MINIMUM TECHNICAL SPECIFICATIONS OF SPV POWER PLANT

Definition:-

A Grid Tied Solar Rooftop Photo Voltaic (SPV) power plant consists of SPV array, Module Mounting Structure, Power Conditioning Unit (PCU) consisting of Maximum Power Point Tracker (MPPT), Inverter, and Controls & Protections, interconnect cables, Junction boxes, Distribution boxes and switches. PV Array is mounted on a suitable structure. Grid tied SPV system is without battery and should be designed with necessary features to supplement the grid power during day time. Components and parts used in the SPV power plants including the PV modules, metallic structures, cables, junction box, switches, PCUs etc., should conform to the BIS or IEC or international specifications, wherever such specifications are available and applicable. Solar PV system shall consist of following equipments/components.

- Solar PV modules consisting of required number of **Crystalline** PV cells.
- Grid interactive Power Conditioning Unit with Remote Monitoring System.
- Mounting structures.
- Junction Boxes.
- Earthing and lightening protections.
- IR/UV protected PVC Cables, pipes and accessories.

1. SPV MODULES

1.1 Type and Quality

The total Solar PV array capacity shall be as specified in price schedule and shall be assembled with minimum 250 Wp (with minimum of 24V) Multi/Mono Crystalline MNRE approved solar modules with 60/ 72 cells with minimum 15% Module Efficiency. The modules should be tested and certified by a Govt. of India authorized test centres or should conform to relevant IEC standard as per MNRE guidelines. Offered module shall have a power output warranty of 90% of the rated power for 10 years. The rated output power and Efficiency of each supplied & installed module shall not be less than the specified power rating and Efficiency of the modules, in any case. Every module should have suitable by-pass diode at its terminal box. The SPV Modules must be installed in such a way so as to deliver proper voltage and current to ensure desired power output as per specifications of CREDA for the size of SPVPP ordered.

1.2 The modules used shall have following specifications:
Type: Mono crystalline/ Multi crystalline as per MNRE approved Solar Modules

Specification and standard: Confirming to MNRE guidelines of 2014-15 under JNNSM.

1.3 The PV modules should be made in India The PV modules used must qualify to the latest edition of IEC PV module qualification test or equivalent BIS standards Crystalline Silicon Solar Cell Modules IEC 61215/IS14286. In addition, the modules must conform to IEC
61730 Part-1 -requirements for construction & Part 2 –requirements for testing, for safety qualification or equivalent IS.

1.4 Each PV module used in solar power project must have 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 (should be made in India)

(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 cells 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 ISO9000 series.

(k) In addition, the modules must conform to IEC 61730 Part 1- requirements for construction & Part 2 - requirements for testing, for safety qualification or Equivalent IS (Under Dev.)

(l) PV modules to be used in a highly corrosive atmosphere (coastal areas etc.) must qualify Salt Mist Corrosion Testing as per IEC 61701 / IS 61701.

(m) **IDENTIFICATION AND TRACEABILITY -**

Each PV module must use a RF identification tag (RFID), which must contain the following information:

(i) Name of the manufacturer of PV Modules (should be made in India).

(ii) Name of the Manufacturer of Solar cells.

(iii) Month and year of the manufacture (separately for solar cells and module).

(iv) Country of origin (separately for solar cells and module).

(v) I-V curve for the module.

(vi) Peak Wattage, Im, Vm and FF for the module.

(vii) Unique Serial No and Model No of the module.

(viii) Date and year of obtaining IEC PV module qualification certificate.

(ix) Name of the test lab issuing IEC certificate.

(x) Other relevant information on traceability of solar cells and module should be as per ISO 9000 series. The RFID must be inside of module lamination. The module laminate, but must be able to

withstand harsh environmental conditions.

(n) Inter connections of solar modules should be through good quality male female joint. Name of manufacturer, S. No. of Module & manufacturing year should be clearly fixed inside the glass lamination of every module. Thermal sticker should be affixed behind every module which should clearly state the specifications & capacity of the module.

(o) Every module should have PID Test report as per the prevailing norms of MNRE.

2. PCU/ Inverter:

As SPV array produce direct current electricity, it is necessary to convert this direct current into alternating current and adjust the voltage levels to match the grid voltage. Conversion shall be achieved using an electronic Inverter and the associated control and protection devices. All these components of the system are termed the "Power Conditioning Unit (PCU)". In addition, the PCU shall also house MPPT (Maximum Power Point Tracker), an interface between Solar PV array & the Inverter, to the power conditioning unit/inverter should also be DG set interactive. If necessary. Inverter output should be compatible with the grid frequency. Typical technical features of the inverter shall be as follows:

Switching devices	IGBT/MOSFET
Control	Microprocessor /DSP
Nominal AC output voltage and frequency	415V, 3 Phase, 50Hz (In case single phase inverters are offered, suitable arrangement for balancing the phases must be made.)
Output frequency	50 Hz
Grid Frequency Synchronization range	+ 3 Hz or more

Ambient temperature considered	-20^{o} C to 50^{o} C
Humidity	95 % Non-condensing
Protection of Enclosure	IP-20(Minimum) for indoor.
	IP-65(Minimum) for outdoor.
Grid Frequency Tolerance range	+ 3 or more
Grid Voltage tolerance	-0.20.15
No-load losses	Less than 1% of rated power

Inverter efficiency(minimum)	>93% (In case of 10 kW or above with in-built galvanic isolation) >97% (In case of 10 KW or above without in-built galvanic isolation)
Inverter efficiency (minimum)	> 90% (In case of less than 10 kW)
THD	< 3%
PF	> 0.9

a) Three phase PCU/ inverter shall be used with each power plant system (10kW and/or above) but in case of less than 10kW single phase inverter can be used.

b) PCU/inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

c) The output of power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power, inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.

d) Built-in meter and data logger to monitor plant performance through external computer shall be provided.

e) **Anti-islanding** (Protection against Islanding of grid): The PCU shall have anti islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard.

f) In PCU/Inverter, there shall be a direct current isolation provided at the output by means of a suitable isolating transformer. If Isolation Transformer is not incorporated with PCU/Inverter, there shall be a separate Isolation Transformer of suitable rating provided at the output side of PCU/PCU units for capacity more than 100 kW.

g) The PCU/ inverter generated harmonics, flicker, DC injection limits, Voltage Range, Frequency Range and Anti-Islanding measures at the point of connection to The Utility services should follow the latest CEA (Technical Standards for Connectivity Distribution Generation Resources) Guidelines.

h) The power conditioning units / inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per Standard codes IEC 61683/IS 61683 and IEC 60068-2(1,2,14,30)/Equivalent BIS Standard.

i) The MPPT units environmental testing should qualify IEC 60068-2 (1, 2, 14,30)/ Equivalent BIS STD. The junction boxes/ enclosures should be IP 65 (for outdoor)/ IP 54 (indoor) and as per IEC 529 specifications.

j) The PCU/ inverters should be tested from the MNRE approved test centres/ NABL/ BIS/IEC accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses.

3. Mechanical Components: MODULE MOUNTING STRUCTURE (MMS):

MMS should be installed along with the hot dipped galvanized (minimum 80 microns) array support structure for mounting of SPV modules at site. The panel frame structure should be capable of withstanding a minimum wind load of 150 Km per hour, after grouting and installation. MMS should be sturdy & designed to assist SPV Modules to render maximum output. The hardware (fasteners) used for installation of SPV Modules & MMS should be of suitable Stainless Steel (SS 304).

Its size should be with reference to the specifications of the selected make SPV modules. Preferably Anti Theft Nut Bolts of SS (with washers) should also be used for better theft proofing.

4. Foundation: The PCC foundation shall have to be designed on the basis of the weight of the structure with module and maximum wind speed of the site, i.e. 150 Km/hour. Normally each MMS should be with four legs grouted on pedestals of proper size.

5. **Junction Boxes for Cables from Solar Array**: The junction boxes shall be made up of Poly Carbonate/PP/ABS (with prior approval of CREDA) with dust, water and vermin proof. It should have with proper locking arrangements.

Junction/Combiner Box (SJB/AJB/DCCB) (whichever is required): All the arrays of the modules shall be connected to Direct Current Combiner Box (DCCB). DCCB shall have terminals of bus-bar arrangement of appropriate size. DCCB shall have suitable cable entry with suitable glanding arrangement for both input and output cables. Suitable markings on the bus bars shall have to be provided to identify the bus bars etc. **suitable ferrules shall also have to be provided to identify interconnections. Every AJB should have suitable arrangement Reverse Blocking diode of suitable rating. Suitable SPD, suitable Isolation switches to isolate the DC input from each array individually to Inverter, has to be installed in DCCB for protection purpose**. Thus DCCB should have DC isolator for disconnecting the arrays from inverter input. DCCB should have provision of isolating each string separately. **If in any case diodes, HRC Fuses, SPDs and isolators are installed in the string inverters, then also there is need to install these in DCCB. If some of these safety gadgets are not installed in String Inverter it should be installed in DCCB.** Cable interconnection arrangement shall be within conduit pipe on saddles installed properly as per CREDA's approvals**. Cable connection should be done in such a manner that fault findings if any, can be identified easily. The cables should be connected in such a manner that clamp meter can be comfortably inserted around the individual cables to measure the data like current, voltage etc.** AJB, if required, should also be marked as A1, A2, & so on. Wherever conduits are laid on wall/roof or ground, then it should be suitably laid in cable tray or appropriate civil structure which should be at least four inches above roof/ground level.

6. PROTECTION & SAFETY:

Both AC & DC lines should have suitable MCB/MCCB, Contractors, SPD, HRC Fuse etc to allow safe start up and shut down before & after string inverter installed in the system. String inverters should have protections for overload, surge current, high Temperature, over/ under voltage and over/ under frequency & reverse polarity. **The complete operation process & safety instructions should printed on the sticker & suitably pasted on the near inverters.**

Inverter should have safety measures to protect inverter from reverse short circuit current due to lightening or line faults of distribution network.

Inverter should be suitably placed in covered area on a suitable platform or concrete platform (on rubber mat) with complete safety measure as per norms.

7. PCU/ARRAY SIZE RATIO:

The combined output wattage of all inverters should not be less than rated capacity of power plant under STC in KW.

- Maximum power point tracker shall be integrated in the PCU/inverter to maximize energy drawn from the array.

8. LIGHTNING AND OVER VOLTAGE PROTECTION:

The SPV Power Plant should be provided with lightening and over voltage protection. The principal aim in this protection is to reduce the over voltage to a tolerable value before it reaches the PV or other sub-systems components. The source of over voltage can be lightening or any other atmospheric disturbance. The Lighting Arrestor (LA) is to be made of 1¼" diameter (minimum) and 12 feet (minimum)long GI spike on the basis of the necessary meteorological data of the location of the projects. Necessary foundation for holding the LA is to be arranged keeping in view the wind speed of the site and flexibility in maintenance in future. Each LA should have dedicatedly earthed through suitable size earth bus with earth pits. The earthing pit shall have to be made as per IS 3043. LA shall be installed to protect the array field, all machines and control panels installed in the control rooms. Number of LA shall vary with the capacity of SPV Power Plant & location. Number of LA should be in such a manner that total layout of solar modules should the effective coverage of LA's.

9. EARTHING PROTECTION:

Each array structure of the PV yard shall be grounded properly. In each array every module should be connected to each other with copper wires, lug teethed washers addition the lightening arrestor/masts shall also be provided inside the array field. Provision shall be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of the plant should be thoroughly grounded in accordance with Indian Electricity Act/IE rules as amended up to date. The earthing pit shall be made as per IS: 3043. All the array structures, equipments, inverters & control systems shall be compulsorily connected to the earth. Number of earthling shall vary with the capacity of SPV Power Plant & soil resistivity of location. Copper strips should be used for connecting earthing instead of G.I. wires. LA should be installed to protect the array field & machines installed in the control rooms. The LA installations should have to be approved from CREDA prior to installation.

10. AC COMBINER BOX (ACCB):

This shall consist of box of AC combiner cum grid interphase panel of good quality PC/PP/ABS or suitable powder coated metal casing. **One Electronic Energy Meter (0.5S Class) as per CSERC regulation to record generations details (should have facility of storing one year generation data)**, ISI make, Three Phase duly tested by CSPDCL (Meter testing Division) with appropriate CT, of good quality shall have to be installed in ACCB suitable placed (in such a manner that if required it can be sealed by CSPDCL) to measure the consumption of power daily generated from SPV Power Plant, as per CSERC Rooftop Notification. Proper rating MCCB & HRC fuse and AC SPDs should be installed to protect feeders from the short circuit current and surges as per the requirement of the site & instructions of CREDA. Separate rotary **AC Isolator Switch of suitable rating, for Grid Connectivity/Disconnection, should have to be installed outside each ACCB with locking arrangements.**

ACCB should be designed in such a way that Solar Generation meter and CTs of it, can be sealed by CSPDCL authority.

11. DANGER BOARDS:

Danger boards should be provided as and where necessary as per IE Act/IE Rules as amended up to date, as per the instructions of CREDA & affixed at various appropriate locations.

12. CABLES/WIRE:

All cables should be of copper as per IS and should be grade as per requirement. All connections should be properly made through suitable lug/terminal crimped with use of suitable proper cable glands. The size of cables/wires should be designed considering the line loses, maximum load on line, keeping voltage drop within permissible limit and other related factors. The cable/wire should be of ISI/ISO mark for overhead distribution, with prior approval of CREDA. For normal configuration the minimum suggested sizes of cables are:

Module to module/SJB/AJB-4 sq mm (single core)

AJBs to MJBs/DCDB -10/16 sq mm (two core), with respect to current ratings of designing

MJBs to **DCCB** - minimum 25 sq mm (single core) or as per design & rating

DCCB to Inverter - minimum 25 sq mm (single core) or as per design & rating

Inverter to ACCB - as per design & rating

The size & rating of the cables may vary depending on the design & capacity of SPV Power Plant. Bidder should compulsorily get the design & rating of the cables approved from CREDA prior to the installation.

13. **CABLE TRAY:** All the cables should be laid in appropriate cable tray as per the requirement of the site, No cable should be laid directly on ground or wall cable tray should be laid such that there is gap of at least four inches above ground/roof/wall**.**

14. DISPLAY BOARD:

The bidder has to display a board at the project site mentioning the following:

- Plant Name, Capacity, Location, Type of Renewable Energy plant (solar), Date of commissioning, details of tie-up with transmission and distribution companies etc.
- The size and type of board and display shall be approved by Engineer-in-charge before site inspection.

15. Manual Disconnection Switch: It should be provided to isolate the system from Grid which should be outside of ACCB.

16. INTEGRATION OF PV POWER WITH GRID:

The output power from SPV would be fed to the inverters which converts DC produced by SPV array to AC and feeds it into the main electricity grid after synchronization. In case of grid failure, or low or high voltage, solar PV system shall be out of synchronization and shall be disconnected from the grid. Once the DG set comes into service PV system should again be synchronized with DG supply and load requirement would be met to the extent of availability of power. 4 pole isolation of inverter output with respect to the grid/ DG power connection need to be provided. A bidirectional energy meter, as per CSERC notification should also be installed in the campus/building of beneficiary, if required.

17. DATA ACQUISITION SYSTEM / PLANT MONITORING

i. Data Acquisition System shall be provided for each of the solar PV plant.

ii. 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.

iii. The following parameters are accessible via the operating interface display in real time separately for solar power plant:

a. AC Voltage.

b. AC Output current.

c. Output Power

d. Power factor.

e. DC Input Voltage.

f. DC Input Current.

g. Time Active.

h. Time disabled.

i. Time Idle.

j. Power produced

k. Protective function limits (Viz-AC Over voltage, AC Under voltage, Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage.

l. The online monitoring should be done through inverter provider web portal only. No third party software shall be allowed.

m. Communication requirement:-

As per CSERC regulation .

vi. All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and read on the digital front panel at any time) and logging facility (the current values, previous values for up to a month and the Average values) should be made available for energy auditing through the internal microprocessor and should be read on the digital front panel.

vii. Solar Meter: Energy Meters to log the actual value of Energy generated by the PV system be provided. Energy meter if required with CT/PT should be of 0.5 accuracy class. It should have one year recording facility.

viii. Computerized DC Array monitoring and AC output monitoring shall be provided as part of the inverter and/or string/array combiner box or separately.

ix. Computerized AC energy monitoring shall be in addition to the solar meter.

x. The data shall be recorded in a common work sheet chronologically date wise. The data file shall be MS Excel compatible. The data shall be represented in both tabular and graphical form.

xi. All instantaneous data shall be shown on the computer screen.

xii. Software shall be provided for USB download and analysis of DC and AC parametric data for individual plant.

xiii. Provision for Internet monitoring and download of data shall be also incorporated.

xiv. Remote Server and Software for centralized Internet monitoring system shall also be provided for download and analysis of cumulative data of all the plants. The data of the solar radiation and temperature monitoring system should also be available on Remote Monitoring server.

xv. Simultaneous monitoring of DC and AC electrical voltage, current, power, energy and other data of the plant for correlation with solar and environment data shall be provided.

xvi. Remote Monitoring and data acquisition through Remote Monitoring System software at the owner location with latest software/hardware configuration and service connectivity for online /real time data monitoring/control complete to be supplied and operation and maintenance/control to be ensured by the supplier. Provision for interfacing these data on web server and portal in future shall be kept.

18. POWER CONSUMPTION:

Regarding the generated power consumption, priority need to give for internal consumption first and thereafter any excess power can be exported to grid. Decisions of appropriate authority like CSPDCL, CEI & CSERC shall have to be followed.

19. GRID ISLANDING:

i. In the event of a power failure on the electric grid, it is required that any independent power-producing inverters attached to the grid turn off in a short period of time. This prevents the DC-to-AC inverters from continuing to feed

power into small sections of the grid, known as “islands.” Powered islands present a risk to workers who may expect the area to be unpowered, and they may also damage grid-tied equipment. The Rooftop PV system shall be equipped with islanding protection. In addition to disconnection from the grid (due to islanding protection) disconnection due to under and over voltage conditions shall also be provided.

ii. A manual disconnect 4 pole isolation switch beside automatic disconnection to grid would have to be provided at utility end to isolate the grid connection by the utility personnel to carry out any maintenance. This switch shall be locked by the utility personnel.

Quality Certification, Standards and Testing for Grid-connected Rooftop Solar PV Systems/Power Plants

Quality certification and standards for grid-connected rooftop solar PV systems are essential for the successful mass-scale implementation of this technology. It is also imperative to put in place an efficient and rigorous monitoring mechanism, adherence to these standards. Hence, all components of grid-connected rooftop solar PV system/ plant must conform to the relevant standards and certifications given below:

Solar PV Modules/Panels	
IEC 61215/ IS14286	Design Qualification and Type Approval for Crystalline Silicon Terrestrial Photovoltaic (PV) Modules
IEC 61701	Salt Mist Corrosion Testing of Photovoltaic (PV) Modules
IEC 61853- Part 1/ IS 16170: Part 1	Photovoltaic (PV) module performance testing and energy rating –: Irradiance and temperature performance measurements, and power rating
IEC 62716	Photovoltaic (PV) Modules – Ammonia (NH3) Corrosion Testing (As per the site condition like dairies, toilets)
IEC 61730-1,2	Photovoltaic (PV) Module Safety Qualification – Part 1: Requirements for Construction, Part 2: Requirements for Testing
IEC 62804	Photovoltaic (PV) modules - Test methods for the detection of potential-induced degradation. IEC TS 62804-1: Part 1: Crystalline silicon (mandatory for applications where the system voltage is > 600 VDC and advisory for installations where the system voltage is < 600 VDC)
IEC 62759-1	Photovoltaic (PV) modules – Transportation testing, Part 1: Transportation and shipping of module package units
Solar PV Inverters	
IEC 62109-1, IEC 62109-2	Safety of power converters for use in photovoltaic power systems – Part 1: General requirements, and Safety of power converters

	for use in photovoltaic power systems Part 2: Particular requirements for inverters. Safety compliance (Protection degree IP 65 for outdoor mounting, IP 54 for indoor mounting)
IEC/IS 61683 (as applicable)	Photovoltaic Systems – Power conditioners: Procedure for Measuring Efficiency (10%, 25%, 50%, 75% & 90-100% Loading Conditions)
BS EN 50530 (as applicable)	Overall efficiency of grid-connected photovoltaic inverters: This European Standard provides a procedure for the measurement of the accuracy of the maximum power point tracking (MPPT) of inverters, which are used in grid- connected photovoltaic systems. In that case the inverter energizes a low voltage grid of stable AC voltage and constant frequency. Both the static and dynamic MPPT efficiency is considered.
IEC 62116/ UL 1741/ IEEE 1547 (as applicable)	Utility-interconnected Photovoltaic Inverters - Test Procedure of Islanding Prevention Measures
IEC 60255-27	Measuring relays and protection equipment – Part 27: Product safety requirements
IEC 60068-2 (1, 2, 14, 27, 30 & 64)	Environmental Testing of PV System – Power Conditioners and Inverters a) IEC 60068-2-1: Environmental testing - Part 2-1: Tests - Test A: Cold b) IEC 60068-2-2: Environmental testing - Part 2-2: Tests - Test B: Dry heat c) IEC 60068-2-14: Environmental testing - Part 2-14: Tests - Test N: Change of temperature d) IEC 60068-2-27: Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock e) IEC 60068-2-30: Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle) f) IEC 60068-2-64: Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance
IEC 61000 – 2,3,5 (as applicable)	Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) testing of PV Inverters

Fuses

IS/IEC 60947 (Part 1, 2 & 3), EN 50521	General safety requirements for connectors, switches, circuit breakers (AC/DC): a) Low-voltage Switchgear and Control-gear, Part 1: General rules b) Low-Voltage Switchgear and Control-gear, Part 2: Circuit Breakers c) Low-voltage switchgear and Control-gear, Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units d) EN 50521: Connectors for photovoltaic systems – Safety requirements and tests
IEC 60269-6	Low-voltage fuses - Part 6: Supplementary requirements for fuse-links for the protection of solar photovoltaic energy systems
Surge Arrestors	
IEC 62305-4	Lightening Protection Standard
IEC 60364-5-53/ IS 15086-5 (SPD)	Electrical installations of buildings - Part 5-53: Selection and erection of electrical equipment - Isolation, switching and control
IEC 61643-11:2011	Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods
Cables	
IEC 60227/IS 694, IEC 60502/IS 1554 (Part 1 & 2)/ IEC69947	General test and measuring method for PVC (Polyvinyl chloride) insulated cables (for working voltages up to and including 1100 V, and UV resistant for outdoor installation)
BS EN 50618	Electric cables for photovoltaic systems (BT(DE/NOT)258), mainly for DC Cables
Earthing /Lightning	

IEC 62561 Series (Chemical earthing)	IEC 62561-1 Lightning protection system components (LPSC) - Part 1: Requirements for connection components IEC 62561-2 Lightning protection system components (LPSC) - Part 2: Requirements for conductors and earth electrodes IEC 62561-7 Lightning protection system components (LPSC) - Part 7: Requirements for earthing enhancing compounds
Junction Boxes	
IEC 60529	Junction boxes and solar panel terminal boxes shall be of the thermo-plastic type with IP 65 protection for outdoor use, and IP 54 protection for indoor use
Energy Meter	
IS 16444 or as specified by the DISCOMs	A.C. Static direct connected watt-hour Smart Meter Class 1 and 2 — Specification (with Import & Export/Net energy measurements)
Solar PV Roof Mounting Structure	
IS 2062/IS 4759	Material for the structure mounting

Note- Equivalent standards may be used for different system components of the plants. In case of clarification following person/agencies may be contacted.

- Ministry of New and Renewable Energy (Govt. of India)
- National Institute of Solar Energy
- The Energy & Resources Institute
- TUV Rheinland
- UL

Typical Single Line Diagram