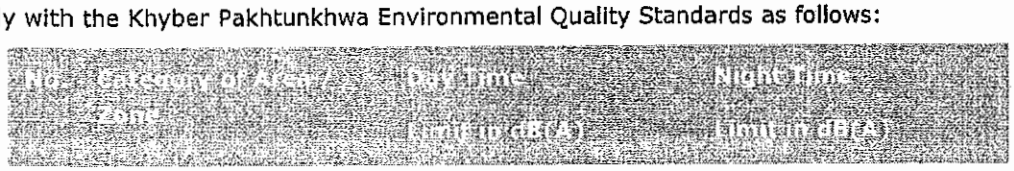
A Site Restoration Plan will be prepared to ensure that temporary construction areas are restored to their natural state. As a result, the overall impact to land use is expected to be non-significant.

6.3.4 Noise level impacts

As the Project area is relatively remote and human presence is rare, ambient noise consists mostly of wind. Noise from traffic and construction activities will temporarily increase noise levels near access roads and around work sites, which will also impact the Batcha Abad village. Construction-related noise will mostly occur during daylight hours. Any impacts are expected to be minimal and temporary.

Mitigation measures:

It is recommended to use low rated equipment and control the timing of noise to least disruptive periods. It is also possible to install a noise barrier if needed to comply with the regulation. The noise has to comply with the Khyber Pakhtunkhwa Environmental Quality Standards as follows:



1	Residential Area (A)	55	45
2	Commercial area (B)	65	55
3	Industrial area (C)	75	65
4	Silence Zone (D)	50	45

Table 3. Noise Level limits as per National Environmental Quality Standards for Noise, Pakistan

Reporting requirements:

- Noise impact shall be monitored to ensure compliance;
- Any complaints related to noise shall be addressed appropriately.

6.3.5 Aesthetic/visual impacts

Temporary visual impact will be created due to the construction activities within the project. During the operation PV power panels will create further visual impact. However, generally PV panels do not cause concerns amongst the inhabitants. The closest village is within 500 meters from the project site. It is expected to have a wall along the site perimeter.

6.3.6 Transportation infrastructure

The Project will use 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 truck/trailers and low bed trailers for transporting substation transformers and other equipment's.

Additionally, the project will be located on top of the unpaved road which is used for transportation purposes. As part of the project a traffic management plan will be developed and a side road will be developed to go around the project site. Any damage on the roads close to site proximity resulting from the project will be repaired.

No impact on Transportation infrastructures is anticipated during the operations phase.

6.3.7 Economic and Community Impact

It is expected that during the construction peak around 200 workers will be used. Therefore, there will be potential the following impacts on the nearby community:

- Influx of workers of different cultural and national backgrounds;
- Potential for communicable diseases; and
- Cultural differences amongst workers and the local communities;
- Security risks.

Mitigation measures:

- Locals should be prioritised in terms of job opportunities;
- Training program shall be developed for local populations;

- Public involvement program shall be organised;
- Traffic Management Plan shall be provided to the local authorities to ensure full consideration of the requirements;
- Any local cultural differences shall be considered;
- Appropriate vaccinations shall be ensured;
- Health checks shall be regularly performed on the workers;
- First Aid shall be available;
- Site shall be secured;
- Health and Safety Plan shall be implemented.

Reporting:

- HSE Log

7 ENVIRONMENT AND SOCIAL MANAGEMENT PLAN

7.1 Waste Management Plan

Objective

This procedure has been developed to ensure sustainable waste practices and support with the waste management in Pakistan in line with the Pakistan's Solid Waste Strategy and the Guidelines for Solid Waste Management.

Roles and Responsibilities

Project Management shall support HSE Manager in activities and emphasise the commitment to the HSE.

There should be a dedicated **HSE manager** on site who will do the following:

- Ensure implementation of the Waste Management Plan;
- Educate all project employees about sustainable waste practices;
- Monitor the implementation of the Waste Management Plan;
- Ensure that only trained personnel is handling waste;
- Ensure any waste incidents are addressed; and
- Prepare report on compliance with the Waste Management Plan in line with the Guidelines for Solid Waste Management.

Workers are responsible for:

- Compliance with the Waste management plan;
- Informing HSE Manager of any waste related incidents.

Procedure

- Waste Management shall be in line with the local municipality requirements.
- During the project construction and operation phases the objective shall be to generate as little waste as possible. The priority should be given to prevention/minimisation of the waste. Where waste cannot be prevented, every effort shall be implied to reduce the amount of waste. Opportunities shall be thought where waste can be reused or recycled.
- Waste must be managed in compliance with the KPK Waste Management Standard.
- Waste shall be separated between hazardous and non-hazardous, and liquid and solid.
- Hazardous waste is waste that is reactive, corrosive, ignitable, oxidizer or toxic, i.e. used vehicles oils, generator machinery oil, contaminated soil. Hazardous waste shall be clearly marked as hazardous and stored in a lockable fenced area with the plastic sheet cover on the floor to prevent soil contamination.
- Non-hazardous waste shall be split into: organic waste (food), inorganic waste (plastic, paper, cardboard), sanitary (septic tanks); construction waste (glass, concrete, brick, clay), metal scrap, and wood scrap. Every effort shall be undertaken to recycle the waste where possible.

- Uncontrolled waste discharge is forbidden. Any spillages shall be prevented as much as possible. Waste shall be stored in appropriate containers. There should be sufficient containers provided for different types of waste. Spill kits shall be available at site and used immediately in case of a spill.
- It is forbidden to dispose any solid or liquid waste by burying, burning, or dumping on land or into water courses.
- Final disposal of the waste shall be to an approved disposal facility.
- Contractors and employees shall ensure proper waste disposal coordination in line with the KPK regulations and local authorities.
- All employees shall be trained in appropriate response to accidental spills.
- Emergency Response Plan shall be developed and the staff shall be trained what to do in case of emergency.
- All waste generated on site shall be regularly removed to the waste disposal facility.
- Waste storage facility shall be kept tidy and continuously fumigated with appropriate disinfectants. It shall be located away from any offices, production areas, traffic routes or accommodation facilities. It shall be designed to prevent and run off and spills.
- Waste shall be handled by trained employees, who use PPEs.
- Waste management plan shall be communicated to all workers. Regular TBT shall be held about appropriate waste management.
- When transferring waste, the containers with waste shall be sealed and labelled with a clear sign.

Monitoring and Reporting

Project area shall be routinely inspected for any spills and ensure compliance with the waste management procedure. HSE Manager shall record any non-compliances such as uncontrolled waste discharge, not using PPE, not using labelling and other incompliances.

HSE Manager shall keep Waste register of produced hazardous and not hazardous waste indicating:

- Type of waste;
- Characterization of waste;
- Produced/delivered quantity of waste;
- Treatment/disposal method; and
- Entrusted waste service provider.

HSE Manager shall produce on a monthly basis a Waste Management Report in line with the guidelines by KPK.

Daily checks shall be performed observing any incompliances related to waste management. Observations shall be recorded into a log.

7.2 Water Management Plan

Objective

This procedure has been developed to ensure sustainable water practices and ensure compliance with the National Environmental Quality Standards on water.

Roles and Responsibilities

Project Management shall support HSE Manager in activities and emphasise the commitment to the HSE.

There should be a dedicated **HSE manager** on site who will do the following:

- Ensure implementation of the Water Management Plan;
- Educate all project employees about sustainable water practices;
- Monitor the implementation of the Water Management Plan;
- Ensure any water leakages are addressed; and
- Prepare report on compliance with the Water Management Plan.

Workers are responsible for:

- Compliance with the Water Management Plan;
- Informing HSE Manager of any water related incidents.

Procedure

- The water will be used in compliance with the KPK and water supply network.
- Potable water shall comply with the National Environmental Quality Standard on Water. Sample of drinking water shall be tested by the KPK. Water quality shall be assured by checking the water quality certificate from the supplier.
- Records of the supplied water shall be kept. Supplied water shall be kept in water tanks with the sealed cover to prevent contamination.
- Water leaks shall be prevented. Plumbing shall be regularly inspected. Any water leaks shall be immediately reported to the management and health and safety officer. Any identified leaks shall be repaired as soon as possible.
- Employees shall receive a regular briefing about the importance of minimizing water consumption and efficient use of water.
- Devices that help to reduce water i.e. self-closing taps, pressure reducing valves shall be installed. If possible, the use of treated wastewater shall be considered for the cleaning of vehicles for instance.
- Any water taps shall be closed when not in use.
- Any water bodies (such as nullah) cannot be contaminated with any type of waste.
- Water shall not be stored near waste storage areas.

Monitoring and Reporting

Project area shall be routinely inspected for any leaks. The HSE inspection checklist shall be available for reporting purposes. HSE Manager shall record any non-compliances such as left water tabs open, water spills and other incompliances.

Impact of water consumption on the community shall also be reviewed if complaints received by the nearby community.

7.3 Traffic Management Plan

Objective

This procedure has been developed to ensure prevention of any traffic incidents associated with the project construction and operation.

Roles and Responsibilities

Project Management shall support HSE Manager in activities and emphasise the commitment to the HSE.

There should be a dedicated **HSE manager** on site who will do the following:

- Ensure implementation of the Traffic Management Plan;
- Educate all project employees about Traffic Management Plan;
- Monitor the implementation and compliance with the Traffic Management Plan; and
- Prepare report on compliance with the Traffic Management Plan.

Workers are responsible for:

- Compliance with the Traffic Management Plan;
- Informing HSE Manager of any traffic related incidents.

Traffic Management Plan

The table below provides the plan for traffic management at the site:

Traffic Management Measures	Responsibilities	Monitoring requirements	Schedule
Vehicle security checks for access i.e. vehicle identification, driver identification	Security Logistics Manager	HSE Manager shall monitor the following: - Security requirements are clear to all personnel - Security requirements are being followed through	Daily
Schedule of vehicle traffic	Logistics Manager	HSE Manager shall monitor the following: - Schedule of vehicles shall	Daily

		be up to date and available - Vehicle traffic schedule does not cause any grievances to the community and shall be suitable for the project requirements	
Safe driving practices i.e. driving, speeds limits, road signage	Logistics Manager	HSE Manager shall monitor the following: - Safe driving practices are follow through at all times	Daily
Parking requirements	Logistics Manager	HSE Manager shall monitor the following: - Parking area shall be clear and way from pedestrians, it shall be well lit.	Daily
Vehicle compliance and safety checks	Logistics Manager	HSE Manager shall monitor the following: - Safe driving practices are follow through at all times; - Ensure vehicle compliance with the regulations through inspection of the vehicles.	Daily
Vehicle access and exit gates	Logistics Manager	HSE Manager shall ensure that vehicle access and exit gates are safe and suitable for purpose.	Daily
Vehicle roads	Logistics Manager	HSE Manager shall ensure that the roads are safe and suitable for purpose.	Daily
Management of traffic related accidents	Logistics Manager	HSE Manager shall conduct training to prepare for traffic incidents to ensure all workers are aware of who to inform and where to call and where to find First Aid.	Daily
Truck load management	Logistics Manager	HSE Manager shall ensure that track loads are covered to prevent from falling.	Daily

Traffic Management Rules:

- Traffic shall be segregated between vehicles and pedestrians on site;
- Only specialised employees are allowed to operate mobile equipment;
- All traffic rules and driving rules shall be complied with;
- Vehicles shall be compliant with the National Environmental Quality Standards for motor vehicle exhaust and noise;
- Inspection shall be carried out of the vehicles and mobile equipment as per their standard;
- There shall be coordination conducted with the local traffic authority to restore any damage done to existing roads;
- Logistics provider shall coordinate the transport in line with the local legislation, including scheduling, authorization, safe operating procedures, safety inspections, parking;
- Vehicle entrance and exit shall be clearly marked and shall have separate gates;
- All drivers shall have a current driver licence and training;
- Truck loads shall be covered to prevent load from falling off;
- Car parks shall be clearly marked and well lit. They shall be located separately from the construction activity;
- Speed limits and signs shall be clearly indicated; and
- Roads shall be firm.

Monitoring and Reporting

All incidents reported shall be recorded in the register.

Daily driver and vehicle inspection shall be conducted by the operations manager.

7.4 Safety and Emergency Plan

Objective

This plan has been developed to ensure efficient and fast response in case of emergency.

Roles and Responsibilities

Project Management shall support HSE Manager in activities and emphasise the commitment to the HSE.

There should be a dedicated **HSE manager** on site who will do the following:

- Provide training on safety and emergency procedures;
- Analyse the incident and prepare a strategy on lessons learned to prevent incident from happening in the future; and
- Organise Emergency drills.

Workers are responsible for:

- Comply with the Emergency Plan; and
- Be aware of what needs to be done during the emergency.

Emergency Management Plan

The table below provides the plan for emergency at the site:

Area	Requirements	Responsibilities	Monitoring requirements	Schedule
Fire	All workers shall be aware of fire safety All workers shall know how to use fire extinguisher All workers shall be informed of fire exits All workers shall have participated in fire drills and shall know the procedure in case of fire Extinguishers shall be available throughout the site and especial close to fire sources. All fire extinguishing equipment shall be in compliance with the Pakistan legislation. All workers shall have access to the phone to call in case of emergency	Fire wardens shall be appointed HSE Manager shall ensure the requirements are met	HSE Manager shall monitor the following: - All workers undertook a fire safety training (including location of emergency exists, how to use fire extinguishers, emergency phones, whom to contact.) - Drawings with the emergency exits and dire extinguishers shall be clear - Fire evacuation plan shall be displayed	Fire drills shall be conducted minimum twice per year. Fire safety trainings can be undertaken once every 2 years. On induction fire exits and equipment, as well as emergency numbers shall be explained to the workers.
First Aid	All workers shall be aware of where First Aid is available and shall be in compliance with local legislation. All workers shall have access to the phone to call in case of emergency. All workers shall be trained in CPR. On site there should be at least one first aid person who is qualified in this area. First kits shall be distributed to all	HSE Manager shall ensure the requirements are met	HSE Manager shall monitor the following: - Ensure a dedicated Frist Aid person is on site - Ensure everybody received the appropriate training - Ensure first kits are available	Daily

	workers, as well as be available on site. Health Clinic shall be available on site.		-	
Signs	Signs shall be used to enforce safety such as "no entry", use of PPE, warn of fire hazards, inform of emergency exits, inform of toxic materials, etc. These shall be in compliance with the Pakistan legislation.	HSE Manager shall ensure the appropriate use of signs.	HSE Manager shall ensure full compliance.	Daily
Evacuation	Evacuation map shall be clear and available to everybody.	HSE Manager shall ensure the map is available and drills have been conducted.	HSE Manager shall ensure full compliance.	Daily

Emergency Procedure:

Upon emergency the following people shall be contacted:

- HSE Manager;
- HSE Manager deputy (in absence of the HSE Manager);
- Site Manager;
- Project Manager;
- Emergency Response Team such as police or ambulance as deemed necessary.

The personnel shall be evacuated promptly.

If safe to do so, witnesses of the emergency shall try to eliminate the danger.

HSE Manager or deputy (in case of the absence of HSE Manager) shall ensure that personnel is available to ensure the Emergency Response Team help can arrive quickly to the site. This can be done by sending personnel to show the way to the emergency location.

The scene of emergency shall be guided:

- Public shall not be allowed to come to the scene;
- Operation of the Emergency shall be facilitated as required;

HSE Manager shall debrief personnel about the emergency and on the way forward, as well as actions to be undertaken to prevent the emergency from occurring.

Monitoring and Reporting

All incidents reported shall be recorded in the register, including actions to be undertaken based on the learnings from the incident, who is responsible for actions to be undertaken, and what is the timeline for follow up actions.

7.5 Grievance Redressal Mechanism

FAS Solar Power Pakistan aims to implement holistic practices whereby any grievance from the community or from the workers is efficiently recorded and addressed. This mechanism will be used to address any complaints that arise.

HSE Manager will facilitate the Grievance Committee which shall ensure the efficient addressing of any complaints related to the project. The Grievance Committee shall include representatives from the local municipality and authorities as mutually agreed, as well as site HSE manager and site project manager.

The Grievance Committee shall establish an individual representing the communities nearby to the project site, i.e. Batcha Abad village and Loni Village representative, who will be communicate any complaints related to the project.

HSE Manager in liaison with project manager shall organise community meetings to inform of the project and address community concerns.

Any individual shall pass the complaint either to the community representative or Grievance Committee or directly to the HSE Manager and Project Manager. Any received complaint shall be logged in complaints register. The complaint shall be aimed to be resolved within 1 week by the HSE Manager and Project Manager. Resolved complaint shall be communicated back to the person who raised the complaint or to the community representative. Complaints register shall then be updated with the description of how the complaint has been solved and how.

In case the complaint is not resolved, it should be further discussed by the Grievance Committee to agree on the next steps to solve the complaint. If the complaint is still not resolved, it should be addressed following local legal processes.

All the complaints shall be registered in the Complaints Register, including the following information:

1. Data the complaint has been raised;
2. Name of the person complaining and contact details;
3. Details of the complain;
4. Actions to be taken to address the complain;
5. Person responsible to address the complain;
6. Target date to implement the measure to resolve the complaint;
7. Measure that was undertaken; and
8. Data for the complaint resolution.

Complaints shall be discussed during the weekly HSE meetings and shall be summarised in Monthly HSE reports.

7.6 Reports and Documentation

The HSE Manager will have the following records ready:

- Daily logs of the following:
  - Air quality compliance;
  - Water management compliance;
  - Waste management compliance;
  - Incidents recorded;
  - Near misses recorded;
  - HSE inspection log; and
  - Traffic management compliance.
- Weekly HSE meeting minutes;
- Monthly HSE Report, which shall include the following:
  - Checks performed on the daily basis
  - Non-compliances registered;
  - Actions taken to remove non-compliances;
  - Water consumption statistics and compliance with Water Management Plan;
  - Waste generation statistics and compliance with the Waste Management Plan;
  - Compliance with the Traffic Management Plan, including Vehicle inspection checklists;
  - Any complains recorded and actions to address them.

7.7 Environmental and Social Trainings

HSE Training Plan will be developed to address fully HSE awareness. All new joiners shall have an HSE induction training which provides information on the Environmental, Health and Safety management plans. Weekly HSE meetings shall be held reporting on any observations and ensuring measures are implemented.

Workers shall also have the following mandatory training:

- Waste Management;
- Water management;
- PPE use;
- Workers who working with any machinery shall have appropriate training to operate the machinery;
- Fire Prevention and precautions;
- First Aid;
- Incident reporting;
- HSE standards and regulations;
- Emergency procedures;
- Risk management;
- Social impact.

7.8 Public Consultation and Disclosure

7.8.1 Public consultation

The community living in the most nearby area, namely, Batcha Abad, was consulted regarding the Project.

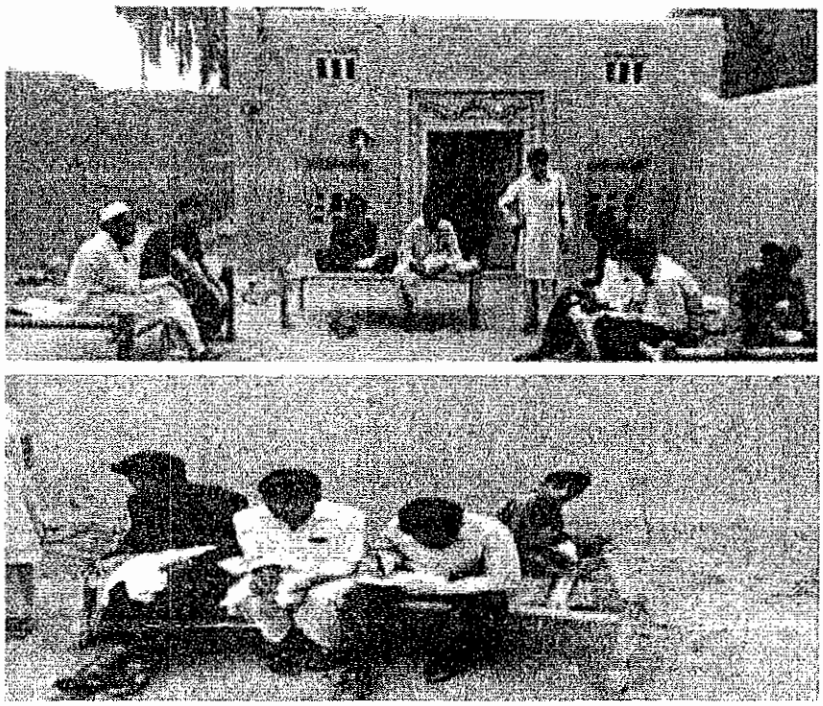


Figure 22. Consulted Community in Batcha Abad

Details of Persons Consulted:

Table 4. Details of persons consulted

Name	Age / Date of Birth (DD/MM/YYYY)	CNIC Number
Khan Muhammad	01-01-1992	12102-5396789-5
Jan Muhammad	02-06-1987	12102-4513851-1
Nauman	01-01-1988	12102-9465269-5
Ghulam Qasim	40	12102-9272399-9
Tahseen Khan	01-01-1984	12102-1478000-1

The community was briefed about the project and was asked whether they have any concerns about the project. Their opinion was that the development of the project is in favour of the community. The community was interested in any job opportunities that might result as a result of the project.

7.8.2 Public Disclosure Requirements

FAS Solar Power Pakistan will disclose this IEE and EMP to all the stakeholders in accordance with the national legislation.

7.9 Community Involvement / Development plan

Objective

This plan is to ensure all of the stakeholders are identified and engaged as needed during the power plant construction and operation. Key objectives of the plan are summarised below:

- Identify key stakeholders of the project, namely, who are impacted by the Project;
- Provide methods of project information dissemination;
- Develop stakeholder engagement process to build beneficial relationships;
- Define reporting and monitoring measures for stakeholder engagement.

Roles and Responsibilities

Project Management shall support HSE Manager in activities and emphasise the commitment to the HSE.

There should be a dedicated **HSE manager** on site who will do the following:

- Ensure implementation of the Community Involvement and Development Plan;
- Monitor the implementation of the Community Involvement and Development Plan; and
- Prepare report on compliance with the Community Involvement and Development Plan.

Workers are responsible for:

- Compliance with the Community Involvement and Development Plan;
- Informing HSE Manager of any community related incidents and feedback;
- Behave in line with the worker code of conduct.

Plan

General requirements

General requirements for stakeholder engagement:

- Management shall demonstrate **transparency** with the community by providing responses in a timely and informative manner;
- Management shall aim to achieve **trust and respect** from the community by taking into account the cultural beliefs and values of the stakeholders and creating open dialogue with the communities.

Stakeholder identification

The following stakeholders are directly impacted by the project:

- Local communities;

- Local businesses; and
- Project workers.

The following stakeholders are indirectly impacted:

- Local Municipalities;
- Lenders;
- Governmental institutions;
- Utility;
- Network Operator;
- Ministries.

Sharing of information

The following information shall be disclosed to the stakeholders:

Stakeholder type	Information to share	Time	Communication types
Local community and businesses	IEE Non-Technical Summary Any job vacancies on the plant Grievance procedures	Once ready Once available Once ready	Website, at the offices, at the municipality offices. Vacancies can be advertised following the best locally preferred method for advertising i.e. noticeboards. Meeting with the community shall be arranged prior to the start of the project construction to inform the community about the project schedule and opportunities, raise any community concerts.
PV plant workers	Safety Policy Environmental Policy Grievance Procedure Code of Conduct Safety Rules	Before starting the recruitment, the policies shall be available	Website, via email, noticeboards, induction training, regular meetings (TBT)
Local municipalities	IEE Non-Technical Summary Reporting of	Non-technical summary shall be published once ready. EHS aspects shall be reported as	Website, sending letters, meetings, emails

	environmental and social aspects Deal with the municipality on the relevant aspects such as water sustainability, waste management	per local legislation. Local municipality shall be liased with to ensure the waste and water practices are in line with their requirements.	
Lenders	Reporting as per agreement	As per agreement	As per agreement
EPA, Governmental institutions	IEE Non-Technical Summary Reporting requirements as per local legislation	Once ready As per Environmental Protection Agency regulations and requirements, and any other governmental legislations	Website, emails, letters, meetings
Utility	IEE Non-Technical Summary	Once ready	Website, emails, letters, meetings
Network Operator	IEE Non-Technical Summary Any relevant information related to grid connection	Once ready	Website, emails, letters, meetings
Ministries	IEE Non-Technical Summary	Once ready	Website

Monitoring and Reporting

All evidence of any type of communication shall be stored and available. Community Communication Report shall be prepared once a year to summarise all the communication with the stakeholders.

8 CONCLUSION AND RECOMMENDATION

In order to identify any environmental impacts the following tasks were undertaken:

1. Topographic study;
2. Geological study;
3. Grid impact study;
4. Site visit;
5. Stakeholder consultation;
6. Secondary data analysis.

Following the above activities performed, no major risks have been identified to be caused by the project. The project is going to be based on the desert land with few trees and bushed within the site perimeter.

The project site does not have any human settlements and hence will not require a resettlement.

Project Land owners have been consulted with and they have agreed to sell the land.

The closest human settlement to the project is 500 meters away from the project site. The community has been consulted and they do not see any concerns about the project. The community, however, expressed an interest in potential job opportunities.

During the construction the project is expected to cause noise and air impact due to excavation activities and increased traffic, as well as waste creation.

During the operational stage, the project is not expected to have any impact apart from any potential waste management i.e. from broken panels.

Baseline activities shall be carried our prior to the commencement of the project, specifically:

- Air quality shall be recorded prior to the commencement of the project construction;
- Water quality shall be recorded in the nearby river prior to the commencement of the project;
- Noise levels shall be recorded prior to the commencement of the project construction.

A list of potential impacts and the recommended mitigation measures are provided below:

Table 5. Summary of identified impacts and recommended mitigation measures for the project

Component	Mitigation measure
Construction and Decommissioning Phase	
Air quality	• Use Traffic Management Plan (Section 7.3) to reduce vehicle use and minimize impacts, including optimize routes and speed limits, and ensure good maintenance. • Apply dust suppressors – water shall be sprinkled daily or when there is dust problem on the exposed surface. • Excavated soil shall be covered, including within the site and when transporting. • Advise nearby residents, as applicable, of significant truck transportation passing through nearby roads. • Utilise transportaiton and equipment in line with the KPK Quality legislation. • Air quality measurements shall be taken before the construction starts to establish a baseline; • Air quality shall be monitored every day and recordings logged.
Noise level	• Use Traffic Management Plan (Section 7.3) to reduce vehicle use and minimize impacts, including optimize routes and speed limits, and ensure good maintenance. • Depending on local feedback, limit construction activity during daylight hours to reduce the potential impact of construction noise. • Noise level shall be taken before the commencement of consutrction; and noise shall be monitored durign the consutrciton to ensure compliance with the requirements. • Noise level shall be in compliance with the KPK noise legislation on. • Use of proper silencers, mufflers and personal protective equipment's; • Any complaints regarding the nosie shall be logged and addressed. • Night-time traffic will be avoided near the communities.
Soil / Surface and Ground Water and Water consumption	• Use Water Management Plan (See Section 7.2) to ensure appropriate use of water. • Consider flooding aspects in the PV plant design. • Use Waste Management Plan (See Section 7.1) to ensure appropriate waste management. • No waste shall be stored within the nullah or within its proximity; • Equip personnel with emergency spill kits. • Train construction and maintenance crews in appropriate responses to accidental spills. • Maintain equipment throughout the construction/decommissioning period to minimize the potential for accidental releases of toxic fluids. • Ensure Contractors have an Emergency Response Plan (ERP) in place, in accordance with the environmental monitoring plan. Train construction staff in the proper implementation of these plans. • All the water plumbing shall be regularly inspected. Any identified leaks shall be repaired straight away; • Water efficiency devices such as self-closing taps, pressure reducing valves, low flow shower heads, toilets etc. shall be installed; • TBT talks shall be contacted on water efficiency by the HSE Manager; and • Cleaning of vehicles shall be minimised whilst still ensuring best maintenance practices. It is recommended to clean vehicles in urban areas instead of on site. • Appropriate approval shall be received from the authority to utilise ground water and river water for project purposes. • Proper drainage system shall be implemented. • Maintenance of vehicle and machinery will only be carried out at designated places to avoid any fuel spill.

Component	Mitigation measure
Waste Management	• Devel and implement Waste Management Plan (See Section 7.1) • 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. • 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.
Ecological and natural resources impacts (vegetation and fauna)	• Identify and delineate work zones prior to undertaking work to minimize the amount of vegetation that needs to be cleared. • Minimize the overall project footprint. • Prepare Site Restoration Plan once the consturction is finished the site is restored as much as possible. • Personnel working during operational phase of the project will be strictly prohibited to hunting and trapping of wild life
Traffic Management	• Implement Traffic Management Plan • There shall be clear separation between pedestrian road and vehicle roads within the site • Speed limits shall be followed at all times • Follow local driving rules • Road Sign board will be fixed at appropriate places to reduce safety hazards associated with project traffic • Project drivers will be trained on defensive driving • Follow strict code of conduct • Safety precautions and display on the notice board of entry gate in both national and local language
Economic and Community Setting and HSE	• Locals shall be prioritized for any job opprotunity. • Develop and implement program for training and job opportunities for the Project during construction for local populations. • Public involvement program • Provide local and regional authorities with Project Traffic Management Plan (or an equivalent document) to avoid any unexpected circulation problems. • Implementation of Health and Safety Incidents Plan (or an equivalent document) to reduce workplace safety risks. • Prepare Site Restoration Plan to restore construction activity consequences. • Any local cultural differences shall be considered. • Appropriate vaccinations shall be ensured. • Health checks shall be regularly performed on the workers. • First Aid shall be available. • Site shall be secured. • Implement Grievance Mechanism. • 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.

Component	Mitigation measure
	• Suitable PPE, training and ongoing safety checks shall be available. • Equipment periodic maintenance according to manufacturers' schedule. • Follow the Trafifc Management Plan. • The project will create employment opportunities for the nearby areas. All the precautionary measures as required for the safety of workers shall apply • Take adequate precautions to prevent danger from electrical equipment. • Provide a first aid. • Ensure workers exposed to loud noise wear ear plugs/ear muffs. • Workers accommodation shall comply with the IFC / ADB standards. • FAS Energy, its contractors and sub contractors comply with the national labor law.
Operations Phase	
Soil / Surface and Ground Water	• Adhere to operational control procedures for the storage and handling of hazardous materials. • Train staff in the proper implementation of HSE procedures.
Waste Management	• Implement waste management plan

Overall the project is feasible and a sustanble option which will result in the following benefits for Pakistan:

- Cleaner Air in the long term – as the project will be using solar resource to generate elecitricyt;
- Creation of jobs during – the project will employ around 200 people during the peka consutrction. This will bring increased business to the area; and
- Better reputation for the country – as usage of solar power is very welcomed by all the communities.

EMP shall be constantly reviewed and updated as needed.

Issue	Impact category (not significant, minor, moderate, major)	Mitigation Measure	Monitoring requirements
Construction Phase			
1- Air Quality			
• Dust emissions during construction activities; • Fuel combustion Emissions from traffic and machinery	Minor	• Use Traffic Management Plan (Section 7.3) to reduce vehicle use and minimize impacts, including optimize routes and speed limits, and ensure good maintenance. • Apply dust suppressors – water shall be sprinkled daily or when there is dust problem on the exposed surface. • Excavated soil shall be covered, including within the site and when transporting. • Depending on local feedback, limit construction activity during daylight hours to reduce the potential impact of construction noise. • Advise nearby residents, as applicable, of significant truck transportation passing through nearby roads. • Utilise transportaiton and equipment in line with the KPK Quality legislation. • Air quality measurements shall be taken before the construction starts to establish a baseline; • Air quality shall be monitored every day and recordings logged.	• Air quality measurements shall be taken before the construction starts to establish a baseline; • Air quality shall be monitored every day and recordings logged.
2- Noise			
• Machinery and equipment • Earth works	Minor	• Use Traffic Management Plan (Section 7.3) to reduce vehicle use and minimize impacts, including optimize routes and speed limits, and	• Noise impact shall be monitored to ensure compliance; • Any complaints related to

		ensure good maintenance. • Depending on local feedback, limit construction activity during daylight hours to reduce the potential impact of construction noise. • Noise level shall be taken before the commencement of consutrction; and noise shall be monitored durign the consutrciton to ensure compliance with the requirements. • Noise level shall be in compliance with the KPK noise legislation on. • Use of proper silencers, mufflers and personal protective equipment's; • Any complaints regarding the nosie shall be logged and addressed. • Nighttime traffic will be avoided near the communities.	noise shall be addressed appropriately.
3- Soil/ Surface and Ground Water and Water consumption			
• Clearing of small bushes and trees • Civil works • Oil leaks and fuel spills • Consumption of water for construction, sanitary and drinking purposes.	Moderate	• Use Water Management Plan (See Section 7.2) to ensure appropriate use of water. • Consider flooding aspects in the PV plant design. • Use Waste Management Plan (See Section 7.1) to ensure appropriate waste management. • No waste shall be stored within the nullah or within its proximity; • Equip personnel with emergency spill kits. • Train construction and maintenance crews in appropriate responses to accidental spills. • Maintain equipment throughout the construction/decommissionin g period to minimize the potential for accidental releases of toxic fluids. • Ensure Contractors have an Emergency Response Plan	Project area shall be routinely inspected for any leaks. The HSE inspection checklist shall be available for reporting purposes. HSE Manager shall record any non-compliances such as left water tabs open, water spills and other incompliances. Impact of water consumption on the community shall also be reviewed if complaints received by the nearby community. Daily checks shall be performed to ensure appropriate waste management procedures are in place. Daily checks shall be performed to ensure appropriate water management procedures are in place. HSE Manager shall keep records

		(ERP) in place, in accordance with the environmental monitoring plan. Train construction staff in the proper implementation of these plans. • All the water plumbing shall be regularly inspected. Any identified leaks shall be repaired straight away; • Water efficiency devices such as self-closing taps, pressure reducing valves, low flow shower heads, toilets etc. shall be installed; • TBT talks shall be contacted on water efficiency by the HSE Manager; and • Cleaning of vehicles shall be minimised whilst still ensuring best maintenance practices. It is recommended to clean vehicles in urban areas instead of on site	of supplied water; Leak inspection results shall be recorded in the log; Quality checks of potable water shall be assessed.
4- Ecological and natural resources impacts (vegetation and fauna)			
• Vegetation and fauna	Not significant	• Identify and delineate work zones prior to undertaking work to minimize the amount of vegetation that needs to be cleared. • Minimize the overall project footprint. • Prepare Site Restoration Plan once the consturction is finished the site is restored as much as possible. • Personnel working during operational phase of the project will be strictly prohibited to hunting and trapping of wild life	Non-compliance observation log
5- Economic and Community Setting and HSE			
• Work environment Health and Safety • Community Health and Safety	Moderate	• Develop and implement program for training and job opportunities for the Project during construction for local populations. • Public involvement program • Provide local and regional authorities with Project Traffic Management Plan (or	• Daily logs of the following: o Air quality compliance; o Water management compliance; o Waste management compliance;

		an equivalent document) to avoid any unexpected circulation problems. • Implementation of Health and Safety Incidents Plan (or an equivalent document) to reduce workplace safety risks. • Prepare Site Restoration Plan to restore construction activity consequences. • Any local cultural differences shall be considered. • Appropriate vaccinations shall be ensured. • Health checks shall be regularly performed on the workers. • First Aid shall be available. • Site shall be secured. • Implement Grievance Mechanism. • 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. • Suitable PPE, training and ongoing safety checks shall be available. • Equipment periodic maintenance according to manufacturers' schedule. • Follow the Trafifc Management Plan. • The project will create employment opportunities for the nearby areas. All the precautionary measures as required for the safety of workers shall apply • Take adequate precautions to prevent danger from electrical equipment. • Provide a first aid. • Ensure workers exposed to loud noise wear ear plugs/ear muffs. • Workers accommodation shall comply with the IFC / ADB standards.	o Incidents recorded; o Near misses recorded; o HSE inspection log; and o Traffic management compliance. • Weekly HSE meeting minutes; • Monthly HSE Report, which shall include the following: o Checks performed on the daily basis o Non-compliances registered; o Actions taken to remove non-compliances; o Water consumption statistics and compliance with Water Management Plan; o Waste generation statistics and compliance with the Waste Management Plan; o Compliance with the Traffic Management Plan, including Vehicle inspection checklists; o Any complaints recorded and actions to address them. o Records of Trainings o Health issue logs o Safety incident logs

		• FAS Energy, its contractors and sub contractors comply with the national labor law.	
6- Waste Management			
• Waste Management	Minor	• Devel and implement Waste Management Plan (See Section 7.1) • 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. • 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. • 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.	Project area shall be routinely inspected for any spills and ensure compliance with the waste management procedure. HSE Manager shall record any non-compliances such as uncontrolled waste discharge, not using PPE, not using labelling and other incompliances. HSE Manager shall keep Waste register of produced hazardous and not hazardous waste indicating: ▪ Type of waste; ▪ Characterization of waste; ▪ Produced/delivered quantity of waste; ▪ Treatment/disposal method; and ▪ Entrusted waste service provider. HSE Manager shall produce on a monthly basis a Waste Management Report in line with the guidelines by KPK. Daily checks shall be performed observing any incompliances related to waste management. Observations shall be recorded into a log.
7 - Traffic Management			
• Traffic: Impacts resulting from increased traffic movements	Moderate	• Implement Traffic Management Plan • There shall be clear separation between pedestrian road and vehicle	All incidents reported shall be recorded in the register. Daily driver and vehicle inspection shall be conducted by

		roads within the site • Speed limits shall be followed at all times • Follow local driving rules • Road Sign board will be fixed at appropriate places to reduce safety hazards associated with project traffic • Project drivers will be trained on defensive driving • Follow strict code of conduct • Safety precautions and display on the notice board of entry gate in both national and local language	the operations manager.
Operations			
1-Soil/Surface and Ground water Impacts			
• Impact on soil quality and water quality	Not significant	• Adhere to operational control procedures for the storage and handling of hazardous materials. • Train staff in the proper implementation of HSE procedures.	Project area shall be routinely inspected for any leaks. The HSE inspection checklist shall be available for reporting purposes. HSE Manager shall record any non-compliances such as left water tabs open, water spills and other incompliances. Impact of water consumption on the community shall also be reviewed if complaints received by the nearby community. Daily checks shall be performed to ensure appropriate waste management procedures are in place. Daily checks shall be performed to ensure appropriate water management procedures are in place. HSE Manager shall keep records of supplied water; Leak inspection results shall be recorded in the log; Quality checks of potable water shall be assessed

• Waste Management	Not significant	• Implement waste management plan	Project area shall be routinely inspected for any spills and ensure compliance with the waste management procedure. HSE Manager shall record any non-compliances such as uncontrolled waste discharge, not using PPE, not using labelling and other incompliances. HSE Manager shall keep Waste register of produced hazardous and not hazardous waste indicating: ▪ Type of waste; ▪ Characterization of waste; ▪ Produced/delivered quantity of waste; ▪ Treatment/disposal method; and ▪ Entrusted waste service provider. HSE Manager shall produce on a monthly basis a Waste Management Report in line with the guidelines by KPK. Daily checks shall be performed observing any incompliances related to waste management. Observations shall be recorded into a log.

Grid connectivity study and its approval

FAS ENERGY PAKISTAN (SMC-PRIVATE) LIMITED.

PESHAWAR ELECTRIC SUPPLY COMPANY
PROJECT MANAGEMENT UNIT PESCO PESHAWAR
Phone # 091-9210987, Fax # 091-9213018

No. CE (Dev)/ 931-32 Dated 21 /02/2018

Chief Commercial Officer
PESCO Peshawar

Subject: **GRID INTERCONNECTION ASSESSMENT (GIA) OF FAS SOLAR PARK 50 MW SOLAR POWER PROJECT AT KULACHI, D.I.KHAN, KPK, PAKISTAN**

Reference (1) your officer letter No. CCO/M(PPC)Solar/FAS 2023-27 dated 24.11.2017
(2) This office letter No. CE (Dev)/258-61 dated 16.01.2018.
(3) Director FAS 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.

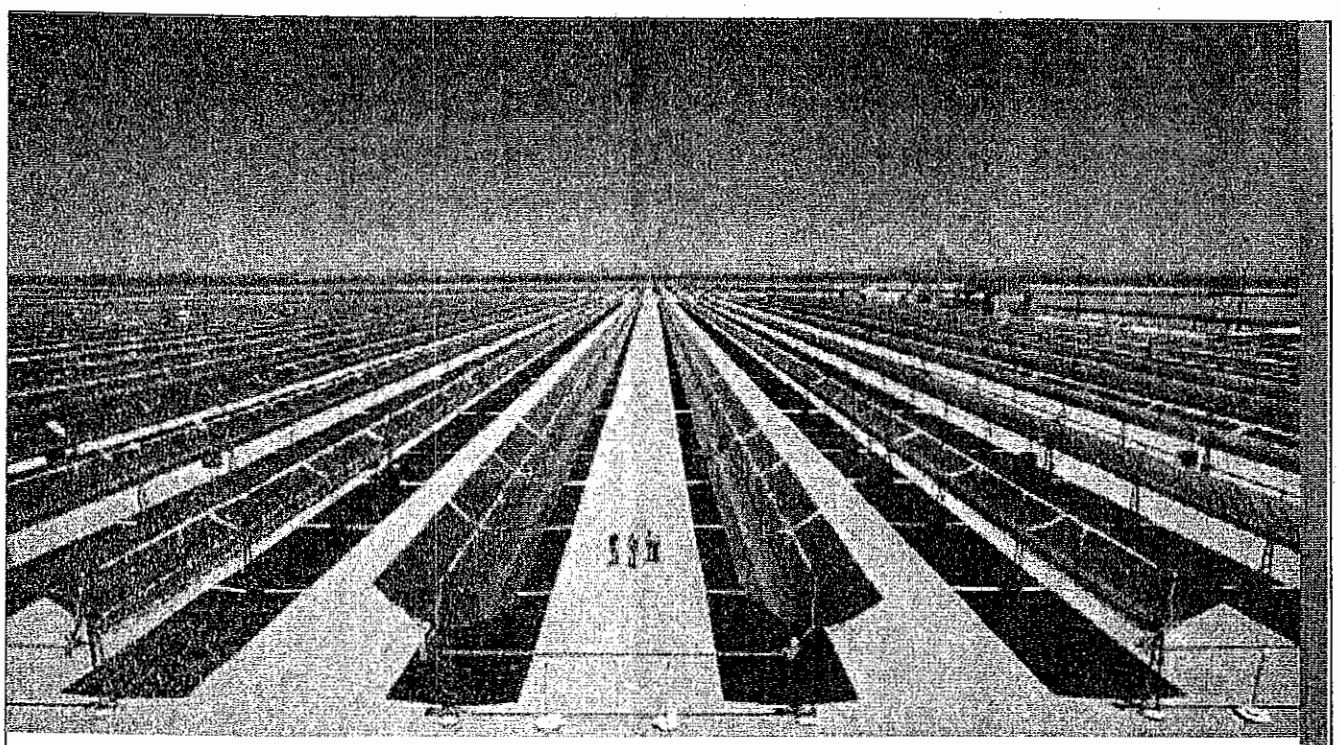
The revised Grid Interconnection Study report of the subject Power Project has been vetted for Load Flow, Contingency, Short Circuit and Stability analysis. The proposed interconnection scheme through 2.5 km In/Out arrangement from single Circuit of 132 KV Kulachi Solar Power - 132 kV Grid Station Kulachi D/C 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 FAS Solar Power Project House No. 28, Street No.2, Sector E-11/1 Islamabad.

Received 21/2/18



GRID INTERCONNECTION ASSESSMENT OF 50MW FAS 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 50MW (AC) Solar PV Power Generation project by FAS Solar Park to the Peshawar Electric Supply Company (PESCO) transmission system at 132kV. The '50MW (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 TARGET PP – KULACHI Grid Station 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 50MW (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 FAS Solar Park "Project Owner" or "PO") for the connection of a 50 MW (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.

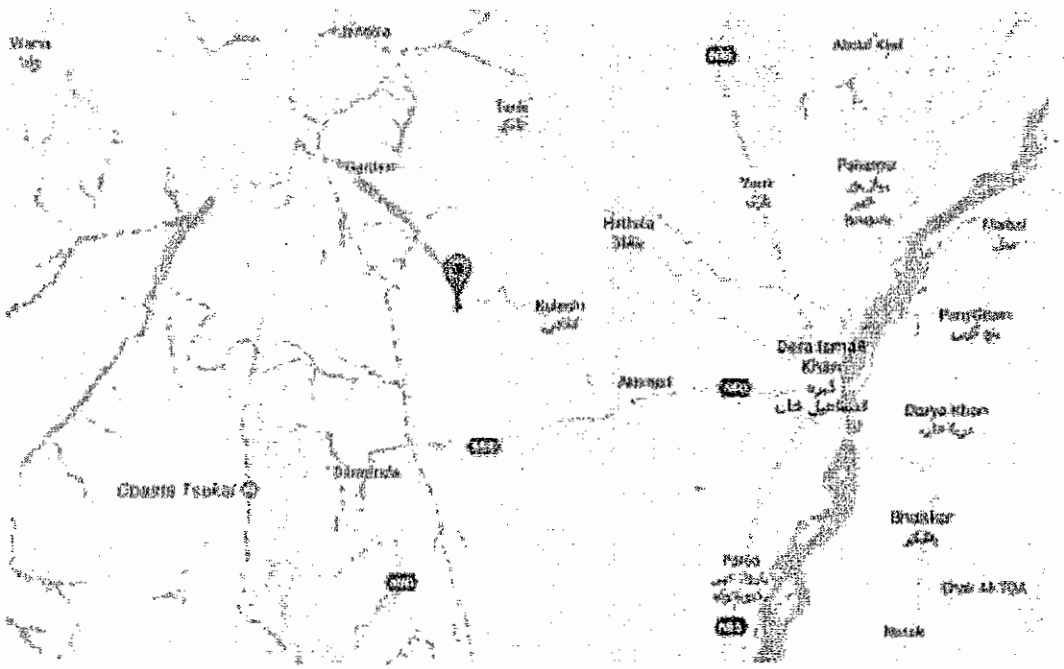

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

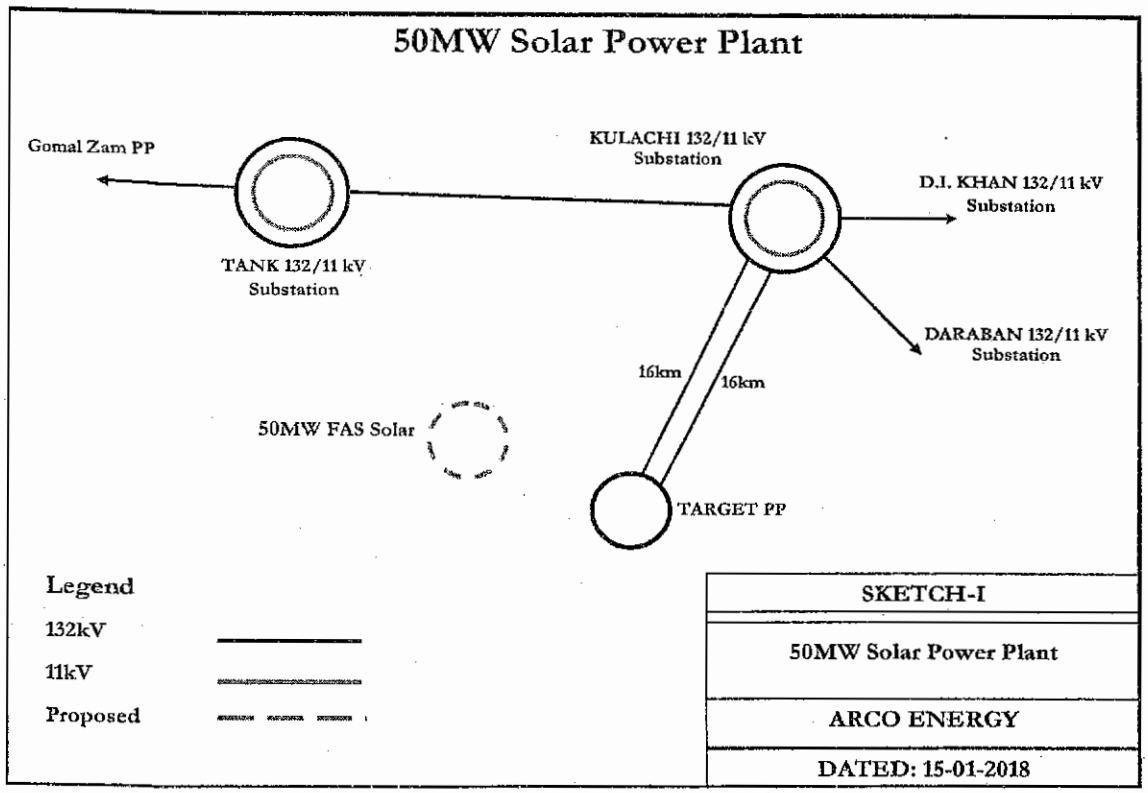

Figure 1.2: Existing Network around FAS Solar Park.

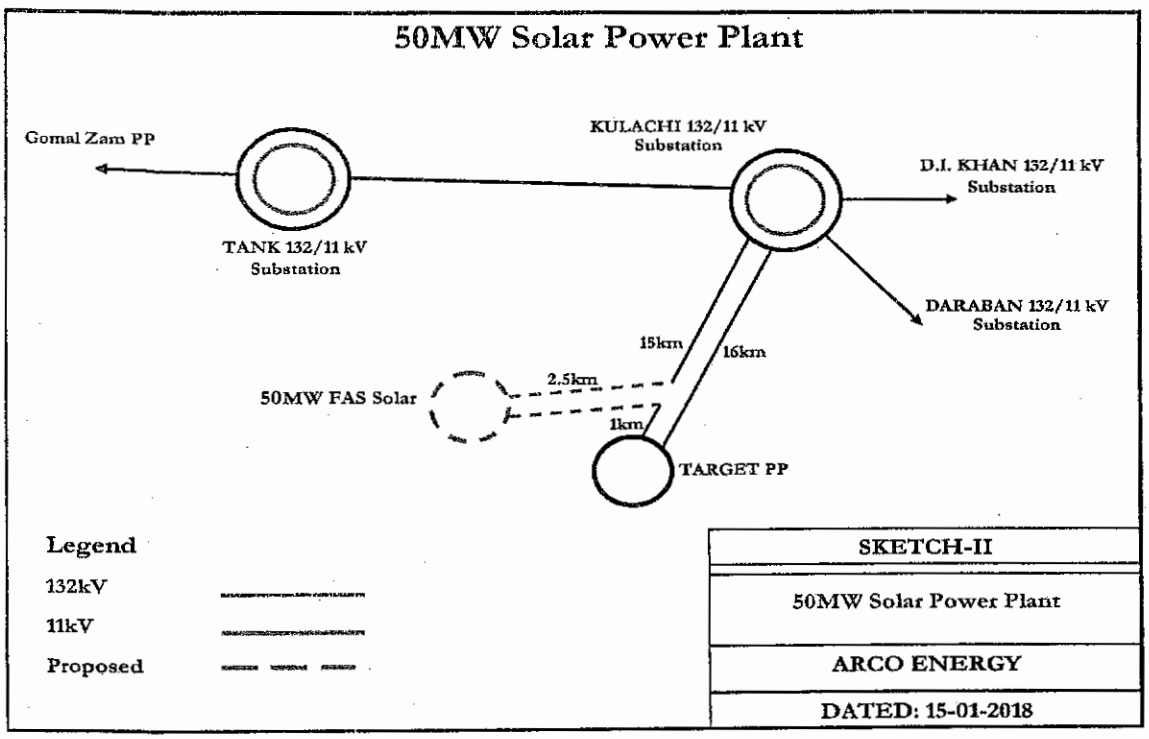

Figure 1.3: Interconnection Proposal of FAS Solar Park.

1.2 Grid Interconnection Arrangement

The project will be connected by making an In/Out on 132kV Rail Single circuit between TARGET PP – KULACHI Grid station by a feed length of 2.5km of Lynx 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.

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
11kV	3-Phase	9 Cycles (180msec)
132kV	3-Phase	5 Cycles (100msec)
132kV (Stuck Breaker)	3-Phase	9 Cycles (180msec)

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 in maximum fault level.

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	5
Generation size of each collector (MVA)	10
Active Power of each collector Pgen. (MW)	9.5
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (MVAR)	-3.1225,3.1225
Rated Frequency	50 Hz
Generation Voltage	0.4kV
Xsource	∞
Switchyard Transformers	
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 50MW FAS 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 FAS 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	FAS Solar PP to KULACHI line out	Figure D-1.1	No overloading
Contingency	FAS Solar PP to TARGET line out	Figure D-1.2	No overloading
Contingency	KULACHI to DI KHAN line out	Figure D-1.3	No overloading
Contingency	KULACHI to TANK 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 FAS 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	FAS Solar PP to KULACHI line out	Figure D-2.1	No overloading
Contingency	FAS Solar PP to TARGET line out	Figure D-2.2	No overloading
Contingency	KULACHI to DI KHAN line out	Figure D-2.3	No overloading
Contingency	KULACHI to TANK 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 FAS 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	FAS Solar PP to KULACHI line out	Figure D-3.1	No overloading
Contingency	FAS Solar PP to TARGET line out	Figure D-3.2	No overloading
Contingency	KULACHI to DI KHAN line out	Figure D-3.3	No overloading
Contingency	KULACHI to TANK 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;

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

$$\%\ \text{Power Loss} = \frac{47.5 - 47.3494}{47.5} \text{ x } 100$$

$$\%\ \text{Power Loss} = 0.3170\%$$

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

$$\%\ \text{Energy Loss} = \frac{416100 - 414780.744}{416100} \text{ x } 100$$

$$\%\ \text{Energy Loss} = 0.3170\%$$

4.2 N-1 Contingency Conditions

Refer to Figure D-1.2 for N-1 contingency conditions, the power loss and energy loss is calculated as under;

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

$$\%\ \text{Power Loss} = \frac{47.5 - 47.3380}{47.5} \text{ x } 100$$

$$\%\ \text{Power Loss} = 0.3410\%$$

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

$$\%\ \text{Energy Loss} = \frac{416100 - 414680.88}{416100} \text{ x } 100$$

$$\%\ \text{Energy Loss} = 0.3410\%$$

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 FAS 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 15 seconds.

5 DYNAMIC STABILITY ANALYSIS

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5.1 Dynamic Model Development

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Component	Model
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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 15 seconds.

5.2.2 3 Phase fault at 132kV 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-1: 3 Phase fault at 132kV FAS Solar Park bus cleared in 5cycles (Stuck Breaker in 100msec)

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

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

5.2.3 3 Phase fault at 132kV TARGET PP cleared in 5 cycles

Three phase fault has been applied at TARGET PP, 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 TARGET PP bus cleared in 5cycles (Stuck Breaker in 100msec)

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

		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) FAS Solar PP to Kulachi Bus (ii) FAS Solar PP to TARGET PP Bus	E-2.1E	Stable

5.2.4 3 Phase fault at 132kV KULACHI bus cleared in 5 cycles

Three phase fault has been applied at KULACHI Grid, 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 (Stuck Breaker in 100msec)

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

5.2.5 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 FAS Solar Park cleared in 9 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 15 seconds.

5.2.6 3 Phase fault at 132kV 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-4: 3 Phase fault at 132kV FAS Solar Park bus cleared in 9cycles (Stuck Breaker in 180msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-4.1	132kV line from FAS Solar PP to TARGET PP	Bus Voltages of (i) 0.4kV FAS LV (ii) 132kV FAS Solar PP (iii) 132kV TARGET PP (iv) 132kV Kulachi (v) 132kV Tank	E-4.1A	Stable

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

5.2.7 3 Phase fault at 132kV TARGET PP cleared in 9 cycles

Three phase fault has been applied at TARGET PP, 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 TARGET PP bus cleared in 9cycles (Stuck Breaker in 180msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-5.1	132kV line from FAS Solar PP to TARGET PP	Bus Voltages of (i) 0.4kV FAS LV (ii) 33kV FAS Solar MV (iii) 132kV FAS Solar PP (iv) 132kV Kulachi (v) 132kV Tank	E-5.1A	Stable
		Frequency of (i) 132kV FAS Solar PP Bus	E-5.1B	Stable
		MW and MVAR of one collector group of FAS Solar PP.	E-5.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gomal-Zam PP (ii) Chashma PP (iii) Tarbela PP	E-5.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) FAS Solar PP to Kulachi Bus (ii) FAS Solar PP to TARGET PP Bus	E-5.1E	Stable

5.2.8 3 Phase fault at 132kV KULACHI cleared in 9 cycles

Three phase fault has been applied at KULACHI Grid, 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 (Stuck Breaker in 180msec)

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

6.2.1 Maximum Short Circuit: Base 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)
FAS Solar MV Bus	33	-N.A-	-N.A-	0.00	5.82
FAS Solar Bus	132	-N.A-	-N.A-	1.78	2.82
TARGET	132	1.77	2.81	1.78	2.82
KULACHI	132	2.07	3.24	2.12	3.31
DARABAN	132	1.29	2.07	1.32	2.12
TANK	132	3.33	5.06	3..35	5.09
DI KHAN	132	3.29	5.16	3.32	5.20

Pre and Post project maximum short circuit analysis summary for the base 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 by making a single In/Out on 132kV circuit from TARGET-KULACHI transmission line at FAS Solar PP 132kV switch yard with feed length of 2.5km.

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 50MW FAS Solar Park meets the NEPRA grid code planning criteria.

PEDO

PAKHTUNKHWA ENERGY DEVELOPMENT ORGANIZATION
Government of Khyber Pakhtunkhwa Peshawar

No. 1722-26/PEDO/DREPP/FAS-Energy
Dated: 29/06/2018

Mr. Tariq Ahmad Khan (Director)
M/s FAS Energy (Pvt.) Limited,
1st Floor, Boquival Tower, Street 27A, Crimson Road,
Sector H, DHA Phase II, Islamabad.

Subject: **Approval of Technical Feasibility Study submitted by M/s FAS Energy (Pvt.) Limited for 50 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 FAS Energy (Pvt.) Limited for their 50 MW Solar PV Project, under RE Policy 2006.

PEDO is pleased to inform that the Technical Feasibility Study of M/s FAS Energy (Pvt.) Limited for 50 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
(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)

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DNV·GL

KULACHI SOLAR PV PLANT

Technical Feasibility Study for a 50MW Solar PV plant in Kulachi, Pakistan

FAS ENERGY

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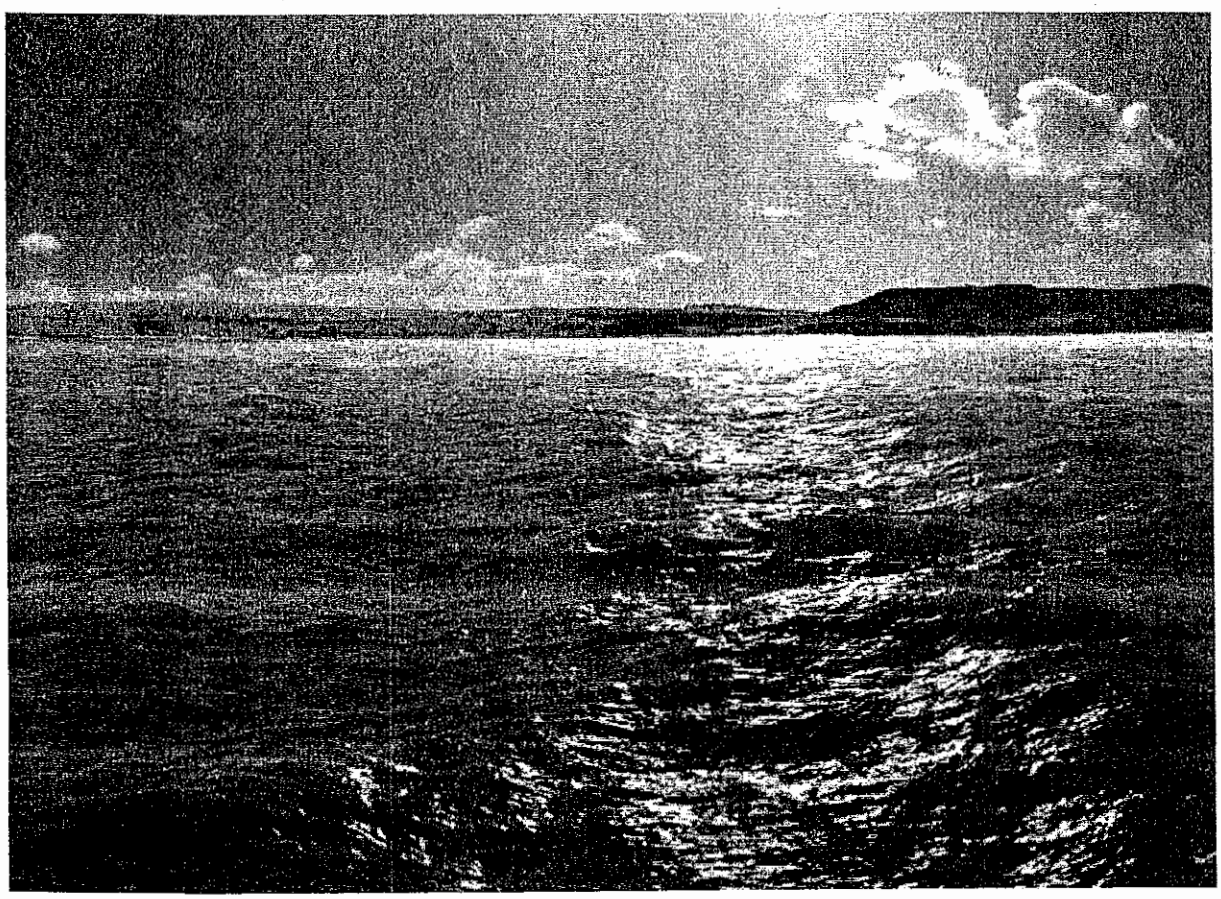

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Table of contents

List of Figures

List of Tables

List of abbreviations and acronyms

Abbreviation	Meaning
AC	Alternating Current
c-Si	Crystalline technology
DC	Direct Current
DHI	Diffuse Horizontal Irradiation
DNV GL	DNV GL AS (Dubai Branch)
EPA	Energy Production Assessment
GCR	Ground Cover Ratio
GHI	Global Horizontal Irradiation
HV	High Voltage
Km	Kilometre
kA	Kilo-Ampere
kV	Kilo-Volt
kW	Kilo-Watt
kWh	Kilo-Watt Hour
kWp	Kilo-Watt Peak
LV	Low Voltage
m-Si	Monocrystalline technology
MPPT	Maximum Power Point Tracking
MV	Medium Voltage
MW	Mega Watt
MWp	Mega Watt Peak
O&M	Operation and Maintenance
P50	The annual energy production reached with a probability of 50%
p-Si	Polycrystalline technology
PV	Photovoltaic
SLD	Single Line Diagram
STC	Standard Test Conditions

1 EXECUTIVE SUMMARY

Based on the data provided by the FAS Energy and the information assessed by DNV GL from the site visit undertaken by Nasir Absar Consulting at Kulachi, the following key findings are considered with regards to the Technical Feasibility Study for a 50MW Solar PV plant in Kulachi, Pakistan.

Site area Requirements

Considering the area identified and designated by Nasir Absar Consulting in consensus with FAS Energy as per the revised site visit undertaken on at 04th November 2017, DNV GL prepared the feasibility study considering the considered area in order to check the possibility to install 50MW Solar PV plant. DNV GL was provided with the preferred suppliers for the project;

- Jinko Solar – 325Wp Module (JKM325PP-72-V)
- Huawei String Inverter - SUN2000-8/12TKL
- Exosun Tracker - Horizon

Considering the above defined components, DNV GL undertook an assessment to define the basic design definition for the PV plant. The following configuration were considered:

65 MW_P / 50 MW_{AC} installed with single axis tracking and Jinko 325Wp crystalline modules;

DNV GL highlights that the considered DC installed capacity and spacing are preliminary and should be revised based on the finalized procured land area. Additionally, DNV GL highlights the considered design are preliminary conceptual design and that, likely, those will change according to the selected EPC contractor design and technology.

Irradiation study

Based on the satellite data (SolarGIS), the estimated yearly long-term GHI at the project site is predicted to be 1,814 kWh/m², the DHI is predicted to be 917 kWh/m² and the average yearly temperature is of 25.4 °C.

Preliminary Energy Production Assessment ("EPA")

Based on the long-term irradiation assessment conducted by DNV GL and the Project design characteristics, the long-term average annual energy yield has been calculated. The values of annual energy yield, long-term average energy production and long-term average annual performance ratio excluding the effects of the PV modules degradation are presented in the table below.

Table 1-1: Annual energy yield, long-term average energy production and long-term average annual performance ratio excluding the effects of the PV modules degradation

Configuration	Annual Yield Factor [kWh/kWp]	Long-term average energy production [MWh/year]	Long-term average annual performance ratio
Tracker + p-Si	1,701	110,594	75.0%

Grid connection

The Grid Interconnection assessment for the proposed PV plant was undertaken by ARCO energy. DNV GL has not reviewed the study undertaken.

2 INTRODUCTION

FAS Energy envisages to develop a 50MW solar PV Plant to be located in Kulachi, Dera Ismail Khan disctrict in Khyber Pakhtunkhwa Province, Pakistan.

DNV GL has been contracted by FAS Energy as Technical Advisor, working in collaboration with the other advisors, to support in the development of the feasibility reports of the project.

The scope of work was defined in the proposal 17-0097 ME-P-02 dated 10th April 2017. signed by both parties. This report (the "Report") is provided per the terms and conditions of the Contract.

The purpose of this Report is to present DNV GL's review of the Kulachi PV Project (the "Project") site conditions and the documentation received and reviewed through to the date of this Report; evaluate technical risks and mitigation measures relative to typical industry practice; and to advise on the status of any issues that could limit the development of the Project. The scope of DNV GL includes the following primary topics:

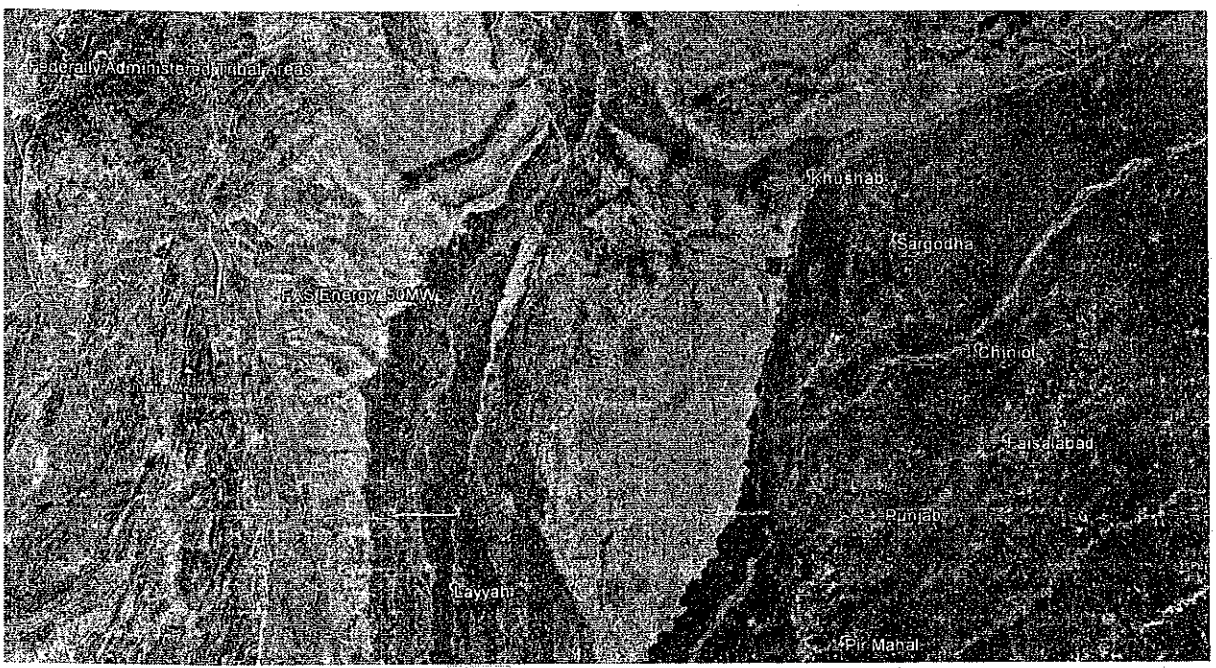
- Technical feasibility study;
- Financial feasibility study; and
- Environmental Impact assessment.

3 SITE ASSESSMENT

3.1 Site Location

The location of the future solar power project is situated approximately 65km, north-west of D.I. Khan City in Khyber Pakhtunkhwa province of Pakistan. The project site is located about 24 km south-east from Garwaki and 17Km North-West from Kulachi.

Figure 3-1 Location of the PV proposed PV plant



The Project site is approximately a square of around 1 km^2 in area, and is expected to accommodate a total PV capacity of approximately 50 MW_{AC}. According to FAS Energy, the land procurement process is not complete yet and will be finalized in the following phases of the development of the project.

Figure 3-2 Boundary of the Proposed PV plant

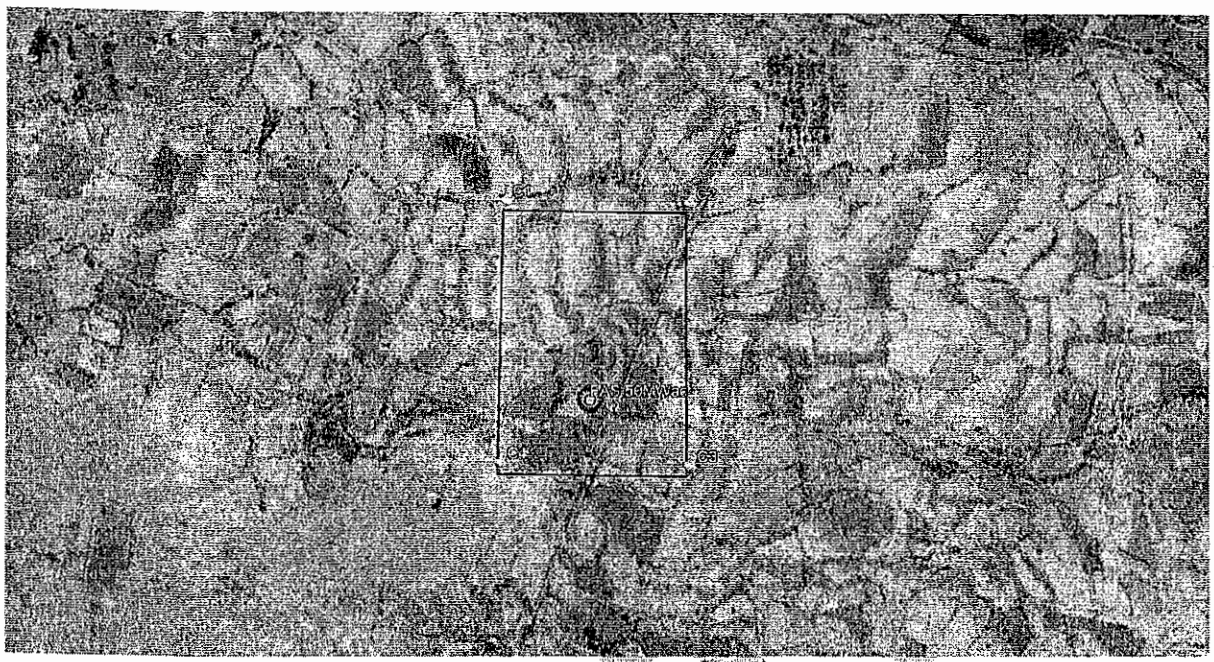


Table 3-1 shows the coordinates and sides dimensions.

Table 3-1: Coordinates of Proposed Project Location

Point	Latitude (N)	Longitude (E)
C1	31.958981°	70.269122°
C2	31.958897°	70.278165°
C3	31.947916°	70.278007°
C4	31.948051°	70.268963°
Side	**Length (km)**	
C1-C2	Approx. 0.86 km	
C2-C3	Approx. 1.21 km	
C3-C4	Approx. 0.85 km	
C4-C1	Approx. 1.22 km	

The site visit was conducted on 4th November 2017. Details of the site visit and tasks undertaken are detailed in the site visit report in APPENDIX B. The entire report is provided as an attachment to this report. [12]

4 TECHNICAL FEASIBILITY STUDY

4.1 Technology Summary

4.1.1 Structure of a solar PV plant

The key components of a typical grid-connected PV system are as follows:

Cells - Forming the basic building blocks of the unit which collects the sun's light, solar cells are in fact large area semiconductor diodes which, due to the photovoltaic effect, convert solar energy into electric energy.

PV Modules - Bringing together large numbers of cells into a unit.

Strings - A group of modules connected in series.

Arrays - A group of strings connected in parallel and mounted on the support structure.

DC cables - Transporting DC electricity from the PV modules to the inverters.

PV combiner boxes - Housing the required electrical protective equipment on the DC network, they collect the electricity from the PV Arrays through the string circuits and feed the inverter.

Supporting structure - Modular structure used to support the arrays at the required inclination. Fixed structures as well as mechanical equipment (trackers) which track the sun position along the day are available.

Inverters - Used to convert DC current into AC current.

AC cables - Transporting AC electricity from inverters to transformers and on to the connection to the grid.

Transformers – Used to elevate the inverter output voltage to the required grid connection voltage.

Substation - Point of connection between the PV plant and the transmission system, it houses the MV or HV components (switchgear, circuit breakers, other interface protection systems and monitoring and control systems).

4.1.2 PV Module Technologies

The two main PV module technology groups available in the market and adopted for large-scale projects are described as follows:

1.1.1.1 Crystalline silicon

Crystalline silicon ("c-Si") technologies are represented by mono-crystalline ("m-Si") and poly-crystalline ("p-Si") technologies. The mono-crystalline cells are made from 99.9999 % pure mono-crystalline silicon, also known as solar-grade silicon. This type of silicon has a homogenous and continuous crystal lattice structure, with almost no defects. The poly-crystalline cells have instead a more irregular surface, the so-called metal-flake effect. Poly-crystalline cells are less efficient than mono-crystalline cells, but they are also less expensive and widely used for utility size power plants. The first c-Si modules were commercially available in the 1970s.

1.1.1.2 Thin film

Since the 1990s, there has been increased development of thin film processes for the manufacture of solar cells. In these processes, photoactive semiconductors are applied in thin layers to a low-cost substrate (in most cases, glass). The primary driving force behind the development of thin film solar cells has been the conviction that they can produce significantly cheaper PV electricity than crystalline silicon technologies, which dominate the market today.

Three major types of technology are currently to be found on the thin film photovoltaic market: Cadmium Telluride ("CdTe"), amorphous silicon and Copper Indium diSelenide.

1.1.1.3 Market Status

In order to understand the presence of the technologies mentioned above in the current market situation, Figure 4-1 shows the percentage of annual production of the PV module for technology technologies, worldwide, and its evolution since 1980. As can be seen, crystalline technologies have dominated the solar PV industry historically, accounting for 90% of the worldwide market share in 2014. From those, p-Si technology leads this market segment.

The market share for thin film technologies slightly increased in 2009, but it has decreased since then. The share is expected to continue decreasing during 2016. As shown in Figure 4-2 amongst thin film technologies, CdTe leads the market. Also, considering previous track record in similar site conditions, CdTe is selected for the purposes of this study.

Figure 4-1: PV cell technology shares 1980-2015 (Fraunhofer, 2016)

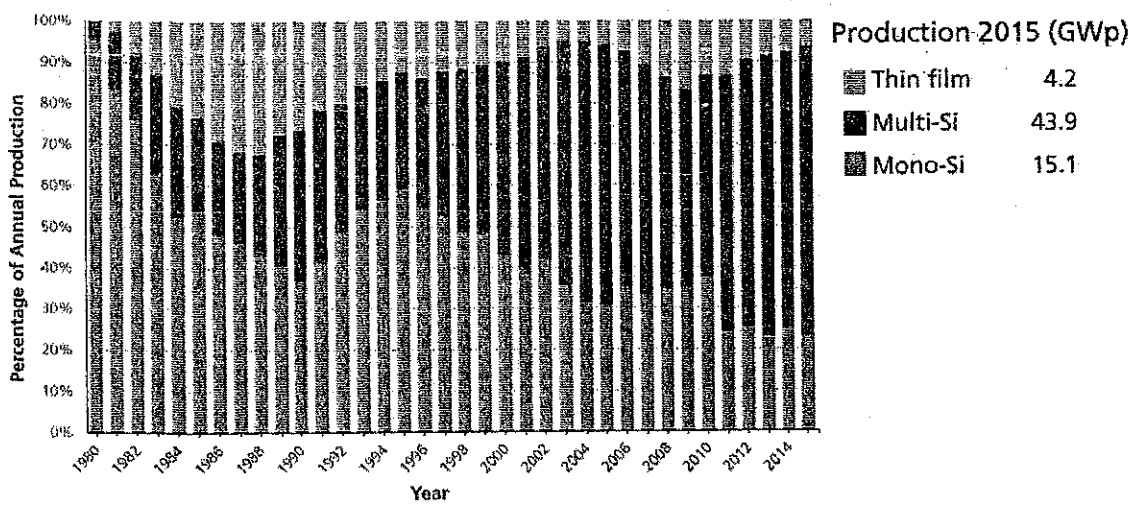
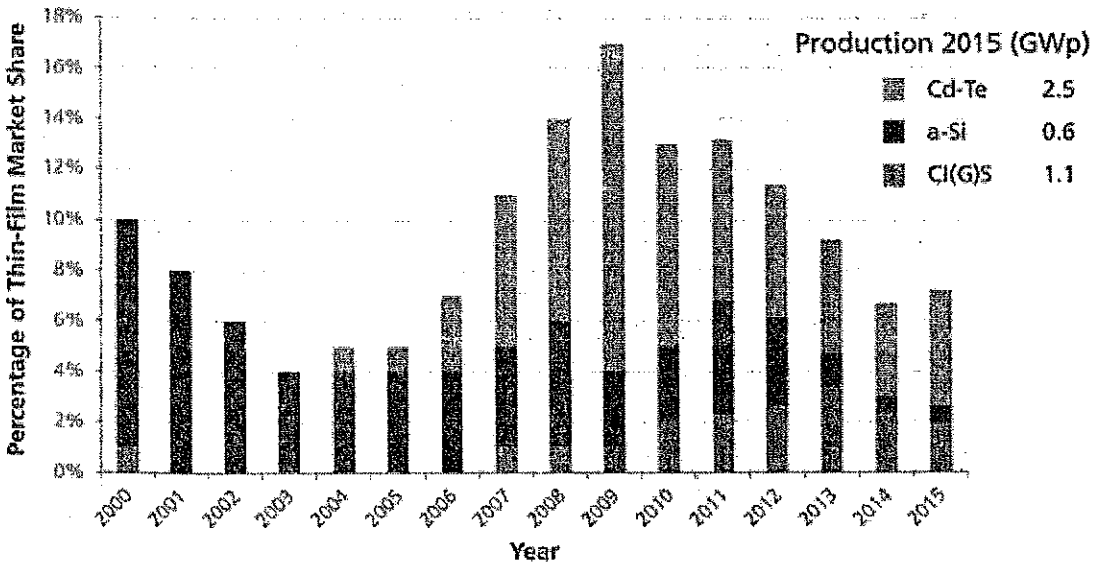


Figure 4-2: Market share of Thin-Film Technology 2000-2015 (Fraunhofer, 2016)



The above trend is expected to continue in the coming years, with the crystalline technologies clearly dominating the market share.

With regard to the production of PV modules, recent market information (2016) shows that most of the manufacturing capacity and production is concentrated in Asia, with a focus on China, as shown in Figure 4-3. In the case of thin film, an important share of the production capacity remains in the Asia Pacific Region ("APAC"), where several Japanese and American manufacturers are based.

Figure 4-3: PV module production by region 1997-2015 (Fraunhofer, 2016)

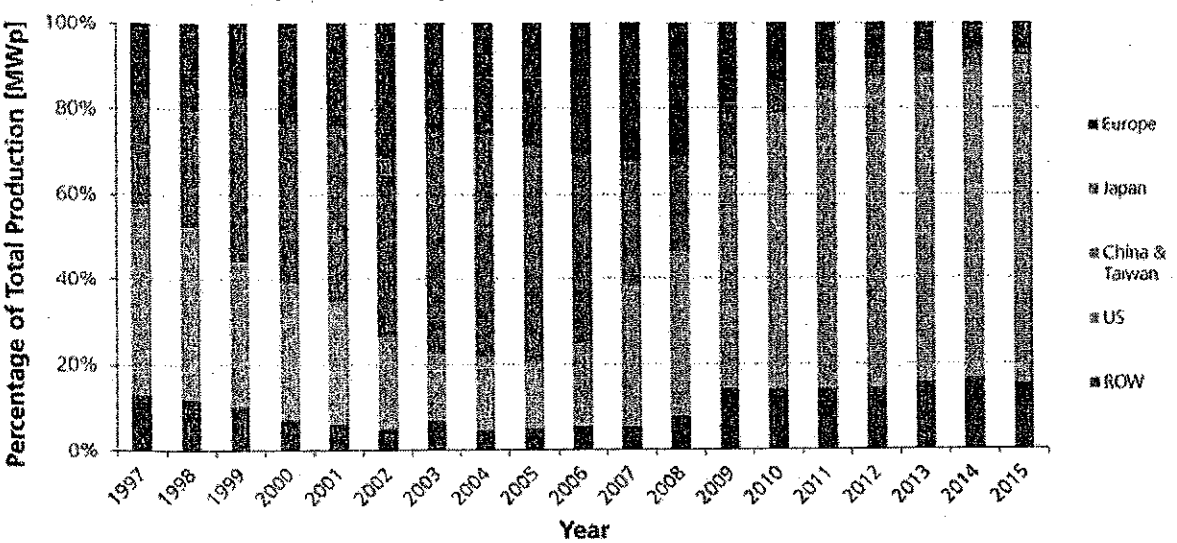


Table 4-1 shows the ranking of module manufacturers in 2015, with regard to shipments. It can be seen that most of the companies listed in rank of 10 are Chinese manufacturers. Within the ranking, few of the companies listed are manufacturing thin film products. First Solar, the American manufacturer of CdTe modules appears in 6th position. The table also shows the change from 2014 and it's remarkable the downgrade of Yingli Green going from 2nd in 2014 to 7th in 2015. First solar showed the best improvement in 2015 among those ranked top 10 in both years 2014 and 2015.

Table 4-1: Ranking of module suppliers worldwide for 2015 (Osborne, 2015)

2015 Rank	Module Supplier	Change from 2014
1	Trina Solar	0
2	Canadian Solar	+1
3	Jinko Solar	+2
4	JA Solar	+2
5	Hanwha SolarOne	-1
6	First Solar	+3
7	Yingli Green	-5
8	SFCE	N/A
9	ReneSola	N/A
10	SunPower Corp	N/A

1.1.1.4 Technology summary

The selected PV technologies for the feasibility study of the solar PV plant will be Crystalline Silicon from Jinko Solar . However, a comparison between Crystalline silicon and Thin Film ("CdTe") are briefed in Table 4-2 below:

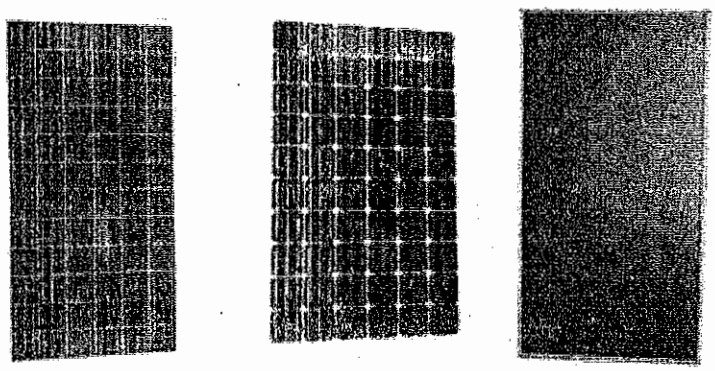
Until now, the higher efficiencies of c-Si modules in front of Thin Film modules have been a decisive criterion when space is limited and the aim is to install the greatest capacity per unit of area. However, First Solar manufacturer has claimed to be close to achieving nearly the same efficiency than standard modern crystalline modules in mass production and has announced to have achieved a new record efficiency of 21.0 % in a laboratory cell test. A better energy yield (kWh produced per kWp installed) can be expected from CdTe technology at locations where the diffuse component of the total irradiation is predominant or in areas of high ambient temperatures and high humidity.

Table 4-2: Crystalline vs. Thin film technology – differences

c-Si	Thin film (CdTe)
Higher MWp per m^2 installed	More suited to diffuse irradiance conditions
Balance of plant costs are lower	Better response to high temperature
Longer track record	Better response to high humidity
Wider commercial availability	Limited commercial availability for certain sub-technologies
Interchangeability of manufacturers	

An illustration of the two technologies can be seen in Figure 4-4, where the aspect of a typical poly-crystalline, mono-crystalline and thin film PV module is shown.

Figure 4-4: Different PV module technologies (from left to right p-Si, m-Si and thin film)



DNV GL considered a polycrystalline and a monocrystalline (310 Wp) and a thin film (CdTe, 115 Wp) PV modules for the feasibility assessment as they represent the most adopted and bankable PV module technologies in the current market conditions.

4.1.3 Supporting Structure

The main purpose of the mounting structure is to hold the modules in the required position without undue stress. The structure also provides a route for electrical wiring and support for PV combiner boxes.

In its simplest form, the mounting structure is a metal framework securely fixed to the ground. It must be capable of withstanding its own weight, the weight of the modules and appropriate environmental stresses for the location, such as wind loads, snow loads and seismic loads.

The PV modules are typically mounted on either of the following supporting structures:

a) **Fixed structure**: A fixed structure does not change its tilt and orientation during operation. Support structures for fixed-tilt solar plants are normally modular, made up of galvanized steel and/or aluminium profiles, stainless steel nuts and bolts and aluminium panel clamps. The modules are fixed to the section bars using suitable bolts and plates.

b) **Tracking structure**: If the PV module's orientation follows the sun, the available irradiation increases. On days with high insolation and a significant direct radiation component, a tracking system enables relatively large radiation gains to be achieved. That said, tracking systems are more complex to build, involve higher costs and, if the tracking system fails, the PV array may be stuck in an inefficient tilt, severely reducing the energy generation.

DNV GL evaluated the option of installing single axis tracking systems with a horizontal north – south rotating axis as per the requirements from the Customer. The details regarding the design considered are further described in Section 4.2.

4.1.4 Inverters

Inverters are the power electronic devices that are directly connected to the PV array (on the DC side) and to the electrical grid (on the AC side). They essentially convert the DC energy produced by the array into the AC energy that is to be injected in the grid.

Different types of inverter arrangements are available in the market, being the central and string inverter configurations the most used. Central inverters are broadly used for utility scale solar PV plants allowing a better modularity of the plant when having homogeneous conditions.

PV inverter technology has evolved rapidly over the past decade, in line with general development within the PV sector – especially in Europe, the US and Japan. There are more than 50 inverter suppliers within the market. European and American inverter manufacturers have topped the ranks globally over the years. Despite the presence of European and American suppliers remaining strong, Asian manufacturers are appearing in leading positions in the ranking of inverter shipments in 2014 and 2015.

Table 4-3: Ranking of inverter manufacturers in 2014, with regard to shipments (Hill, 2016)

2014 RANK	2015 RANK	SUPPLIER	ORIGIN
-	1	Huawei	China
4	2	Sungrow	China
1	3	SMA	Europe
2	4	ABB	Europe
-	5	Sineng	China
-	6	TMEIC	China
-	7	TBEA	China
8	8	Schneider Electric	Europe
-	9	Power Electronics	Europe
-	10	Solar Edge	Israel

DNV GL was requested to model the feasibility study based on String Inverters, as per the requirements from the customer. It is noted that the assumption of this inverter is for feasibility purposes only and should in no way bias any future bidding process for the Project.

4.1.5 Array Transformers

Array transformers collect the AC power coming from the inverters at LV (230 V-400 V) and elevate it at MV (10 kV-33 kV). The MV level is required to limit the cable losses associated to transport of energy.

Some inverter manufacturers offer solar inverter units that are already equipped with the LV/MV transformer. The inverter, the transformer and all the associated equipment (switchgear, ventilation fans, etc.) are allocated within the same shelter. This is a usual, convenient and cost-effective option for PV plants in excess of about 2 MW peak installed capacity.

4.1.6 Transformer Network

In large PV systems, an MV AC electrical network is used for interconnecting the array, the inverter, the transformers and the substation.

MV levels tend to be designed in the range 10 kV to 33 kV. Underground networks within the plant boundaries are typically used. Power cables made of aluminium or copper conductors are typically buried in trenches up to 1m deep. Both radial and ring designs are standard practice for large PV systems, even though the latter are preferred in virtue of their reliability against failures.

4.1.7 Substation or control room

The metering point of the PV plant is usually set at the site substation or control room. The substation building houses the equipment that connects the PV plant to the local distribution network. The connection usually requires two circuit breakers with one containing the meter equipment. Depending on the export voltage, this building may also house a step up transformer.

The design has to be compliant with electrical utility requirements at the connection point, allowing remote monitor and control of the plant.

4.1.8 SCADA

SCADA is defined as Supervisory Control and Data Acquisition system. The system monitors the performance of the plant by means of a mathematical model initialized with the design characteristics of the PV plant. The typical inputs into the SCADA systems are the PV panel's peak power and numbers, Inverter specifications and total output power, manufacturer provided electrical parameters, number of strings, string lengths etc. The SCADA system will provide an overall control over the operational aspects of the PV plant.

4.2 Proposed Preliminary Design for Kulachi

For the Kulachi project location, DNV GL analysed the available area for the PV plant as per the site visit conducted. The preferred supplier list was already provided to DNV GL from the customer. DNV GL undertook a basic design definition of the plant using the available data considering standard practice technical design for the Project based on the state of the art for PV modules, mounting solution and inverters. DNV GL considered the adoption of poly-crystalline silicon, on single axis solar tracker (horizontal north – south axis) and a string inverter configuration. DNV GL used equipment list provided from the customer. DNV GL was also provided with a Site Topography study undertaken by a sub-contractor. Based on the review of the site topography study, it can be understood for the location to be considered to be typically flat, with minor undulations around the plant area. A existing road cuts across the project site. However, a rerouting of the existing road is suggested in the Initial Environmental Examination Report. For the design definition of the PV plant, the re-routing is already considered. The findings of the topography study are considered at a high level for the preliminary design definition for the project. The Site topography report will be submitted as a separate report to this report. A summary of the main components used in the study is provided in Table 4-4.

Table 4-4: Components considered in the design options proposed

Design assumption	
Plant Arrangement	Single axis solar tracker (Exosun HZ tracker)
Tracker Range	±50°
Row Spacing E/W	5m
PV Module Technology	p-Si – Jinko Solar (JKM325PP-72-V)
PV Module Power [Wp]	325
Inverter Type	String inverter configuration (Huawei 2000-36KTL)
Inverter Capacity [kW]	40
Proposed Capacity [MW_{AC}]	50

APPENDIX A includes datasheets for the equipment used in the assessment.

4.2.1 Axis Tracking Solar PV Plant Design

DNV GL evaluated the feasibility of installing solar single axis trackers at the project site. The installation of a solar tracker typically requires greater land occupation; hence it would be recommendable to make use of technology with a higher efficiency per unit area (c-Si) in order to reduce the land occupation rate per MW installed.

The row spacing and tilt angle may vary in the final design, and therefore some of the assumptions and calculation presented in this report may change as well.

1.1.1.5 Tracking System Proposed

There are several tracking systems available in the industry with different grades of complexity for construction, implementation and operation. Depending on their size and design, some of them require more complex civil infrastructure, structural design or control during operation.

Solar trackers are divided in two main groups:

Single Axis Solar Trackers - single axis solar trackers can follow the sun position in one dimension (azimuth or inclination). The ones that track the sun azimuth position are those which are relatively easier to implement (horizontal trackers with north-south rotating axis) and perform properly at equatorial and tropical regions where the sun position is relatively high all over the year.

Dual Axis Solar Trackers - The system always maintains optimum alignment to the sun, changing the tilt angle and azimuth position to maintain normal to the beam component of the irradiation. These are more complex compared to single axis tracking systems, require higher ratio of land per MW installed but provide the highest irradiation gain.

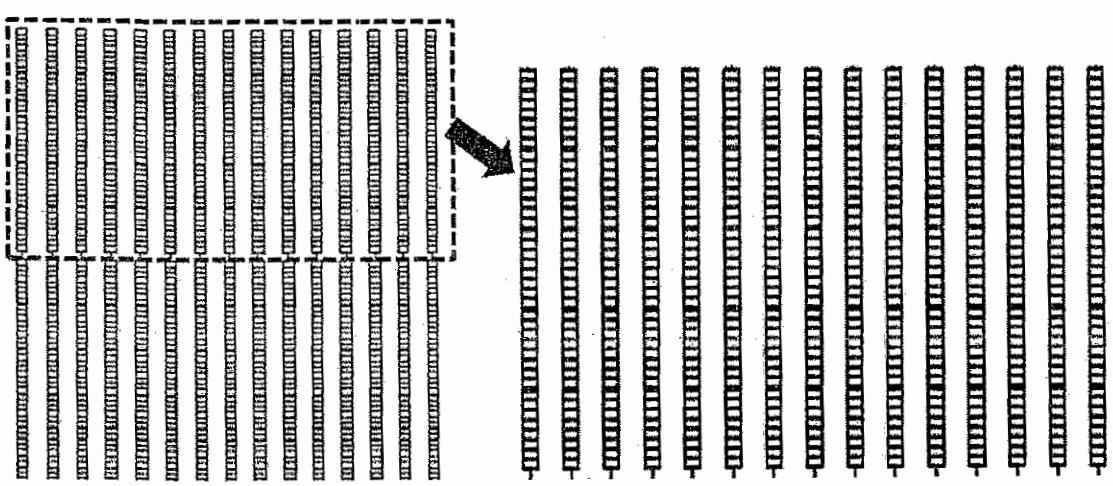
As suggested by the customer, DNV GL considered the use of horizontal single axis tracking system with a north – south rotation axis being the most used tracking system for large PV plants. Dual axis solar trackers involve a higher upfront cost and need much more land and maintenance and, after some installations in the last years, have been progressively abandoned by the developers. Therefore, single axis tracking system will be considered onwards in the feasibility study.

1.1.1.6 Design Configuration

DNV GL proposes a layout that sets the shading losses to an acceptable figure. The PV modules are considered as installed in portrait orientation along the north-south axis of the tracker. The connection of the PV modules into strings is recommended to be parallel to the rotation axis (horizontal connection) in order to reduce electrical shading losses.

For the proposed capacity of 50MWac a total area of approximately 1 Sq km is available. DNV GL additionally considered the tracker ground cover ratio capability. The tracker can be designed considering a ground cover ratio from 26% to 50%. DNV GL suggests a pitch of 5m allowing finding an acceptable combination between irradiance gains and shading losses and according to the available land.

Figure 4-5: Representative Tracker configuration



The resulting selected design for the PV plant is given in Table 4-5.

Table 4-5: DNV GL preliminary designs of the PV plant for the single axis tracker arrangement

Design assumption	Kulachi
Plant Arrangement	single axis solar tracker
Tracker rotation [°]	±50
PV Module Technology	p-Si
Pitch E/W [m]	5.0
PV module rated power [Wp]	325
Ratio modules/string	20
Ratio strings/inverter	8
Number of inverters	1250
Inverter rated AC power [kW]	40
Total rated power P_{DC} [MWp]	50.0
Total rated power P_{AC} [MW]	65.0
Ratio P_{DC}/P_{AC}	1.30
Plant available area [ha]	103
Plant area ratio [ha/MWp]	1.03

1.1.1.7 String design

From an electrical point of view, the PV field is arranged in strings. Each string is formed by wiring number of PV modules in series. The strings are then connected to each inverter (DC side), normally via array boxes.

A robust design of the strings should consider two basic electrical constraints (derived from the inverters characteristics):

- Series connection: the string size, i.e. the number of PV modules that can be connected in series, is limited by the inverter's DC input voltage. Two main inverter variables must be considered here:
  - the maximum DC voltage, a value which must be cross-checked with the PV module's open circuit voltage; and
  - the MPPT voltage range, a value which must be cross-checked with the PV module's MPPT voltage.
- Parallel connection: the number of strings to be parallel connected to an inverter is limited by the inverter's maximum DC input current.

As a result, a maximum number of PV modules (of the same type) can be connected to a single inverter. This number can be calculated as being the product of the maximum number of strings (limited by current) and the maximum string size (limited by voltage).

A common string size of 20 modules in series per string is used for the Project in series per string.

Each 40 kW inverter will be equipped with 8 strings distributed across 4 MPP trackers of the inverter. The above has been checked for the designs proposed for the Project and are both acceptable and robust with regards to the inverter electrical characteristics.

1.1.1.8 Inverter DC power

A basic constraint in the number of PV modules connected to a single inverter is provided by the maximum DC power input recommended by the inverter manufacturer. Table 4-6 below, lists the design considered.

Table 4-6: Inverter DC input to peak power ratio for the inverter proposed

	Number of modules per string	Number of strings per inverter	DC Power per inverter [kWp]	Recommended DC Power per inverter [kWp]	Check
Jinko p-Si PV Modules	20	8	52	40.80	x

The proposed design is above the mentioned rated usable power of the inverter in the datasheet but within the maximum current rating of the inverter. However, the suggested design provides a moderate compromise between the selected module power and tracker design. DNV GL recommends that a conformity of design letter can be requested from the inverter manufacturer to avoid any warranty issue. Additionally, DNV GL highlights the design criteria's could change as selection of the final components are completed.

Temperature behaviour

The current vs. voltage characteristic of a PV module, measured at Standard Test Condition ("STC"), may vary significantly in normal outdoor operation, mainly due to temperature. Characterisation of this variation is provided by the module manufacturers in the form of temperature coefficients for the relevant electrical characteristics.

For the modules proposed, the manufacturers provide the temperature coefficients shown in Table 4-7. For further details, see the datasheet enclosed in APPENDIX A.

Table 4-7: Temperature coefficients for the selected PV modules in the Project

Temperature coefficients	For open circuit voltage V_{oc} [%/°C]	For short circuit current I_{sc} [%/°C]
Jinko 325Wp (p-Si) PV module	- 0.30	0.06

DNV GL reviewed the open circuit, short circuit and maximum power point characteristics of the design for a range of temperatures, based on the PV module datasheet provided and expected ambient temperature for the Project location.

The long term dataset, derived from the satellite data (or from on-site correlated data when available), is used to create a "synthetic year", a series of hourly values randomly generated but representing the long term averages calculated above, that is then processed by the energy simulation tool.

The energy simulation tool estimates, having as input the hourly GHI, DHI and air temperatures of the synthetic year and the design of the PV plant, a number of operational parameters describing how the plants operates at each time step (each hour in this case).

Some of the characteristics estimated in the energy simulation tool are:

- Maximum cell temperature in operating conditions: estimated 70°C for the site;
- Summer air temperature operating conditions: estimated 50°C;
- Winter minimum cell temperature in operating conditions: estimated 10°C; and
- Absolute cell lower temperature: estimated 0°C.

Considering the climatic conditions of the site, the technical characteristics of the equipment and the design of the plant, DNV GL verified that the voltage levels achieved at extreme temperature conditions stay within the acceptable inverter limits.

DNV GL considers the proposed design robust and able to withstand the foreseeable extreme temperature conditions at the site.

4.3 Preliminary Energy Production Assessment

4.3.1 Solar resource assessment

The best way to determine the solar radiation regime at a particular site is by measuring different parameters of interest at the location of the site using the appropriate instruments. For example, Global Horizontal Irradiation ("GHI") is typically measured using a horizontally mounted solar sensor calibrated under recognized standards. In the absence of these data, values obtained from several databases can be consulted. These databases may contain data from measurements or computational models, or both and would have normally an increased uncertainty compared to site measurements.

The methodologies used in computational models for the interpretation of satellite images that are developed and verified in one region, may not produce reasonable results in other regions. The known issues are as follows:

- Predominant cloud types may be different;
- Atmospheric aerosols may be more or less absorbent;
- Surfaces may have large differences in albedo; and
- Seasonal wind patterns may transport significant pollutants and sand/dust either into or out of the region.

Ignoring regional differences can produce bias error. For this reason, comparison between several databases is essential for a good assessment of the solar resource.

DNV GL has used the following sources of irradiation and temperature data for the Project:

- Meteonorm software version 7.1 (1991 – 2010) (Meteotest): This software is a meteorological database containing relevant data from more than 8,300 ground stations in the world. From those, 1,200 stations provide ground measured GHI data. The software undertakes an interpolation of the data from the three stations with measurements closest to the site coordinates. If no stations are available within a reasonable radius, purely satellite derived data is provided. The output of the software is monthly, daily or hourly GHI averages, and other parameters, for the period available. Due to the absence of recent data, this database has been used for comparative purposes only;
- NASA Surface meteorology and Solar Energy (NASA-SSE) (1983 – 2005) (NASA): This database provides daily values of GHI and ambient temperature (at 10 m height) froml 1983 to June 2005 derived from satellite imagery for any location in the world. The grid resolution is approximately of 111 x 111 km2. Due to the absence of recent data and the low spatial resolution of 111 x 111 km2 this database has also been used comparative purposes only;
- PVGIS 3 and PVGIS 4-CMSAF (The Photovoltaic Geographical Information System) (PVGIS, PVGIS 3) (PVGIS, PVGIS 4 CM SAF): PVGIS 3 derives irradiation data for European and African locations based on 566 ground meteorological stations and satellite data. The time period of data is from 1981 to 1990. This database is based on old data and has been used only for the purpose of comparison. A new version of PVGIS (called PVGIS-CMSAF or PVGIS 4) was released in November 2010 by the European JRC (Joint Research Center), in collaboration with the CMSAF (Climate Monitoring Satellite Application Facility). The coverage extends from 0° N (equator) to 58° N and from 15° W to 35° E. The spatial resolution is 1.5 arc-minutes (about 3 km directly below the satellite at 0° N, 0°W) and the time period of data is from 1998 to 2011. This database combines very recent data and medium spatial resolution of 3 x 3 km2; and

- Satellite-derived monthly GHI and diffuse horizontal irradiation ("DHI") for the Project location, for the period from January 1999 to June 2017, calculated from Meteosat and GOES (Geostationary Operational Environmental Satellite) which has a resolution of approximately 250 m (SolarGIS). This data set is considered to be the most representative for the site location and is presented in the following table. These data has not been calibrated with ground measurements.

The results derived from each reference data source are presented in Table 4-8.

Table 4-8: Monthly Results of GHI for the Site

	Global Horizontal Irradiation [kWh/m²]			
Month	**Meteonorm 7.1**	**PVGIS 4**	**NASA**	**SolarGIS**
	1991-2010	**1998-2011**	**1983-2005**	**1999-2017**
Jan	100	103	108	99
Feb	110	112	119	109
Mar	149	174	153	157
Apr	175	197	166	183
May	198	226	193	210
Jun	193	208	190	196
Jul	182	195	180	173
Aug	171	191	167	172
Sep	159	173	152	164
Oct	138	153	140	147
Nov	111	113	111	106
Dec	96	101	99	98
Year	**1782**	**1947**	**1776**	**1814**

Based on validation reports available, data resolution and coverage and length of period available, DNV GL has selected SolarGIS as the most representative reference irradiation dataset for the proposed site. It is noted that the SolarGIS result is broadly supported by the other datasets consulted.

4.3.2 Temperature

The long-term average ambient temperatures used to characterise the Site are shown in Table 4-9.

Table 4-9: Long-term monthly temperature estimated at the Site

Month	Meteonorm 7.1	NASA	SolarGIS
	Site Co-ordinates [°C]	Site Coordinates [°C]	Site Coordinates [°C]
	2000-2009	1983-2005	1999-2015
Jan	10.9	9.0	12.7
Feb	14.9	11.6	15.4
Mar	20.5	17.5	21.0
Apr	26.3	23.4	27.4
May	31.5	28.4	33.0
Jun	32.0	31.8	35.5
Jul	30.5	30.4	35.3
Aug	29.9	28.2	34.1
Sep	28.1	26.7	31.0
Oct	24.3	22.2	25.6
Nov	18.0	16.5	19.5
Dec	12.8	11.4	14.7
Year	**23.3**	**21.5**	**25.4**

NASA and SolarGIS, presenting a larger period of data collection, remain satellite estimations of a site temperature, while Meteonorm refers to the meteo-station located more than 320 km from the site. After comparing the three different temperature datasets, DNV GL has considered data from the SolarGIS data to be more representative of the site location.

The final dataset representative for the site conditions containing GHI, DHI and ambient temperature data are presented in Table 4-10 in the form of monthly mean values.

Table 4-10: Monthly means of GHI, DHI and temperature for Kulachi

Month	GHI (kWh/m²)	DHI (kWh/m²)	T (°C)
	SolarGIS	SolarGIS	SolarGIS
Jan	99	46	12.7
Feb	109	50	15.4
Mar	157	75	21.0
Apr	183	85	27.4
May	210	100	33.0
Jun	196	105	35.5
Jul	173	107	35.3
Aug	172	102	34.1
Sep	164	85	31.0
Oct	147	69	25.6
Nov	106	51	19.5
Dec	98	42	14.7
Year	**1,814**	**917**	**25.4**

The long-term dataset, derived from the satellite data (or from on-site correlated data when available), is used to create a "synthetic year". The synthetic year is a series of hourly values randomly generated, as they have to be representative of any possible year and not linked to the conditions recorded during a particular year, but with the condition of presenting monthly averages equal to the long-term ones calculated above. In this way, the hourly extreme temperatures are taken into account. Moreover, the dataset is representative of the long-term conditions.

The Global Incident Irradiation ("GI") on the collecting plane used for further steps in energy simulation assessment is then calculated via transposition using the Pérez model (Perez, Ineichen, Seals, Michalsky, & Stewart, 1990).

4.3.3 Long-term Variation

The uncertainty associated with the GHI and DHI estimates should be revisited and compared with on-site measurements taken with an appropriate pyranometer (Secondary Standard pyranometer calibrated under ISO 9060) and the deviation observed during sandstorm should be further investigated. Having this information, a calibration of the satellite-derived data at the Site can be conducted thus reducing the total uncertainty of the estimate.

At present, the irradiation uncertainty is assumed equal to the uncertainty of the satellite data for the region, which lies in the range of 4 % to 8 %.

4.3.4 Preliminary layout

DNV GL prepared a 3D model to check the possibility to install 50 MWac PV plant. It is noted that the 50 MWac power corresponds to the nominal AC power of all the inverters considered in the PV plant. The following configuration was considered:

- 50 MW_{AC} installed with single axis tracker system and crystalline modules;

The available land as per the site visit report is approximately 2 Sq.km [12]. DNV GL analysed the available area and considers a reasonable usage of the land for the PV plant. Additionally, DNV GL reviewed the tracker datasheet and the ground cover ratio (GCR) capability of the tracker. The tracker has a capability to work between a ground cover ratio between 26% to 50%. DNV GL based on it's preliminary design considers a pitch of 5m considering reasonable shading effects. The Proposed PV plant with the specified pitch will correspond to a GCR of 38%. For each configuration, a block of modules and inverters was defined and then distributed on the available area.

DNV GL highlighted that the considered layout may change according to the finalized land area and contractor specific design and technology.

4.3.5 Energy Production Assessment

In order to assess the energy production, as an input for the preliminary feasibility of the Project, DNV GL has performed a preliminary independent Energy Production Assessment ("EPA") for a generic 50 MW AC solar PV plant located at the Site.

The estimation of expected solar power generation is typically performed by DNV GL in several steps:

1. The solar climatic conditions - mainly the global and diffuse irradiation on the horizontal plane - are determined.
2. Irradiation on a tilted plane can be calculated by using the known global and diffuse irradiation on the horizontal plane. Transposition is the calculation of incident irradiance on a tilted plane, using horizontal irradiance data. Transposition is typically calculated using either the Hay model or the Perez model. For this study, DNV GL has used the Perez model.
3. Both irradiation losses (due to optical effects and usable irradiation) can be calculated by using the known layout of the PV plant (dimension and geometrical arrangement of the modules, orientation and distance of rows, etc.).
4. The electrical simulation takes into account the properties of the PV modules (output power, partial shading effects, temperature behaviour, etc.) and inverters (conversion efficiency, partial load etc.), along with losses in electrical cabling, in order to calculate the energy delivered at the output of the inverter.
5. The AC cabling losses between the inverter and the revenue meter are estimated.
6. Finally, other production losses are considered - soiling, power quality, mismatch, plant availability, etc.

The PV plant simulation consists of an electricity production calculation corresponding to the global horizontal irradiation – steps 2 to 4, as indicated above. The most commonly used simulation model within the PV industry is the "one-diode" model (Duffie & Beckman, 1991). The "one-diode" model is non-linear and implicit, and the required hourly calculations must be performed with the aid of computational software.

DNV GL has undertaken simulations based on the parameters described in Section 4.3.4. It is recommended to update this assessment once detailed engineering will be available for the project.

Table 4-11: Energy estimation for Kulachi PV Plant (no degradation applied) presents the predicted long-term annual energy production for the project, excluding the effects of PV module degradation at a hypothetical grid connection point, considering a standard PV plant and grid availability. The net energy prediction presented below represents the long-term mean, 50 % exceedance level, for the annual energy production of the PV plant (P50).

Table 4-11: Energy estimation for Kulachi PV Plant (no degradation applied)

		PV module technology	p-Si
		Unit	Single Axis tracker design
Input Data	GHI	kWh/m²/year	1,814
	GTI	kWh/m²/year	2,268
	Ambient Temperature	°C	25.4
	Azimuth	Deg.	0
	Tilt angle	Deg.	-50 / + 50
	Peak Power	MWp	65.00
Loss Factors	Horizon *	[%]	0.3
	Shadings *	[%]	4.1
	Soiling *	[%]	4.0
	IAM	[%]	1.7
	Irradiance	[%]	0.4
	Temperature	[%]	9.6
	Light induced degradation*	[%]	2.0
	Module quality *	[%]	0.1
	Mismatch *	[%]	0.5
	Ohmic (DC) *	[%]	0.8
	Inverter	[%]	1.8
	Other electrical losses *	[%]	2.0
	System Unavailability*	[%]	1.0
Results	**Yield Factor**	**kWh/kWp**	**1,701**
	Net Energy	**MWh/year**	**110,594**
	Performance Ratio	**[%]**	**75.0%**

*DNV GL Assumption

4.3.6 Loss Factors

Several loss factors are calculated, applied or estimated during the simulation. These are described below.

a) Shading losses:

There are two types of shading loss:

- Far shading: requiring calculations to define the horizon line. The horizon line was assessed by DNV GL remotely and also reviewed data during the site visit conducted; and
- Near shading: this requires calculation which takes into account a detailed 3D description of the PV system and the surrounding area. A 3D model of the PV plant has been created for computer simulation. The near shading loss essentially takes into account the inter-array shading as well as other surrounding elements that may affect the PV plant performance.

b) Soiling losses:

Soiling losses depend strongly on the location of the PV system and on the frequency of cleaning and raining. These losses are associated either with dirt or with urban pollution, which accumulates on the surface of modules and may result in PV cells receiving less irradiance. In other cases, there may be non-uniformly distributed dirt, such as bird droppings; this dirt tends to produce significant partial shading on cells. Adequate O&M activities should be implemented to achieve a reasonable figure, especially during drought periods. Based on DNV GL experience in similar site conditions and assuming a monthly cleaning regime, a lower soiling factor loss (about 2%) can be reached. However, without any specific information on the cleaning regime a soiling factor loss of 4% is considered in the study.

c) Reflection effects:

The reflection effects, or incidence effect (the other typical designated term is IAM, for "Incidence Angle Modifier"), corresponds to the weakening of irradiation actually reaching the PV cell surface, with respect to irradiation under normal incidence. In practice, this is commonly calculated using the ASHRAE-model, defined by the American Society of Heating, Refrigerating and Air-conditioning Engineers ("ASHRAE") as has become standard in America.

d) Irradiance level losses:

This loss is the difference between efficiency at 1,000 W/m² (irradiance under STC conditions) and actual irradiance within each hour. It is typically recommended to use detailed information on the electrical parameters for the PV modules selected, in order to estimate this loss.

e) Temperature losses:

The temperature coefficient of power given for a PV module expresses the reduction of module output power with increasing module temperature. The temperature of the module is typically calculated from its thermal balance. The thermal behaviour of the field, which strongly influences electrical performance, is determined by a thermal balance between the ambient temperature and the cell heating, due to incident irradiation. DNV GL has applied the thermal parameter (power temperature coefficient) recommended by the PV module manufacturer for these purposes.

f) Module quality losses:

Module quality losses include those associated with the MPP tracking error of the inverter (set at 0.5% for this Project), the PV module positive tolerance on the nominal power of the module and the PVSyst modelling systematic error.

g) Light-induced degradation losses:

Light-induced degradation ("LID") (or light soaking effect, "LSE") corresponds to an attenuation of the module's power once it has been exposed to real operating conditions. This factor is typically verified through independent measurements taken from the modules proposed for the Project. In the absence of the above-mentioned supporting information, DNV GL has considered pragmatic values for the crystalline technology.

h) Module mismatching losses:

Losses due to mismatch are related to the fact that the real modules in the array do not all have exactly the same current-voltage characteristics. The estimation of mismatch loss is normally undertaken in accordance with typical module performance dispersion. In a series connection, the array mismatch loss can be kept low by using modules of the same type (with very similar currents) only. As flash tests are not available at the moment of this report, DNV GL made a pragmatic assumption of 0.5% losses due to module mismatching.

i) Ohmic wiring losses (DC):

The wiring resistance induces losses between the power available from the modules and that at the input of the inverter. The effective loss during a given period is calculated during the simulation. It is usually lower than the relative loss, when operating at Maximum Power Point (MPP). DNV GL has considered a pragmatic value of 0.7% at STC conditions for the Project.

j) Inverter losses:

The inverter losses include efficiency, and other losses due both to the power and voltage threshold and to operation above nominal power and voltage. This factor has been calculated by hourly simulations based on the technical information of the inverter manufacturer.

k) Other electrical losses:

DNV GL has considered the following on account of other electrical losses:

- Wiring losses (AC network): DNV GL has considered a pragmatic value of 1.0% at STC conditions for the Project;
- Transformation losses: DNV GL has considered the loss per LV/MV step up transformer at the Project according to the information available; and
- Auxiliary losses.

l) Availability losses:

DNV GL has included an experience based allowance for plant availability and grid availability.

All of the above loss factors are computed for the performance ratio calculation.

4.3.7 Uncertainty Analysis

The uncertainty of the final result is a consequence of the uncertainty in the solar radiation data, the inaccuracies of the simulation procedure itself (e.g. choice of models), and uncertainties associated with "external" influences (e.g. shading, soiling, deviation of components from specification, inverter losses, cabling losses, etc.).

In the case of on-site measurements being correlated with the satellite derived data, the following parameters have to be considered when determining the uncertainty of the predicted long-term solar radiation:

- Pyranometer uncertainty;
- Correlation uncertainty;
- Historical solar radiation data period uncertainty; and
- Future variability of the solar radiation.

The uncertainty of the final result is a consequence of the uncertainty in the solar radiation data, the inaccuracies of the simulation procedure itself (e.g. choice of models), and uncertainties associated with "external" influences (e.g. shading, soiling, deviation of components from specification, inverter losses, cabling losses, etc.).

The above sources have been estimated for the Project. The breakdown of the uncertainty is shown in Table 4-9 below. It is assumed that all errors are independent and that the Gaussian distribution is applicable. Therefore the total uncertainty represents the standard deviation of what is assumed to be a Gaussian process.

Table 4-12: Total uncertainty for the Kulachi Solar PV plant

Source of Uncertainty	Total Uncertainty Standard Deviation (%) Future variability One-year	Future Variability Ten-year
GHI Data and Simulation	8.6	
Expected Future Variability	2.5	0.6
TOTAL	9.0	8.7

The confidence limits for probabilities exceeding 90 %, 75 % and 50 %, for the one-year and ten-year predictions are presented in Table 4-12 for the Project.

4.3.8 Long-term results

The energy figures in previous sections do not include the power degradation ratio. DNV GL remarks that the typical power degradation considered for crystalline silicon PV modules is usually within the range of a 0.5 % to 0.8 % power reduction, per year (Kirk, Jordan, & Kurz, June 2012). Most of the literature references refer to module-only degradation results. System-level effects add to the overall degradation rate, though the exact mechanisms are not well characterised.

DNV GL recommends incorporating a system level degradation rate of 0.64 % per year into the long-term energy projection estimates beyond year one.

A detailed technical review of the technology is recommended once the detailed design is available and based on the contractual agreement made with the PV module manufacturer. These assumptions will be reviewed accordingly.

The degradation factor at the end of a single year has been applied at the beginning of the same year, based on a slightly conservative approach. The resulting production figures for the one-year period with corresponding Performance Ratio, are presented in Table 4-12.

Table 4-13: Performance ratios and net energy outputs [MWh/year] (degradation of 0.64% per year)

Year	PR	P50	P75	P90
1	75.0%	110,594	103,881	97,838
2	74.6%	109,886	103,216	97,212
3	74.1%	109,179	102,551	96,586
4	73.6%	108,471	101,886	95,960
5	73.1%	107,763	101,221	95,334
6	72.6%	107,055	100,557	94,707
7	72.2%	106,347	99,892	94,081
8	71.7%	105,640	99,227	93,455
9	71.2%	104,932	98,562	92,829
10	70.7%	104,224	97,897	92,203
11	70.2%	103,516	97,232	91,577
12	69.8%	102,808	96,567	90,950
13	69.3%	102,101	95,903	90,324
14	68.8%	101,393	95,238	89,698
15	68.3%	100,685	94,573	89,072
16	67.8%	99,977	93,908	88,446
17	67.4%	99,269	93,243	87,820
18	66.9%	98,562	92,578	87,193
19	66.4%	97,854	91,914	86,567
20	65.9%	97,146	91,249	85,941
21	65.4%	96,438	90,584	85,315
22	65.0%	95,730	89,919	84,689
23	64.5%	95,023	89,254	84,063
24	64.0%	94,315	88,589	83,437
25	63.5%	93,607	87,925	82,810

5 GRID CONNECTION ASSESSMENT

Grid connection assessment has been undertaken by ARCO Energy.

6 CONCLUSIONS AND RECOMMENDATIONS

DNV GL has undertaken a feasibility study for 50 MWAC solar photovoltaic power plant in Kulachi, Pakistan. The following conclusions and recommendations are drawn:

- The project site boundaries and site orientation identified during the site visit allow the development and construction of 50 MWAC solar PV plant for the selected technologies.
- The results obtained for the Energy Production Assessment are presented in 4.3.5 for the selected PV module technology. The results are subject to substantial uncertainty. It is considered that the prediction of energy production, while suitable for assisting with the decision to develop the project, must be interpreted with caution due to inherent uncertainties. DNV GL recommends that the absolute results presented within this report be interpreted with caution as they are intended to be indicative only.
- It is noted that the assumptions of equipment used for the preliminary layout design are for indicative purposes only and should in no way bias any future bidding process for the project.
- DNV GL has provided the results presented in this report for strategic and feasibility purposes and to assist in the design of a 50 MWAC PV power plant at Kulachi PV site. At the time of undertaking this assessment, DNV GL has considered that the maximum power capacity to be installed is 50 MWAC.

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APPENDIX A. DATASHEETS

A.1. Solar PV modules datasheet (p-Si)

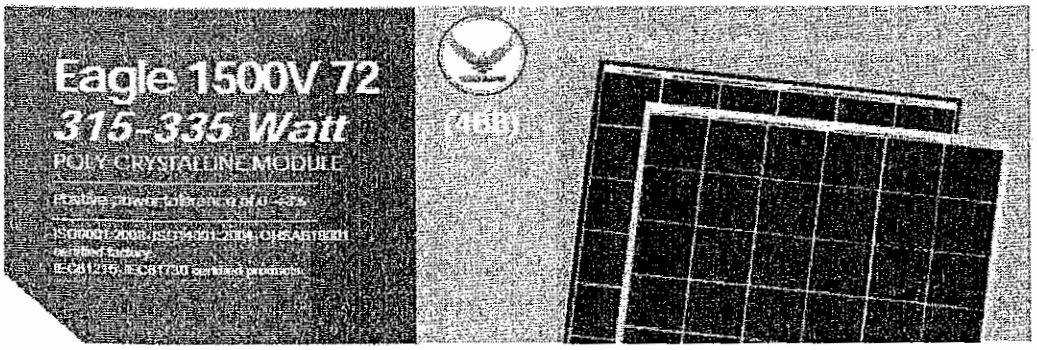
www.jinkosolar.com

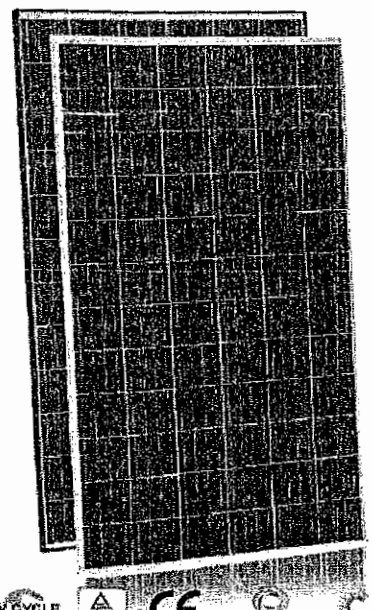
JinKO Solar

Eagle 1500V 72

315-335 Watt

POLY CRYSTALLINE MODULE





KEY FEATURES

System Voltage:
The maximum voltage is promoted to 1500V and the module strings are extended by 50% which reduces the overall system BOS.

High Power Output:
Polycrystalline 72 cell module achieves a power output up to 335Wp.

PID RESISTANT:
The Eagle modules can pass maximum voltage 1500V PID testing under 60°C /85%RH condition to ensure the outdoor durability and energy output via high-voltage resistance technology.

Low-light Performance:
Advanced glass and surface texturing allow for excellent performance in low-light environments.

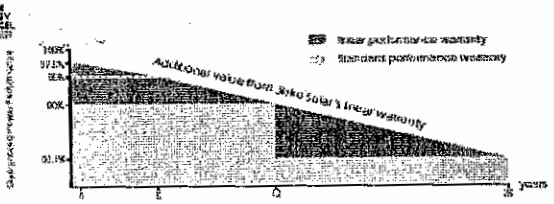
Severe Weather Resilience:
Certified to withstand: wind load (2400 Pascal) and snow load (5400 Pascal).

Durability against extreme environmental conditions:
High salt mist and ammonia resistance certified by TUV NORD

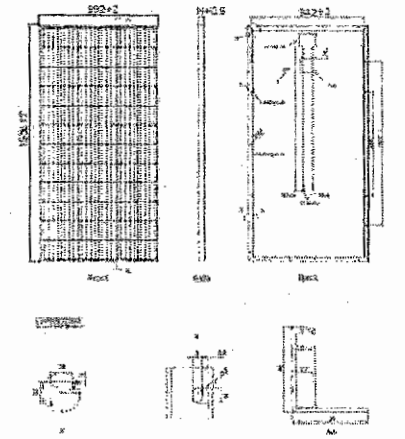
Temperature Coefficient:
Improved temperature coefficient decreases power loss during high temperature.

LINEAR PERFORMANCE WARRANTY

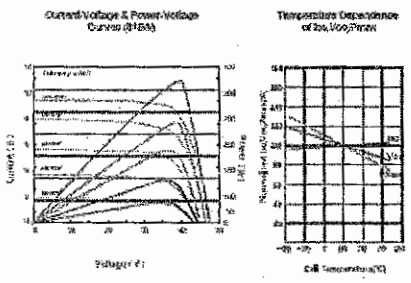
10 Year Product Warranty • 25 Year Linear Power Warranty



Engineering Drawings



Electrical Performance & Temperature Dependence



Packaging Configuration

(Two boxes=One pallet)

26pcs/box, 52pcs/pallet, 624 pcs/20'GP Container

Mechanical Characteristics

Cell Type	Poly-crystalline 156×156mm (6 inch)
No. of cell	72 (6×12)
Dimensions	1956×992×40mm (77.01×39.05×1.57 inch)
Weight	26.5 kg (58.4 lbs)
Front Glass	4.0mm, Anti-Reflection Coating, High Transmission, Low Iron, Tempered Glass
Frame	Anodized Aluminium Alloy
Junction Box	IP67 Rated
Output Cables	TUV 1×4.0mm², Length: 900mm or Customized Length

SPECIFICATIONS

Module Type	JKM315PP-72-V		JKM320PP-72-V		JKM325PP-72-V		JKM330PP-72-V		JKM335PP-72-V	
	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax)	315Wp	236Wp	320Wp	236Wp	325Wp	242Wp	330Wp	246Wp	335Wp	250Wp
Maximum Power Voltage (Vmp)	37.2V	34.1V	37.4V	34.3V	37.6V	34.6V	37.8V	34.7V	38.0V	34.8V
Maximum Power Current (Imp)	8.48A	6.94A	8.56A	6.88A	8.65A	6.99A	8.74A	7.07A	8.82A	7.02A
Open-circuit Voltage (Voc)	45.2V	42.2V	45.4V	42.7V	45.6V	42.9V	45.8V	43.2V	46.0V	43.4V
Short-circuit Current (Isc)	9.03A	7.28A	9.09A	7.38A	9.10A	7.34A	9.14A	7.38A	9.18A	7.43A
Module Efficiency STC (%)	16.24%		16.49%		16.75%		17.01%		17.26%	
Operating Temperature(℃)	-40℃~+85℃									
Maximum system voltage	1000VDC (IEC)									
Maximum series fuse rating	15A									
Power tolerance	0~+3%									
Temperature coefficients of Pmax	-0.40%/℃									
Temperature coefficients of Voc	-0.30%/℃									
Temperature coefficients of Isc	0.04%/℃									
Nominal operating cell temperature (NOCT)	46±2℃									

*STC: Irradiance 1000W/m² Cell Temperature 25℃ AM=1.5

NOCT: Irradiance 800W/m² Ambient Temperature 20℃ AM=1.5 Wind Speed 1m/s

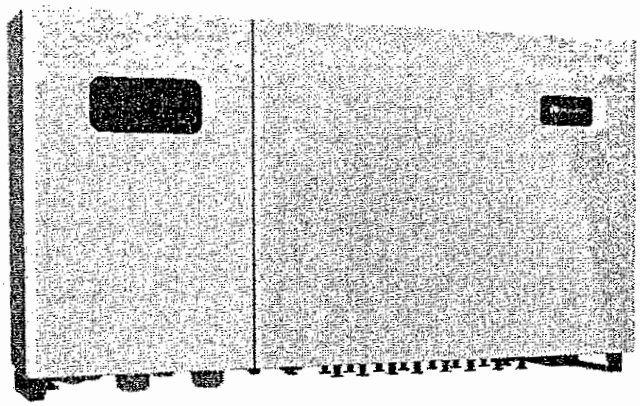
* Power measurement tolerance: ± 3%

The company reserves the final right for explanation on any of the information presented hereby. EN-JKM-335PP-V_1.0_rev2017

A.2. Inverter datasheet

String Inverter (SUN2000-36KTL)

HUAWEI



Smart

- 4 MPPTs for versatile adaptions to different layouts
- 8 strings intelligent monitoring and fast trouble-shooting
- Power Line Communication (PLC) supported

Safe

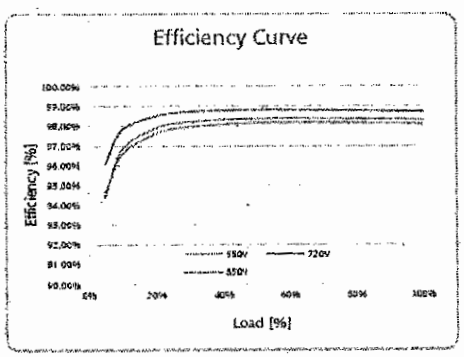
- DC disconnect integrated, safe and convenient for maintenance
- Type II surge arresters for both DC and AC
- Ground fault protection
- Residual Current Detection (RCD) protection

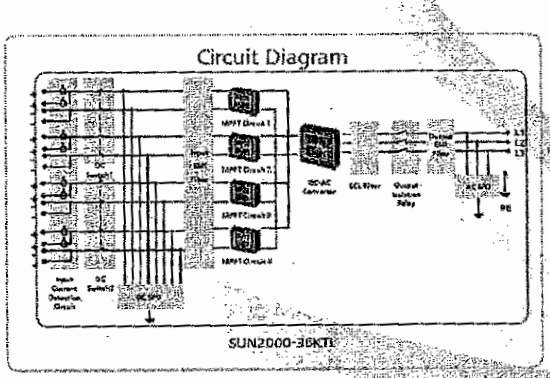
Efficient

- Max. efficiency 98.8%, European efficiency 98.6%

Reliable

- No need for external fans with natural cooling technology
- Protection rating of IP65





Always Available for Highest Yields

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String Inverter (SUN2000-36KTL)

HUAWEI

Technical Specifications	SUN2000-36KTL
	Efficiency
Max. Efficiency	98.8%
European Efficiency	98.6%
	Input
Max. DC Usable Power	40,800 W
Max. Input Voltage	1,100 V
Max. Current per MPPT	22 A
Max. Short Circuit Current per MPPT	30 A
Min. Operating Voltage / Start Input Voltage	200 V / 250 V
Full Power MPPT Voltage Range	480 V ~ 850 V @380Vac/ 400Vac 580V~850V@480Vac
MPPT Operating Voltage Range	200 V ~ 1000 V
Rated Input Voltage	520 V @380Vac / 400Vac 720V@480Vac
Max. Number of Inputs	8
Number of MPP Trackers	4
	Output
Rated AC Active Power	36,000 W
Max. AC Apparent Power	40,000 VA
Max. AC Active Power (cosφ=1)	Default 40,000W; 36,000W optional in settings
Rated Output Voltage	220V / 380V, 230V / 400V, default 3W+N+PE; 3W+PE optional in settings 277V/480V, 3W+PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Max. Output Current@380V/400V/480V	60.8 A/57.8A/46.2A
Adjustable Power Factor	0.8 LG ... 0.8 LD
Max. Total Harmonic Distortion	< 3%
	Protection
Input-side Disconnection Device	Yes
Anti-Islanding Protection	Yes
DC Reverse-Polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
Insulation Monitoring	Yes
Residual Current Detection	Yes
	Communication
Display	LED Indicators
USB / Bluetooth+APP	Yes
RS485	Yes
PLC	Yes
Fast Ethernet	Optional
	General
Dimensions (W×H×D)	930 × 550 × 260 mm (36.6 × 21.7 × 10.2 inches)
Weight	55 kg (121 lb.)
Operation Temperature Range	-25 °C ~ 60 °C (-13°F ~ 140°F)
Cooling	Natural Convection
Max. Operating Altitude Without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
DC Connector	Amphenol H4
AC Connector	Waterproof PG Terminal + DT Connector
Protection Rating	IP65
Internal Consumption at Night	< 1 W
Topology	Transformerless
	Standards Compliance
Safety / EMC	EN/IEC 61000-1, EN/IEC 61000-2, EN/IEC 61000-3, EN/IEC 61000-4, EN/IEC 62109-1, EN/IEC 62109-2
Grid Code	IEC 61727, IEC62116, VDE-AR-N4105, VDE 0126-1-1, BDEW 2008, G59/3, UTE C 15-712-1, CEI 0-16, CEI 0-21, EN-50438-Turkey

Always Available for Highest Yields

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A.3. Tracker datasheet

TECHNICAL DATASHEET

exotrackHZ

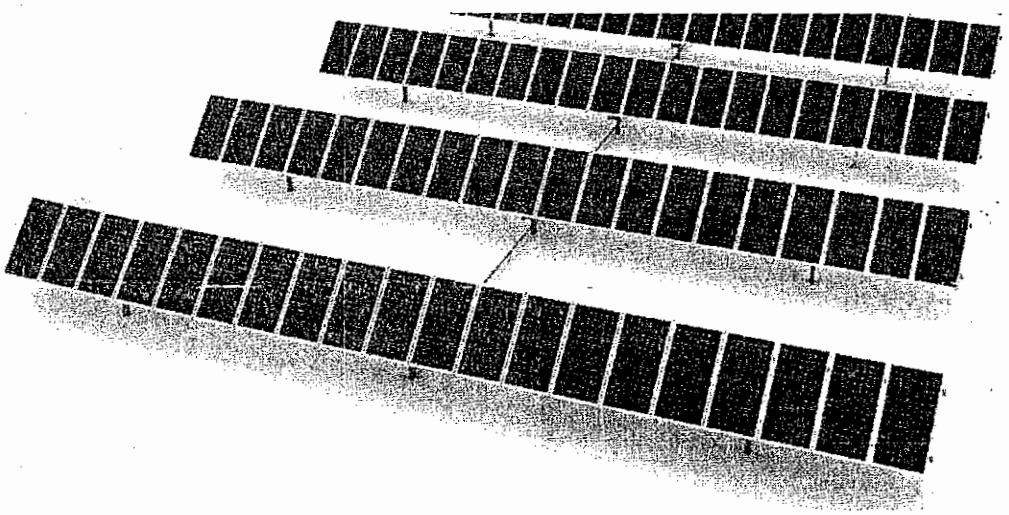
SINGLE AXIS TRACKER FOR PV MODULES

Less Maintenance, More Power

At Exosun, our solar trackers are the result of perfectionist engineering and years of hands-on experience. Flawless in their simplicity, robustness, and flexibility, our trackers are the smartest solution on the market for smooth and fast project deployment, high solar performance and profits.

FRAMED & GLASS / GLASS MODULES COMPLIANT

1000 & 1500 VOLTS VERSIONS



Highest flexibility for flowing topography

- Follows hilly landscapes without land grading.
- 10% slope tolerances in all directions & between tables.
- Short tables for better adaptation and layout flexibility.

Unrivalled simplicity for smooth and fast installation

- Highest ramming and installation tolerances.
- Mechanical installation less than 200 man-hours/MW.
- Fast deployment and increased safety: no specific machine needed thanks to lightweight parts.

DC wiring optimization

- Optimally engineered with 1 string per tracker row.
- Integrate combiner boxes or string inverters directelly onto the tracker
- No specific DC string trenches.

Market leading reliability: Avoid unexpected OPEX

- Balanced design, structural stiffness, and high quality materials.
- Complete lubrication-free solution, no on-site yearly greasing.
- Limited maintenance with 1 controller and 0 sensors for 10 MW.

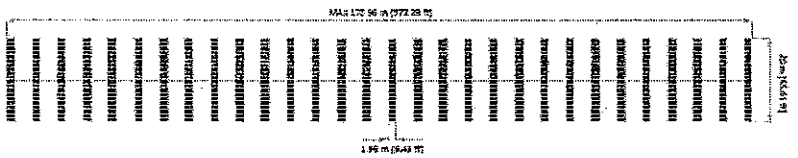
exosun

TECHNICAL SPECIFICATIONS — EXOTRACK HZ FOR cSi MODULES 60/72 cells

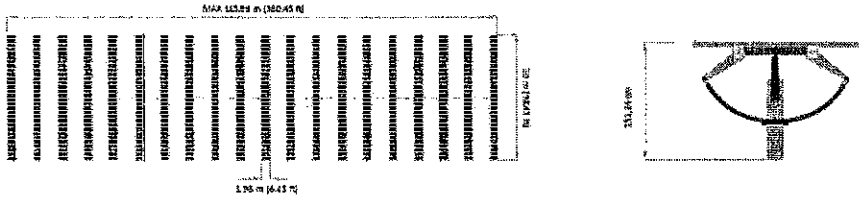
	1000 V	1500 V
GENERAL CHARACTERISTICS		
Tracked area	Up to 1200 m² (12916 ft²).	
Motors per MWp*	5	
Power per tracker*	200 kWp	
Rows per tracker*	Up to 30	Up to 20
Strings per row	1 string	
Daily tracking	± 50°, optional range increase on project basis	
Piles per MW*	450	500
Foundation installation tolerances	xy : ± 4 cm (1.6 in), tilt ± 2°, twist ± 8°, z : ± 4 cm (1.6 in)	
Module configuration	1 in portrait (60/72 cells)	
Module fixation	Framed modules: proprietary clamp with integrated grounding Glass/Glass modules: proprietary clamp	
Slope acceptance	Up to 10% between tables. Undulating slopes accepted	
Ground coverage ratio*	From 26 to 50%	
MATERIALS AND DIMENSIONS		
Structure	Maintenance-free movement transmission HDG / Galvanized steel / Stainless steel / Composite / Aluminum	
DC string management	Cable trays or raceways	
ELECTROMECHANICAL CHARACTERISTICS AND AUTOMATIC DEVICE		
Drive type	Brushless gear motor, 3 phases, 400 VAC (CE) or 460 VAC (UL)	
Power consumption*	± 500 kWh/MWp/year (including stand-by mode)	
Control system architecture	Exobox centralized piloting system. Up to 1 per 10 MWp	
REMOTE CONTROL AND SCADA INTERFACE		
Remote control	Via ExoPortal -web application-	
Monitoring and data access	Via OPC server or Modbus TCP	
WIND & SNOW RESISTANCE - Eurocodes (ASCE 7-10)	Indicative value, can vary depending on tracker configuration	
In any position	Up to 100 km/h (62 mph)	Up to 100 km/h (62 mph)
In stow position	Up to 215 km/h (135 mph)	Up to 160 km/h (110 mph)
Snow resistance	Up to 2 025 N/m² (30 psf)	
WARRANTIES		
Warranties	5 years on product - 10 years on structure Optional warranties available - 20 years extensions	

* Module and/or project specific

Exotrack HZ tracker - cSi 1000V

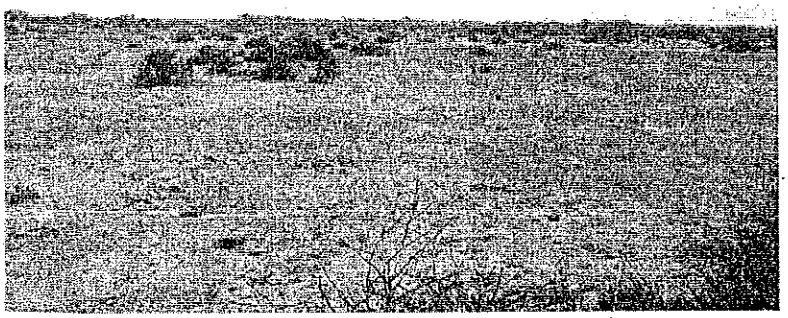


Exotrack HZ tracker - cSi 1500V



APPENDIX B. SITE VISIT REPORT (PART REPORT)

SITE VISIT REPORT OF
KULACHI 50 MW SOLAR PV PLANT



Client:

FAS Energy (Pvt.) Ltd.
P.O. Box 341904,
Riyadh 11333, KSA
Contact: +92 51 8734204

Consultant:

Nasir Absar Consulting (Pvt.) Ltd.
Office No 1, 2nd Floor, VIP Sqaure,
I-8 Markaz, Islamabad
Contact: +92 51 4861322-24

1 INTRODUCTION

50 MW Kulachi Solar PV Power Plant is an initiative of FAS Energy "Company". The Company is to develop, construct and operate power project located at Kulachi, Dera Ismail Khan, Khyber Pakhtunkhwa.

FAS Energy is in the process of performing Feasibility Study Report of the Project. For the purpose, site visit was required. A document comprising the guidelines, to perform a site assessment and collect, on-site information was provided.

The Solar project is located near Batcha Abad village, about 13 km from Kulachi city, a city named after the Kulachi Baloch tribe and is the headquarters of Kulachi Tehsil (an administrative subdivision) of Dera Ismail Khan District in Khyber-Pakhtunkhwa province of Pakistan. It is located at 31°55'49"N 70°27'31"E at an altitude of 209 metres.

The project shall be developed as an Independent Power Producer "IPP" under the Sovereign Guarantee provided by the Federal Government of Pakistan. Sale of the Power shall be made to the Central Power Purchasing Agency (Guarantee) Limited "CPPA (G)".

M/S FAS Energy engaged the services of M/S Nasir Absar Consulting (Pvt.) Ltd. "NACL" to perform the site assessment and collect the on-site information related to road access and environment.

2 PURPOSE OF THE SITE INSPECTION

NACL personnel conducted the visual inspection of the project area. The purpose of the site visit was to evaluate the situation of:

- Road Access
- Site Access
- Activities performed in the area
- Connection Point
- Vegetation and Forestry
- Animal Presence
- Mountains, Hills and Obstacles
- Stakeholder Views
- Internal Roads and
- General Environmental Information.

3 DETAILS OF VISIT

Date of Visit	Saturday, November 4, 2017	
NACL Personnel	Syed Ibrahim Ahmad	Engineer
	Dr. Anila Nisar Syed	Environmentalist
	Muhammad Yameen Khan	Sociologist
Site Coordinates	Latitude	31°56'37.72806"
	Longitude	70°16'47.45"E

4 SITE ASSESSMNET

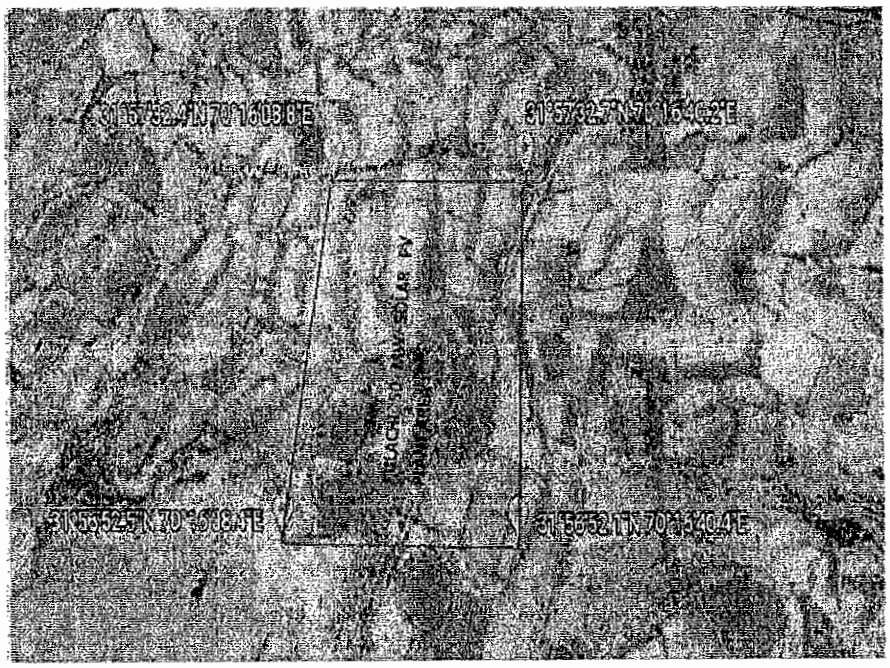
General Information

Project Name	50 MW Javed Solar Park
Location	Loni-Kulachi, Dera Ismail Khan, KPK
Plot Corner Coordinates	31°57'32.7"N 70°16'40.2"E 31°57'32.4"N 70°16'08.8"E 31°56'52.5"N 70°16'08.4"E 31°56'52.1"N 70°16'40.4"E
Observation	The area is an agricultural zone. It lies at the foot of the Sulaiman Range and hence is irrigated by flood water from Sulaiman Mountains. The system of irrigation is called Rod Kohi, a system of mountain channels or hill-torrents inundating the whole valley of Damaan ("Rod" means "channel" and "Koh" means "mountain" in Persian). The Rod Kohi system based on "Kulyat Riwajat" (Fromulae and Traditions) governed the irrigation system ever since the Pathan tribes had moved into Damaan. The British officers reduced all these to writing during their Land Settlemts in the later part of nineteenth century. The Bolton Irrigation Notes of 1908 are still considered as the Bible of Rod Kohi Irrigation. In appearance the Project area bears a generic resemblance to the Dera Ismail Khan district, except for the stony plain

and the line of barren and unsightly slope terrain which form its western border. The plain is much cleft by deep channels which carry off the rain-water from the hills, and these are utilized for irrigation with great skill.

There is no habitation within the plot limits; however, there is a small village with some houses at northernside, outside the plot limits. The site contains small bushes and trees at scattered location and are very thin in numbers. There is a low voltage transmission line passing at north – east corner side of the plot.

Google Image of Project Area



4.1 ROAD ACCESS TO PROJECT SITE

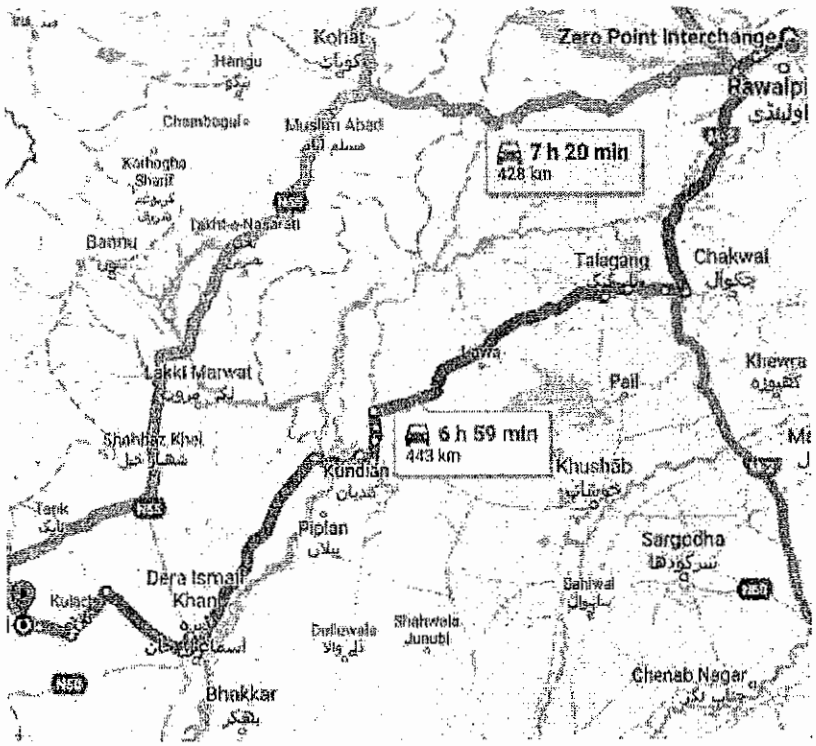
The Project Site from Islamabad, Capital of Pakistan can be accessed through:

Kashmir Highway – Islamabad Motorway Link Road – Lahore-Islamabad Motorway M2 – Balkasar Interchange – Talagang-Chakwal Road – Talagang Bypass Road – Mianwali-Rawalpindi Road – Mianwali-Talagang Road – Sargodha-Mianwali Road – Mianwali-Muzafargarh Road – Dera Ismail Khan Road – Chashma Road – Dera Ismail Khan-Mianwali

Road – Bannu Road – Indus Highway – Tank-D.I.Khan Road – Kulachi NH55 Link Road – Kulachi-Loni Road – Loni-Daraban Road - Loni Village – Batcha Abad Village – Project Site.

Total Distance of 443 km could be covered at a travel time of approx. 7 h.

The road is metal road all the way till Loni however, from Loni to Badshahbad village to Project site is rough track (Katachy road).



About DNV GL

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