

TECHNICAL SPECIFICATIONS

1. SCOPE OF THE WORK

The scope includes the Supply, Installation, Testing and Commissioning of Ground mounted On-Grid SPV power plant. All the necessary approvals from KSEBL/Electrical Inspectorate, feasibility study, necessary civil work, Mounting of Module Structures, PV Module Installation, Inverter Installation, DC/AC Cabling and interconnections, Installation of Lightning Arresters and Earthing System as per the standards, Arranging all the necessary inspections from KSEBL/Electrical Inspectorate/ ANERT District Office as part of Pre-Commissioning, if any, Commissioning of the PV Power Plant, are coming under the scope of the bidder.

- i. Requirement: - Prior visit to the Site must be carried out by the prospective bidders before submission of bids and no enhancement of rates shall be permitted thereafter

ii. SITE DETAILS

The proposed location for installation of the Ground Mounted solar PV power plant in Plantation valley resort of The Plantation corporation of Kerala Ltd (25 KW). The inverters are to be placed in the KSEB meter room building and to be connected at the incomer at Plantation vally resort of PCK LTD.

Bidders are to visit the site before quoting to avoid any sort of confusions during the work awarding stage; This is mandatory

#	Site Address	Building Name	Latitude	Longitude	Capacity of Power plant
1	Plantation vally Resort Pillappara, Vettilappara PO, The Plantation Corporation of Kerala Ltd.	Plantation Vally Resort	10.29074	76.54742	25kW

#	Site	Plantation Vally Resort
a.	Ground	Ground mounted
b.	Accessibility	Accessible
c.	Type of Electrical Consumer	LT

#	Site	Plantation Vally Resort
d.	Whether DG is available	Yes

(For reference only, Bidders are requested to submit bids only after site visit and a detailed estimation. The details provided don't entitle any claim during or after the tender process or after award of works):

2. SYSTEM COMPONENTS- TECHNICAL COMPLIANCE FOR SYSTEM COMPONENTS

S/N	System Component	Capacity/ rating	Minimum Technical Compliance
1.	PV Modules (Mono PERC Half cut cells – 380 W or above)	As per the required capacity	IS 14286 -Design Qualification and Type Approval for Crystalline Silicon Terrestrial Photovoltaic (PV) Modules IEC/IS 61730: Part I& II;
2.	Grid Tied Inverter (DC to AC ratio of 1.1 to be maintained at all sites)	As per the required capacity	IS 16221: Part 1 &2- Safety of Power Converters for use in Photovoltaic Power Systems IS 16169 - Test Procedure of Islanding Prevention Measures for Utility-Interconnected Photovoltaic Inverters
3.	Module Mounting Structure	As per the required capacity	IS 2062 - Hot Rolled Medium and High Tensile structural Steel IS 4759 - Hot-dip Zinc Coatings on structural steel and other products
4.	Cables	As required	IEC 60227 / IS 694 IEC 60502 / IS 1554 (Pt. I & II)
5.	Switches/ Circuit Breakers	As required	IEC 60947 part I, II, III /IS 60947 Part I, II, III
6.	Connectors		EN 50521
7.	Surge Protection Device		IEC 60364-5-53 / IS 15086-5
8.	Junction Boxes/Enclosuresfor Inverters/ ChargeControllers	As required	IP 54 (for outdoor) or IP 65 / IP 21(for indoor) as per IEC 529
9.	Energy Meter for Recording Solar Electricity Generated&Two-way meter for Distribution Licensee grid connection		As per CEA Regulations; IEC 60687/ IEC 62052-11 / IEC62053-22 / IS 14697
10.	Lightning Protection	As required	As per IEC 62305 / IEC 62561
11.	Electrical Grounding (Earthing)	AC and DC side	As per IS 3043

3. STANDARDS AND REGULATIONS TO BE COMPLIED

The connectivity should be as per

- a. Technical Standards for connectivity of the Distributed generation resources, Regulation, 2013.
- b. KSERC (Renewable Energy and Net Metering) Regulations, 2020.
- c. KSERC (Grid interactive Distributed Solar Energy Systems) Regulations, 2014.
- d. CEA Regulation 2010 has to be followed safety and Electricity supply.
- e. Metering should be as per CEA regulation 2006.
- f. Any amendments thereof will also be applicable.

4. SPV MODULES

- 4.1 Only PV modules listed in the ALMM list issued by MNRE from time-to-time can be used for the work. Mono PERC Half cut cell modules of capacity 380 W or higher capacity with a photo conversion efficiency above 17% should be used in the power plant.
- 4.2 The PV modules must be PID compliant, salt, mist & ammonia resistant and should withstand weather conditions for the project life cycle.
- 4.3 The back sheet of PV module shall be minimum of three layers with outer layer (exposure to ambience) and shall be made of PVDF or PVF. The Back sheets for PV Module with 2 layered or 3 layered Polyester types or the back sheets with Polyester (PET type) at Air side material are not permitted for the empanelment; The minimum thickness of the core layers (without adhesive and inner EVA coated) must be 300 microns. The maximum allowed water vapor transmission rate shall be less than 2 g/m²/day and shall have a Partial Discharge > / = 1500V DC
- 4.4 The front glass shall meet the following specifications:
 - a. The facing glass must be Tempered, PV grade with Low iron and high transmission.
 - b. The transmission shall be > 93 %
 - c. Thickness shall be min 3.2 mm
 - d. Textured to trap more light

- e. The glass shall have an Anti-reflective coating for the better transmission and light absorption.
 - f. Tempered glass to meet the external load conditions
- 4.5 The encapsulant used for the PV modules should be UV resistant in nature. No yellowing of the encapsulant with prolonged exposure shall occur. The sealant used for edge sealing of PV modules shall have excellent moisture ingress Protection with good electrical insulation and with good adhesion strength. Edge tapes for sealing are not allowed.
- 4.6 Anodized Aluminium module frames of sufficient thickness shall be used which are electrically & chemically compatible with the structural material used for mounting the modules having provision for earthing.
- 4.7 UV resistant junction boxes with minimum three numbers of bypass diodes and two numbers of MC4 connectors or equivalent with appropriate length of 4 sq.mm Cu cable shall be provided. IP67 degree of protection shall be used to avoid degradation during Life.
- 4.8 Shading correction/ bypass diode for optimizing PV out to be incorporated in each solar module or panel level.
- 4.9 Each PV module used in any solar power project must use a RF identification tag (RFID), which must contain the following information. The RFID can be inside or outside the module laminate but must be able to withstand harsh environmental conditions.
- a. Name of the manufacturer of PV Module.
 - b. Name of the manufacturer of Solar cells.
 - c. Month and year of the manufacture (separately for solar cells and module).
 - d. Country of origin (separately for solar cell and module).
 - e. I-V curve for the module.
 - f. Peak Wattage, IM, VM and FF for the module.
 - g. Unique Serial No. and Model No. of the module.
 - h. Date and year of obtaining IEC PV module qualification certificate.
 - i. Name of the test lab issuing IEC certificate.
 - j. Other relevant information on traceability of solar cells and module as per ISO 9000 series.

- 4.10 The following details should be provided on the module
- a. Name of the manufacture.
 - b. Month and year of manufacture.
 - c. Rated Power at STC.
 - d. VMP, IMP, VOC, Isc.
- 4.11 The successful bidder shall arrange an RFID reader to show the RFID details of the modules transported to sites, to the site Engineer in charge up to their satisfaction, which is mandatory for the site acceptance test.
- 4.12 Each PV module used in any solar power project must use a RF identification tag (RFID), which must contain the following information. The RFID can be inside or outside the module laminate but must be able to withstand harsh environmental conditions.
- 4.13 The PV modules must qualify (enclose Test Reports/Certificates from IEC/NABL accredited laboratory) as per relevant IEC standard. The Performance of PV Modules at STC conditions must be tested and approved by one of the IEC/NABL Accredited Testing Laboratories.
- 4.14 PV modules used in solar power plant/ systems must be warranted for 10 years for their material, manufacturing defects, workmanship. The output peak watt capacity which should not be less than 90% at the end of 10 years and 80% at the end of 25 years
- 4.15 Original Equipment Manufacturers (OEM) Warrantee of the PV Modules shall be submitted by the successful bidder when the materials delivered at site.
- 4.16 The PV modules shall conform to the following standards:
- a. IS 14286: Crystalline silicon terrestrial photovoltaic (PV) modules — design qualification and type approval.
 - b. IEC 61215 / IEC 61646: c-Si (IEC 61215): Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval Thin Film (IEC 61646): Design, Qualification & Type Approval
 - c. IEC 61730-1: Photovoltaic Module safety qualification- Part 1: Requirements for construction

- d. IEC 61730-2: Photovoltaic Module safety qualification- Part 2: Requirements for testing
- e. IEC 61701: Salt mist corrosion testing of photovoltaic modules
- f. IEC 62716: Test Sequences useful to determine the resistance of PV Modules to Ammonia (NH₃)

5. POWER CONDITIONING UNIT (PCU)

The Power Conditioning Unit shall be String Inverter with power exporting facility to the Grid. The List of Inverters under On-Grid category is available in ANERT website. However, the specifications for the ON-Grid Inverters are detailed below:

General Specifications:

- 5.1 All the Inverters should contain the following clear and indelible Marking Label & Warning Label as per IS16221 Part II, clause 5. The equipment shall, as a minimum, be permanently marked with:
 - a. The name or trademark of the manufacturer or supplier.
 - b. A model number, name or other means to identify the equipment.
 - c. A serial number, code or other markings allowing identification of manufacturing location and the manufacturing batch or date within a three-month time period.
 - d. Input voltage, type of voltage (A.C. or D.C.), frequency, and maximum continuous current for each input.
 - e. Output voltage, type of voltage (A.C. or D.C.), frequency, maximum continuous current, and for A.C. outputs, either the power or power factor for each output.
 - f. The Ingress Protection (IP) rating
- 5.2 The inverter output shall be 415 VAC, 50 Hz, 3 phase or 230 VAC, 50 Hz, 1 phase.
- 5.3 The inverter shall include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of inverter component failure or from parameters beyond the inverter's safe operating range due to internal or external causes.
- 5.4 The Technical Specification of On-Grid Inverters are summarized below:

Specifications of Inverters

Parameters	Detailed specification
Nominal voltage	230V/415V
Voltage Band	Between 80% and 110% of V nominal
Nominal Frequency	50 Hz
Operating Frequency Range	47.5 to 50.5 Hz
Waveform	Sine wave
Harmonics	AC side total harmonic current distortion < 3%
Ripple	DC Voltage ripple content shall be not more than 1%
Efficiency	Efficiency shall be >97%
Casing protection levels	Degree of protection: Minimum IP-54 for internal units and IP-65 for outdoor units
Operating ambient Temp range	-10 to + 60 degree Celsius
Operation	Completely automatic including wakeup, synchronization (phase locking) and shut down
MPPT	MPPT range must be suitable to individual array voltages
Protections	Over voltage: both input and output Over current: both input and output Over / Under grid frequency Over temperature Short circuit Lightning Surge voltage induced at output due to external source Islanding
Ingress Protection	IP 65 for Outdoor / IP 54 for Indoor
Recommended LED indications	ON Grid ON Under/ Over voltage Overload Over temperature

Specifications of Inverters	
Parameters	Detailed specification
Recommended LCD Display on front Panel	DC input voltage DC current AC Voltage (all 3 phases) AC current (all 3 phases) Frequency Ambient Temperature Instantaneous power Cumulative output energy Cumulative hours of operation Daily DC energy produced
Communication Interface	RS485/ RS232/Wi-Fi (with or without USB)

5.5 The Technical Specification for Interconnection are summarized below:

Sl No	Parameters	Requirements	Reference
1	Overall conditions of service	Reference to regulations	Conditions for Supply of Electricity
2	Overall Grid Standards	Reference to regulations	Central Electricity Authority (Grid standards) Regulations 2010
3	Equipment	Applicable industry standards	IEC/EN standards
4	Safety and Supply	Reference to regulations, (General safety requirements	Central Electricity Authority (Measures of safety and electricity supply) Regulations, 2010 and subsequent amendments
5	Meters	Reference to regulations and additional conditions issued by the commission.	Central Electricity Authority (Installation & operation of meters) regulations 2006 and subsequent amendments
6	Harmonic current	Harmonic current injections from a generating station shall not exceed the limits specified in IEEE 519	IEEE 519 relevant CEA (Technical Standards for connectivity of the distributed generation resource) Regulations 2013 and subsequent amendments
7	Synchronization	Photovoltaic system must be equipped with a grid	Relevant CEA (Technical Standards for Connectivity of

		frequency synchronization device, if the system is using synchronizer inherently built in to the inverter, then no separate synchronizer is required	the distributed generation resources) regulations 2013 and subsequent amendments.
8	Voltage	The voltage-operating window should minimize nuisance tripping and should be under operating range of 80% to 110% of the nominal connected voltage. beyond the clearing time of 2 seconds, the Photovoltaic system must isolate itself from the grid	
9	Flicker	Operation of Photovoltaic system should not cause voltage flicker in excess of the limits stated in IEC 61000 or other equivalent Indian standards if any	Relevant CEA regulations 2013 and subsequent if any, (Technical standards for connectivity of the distributed generation resource)
10	Frequency	When the distribution system frequency deviates outside the specified limits (50.5 Hz on upper side and 47.5 Hz on lower side) up to 0.2 sec, the Photovoltaic systems shall automatically disconnect from grid and be in island mode.	
11	DC injection	Photovoltaic system shall not inject DC current greater than 0.5% of full rated output at the interconnection point or 1% rated inverter output current into distribution system under any operating conditions.	
12	Power Factor	While the output of the	

		inverter is greater than 50%, a lagging power factor greater than 0.9 shall be maintained.	
13	Islanding and Disconnection	The photovoltaic system in the event of voltage or frequency variations must island/disconnect itself with the time stipulated as per IEC standards	
14	Overload and overheat	The inverter should have the facility to automatically switch off in case of overload or overheat and should restart when normal conditions are restored	

5.6 The IEC Certifications of On-Grid Inverters are summarized below:

Standard	Description
IEC 61683	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
IEC 61727	Photovoltaic (PV) systems- Characteristics of the utility interface
IEC/EN 62109-1	Safety of power converters for use in photovoltaic power systems - Part 1: General requirements
IEC/EN 62109-2	Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters
IEC/EN 61000-3-3/ 3-11/ 3-5	Electromagnetic compatibility (EMC) - Part 3-11; Limits; Limitation of Voltage Change, Voltage Fluctuations and Flicker in Public Low- Voltage Supply Systems; Rated Current <16A / >16A and <75A / >75A per Phase respectively
IEC/EN 61000-3-2/ -3-12/ -3-4	Electromagnetic compatibility (EMC) - Part 3-12; Limits; Limits for Harmonic Currents produced by equipment connected to the public low voltage systems with Rated Current <16A / >16A and <75A / >75A per Phase respectively
*IEC/EN 61000-6-1 / 6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for residential and commercial / industrial environments

Standard	Description
*IEC/EN 61000-6-3 / 6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for residential and commercial / industrial environments
IEC 62116	Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures
IEC 60068-2-1	Environmental testing - Part 2-1: Tests - Test A: Cold
IEC 60068-2-2	Environmental testing - Part 2-2: Tests - Test B: Dry heat
IEC 60068-2-14	Environmental testing - Part 2-14: Tests - Test N: Change of temperature
IEC 60068-2-30	Environmental testing - Part 2-30: Tests - Test Db; Damp heat, cyclic (12 h + 12 h cycle)

***Recommended but not mandatory**

6. REMOTE MONITORING SYSTEM

A dedicated Remote Monitoring System (Hardware and software) for monitoring the plant shall be provided even if the inverter has embedded data logging system. The following weather parameters are to be measured as part of the datalogging system.

a) Solar Irradiance:

A Pyranometer/ Solar cell-based irradiation sensor (along with calibration certificate) shall be provided, with the sensor mounted in the plane of the array. Readout shall be integrated with data logging system

b) Temperature: Integrated temp, sensors for measuring the module surface temp., inverter inside enclosure temp, and ambient temp to be provided complete with readouts integrated with the data logging system.

It is recommended that the following important parameters shall be accessible through the Data Logging Facility.

- a) AC Voltage
- b) AC Output current
- c) Output Power
- d) Energy in kWh
- e) DC Input Voltage
- f) DC Input Current
- g) Temperatures (C)

- h) Invertor Status
- i) Irradiation
- j) Module temperature
- k) String Voltage & Current (For PV Plants from 100kWp onwards)

Provision for Internet monitoring and download of historical data shall be incorporated. GSM Modem/Wi Fi modem in case GSM connectivity is used or Wireless Router + modem in case Ethernet connection is being used for remote access must be provided.

7. ELECTRICAL SAFETY, EARTHING AND PROTECTION

- 7.1 Internal Faults: In built protection for internal faults including excess temperature, commutation failure, over load and cooling fan failure (if fitted) is obligatory.
- 7.2 Over Voltage Protection: Over Voltage Protection against atmospheric lightning discharge to the PV array is required. Protection is to be provided against voltage fluctuations in the grid itself and internal faults in the power conditioner, operational errors and switching transients.
- 7.3 Earth fault supervision: An integrated earth fault device shall have to be provided to detect eventual earth fault on DC side and shall send message to the supervisory system.

8. CABLING PRACTICE

Cable Cabling is required for wiring from AC output of inverter/PCU to the Grid Interconnection point. It includes the DC cabling from Solar Array to AJB and from AJB to inverter input.

- 8.1 All cables of appropriate size to be used in the system shall have the following characteristic:
 - a. Shall conform to IEC 60227 / IS 694 & IEC 60502 / IS 1554 standards.
 - b. Temperature Range: -10 degree Celsius to +80 degree Celsius
 - c. Voltage rating: 660/1000V
 - d. Excellent resistance to heat, cold, water, oil, abrasion, UV radiation
 - e. Flexible

- 8.2 Sizes of cables between any array interconnections, array to junction boxes, junction boxes to inverter etc. shall be so selected to keep the voltage drop (power loss) of the entire solar system to the minimum (2%).
- 8.3 For the DC cabling, XLPE or XLPO insulated and sheathed, UV stabilized single core flexible copper cables shall be used; Multi-core cables shall not be used.
- 8.4 For the AC cabling, PVC or XLPE insulated and PVC sheathed single or, multi-core flexible copper cables shall be used. However, for above 25kWp systems, XLPE insulated Aluminium cable of suitable area of cross section can be used in the AC side subject to a minimum area of cross section of 10 sq.mm. Outdoor AC cables shall have a UV -stabilized outer sheath IS/IEC 69947.
- 8.5 All LT XLPE cables shall conform to IS:7098 part I&II.
- 8.6 The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%
- 8.7 The total voltage drop on the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%
- 8.8 The DC cables from the SPV module array shall run through a UV-stabilized PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm
- 8.9 Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers
- 8.10 All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50cm; the minimum DC cables size shall be 4.0mm² copper; the minimum AC cable size shall be 4.0mm² copper. In three phase systems, the size of the neutral wire size shall be equal to the size of the phase wires.
- 8.11 Cable Marking: All cable/wires are to be marked in proper manner by good quality ferule or by other means so that the cable can be easily identified. The following colour code shall be used for cable wires
- a. DC positive: red (the outer PVC sheath can be black with a red line marking)
 - b. DC negative: black
 - c. AC single phase: Phase: red; Neutral: black
 - d. AC three phase: phases: red, yellow, blue; neutral: black
 - e. Earth wires: green

- 8.12 Cables and conduits that have to pass through walls or ceilings shall be taken through PVC pipe sleeve.
- 8.13 Cable conductors shall be terminated with tinned copper end ferrules to prevent fraying and breaking of individual wire strands. The termination of the DC and AC cables at the Solar Grid Inverter shall be done as per instructions of the manufacturer, which in most cases will include the use of special connectors.
- 8.14 All cables and connectors used for installation of solar field must be of solar grade which can withstand harsh environment conditions including high temperatures, UV radiation, rain, humidity, dirt, salt, burial and attack by moss and microbes for 25 years and voltages as per latest IEC standards. DC cables used from solar modules to array junction box shall solar grade copper (Cu) with XLPO insulation and rated for 1.1 kV as per relevant standards only.
- 8.15 Bending radii for cables shall be as per manufactures recommendations and IS: 1255.
- 8.16 For laying/termination of cables latest BIS/IEC Codes/ standards shall be followed.

9. FACTORY TESTING

- a. PCU shall be tested prior to shipment and factory test certificate for relevant parameters should be provided with the PCU supplied. Plantation Corporation of Kerala Ltd. (PCK) / ANERT or authorised representative of Plantation Corporation of Kerala Ltd. (PCK) / ANERT may be allowed to witness the tests if required.
- b. Factory testing shall not only be limited to measurement of phase currents, efficiencies, harmonic content and power factor, but shall also include all other necessary tests/simulation required and requested by the Purchasers Engineers. Tests may be performed at 25, 50, 75 and 100 percent of the rated nominal power.

10. DATA LOGGING / DATA ACQUISITION SYSTEM

- a. Net meter as per CEA standards approved by the utility as per accuracy class has to be supplied and installed.

- b. A separate Energy Meter shall be provided at the output of PCU to record the energy generation from the solar system. (This energy meter should not be integrated with PCU). This has to calibrate and installed nearer to the meter board so that meter reader from Electrical utility could access while meter reader comes to record the meter reading, they have access to the solar meter. In case the solar meter cannot be installed near to the consumer meter board/Net meter facility, an additional display may be provided near the meter board utilising the communication protocols available within this meter.
- c. Data Logging Provision for plant control and monitoring, time and date stamped system data logs for analysis with the high quality, suitable PC. Metering and Instrumentation for display of systems parameters and status indication to be provided.
- d. **Solar Irradiance:** An integrating Pyranometer / Solar cell-based irradiation sensor (along with calibration certificate) provided, with the sensor mounted in the plane of the array. Readout integrated with data logging system.
- e. **Temperature:** Temperature probes for recording the Solar panel temperature and/or ambient temperature to be provided complete with readouts integrated with the data logging system
- f. An integrated data acquisition shall be supplied which should be capable of communicating with all inverters at each site and provide information of each Inverter and the entire Grid interactive power plants. The DAS shall also provide information of the instantaneous output energy and cumulative energy for each of the inverter
- g. **Proper DAS terminal shall be provided in the Control/ DAS room/ cabin constructed for the project. All communication cabling and inter faces required for the remote monitoring of the proposed SPV plant shall be within the scope of the bidder.**
- h. The data acquisition system shall perform the following operations, which include the measurement and continuous recording of:
 - i. Ambient air temperature near array field
 - ii. Control room temperature
 - iii. Module back surface temperature

- iv. Wind speed at the level of array plane
 - v. Solar radiation incidental to array plane
 - vi. Inverter output
 - vii. DC output
 - viii. AC and DC side Power of each inverter
 - ix. Energy delivered to the Grid in kWh
 - x. System frequency
 - xi. Solar irradiation
 - xii. Voltage of the HT Side
 - xiii. Current and voltage of each sub-array/string.
 - xiv. Power at 11 kV terminal
 - xv. Any other parameter considered necessary by supplier based on current prudent practice.
- i. All data shall be recorded chronologically date wise. DAS shall store the daily energy produced by the plant, monthly energy and the annual energy. DAS shall be provided with a reliable power supply and have internal reliable battery backup to record all sorts of data simultaneously round the clock. All the trend and cumulative graphs shall be able to be viewed and stored. Also, all the events including outages and faults shall be logged and stored with time and date stamped. DAS should also have provision for offline viewing of daily, monthly and annual average of the above parameters.
 - j. Representation of monitored data shall be displayed in graphics mode or in tabulation form. All instantaneous data can be shown in the computer screen. Provision should be available for remote monitoring through GPRS system.
 - k. DAS shall provide 15-minute interval daily, monthly and annual average of following parameters:
 - i. Exported Energy
 - ii. Energy of each inverter
 - l. The DAS shall have the feature to be integrated with the Network system as well as remotely via the web using a standard modem or a GSM/ WIFI modem. Compatible software and hardware are to be provided so that data can be transmitted via standard modem. The DAS system shall conform to IEC

61724 (Photo voltaic system performance monitoring – Guidelines for Measurement) standard.

- m. **Communication Software:** Graphical user interface software for real time communication and control
- n. **Data acquisition & logging:** RS232/RS485. MOD Bus/Telephone Modem/WiFi
All parameters should be accessible through an industrial standard communication link.

11. ARRAY SUPPORT STRUCTURE

- a. Photovoltaic arrays must be mounted on a stable, durable structure that can support the array and withstand wind, rain, and other adverse conditions. The modules will be fixed on structures with fixed arrangement.
- b. The module mounting structures shall have adequate strength and appropriate design suitable to the locations, which can withstand the load and high wind velocities. Stationary structures shall support PV modules at a given orientation, absorb and transfer the mechanical loads to the surface properly.
- c. Each structure with fixed tilt should have a tilt angle as per the site conditions to take maximum insolation which will be approximately equal to the latitude of the location facing true South with a North - South orientation. The tilt angle can vary from 9 degree to 12 degree based on the location's latitude in Kerala
- d. The PV module mounting structure shall have a capacity to withstand a wind velocity of 150 km/hr unless specified for dedicated requirements
- e. Suitable fastening arrangement such as grouting and calming should be provided to secure the installation against the specific wind speed. The PV array structure design shall be appropriate with a factor of safety of min 1.5.
- f. The materials used for structures shall be Hot dip Galvanized Mild Steel conformed to IS 2062:1992 or aluminium of suitable grade minimum alloy 6063 or better.
- g. The minimum thickness of galvanization for hot dip Galvanized Mild Steel should be at least 80 microns as per IS 4759.
- h. The Bolts, Nuts, fasteners, and clamps used for panel mounting shall be of Stainless-Steel SS 304.

- i. No Welding is allowed on the mounting structure
- j. Aluminium structures used shall be protected against rusting either by coating or anodization.
- k. Aluminium frames should be avoided for installations in coastal areas.
- l. The structure shall be designed to withstand operating environmental conditions for a period of minimum 25 years. And shall be free from corrosion while installation.
- m. Screw fasteners shall use existing mounting holes provided by module manufacturer. No additional holes shall be drilled on module frames
- n. The total load of the structure (when installed with PV modules) on the terrace should be less than 60 kg/m².
- o. Minimum distance between the lower level of PV Module and the ground shall be 0.6m from the ground level.
- p. The PV Panel area shall be accessible for cleaning and for any repair work.
- q. Sufficient gap needs to be provided between the rows to avoid falling of shadow of one row on the next row. Seismic factors for the site will be considered while making the design of the foundation.
- r. Adequate spacing shall be provided between any two modules secured on PV panel for improved wind resistance.
- s. Installation of structure for solar PV mounting should not tamper with the water proofing of the roofs.

12. SURGE PROTECTION

The system should have installed with Surge Protection Device (SPD) for higher withstand of the continuous PV-DC voltage during earth fault condition. SPD shall have safe disconnection and short circuit interruption arrangements through integrated DC in-built bypass fuse (parallel) which should get tripped driving failure mode of MOV, extinguishing DC arc safely in order to protect the installation against fire hazards. The SPD should be provided in the AC Distribution Box as well.

13. EARTHING

The Solar PV Plant should have a dedicated earthing system. The Earthing for array and LT power shall be made as per the provisions of **IS:3043-2018** “Code of practice for earthing (Second Revision),” that governs the earthing practices of a PV system and **IS 732:2019** “Code of practice for electrical wiring installations (Fourth Revision)

- 13.1 Earthing System shall connect all non –current carrying metal receptacles, electrical boxes, appliance frames, chassis and PV module mounting structures in one long run. The earth strips should not be bolted. Earthing GI strips shall be interconnected by proper welding.
- 13.2 The earthing conductor should be rated for 1.56 times the maximum short circuit current of the PV array. The factor 1.56 considers 25 percent as a safety factor and 25 percent as albedo factor to protect from any unaccounted external reflection onto the PV modules increasing its current
- 13.3 In any case, the cross-section area or the earthing conductor for PV equipment should not be less than 6 mm² if copper, 10 mm² if aluminium or 70 mm² if hot-dipped galvanized iron. For the earthing of lightning arrestor, cross-section of the earthing conductor should not be less than 16 mm² of copper or 70 mm² if hot-dipped galvanized iron. The complete Earthing system shall be mechanically & electrically connected to provide independent return to earth. The Earth wires being used must comply with IS 2141:2000 and IS 12776:2002.
- 13.4 Masonry enclosure with the earth pit of size not less than 400mm X 400 mm(depth) complete with cemented brick work (1:6) of minimum 150mm width duly plastered with cement mortar (inside)shall be provided. Hinged inspection covers of size not less than 300mm X 300mm with locking arrangement shall be provided. Suitable handle shall be provided on the cover by means of welding a rod on top of the cover for future maintenance.
- 13.5 Minimum four (04) numbers of interconnected earth pit need to be provided in each location. Minimum required gap shall be provided in between earth pits as per relevant standard. Body earthing shall be provided in inverter, each panel frame, module mounting structure, kiosk and in any other item as required.

- 13.6 Earth pit shall be constructed as per IS: 3043-2018. Electrodes shall be embedded below permanent moisture level. Earth pits shall be treated with salt and charcoal if average resistance of soil is more than 20-ohm meter.
- 13.7 Earth resistance shall not be more than 5 ohms. Earthing system must be interconnected through GI strip to arrive equipotential bonding. The size of the GI earth strip must be minimum 25mm X 6mm
- 13.8 In compliance to Rule 11& 61 Of Indian Electricity Rules,1956(as amended up to date), all non-current carrying metal parts shall be Earthing with two separate and distinct earth continuity conductors to an efficient earth electrode.
- 13.9 The equipment grounding wire shall be connected to earth strip by proper fixing arrangement. Each strip shall be continued up to at least 500mm from the equipment.
- 13.10 Necessary provisions shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.
- 13.11 For each earth pit, a necessary test point shall be provided.

14. LIGHTNING PROTECTION FOR PV ARRAY

The SPV power plant should be provided with lightning and over voltage protection. The source of over voltage can be lightning or other atmospheric disturbance. The lightning conductors shall be made as per applicable Indian Standards in order to protect the entire array yard from lightning stroke.

The design and specification shall conform to IS/IEC 62305, "Protection against lightning" govern all lightning protection-related practices of a PV system.

- The entire space occupying SPV array shall be suitably protected against lightning by deploying required number of lightning arresters. Lightning protection should be provided as per IS/ IEC 62305.
- Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.
- The protection against induced high voltages shall be provided by the use of surge protection devices (SPDs) and the earthing terminal of the SPD shall be connected to the earth through the earthing system.

- The EPC Contractor / Company shall submit the drawings and detailed specifications of the PV array lightning protection equipment to Employer for approval before installation of system.

15. STRING COMBINER BOX OR ARRAY JUNCTION BOXES:

- a. The string combiner box/ Array junction box shall be dust, vermin and waterproof and made of FRP/ABS Plastic. The terminal will be connected to copper bus-bar arrangement of proper size to be provided. The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. Suitable markings shall be provided on the bus-bars for easy identification and cable ferrules will be fitted at the cable termination points for identification.
- b. The string combiner box/ Array junction box shall be with protection class IP 65 for mounting outside in Open weather condition.
- c. Each string combiner box/ junction box will have suitable Reverse Blocking Diodes of maximum DC blocking voltage of 600 / 1000V with suitable arrangement.
- d. The string combiner box/ Array junction Box will also have suitable surge protection device. The Surge Protective Device shall be of Type 2 as per IEC 60364-5-53.
- e. The junction Boxes shall have suitable arrangement for the following (typical): -
 - i. Combine groups of modules into independent charging sub-arrays that will be wired into the controller.
 - ii. Provide arrangement for disconnection for each of the groups.
 - iii. Provide a test point for each sub-group for quick fault location.
- f. The current carrying ratings of the string combiner box/ Array junction box shall be suitable with adequate safety factor, to inter connect the Solar PV array.
- g. **String Monitoring Unit (SMU):** Combiner box shall house string monitors which shall give operational status of each sub array/string by current and/or power and shares the information with DAS. Foot print of PV array showing the location

of each SMU shall be displayed as a screen shot on the DAS screen so that operator can identify the faulty SMU and the string from the DAS screen. The enclosure shall be Fire Retardant with Self-Extinguishing property and free from Halogen. It should be UV resistant in accordance with UL 746C suitable for outdoor

application. The mechanical impact resistance shall be of IK 07 or better as per IEC 62262 or equivalent standard. The enclosure rating shall be IP65 or better. The control PCB housed in each SMU shall be rugged and proven for reliable performance. Each SMU shall be provided with properly rated Surge Protection Device (SPD). Either precision shunt or Hall sensor can be employed for sensing of string. Maximum of 2 (two) PV strings can be paralleled per channel of SMU for current measurement.

16. AC DISTRIBUTION PANEL BOARD

- a. AC Distribution Board (ACDB) shall control the AC power from inverter and should have necessary surge arrestors.
- b. An ACDB panel shall be provided in between PCU and Utility grid. It shall have MCB/MCCB/ACB or circuit breaker of suitable rating for connection and disconnection of PCU from grid.
- c. The connection between ACDB and Utility grid shall be of standard cable/ Conductor with suitable termination. It shall have provision to measure grid voltage, current and power.
- d. The incomer shall be selected at required rating. The ACDB enclosure shall be of good protection and suitable for mounting on the trenches / on wall.
- e. All the 415 V AC or 230 V AC devices/equipment like bus support insulators, circuit breakers, SFU isolators (if applicable), SPD, etc. mounted inside the switch gear shall be suitable for continuous operation
- f. Switches/ circuit breakers/ connectors meeting general requirements and safety measurements as per IS 60947 Part I, II, III and IEC 60947 part I, II and III.
- g. Junction boxes, enclosures, panels for inverters/ Controllers shall meet IP 54 (for outdoor)/ IP 65 (for indoor) as per IEC 529.

17. DC DISTRIBUTION BOARD

- a. DC bus/ cable which can handle the current and the voltage of inverter output safely with necessary surge arrester as per the relevant IS standards.
- b. DC panel should be equipped with an adequate capacity indoor DC circuit breaker along with control circuit, protection relays, fuses, annunciations and remote operating and controlling facility from the main control facility.
- c. DCDB shall have sheet from enclosure of dust and vermin proof, the busbar/ cables are to be made of copper of desired size. DCDB shall be fabricated to comply with IP 65 protection.

18. CABLES, SWITCHES AND GENERAL REQUIREMENTS

- a. PVC insulated copper cables with current rating suitable for AC and DC as per the National Electric Code, and meeting:
 - i. General Test and Measuring Method as per IEC 60189/ IS 694
 - ii. PVC insulated cables for working voltages up to 1100 V and UV resistant for outdoor installation as per IEC 60502/ IS 1554 (Pt. I & II)
- b. Cable Marking: All cable/wires are to be marked in proper manner by good quality ferule or by other means so that the cable can be easily identified.
- c. Switches/ circuit breakers/ connectors meeting general requirements and safety measurements as per IS 60947 Part I, II, III and EN 50521 for AC/DC.
- d. Junction boxes, enclosures for inverters/ charge controllers shall meet IP 54 (for outdoor)/ IP 21 (for indoor) as per IEC 529.

19. AC/DC WIRING

- a. Before submitting the tender, actual measurement of cables required for wiring from AC output of inverter/PCU to load point should be calculated and this work is also included in the tender. The actual cable required from module to DC distribution board and DC distribution board to inverter input should be calculated and this work should be done as a part of Solar Power Plant installation. Separate drawings for exclusively for the AC/DC Wiring should be provided.

20. CIVIL WORKS

While installing solar power plants on rooftops, the physical condition of the rooftop, chances of shading, chances water level rise in the rooftop during raining due improper drainage in the roof-top should be taken in to consideration.

- 20.1 PV array shall be installed in the terrace space free from any obstruction and/or shadow and to minimize effects of shadows due to adjacent PV panel rows.
- 20.2 PV array shall be oriented in the south direction in order to maximize annual energy yield of the plant.
- 20.3 The solar PV array must be installed on the rooftop in such a way that there is sufficient space on the rooftop for maintenance etc.
- 20.4 There should not be any damage what so ever to the rooftop due to setting up of the solar power plant so that on a later day there is leakage of rainwater, etc. from the rooftop.
- 20.5 Some civil works are inevitable for erecting the footings for the module mounting structure as discussed in Module Mounting Structure section. The roof top may be given a suitable grading plaster with suitable leak proof compound so as to render the roof entirely leak proof.
- 20.6 Ample clearance shall be provided in the layout of the inverter and DC/AC distribution boxes for adequate cooling and ease of maintenance.
- 20.7 While cabling the array, care must be taken such that no loose cables lie on the rooftops.
- 20.8 The roof top should look clean and tidy after installation of the array.
- 20.9 Neatness, tidiness and aesthetics must be observed while installing the systems.
- 20.10 RCC Works - All RCC works shall be as per IS 456 and the materials used viz. Cement reinforcement, steel etc. shall be as per relevant IS standards. Reinforcement shall be high strength TMT Fe 415 or Fe 500 conforming to IS: 1786-1985.
- 20.11 Brick Works (If any) - All brick works shall be using 1st class bricks of approved quality as per IS 3102.
- 20.12 Plastering - Plastering in cement mortar 1:5, 1:6 and 1:3 shall be applied to all.

- 20.13 Display of mandatory items- Single Line Diagram and layout diagram of modules and interconnection at installation site shall be provided near the inverter for greater than 10 kWp systems.
- 20.14 For painting on concrete, masonry and plastered surface IS:2395 shall be followed. For distempering IS 427 shall be followed referred. For synthetic enamel painting IS 428 shall be followed. For cement painting IS 5410 shall be followed.
- 20.15 All Civil works required for the installation of the PV Plant and other civil and electrical work in evacuation infrastructure, wherever necessary, shall be within the scope of the bidder
- 20.16 The layout of Inverter accommodation shall be designed to enable adequate heat dissipation and availability. Mount within the existing infrastructure available in consultation with the Site in charge. String Inverters may be installed with Canopy type structure over it to protect it from frequent monsoon and weather changes.

21. NET METERING AND UTILITY INTERCONNECTION

- a. Net metering equipment (an Import-Export Energy Meter) approved and tested by the electrical utility based on the accuracy class required for the proposed capacity of the system must be provided with the necessary data cables if required.
- b. Net Metering and Utility Interconnection should be accomplished according the Kerala State Electricity Regulatory Commission (Grid Interactive Distributed Solar Energy Systems) Regulations 2014 Clauses (8) & (9) (Notification No. 2096/KSERC/CT/2014 dt. 10th June 2014)

22. INTER CONNECTION OF INVERTER OUTPUT WITH UTILITY GRID

- a. The interconnection of load with inverter output should be done after obtaining permission from Electrical Inspectorate and Electrical Utility.
- b. The plan scheme and drawing related to interconnection details should be submitted to Electrical Inspectorate through a licensed Electrical contractor with the guidance appropriate Engineering Authority.

- c. The panel board and distribution board required for AC interconnection should be done as per specification/ instruction given appropriate Engineering Authority.
- d. All the electrical works required for the interconnection of load with inverter output should be done by the successful bidder as a part of the Solar Power Plant installation.
- e. Bidder should visit the actual site and ensure the exact place for providing Solar Modules and Inverter etc. in presence of technical representative from the Plantation Corporation of Kerala Ltd. (PCK) / ANERT.
- f. Net Metering Equipment shall be installed and maintained in accordance with the provisions of The Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006 as amended from time to time. The Contractor shall maintain the Metering System as per metering code and CEA guidelines. The defective meter shall be immediately tested and calibrated.
- g. The accuracy class of the Net Metering Equipment will be selected so that all levels of energy produced or taken by the Solar Power Plant will be measured accurately, and this equipment has applicable accuracy class.
- h. Net Metering Equipment shall be microprocessor based conforming to the relevant IEC standards with Advanced Metering Infrastructure (AMI) with RS232 cable facility.
- i. Net Metering Equipment shall measure active energy (both import and export) and reactive energy (import) by 3 ph, 4 wire principle suitable for balanced / un-balanced 3 phase load (With KVA_r, KWh, KVA measuring registers). Tri-vector based energy meter shall have an accuracy class of energy measurement of at least Class 0.2 for active energy and at least 0.5 Class for reactive energy according to IEC 60687.
- j. Display parameters: LCD test, KWH import, KWH export, MD in KW export, MD in KW import, Date & Time, AC current and voltages and power factor (Cumulative KWH will be indicated continuously by default)

23. PERMISSION FROM KSEBL BY BIDDER

- a. The procedures for Grid Connectivity of the PV Plants for capacities from 1kWp to 1MWp are governed by the KSEBL Circular No. CE(REES)/Escot/AEE6/Solar-General/16-17/766(1) Dt. 09-09-2016 and its Amendments.
- b. The Plantation corporation of kerala Ltd / ANERT will obtain a feasibility certificate by submitting an application form along with the documents and a fee of Rs 1000/- as per the Annexure-I form of KSEBL.
- c. After submitting all the documents and clarification required by KSEBL, the successful bidder will pay a Registration fee of Rs 1000/- per kW to KSEBL (Eg: If the plant size is 3.65kW then it will be considered as 4kW and the applicant has to pay a sum of Rs 4000/-) to acquire a SPIN (Solar Plant Identification Number). For example, 5501-00001 where 5501 is the section office code for the locality and 00001 is the solar plant number.
- d. Request for the cancellation of Registration by the applicant will be verified by the Assistant Engineer, KSEBL and a decision will be taken on this by division Executive Engineer, KSEBL and 80% of the amount shall be reimbursed based upon the recommendation of Assistant Engineer.
- e. The application for testing of the installed PV power plant has to be submitted at the Electrical Section office by the contractor. For plant capacities above 10kWp the application must be submitted along with Energization Certificate from Electrical Inspectorate and for the plant capacities below 10 kWp the application must be submitted along with a Completion Report of a Certified Electrical Contractor. The minimum qualification for carrying out the installation work of a PV Plant shall be a B-Class contractor licensee and depending upon the capacity of installation, eligible contractors can carry out the work. (Circular no. B2-13958/2017/CEI Dtd 24.07.2018).
- f. The officials from Electrical Inspectorate and KSEBL will visit the site with prior notice to the beneficiary.
- g. Tests shall be conducted as per system capacity norms issued by KSEBL/Electrical Inspectorate

- h. Test Certificate for Solar Plant Installation as per annexure 9 of KSEBL order will be issued by the Assistant Engineer, once the PV plants is successfully performing as per the standards
- i. Agreement for Connecting Solar Energy System as per Annexure 10 of KSEBL order shall be signed between KSEBL and the applicant as per the Annexure 11 (KSEBL Order) in which the capacity of the net meter should be mentioned. The contractor is required to undertake all the liaison work required for the same.
- j. The contractor shall submit Test Certificates from NABL or KSEBL test labs for the Net meter purchased.
- k. The import and export will be calculated based upon the Net meter installed at the site of the consumer for which the reading will be taken on every month from the Net meter and Solar meter.
- l. The panel board and distribution board required for AC interconnection should be done as per specification/instruction given by PWD Electrical wing/Electrical Inspectorate Authorities /A.E, L.S.G.D. /appropriate Engineering Authorities

24. WARRANTY

- a. 5 years' warranty should be provided by the supplier for the system and components or part of the system has to be provided as per the special conditions of the contract.
- b. PV modules used in solar power plants/ systems must be warranted for their output peak watt capacity, which should not be less than 90 % at the end of 10 years and 80% at the end of 25 years
- c. The Warranty Card to be supplied with the system must contain the details of the system supplied.

25. OPERATION AND MAINTENANCE

- 25.1 For the optimal operation of a PV plant, maintenance must be carried out on a regular basis. All the components should be kept clean. It should be ensured that all the components are fastened well at their due place.

25.2 The service personnel should visit the installations at least once a month for preventive maintenance even if no faults are reported. **Reports of these preventive maintenance visits and generation data should be submitted to the concerned Plantation Corporation of Kerala Ltd. (PCK) on a quarterly basis.**

25.3 Maintenance guidelines for various components viz. solar panels, inverter, wiring etc. are discussed below:

25.3.1 SOLAR PV PANELS

Although the cleaning frequency for the panels will vary from site to site depending on soiling, it is recommended that

- a) The panels are cleaned at least once every thirty days.
- b) Use water and a soft sponge or cloth for cleaning.
- c) Do not use detergent or any abrasive material for panel cleaning.
- d) Iso-propyl alcohol may be used to remove oil or grease stains.
- e) Do not spray water on the panel if the panel glass is cracked or the back side is perforated.
- f) Wipe water from module as soon as possible.
- g) Use proper safety belts while cleaning modules at inclined roofs etc.
- h) The modules should not be cleaned when they are excessively hot. Early morning is particularly good time for module cleaning.
- i) Check if there are any shade problems due to vegetation or new building. If there are, make arrangements for removing the vegetation or moving the panels to a shade-free place.
- j) Ensure that the module terminal connections are not exposed while cleaning; this poses a risk of electric shock.
- k) Never use panels for any unintended use, e. g. drying clothes, chips etc. | Ensure that monkeys or other animals do not damage the panels.

25.3.2 CABLES AND CONNECTION BOXES

- a) Check the connections for corrosion and tightness.

- b) Check the connection box to make sure that the wires are tight, and the water seals are not damaged.
- c) There should be no vermin inside the box.
- d) Check the cable insulating sheath for cracks, breaks or burns. If the insulation is damaged, replace the wire.
- e) If the wire is outside the building, use wire with weather-resistant insulation.
- f) Make sure that the wire is clamped properly and that it should not rub against any sharp edges or corners.
- g) If some wire needs to be changed, make sure it is of proper rating and type.

25.3.3 INVERTER

- a) The inverter should be installed in a clean, dry, and ventilated area.
- b) Remove any excess dust in heat sinks and ventilations. This should only be done with a dry cloth or brush.
- c) Check that vermin have not infested the inverter. Typical signs of this include spider webs on ventilation grills or wasps' nests in heat sinks.
- d) Check functionality, e.g., automatic disconnection upon loss of grid power supply, at least once a month.
- e) Verify the state of DC/AC surge arrestors, cable connections, and circuit breakers.

25.4 Inspection and Maintenance Schedule

Component	Activity	Description	Interval
PV Module	Cleaning	<ul style="list-style-type: none"> • Clean PV modules with plain water or mild dishwashing detergent. • Do not use brushes, any types of solvents, abrasives, or harsh detergents. 	Monthly or as per site conditions
PV Array	Inspection	<ul style="list-style-type: none"> • Check the PV modules and rack for any damage. • Note down location and serial number of damaged modules. 	Annual
	Inspection	<ul style="list-style-type: none"> • Determine if any new objects, such as vegetation growth, are causing shading of the array and move them if possible. 	Half Yearly
	Vermin Removal	<ul style="list-style-type: none"> • Remove bird nests or vermin from array and rack area. 	Half Yearly

Junction Boxes	Inspection	<ul style="list-style-type: none"> Inspect electrical boxes for corrosion or intrusion of water or insects. Seal boxes if required. Check position of switches and breakers. Check operation of all protection devices. 	Annual
Wiring	Inspection	<ul style="list-style-type: none"> Inspect cabling for signs of cracks, defects, loose connections, overheating, arcing, short or open circuits, and ground faults. 	Annual
Inverter	Inspection Service	<ul style="list-style-type: none"> Observe instantaneous operational indicators on the faceplate of the inverter to ensure that the amount of power being generated is typical of the conditions. Inspect Inverter housing or shelter for physical maintenance, if required. 	Monthly
Plant	Monitoring	<ul style="list-style-type: none"> Operation and Performance Monitoring 	Monthly
Spare Parts	Management	<ul style="list-style-type: none"> Manage inventory of spare parts. 	As needed

25.5 The faulty system or components should be replaced/ repaired within 7 days of fault reporting. The servicing should be carried out at the site of installation. If any of the components are to be taken out from the site for repair, a standby must be provided to ensure un-interrupted power generation and the systems functions smoothly.

25.6 Any Delay in servicing beyond 7 days of fault reporting would attract penalty at the rate of at the rate fixed by The Plantation Corporation of Kerala LTD / ANERT and further actions will be initiated against the agency.

25.7 A designated contact Telephone Number and address should be submitted for reporting faults during the O&M period of 5 years.

25. BILL OF MATERIAL

The bidder should provide the bill of material mentioning the quantity of each of the item consisting in the system, along with the offer in the format as show below for each capacity:

Sl. No.	Item	Make (if any)	Model & Individual Capacity (If any)	Qty (Nos)	Rating/Capacity
1.	PV Module				
2.	PCU/Inverter				
3.	DC Cables				
4.	AC Cables				
5.	AJB/SCB				
6.	Module Mounting Structure (MMS)				
7.	ACDB				
8.	Lightning Arrester				
9.	Earthing System Details and No. of Earth pits				
10.	Data Acquisition System				

26. OPERATION MANUAL

- a. An Operation, Instruction and Maintenance Manual, in English and Malayalam should be provided with the system.
- b. The following minimum details must be provided in the manual:
 - i. About solar power plant – its components and expected performance.
 - ii. About PV module
 - iii. About electronics
 - iv. About charging and significance of indicators
 - v. DO's and DON'T's

- vi. Clear instructions on regular maintenance and troubleshooting of solar power plant
- vii. Name and address of the contract person in case of non-functionality of the solar power plant.

27. DISPLAY BOARD

- a. A Display Board of size 4 ft x 3 ft with the matter as provided by work awarding agency shall be provided by the successful bidder.

28. INSURANCE

- a. The power plant must be insured at every stage of operation – from Material dispatch, storage, completion of installation and till 5 years after commissioning. The insurance coverage on handing over of the system must include all conditions of **Standard Fire and Special Perils Policy (Material Damage)**.
- b. The insurance premium for the 5 years of warranty is to be paid by the bidder. On handing over of the system, the original insurance policy is to be handed over to the authorised person at the site of installation and a copy to The Plantation corporation of Kerala ltd (PCK LTD). The annual premium payment receipt must be handed to the authorised person at the site of installation.

30. SITE INSPECTON

It is recommended that the bidders visit all the sites listed here for the physical verification and for correctly estimating the quantity, especially related to structure and cabling, before submitting the bids. **Bidder must include all the AC/DC wiring cost, replacement of instrument transformers, panel boards etc only after visiting the proposed site.**

31. CLEANING

- a. The bidder shall provide permanent arrangement for module washing in the SPV Plant. Water lines may be drawn to feed water from the available resources. Contractor has to provide additional facility including pipeline, motor for pumping to the additional overhead tank, if required.

32. ENGINEERING DRAWINGS

The bidder should submit and get the necessary approval of the following detailed Engineering Drawings before execution of the project but not limited to:

- i. Schematic drawing showing the PV panels, Power conditioning Unit(s)/Inverter, Array Junction Boxes (AJBs)/String Combiner Boxes (SJB), AC and DC Distribution Box, Net meters, MSB etc.
- ii. Layout of solar PV Array
- iii. Single Line Diagram (SLD) with specification of all components.
- iv. Design document for Module Mounting Structure (MMS) including certificate showing wind speed withstanding capacity of the structure (STAAD/Equivalent).
- v. Module Mounting Structure (MMS) drawing along with foundation details for the structure.
- vi. Sizes and specification of cables for PV Module interconnections, PV Array to Array Junction Boxes, Array Junction Boxes to Inverter, Inverter to ACDB/ Grid Connection point etc. shall be furnished.

All PV plant design should contain the following details which should be approved by the concerned officer before installation.

- i. Design of strings including the number of PV modules in series and number of strings
- ii. AC Protection (Circuit Breaker, Switches, Fuses, SPD)
- iii. DC Protection (Switches, Fuses, SPD)
- iv. AJB / SCB details
- v. DC Cable size and length from point to point
- vi. AC Cable size and length from point to point
- vii. Earthing system details and number of pits
- viii. Lightning protection details/specification
- ix. PV Syst Simulation Report / any other Shadow analysis reports
- x. Design document for mounting structure.
- xi. Mounting structure drawing
- xii. Structural drawing along with foundation details for the structure.

- xiii. Cable layout(indicating details of cable route for power & communication cables)
- xiv. Itemized bill of material for complete SPV plant covering all the components and associated accessories.
- xv. Sizes and specification of cables between array interconnections, array to junction boxes, junction boxes to Inverter etc. shall be furnished.