SIACHEN ENERGY LIMITED

ENERGY FOR A BETTER TOMORROW

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

Ref : SEL/NEPRA/2023-007
Date : March 22, 2023

Subject: **Submission of the License Proposed Modification (LPM) of our 100 MWp Solar Power Project**

Dear Sir,

With reference to your letter # NEPRA/R/TRF-100/4539 dated March 03, 2023 and further to our letter # SEL/NEPRA/2023-005 Dated March 16, 2023 we hereby submit the following document for kind consideration and favorable approval by the Authority in accordance, inter alia with section-31 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 read with Rules 3 of the NEPRA tariff Standards and Procedure Rules, 1998 and other applicable provisions of NEPRA law.

a. License Proposed Modification (including its Annexures) in triplicate.
b. Board Resolution of Siachen Energy Limited.
c. Affidavit of Mr. Muhammad Kashif Shamsi.
d. Bank Cheque # CLK 00028999 dated 12-Jan-2023 and Pay Order No. 16575057 dated 22-03-2023 total amounting **PKR 1,019,022/- (Pak Rupees One Million Nineteen Thousand and Twenty Two only)** being requisite filing fee.

Yours Sincerely,

Muhammad Sohail Shamsi
Chief Executive Officer
Siachen Energy Limited

4th Floor, Plot 36-C, Lane # 13, Bukhari Commercial Area, Phase VI, DHA, Karachi 75500, Pakistan
T: 35156172-3 F: 35156175 E: ms.shamsi@sel.com.pk W: www.sel.com.pk

Cover Letter

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Board Resolution

SIACHEN ENERGY LIMITED

ENERGY FOR A BETTER TOMORROW

Extracts of the Resolution
Passed by the Board of Directors of Siachen Energy Limited
In its meeting held on 26th day of October 2022

Resolution:

1. **RESOLVED THAT,** "the Board of Directors of Siachen Energy Limited ("Siachen") hereby approved to file the License Proposed Modification (LPM) with National Electric Power Regulatory Authority ("NEPRA" or the "Authority") in respect of 100 MW Solar Power Plant to be located at Mirpur Sakro, District Thatta, Sindh (the "Project") and in relation thereto enter into and execute any and all required documents, make all filings, do any act and pay all applicable fees, whatever it may be in each case, of any nature whatsoever as may be required."

2. **FURTHER RESOLVED THAT,** "in respect of License Proposed Modification (LPM) and applications etc. to be submitted to NEPRA, Mr. Muhammad Kashif Shamsi, is the duly authorized representative on behalf of the Company for the purpose of filing the License Proposed Modification (LPM) and is hereby empowered and authorized for and on behalf of the Company to:
   a. Review, execute, submit and deliver the License Proposed Modification (LPM) or applications (including modifications thereto) and related documentation required by NEPRA, inter alia, any consents, contract, document, power of attorney, affidavits, statements, letters, forms, applications, deeds, undertakings, approvals, memoranda, amendments, communications, notices, certificates, request and any other instruments of any nature whatsoever;
   b. Sign and execute necessary documentation, pay necessary fees, appear before NEPRA as needed and do all necessary things for the issuance of tariff for the Project;
   c. Represent and respond on behalf of the Company, in the public hearings, to all of NEPRA's queries, case officers, stakeholders and to attend pre and post hearing meetings;
   d. Do all such acts, matters and things as may be necessary for carrying out the purposes aforesaid and give full effect to the above-said; and
   e. Delegate all or any of the above powers in respect of the foregoing to any other officials of the Company as deemed appropriate.

CERTIFIED TO BE TRUE COPY

Siachen Energy Limited SEL

Dated: October 26, 2022

4th Floor, Plot 36-C, Lane # 13, Bukhari Commercial Area, Phase VI, DHA, Karachi 75500, Pakistan
T: 35156172-3 F: 35156175 E: ms.shamsi@sel.com.pk W: www.sel.com.pk

Text of the Proposed Modification

SEL has selected Tier-1 PV Module "550 watt Bifacial Mono PERC Module" for its 100MW Solar Power Plant. It is considered as the state of the art in the Photovoltaic technology with the IEC 61215, IEC 61730, UL 61215, UL 61730 and IEC TS 62941 certification. It has 144 number of cells and maximum voltage is promoted to 1500V and the module strings are extended by 50% which reduces the overall system BOS. This new technology adapts 6 busbar solar cell improve the efficiency of modules , offers a better aesthetic appearance, making it perfect for Grid Connected Systems. In addition it has higher module conversion efficiency (up to 21.3%) benefit from Passivized Emitter Rear Contact (PERC) technology. Furthermore, The PV module 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. Also, its advanced glass and solar cell surface texturing allow for excellent performance in low-light environments. Hence, This PV Modules series is compatible with 1500V plant architectures, gives highly predictable energy in all climates and applications, and is independently certified for reliable performance in high temperature, high humidity, extreme desert and coastal environments.

The project mainly selects PV modules, and the PV modules are connected in series to form array strings. PV modules have advantages of high battery conversion efficiency, good stability, small size for equal capacity, etc. The PV modules with STC rated output (Pmpp) 550Wp are suggested for the project. In relation to the above please find attached the modifications required in Schedules I and II of the Generation License of the Company.

The Company Previously submitted SG2500 HV type Inverters having system voltage of 1500 V. Our new inverters are 8.8MW (8*1100kW) with advanced three level technology and maximum inverter efficiency of 98.7% (EU).

The new inverters have effective cooling with 1.1 overload capacity and has no derating up to 5ºC with degree of protection of NEMA 3R making it suitable for harsh environment conditions. In addition, it complies with the UL1741, UL1741 SA, IEEE 1547, Rule 21 and NEC code.

An all-in-one PC including eight 1100kW inverters with 8800kW capacity is selected. By adopting variable structure PWM modulation algorithms and advanced MPPT control algorithms, the system loss can be reduced to the greatest extent, making the whole system efficiency highest, up to the maximum of 99.0%. At the same time, the inverter uses digital DSP control chips and dual power supply, increasing the reliability of the system. The inverter should have passed the TUV certification.

Statement of the reasons in support of the modification

The Company is a public limited company registered under the Companies Ordinance, 1984. The Company has been setup as a Special Purpose Company to setup and operate power projects.

The Company is seeking to develop, own and operate two solar power projects of 100 MW each in the province of Sindh. The Project is being developed pursuant to a Letter of Intent issued by the Sindh Alternative Energy Development Board ("SAEDB").

On October 10, 2017, NEPRA issued Generation License No. SPGL/24/2017 to the Company, which Generation License was based on PV Modules 250 Watt of model Sungrow SG2500U with a total capacity' of 100 MWp. This was the most advanced technology available for solar power generation at that time.

Since then, there has been great deal of changes happened in the technology and prices of the solar modules due to international demand and competition.

Further, the scope of the review on the Determination is established under paragraph XI that states:

> *"Projects that are going back for review of tariff will be asked to submit their applications on the basis of latest technology and technology related factors".*

Accordingly our EPC contractors have revised their Offshore and Onshore contracts for supply of equipment and construction of the project which reflects the latest technology. Hence, the Company seeks to incorporate those changes in the Generation License.

The Company has selected Power china International Group Limited as the equipment supplier for the Project. The engineering, procurement and construction works in relation to the Project will be undertaken by HDEC Engineering (Pvt.) Ltd, China. The said contractors have vast international experience in development and setting-up of power projects, including solar power projects.

The Company has already achieved the following key milestones in respect of the Project:

- All project approvals including LOI from SAEDB Government of Sindh along with latest extension, land documents, Environmental study, interconnection study and feasibility study;

- The EPC and O&M contracts in respect of the Project have been finalized;

- The Company has filed a new tariff with NEPRA on 25 June 2020 and received the new Tariff Determination by NEPRA on November 29, 2021 *(The earlier Tariff Determination expired on 18 November 2019)*

- Project debt financing has been arranged (on the basis of earlier debt equity structure approved by NEPRA in the Determination dated 18 November 2018) and lenders have taken their internal approvals, and sponsors have committed the required equity for the Project. Indicative term sheet to finance the project from industrial & Commercial Bank of China ("ICBC").

In view of the foregoing, the Company expects to achieve financial close in respect of the Project within the next few months. As part of its various milestones for achieving financial close, the Company desires to seek modification of its Generation License in order to reflect the change in technology of the PV Modules from 250 Watt of model Sungrow SG880UD to Tier-1 PV Modules "550 watt Bifacial Mono PERC Module" for its 100MW Solar Power Plant.

The Company Previously submitted SG2500 HV type Inverters having system voltage of 1500 V. Our new inverters are 8.8MW with advanced three level technology and maximum inverter efficiency of 98.7%

The Company hereby requests NEPRA to approve the proposed modification to the Generation License as such modification would allow the Company to proceed further with the Project and achieve financial close in a timely manner.

The present request is consistent with the guidelines set out in the Policy for Development of Renewable Energy for Power Generation, 2006 issued by the Government of Pakistan and the NEPRA (Application and Modification Procedure) Regulations. 1999.

We do hope NEPRA will consider our request and provide us the Modified Generation License based on the new Modules and Inverters as specified herein this application.

Statement of the impact on the tariff, quality of service and the performance by the licensee of its obligations under the license

The Company had previously awarded a Tariff Determination by NEPRA which expired on 18 November 2019 for reasons beyond our control. The Company filed a review motion with NEPRA for time extension in the Tariff which was declined on 27 March 2020 and we were advised to file a new Tariff based on latest technology and prevailing prices of the equipment.

Therefore, the Company has filed a new Tariff on 25 June 2020 and received the new Tariff Determination by NEPRA on November 29, 2021. All the changes in technology and equipment prices have been incorporated in the tariff application. The proposed modification to the Company's Generation License will have impact on the tariff awarded to the Company.

The Company hereby certifies that the tariff to be awarded to the Company will be acceptable to the Company; and that the quality of service and the performance by the Company under the Generation License or tariff will not be affected by the proposed modification to its Generation License.

The Company has selected top quality Tier-1 PV Modules "550 watt Bifacial Mono PERC Module" for its 100MW Solar Power Plant and inverters of 8.8MW with advanced three level technology and maximum inverter efficiency of 98.7%.

With this latest technology and equipment, we are confident that we will able to provide both the quality of service and performance required by NTDC.

Modification in Schedule I

A. General Information:

Name of Applicant / Company	SIACHEN ENERGY LIMITED
Registered Office	74, J STREET OFF KHAYABAN E MUHAFIZ, PHASE-VI, DHA, KARACHI.
Plant Location	GHULAMULLAH ROAD, TALUKA MIRPUR SAKRO, DISTRICT THATTA, SINDH.
Type of Generation Facility	SOLAR POWER

B. Solar Farm Capacity & Configuration:

S. No.	Description	Stated in the Generation License	Proposed Modification
(i)	Solar Modules type. Make & Model	Polycrystalline PV Module 250 Watt Model Sungrow	Mono-crystalline PV Module 550 Watt PERC technology
(ii)	Installed Capacity	100 MW	100 MW
(iii)	Number of Modules / Size of each Unit (kwh)	400,000 modules/ 1650 mm x 992 mm x 35 mm	181,832 modules / 2278*1134*35 mm
(iv)	Number of solar cells in each module	60 cells	144 cells (6 x 24)

C. Technical Details

ELECTRICAL SPECIFICATIONS	
STC rated output (Pmpp)*	550Wp (above)
Rated voltage (Vmpp) at STC	41.96 V
Rated current (Impp) at STC	13.11 A
Module efficiency	21.3%
Types of solar PV cell	Mono-crystalline
Tolerance	0/+5W or better
Coefficient temperature	-0.350%/°C
cable	4mm^2
Connector type	MC4
NOCT	45+2,45-2
Frontal Glass	Single glass, 2.0mm coated tempered
Certifications	TUV/IEC/MCS/UL/ISO/TS/OHSAS
Warranty	First year 2% degradation, 2nd to 25th 0.45% linear degradation or less
Operating temperature	-40°C to 85°C
Maximum voltage	1500V DC
Module Area	2.6 m^2
Open circuit voltage(Voc)	49.90
Short circuit current (Isc)	14.00
Maximum system open Circuit Voltage	1500 DC
CIVIL SPECIFICATIONS	
No. of Tracker	2165
Phi angle	±60°

D. Other Details

RELATED PARAMETERS	
Cell type	Mono crystalline
Number of cells/cell arrangement	144/6*24
Packing unit	31 psc/Pallet

MECHANICAL SPECIFICATIONS	
Outer dimensions(L*W*H)	2244*1112*35 mm
Frame technology	Anodized Aluminum Alloy
Module composition	Glass/EVA/Back sheet(White)
Weight(module only)	31.8kg
Front glass thickness	2.0mm
Junction box IP rating	IP 68, three diodes
Cable diameter(UL/IEC)	$4mm^2$
Fire performance	UL Type 29
Connector type	MC type 4 compatible

Inverter

This project selects a grid-connected inverter with all-in-one PC including eight 1100kW inverters with 8800 kW capacity. By adopting variable structure PWM modulation algorithms and advanced MPPT control algorithms, the system loss can be reduced to the greatest extent, making the whole system efficiency highest, up to the maximum of 98.7%. At the same time, the inverter of this model uses digital DSP control chips and dual power supply, increasing the reliability of the system. The inverter of this model has passed the TUV certification, and it is suitable for Asian markets. Specific technical parameters are as follows

INVERTER SPECIFICATIONS		
Manufacturer	SUNGROW	
DC Parameter	Maximum DC Voltage	1500V
	MPPT Voltage Range	905V ~ 1300V
	Number of Inverters	8
	Maximum DC Current	8*1400A
	DC Inputs	40 Inputs
AC Parameter	Output electrical system	3 phase, 3 wire
	Rated Output Power (Total Power)	8800kW@40℃
	Rated Grid Voltage	630V
	Allowable Grid Voltage	510 ~ 660 V
	Maximum Output Current	8*1160 A
	Rated Grid Frequency	50 Hz (60Hz Optional)
	Allowable Grid Frequency	45~55Hz(55~65Hz Optional)
	Power Control	MPP tracker
	Allowable relative humidity range	0-100%
	Degree of protection	Inverter: IP55 (optional: IP65) / Others: IP54
	Max. operating altitude	1000 m (standard) / > 1000 m (optional)

	Adjustable Range of Power Factor	>+0.99,0.8 Leading,-0.8 Lagging
	Total Current Waveform Deviation Factor	<3%
	Maximum Efficiency	99.0%
	Euro Efficiency	98.7%
Grid Operating Protection	A	Fuse+ Load Switch
	B	AC circuit breaker
	C	DC overload protection
	D	Overheat Protection
	E	Grid monitoring
	F	Insulation monitoring
	G	Ground fault monitoring

Power Transformer

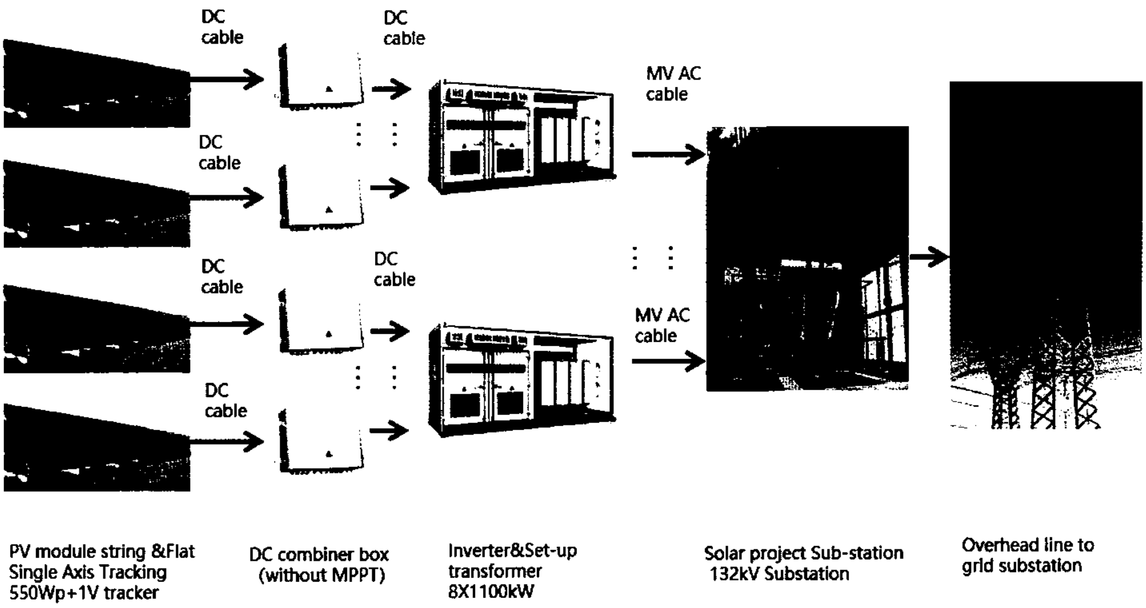
POWER TRANSFORMER SPECIFICATIONS		
	Rating	2x100MVA
	Type of Transformer	ONAF
	Purpose of transformer	Step-up (33 kV/132 kV)
	Output Voltage	132kV

Unit Transformer

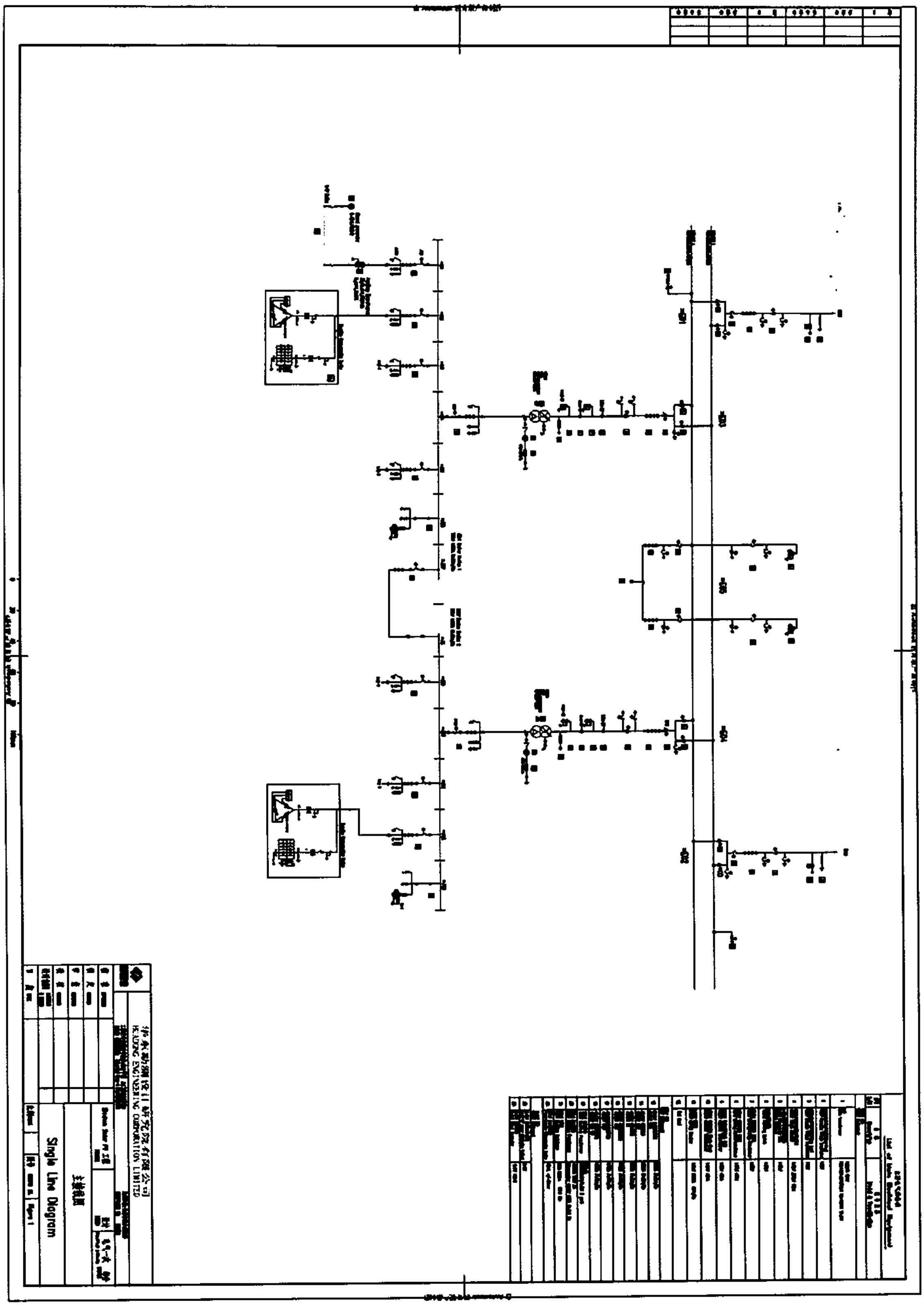
UNIT TRANSFORMER SPECIFICATIONS		
	Rating	9x8800MVA
	Type of Transformer	33 KV oil typed transformer
	Purpose of transformer	Step-up (2*0.63 kV/33 kV)
	Output Voltage	33kV

OTHER DETAILS	
Project Commercial Operation date (COD)- Anticipated	**December 31, 2024**
Expected Life of the Project from Commercial Operation date (COD)	**25 Years**

Process Flow Diagram of the Generation Facility/Solar Power Plant/Solar Farm



Single Line Diagram of the Generation Facility/Solar Power Plant/Solar Farm

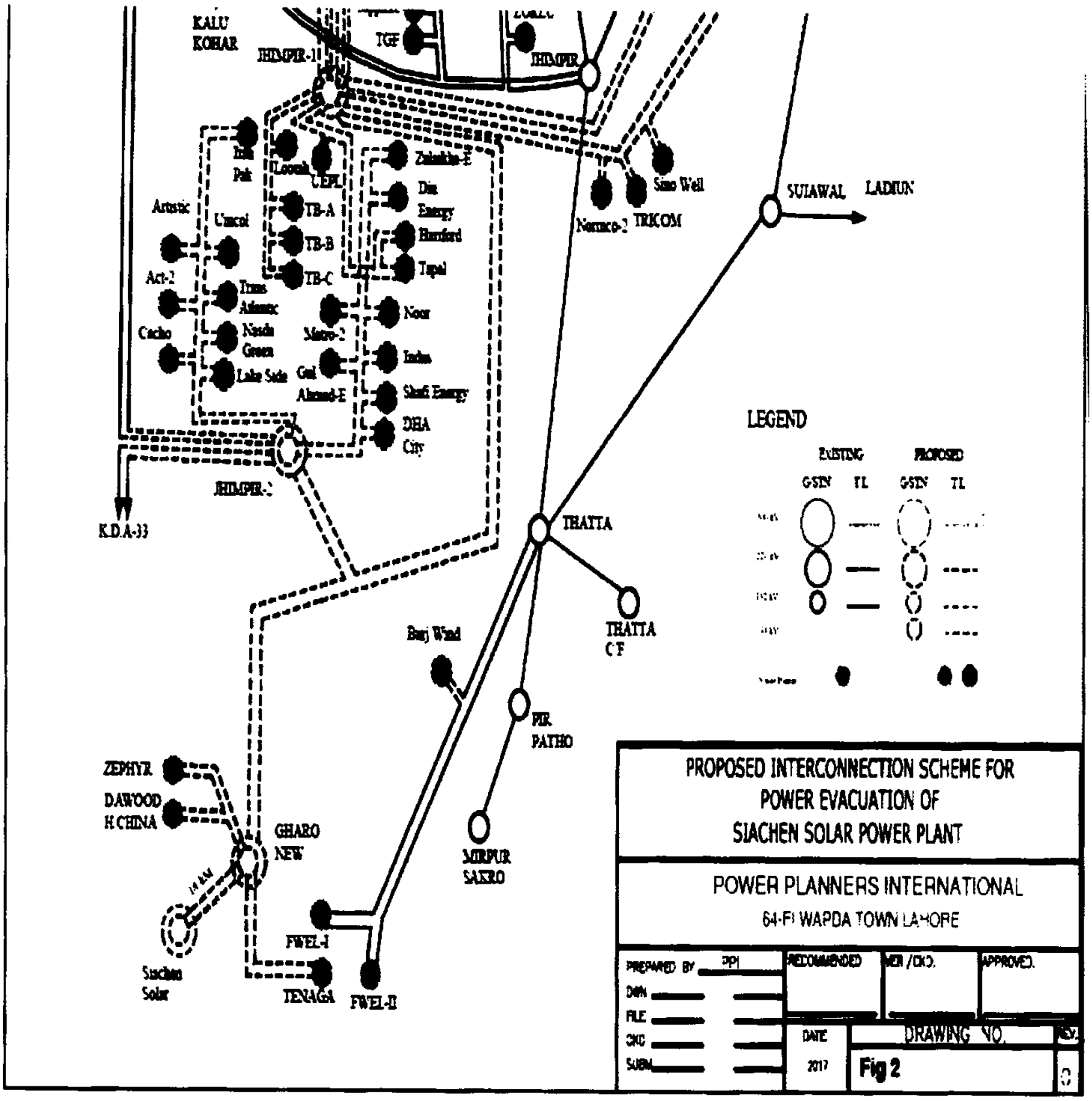


Interconnection Arrangement/ Transmission Facilities for Dispersal of Power from the Generation Facility/Solar Power Plant/Solar Farm

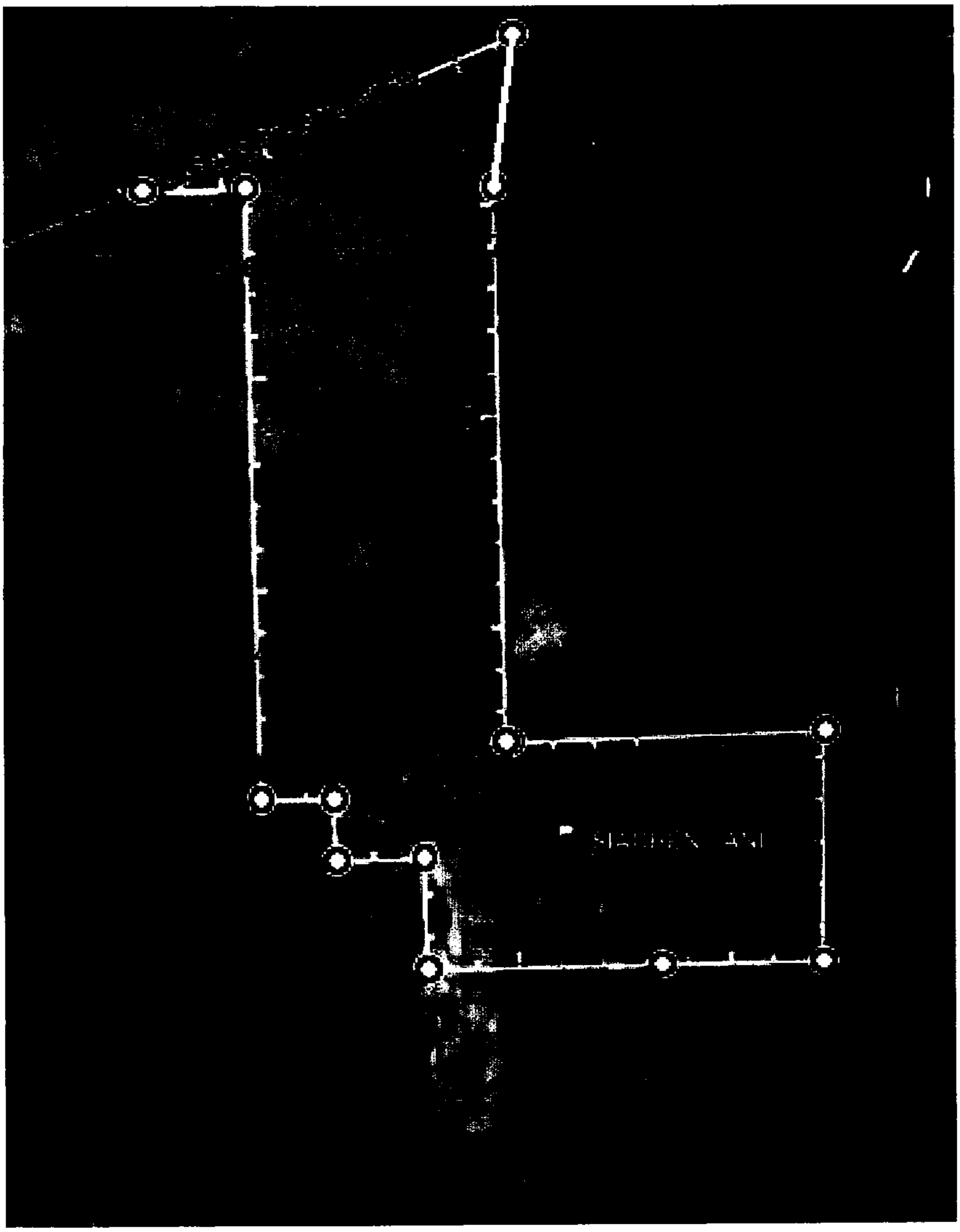
NTDC/MEPCO/Local Grid is responsible to install a new 132kV overhead line for grid connection of the Project. Note that this is yet to be installed. The Contractor shall be responsible for energizing of the grid connection in accordance with the Energy Purchase Agreement between the Employer and the grid operator, and to suit the programme for energizing the project complex.

Schematic Diagram for Dispersal of Electric Energy/Power from the Generation Facility/Solar Power Plant

Schematic Diagram of the Interconnection Arrangement/Transmission Facility for Dispersal of Power from the Generation Facility/Solar Power Plant /Solar Farm



Solar Farm Coordinates



Annex -1 Module Data Sheets

Mono

550W MBB Bifacial Mono PERC
Half-cell Double Glass Module
JAM72D30 525-550/MB Series

Introduction

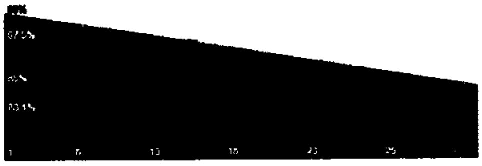
Assembled with 11BB bifacial PERCIUM cells and half-cell configuration, these double glass modules have the capability of converting the incident light from the rear side together with the front side into electricity, providing higher output power, lower temperature coefficient, less shading loss, as well as enhanced tolerance for mechanical loading.

- Higher output power
- More reliable, more stable power generation
- Less shading effect
- Lower temperature coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty

0.45% Annual Degradation Over 30 years



- Bifacial double glass module linear power warranty
- Standard module linear power warranty

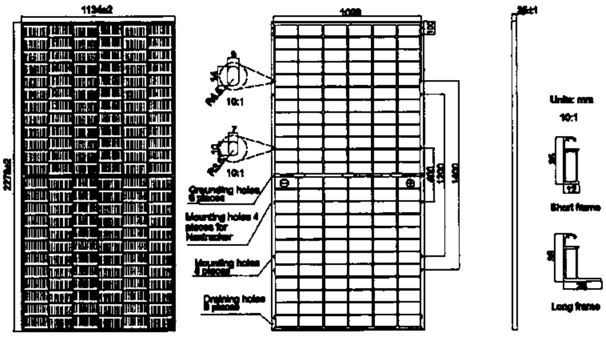
Comprehensive Certificates

- IEC 61215, IEC 61730,UL 61215, UL 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC TS 62941: 2016 Terrestrial photovoltaic (PV) modules – Guidelines for increased confidence in PV module design qualification and type approval

JA SOLAR

JAM72D30 525-550/MB

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono
Weight	31.8kg±3%
Dimensions	2278±2mm×1134±2mm×35±1mm
Cable Cross Section Size	4mm² (IEC), 12 AWG(UL)
No. of cells	144(6×24)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-35
Cable Length (Including Connector)	Portrait:300mm(+)/400mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	31pcs/Pallet 620pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D30 -525/MB	JAM72D30 -530/MB	JAM72D30 -535/MB	JAM72D30 -540/MB	JAM72D30 -545/MB	JAM72D30 -550/MB
Rated Maximum Power(Pmax) [W]	525	530	535	540	545	550
Open Circuit Voltage(Voc) [V]	49.15	49.30	49.45	49.60	49.75	49.90
Maximum Power Voltage(Vmp) [V]	41.15	41.31	41.47	41.64	41.80	41.96
Short Circuit Current(Isc) [A]	13.65	13.72	13.79	13.86	13.93	14.00
Maximum Power Current(Imp) [A]	12.76	12.83	12.90	12.97	13.04	13.11
Module Efficiency [%]	20.3	20.5	20.7	20.9	21.1	21.3
Power Tolerance	0~+5W					
Temperature Coefficient of Isc(α_Isc)	+0.045%/°C					
Temperature Coefficient of Voc(β_Voc)	-0.275%/°C					
Temperature Coefficient of Pmax(γ_Pmp)	-0.350%/°C					
STC	Irradiance 1000W/m², cell temperature 25°C, AM1.5G					

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D30 -525/MB	JAM72D30 -530/MB	JAM72D30 -535/MB	JAM72D30 -540/MB	JAM72D30 -545/MB	JAM72D30 -550/MB
Rated Max Power(Pmax) [W]	582	587	572	578	583	589
Open Circuit Voltage(Voc) [V]	49.54	49.67	49.80	49.93	50.03	50.21
Max Power Voltage(Vmp) [V]	41.14	41.31	41.47	41.65	41.78	41.95
Short Circuit Current(Isc) [A]	14.61	14.68	14.76	14.83	14.91	14.98
Max Power Current(Imp) [A]	13.65	13.73	13.80	13.88	13.95	14.03
Irradiation Ratio(rear/front)	10%					

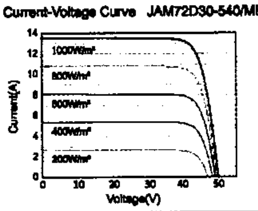
*For NexTracker installations, Maximum Static Load, Front is 2400Pa while Maximum Static Load, Back is 2400Pa.
**Bifaciality=Pmax,rear/Rated Pmax,front

OPERATING CONDITIONS

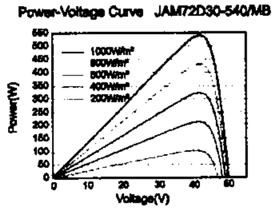
Maximum System Voltage	1500V DC
Operating Temperature	-40°C~+85°C
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* Maximum Static Load,Back*	5400Pa(112 lb/ft²) 2400Pa(50 lb/ft²)
NOCT	45±2°C
Bifaciality**	70%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

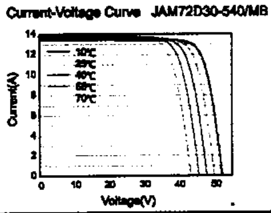
Current-Voltage Curve JAM72D30-540/MB



Power-Voltage Curve JAM72D30-540/MB



Current-Voltage Curve JAM72D30-540/MB

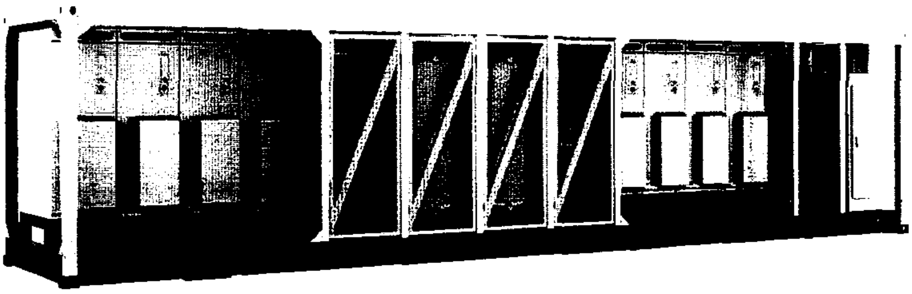


Annex-2 INVERTER Data Sheets

SG6600/8800UD-MV

Turnkey Station for 1500 Vdc System MV Transformer Integrated

Preliminary



LOW LCOE

- Effective cooling, full power operation at 40 ℃
- Integrated transformer, switchgear and LV auxiliary power supply
- Q at night function (optional), saving investment

SMART O&M

- Modular equipment, 1.1 – 8.8 MW block flexible design
- Modular system, flexible PV DC/AC ratio and ESS capacity
- Modular component, plug and play, no need professional

SAFETY & RELIABLE

- DC arc fault protection, 200 ms cut off fault
- AC LV copper bar connection, no risk of insulation failure
- Inverter and MV factory test, more reliable

GRID SUPPORT

- SCR ≥ 1.02, stable operation in extremely weak grid
- Reactive power response time < 20 ms
- Compliant with grid code

SUNGROW
Clean power for all

Type designation	SG6600UD-MV	SG8800UD-MV
Input (DC)		
Max. PV input voltage	1500 V	
Min. PV input voltage / Startup input voltage	905 V / 945 V	
MPP voltage range	905 – 1300 V	
No. of independent MPP inputs	6	8
No. of DC inputs	30 (optional: 36/42 inputs negative grounding)	40 (optional: 48/56 inputs negative grounding)
Max. PV input current	6 * 1400 A	8 * 1400 A
Max. DC short-circuit current	6 * 5000 A	8 * 5000 A
PV array configuration	Negative grounding or floating	
Output (AC)		
AC output power	6600 kVA @ 40 ℃, 7590 kVA @ 20 ℃	8800 kVA @ 40 ℃, 10120 kVA @ 20 ℃
Max. inverter output current	6 * 1160 A	8 * 1160 A
Max. AC output current	219 A	293 A
AC voltage range	20 kV – 35 kV	
Nominal grid frequency / Grid frequency range	50 Hz / 45 – 55 Hz, 60 Hz / 55 – 65 Hz	
Harmonic (THD)	< 3 % (at nominal power)	
Power factor at nominal power / Adjustable power factor	>0.99 / 0.8 leading – 0.8 lagging	
Feed-in phases / AC connection	3 / 3-PE	
[illegible]		
Inverter max. efficiency	99.0 %	
Inverter European efficiency	98.7 %	
[illegible]		
Transformer rated power	6600 kVA	8800 kVA
Transformer max. power	7590 kVA	10120 kVA
LV / MV voltage	0.63 kV / 0.63 kV / (20 – 35) kV	
Impedance	8 % (0 – ±10 %) @ 6600 kVA	9.5 % (0 – ±10 %) @ 8800 kVA
Transformer vector	Dy11y11	
Transformer cooling type	ONAN (Oil-natural, air-natural)	
Oil type	Mineral oil (PCB free) or degradable oil on request	
Protection & Function		
DC input protection	Load break switch + fuse	
Inverter output protection	Circuit breaker	
AC MV output protection	Circuit breaker	
Surge protection	DC Type II / AC Type II	
Grid monitoring / Ground fault monitoring	Yes / Yes	
Insulation monitoring	Yes	
Overheat protection	Yes	
Q at night function	Optional	
[illegible]		
Dimensions (W*H*D)	12192*2896*2438 mm	
Weight	≤ 27 T	≤ 30 T
Degree of protection	Inverter: IP55 (optional: IP65) / Others: IP54	
Auxiliary power supply	5 kVA (optional: max. 40 kVA)	
Operating ambient temperature range	-35 to 60 ℃ (> 50 ℃ derating)	
Allowable relative humidity range	0 – 100 %	
Cooling method	Temperature controlled forced air cooling	
Max. operating altitude	1000 m (standard) / > 1000 m (optional)	
Display	LED indicators, WLAN+WebHMI	
Communication	Standard: RS485, Ethernet; Optional: optical fiber	
Compliance	CE, IEC 62109, IEC 61727, IEC 62116, IEC 62271-202, IEC 62271-200, IEC 60076	
Grid support	Q at night (Optional), L/HVRT, active & reactive power control and power ramp rate control	

Modification in 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 Installed Capacity of the Generation Facility/Solar Power Plant/Solar Farm	100.00MWp
(2)	Average Sun Hour Availability/Day (Irradiation on Inclined Surface)	5-6 hours
(3)	No. of days per Year	365
(4)	Annual generating capacity of Generation Facility/Solar Power Plant/Solar Farm (As Per Simulation)	206,999MWh
(5)	Total expected generation of the Generation Facility/Solar Power Plant/Solar Farm during the Twenty-five (25) years term of the license	4,549,912MWh
(6)	The annual generation of Generation Facility/Solar Power Plant/Solar Farm based on 24 hours of working	100×24×365=876,000 MWh
(7)	Net Capacity Factor of Generation Facility/ Solar	23.63%

All the above figures are indicated as provided by Licensee. The Net energy available to NTDC for dispatch will be determined through procedure contained in the Energy Purchase Agreement.

Version 7.2.3

PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: Siachen

Variant: New simulation variant

Trackers single array, with backtracking

System power: 100.0 MWp

Tharmal Power House Colony - Pakistan

Author

Project summary

Geographical Site
Tharmal Power House Colony
Pakistan

Situation

Latitude	24.55 °N
Longitude	67.70 °E
Altitude	124 m
Time zone	UTC+5

Project settings
Albedo 0.20

Meteo data
nooriabad
SolarGIS Monthly aver. , period not spec. - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Trackers single array, with backtracking

PV Field Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	181888 units
Pnom total	100.0 MWp

Inverters

Nb. of units	80 units
Pnom total	88.00 MWac
Pnom ratio	1.137

Results summary

Produced Energy	207018 MWh/year	Specific production	2069 kWh/kWp/year	Perf. Ratio PR	80.76 %
Apparent energy	207018 MVAh				

Table of contents

General parameters

Grid-Connected System

Trackers single array, with backtracking

PV Field Orientation

Orientation

Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Backtracking strategy

Nb. of trackers 180 units
Single array

Sizes

Tracker Spacing 6.00 m
Collector width 2.28 m
Ground Cov. Ratio (GCR) 38.0 %
Left inactive band 0.02 m
Right inactive band 0.02 m
Phi min / max. -/+ 60.0 °

Backtracking limit angle

Phi limits +/- 67.1 °

Models used

Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon

Free Horizon

Near Shadings

Linear shadings

User's needs

Unlimited load (grid)

Bifacial system

Model 2D Calculation
unlimited trackers

Bifacial model geometry

Tracker Spacing 6.00 m
Tracker width 2.32 m
GCR 38.6 %
Axis height above ground 1.50 m

Bifacial model definitions

Ground albedo average 0.15
Bifaciality factor 68 %
Rear shading factor 5.0 %
Rear mismatch loss 8.0 %
Module transparency 2.0 %

Monthly ground albedo values

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

Grid injection point

Power factor

Cos(phi) (leading) 1.000

PV Array Characteristics

PV module

Manufacturer JA Solar
Model JAM72D30-550/MB
(Custom parameters definition)
Unit Nom. Power 550 Wp
Number of PV modules 181888 units
Nominal (STC) 100.0 MWp
Modules 6496 Strings x 28 In series

At operating cond. (50° C)

Pmpp 91.98 MWp
U mpp 1062 V
I mpp 86614 A

Inverter

Manufacturer Sungrow
Model SG1100UD
(Custom parameters definition)
Unit Nom. Power 1100 kWac
Number of inverters 80 unit
Total power 88000 kWac
Operating voltage 960-1300 V
Max. power (=>25°C) 1320 kWac
Pnom ratio (DC:AC) 1.14

PV Array Characteristics

Total PV power		Total inverter power	
Nominal (STC)	100038 kWp	Total power	88000 kWac
Total	181888 modules	Nb. of inverters	80 units
Module area	469863 m²	Pnom ratio	1.14
Cell area	432690 m²		

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 0.27 mΩ
Loss Fraction 2.0 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction 0.3 %

Module mismatch losses
Loss Fraction 1.5 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 1
Loss factor 0.8 %/year

Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): Sandia model, acc. to database

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.990	0.956	0.856	0.755	0.597	0.363	0.024

System losses

Unavailability of the system
Time fraction 1.0 %
3.7 days,
3 periods

Auxiliaries loss
Proportionnal to Power 5.0 W/kW
0.0 kW from Power thresh.

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 660 Vac tri
Loss Fraction 0.83 % at STC

Inverter: SG1100UD
Wire section (80 Inv.) Copper 80 x 3 x 700 mm²
Average wires length 109 m

MV line up to HV Transfo
MV Voltage 33 kV
Average each inverter
Wires Copper 3 x 15000 mm²
Length 528800 m
Loss Fraction 0.50 % at STC

AC losses in transformers

MV transfo
Medium voltage 33 kV

Operating losses at STC
Nominal power at STC 98584 kVA
Iron loss (24/24 Connexion) 8.22 kW/Inv.
Loss Fraction 0.10 % at STC
Coils equivalent resistance 3 x 0.53 mΩ/inv.
Loss Fraction 1.00 % at STC

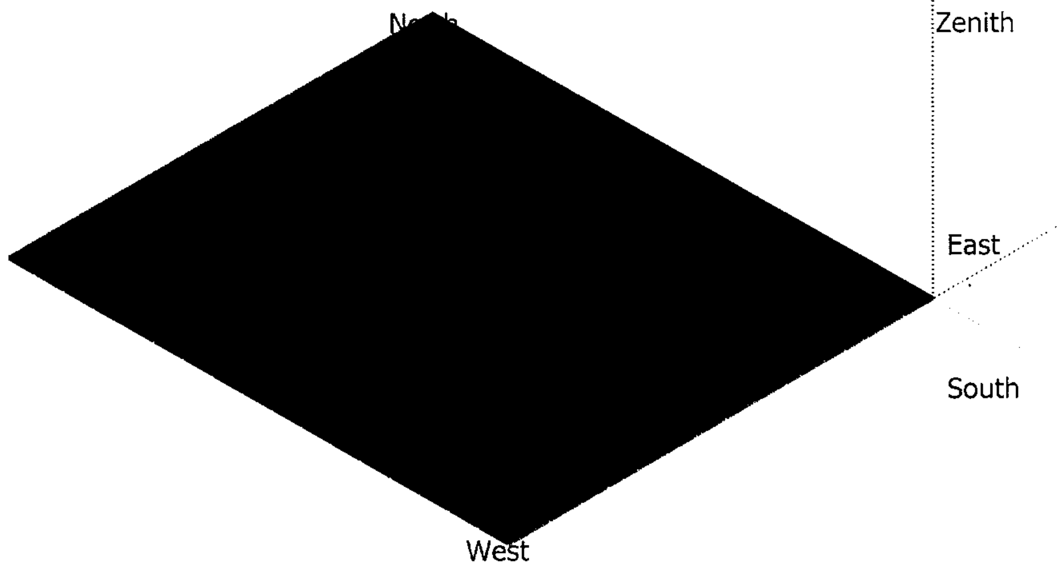
AC losses in transformers

HV transfo

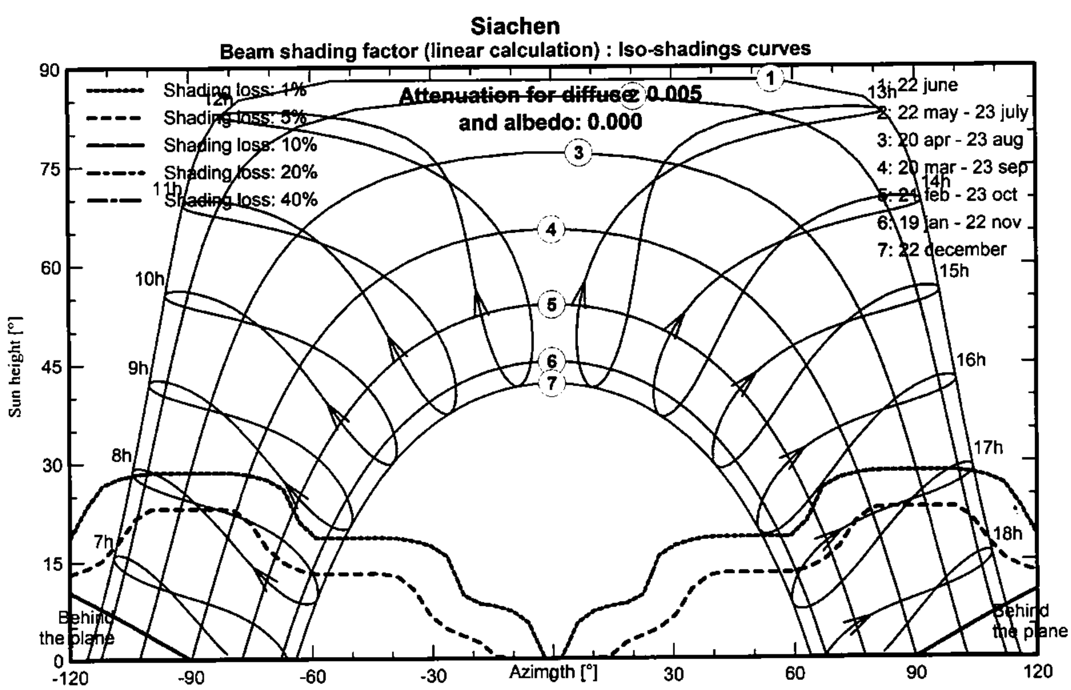
Grid voltage	132 kV		
Transformer from Datasheets		**Operating losses at STC**	
Nominal power	110000 kVA	Nominal power at STC	98584 kVA
Iron loss	55.00 kVA	Iron loss (24/24 Connexion)	55.00 kW
Loss Fraction	0.05 % of PNom	Loss Fraction	0.06 % at STC
Copper loss	300.00 kVA	Coils equivalent resistance	3 x 27.00 mΩ
Loss Fraction	0.27 % of PNom	Loss Fraction	0.24 % at STC

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Main results

System Production

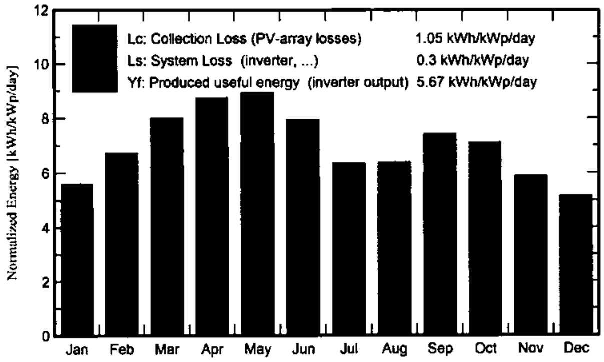
Produced Energy (P50) 207018 MWh/year — Specific production (P50) 2069 kWh/kWp/year — Performance Ratio PR 80.76 %

Produced Energy (P99) 192 GWh/year — Specific production (P99) 1921 kWh/kWp/year

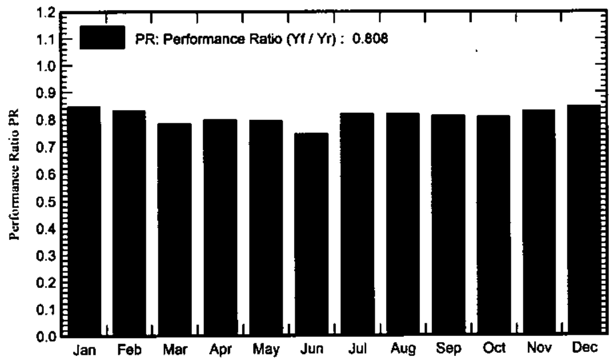
Produced Energy (P95) 197 GWh/year — Specific production (P95) 1965 kWh/kWp/year

Apparent energy 207018 MVAh

Normalized productions (per installed kWp)



Performance Ratio PR



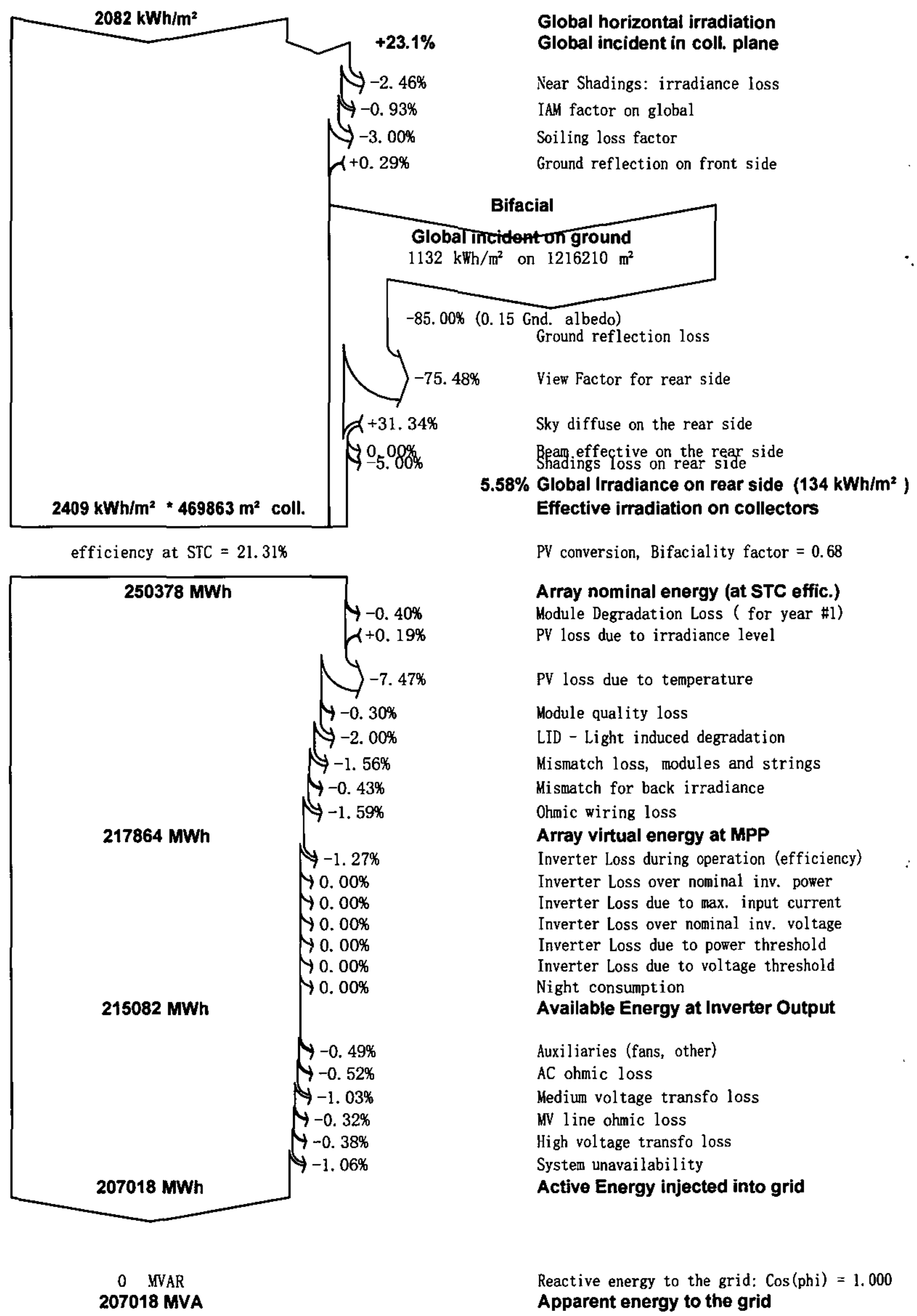
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR ratio
January	135.7	51.8	17.70	173.7	163.1	15342	14731	0.848
February	149.1	53.0	20.90	188.6	177.7	16362	15701	0.832
March	196.1	71.8	25.60	248.2	233.9	20977	19467	0.784
April	212.2	83.2	29.30	262.5	247.8	21813	20916	0.797
May	226.5	97.9	31.00	277.1	261.0	22969	22046	0.795
June	201.4	100.2	31.20	238.2	223.9	20028	17731	0.744
July	171.2	105.2	29.80	196.9	183.7	16771	16130	0.819
August	171.1	97.5	28.60	198.1	185.5	16905	16239	0.819
September	178.0	79.5	28.70	222.4	209.1	18820	18075	0.812
October	174.2	63.6	28.50	220.4	207.7	18567	17826	0.808
November	139.0	54.0	24.10	176.2	165.4	15207	14609	0.829
December	127.4	49.6	19.09	160.0	149.9	14102	13546	0.846
Year	2081.9	907.3	26.23	2562.3	2408.7	217864	207018	0.808

Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

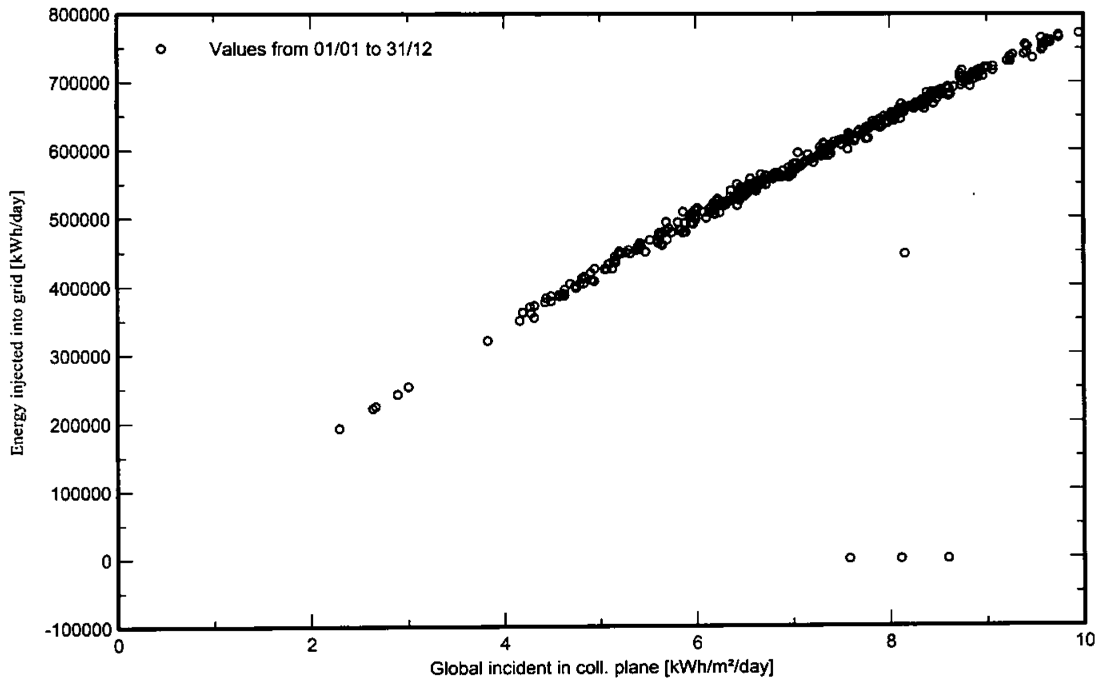
Loss diagram



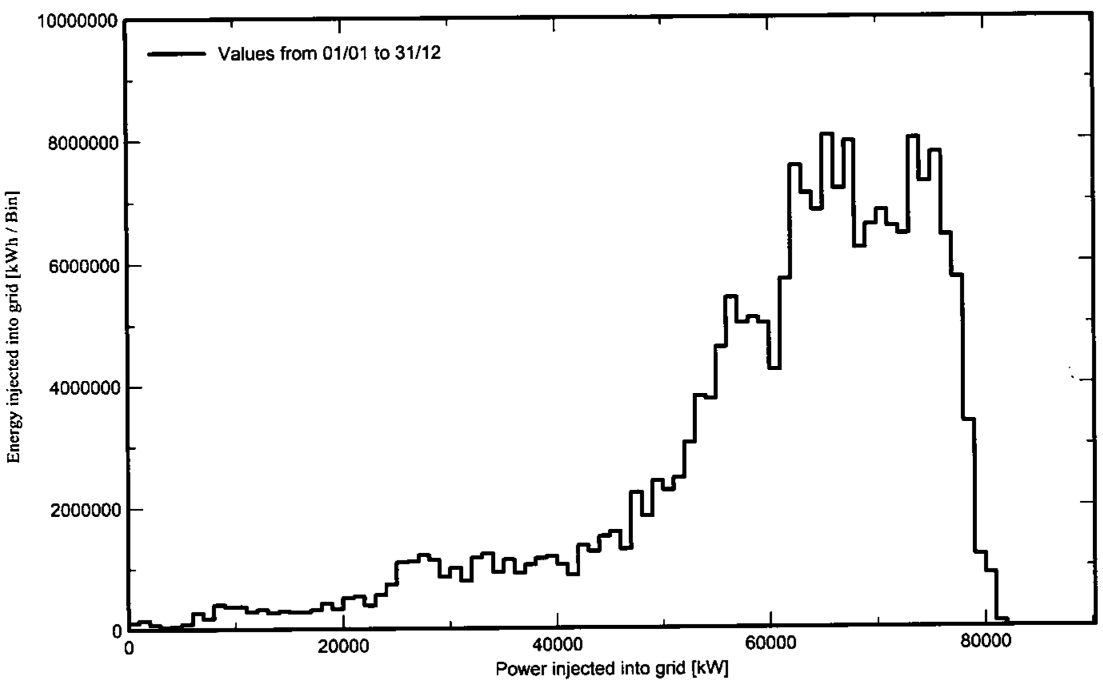
PVsyst V7.2.3
VCP, Simulation date:
17/11/22 17:32
with v7.2.3

Special graphs

Daily Input/Output diagram



System Output Power Distribution



Aging Tool

Aging Parameters

Time span of simulation 25 years

Module average degradation

Loss factor 0.8 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

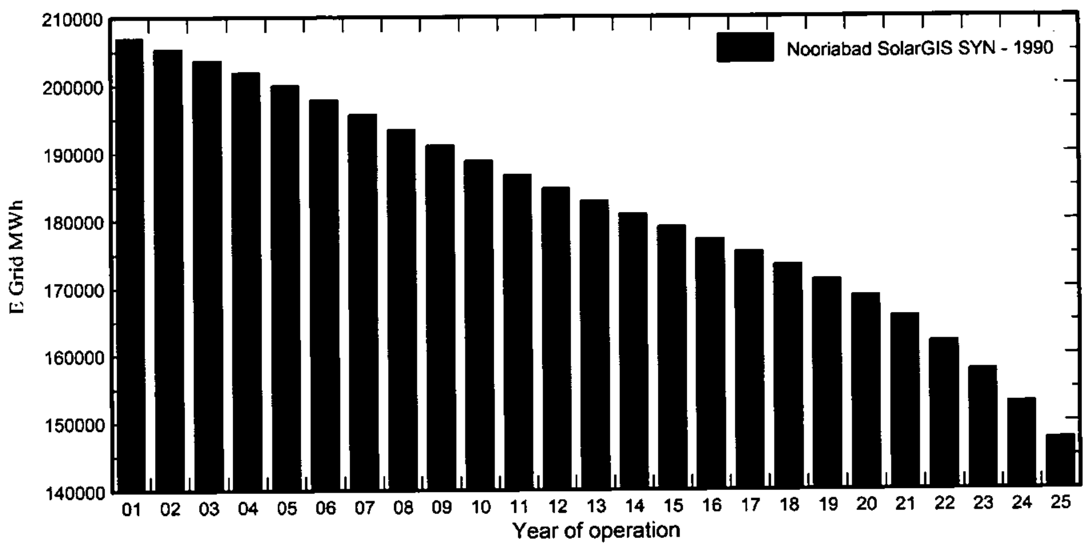
Meteo used in the simulation

#1 Nooriabad SolarGIS SYN

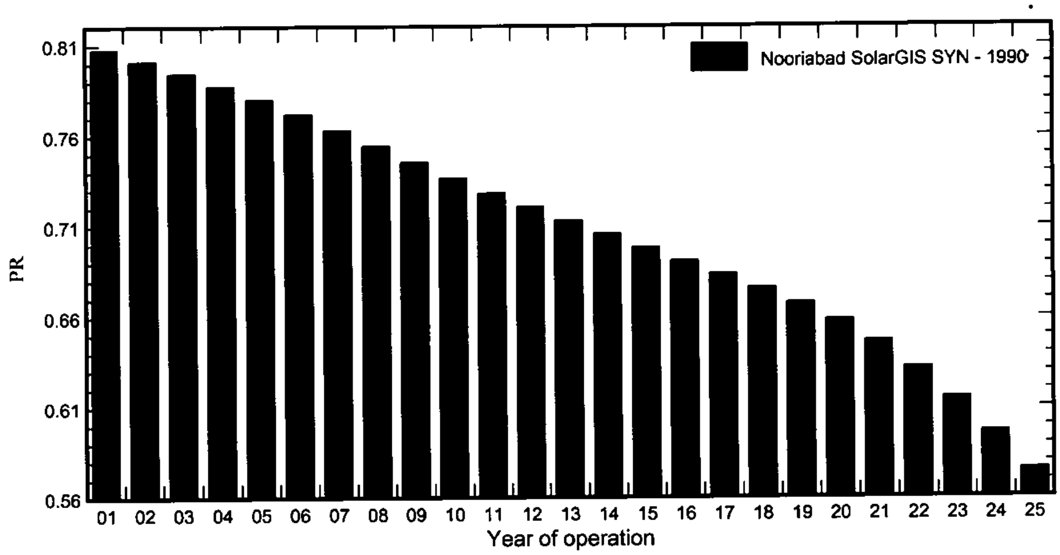
Years 1990 (reference year)

Years simulated 1-25

Energy injected into grid



Performance Ratio



Aging Tool

Aging Parameters

Time span of simulation 25 years

Module average degradation

Loss factor 0.8 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

Meteo used in the simulation

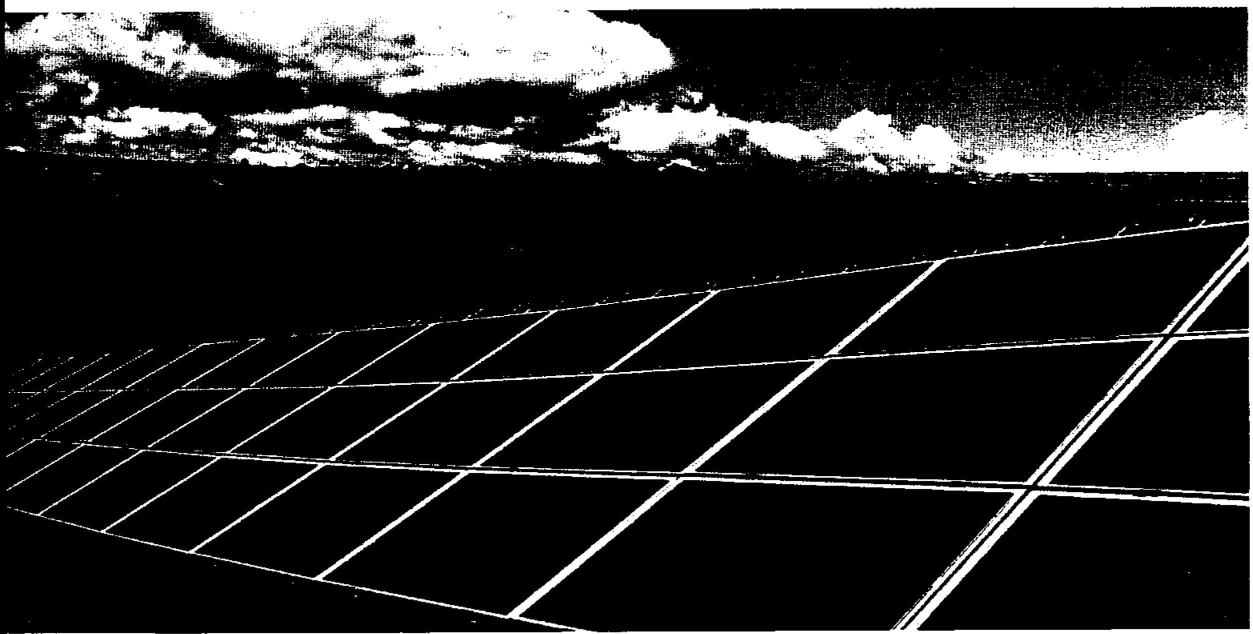
#1 Nooriabad SolarGIS SYN

Years 1990 (reference year)

Years simulated 1-25

Nooriabad SolarGIS SYN

Year	E Grid	PR	PR loss
	MWh		%
1	207018	0.808	0%
2	205414	0.801	-0.8%
3	203707	0.795	-1.6%
4	201900	0.788	-2.5%
5	199994	0.78	-3.4%
6	197912	0.772	-4.4%
7	195671	0.763	-5.5%
8	193386	0.754	-6.6%
9	191086	0.745	-7.7%
10	188804	0.737	-8.8%
11	186681	0.728	-9.8%
12	184722	0.721	-10.8%
13	182797	0.713	-11.7%
14	180889	0.706	-12.6%
15	178974	0.698	-13.5%
16	177112	0.691	-14.4%
17	175259	0.684	-15.3%
18	173283	0.676	-16.3%
19	171118	0.668	-17.3%
20	168685	0.658	-18.5%
21	165645	0.646	-20%
22	161898	0.632	-21.8%
23	157642	0.615	-23.9%
24	152843	0.596	-26.2%
25	147471	0.575	-28.8%



Technical Feasibility Study

Mirpur Sakro 100 MWp Solar PV Plant

Siachen Energy Limited

October 2022

01083.8 - v1.8

Issue and Revision Record

Rev	Date	Originator	Checker	Approver	Narrative
1.0	04/12/15	RS/DR/SR T/BA	SH	DH	Draft
1.1	29/04/16	SG/DR/RS/ GRS/JA	ANB		Revised tariff and grid, updated following SEL comments
1.2	27/05/16	ANB	CM	DH	Updated following further comments
1.3	17/06/16	ANB / GRS	SR	DH	Further updates
1.4	29/06/16	ANB	DH	DH	Minor updates
1.5	14/07/16	ANB	DH	DH	Minor updates
1.6	25/7/16	ANB	DH	DH	Minor update.
1.7	27/6/17	ANB	DH	DH	Minor update.
1.8	23/1/18	ANB	DH	DH	Minor update.

Disclaimer

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Awards and Recognitions

ACQ Magazine:
'UK Technical Advisor of the Year'
2014, 2012 and 2009

Finance Monthly Magazine:
'UK Renewables Advisory Firm of the Year'
2014 and 2010

Contents

Appendices

Glossary / list of abbreviations

Acronym or keywords	Definition
AC	Alternating Current
AEDB	Alternative Energy Development Board
Capex	Capital Expenditure
CPPA	Central Power Purchase Agency
CUF	Capacity Utilisation Factor – the ratio, given as percentage, of the actual AC output from a solar plant over the year to the maximum output that would be generated if operated continuously at maximum capacity
DC	Direct Current
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Energy Purchase Agreement – in this case the template agreement provided by the AEDB.
EPs	Equator Principles
EPFIs	Equator Principles Financial Institutions
EPC Contractor	Engineering, Procurement and Construction Contractor – the entity that will be contracted to design, buy the necessary materials, and construct the Plant
ESAP	Environmental and Social Action Plan
ESMP	Environmental and Social Management Plan
FRA	Flood Risk Assessment
GHG	Greenhouse Gases
GHI	Global Horizontal Irradiation – the amount of irradiation falling on a horizontal plane over a period of time. Usually measured in kWh of energy falling on a square metre over a set amount of time (hourly, daily, monthly or annually), e.g. $kWh/m^2/yr$
GII	Global Inclined Irradiation – the amount of irradiation falling on an inclined or tilted plane over a period of time. Effective GII is the amount of irradiation that falls on a plane that tracks the sun such as those used in single axis tracking PV systems
GRID	Global Risk Data
HV	High Voltage
IAM	Incidence Angle Modifier
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labour Organisation
IPPs	Independent Power Producers
IRR	Internal Rate of Return – the rate that results in the Net Present Value equal

Acronym or keywords	Definition
	to zero
kV	Kilo-Volts (1 kV = 1000 Volts)
LEP	Labour and Employment Plan
LID	Light Induced Degradation
LV	Low Voltage
MPPT	Maximum Power Point Tracker
MV	Medium Voltage
MVA	Mega-Volt-Amps, a measure of the capacity of a power line or transformer to carry real and reactive power
MW_{AC}	The amount of power the plant is capable of exporting at the point of grid connection
MWp	The nameplate capacity of PV modules on a site measured in Mega-Watt peak. Also expressed as kWp or Wp
NOCT	Normal Operating Cell Temperature
O&M	Operations and Maintenance
Opex	Operational Expenditure
OST	OST Energy Pty Ltd
PPIB	Private Power & Infrastructure Board
P50	A value which, based on uncertainties and probabilities, has a 50% chance of being exceeded. For example, the P50 yield number is the estimate for the yield produced and the probability of the actual yield being higher is 50% and lower is also 50%
P90	A value which, based on uncertainties and probabilities, has a 90% chance of being exceeded. For instance, the P90 yield number is the estimate for which the probability of the actual yield being higher is 90% and lower is 10%
PGA	Peak Ground Acceleration
PPI	Power Planners International Ltd
PR	Performance Ratio – a measure of how well the plant performs compared to an ideal case. This parameter, given as a percentage, indicates the ratio between the actual and theoretically possible energy outputs. If multiplied by the GII, this ratio gives the P50 Specific Yield of a project
PV	Photovoltaic
SEPA	Sindh Environmental Protection Agency
Siachen	Siachen Energy Limited
SEP	Stakeholder Engagement Plan
SLD	Single Line Diagram
Specific Yield	A measure of the energy produced by the plant over a year divided by its nominal installed capacity which allows for comparison of the performance of different sized plants. Usually measured in kWh/yr of energy produced

Acronym or keywords	Definition
	per kWp of PV installed
SRP	Sulphate Resisting Portland
UNEP	United Nations Environment Programme
USD	United States Dollars
WM	Weighted Mean

Executive Summary

OST Energy Pty Ltd (OST) has been appointed by Siachen Energy Limited ('Siachen' or the 'Client') to assist with the development of a 100 MWp PV plant at Mirpur Sakro, Sindh, Pakistan (the 'Project' or the 'Plant').

This report is based on discussions held with the Client, a review of shared documentation, a site visit and specialist reports.

Site assessment

The site is located 9 km to the east of the town of Mirpur Sakro in the district of Thatta, Sindh Province, Pakistan, approximately 75 km south east of Karachi.

The site is within the Indus River Delta, with the open sea about 50 km to the west but inlets extending 20 km closer. The main Indus River flows to the south, about 25 km west of the site. The site assessed is predominantly flat.

The climate in Thatta District is mainly arid, with hot and dry summers and mild and dry winters. Average maximum temperatures at the site range from 19 °C in January to 32 °C between May and June. The high temperature profile of the site will have an unfavourable effect on the expected Performance Ratio (PR) of the system; this has been taken into account in OST's yield assessment.

The available site, of approximately 203 hectares, is comprised of privately owned land that is described as barren. SEL has obtained the rights to the majority of the land but is still in the process of finalising ownership of some sections of the planned site.

Approximately 75 m to the north of the site and parallel to Mirpur Sakro to Ghulamullah Road runs a 132 kV overhead transmission line on steel lattice towers. It is proposed that a new 132 kV substation, dedicated to the solar power Plant, be constructed on a plot between the road and the transmission line, across from the solar power Plant site. This substation would be connected to Gharo-New 132kV grid substation through a new 18km length, double circuit 132kV Over Head Line (OHL).

The soil is comprised of soft finely textured silt or sand and during our visit appeared moist below the dusty surface. Salt was evident on the surface in patches. Except where cultivated, the surface of the ground is generally bare, or sparsely vegetated with low lying bushes and grass. Evidence of standing water was noted during the visit, particularly further south on the site where large areas of cracked mud were encountered.

The Initial Environmental Examination (IEE) undertaken for the Project states that the site is outside of the flood zone, nevertheless given the site's proximity to waterways we recommend that a Flood Risk Assessment (FRA) is undertaken before financial close to confirm that there is no risk to the site from flooding. It is also recommended that construction activities be avoided during and immediately after the monsoon season to ensure that the site is trafficable for construction equipment and equipment deliveries.

The geotechnical report provided for review defines several types of soil across the site. These soils are generally easy to excavate and may be suitable for long ground screw anchors or other piling methods, such as helical piles. Nonetheless, their low bearing capacity will require careful consideration of foundation design, especially to accommodate wind uplift forces. Furthermore, we note that the earthing study conducted across the site highlighted the saline nature of the hydrogeological subsurface. This results in a high conductivity and therefore high corrosion potential that should be taken into account whilst designing metal foundations and earthing system.

Alternatively, other solutions such as poured or pre-cast reinforced concrete footings may be considered once the mounting structure design is finalized.

Laboratory test results have concluded that the aggressiveness of the soil is low, either for sulphate or chloride content. Sulphate content in groundwater is found to be moderate and the use of sulphate-resisting Portland cements (Type II or V) is recommended for substation foundations.

Since water table has been encountered at depths of approximately 180 mm, the excavation for the substation foundations will require dewatering. We recommend that either sumps or wells are considered and costs for the ground preparation are included in the final economic analysis of the Project. Similarly, while constructing the access roads, we advise that gravel / rock drains or open ditches alongside these roads are used to keep the water table low.

Considering the alluvial nature of the soil and the seismic zone, ground water level at superficial depths may result in liquefaction issues. We note that the geotechnical report has assessed the liquefaction potential at the site following the US Department of Defence approach. Results conclude that the phenomenon of liquefaction is unlikely and solely occurs in marginal cases. Nonetheless, in order to avoid any subsidence in a seismic event, it is advisable to increase the depth of the key equipment foundations where loose sandy silt is encountered.

The only shading anticipated on site would be caused by the local distribution overhead lines traversing the northern part of the site, 350-500 m from the road. The preliminary solar field layout (see Appendix C) has been arranged to avoid the installation of modules under the overhead lines.

The site is accessed from the Mirpur Sakro to Ghulamullah Road. This road crosses several canals. We recommended that the suitability of the bridges and culverts for the delivery of heavy components be confirmed, particularly transformers for the 132 kV substation.

We consider that the most logical location for the site entrance and laydown area be in the north-west corner of the site. This location offers not only easy access but will minimise disruption to construction activities within the solar field and is adjacent to the proposed new substation site. Fencing and security should be provided for the laydown area at the site from commencement.

The closest hospitals and police station are situated in the regional centre of Thatta, approximately 40 km north east of the site. We recommend that the Project undertake thorough emergency planning for both the construction and operational phases of the Project.

Environmental and Social

As part of the application process for the issue of an environmental permit from the Sindh Environmental Protection Agency (SEPA), an assessment of the potential environmental and social impacts of the project and proposals for their mitigation must be submitted. The Government of Sindh Environmental Protection Agency IEE/EIA Regulations 2014 specifically categorise solar projects under schedule I of the regulations, and therefore only an Initial Environment Examination (IEE) is required by SEPA.

The IEE outlines the baseline environmental and social context of the site and surrounding area, the potential environmental and social impacts of the development and proposed measures for the mitigation of these impacts. It is required to demonstrate that the impact on the environment and local communities is acceptable and that the Project complies with national environmental laws and regulations. An IEE for the Project was prepared and submitted to SEPA 3rd December 2015 and received a decision notice according approval on 13th January 2016. The decision included a number of conditions, most of which we consider normal good practice and not unduly onerous.

We note that Condition 16 concludes that "This approval is not valid for the construction/operation of solar power at the agricultural land". We recommend that compliance with this condition be confirmed with SEPA based on the final layout.

The IEE includes an outline Environmental and Social Management Plan (ESMP), which lists proposed mitigation measures to be included in the project, relating to various aspects of environmental and social management. One of the key measures identified is the provision of an Environmental Management Plan (EMP), the objectives of which include the following:

- Definition of environmental management responsibilities within the project covering the design, construction and operational phases
- Provision of technical details of each project impact
- Identification of training requirements
- Identification of resources required to implement the EMP

The following issues are expected to be incorporated into the above provisions, as standard practice in the design of a large scale solar project:

- Ecology – a site survey by an independent ecologist to confirm whether any protected species are present and to propose suitable mitigation if necessary
- Landscape and Visual – investigation of potential views from nearby residential receptors and any appropriate landscaping that may mitigate these impacts
- Heritage and Archaeology - confirmation from the Sindh region Department of Antiquities that the site does not cover any areas of heritage or archaeological potential that may require further investigation or mitigation measures
- Agricultural Land Use – identification of any users of the land in order to assess the potential for economic displacement as a result of the project. In addition, details should be provided of control measures for any soil erosion that may occur as a result of clearance of vegetation on site
- Water Use – an assessment of water use requirements for the various site activities during construction and operational phases, and provision of water quality assessments with regard to potability and suitability for panel washing
- Waste – provision of a decommissioning plan is provided to ensure responsible disposal of site infrastructure, and specifically commitment to recycling of solar panels, at the end of the life of the project

The IEE also proposes the following action plans to be developed under the ESMP:

- A construction Labour and Employment Plan (LEP)
- Health and Safety management plan for the construction phase

OST recommend that the LEP is based on International Labour Organisation (ILO) and IFC standards, as these provide a benchmark for good practice and adherence to IFC Performance Standards across the project will be necessary should at any stage the provision of international financing be required. The LEP should include details of accommodation for the construction workforce based on the IFC and EBRD guidance note on workers' accommodation.

It is considered that a project of this scale will offer significant employment opportunities to the local population during the construction phase and OST recommend that commitments are made to providing jobs to local people where possible.

The IEE describes the local area as under-developed, with poor standards of education, inadequate medical facilities and lacking sewage, gas and water supply infrastructure. SEL states that a Corporate Social Responsibility budget has been established and a medical facility confirmed as a requirement after discussion with local representatives.

Preparation of the IEE has involved initial consultation with people in the local area. Stakeholder engagement is an essential element of a robust environmental and social assessment and is usually a key lender requirement. OST therefore advise that this initial consultation is followed up by the implementation of a full Stakeholder Engagement Plan (SEP), to ensure continued engagement with the local community through all stages of the project.

Grid connection

OST has reviewed a "Grid Interconnection Report" for the Siachen Project (the 'Study') carried out by Power Planners International ('PPI') and dated March 2017.

The coverage of the Study is detailed and does not appear to omit any major subjects or topics that we would typically expect to see. We recommend that confirmation is sought from the local T&D operators (HESCO and NTDC) that the scope and assumptions used are accepted.

The Study concludes that the June 2019 grid system with expected upgrades will be suitable to cope with the evacuation of power from the Project and no bottlenecks or technical constraints.

The works required as a pre-requisite for the Project connection are extensive. The Study identifies that the works will be in place by "the end of 2018". The Template Energy Purchase Agreement (EPA) available from the AEDB states that the Purchaser will construct and finance all works on the Purchaser's side of the interconnection, and it is therefore understood that the Project will not have to contribute towards any cost apportionment for the on-going upgrade and expansion works of the T&D network. The template EPA contains a take or pay clause in which the Energy Purchaser compensates the Project for missed energy sales due to delays with the Purchaser's side of the grid connection. This clause is discussed in Section 5.4.

The maximum AC active power should be clarified to ensure the upper limit of AC generation capacity is respected and the detailed designs to be in-line with the findings of the Study.

The Study proposes that the Project is connected to Gharo-New 132kV grid substation through a new 18km length, double circuit 132kV Over Head Line (OHL). The OHL route and length calculation are not provided and any environmental or land ownership issues in the cable route have not been identified, however this does not fall under the Project scope. It is noted that a considerable amount of redundancy is built into the proposed design of the connection works.

Static Var Compensators (SVC) are required to meet the power factor requirements of the grid code. With the addition of these SVCs we do not expect the inverters will be required to operate at a non-unity power factor under normal conditions. It should be confirmed, when appropriate in the design phase, whether there will be a requirement for the inverters to operate at a non-unity power factor which will have an impact on its active power production capability and should be accounted for in the energy yield assessment.

Budget costs for the new 33/132kV substation adjacent to site have been included in our EPC cost estimates. We have not included for the cost of the 18km of OHL works and connection at Gharo-New as these do not fall under SEL's scope.

Conceptual design and energy yield assessment

OST has prepared a high level system design to suit the shape, size and location of the site. This conceptual design is subject to final component selection and has not been fully optimised for cost or performance.

The layout proposed is based on SEL having the rights to the full site and is selected to minimize costs associated with site access and electrical systems. The total site proposed by Siachen is larger than that required for a 100MWp PV Plant and alternative layouts within the site boundaries are therefore possible. Since the site is large and virtually flat alternative layouts with the same basic architecture will have a similar performance.

It is preferable for the Plant to be contiguous to avoid the cost and complication of interconnections and associated wayleaves.

An energy yield assessment was carried out to determine the expected energy yield of the proposed Plant. The conceptual design of the Plant considers Tier 1 Monoycrystalline modules and central inverters. Details of the main requirements of the Plant's key components can be found in Appendix B, while indicative datasheets of the major components proposed for the Project are reported in Appendices F, G, and H.

On the basis of the system design assumptions a Performance Ratio has been calculated using industry-standard software PVsyst and OST proprietary models. Resulting first year energy yield predictions are shown in Table 1.

Table 1: Year one P50 energy yield summary

PR	Installed Capacity (MWp)	Probability of Exceedance	Spec. Yield (kWh/kWp)	1st Year Production (MWh)
76.76%	99.99	P50	1,829	182,982
		P75	1,723	172,399
		P90	1,628	162,873
		P99	1,464	146,478

98% Plant availability has been assumed in the above specific yield and production figures. Grid availability has not been considered at this stage of the analysis.

Economic analysis

An economic analysis has been carried out to assess the profitability of the development of the Project at the proposed site.This preliminary economic assessment is provided to demonstrate the likely feasibility of the project and should not be considered as financial advice. We recommend seeking professional financial and accounting advice before making any investment decision.

The outcomes of the economic analysis are summarised in Table 2 below.

Table 2: Project IRR and Payback period

Item	Levered Cash Flow	Unlevered Cash Flow
Payback period (years)	6.20	8.70
IRR (%)	16.0%	8.8%

The results of the economic analysis, although indicative and to be confirmed by financial advisors, indicate that the proposed Project will be economically viable.

We also consider that over its design lifetime the project will provide a number of other benefits including:

- An average generation of approximately 168,405 MWh/yr will help in reducing Pakista -n's current energy deficit and provide for future economic and social development
- Saving the emission of more than 2.4 million tonnes of CO_2-e and making a meaningful step towards greater sustainability
- Contributing to the development of a diverse and robust mix of generation technologies with less reliance on imported fossil fuels
- Providing a diversification of employment opportunities and income for the local community.

1 Introduction

OST Energy Pty Ltd (OST) has been appointed by Siachen Energy Limited ('Siachen' or 'the Client') to assist with their development of a 100 MWp photovoltaic plant at Mirpur Sakro, Sindh, Pakistan (the 'Project' or the 'Plant').

This report has the objective to assess the feasibility of the Project and is structured as follows:

- Project overview
- Site assessment
- Permitting / Environmental Assessment
- Preliminary Grid Connection Study
- Conceptual Design
- Energy Yield Assessment
- Economic Analysis

This report is based on discussions held with the Client, a review of shared documentation, a site visit and specialist geotechnical, interconnection, and environmental reports.

2 Project overview

2.1 Site and Works overview

Key details for the project are shown in Table 3 and the location of the proposed site is indicated by the red marker as shown on map views in Figure 1 and Figure 2.

Table 3: Key details

Property	Value
Site coordinates	24.557 N, 67.711 E
Altitude (metres above sea level)	5
Site area (ha)	203
Proposed capacity (MW_{AC} / MW_{DC})	83.5/ 99.99
Global Horizontal Irradiation (kWh/m²/year)	1,992
Proposed layout concept	The proposed layout is for a ground mounted fixed system using Tier 1 Monocrystalline modules and central inverters. A drawing of the proposed layout is shown in Appendix C

Figure 1: Local satellite view

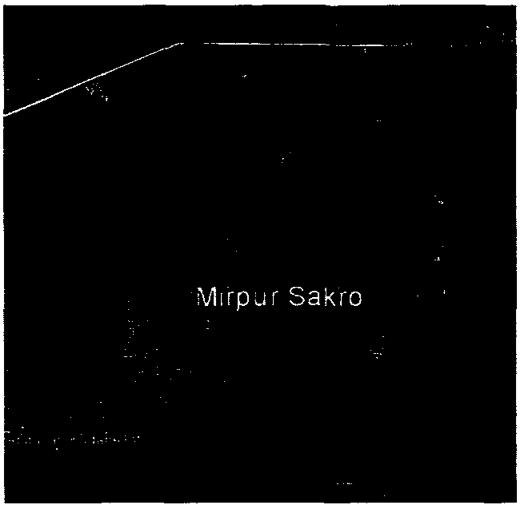
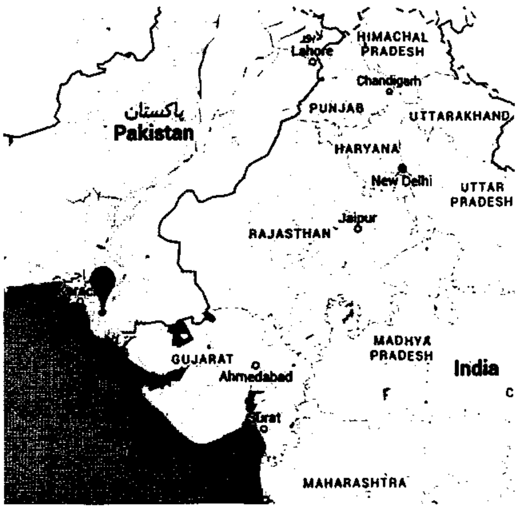
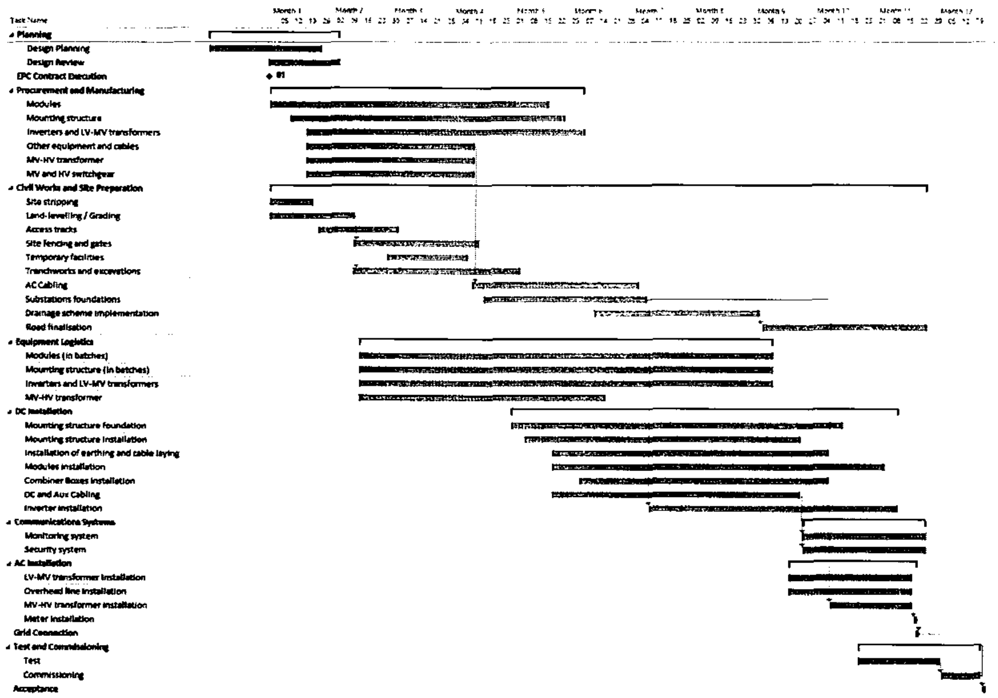


Figure 2: National map view



An indicative timeline for the Project is shown in Figure 3. Contractors will be required to comply with a prearranged schedule of works and complete the construction and installation of equipment by the required deadline. We recommend that permits, equipment, infrastructure logistics and grid application be secured for the Project prior to commencement of works.

Figure 3: Planned timeline for works



2.2 Pakistan Power Market

2.2.1 Power Sector Structure Overview

The generation, transmission, distribution and retail supply of electricity in Pakistan is presently undertaken by a number of public and private sector entities comprising of one national transmission company; nine regional public sector-owned distribution companies; four public sector thermal generation companies; one public sector hydropower generation company and 41 independent power producers (IPPs). These entities enable the supply of power to the entire country except for Karachi. The metropolitan city of Karachi and some of its surrounding areas are supplied power by K-Electric, which is a vertically integrated utility owned by the private sector responsible for the generation, transmission and distribution of electricity in its region. Central Power Purchase Agency (CPPA), a public sector agency, has recently become active for the centralised purchase of power from all existing and upcoming private and public sector power producers. All public sector agencies/companies are administered/overseen by the Ministry of Water & Power, Government of Pakistan.

The National Electric Power Regulatory Authority (NEPRA) is an independent regulator setup for the regulation of Pakistan's power sector; in order to balance the interests of consumers and power sector companies. NEPRA develops the regulatory regime and future market design for the power sector. All generation, transmission, and distribution companies are now licensees of NEPRA and matters related to tariffs, licensing, safety, grid codes, consumer interest are regulated by NEPRA.

2.2.2 Electricity Demand & Supply – a Deficit Power Market

The total installed generation capacity of Pakistan (excluding K-Electric area) is approximately 20,000 MW distributed as follows:

- Hydel: 7,121 MW (90 MW in private sector)
- Thermal (Public Sector): 3,678 MW
- Private Sector Producers: 9,282 MW

However due to a number of factors including seasonality of hydel & renewable resources, lack of maintenance/aging of public sector thermal units and consequent reduced capacity and technical issues with certain private sector producers the sector has been facing an average supply-demand gap of about 6,000 MW in the recent past. Despite an installed capacity of roughly 20,000 MW the sector had a maximum generation of approximately 15,500 MW in September 2015 at which time a demand-supply gap of approximately 4,600 MW still existed. This gap increases significantly during summer, low water or low gas supply months.

The present electricity demand supply gap, coupled with consistent growth in demand (6-7% per annum), indicates the fundamental need for enhancing the country's current power generation capability. It may also be noted that approximately 5,800 MW of existing private sector generation capacity and 3,700 MW of existing public sector generation capacity may be decommissioned on account of the plant life and fuel inefficiencies.

2.2.3 Pakistan Power Pakistan – Key Challenges

Pakistan's power sector is currently afflicted by a number of challenges:

- A supply-demand gap, where the demand for electricity outstrips the current generation capacity leading to a gap of up to 4,500 – 6,500 MW. The supply-demand gap has continuously grown over the past 5 years and has led to significant load-shedding across the country.
- Expensive electricity generation (approximately PKR 12/kWh) due to increased dependence on expensive thermal fuel sources including furnace oil and high speed diesel.
- Inefficient power transmission and distribution system that currently records losses of 23-25%. Government has estimated the true cost of delivering a unit of electricity to the end consumer at greater than PKR 15.60 after taking into account the collection losses and the real losses to the distribution companies.
- The aforementioned inefficiencies and high cost of generation are resulting in high levels of subsidies and circular debt.

2.2.4 Private Sector Participation in Pakistan's Power Sector

Private sector participation in the Pakistan power sector dates back to mid-1990s with investment by a number of international companies and renewed interest by Chinese companies in recent years. Presently, approximately 45% of the installed generation capacity of the country is in private sector, with another 5,000 MW of IPPs under construction. Successive governments in the country have reiterated the commitment to increase private sector participation.

Private Power & Infrastructure Board (PPIB) and the Alternate Energy Development Board (AEDB) have a track-record of attracting investment in the power sector for two decades or so and provide a one window facility for the processing of private power generation projects. PPIB deals with power projects thermal and hydropower projects above 50 MW whereas AEDB is responsible for providing facilitation for renewable energy based projects (including hydropower projects below 50 MW). Certain provinces also have their own facilitation agencies.

Investment in the sector is primarily governed by the Policy for Power Generation Projects, 2015 administered by PPIB and the Policy for Renewable Power Generation 2006. These are investor-friendly policies that offer an attractive set of fiscal and financial incentives to the private sector providing a balanced risk profile for investors, lenders, and government agencies.

3 Site Assessment

OST has carried out an assessment of the site for the development of the 100 MWp PV plant to check that the selected area can accommodate the proposed development. The location and boundaries of the site have been provided by Siachen. We consider that the site is sufficiently sized and suitable to install the 100 MWp capacity.

This assessment was carried out via a desktop analysis of the site and information collected during a site visit undertaken by David Hawkins of OST during October 2015. The purpose of the assessment was to evaluate the suitability of the proposed site in terms of:

- Site setting
- Topography, terrain, and hydrology
- Near and onsite shading
- Site access, laydown area and security

These aspects are discussed in the following sections.

3.1 Site setting

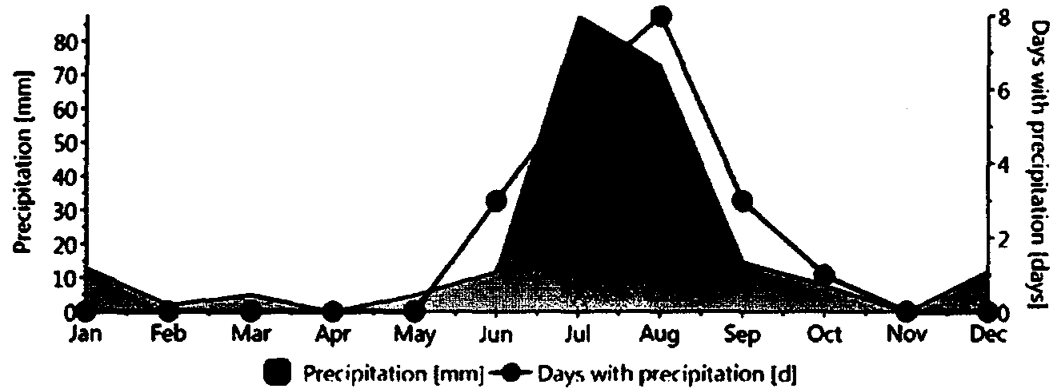
It is important to consider the site setting in order to establish whether the local climate, weather, and landscape is suitable for a solar PV development. Local conditions can affect all aspects of the project including the equipment selection and the operations and maintenance activities. Sites which experience extremes in climate, weather, or landscape can affect project viability.

The site is located 9 km to the east of the town of Mirpur Sakro in the district of Thatta, Sindh Province, Pakistan, approximately 75 km south east of Karachi.

The site is within the Indus River Delta, with the open sea about 50 km to the west but inlets extending 20 km closer. The main Indus River flows to the south, about 25 km west of the site. The site assessed is predominantly flat.

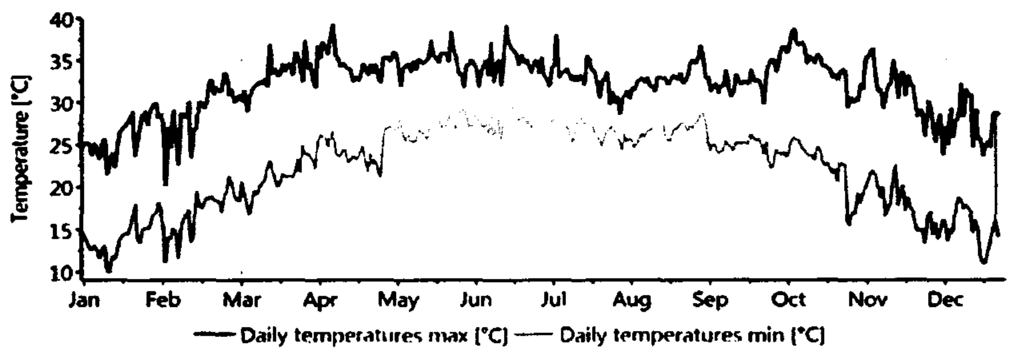
According to the Köppen Climate Classification System (the most frequently used system to classify an area's climate) the climate in Thatta District is mainly arid, with hot and dry summers and mild and dry winters. Significant rainfall is expected at the site only during the wet season (June to September), as shown in Figure 4.

Figure 4: Average rainfall in the assessed site (rain days per month)[1]



The average wind speed is 3.5 m/s (12.6 km/h) with peaks around 5 m/s (18 km/h) between May and July. These values are not considered to represent an onerous load to solar PV structures.

Figure 5: Daily temperature at the assessed site[2]



Average maximum temperatures at the site can be seen in Figure 5 and range from 19 °C in January to 32 °C between May and June. The high temperature profile of the site will have an unfavourable effect on the expected PR of the system; nevertheless, it should be noted that wind has a cooling effect on PV cell temperatures that benefits the performance of the PV modules. All meteorological phenomena have been taken into account in OST's yield assessment.

The available site, an irregular shape comprising of consolidated field boundaries and elongated in the north south direction, aggregates to a total of approximately 203 hectares. SEL has obtained the rights to the majority of the site however are still in the process of confirming two parcels of land within the planned site.

It is comprised of privately owned land that is currently largely uncultivated or used for free-range livestock grazing, although the pattern of field boundaries suggests that it has been used for more intensive agriculture in the past.

[1] Source: SolarGIS

[2] Source: SolarGIS

Figure 6 shows the boundaries of the site and its immediate surroundings. The red line denotes the boundary of the available plot, the blue area shows installed solar field for 100 MW_{DC} capacity. Orange lines are overhead power lines.

Figure 6: Site and surroundings

The site is bounded to the north by the Mirpur Sakro to Ghulamullah Road, which is a single lane sealed road running from east to west. Approximately 75 m to the north of the road and parallel to it, runs a 132 kV overhead transmission line on steel lattice towers. It is proposed that a new 132 kV substation, dedicated to the solar power Plant, be constructed on a plot between the road and the transmission line, across from the solar power Plant site. The grid connection study has identified that the new substation should be connected to Gharo-New 132kV grid substation through a new 18km length, double circuit 132kV Over Head Line (OHL). Between 800 and 400 m further north of the road and roughly parallel to it lies a canal. A local distribution line, estimated to be 33 kV runs across the site at a distance of between 350 and 500 metres south of the road.

Close to the western boundary of the site a drain (the 'Western Drain') runs south from the road and is intersected near the south west corner of the by another drain (the 'Southern Drain', see Figure 6) which bisects the southern end of the site in a north-east to south-west direction. Across the western side of the Western Drain, the land becomes more cultivated with dispersed homes. The satellite photographs indicate a small settlement approximately 350 m west of the south west corner of the site.

Land to the east of the site is generally similar to it and separated only by field boundaries. It is bisected by another drain (the 'Eastern Drain'), apparently unconnected to the others, which runs in a south westerly direction from the road to the eastern boundary of the proposed solar power Plant. This area is being considered by Siachen for another solar power plant.

Some of these features are shown in Figure 7, Figure 8, and Figure 9 which were taken from the Mirpur Sakro to Ghulamullah Road, at the northern end of the Western Drain and at the north western corner where the site entrance would be located.

Figure 7: Looking east from site entrance towards Mirpur Sakro

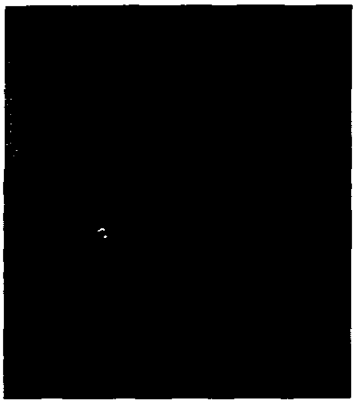


Figure 8: Looking north from site entrance to 132kV OHL

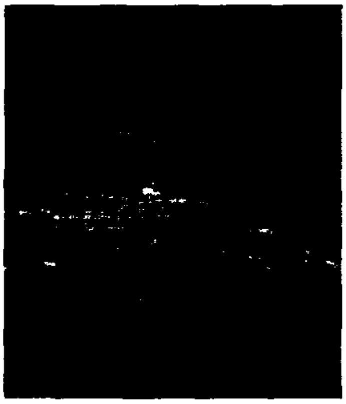


Figure 9: Looking south from site entrance

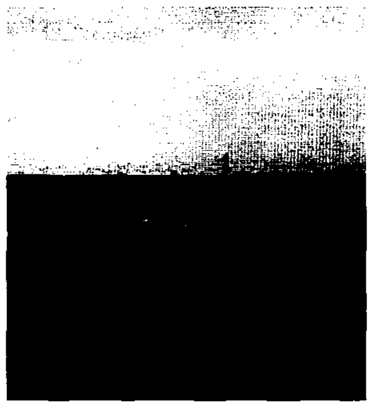


Table 4 provides a summary of the site settings.

Table 4: Summary of site setting

Item	Mirpur Sakro-Ghulamullah Site
Current land use	Mostly barren land
Neighbouring properties	Privately owned
Services (i.e. water, sewerage, electricity)	None
Distance from the town of Mirpur Sakro	Approximately 9 km
Neighbouring settlements	Approximately 350 m west of the site boundary
Likely Environmental and Social Impacts of the Project	Traffic during construction

3.2 Topography, terrain and hydrology

Examinations of the topography, terrain, and hydrology are undertaken as further checks for the suitability of the site setting. Certain parameters of the site design, such as row spacing, can be heavily influenced by surface topography. The terrain must be surveyed for geological composition in order to check the suitability of components such as the mounting structure. Local hydrology must be considered in order to understand the risks of certain types of flooding.

The proposed site is predominantly flat. The soil is comprised of soft finely textured silt or sand and during our visit appeared moist below the dusty surface. Salt was evident on the surface in patches, possibly denoting a high and salty water table, which may also account for the land's apparent bareness where irrigation has not been carried out. Except where cultivated, the surface of the ground is generally bare, or sparsely vegetated with low lying bushes and grass.

The site is generally extremely flat and there was evidence of standing water, particularly further south on the site where large areas of cracked mud were encountered, see Figure 11. Whether this is due to local rainwater that failed to drain during the monsoon or was introduced as irrigation or flowed from elsewhere could not be determined. The soil pattern evident in satellite photographs suggests that the area has experienced surface water flows at some unknown time in the past and the area has a number of oxbow lakes and remnants of riparian flow typical of a delta area. However, it was understood from local people that the site has not flooded in their memory. The IEE report suggests that the site is outside the flood zone and SEL states that the site was not affected by recent events that led to severe flooding elsewhere in the district.

Nevertheless, we recommend that a specific Flood Risk Assessment (FRA) be undertaken before financial close to understand the particular characteristics of the site. It is also recommended that construction activities be avoided during and soon after the monsoon season to ensure that the site is trafficable for construction equipment and equipment deliveries. All electrical equipment, including inverter houses and junction boxes should be mounted on structures well clear of ground level. Module mounting height should be sufficiently elevated to ensure adequate clearance from surface water during high rainfall events. Access roads should be elevated to ensure all weather trafficability and particular attention paid to design of the site drainage system.

Figure 10: Looking south from road to Eastern Drain

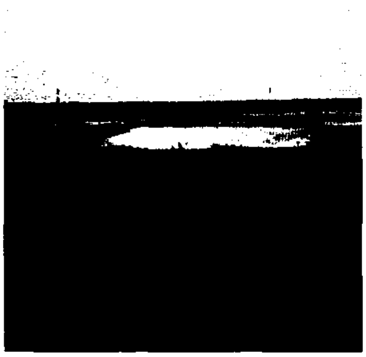


Figure 11: Cracked mud at southern boundary

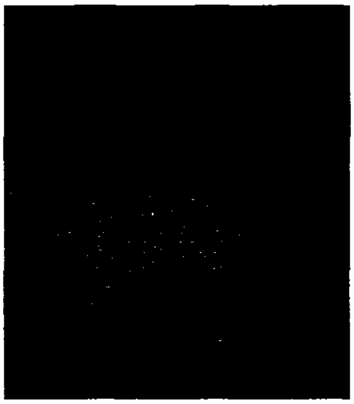
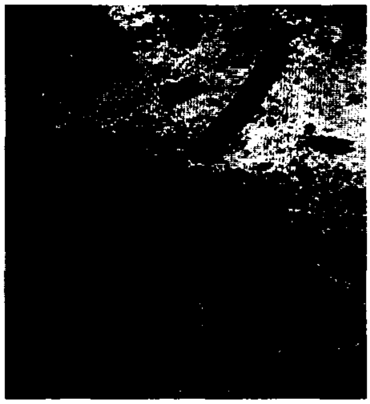


Figure 12: Ground conditions with mud and salt



The light, silty soil and barren soil, together with the open aspect of the site and its agricultural surrounds increases the potential for dust soiling on modules, which will have an impact on the annual yield of the solar Plant. We have accounted for these losses in the yield analysis described in Section 7.3.

The geotechnical report provided for review defines several types of soil across the site, which can be classified as light: loose to medium sandy silt or silty sand as well as very soft to soft silty clay or clayey silt. Underlying strata consist of medium dense to dense layers of silt and sand.

These soils are generally easy to excavate and may be suitable for ground screw anchors or other piling methods, such as helical piles, which can be quickly installed. Nonetheless, their low bearing capacity will require careful consideration of foundation design, especially to accommodate wind uplift forces. Furthermore, the earthing study conducted across the site highlighted the saline nature of the hydrogeological subsurface. This results in a high conductivity and therefore high corrosion potential that should be taken into account whilst designing metal foundations and earthing system.

Alternatively, other solutions such as poured or pre-cast reinforced concrete footings may be considered once the mounting structure design is finalised.

Laboratory test results from 5 samples have concluded that the aggressiveness of the soil is low, either for sulphate or chloride content, as well as the pH level of the soil is within a neutral range of 7.5 to 7.6. Similar pH level (7.6 to 7.8) has been encountered in the groundwater. However, the sulphate content in groundwater is found to be moderate. The use of sulphate-resisting Portland cements (Type II or V) is recommended for substation foundations.

Since water table has been encountered at depths of approximately 180 mm, the excavation for the substation foundations will require dewatering, which may become a costly issue if overlooked during project first stages. We therefore recommend that either sumps or wells are considered and costs for the ground preparation are included in the final economic analysis of the Project. Similarly, while constructing the access roads, we advise that gravel / rock drains or open ditches alongside these roads are used to keep the water table low.

Finally, considering the alluvial nature of the soil and the seismic zone, ground water level at superficial depths may result in liquefaction issues. We note that the geotechnical report has assessed the liquefaction potential at the site following the US Department of Defence approach. This approach is based on the shear stress a soil layer is subjected to by an earthquake, which in this case has been considered to reach a peak horizontal acceleration of 0.15g and a magnitude of 6.0 in the Richter Scale. Results conclude that the phenomenon of liquefaction is unlikely and may solely occurs in marginal cases. Nonetheless, in order to avoid any subsidence in a seismic event, it is advisable to increase the depth of the key equipment foundations where loose sandy silt is encountered. Moreover, the construction of gravel and / or rock drains around the key equipment foundations could also provide a rapid dissipation of earthquake shock-induced pore pressures.

Table 5: Summary of topography, terrain and hydrology

Item	Characteristics
Topography	Slope-free and generally flat
Terrain	Barren silt and sand with some irrigated cultivation
Flood risk	No indication of flood risk noted. We recommend an FRA is carried out before financial close for assurance.
Seismic Zone	Reported peak horizontal ground acceleration of 0.15g; Area included within zone 2A (0.08 to 0.16 g) in the Seismic Provisions (2007) of Building Code of Pakistan
Climate	Arid with rainfall between June and September
Water access	Water available from canal to the north of the site. In addition, we understand from the Client that a water allotment application is being prepared to be submitted
Impacts	Surrounding land use, including ploughing, may result in module soiling Drainage system and elevated electrical equipment to avoid surface water Careful attention to foundation design required including pile pulling tests

Concerning the risk of earthquakes in the area, we have extracted data from Global Risk Data (GRID) platform to assess the earthquake occurred in the past, their frequency and intensity, as well as future hazards.

The earthquake data and visual maps have been made available by the United Nations Environment Programme (UNEP) and the GRID centre in Geneva, whose research has been based on the United States Geological Survey ShakeMap Atlas.

We note that no direct event has occurred in the site area and that the closest events are reported in the Badin district on 13th February 1970 (magnitude 5.2 and epicentre at 91 km of the site) and on 4th June 1976 (magnitude 5.2 and epicentre at 71 km of the site).

According to the GRID platform, the expected Peak Ground Acceleration (PGA) within the boundaries of the site is lower than 65 cm/sec^2 (0.065g) for a return period of 250 years and close to 125 cm/sec^2 (0.125g) for a return period of 1500 years. This peak acceleration measures the expected maximum force that a small mass located at the surface of the ground can experience during an earthquake and is a suitable index to assess the hazard for stiff structures such as the mounting structure and key equipment substations. We note that this PGA is classified as 2A in the Seismic Provisions (2007) of Building Code of Pakistan and recommend that this is taken into account in the design of the substation foundations and buildings.

3.2.1 Near and on-site shading

Shading on PV modules reduces the amount of electricity generated, consequently it is essential to consider the potential shading from both on-site and near-site objects. In addition to this, it is also important to consider the variation of size and shape of possible shading objects with time. These variations, in fact, may create shading issues where there were none previously.

The site is very flat and largely barren with only limited vegetation comprising mostly low lying bushes and grasses. The only shading anticipated on site would be caused by the local distribution overhead lines traversing the northern part of the site, 350-500 m from the road. These can be seen in the distance of Figure 9 and Figure 10. The preliminary solar field layout (see Appendix C) has been arranged to avoid the installation of modules under the overhead lines.

There are no buildings or tall structures around the site expected to cause shading on the arrays. Additionally, no hills or mountains were visible on the horizon.

3.3 Site access, laydown area and security

Construction of a solar PV plant requires safe and reliable access for large and heavy vehicles. It is important to consider the suitability of the current access, and highlight if any works will be required to enable satisfactory access pre-construction. The hardware and equipment used must be unloaded and stored somewhere before installation. This area is known as the laydown area and will normally also house site offices. Considering the build-up of equipment, personnel, and traffic, its location is critical. Security is very important in reducing the risk of theft and ensuring safe access for authorised personnel. Mitigation measures such as fencing and site management should be among the first things present and installed on site.

The site is accessed from the Mirpur Sakro to Ghulamullah Road, which is a single lane sealed road with broad unsealed shoulders to allow vehicles to pass each other. During our site visit traffic was light but included a few heavy vehicles. It is expected that most deliveries would be received via the town of Mirpur Sakro, 9 km to the west of the site. Mirpur Sakro has a crowded central market area and is on the more major Gaarho to Keti Bandar Highway, which is a sealed two lane road that connects the district to Karachi.

The road from Mirpur Sakro crosses several canals (see Figure 13). Whilst these bridges and culverts are relatively short and are currently accepting local agricultural vehicles, it is recommended that their suitability for the delivery of heavy components be confirmed, particularly transformers for the 132 kV substation.

We recommend that a community consultation process be carried out to prepare local residents for the additional heavy vehicle movements anticipated, particularly during equipment delivery. This consultation should include not only local residents and businesses, but also those in hamlets along the road from Mirpur Sakro and in the area of Mirpur Sakro market where there is a restricted and crowded intersection with the Gaarho to Keti Bandar Highway. A construction traffic management plan should be prepared prior to commencement of works. This plan should consider pre-staging for incoming deliveries and prevention of 2-way traffic along narrow sections of the access.

Figure 13:Bridge on Mirpur Sakro - Gullamullah Road

Figure 14: Southern Drain, looking northeast

Figure 15: Southern boundary, looking east

The site will require laydown areas where materials, machinery and equipment can be delivered and stored securely. The most logical location for the site entrance and laydown area is in the north-west corner of the site, adjacent to the road and Western Drain. This location offers not only easy access but will minimize disruption to construction activities within the solar field and is adjacent to the new proposed substation site. Fencing and security should be provided for the laydown area at the site from commencement.

It was noticed that all the current vehicle tracks at the site are raised (see Figure 15) and it is recommended that access roads within the solar field are also elevated to maintain their trafficability in wet weather, adequate culverts should be provided under the roads to release water. It may be possible to make a raised perimeter security track into a berm that will prevent water from neighbouring areas entering the site.

A detailed assessment of the security of the Project location and possible mitigation measures is outside the scope of this report. We recommend that security costs be considered in the final economic analysis of the Project, that preliminary discussions be held at an early stage with potential EPC contractors to ensure that they are able to operate in this location and that major vendors, including inverter suppliers, are confirmed as able to provide specialist staff for commissioning and ongoing service support.

The closest hospitals and police station are situated in the regional centre of Thatta, approximately 45 km north east of the site. There may be an opportunity to support local health care facilities to the benefit of both the Project and local community. In any case we recommend that the Project undertakes thorough emergency planning for both the construction and operational phases of the Project.

There is no municipal water supply or sewerage at the site and therefore water and ablution facilities will need to be provided for the construction of the plant as well as during operations and maintenance. Table 6 gives a summary of the access for the site.

Table 6: Summary of site access, laydown area and security

Item	Mirpur Sakro Site
Site access	From National Highway N-5 to N-110(Gharo to Mirpur Sakro) Double Lane sealed road with bridges.
Access point	North western corner of boundary
Access road length from main road	Direct from Mirpur Sakro to Ghulamullah Road
Laydown area	North western corner of site recommended

3.4 Conclusion

OST considers the site setting satisfactory for the development of the Project. Local weather conditions are relatively hot and dry aside from the rain in monsoon season. The high temperatures experienced during the year as well as the dusty conditions of the site unfavourably affect the Plant performance. This has been accounted for in the yield assessment. The construction will likely cause higher volumes of local traffic however this can be safely managed.

At this stage of review, no significant issues have been identified with regard to the site topography, terrain, and hydrology although considering the site's location on a delta we recommend that a site specific FRA be conducted. OST recommends that construction should be avoided during monsoon rains and specific attention paid to site drainage and road construction. The geotechnical study has assessed the possibility of liquefaction and makes recommendations for consideration during detailed design of the foundations and drainage systems.

We additionally recommend that the seasonal level of water table is accounted for prior to any foundation and excavation activities in order to assess the drainage solutions to implement.

No particular shading issues have been identified for the proposed site. The site layout has been configured to avoid installation of modules under existing overhead distribution lines in order to facilitate construction and minimise shading issues.

Unsealed roads should be adequately prepared to support large and heavy vehicles, and a survey should be conducted on bridges along the access route in order to check safe loading capacity. OST highlights that security and welfare arrangements should be considered from the Project outset.

4 Desktop Environmental and Social Impact Assessment

A project of this nature is required to obtain the necessary environmental permit from the Sindh Environmental Protection Agency (SEPA). Environmental reporting for energy generation projects in Pakistan falls under the Pakistan Environmental Protection Agency Regulations 2000, which categorises development projects into two main schedules, Schedule I for lower impact and Schedule II for higher impact projects. No specific provision is made within these national regulations for solar projects, however the Government of Sindh Environmental Protection Agency IEE/EIA Regulations 2014 place solar projects under schedule I, for which only the IEE is required as part of the planning and approval process.

The IEE is required to demonstrate that the impact on the environment and local communities is acceptable and that the Project complies with national environmental laws and regulations. An IEE for the Project was prepared and submitted to SEPA 3rd December 2015 and received a decision notice according approval on 13th January 2016. The decision included a number of decisions, most of which we consider normal good practice and not unduly onerous.

No agricultural activity on the site was recorded in the IEE, however we note that Condition 16 concludes that "This approval is not valid for the construction/operation of solar power at the agricultural land". We recommend that compliance with this condition be confirmed with SEPA based on the final layout.

If the Project depends at any stage on international financing it will need to demonstrate compliance with the requirements of international financing institutions, such as development agencies and banks. This is generally achieved by following the International Finance Corporation's (IFC) performance standards on social and environmental sustainability, and Industry Sector Guidelines. The standards relate to various elements of social and environmental assessment and management, summarised as follows:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
- Performance Standard 2: Labour and Working Conditions
- Performance Standard 3: Resource Efficiency and Pollution Prevention
- Performance Standard 4: Community Health, Safety, and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

The IFC Performance Standards are reinforced by the Equator Principles (EPs), a credit risk management framework for determining, assessing and managing environmental and social risk in Project finance transactions. As Lenders for this type of project are generally Equator Principles Financial Institutions (EPFIs), it is likely that adherence to these Principles will be required.

In order to identify where the IEE produced for the Project requires additional issues to be addressed in order to comply with IFC Standards and EPs, a full gap analysis would need to be prepared. This analysis will produce an Environmental and Social Action Plan (ESAP), listing actions required to meet the various standards. By systematically addressing the ESAP actions, risk to the Project will be reduced by safeguarding against any environmental and social uncertainties. It should be noted that this gap analysis is not within the scope of our report.

The EPAP actions would form part of a Condition Precedent issued by the lender and can be addressed as financing proceeds. As a result, incorporating these standards is unlikely to result in delays to the Project or prohibitive costs.

The principal impacts of a solar development are discussed below.

4.1 Environment

The minimum plant area required for a 100 MWp Single Axis Tracking PV plant is approximately 198 hectares. The SEL site has an area of 203 hectares, sufficient for a PV plant of this size. Although covering a large land area, once constructed, the solar projects will have very limited impacts on the surrounding environment. The panels are passive in nature, do not result in any emissions, do not generate waste during normal operation (aside from any required replacement of components) and require limited onsite activity during operation. The solar farm will not result in hazardous impacts, and it does not involve any unusually complex technologies. The risk of accidents is considered low, and restricted mainly to construction and maintenance activities.

In addition, the production of electricity from a renewable source will make a significant contribution to reductions in Greenhouse Gases (GHG) emissions over the lifetime of the Project. In particular, the Plant will contribute to a reduction of GHG emissions of approximately 0.54 $tonCO_2/MWh$,year[3] which corresponds to a total estimated reduction of 2.4 million $tonCO_2$ assuming 25 years Project lifetime. The numbers are based on our annual generation estimation, including the annual degradation.

The principal environmental and social aspects identified as part of our early observations are outlined below for the proposed project site, with a brief statement regarding possible mitigations that have been identified at this early stage.

4.1.1 Ecology

The site is described in the IEE report as barren land with some patches of agriculture and no significant populations of flora or fauna. There are a small number of shrubs and trees on the site, which may have the potential to provide habitat for various faunal species and it is recommended that an independent ecologist survey the site in order to confirm whether any protected species are present, and propose suitable mitigation if necessary.

4.1.2 Cultural Heritage

The city of Thatta, located approximately 45km from the Project site is noted in the IEE as featuring a number of world heritage sites, however no heritage or archaeological assets are reported on or nearby the site itself in the IEE. Confirmation should be obtained from the Sindh

3 Source: PROGRAMME DESIGN DOCUMENT FORM FOR CDM PROGRAMMES OF ACTIVITIES, 2012, available online at: https://cdm.unfccc.int/filestorage/s/4/37F2YI6MBTJ80EPC4AH9NVLK1GZWQD.pdf/7.pdf?t=cWp8bnZ5aDJyfDAtCwhmbuqWjHBAOlg3CanD

region Department of Antiquities that the site does not cover any areas of heritage or archaeological potential that may require further investigation or mitigation measures.

4.1.3 Landscape and Visual

The site and surrounding area are characterised by an overall flat topography, with no elevated areas in the vicinity to give significant views of the development. There are a number of small settlements in the vicinity of the site, the closest village being Saman, an irregular settlement adjacent to the site, and the villages of Qadir Bakish Shoro and Gharoa, three to four kilometres distant. Mirpur Sakro sits approximately 9km to the west of the site. Due to the flat topography and the low height of the proposed development, views from any nearby residences are unlikely to be significant. Some existing areas of vegetation provide additional screening and it is recommended that measures to extend and infill this vegetation are investigated where any significant views of the site from residential areas may be identified.

The Project will be visible from the Mirpur Sakro to Ghulamullah Road, which runs along the northern boundary of the site.

4.1.4 Agricultural Land Use

Although the IEE identifies the site as barren, during the site visit some agricultural activity was noted nearby. Any informal or intermittent users of the land need to be identified in order to assess the potential for economic displacement as a result of the Project. The current proposed layout is designed not to impact these agricultural areas, however SEPA's approval is conditional on the Project not taking place on agricultural land so these areas should be avoided should changes to the layout be made. We recommend that compliance with this condition be confirmed with SEPA based on the final layout.

Soil erosion control measures will be undertaken where necessary by the developers in order to maintain any agricultural potential of the land for possible cultivation after decommissioning of the Project.

Overall, there will be minimal loss of existing agricultural land and the installation of the solar farm will provide income from a previously unproductive area.

4.1.5 Hydrology and Water Use

The climate in the region is semi-arid, with hot and rainy summers and dry warm winters. The IEE describes mean temperatures in the central Sindh plains of between 35 and 39°C in summer and 18 to 20°C in the winter. The average annual precipitation in the region is approximately 210mm, with over 50% of this falling during the wet season in July and August. Groundwater levels peak in the post-monsoon season (October to November).

Water will be required for the cleaning of panels as part of the O&M activities. Dust from traffic movement along the Mirpur Sakro Ghulamullah Road to the north, the ploughing of surrounding agricultural fields and the site's proximity to surrounding desert areas are all likely to lead to windblown particulates soiling the panels, which will therefore need to be cleaned to reduce yield losses.

Water will also be required during construction for human consumption and washing facilities and for dust control purposes. In addition, should installation of panels by direct piling be considered inappropriate to ground conditions or the potential effects of seismic activity in the area, water for concrete foundations will also be required. The quantity of water required for the various site activities during the construction and operation of the Project should be assessed prior to those activities. Approximate values can be estimated using figures for water use requirements for similar solar projects:

- During construction, approximately 50 litres/person/ day may be used for washing and consumption by site staff. Water required for dust control will depend on ground and weather conditions during construction. If selected, concrete foundations would require a total of approximately 14,000 m^3 for the whole site, based on 0.6 m^3 concrete per pile and a single pile table design.
- During operation, the principal water use will be for the washing of panels, which may require up to 2ML per wash, based on a standard figure of 3 litres per square metre of modules. We have assumed 4 washes per year for the energy yield calculations (therefore requiring 8ML of water per year for washing) however the frequency of washing required will vary during the year, depending on levels of precipitation, wind activity and other prevailing conditions. Staffing levels will be considerably less than during construction, and water use for human consumption will be proportionately reduced.

Water will be obtained via tube wells constructed on site. The IEE describes a groundwater analysis, which gave a TDS level of 830 mg/l, which is within the parameters considered suitable for panel washing. However, this figure is likely to vary considerably during the year as the rainfall / evaporation balance fluctuates, so periodic groundwater testing is recommended to ensure abstracted water is suitable for onsite use, and whether water treatment may be required. Effluent water from panel cleaning will be passed through a sump with a baffle wall to arrest any suspended solids and collected in ponds before being discharged into the drain which passes through the site. Permission for discharge will be obtained from the appropriate department. It is noted that no chemicals will be added to the water used for panel cleaning so no further treatment of the run-off will be required.

It is recognised that over-extraction of groundwater from boreholes could lead to negative impacts on nearby communities; further investigation will be required into water availability in the area and permitting requirements relating to water abstraction.

High arsenic content is reported in water extracted from local wells, and sewage contamination in some wells is also reported. The IEE states that drinking water requirements for onsite workers will be met through storage of the local public supply in water tanks or through delivery by water tanker from nearby areas where adequate supply is available.

4.1.6 Dust Management

Dust generation on site will be reduced by paving the internal access roads. Although the site is largely barren, clearance of any vegetation during construction will result in additional risk of dust impacting on the Project and surrounding areas; further dust management measures should be applied where necessary to mitigate any impacts resulting from the clearance of onsite vegetation.

4.1.7 Waste Management

Accommodation for Project construction workers will be provided on site and a waste water treatment facility is proposed for sewage and kitchen waste produced.

Solid and hazardous waste quantities generated are expected to be minimal and not significant during both construction and operational phases of the Project and standard good waste management practices should be adequate to manage risks associated with the disposal and handling of this waste.

The most significant issue associated with waste management for the proposed solar PV Project is the disposal of the panels at the end of the lifetime of the Project. Opportunities for recycling of the panels should be investigated as a preferable option. If disposal of the panels is necessary, PV panels are classified as electronic waste and therefore must be disposed at a hazardous waste treatment facility. We consider that a decommissioning plan will be required to outline how responsible management of the panels at end of life will be ensured.

4.2 Social

The solar project should place emphasis on Corporate Social Responsibility (CSR). It is considered that a project of this scale will offer significant employment opportunities to the local population during the construction phase. It is recommended that commitments are made to providing jobs to local people where possible. We also recommend that a Labour and Employment Plan (LEP), based on International Labour Organisation (ILO) and IFC standards, is developed and implemented, covering hiring, training, worker rights etc. The LEP should also cover accommodation for construction workforce and be based on IFC and EBRD guidance note on workers' accommodation. It is recommended that careful and appropriate management of local expectations with regard to job opportunities offered by the Project, particularly in the long term, as operational and maintenance employment opportunities are fairly limited in comparison to more traditional energy projects of this scale.

The IEE describes the local area as under-developed, with poor standards of education, inadequate medical facilities and lacking sewage, gas and water supply infrastructure. SEL states that a CSR budget has been established and a medical facility confirmed as a requirement after discussion with local representatives.

The CSR strategy should be established for the project, which should reflect appropriate level of community benefit for the project size and should meet the reasonable expectations of the local people.

4.3 Environmental and Social Management

4.3.1 Impact Assessment

The IEE provides a description of the environmental and social setting of the development, an assessment of potential impacts and recommendations for mitigation measures. The report concluded that, "...it is expected that adverse impacts from the Project's life cycle will be minimal."

4.3.2 Environmental Management Plan

A key requirement of the Project under PEPA regulations is the preparation of an Environmental Management Plan (EMP). The objectives of the EMP for the solar project are set out in Section 7 of the IEE, and include the implementation of mitigation measures and monitoring mechanisms for the development and the allocation of responsibilities for the environmental management of the Project.

Although the Project may be established using local financing, we recommend compliance with IFC Performance Standards is considered in the preparation of the EMP as this is industry best practice and demonstrates ongoing and responsive management of all potential social and environmental impacts throughout both construction and operational phases. Compliance with the IFC Standards will also be required should the Project require international financing at any stage. This compliance can effectively be demonstrated through a comprehensive and robust EMP, targeted to the IFC standards.

It is recommended that, once the EPC contractor has been appointed, the responsibilities with regards to fulfilling the requirements of the EMP and any other social, labour and employment commitments associated with the Project are clearly specified within the EPC.

4.3.3 Stakeholder Engagement Plan

Stakeholder engagement is an essential element of a robust environmental and social assessment and is a key lender requirement, eg. Principle 5: Stakeholder Engagement, of the Equator Principles, and IFC Good Practice Handbook for Stakeholder Engagement. The general stakeholder process is as follows:

- To identify people or communities that are or could be affected by the Project, as well as other interested parties.
- To ensure that such stakeholders are appropriately engaged on environmental and social issues that could potentially affect them through a process of information disclosure and meaningful consultation.
- To maintain a constructive relationship with stakeholders on an ongoing basis through meaningful engagement during Project implementation.
- To provide a grievance mechanism by which the general public and other stakeholders can raise concerns, which the Company will handle in a prompt and consistent manner.

The initial stages of public consultation for the Project has involved the distribution of an information pamphlet in the local area followed by briefings held in eight local villages. During the briefings, feedback on the proposals was gathered through a questionnaire, which was completed by a total of 20 people. The principal concern raised was in relation to local employment and comment(s) were also received regarding the provision of schoolteachers. All 20 of the respondents are reported to have consented to the implementation of the Project.

To follow up this initial consultation, it is recommended that a Stakeholder Engagement Plan (SEP) is developed that identifies how engagement with local communities will continue throughout the construction and operational phases of the Project. This should identify Project stakeholders and set out a stakeholder engagement programme and Action Plan, with particular focus on locally affected communities. It is noted that all of the 20 respondents to the initial consultation were male; notwithstanding cultural and religious norms, effective stakeholder engagement should make attempts to allow all people affected by the Project to have a voice in the consultation process. The document should also include a grievance mechanism for stakeholders to raise their concerns about the Project.

A project of this kind may give rise to expectations in the local population regarding short and long term economic and social benefits. It is important that public perceptions inform the management of the stakeholder engagement process and that any misconceptions are addressed at an early stage.

4.3.4 Labour and Employment Plan

Although it might be not essential, it is recommended that the project provides a Labour and Employment Plan (LEP) for implementation by the EPC, which takes into consideration relevant guidelines put forward by the International Labour Organisation (ILO), the IFC as well as national regulations. Should the Project seek refinancing at a later stage on the international market then there is a risk that EPs may apply in the future. As well as satisfying lenders requirements, a commitment to upholding standards relating to issues such as working conditions, health and safety, equal opportunities and remuneration, and discrimination will help foster goodwill within in the surrounding community and reduce any risks that may result from local dissatisfaction with the Project. At a minimum, a clear policy statement should be drafted that commits the Project to the relevant ILO and IFC standards on labour and employment, as well as emphasising local employment. If the developer has plans for more similar projects, it is advisable to have a LEP and policies that can then be easily applied to additional projects.

5 Grid Connection

OST has reviewed a "Final Grid Interconnection Report" for the Siachen Project (the 'Study') carried out by Power Planners International ('PPI') and dated March 2017.

5.1 Grid Connection Study

The Study aims to analyse the impact of the Project on the local power Transmission and Distribution (T&D) system and also details the technical requirements to facilitate the connection in line with the relevant grid code. The main objectives and topics covered in the Study are:

- Develop a feasible connection scheme for the Project to the ESCO/NTDC network at 132kV
- Load flow studies, including consideration for future network conditions to determine load-ability of equipment and voltage profiles
- Reactive power limitations of the Project
- Fault contributions and network short circuit strength
- N-1 Contingency analysis and transient stability analysis
- Power quality issues including voltage flicker, un-balance and harmonic emissions.

The coverage of the Study is detailed and does not appear to omit any major subjects or topics that we would typically expect to see. We recommend that confirmation is sought from the local T&D operators (NTDC) that the scope and assumptions used are accepted.

The region surrounding the Siachen Project is currently experiencing a large amount of power generation projects being planned, developed and under construction, many of which are solar PV and wind power generators. The Study has been undertaken considering the expected scenario of June 2019 including the planned generation connections and the wider transmission network expansion works required. We note that there are a considerable number of new generator connections and T&D expansion works following the date of the study up to year 2021 / 2022; it is recommended that the Project seeks further assurance regarding the impact of the planned works on the availability of the Project to export its full capacity post connection. OST has not considered grid un-availability as part of the energy yield analysis.

The Study concludes that the June 2019 grid system with expected upgrades will be suitable to cope with the evacuation of power from the Project and no bottlenecks or technical constraints were found in the grid system (at June 2019).

PPI has confirmed that the grid simulations studies were conducted using 88MW as the maximum AC power generation level. This is consistent with the conceptual design and yield assessment in this feasibility study.

5.2 Network Re-enforcement Works

The scheme of interconnection proposes the following reinforcements in place at Jhimpir cluster.

- 220 kV D/C tranmission line approx. 5km long on twin bundled Greeley conductor looping In/out of second circuit of existing Jamshoro - KDA - 33 D/C transmission line at the proposed Jhimpir-2 220 / 132 kV substation.
- Addition of fourth 220/132 kV transformer at the newly proposed Jhimpir-2 220/132 kV substation.
- 132 kV D/C transmission line approx. 135 km long on twin bundled Greeley conductor for connecting 8 WPPs in the first loop to Jhimpir-2 220/132 kV newly proposed substation.
- 132 kV D/C transmission line approx. 168 km long on twin bundled Greeley conductor for connecting 8 WPPs in the second loop to Jhimpir-2 220/132 kV newly proposed substation.
- 132 kV D/C transmission line approx. 18 km has been proposed from Siachen Solar PP to Gharo-New 132 kV grid station to evacuate the maximum of 88 MW power from the Siachen Solar PP to National Grid. The Conductors used will be Greeley. As the 88 MW could not have been merged with any sub collector already proposed at Gharo-New 132 kV.

The template EPA states that the Purchaser will construct and finance all works on the Purchaser's side of the interconnection, and it is therefore understood that the Project will not have to contribute towards any cost apportionment for the on-going upgrade and expansion works of the T&D network.

The template EPA also contains a take or pay clause in which the Energy Purchaser compensates the Project for missed energy sales due to delays with the Purchaser's side of the grid connection. This clause is discussed in Section 5.4.

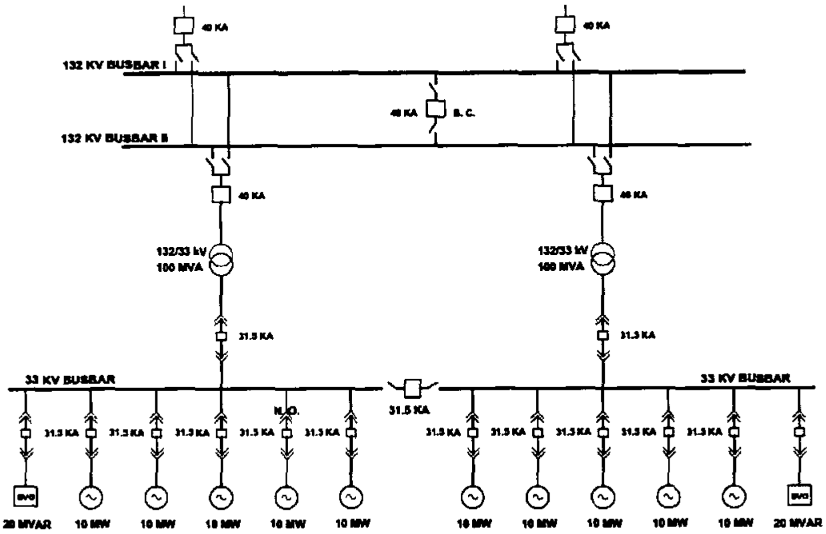
5.3 Project Connection Works

The Study proposes that the Project is connected to Gharo-New 132kV grid substation through a new 18km length, double circuit 132kV Over Head Line (OHL). The OHL route and length calculation are not provided and any environmental or land ownership issues in the cable route have not been identified. As above, there is a take or pay clause in the EPA which will compensate the Project should there be delays with the Purchaser's side of the Project Connection works. This clause is discussed in Section 5.4

The Project is connected to the OHL through a double 132kV busbar with a bus coupler and two 100MVA, 132/33kV transformer units with required protection and isolation switchgears. It is noted that a considerable amount of redundancy is built into the proposed design to enable the system to continue to operate at full rated power in N-1 conditions, i.e. where one outage of a single piece of equipment is present such as a line or transformer outage due to fault or a maintenance activity. The Study states that N-1 reliability is a condition of the Gird Code.

Figure 16 shows a single line diagram of the Project electrical infrastructure as proposed in the Study:

Figure 16: Proposed Single Line Diagram by PPI



To meet the power factor requirements of the grid code in steady state, normal and outage conditions, the Study identifies the need for Static VAR Compensators, (SVC) of 40 MVAR at the 33kV bus, these are split between each separated 33kV bus as seen in Figure 16. This requirement is additional to the reactive power capability of the PV inverters used on the Project. The grid code requires the Project to provide reactive power control at the interconnection point within the power factor range of 0.95 lagging to 0.95 leading. To meet this requirement, particularly to export reactive power to the network, the SVCs are required to compensate the effects of the Project connection equipment, such as the transformers.

Considering the inclusion of the SVCs it is expected that the inverters will be able to generate at unity power factor in normal conditions, and therefore will not incur active power losses. It should be confirmed, when appropriate in the design phase, whether there will be a requirement for the inverters to operate at a non-unity power factor which will have an impact on its active power production capability and should be accounted for in the energy yield assessment.

The Study states that the output energy will be metered at the 132kV side of the transformers, typical power losses for the 132/33kV transformers have been considered in OST yield analysis.

Budget costs for the new 33/132kV substation adjacent to site has been included in our EPC cost estimates. We have not included for the cost of the 18km of OHL works and connection at Gharo-New.

5.4 Impact of Connection Delays

A template Energy Purchase Agreement (EPA) is available on the Alternative Energy Development Board's website[4]. This template EPA states that the Purchaser (Central Power Purchasing Agency (Guarantee) Limited on behalf of ex-WAPDA Distribution Companies) is responsible for the Purchaser Interconnection Facilities, which are the facilities and equipment to be designed, constructed or installed by or on behalf of the Purchaser on the Purchaser's side of the Interconnection Point, as described in Schedule 3.

Schedule 3 has not been provided by AEDB with the template EPA, however SEL has stated that the Purchaser is responsible for the construction and costs for the OHL and network re-enforcement works required to connect the Plant to the network.

Under the template EPA, the Owner will receive compensation for any delays to the commissioning of the Project longer than fifteen days that are caused by delays on the Purchaser's side of the meter. The template EPA gives this compensation as:

> *The Purchaser shall pay to the Seller Monthly, in arrears, the Carrying Costs plus fifty percent (50%) of the O&M Component and fifty percent (50%) of the Insurance Component multiplied by the Average Daily Energy for each Day during the period of such delay.*

If these delays extend beyond sixty days[5] then, in addition to the above costs, then the Purchaser shall also be required to pay the principal sum of the debt when due pursuant to the repayment schedule.

From the EPA:

> *Such payments shall continue until the earlier of (A) the end of the period equal to the period of delay or deferral of any Commissioning Test, and (B) completion of the first attempted Commissioning Tests (whether successfully completed or not), provided, that any payments made by the Purchaser pursuant to this Section 6.5(b) on account of payments of principal sum of the debt shall be recovered, together with interest at KIBOR plus 3.5% per annum (on the monthly outstanding balance of such amounts) commencing on the date of such payments by the Purchaser and ending on the date of complete repayment thereof by the Seller through successive deductions of the Return on Equity Component from the monthly Energy Payments until such amounts have been completely recovered.*

The impact of any commissioning delays on the financial model of the Project have not been included in the preliminary economic analysis in this report and should be assessed by a financial advisor before making an investment decision.

[4] http://www.aedb.org/index.php/component/judownload/19-solar-standard-docs/33-energy-purchase-agreement?Itemid=101

[5] The Energy Purchase Agreement has sixty days as a proposed length of delays for this clause to take effect. This should be confirmed prior to financial close.

5.5 Conclusions and Summary

OST has reviewed a "Final Grid Interconnection Report" for the Siachen Project (the 'Study') carried out by Power Planners International ('PPI') and dated March 2017.

The coverage of the Study is detailed and does not appear to omit any major subjects or topics that we would typically expect to see. We recommend that confirmation is sought from the local T&D operators (HESCO and NTDC) that the scope and assumptions used are accepted.

The Study concludes that the June 2019 grid system with expected upgrades will be suitable to cope with the evacuation of power from the Project and no bottlenecks or technical constraints were found in the grid system (at June 2019).

The works required as a pre-requisite for the Project connection are extensive. The Study identifies that the works will be in place by "the end of 2018". Any delays in these works will cause compensation to be paid to the Project as described in Section 5.4.

The Study proposes that the Project is connected to Gharo-New 132kV grid substation through a new 18km length, double circuit 132kV Over Head Line (OHL). The OHL route and length calculation are not provided and any environmental or land ownership issues in the cable route have not been identified. SEL state that the Project is not responsible for the OHL. It is noted that a considerable amount of redundancy is built into the proposed design of the connection works.

Static Var Compensators (SVC) are required to meet the power factor requirements of the grid code. With the addition of these SVC's we do not expect the inverters will be required to operate at a non-unity power factor under normal conditions. It should be confirmed, when appropriate in the design phase, whether there will be a requirement for the inverters to operate at a non-unity power factor which will have an impact on its active power production capability and should be accounted for in the energy yield assessment.

Budget costs for the new 33/132kV substation adjacent to site have been included in our EPC cost estimates. We have not included for the cost of the 18km of OHL works and connection at Gharo-New.

6 Conceptual Design

This section describes the conceptual design of the Plant, which follows proven commercial practice. Detailed design will be undertaken by the EPC Contractor according the Technical Specification which will include specific Project's owner requirements, performance requirements and applicable standards including Pakistan Building Code and IEC standards. The Plant shall be designed for a minimum of 25 years life. During the tender evaluation phase, alternative designs, including the use of trackers or string inverters should be considered.

Appendix B provides preliminary details for each of the major components.

A preliminary layout for this Project is included as Appendix C.

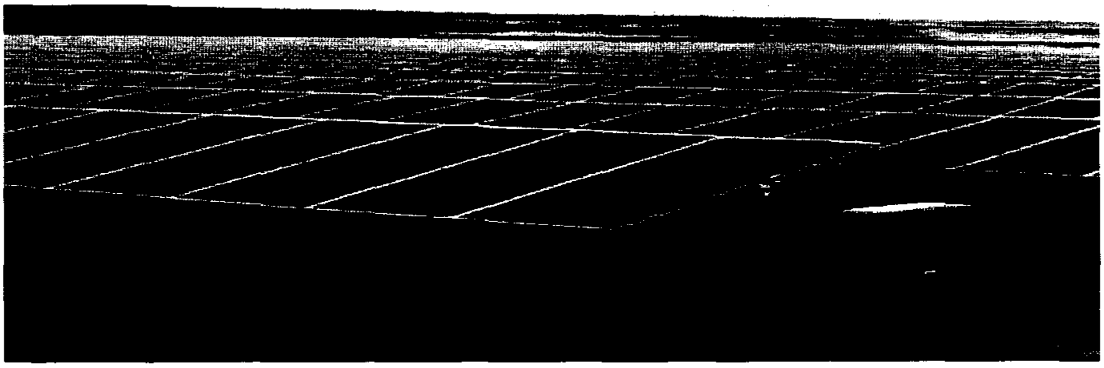
6.1.1 Modules and mounting frames

A module is an array of solar cells that converts the energy received from sunlight into electrical energy through use of the photovoltaic effect. Silicon solar cells are made from either mono-crystalline wafers which offer slightly higher efficiency at a higher cost, or poly-crystalline wafers which offer slightly lower efficiency but at a lower cost. Each individual photovoltaic module is approximately 2.278 x 1.134 x 0.035m and is of a glass construction, typically set in an outer metal framework. The front surface is generally treated with anti-reflective coatings.
The modules are electrically connected by string cables which run through conduits placed behind the rows of modules. The string cables terminate at junction boxes which are generally found adjacent to module rows. Junction boxes then connect to inverters via larger diameter underground cables.

Modules are mounted on a rotating steel framework structure which securely holds the modules in the design-specified position, inclination, and orientation as shown in Figure 17.

The structure may be supported on a variety of different foundation designs including steel mini-piles driven directly into the ground or concrete foundations formed in place. The module support structure is arranged in rows, and follows the landform, generally rising approximately 2.2 m above ground level at any point. The rows are separated from one another by an open space, which is determined by the site and project but generally between 3 m to 8 m.

Figure 17: **Proposed module elevations**



The framework mounting system employ tracker technology which varies the orientation of the modules to follow the sun's position through the day. The most common tracking solution in today's market is single axis tracking, which supports the modules in north-south rows and tracks the sun's position as it passes from east to west each day. The use of tracking system can improve the irradiation hitting the modules up to 19.5% of that of GHI which result in consequent increase of the yield. This can increase revenues in areas of high direct irradiation.

Generally the site area will be beneath solar arrays or taken up by ancillary buildings, leaving the remaining area as open space. The unoccupied ground between rows of modules and under the modules can be seeded to produce vegetation as desired. Once constructed, it is viable for farming activity to occur such as grazing of medium-sized animals like sheep.

Module manufacturers are classified by Bloomberg New Energy Finance into different tiers and are used to evaluate the bankability of the module provider. Tier 1 modules will generally be own-brand, own-manufacturer products, which have been financed by five different non-development banks in the past two years. OST notes that the Bloomberg Tier system does not consider manufacturing quality, but only the "bankability" of the manufacturer; OST would be happy to offer a comprehensive technical review of modules if desired.

As an alternative to poly- or mono-crystalline silicone modules, thin film modules from a proven and bankable manufacturer may be employed. Such modules typically offer a lower capital cost for module purchase and potentially suffer reduced performance degradation at high ambient temperatures such as experienced at Mirpur Sakro. However against this must be weighed their generally lower efficiency which, in some cases, can minimise the price advantage. The Cd-Te technology employed by some thin film manufacturers would also make it imperative that firm provisions are made for removal and safe recycling of the modules at the end of the project life.

6.1.2 Inverters and transformers

Inverters are required to convert the direct current (DC) electricity generated by the PV modules into alternating current (AC) which is suitable for exporting to the grid. The inverters also manage and optimise specific electrical parameters in order to maximise energy production.

Inverters are most commonly available as either string inverters or central inverters. String inverters are smaller devices, each managing a small number of modules, typically mounted on the module support structures and with a capacity typically less than 50 kW. They are better able to optimise electrical parameters and maximise energy production in conditions where orientation or shading vary, particularly rooftops. However, the large number required for a utility scale application often results in higher installation and maintenance costs, including replacement over the Plant lifetime.

Central inverters are larger devices with capacities up to 1,000 kW or more which manage greater sections of the Plant. They are generally able to optimise energy production more efficiently and are generally less resource intensive to maintain and can be more economical to purchase and install. Central inverters are generally housed within weatherproof skid-mounted enclosures with approximate dimensions 8.5 m long, 2.9 m wide and 3.2 m high. Alternatively they may be installed in a masonry building with adequate ventilation. Care should be taken to ensure adequate ventilation, particularly considering the high ambient temperatures at this site.

OST considers that for a project of this scale, location, and landform, central inverters are likely to offer the best solution.

The transformers are required to step-up the relatively low AC voltage as generated by inverters (typically 300-400 V), into the internal 33kV MV network, and then again to 132kV for grid connection. The inverter to MV transformers may be installed integrally with the inverter enclosures or adjacent to them, whereas the MV to HV transformers will be housed adjacent to the switchgear.

6.1.3 Switchgear

Switchgear is used to control the connection between the Plant and the electricity distribution network. Typically there are two sets; one belonging to the Distribution Network Operator (DNO), HESCO/NTDC/CPPA in this case, and one belonging to the Plant, which are housed in separate cabins or switchrooms. The appearance and size of the cabins will be determined by the requirements of the DNO and the Project, but it is likely they will be fabricated from brick or Glass-fibre Reinforced Plastic with approximate dimensions of 5 to 7.5 m long, 2.75 to 4.75 m wide and 3 to 4 m high.

6.1.4 Monitoring and Control Room

Monitoring systems are required to provide feedback and information on the operational status of the Plant. Systems for monitoring the Plant such as the Supervisory Control and Data Acquisition (SCADA) operating system will be located in an air-conditioned cabin or office, which will also provide a working environment for the Plant operator or manager. The cabin dimensions would typically be 7 m long, 3 m wide and 3 m high and may be fabricated from GRP or masonry.

6.1.5 Security

From the beginning of construction, security measures are required to prevent unauthorised access into the solar farm, which is an energy generation system, and to protect the solar farm.

SEL have stated that based on local conditions the security arrangement should consist of a boundary wall of at least 2.2m topped with barbed wire to be installed within the site boundary, and pole mounted security cameras at approximately 3.25 m high positioned around the wall perimeter. The security cameras should employ infra-red technology and site lighting will not be required. Alternative security arrangements based on manned patrols may also be employed.

Table 11: Other modelling assumptions

Criteria	Assumptions
Inter row spacing (pitch)	8.0m
Module inclination	Single Axis Tracking
Module Azimuth	Due south (180°)
Array configuration	2 modules in Portrait
Site terrain	Assumed flat
Horizon line	Assumed free from material shading
Module tolerance	0 / +3%
DC peak : AC nominal ratio	1.19
Delivery/metering point	At the 132kV substation

7.2.1 Temperature and wind velocity

Site specific temperature and wind velocity data for this site has been sourced from SolarGIS data and is shown in Table 9.

Table 9: Monthly and average yearly temperature and wind velocity values

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av.
Amb. Temp. (°C)	19.4	22.3	26.4	29.5	30.9	31.6	30.3	29.2	29.4	29.0	25.1	20.8	**27.0**
Wind speed (m/s)	2.4	2.6	2.9	3.7	4.9	5.1	5.2	4.8	4.2	2.5	1.9	2.2	**3.5**

7.3 Plant system design assumptions and PR analysis

7.3.1 System design assumptions

The conceptual design used for the yield assessment considers Tier 1 Monocrystalline modules and central inverters based on the principles described in Section 6. The system design is high level only and has not been fully optimised for cost or performance. The system is sized for 99.99 MWp and the layout has been adjusted to account for the size and shape of the site. The modelled design is subject to component availability. The conceptual design used for the yield assessment considers Chinese Tier 1 Monocrystalline modules and inese central inverters. The Plant design life shall be 25 years. Appendices F, G, and H of this report show indicative datasheets of the major components proposed for the Project, while Appendix B details the main requirements of the plant's key components.

Performance estimates below are calculated on the basis of the high-level system configurations prepared by OST and along with other modelling assumptions are shown in Table 10 and Table 11.

Table 10: System design assumptions

Array size (MWp)	Module model	Module nominal capacity (Wp)	No. of modules	Inverter model	Max. inverter output power (kVA)	No. of inverters	No. mods per string	No. strings per inverter
100MWp	550Watt Mono	550	181,832	8x110KW	8800KVA	11	28	738

Table 8: Monthly and yearly incident irradiation for Mirpur Sakro site

kWh/m²	J	F	M	A	M	J	J	A	S	O	N	D	Total
GHI	139	151	198	214	218	181	143	141	164	174	140	130	**1,992**
GII - 26°	184	185	220	215	204	165	133	137	172	205	180	176	**2,175**
Single Axis Tracking													**2,362**
Dual Axis Tracking													**2,663**

Based on the preliminary design assumption of Single Axis Tracking, we would consider that an Global inclined irradiation of **2,362 kWh/m²/year** can be applied to the site and this figure has been carried forward in the analysis.

7 Irradiation analysis and climatic conditions

7.1.1 Global Horizontal Irradiation (GHI)

The global horizontal irradiance is a measure of the total solar electromagnetic radiation hitting a surface at any one time (W/m^2) and is composed of direct beam irradiance and diffuse (scattered) irradiance. Irradiation is a measure of how much irradiance is incident per m^2 over a certain period of time (Wh/m^2). This irradiation is the energy source for a solar project and as such it is important that sufficient data is collected for the sites in question. A location at the centre of the site was selected as the point of interest for the irradiation assessment. Should the location be affected by horizon shading, the irradiation databases that we are using already take this effect into account.

There are several databases available that use information from either satellite (along with other observations and models) or ground measurements in order to estimate long term average GHI values at any specified location. A description of the databases used in the irradiation analysis is included in Appendix A.

We have taken GHI values from a number of databases for comparison and these can be seen in Table 7.

Table 7: Annual Global Horizontal Irradiation (GHI) from various sources

Data source	Measurement duration	GHI (kWh/m^2)
SolarGIS	1999-2015	1,992
PV GIS (CM SAF)	1996-2013	2,146
NREL CSR	1985-1991	2,013
Final value		**1,992**

Considering the uncertainty characterising meteorological data in Southern Asia due to the presence of high levels of airborne dust and aerosols, we have decided to conduct this feasibility study considering a conservative scenario. Subject to further study and correlation with site data, there may be potential to revise this figure at a later stage.

For this feasibility study, the SolarGIS figure of **1,992 kWh/m^2/year** has been selected for the continuation of the irradiation assessment.

7.2 Global Inclined Irradiation (GII)

GHI values have been uplifted to obtain GII, the incident irradiance on an inclined plane. This has been carried out by using the industry standard Perez model, which is a sophisticated model that relies on the GHI and empirical coefficients to set the variables that will affect GII. For this site it is assumed that the modules' orientation will be due south.

Estimated figures for monthly and yearly inclined irradiations are shown in Table 8:

7.4 Energy Yield estimates

7.4.1 Monthly yield and performance

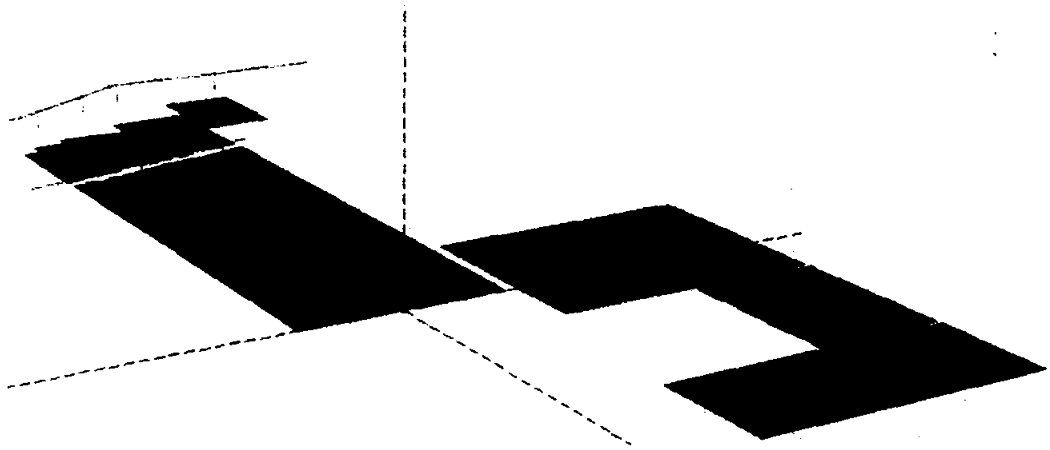
Table 14 below shows a monthly breakdown of the PR and specific yield for the Project.

Table 14: Monthly yield and performance

Month	In-plane Irradiation (kWh/m^2)	PR	Specific yield (kWh/kWp)	Yield (MWh)
Jan	195	80.6%	157	15,735
Feb	199	79.5%	158	15,884
Mar	246	78.4%	193	19,317
Apr	236	76.9%	181	18,186
May	224	76.8%	172	17,233
Jun	174	76.2%	133	13,327
Jul	138	77.8%	107	10,761
Aug	145	78.5%	113	11,399
Sep	185	76.2%	141	14,154
Oct	229	77.4%	177	17,771
Nov	196	73.8%	144	14,479
Dec	190	77.5%	147	14,731
Total	**2,362**	76.7%	**1829**	182982

A shading scene was created in PVsyst to model inter row shading throughout the year. The shading scene used to model the system is shown in Figure 18.

Figure 18: PVsyst near shading model



7.3.2 PR calculations

There are a number of losses associated with the conversion of DC power from the modules to grid exportable AC power, and the cumulative loss is called the Performance Ratio. A description of these losses is given in Table 12.

Table 12: Overview of PR losses

Loss	Description
Near shading	Loss of irradiance that can be caused by obstructing objects, e.g. external shading from nearby trees or large buildings, and mutual shading from neighbouring modules
Spectral	Loss from operating in a different air mass and solar spectrum compared to Standard Test Conditions (STC)
Angular / IAM	Loss due to instances when the sun is not perpendicular to the module. Causes an increase in the reflection of light from the front glass
Dust / Soiling	Loss of irradiance. Over the working life of the module surface contaminants will increase (dirt, bird droppings and vegetation) and reduce the amount of light penetrating the glass.
Low irradiance performance	Loss due to the lower relative efficiency of the module when operating at a different irradiance level than measured at STC
Light Induced Degradation	Loss due to degradation which occurs during the modules first operating hours in outdoor conditions. Reduces module performance compared to the standard values measured at STC

Loss	Description
Module quality / Tolerance	Loss/gain due to the module power tolerance is a result of the deviation in the average effective module efficiency relative to manufacturer specifications
Module temperature losses	Loss due to operating at a different temperature to STC
Shading: electrical effect	Loss due to the current of a string of modules/cells being reduced and limited by the current in the most shaded module/cell
Mismatch	When combining modules with varied characteristics, caused by allowable manufacturing tolerances, the current is limited by the lowest rated module and ultimately limits the power for all the modules in the string
Ohmic, DC wiring	Electrical loss due to the Joule Effect. Proportional to the voltage drop along the wiring between the modules and the inverters
Inverter efficiency	Loss due to the inverter's capacity to efficiently convert the DC power from the modules to grid-exportable AC power
Undersizing of the inverter	Loss due to the maximum DC input capacity of inverter. More DC power may be supplied than can be converted to AC power. This typically occurs if the DC field is excessively oversized relative to the rated AC output of the inverter
MPPT performance	Loss due to accuracy of the maximum power point tracking algorithm of the inverter. Inverter manages specific electrical parameters to maximise the AC power output from the DC input conditions, and this system has a small operational inefficiency
AC LV wiring	Loss due to the Joule Effect. Proportional to the voltage drop along the wiring between the inverters and the transformers
LV to MV and MV to HV transformers	Loss due to the efficiency of the transformers in converting power from LV to MV and MV to HV for compliance with the connection characteristics of the grid
AC MV wiring	Loss due to the Joule Effect. Proportional to the voltage drop along the wiring between the transformers and point of connection
Self-consumption	Loss due to energy consumption from the site. Deducted from the generation. Auxiliary loads can include fans, heaters, air conditioning, CCTV, lights, etc.
Power Factor	Losses due to the reduction in active power capability of the inverter and the reactive current running through the AC components when not running at unity power factor
Grid clipping	Loss due to limitation of the plant output due to the grid maximum export capacity
Module degradation	Loss due to natural degradation of the modules performance during its operating life

System design has been modelled with industry standard software PVsyst and proprietary OST modelling techniques to produce yield estimates for the high level system. Calculations are performed using site specific hour by hour irradiance and ambient temperature values.

The rate of module soiling is expected to be high due to the light, silty soil and barren soil, the open aspect of the site, and its agricultural surrounds. Soiling losses have been estimated based on an assumption that the PV modules will be cleaned monthly during periods without rainfall, resulting in approximately seven cleans in a typical year. We therefore estimate that with this cleaning regime a reasonable assumption for soiling losses is 1.9%. This is an estimate only and we would expect that the soiling loss would be fixed in the O&M contract, with the cleaning schedule adjusted accordingly.

The calculated PR and associated losses for the Plant can be seen in Table 13. Losses are expressed as a percentage of the energy input; factorised losses indicate the difference between unity and the loss.

Table 13: PR calculation

Description	Loss	Factorised
Near shadings	3.25%	0.967
Spectral	0.00%	1.000
Angular / IAM	1.90%	0.981
Soiling	1.90%	0.981
Low irradiance performance	0.40%	0.996
Light Induced Degradation	0.70%	0.993
Module quality - Tolerance	-1.00%	1.010
Module Temperature Losses	9.00%	0.910
Shading: Electrical loss according to strings	0.00%	1.000
Mismatch	0.50%	0.995
Ohmics, DC wiring	1.40%	0.986
Inverter Efficiency	1.50%	0.985
Undersizing of the inverter	0.00%	1.000
MPPT Performance	0.80%	0.992
Ohmics, AC LV wiring	0.25%	0.9975
Ohmics, AC MV wiring	0.25%	0.9975
LV-MV transformer	1.30%	0.987
MV-HV transformer	0.50%	0.995
Self-consumption	0.60%	0.994
Module degradation	0.70%	0.993
Plant unavailability	2.00%	0.980
PR unavailability included	**76.76%**	
CUF	**22%**	

For our calculations we have not applied any assumption for grid unavailability at this stage of the feasibility study.

The soiling loss in Table 13 is assuming an O&M contract with monthly cleanings during the dry period; modelling suggests a minimum of 7 module cleanings per typical year.

7.4.2 First year specific yield estimates

Specific yield is a measure of the output of a PV system per unit of installed capacity (kWh/kWp). It is a function of the irradiation experienced by a system, and its Performance Ratio. Year one specific yield calculations for the Project are shown in Table 15.

Table 15: Year one P50 energy yield summary – availability included

PR	Installed Capacity (MWp)	Probability of Exceedance	Specific Yield (kWh/kWp)	1st Year Production (MWh)
76.7%	99.99 MWp	P50	1,829	182,982
		P75	1,723	172,399
		P90	1,628	162,873
		P99	1,464	146,478

98% Plant availability has been assumed in the above specific yield and production figures. No assumption for grid unavailability has been implemented at this stage of the feasibility study.

The figures in Table 15 already contain an allowance for the first year's degradation. For subsequent years we typically consider an annual degradation for this technology of 0.7%. The same figure is used in the financial model in section 8.

7.4.3 Forecast Specific Yields over 25 years

Table 16 shows the year 1, year 10 and year 25 specific yield and generation figures at varying probabilities of exceedance. These figures include 98% Plant availability assumptions, and an annual linear degradation of 0.7% has been applied after Year 1. Grid availability has not been considered in these figures.

Table 16: Specific yield and generation at varying probabilities of exceedance

	Probability of Exceedance	Specific Yield (kWh/kWp)	Generation (MWh)
1	P50	1,829	182,982
	P75	1,723	172,399
	P90	1,628	162,873
	P99	1,464	146,478
10	P50	1,801	180,126
	P75	1,707	170,800
	P90	1,623	162,406
	P99	1,479	147,959
25	P50	1,753	175,365
	P75	1,663	166,397
	P90	1,493	149,357
	P99	1,444	144,433

7.5 Uncertainty Analysis

The uncertainties feeding into our yield analysis can be separated into three discrete parts:

- Variation in year on year irradiation
- Duration of forward modelling period irradiation variability
- Uncertainties in the PR modelling assumptions

Each of these uncertainties is discussed in turn below.

7.5.1 Long term irradiation variability

Variability of irradiation is a key driver for the income of the Project. Long term irradiation data from SolarGIS was used to assess irradiation variability and details are shown in Table 17.

Table 17: Long term time series data

Satellite datasource	Years of data	Standard deviation	Standard error of the mean
SolarGIS	17	4.60%	1.03%

The standard deviations in the table above are applied to the local inclined irradiation to achieve the P75 and P90 values. Table 18 shows the resulting irradiation values for a single year period.

Table 18: Probability distribution of Global Inclined Irradiation in a single year (kWh/m²/yr)

Probability of exceedance	Global Inclined Irradiation
P50	2,362
P75	2,299
P90	2,242
P99	2,144

7.5.2 Irradiation uncertainty over multiple years

Uncertainties associated with annual irradiation over a longer period of time are dependent upon the number of years within that period. Over a longer modelling period, the standard error would be expected to reduce. Additional uncertainties associated with various forward modelling periods are shown in Table 19.

Table 19: Standard error of irradiation data over various modelling time periods

Number of years	Standard error of the mean
1	4.60%
10	1.45%
25	0.92%

7.5.3 Uncertainty in yield modelling assumptions

Uncertainties in the GHI, GII and PR (and therefore CUF) modelling assumptions are shown in Table 20. The uncertainty of the GHI has be estimated using SolarGIS database.

Table 20: Yield modelling uncertainty

Item	Uncertainty	Explanation
Global Horizontal Irradiance	± 8.00%	Metrological and methodical uncertainty related to available irradiation data sources and the applied value in yield calculations.
Horizontal-to-Inclined Calculation	± 0.80%	Additional uncertainty associated with the calculation model for the different components of inclined surface irradiation.
Near shadings	± 0.30%	Uncertainty arising from the temporal resolution and from the approximations made in the simulation.
Spectral	± 0.50%	Uncertainty due to the estimation of the effect of solar spectrum on modules according to literature.
Angular / Reflection	± 0.30%	Uncertainty associated with the calculation model.
Soiling	± 2.00%	Uncertainty associated with the estimation of soiling loss.
Low Irradiation	± 0.30%	Uncertainties of η(G) mainly arise only during periods of low irradiance.
LID (Light Induced Degradation)	± 0.20%	Uncertainty associated with the estimation of LID loss.
Module quality - Tolerance	± 2.00%	Uncertainty (standard deviation) obtained in round-robin tests performed at international calibration laboratories.
Module Temperature Losses	± 0.70%	Uncertainty arising from uncertainties of input data.
Mismatch	± 0.35%	Uncertainty coming from input data tolerances as well as approximations made in the calculation.
Ohmics,	± 0.50%	Uncertainty arising mainly due to the calculation of low DC

Item	Uncertainty	Explanation
DC wiring		power.
Inverter Efficiency	± 1.00%	Uncertainty arising from uncertainties of input data as well as approximations made in the model.
Undersizing of the inverter	± 0.00%	Uncertainty induced by temporal resolution and approximations made in the simulation.
MPPT Performance	± 0.30%	Uncertainty coming from input data uncertainties and approximations made in the calculation.
Ohmics, AC LV wiring	± 0.10%	Uncertainty arising mainly due to the calculation of low voltage AC power.
Ohmics, AC MV wiring	± 0.10%	Uncertainty arising mainly due to the calculation of medium voltage AC power.
LV to MV transformer	± 0.50%	Uncertainty in the calculation of transformer losses.
MV to HV transformer	± 0.20%	Uncertainty in the calculation of transformer losses.
Self-consumption	± 0.30%	Uncertainty in the calculation of self-consumption losses.
Degradation	± 0.30%	Uncertainty due to the assumption of published degradation rates.
Modelling uncertainty	**± 8.70%**	

The overall uncertainty in the yield and PR estimations corresponds to a value of **± 8.70%**. This value is calculated via the standard error approach, which measures how a sample mean deviates from the actual mean. The final value is the square root of the sum of the squares of each individual uncertainty value.

7.5.4 Combined uncertainties

The three uncertainties listed above are combined using the common standard error approach. The overall combined uncertainty which will be applied to the calculated specific yield figures in the next section for a one year, 10 year and 25 year period are shown in Table 21.

Table 21: Combined uncertainties over various modelling time periods

	Uncertainties		
Number of years being modelled	1	10	25
Standard error historic irradiation uncertainty		1.03%	
Standard error irradiation uncertainty over time	4.60%	1.45%	0.92%
Standard error PR uncertainty		8.70%	
Combined uncertainty	**9.90%**	**8.88%**	**8.82%**

7.5.5 Probabilities of exceedance estimation

Specific yields at varying levels of probability and over varying time periods may be calculated by applying the factors in Table 22 below to the first year P50 value found in previous sections.

Table 22: Specific yield probability adjustment factors beyond Year One

Number of Years		1	10	25
Probability Level	P50	1.00000	1.00000	1.00000
	P75	0.93328	0.94012	0.94052
	P90	0.87322	0.88623	0.88699
	P99	0.76987	0.79347	0.79486

7.6 Conclusions

The global horizontal irradiation is highly favourable for development of a solar project, despite the conservative scenario assumed in the area mainly due to the uncertainty about meteorological data. Subject to further study and correlation with site data, there may be potential to revise this figure at a later stage.

The in-plane-irradiation has been assessed for different inclinations. The correct balance between these factors will determine the optimal configuration of the Project. The design and simulation provided have carried forward with single axis tracking having rotation limit of -52° to 52°, which is indicative but expected to be close to optimal at this stage.

Concerning losses, temperature and soiling losses can be significant and have a major impact on the performance of the PV system. Whereas the former cannot be controlled, the latter can be mitigated by employing an adequate cleaning protocol. Therefore, we would expect the soiling loss to be fixed in the O&M contract.

Finally, a PR estimate of 76.7% and CUF of 22%, including Plant availability but excluding grid availability, have been calculated for the representative design outlined in Table 10. These figures lead to a first year P50 specific yield of **1,829 kWh/kWp**, which is in line with our expectations.

8 Economic Analysis

The economic analysis of a project represents one of the main steps in the assessment of the Project feasibility. The analysis is carried out using a financial model.

This preliminary economic assessment is provided to demonstrate the likely feasibility of the project and should not be considered as financial advice. We recommend seeking professional financial and accounting advice before making any investment decision.

Inputs and outputs of the Project financial model are listed as follows:

Inputs

- Capacity Utilisation Factor (CUF)
- Capital Expenditure (Capex)
- Operating Expenditure (Opex)
- Financing parameters

A breakdown of the Capex and Opex costs is shown in Table 23 and Table 24 below. Costs have been suggested and / or agreed with the Client.

The analysis reported in this section is a preliminary economic analysis and the impacts of delays were not considered. We recommend that any additional site-specific costs, including those highlighted in Section 3, be included in the final version of the Project sponsor's financial model.

Table 23: Capex costs estimation

Item	Total (USD)
EPC costs	86,000,000
Development	4,914,000
Insurances	—
Financial charges	1,647,125
Interest during construction	2,625,421
Land Costs	2,692,000
Total	**97,878,546**

Table 24: Opex costs estimation

Item	Total (USD/yr)
O&M costs	1,400,000
Insurance	—
Total	**1,400,000**

Outputs

- Equity Internal Rate of Return (IRR)
- Payback period

8.1 Model inputs

Table 25 below summarises the assumptions included in the Project financial model.

Table 25: Summary of assumptions

Item	Unit	Value
Project Assumptions:		
System size (DC capacity)	MWp	99,990.60
Generation (including 98% Plant availability)	MWh	182,982
Capacity Utilisation Factor (CUF)	%	20.89
Annual degradation	%	0.7
Incentives Assumptions[6]:		
Project lifetime	years	25
Feed in tariff (FiT) year 1 – 14 @CUF > 18	USD/MWh	70.94
FiT year 15- 25 @ CUF > 18	USD/MWh	28.37
Annual indexation of FiT[7]	%	–
Financial Assumptions:		
Income tax	%	–
Debt / Equity ratio	-	75 / 25
Initial debt	$m USD	73.41
Annual nominal interest[8]	%	5.20%
Period of loan	years	14
Repayment Frequency	Quarterly	56
Cost Assumptions:		
Capex	$m USD	97.88
Opex	$m USD/yr	1.40
Annual inflation	%	–

[6] These figures have been suggested and / or agreed with the Client.

[7] These figures have been suggested and / or agreed with the Client.

[8]These figures have been suggested and / or agreed with the Client.

8.2 Results

The outcomes of the economic analysis based on the assumptions described in the previous section are reported as follows. The economic feasibility of the Project has been carried out evaluating the Project's Payback period and IRR, corresponding to the both levered and unlevered cash flow.

The IRR measures the discount rate at which the NPV becomes zero. When compared with the internal weighted average cost of capital of the project vehicle, the IRR can provide an assessment of the likely profitability of the project.

The payback period provides an estimation of the predicted length of time to recover the cost of the investment based on undiscounted cash flows. The results of the analysis are shown in Table 26 below.

Table 26: Project Payback period and IRR

Item	Levered Cash Flow	Unlevered Cash Flow
Payback period (years)	6.20	8.7
IRR (%)	16.0%	8.8%

The results of the economic analysis, although indicative and to be confirmed by financial advisors, indicate that the proposed Project will be economically viable.

We also consider that over its design lifetime the project will provide a number of other benefits including:

- An average generation of approximately 168,405 MWh/yr to help overcome Pakistan's current energy deficit and provide for future economic and social development
- Exporting power into the local distribution system, thus reducing energy losses and the strain on the local distribution grid
- Saving the emission of more than 2.4 million tonnes CO_2-e and making a meaningful step towards greater sustainability
- Contributing to the development of a diverse and robust mix of generation technologies with less reliance on imported fossil fuels
- Providing a diversification of employment opportunities and income for the local community.

Appendices

A. Irradiation Database Overviews

Table 27: Irradiation database details

Database Name	Description
SolarGIS	This dataset is calculated from satellite data from Meteosat, GOES and IODC satellite data, meteorological data and other geographical parameters, Meteosat data is based on satellite data obtained over thirty minute periods between 1994 and 2004 (Meteosat First Generation) and over fifteen minute periods between 2005 and 2010 (Meteosat Second Generation). For Asia, IODC region, irradiation data are available from 1999. The outputs include the modelled time-series GHI and DNI data and are resampled to 2 arc-minutes regular grid, The outputs are validated using ground measurements from worldwide met stations with a relative mean bias for GHI of 1.1% in Europe.
Photovoltaic Geographical Information System (PVGIS) Climate SAF	This dataset is based on calculations from satellite images performed by CM-SAF. The database represents a total of 13 years of data combining MFG first generation Meteosat satellite data (1998 to 2005) with MSG second generation Meteosat satellite data (2006 to 2011). The spatial resolution is 1.5 arc-minutes (around 2.5 km x 2.5 km).
NREL CSR	NREL has developed 40-km resolution solar datasets of the period 1985-1991 for Central America/Cuba, the Caribbean, Asia/South Asia, Africa and South America. The data are based on gridded cloud cover data and aerosol optical depth data, which serve as inputs to NREL's Climatological Solar Radiation (CSR) model. The datasets have been developed for United Nations Environmental Program (UNEP)'s Solar and Wind Energy Resource (SWERA) project, which also included data

B. Requirements for Key Components

B.1. Photovoltaic Modules

B.1.1. Technical requirements

The EPC Contractor is allowed to make use of the following photovoltaic module technology:

- Monocrystalline silicon

Crystalline silicon modules are required to be IEC 61215 certified. Detailed specification sheets and certificates of compliance to these standards are to be provided.

In addition, the modules shall feature the following qualities:

- Normal Operating Cell Temperature (NOCT) is at maximum 45°C with a tolerance of ±2°C
- The module operating temperature range is to be at least -40 to 85°C
- The temperature coefficients for power is to be at least -0.39%/°C (i.e. the magnitude of the power loss is less than 0.39%/°C)
- All modules are required to have a positive output tolerance
- Modules shall have anti-reflective coating

B.1.2. Flash Tests

A comprehensive IV flash test report for each PV module procured shall be provided to the Project Manager in Excel format prior to commencement of construction. The data must have the following information:

- Product name and number (external and internal)
- The test condition the measurement is carried out
- Serial number of the tested module, including which modules are in which shipping containers and pallets
- Power at maximum power point (Pmpp)
- Voltage at MPP (Vmpp)
- Current at MPP (Impp)
- Fill factor
- Open circuit voltage (Voc)
- Short circuit current (Isc)
- Module surface temperature (measured by temperature sensor, corrected and uncorrected if possible)

This information shall be provided by latest two (2) weeks prior to the arrival of PV modules on the Site.

B.1.3. Installation

The EPC Contractor is responsible for the installation of modules according to the manufacturer's specifications. The PV module installation manual must be provided as part of the as-built documentation. The manual shall contain all the necessary requirements and specifications for proper module installations such as (but not limited to):

- Types of mounting structures including physical requirements for securing mechanisms (screws, clamps, dimensions, tightening force, locations) and useful information such as recommended mounting types, recommended spacing to guarantee sufficient air circulation, restrictions to certain environments etc.
- Mechanical and electrical configuration guidelines (landscape, portrait, string and array sizing, grounding etc.).
- Earthing requirements.

B.1.4. Guarantees and Warranties

Modules shall carry a defect warranty of at least 10 years and a 25 year linear performance guarantee with 80% of rated module power being guaranteed at year 25.

The warranties offered by the module manufacturer shall be transferrable to the Project's owner. Other terms and conditions for warranties transferability must be clearly defined.

The sales agreement with the module manufacturer shall clearly define the claiming procedure of defective modules, the required additional specific independent party involvement and any other conditions that might influence the honouring of the warranty and guarantee.

- If inverters are installed outdoors must have to be protected from direct sunlight
- The inverter requires an external DC switch

In cases where applicable, there may special grounding requirements for inverters. These are stipulated by the PV module manufacturer. In such cases, it is the EPC Contractor's responsibility to notify the Project Manager and implement these requirements.

B.2.2. Guarantees and Warranties

Inverters shall have a warranty of at least 10 years. The contract sales agreement with the inverter manufacturer shall clearly define the claiming procedure of defect inverters or parts. The required testing, independent verification requirements and any other conditions that might influence the honouring of the warranties.

Any extension and the full scope of that extension to the standard limited warranty that is included in the price should be indicated clearly.

Upon request by the Project Manager, the EPC Contractor must provide proof that the inverter manufacturers have sufficient financial backup that covers manufacturers in bankruptcy or insolvency procedures.

The conditions which void the warranties shall be clearly stated.

The warranties offered by the Inverter manufacturers shall be transferrable to the Project's owner. Other terms and conditions for warranties transferability must be clearly defined.

B.3. Mounting structure

Modules shall be mounted on a non-corrosive support structures. Structure and foundation or fixation arrangements should withstand the required dead and wind loads.

B.3.1. Fixed-inclination structure

Single Axis module structure, if selected, will be installed with modules facing due south at the required inclination to maximize annual energy output.

B.4. Balance of Plant

B.4.1. Transformers

The transformer shall comply with IEC 60076 and have a design life of at least 25 years. The transformer can be incorporated into a containerised solution (central) inverter, standalone or incorporated in a container with the Ring Main Unit. The internal ring voltage is 33kV. Transformers may be oil-immersed or dry type. The transformer shall have the appropriate IP class for the indoor or outdoor application in terms of IEC 60529. Maximum energy loss from the LV/33kV transformer shall be less than 1.3% of the annual energy production. Maximum energy loss from the 11/132kV transformer shall be 0.5% of the annual energy production.

B.4.2. Ring Main Unit

The Ring Main Unit (RMU) may be incorporated inside a cabinet together with the transformer or be a standalone unit within a cabinet. The RMU shall feature motorised contactors to allow remote operations. The RMU shall comply with IEC 62271-202/200/100.

B.4.3. Protection and control devices

The protection and switching methodology shall be determined by the EPC Contractor's proposed design and technology but the degrees of protection shall comply with the applicable standards associated with PV and electrical works in general. Overcurrent and overvoltage devices shall be required on the DC and AC sides. Switchgear used in any switchboards shall comply with IEC 60947 and IEC 62271.

B.4.4. Lightning Protection and Earthing

The EPC Contractor is to conduct a risk mitigation study of lightning damage as per IEC 62305 and implement sufficient Lightning Protection System (LPS).

Earthing shall comply with IEC. A neutral earthing design is required

All structures, enclosures, PV modules and cabinets shall be earthed appropriately.

B.5. Cabling

B.5.1. General

All cabling shall be installed in accordance with manufacturers' requirements and to meet the design conditions used in the sizing calculations.

The combined cable DC and AC losses shall not exceed 3%.

B.5.2. DC cables

The DC cables of the PV installation must have the following characteristics as minimum:

- Cables used outside shall be UV resistant and ozone protected
- Cables should have Class II rating for insulation
- Cables must be rated for temperatures from -15°C to +90°C. This requirement is also applicable to all materials used in the installation (such as cable conduits)
- The cable shall be made of double insulated component and shall have a minimal life span of 25 years
- Cables shall comply with TÜV 2 Pfg 1169
- All DC solar cable shall be halogen free, flame resistant & fire retardant
- Cables shall be terminated with MC4 connectors
- The cable bending radius shall be at minimum four times the cable diameter or as specified by manufacturer, if different
- Cables have to be sized to allow a current up to 1.25 Isc and up to 1.2 Voc

Cables must be installed in conduits and hooded cable trays. The cable return path should follow the same way to avoid induction loops.

Cables must be dimensioned according to CEI 20-40 and CEI 20-67. Norm CEI 64-8 should be followed to prevent short-circuit-induced current. Norm CEI 82-25 should be followed regarding arrangement of cables and cables trays.

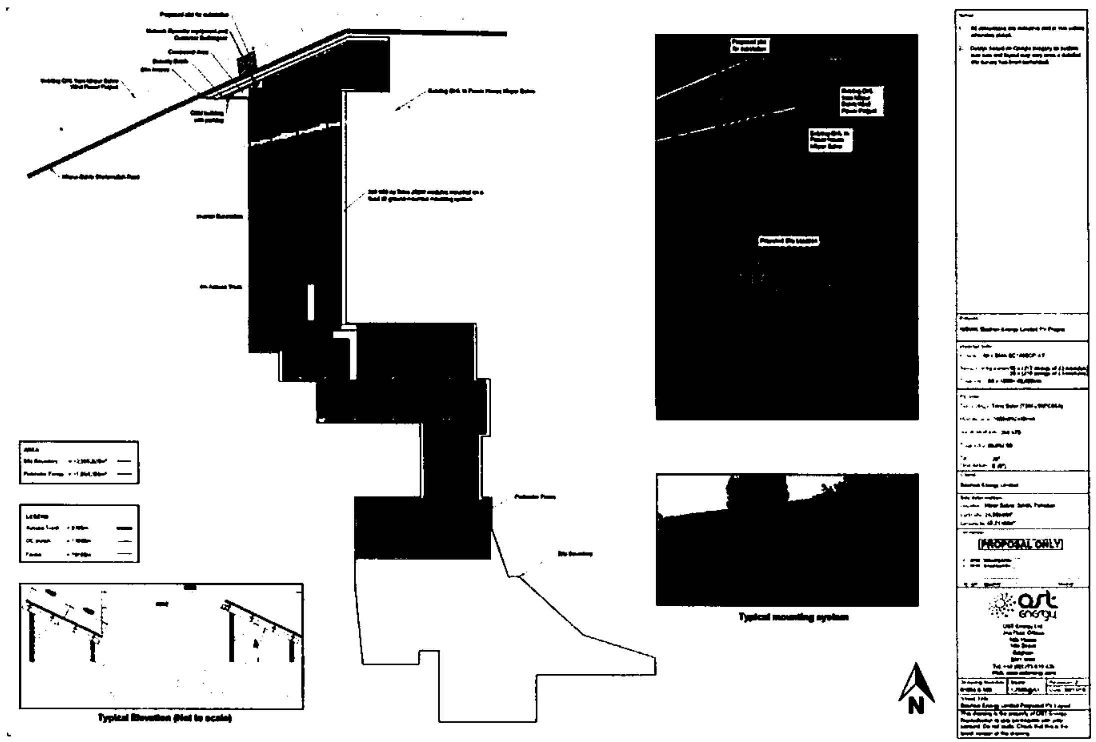
Combined DC cable losses are to be less than 2% at Standard Test Conditions.

B.5.3. AC cables

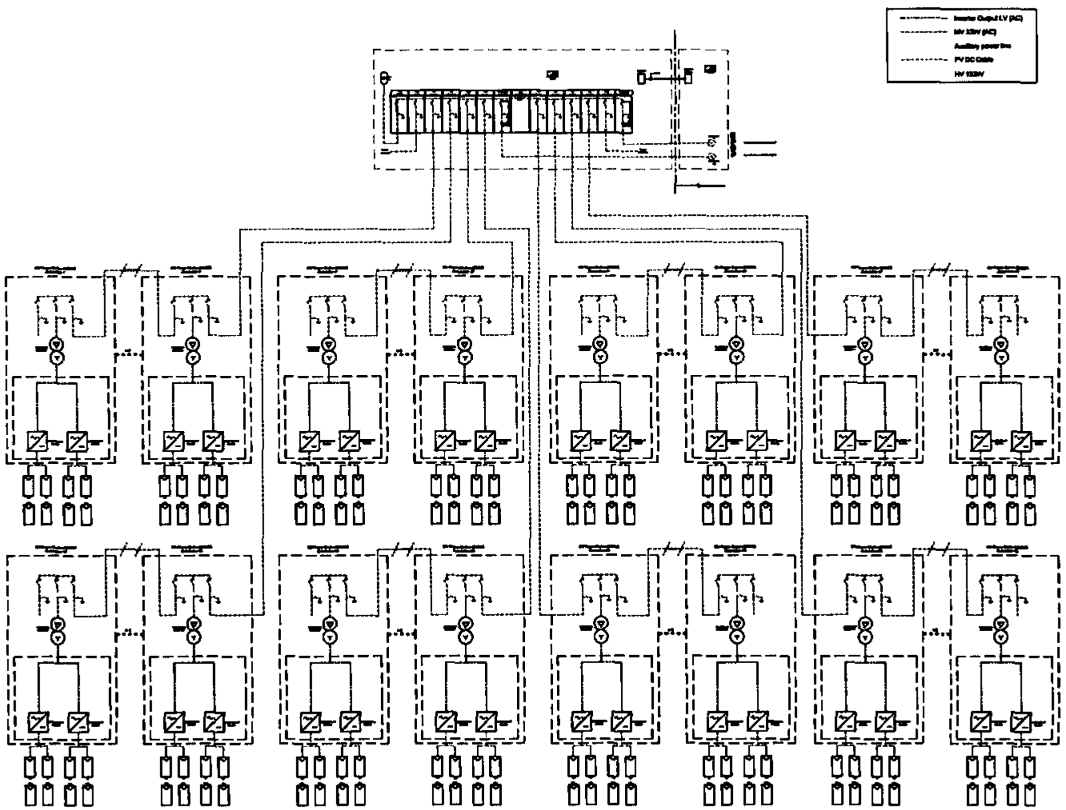
The AC cables of the PV installation must have the following characteristics as minimum:

- All AC cables may be XLPE or PILC with aluminium or copper stranded wire conductors
- All cable construction shall be according to IEC 60502
- All AC cables shall be suitable for direct buried (armoured) or ducted installation
- All joints and terminations be completed and tested in accordance with the manufacturer's recommendations
- AC cables are to be terminated in suitable lugs

C. Proposed layout



D. Plant Single Line Diagram (SLD)



E. Financial model

Cash flow								
Net profit	USD		3,934,044	4,038,396	4,152,936	4,278,415	4,415,415	4,564,551
Depreciation	USD		3,915,142	3,915,142	3,915,142	3,915,142	3,915,142	3,915,142
Total operating cash flow	USD		7,849,186	7,953,538	8,068,078	8,193,556	8,330,557	8,479,692
CAPEX	USD	(97,878,546)						
Drawdown of equity	USD	24,469,637						
Drawdown of senior loan	USD	73,408,910						
Repayment of senior loan	USD		(3,661,742)	(3,856,757)	(4,062,157)	(4,278,497)	(4,506,359)	(4,746,356)
Dividends	USD		(4,187,444)	(4,096,782)	(4,005,920)	(3,915,059)	(3,824,198)	(3,733,336)
	USD		*17.11%*	*16.74%*	*16.37%*	*16.00%*	*15.63%*	*15.26%*
Total financing & investing cash flow	USD		(7,849,186)	(7,953,538)	(8,068,078)	(8,193,556)	(8,330,557)	(8,479,692)
Beginning cash	USD							
Change in cash	USD							
Ending cash	USD							
Balance								
Fixed assets	USD	97,878,546	93,963,404	90,048,262	86,133,121	82,217,979	78,302,837	74,387,695
Cash	USD	0						
Total assets	USD	97,878,546	93,963,404	90,048,262	86,133,121	82,217,979	78,302,837	74,387,695
	USD							
Net equity	USD	24,469,637	24,216,236	24,157,851	24,304,867	24,668,222	25,259,440	26,090,654
Total debt	USD	73,408,910	69,747,168	65,890,411	61,828,254	57,549,756	53,043,397	48,297,041
Total equity & liabilities	USD	97,878,546	93,963,404	90,048,262	86,133,121	82,217,979	78,302,837	74,387,695
			-	-	-	-	-	-
Revenues								
Degradation	%			0.70%	0.70%	0.70%	0.70%	0.70%
Cumulative dregradation			100.00%	99.30%	98.60%	97.90%	97.20%	96.50%
Total generation			182,982	181,701	180,420	179,139	177,859	176,578
Generation @ 20.89 tariff	MWh		182,979	181,701	180,420	179,139	177,859	176,578
Generation @ > 20.89 tariff	MWh		3	-	-	-	-	-
PPA inflation	MWh		-	-	-	-	-	-
Cumulative inflation	%		100%	100%	100%	100%	100%	100%
PPA price @ CF = 20.89	%		70.94	70.94	70.94	70.94	70.94	70.94
PPA price 20.89%<CUF<21.89	USD		-	-	-	-	-	-
Revenues from energy sale	USD		12,979,995	12,889,333	12,798,471	12,707,610	12,616,749	12,525,887
Costs								
Inflation	%		0%	0%	0%	0%	0%	0%
Cumulative inflation	%		100%	100%	100%	100%	100%	100%
Costs	USD		1,400,000	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000
OPEX	USD							
Asset management	USD							
Depreciation								
			97,878,546	93,963,404	90,048,262	86,133,121	82,217,979	78,302,837
Bookvalue BOP	USD	97,878,546						
CAPEX	USD							
Depreciation	USD		(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)
Book value EOP	USD		93,963,404	90,048,262	86,133,121	82,217,979	78,302,837	74,387,695
Financing								
Debt BOP	USD		73,408,910	69,747,168	65,890,411	61,828,254	57,549,756	53,043,397
Drawdown	USD	73,408,910						
Repayment	USD		(3,661,742)	(3,856,757)	(4,062,157)	(4,278,497)	(4,506,359)	(4,746,356)
Debt EOP	USD		69,747,168	65,890,411	61,828,254	57,549,756	53,043,397	48,297,041
Interest	USD		(3,730,809)	(3,535,794)	(3,330,394)	(3,114,054)	(2,886,192)	(2,646,195)
Total debt service	USD		7,392,551	7,392,551	7,392,551	7,392,551	7,392,551	7,392,551
Tax								
Tax rate	%							
EBITDA	USD		11,579,995	11,489,333	11,398,471	11,307,610	11,216,749	11,125,887
Interest	USD		(3,730,809)	(3,535,794)	(3,330,394)	(3,114,054)	(2,886,192)	(2,646,195)
Capital allowances	USD		-	-	-	-	-	-
Taxable amount	USD		7,849,186	7,953,538	8,068,078	8,193,556	8,330,557	8,479,692
Tax losses utilised			-	-	-	-	-	-
Profit subject to tax			7,849,186	7,953,538	8,068,078	8,193,556	8,330,557	8,479,692
Tax			-	-	-	-	-	-
Tax loss carryforward BOP	USD		-	-	-	-	-	-
Losses for the period	USD		-	-	-	-	-	-
Tax losses utilised	USD		-	-	-	-	-	-
Tax loss carry forward EOP	USD		-	-	-	-	-	-
Capital allowances b/f	USD		97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546
Additions	USD	97,878,546	-	-	-	-	-	-
Allowances	USD	-	-	-	-	-	-	-
Capital allowances c/f	USD	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546
Dividends								
Available dividends	USD		4,187,444	4,096,782	4,005,920	3,915,059	3,824,198	3,733,336
Dividends	USD		4,187,444	4,096,782	4,005,920	3,915,059	3,824,198	3,733,336
Levered cashflow								
CF date	Date	December-15	June-16	June-17	June-18	June-19	June-20	June-21
Equity investment	USD	(24,469,637)						
Dividends	USD	(24,469,637)	4,187,444	4,096,782	4,005,920	3,915,059	3,824,198	3,733,336
Levered IRR	USD	16.0%						
Payback Period		6.20						
Unlevered cashflow								
CF date	Date							
Investment	USD	(97,878,546)						
Dividends	USD		4,187,444	4,096,782	4,005,920	3,915,059	3,824,198	3,733,336
Debt cashflow	USD		7,392,551	7,392,551	7,392,551	7,392,551	7,392,551	7,392,551
Total	USD	(97,878,546)	11,579,995	11,489,333	11,398,471	11,307,610	11,216,749	11,125,887
Unlevered IRR		8.8%						
Payback Period		8.70						

Cash flow							
Net profit	USD	4,726,468	4,901,847	5,091,406	5,295,900	5,516,123	5,752,914
Depreciation	USD	3,915,142	3,915,142	3,915,142	3,915,142	3,915,142	3,915,142
Total operating cash flow	USD	8,641,610	8,816,989	9,006,548	9,211,042	9,431,265	9,668,056
CAPEX	USD						
Drawdown of equity	USD						
Drawdown of senior loan	USD						
Repayment of senior loan	USD	(4,999,135)	(5,265,376)	(5,545,796)	(5,841,151)	(6,152,235)	(6,479,888)
Dividends	USD	(3,642,475)	(3,551,614)	(3,460,752)	(3,369,891)	(3,279,029)	(3,188,168)
	USD	*14.89%*	*14.51%*	*14.14%*	*13.77%*	*13.40%*	*13.03%*
Total financing & investing cash flow	USD	(8,641,610)	(8,816,989)	(9,006,548)	(9,211,042)	(9,431,265)	(9,668,056)
Beginning cash	USD						
Change in cash	USD						
Ending cash	USD						
Balance							
Fixed assets	USD	70,472,553	66,557,411	62,642,269	58,727,128	54,811,986	50,896,844
Cash	USD						
Total assets	USD	70,472,553	66,557,411	62,642,269	58,727,128	54,811,986	50,896,844
	USD						
Net equity	USD	27,174,647	28,524,881	30,155,535	32,081,544	34,318,638	36,883,384
Total debt	USD	43,297,906	38,032,530	32,486,734	26,645,583	20,493,348	14,013,460
Total equity & liabilities	USD	70,472,553	66,557,411	62,642,269	58,727,128	54,811,986	50,896,844
		-	-	-	-	-	-
Revenues							
Degradation	%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%
Cumulative dregradation		95.80%	95.10%	94.40%	93.70%	93.00%	92.30%
Total generation		175,297	174,016	172,735	171,454	170,173	168,892
Generation @ 20.89 tariff	MWh	175,297	174,016	172,735	171,454	170,173	168,892
Generation @ > 20.89 tariff	MWh	-	-	-	-	-	-
PPA inflation	MWh	-	-	-	-	-	-
Cumulative inflation	%	100%	100%	100%	100%	100%	100%
PPA price @ CF = 20.89	%	70.94	70.94	70.94	70.94	70.94	70.94
PPA price 20.89%<CUF<21.89	USD	-	-	-	-	-	-
Revenues from energy sale	USD	12,435,026	12,344,165	12,253,303	12,162,442	12,071,581	11,980,719
Costs							
Inflation	%	0%	0%	0%	0%	0%	0%
Cumulative inflation	%	100%	100%	100%	100%	100%	100%
Costs	USD	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000
OPEX	USD						
Asset management	USD						
Depreciation							
		74,387,695	70,472,553	66,557,411	62,642,269	58,727,128	54,811,986
Bookvalue BOP	USD						
CAPEX	USD						
Depreciation	USD	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)
Book value EOP	USD	70,472,553	66,557,411	62,642,269	58,727,128	54,811,986	50,896,844
Financing							
Debt BOP	USD	48,297,041	43,297,906	38,032,530	32,486,734	26,645,583	20,493,348
Drawdown	USD						
Repayment	USD	(4,999,135)	(5,265,376)	(5,545,796)	(5,841,151)	(6,152,235)	(6,479,888)
Debt EOP	USD	43,297,906	38,032,530	32,486,734	26,645,583	20,493,348	14,013,460
Interest	USD	(2,393,416)	(2,127,175)	(1,846,755)	(1,551,400)	(1,240,316)	(912,664)
Total debt service	USD	7,392,551	7,392,551	7,392,551	7,392,551	7,392,551	7,392,551
Tax							
Tax rate	%						
EBITDA	USD	11,035,026	10,944,165	10,853,303	10,762,442	10,671,581	10,580,719
Interest	USD	(2,393,416)	(2,127,175)	(1,846,755)	(1,551,400)	(1,240,316)	(912,664)
Capital allowances	USD	-	-	-	-	-	-
Taxable amount	USD	8,641,610	8,816,989	9,006,548	9,211,042	9,431,265	9,668,056
Tax losses utilised		-	-	-	-	-	-
Profit subject to tax		8,641,610	8,816,989	9,006,548	9,211,042	9,431,265	9,668,056
Tax		-	-	-	-	-	-
Tax loss carryforward BOP	USD	-	-	-	-	-	-
Losses for the period	USD	-	-	-	-	-	-
Tax losses utilised	USD	-	-	-	-	-	-
Tax loss carry forward EOP	USD	-	-	-	-	-	-
Capital allowances b/f	USD	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546
Additions	USD	-	-	-	-	-	-
Allowances	USD	-	-	-	-	-	-
Capital allowances c/f	USD	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546
Dividends							
Available dividends	USD	3,642,475	3,551,614	3,460,752	3,369,891	3,279,029	3,188,168
Dividends	USD	3,642,475	3,551,614	3,460,752	3,369,891	3,279,029	3,188,168
Levered cashflow							
CF date	Date	June-22	June-23	June-24	June-25	June-26	June-27
Equity investment	USD						
Dividends	USD	3,642,475	3,551,614	3,460,752	3,369,891	3,279,029	3,188,168
Levered IRR	USD						
Payback Period							
Unlevered cashflow							
CF date	Date						
Investment	USD						
Dividends	USD	3,642,475	3,551,614	3,460,752	3,369,891	3,279,029	3,188,168
Debt cashflow	USD	7,392,551	7,392,551	7,392,551	7,392,551	7,392,551	7,392,551
Total	USD	11,035,026	10,944,165	10,853,303	10,762,442	10,671,581	10,580,719
Unlevered IRR							
Payback Period							

Cash flow							
Net profit	USD	6,007,154	6,279,774	(632,350)	(668,691)	(705,032)	(741,373)
Depreciation	USD	3,915,142	3,915,142	3,915,142	3,915,142	3,915,142	3,915,142
Total operating cash flow	USD	9,922,296	10,194,916	3,282,792	3,246,451	3,210,110	3,173,769
CAPEX	USD						
Drawdown of equity	USD						
Drawdown of senior loan	USD						
Repayment of senior loan	USD	(6,824,990)	(7,188,471)	-	-	-	-
Dividends	USD	(3,097,307)	(3,006,445)	(3,282,792)	(3,246,451)	(3,210,110)	(3,173,769)
	USD	*12.66%*	*12.29%*	*13.42%*	*13.27%*	*13.12%*	*12.97%*
Total financing & investing cash flow	USD	(9,922,296)	(10,194,916)	(3,282,792)	(3,246,451)	(3,210,110)	(3,173,769)
Beginning cash	USD						
Change in cash	USD						
Ending cash	USD						
Balance							
Fixed assets	USD	46,981,702	43,066,560	39,151,418	35,236,277	31,321,135	27,405,993
Cash	USD						
Total assets	USD	46,981,702	43,066,560	39,151,418	35,236,277	31,321,135	27,405,993
	USD						
Net equity	USD	39,793,231	43,066,560	39,151,418	35,236,277	31,321,135	27,405,993
Total debt	USD	7,188,471	0	-	-	-	-
Total equity & liabilities	USD	46,981,702	43,066,560	39,151,418	35,236,277	31,321,135	27,405,993
		-	-	0	0	0	0
Revenues							
Degradation	%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%
Cumulative dregradation		91.60%	90.90%	90.20%	89.50%	88.80%	88.10%
Total generation		167,612	166,331	165,050	163,769	162,488	161,207
Generation @ 20.89 tariff	MWh	167,612	166,331	165,050	163,769	162,488	161,207
Generation @ > 20.89 tariff	MWh	-	-	-	-	-	-
PPA inflation	MWh	-	-	-	-	-	-
Cumulative inflation	%	100%	100%	100%	100%	100%	100%
PPA price @ CF = 20.89	%	70.94	70.94	28.37	28.37	28.37	28.37
PPA price 20.89%<CUF<21.89	USD	-	-	-	-	-	-
Revenues from energy sale	USD	11,889,858	11,798,996	4,682,792	4,646,451	4,610,110	4,573,769
Costs							
Inflation	%	0%	0%	0%	0%	0%	0%
Cumulative inflation	%	100%	100%	100%	100%	100%	100%
Costs	USD	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000
OPEX	USD						
Asset management	USD						
Depreciation							
		50,896,844	46,981,702	43,066,560	39,151,418	35,236,277	31,321,135
Bookvalue BOP	USD						
CAPEX	USD						
Depreciation	USD	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)
Book value EOP	USD	46,981,702	43,066,560	39,151,418	35,236,277	31,321,135	27,405,993
Financing							
Debt BOP	USD	14,013,460	7,188,471				
Drawdown	USD						
Repayment	USD	(6,824,990)	(7,188,471)				
Debt EOP	USD	7,188,471	0				
Interest	USD	(567,562)	(204,080)				
Total debt service	USD	7,392,551	7,392,551				
Tax							
Tax rate	%						
EBITDA	USD	10,489,858	10,398,996	3,282,792	3,246,451	3,210,110	3,173,769
Interest	USD	(567,562)	(204,080)	-	-	-	-
Capital allowances	USD	-	-	-	-	-	-
Taxable amount	USD	9,922,296	10,194,916	3,282,792	3,246,451	3,210,110	3,173,769
Tax losses utilised		-	-	-	-	-	-
Profit subject to tax		9,922,296	10,194,916	3,282,792	3,246,451	3,210,110	3,173,769
Tax		-	-	-	-	-	-
Tax loss carryforward BOP	USD	-	-	-	-	-	-
Losses for the period	USD	-	-	-	-	-	-
Tax losses utilised	USD	-	-	-	-	-	-
Tax loss carry forward EOP	USD	-	-	-	-	-	-
Capital allowances b/f	USD	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546
Additions	USD	-	-	-	-	-	-
Allowances	USD	-	-	-	-	-	-
Capital allowances c/f	USD	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546
Dividends							
Available dividends	USD	3,097,307	3,006,445	3,282,792	3,246,451	3,210,110	3,173,769
Dividends	USD	3,097,307	3,006,445	3,282,792	3,246,451	3,210,110	3,173,769
Levered cashflow							
CF date	Date	June-28	June-29	June-30	June-31	June-32	June-33
Equity investment	USD						
Dividends	USD	3,097,307	3,006,445	3,282,792	3,246,451	3,210,110	3,173,769
Levered IRR	USD						
Payback Period							
Unlevered cashflow							
CF date	Date						
Investment	USD						
Dividends	USD	3,097,307	3,006,445	3,282,792	3,246,451	3,210,110	3,173,769
Debt cashflow	USD	7,392,551	7,392,551	-	-	-	-
Total	USD	10,489,858	10,398,996	3,282,792	3,246,451	3,210,110	3,173,769
Unlevered IRR							
Payback Period							

Cash flow								
Net profit	USD	(777,714)	(814,055)	(850,396)	(886,737)	(923,078)	(959,419)	(995,760)
Depreciation	USD	3,915,142	3,915,142	3,915,142	3,915,142	3,915,142	3,915,142	3,915,142
Total operating cash flow	USD	3,137,428	3,101,087	3,064,746	3,028,405	2,992,064	2,955,723	2,919,382
CAPEX	USD							
Drawdown of equity	USD							
Drawdown of senior loan	USD							
Repayment of senior loan	USD	-	-	-	-	-	-	-
Dividends	USD	(3,137,428)	(3,101,087)	(3,064,746)	(3,028,405)	(2,992,064)	(2,955,723)	(2,919,382)
	USD	*12.82%*	*12.67%*	*12.52%*	*12.38%*	*12.23%*	*12.08%*	*11.93%*
Total financing & investing cash flow	USD	(3,137,428)	(3,101,087)	(3,064,746)	(3,028,405)	(2,992,064)	(2,955,723)	(2,919,382)
Beginning cash	USD							
Change in cash	USD							
Ending cash	USD							
Balance								
Fixed assets	USD	23,490,851	19,575,709	15,660,567	11,745,426	7,830,284	3,915,142	0
Cash	USD							
Total assets	USD	23,490,851	19,575,709	15,660,567	11,745,426	7,830,284	3,915,142	0
	USD							
Net equity	USD	23,490,851	19,575,709	15,660,567	11,745,426	7,830,284	3,915,142	(0)
Total debt	USD	-	-	-	-	-	-	-
Total equity & liabilities	USD	23,490,851	19,575,709	15,660,567	11,745,426	7,830,284	3,915,142	(0)
		0	0	0	0	0	0	0
Revenues								
Degradation	%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%	0.70%
Cumulative dregradation		87.40%	86.70%	86.00%	85.30%	84.60%	83.90%	83.20%
Total generation		159,926	158,645	157,365	156,084	154,803	153,522	152,241
Generation @ 20.89 tariff	MWh	159,926	158,645	157,365	156,084	154,803	153,522	152,241
Generation @ > 20.89 tariff	MWh	-	-	-	-	-	-	-
PPA inflation	MWh	-	-	-	-	-	-	-
Cumulative inflation	%	100%	100%	100%	100%	100%	100%	100%
PPA price @ CF = 20.89	%	28.37	28.37	28.37	28.37	28.37	28.37	28.37
PPA price 20.89%<CUF<21.89	USD	-	-	-	-	-	-	-
Revenues from energy sale	USD	4,537,428	4,501,087	4,464,746	4,428,405	4,392,064	4,355,723	4,319,382
Costs								
Inflation	%	0%	0%	0%	0%	0%	0%	0%
Cumulative inflation	%	100%	100%	100%	100%	100%	100%	100%
Costs	USD	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000	1,400,000
OPEX	USD							
Asset management	USD							
Depreciation								
		27,405,993	23,490,851	19,575,709	15,660,567	11,745,426	7,830,284	3,915,142
Bookvalue BOP	USD							
CAPEX	USD							
Depreciation	USD	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)	(3,915,142)
Book value EOP	USD	23,490,851	19,575,709	15,660,567	11,745,426	7,830,284	3,915,142	0
[illegible]								
Debt BOP	USD							
Drawdown	USD							
Repayment	USD							
Debt EOP	USD							
Interest	USD							
Total debt service	USD							
[illegible]								
Tax rate	%							
EBITDA	USD	3,137,428	3,101,087	3,064,746	3,028,405	2,992,064	2,955,723	2,919,382
Interest	USD	-	-	-	-	-	-	-
Capital allowances	USD	-	-	-	-	-	-	-
Taxable amount	USD	3,137,428	3,101,087	3,064,746	3,028,405	2,992,064	2,955,723	2,919,382
Tax losses utilised		-	-	-	-	-	-	-
Profit subject to tax		3,137,428	3,101,087	3,064,746	3,028,405	2,992,064	2,955,723	2,919,382
Tax		-	-	-	-	-	-	-
Tax loss carryforward BOP	USD							
Losses for the period	USD	-	-	-	-	-		
Tax losses utilised	USD	-	-	-	-	-		
Tax loss carry forward EOP	USD	-	-	-	-	-	-	-
Capital allowances b/f	USD	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546
Additions	USD	-	-	-	-	-	-	-
Allowances	USD	-	-	-	-	-	-	-
Capital allowances c/f	USD	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546	97,878,546
[illegible]								
Available dividends	USD	3,137,428	3,101,087	3,064,746	3,028,405	2,992,064	2,955,723	2,919,382
Dividends	USD	3,137,428	3,101,087	3,064,746	3,028,405	2,992,064	2,955,723	2,919,382
Levered cashflow								
CF date	Date	June-34	June-35	June-36	June-37	June-38	June-39	June-40
Equity investment	USD							
Dividends	USD	3,137,428	3,101,087	3,064,746	3,028,405	2,992,064	2,955,723	2,919,382
Levered IRR	USD							
Payback Period								

F. Module Datasheet

ELECTRICAL SPECIFICATIONS	
STC rated output (Pmpp)*	550Wp (above)
Rated voltage (Vmpp) at STC	41.96 V
Rated current (Impp) at STC	13.11 A
Module efficiency	21.3%
Types of solar PV cell	Mono-crystalline
Tolerance	0/+5W or better
Coefficient temperature	-0.350%/°C
cable	$4mm^2$
Connector type	MC4
NOCT	45+2,45-2
Frontal Glass	Single glass, 2.0mm coated tempered
Certifications	TUV/IEC/MCS/UL/ISO/TS/OHSAS
Warranty	First year 2% degradation, 2nd to 25th 0.45% linear degradation or less
Operating temperature	-40°C to 85°C
Maximum voltage	1500V DC

RELATED PARAMETERS	
Cell type	Mono crystalline
Number of cells/cell arrangement	144/6*24
Packing unit	31 psc/Pallet

MECHANICAL SPECIFICATIONS	
Outer dimensions(L*W*H)	2244*1112*35 mm
Frame technology	Anodized Aluminium alloy
Module composition	Glass/EVA/Back sheet(White)
Weight(module only)	31.8kg
Front glass thickness	2.0mm
Junction box IP rating	IP 68, three diodes
Cable diameter(UL/IEC)	$4mm^2$
Fire performance	UL Type 29
Connector type	MC type 4 compatible

G. Inverter Datasheet

INVERTER SPECIFICATIONS		
DC Parameter	Maximum DC Voltage	1500V
	Operating Voltage Range	905V ~ 1300V
	Maximum DC Current	8*1400A
	DC Inputs	40 Inputs
Ac Parameter	Rated Output Power	8800kW@40℃
	Rated Grid Voltage	630V
	Allowable Grid Voltage	510 ~ 660 V
	Maximum Output Current	8*1160 A
	Rated Grid Frequency	50 Hz (60Hz Optional)
	Allowable Grid Frequency	45~55Hz(55~65Hz Optional)
	Adjustable Range of Power Factor	>+0.99,0.8 Leading,-0.8 Lagging
	Total Current Waveform Deviation Factor	<3%
	Maximum Efficiency	99.0%
	Euro Efficiency	98.7%

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SIACHEN ENERGY LIMITED

ENERGY FOR A BETTER TOMORROW

Extracts of the Resolution
Passed by the Board of Directors of Siachen Energy Limited
In its meeting held on 26th day of October 2022

Resolution:

1. **RESOLVED THAT,** "the Board of Directors of Siachen Energy Limited ("Siachen") hereby approved to file the License Proposed Modification (LPM) with National Electric Power Regulatory Authority ("NEPRA" or the "Authority") in respect of 100 MW Solar Power Plant to be located at Mirpur Sakro, District Thatta, Sindh (the "Project") and in relation thereto enter into and execute any and all required documents, make all filings, do any act and pay all applicable fees, whatever it may be in each case, of any nature whatsoever as may be required."

2. **FURTHER RESOLVED THAT,** "in respect of License Proposed Modification (LPM) and applications etc. to be submitted to NEPRA, Mr. Muhammad Kashif Shamsi, is the duly authorized representative on behalf of the Company for the purpose of filing the License Proposed Modification (LPM) and is hereby empowered and authorized for and on behalf of the Company to:
   a. Review, execute, submit and deliver the License Proposed Modification (LPM) or applications (including modifications thereto) and related documentation required by NEPRA, inter alia, any consents, contract, document, power of attorney, affidavits, statements, letters, forms, applications, deeds, undertakings, approvals, memoranda, amendments, communications, notices, certificates, request and any other instruments of any nature whatsoever;
   b. Sign and execute necessary documentation, pay necessary fees, appear before NEPRA as needed and do all necessary things for the issuance of tariff for the Project;
   c. Represent and respond on behalf of the Company, in the public hearings, to all of NEPRA's queries, case officers, stakeholders and to attend pre and post hearing meetings;
   d. Do all such acts, matters and things as may be necessary for carrying out the purposes aforesaid and give full effect to the above-said; and
   e. Delegate all or any of the above powers in respect of the foregoing to any other officials of the Company as deemed appropriate.

CERTIFIED TO BE TRUE COPY

Siachen Energy Limited SEL

Dated: October 26, 2022

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Rupees

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07 MAR 2023

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Notary Public
KARACHI PAKISTAN

AFFIDAVIT
BEFORE THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA)

I, Mr. Muhammad Kashif Shamsi s/o Abdul Samad Shamsi, Muslim, Adult, having CNIC 42301-2478227-7, Authorized Representative of Siachen Energy Limited ("The Company"), having its registered office at 74 J-Street, Off Khayaban-e-Muhafiz, Phase VI, DHA, Karachi, do hereby solemnly affirm and declare as under:-

1. That I am the Authorized Representative of the Company.
2. That I, on behalf of the Company, have filed accompanying License Proposed Modification, together with supporting documents to the NEPRA and the contents of the same may kindly be read as an integral part of this affidavit.
3. That the content of the accompanying License Proposed Modification and all further documentation and/or information to be provided by me in connection with the accompanying Tariff Petition are true and correct to the best of my knowledge and belief.
4. That nothing has been concealed in this regard.

DEPONENT
[Muhammad Kashif Shamsi]

VERIFICATION
Verified on oath on this _th Day of March, 2023 that the contents of this affidavit are true to the best of my knowledge and belief.

ATTESTED