UPNEDA Rates Discovered in February/March 2025

Supply Installation & Commissioning of Netmetered Hybrid Solar Power Plant with Battery Backup in Government Buildings with 10 Year Comprehensive Warranty & Maintenance

S. No.	Plant Capacity (Kw)	Discovered rates (Validity upto February 2026)			
		Discovered Price including GST (Rs. Per Kw)	UPNEDA contigent charges (@3% of base price and 18% gst on it) (Rs. Per Kw)	Total Cost of the system including all taxes, gst & contigent charges (Rs. Per Kw)	Discovered Price including GST = Base Price + GST (Rs. Per Kw)
1	2	3	4	5	6
1	1 Kw to 10 Kw (with netmetering)	**140000.00**	4355.00	**144355.00**	140000 = 123022.85 + 16977.15
	1 Kw to 10 Kw (without netmetering)	**132000.00**	4106.00	**136106.00**	132000 = 115992.97 + 16007.03
2	11 Kw to 50 Kw (with netmetering)	Tender in process			
	11 Kw to 50 Kw (without netmetering)				
3	51 Kw to 75 Kw (with netmetering)	**132125.00**	4110.00	**136235.00**	132125 = 116102.81 + 16022.19
	51 Kw to 75 Kw (without netmetering)	**131938.00**	4104.00	**136042.00**	131938 = 115938.49 + 15999.51

Hybrid Solar rooftop Power Plant Empanelled Firms Details 2024-25						
S.No.	**Name of the Firm**	**Firm Address**	**Capacity in KW**	**Agreement Date**	**Mail-ID**	**Mobile No.**
1	GEIE SOLAR PRODUCTS INDIA PVT. LTD. (L-1)	80G, Rajender Nagar, Industrial Area, Sahibabad, Ghaziabad UP-201005	01-10	03-11-2025	geie@geie.co.in	7982319393
2	MARS (INDIA) ANTENNAS & RF SYSTEMS PVT LTD (L-2)	56-A, Dadanagar Industrail Area, Dadanagar, Kanpur-208022	01-10	09-04-2025	info@marsmobility.in	7839999935
3	KLK Ventures Private Limited (L-3)	1517, Hemkunt Chambers 89, Nehru Place, New Delhi110019	01-10	05-05-2025	director.klk@gmail.com	9625940034
4	Servotech Power Systems Limited (L-4)	806, 8th Floor, Crown Heights, Hotel Crown Plaza, Sector-10, Rohini, New Delhi110085	01-10	24-03-2025	sarika78@servotechindia.com	9818680033
5	True Power Limited (L-1)	Plot No 07, Pragati Vihar, Takrohi, Lucknow Uttar Pradesh-226016	51-75	18-03-2025	fno@truepowerearthings.in	9557210802
6	Sunshade Energy Pvt Ltd (L-2)	G-1 Kamla Nagar Bye pass Road Agra-282005	51-75	16-01-2025	sunshadeenergy@gmail.com	7500502200

SCOPE OF WORK AND TECHNICAL SPECIFICATIONS

a. Scope of work covers Design, Supply, Installation, Commissioning and five years Comprehensive warranty Maintenance and Operation of various capacity of On-grid Hybrid Solar Rooftop Plant with Battery backup for captive use (Capex Mode) in various Government buildings at various places in the State of Uttar Pradesh as per the technical specification given in this bid.
b. Wiring up to Distribution Board from the SPV Rooftop system will be in the scope of the Successful bidder(s).
c. Performance testing of the complete system.
d. Remote Monitoring System
e. All the necessary approvals from UPPCL/DISCOM (Electrical Utility)/Electrical Inspectorate, feasibility study, necessary civil work, Mounting of Module Structures, PV Module Installation, Inverter Installation, Battery Installation, DC/AC Cabling and interconnections, Installation of Lightning Arresters and Earthing System as per the standards, Net Metering, arranging all the necessary inspections from UPNEDA/UPPCL/Electrical Inspectorate/ UPNEDA District Office as part of Pre Commissioning, if any, Commissioning of the PV Power Plant, are coming under the scope of the bidder.

Make of Items must be as per the BIS/ MNRE technical specification and equivalent make offered by the bidders in the Bid. The Bidders may change the make of items with the permission of competent authority of UPNEDA as and when required on valid circumstantial conditions. The bidder shall provide Test Certificate of the proposed make of items issued from MNRE authorized testing center or NABL accredited test lab.

TECHNICAL SPECIFICATIONS

A On-Grid Hybrid Solar Rooftop Photo Voltaic (SPV) power plant consists of SPV array, Module Mounting Structure, Power Conditioning Unit (PCU)/Hybrid Inverter consisting of Maximum Power Point Tracker (MPPT), Inverter, Controls & Protections, Net meter, interconnect cables, Junction boxes, Distribution boxes and switches. PV Array is mounted on a suitable structure. Grid tied SPV system will be with battery and bi-directional should be designed with necessary features. Components and parts used in the SPV power plants including the PV modules, metallic structures, cables, junction box, switches, PCUs, Battery etc.,should conform to the BIS or IEC or international specifications, wherever such specifications are available and applicable. Solar PV rooftop system shall consist of following major equipment/components.

- Solar PV module
- Hybrid Inverter
- Mounting structures
- Junction Boxes.
- Earthing and lightening protections.
- Battery
- IR/UV protected PVC Cables, pipes and accessories
- Remote Monitoring System

The solar photovoltaic technology Crystalline based RTS projects for generation of electricity will be deployed under the Programme. Project proponents to adhere to the national/ international standards specified by MNRE from time to time.

SOLAR PHOTOVOLTAIC MODULES:

Solar PV modules should be of the crystalline solar Photovoltaic Technology, manufactured in India. Detailed specifications of the solar PV modules are given below

	Must have test certificate as per MNRE guide lines and specified in this tender
Origin	**Manufactured in India both cell and module**
Efficiency module	>= 19%
Fill factor	>= 70%
warranty	Panel output (W_p) capacity to be >=90% at the end of 10 years and >=80% of at the end of 25 years.
Module frame	Non-corrosive and electrically compatible with the mounting structure material
Termination box	Thermo-plastic, IP 65, UV resistant
Blocking diodes	Schottky type
Module minimum rated power	The nominal power of a single PV module shall not be less than 350Wp.
Identification tag for each solar module	Shall be provided inside the module and must be able to withstand environmental conditions and last the lifetime of the solar module.
Identification tag data	Name of the manufacturer with logo Month and year of manufacture Model No (Should consists of the voltage and rate wattage) Module serial number Made in India
Power output rating	To be given for standard test conditions (STC). I- V curve of the each module shall be submitted
Compliance with standards and codes	IEC 61215 / IS 14286 IEC 61730 Part 1 and 2
Salt Mist Corrosion Testing	As per IEC 61701

The bidder shall carefully design & accommodate requisite numbers of the modules to achieve the rated power output and overall performance of plant.

The Modules and Cells should be manufactured in India and should be complied with the prevailing MNRE Approved List of Models and Manufacturers of Solar Photovoltaic Modules and subsequent amendments and clarifications issued by MNRE, shall be applicable for this Bid. The Successful Bidder must procure Solar PV Modules from MNRE ALMM List as per the UPNEDA office order no 144 dated 08.04.2024.

The rated output power of any supplied module shall have maximum tolerance of +/- 3%. The peak-power point voltage and the peak-power point current of any supplied module

and/or any module string (series connected modules) shall not vary by more than 2 (two) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.

WARRANTIES:

a) Material Warranty:

i. Material Warranty is defined as: The manufacturer should warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than twenty five (25) years from the date of sale to the original customer.

ii. Defects and/or failures due to manufacturing

iii. Defects and/or failures due to quality of materials

Non conformity to specifications due to faulty manufacturing and/or inspection processes. If the solar Module(s) fails to conform to this warranty, the manufacturer will replace the solar module(s), at the Owners sole option.

Test reports/ certificate from IEC/NABL/MNRE accredited laboratory to be mandatorily enclosed for relevant IEC/equivalent BIS Standards.

Solar PV Mounting Structure:

The PV modules shall be mounted on fixed metallic structures having adequate strength and as per requirement of site to withstand the load of the modules and high wind velocities. The mounting structure steel shall be as per latest IS 2062: 1992 and galvanization of the mounting structure shall be in compliance of latest IS 4759.

Mounting structure:

1. Supply, installation, erection and acceptance of module mounting structure (MMS) with all necessary accessories, auxiliaries and spare part shall be in the scope of the work.
2. Module mounting structures can be made from three types of materials. They are Hot Dip Galvanized Iron, Aluminium and Hot Dip Galvanized Mild Steel (MS). However, MS will be preferred for raised structure.
3. MMS Steel shall be as per latest IS 2062:2011 and galvanization of the mounting structure shall be in compliance of latest IS 4759. MMS Aluminium shall be as per AA6063 T6. For Aluminium structures, necessary protection towards rusting need to be provided either by coating or anodization.
4. All bolts, nuts, fasteners shall be of stainless steel of grade SS 304 or hot dip galvanized, panel mounting clamps shall be of aluminium and must sustain the adverse climatic conditions. Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts.
5. The module mounting structures should have angle of inclination as per the site conditions to take maximum insolation and complete shadow-free operation during generation hours. However, to accommodate more capacity the angle of

inclination may be reduced until the plant meets the specified performance ratio requirements.

6. The Mounting structure shall be so designed to withstand the speed for the wind zone of the location where a PV system is proposed to be installed. The PV array structure design shall be appropriate with a factor of safety of minimum 1.5.
7. The upper edge of the module must be covered with wind shield so as to avoid build air ingress below the module. Slight clearance must be provided on both edges (upper & lower) to allow air for cooling.
8. Suitable fastening arrangement such as grouting and calming should be provided to secure the installation against the specific wind speed. The Empanelled Agency shall be fully responsible for any damages to SPV System caused due to high wind velocity within guarantee period as per technical specification.
9. The structures shall be designed to allow easy replacement, repairing and cleaning of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels. Necessary testing provision for MMS to be made available at site.
10. Adequate spacing shall be provided between two panel frames and rows of panels to facilitate personnel protection, ease of installation, replacement, cleaning of panels and electrical maintenance.
11. The structure shall be designed to withstand operating environmental conditions for a period of minimum 25 years.
12. The Rooftop Structures maybe classified in three broad categories as follows:-

i. Ballast structure

a. The mounting structure must be Non-invasive ballast type and any sort of penetration of roof to be avoided.
b. The minimum clearance of the structure from the roof level should be in between 70-150 mm to allow ventilation for cooling, also ease of cleaning and maintenance of panels as well as cleaning of terrace.
c. The structures should be suitably loaded with reinforced concrete blocks of appropriate weight made out of M25 concrete mixture.

ii. Tin shed

a. The structure design should be as per the slope of the tin shed.
b. The inclination angle of structure can be done in two ways-

   b.1. Parallel to the tin shed (flat keeping zero-degree tiling angle), if the slope of shed in Proper south direction

   b.2. With same tilt angle based on the slope of tin shed to get the maximum output.
c. The minimum clearance of the lowest point from the tin shade should be more then 100mm.
d. The base of structure should be connected on the Purlin of tin shed with the proper riveting.

e. All structure member should be of minimum 2 mm thickness.

iii. RCC Elevated structure: It can be divided into further three categories:

A. Minimum Ground clearance (300MM – 1000 MM)

a. The structure shall be designed to allow easy replacement of any module and shall be in line with site requirement. The gap between module should be minimum 30MM.
b. Base Plate – Base plate thickness of the Structure should be 5MM for this segment.
c. Column – Structure Column should be minimum 2MM in Lip section / 3MM in C-Channel section. The minimum section should be 70MM in Web side and 40MM in flange side in Lip section.
d. Rafter - Structure rafter should be minimum 2MM in Lip section / 3MM in C-Channel section. The minimum section should be 70MM in Web side (y-axis) and 40MM in flange side (x-axis).
e. Purlin - Structure purlin should be minimum 2MM in Lip section. The minimum section should be 60MM in Web side and 40MM in flange side in Lip section.
f. Front/back bracing – The section for bracing part should be minimum 2MM thickness.
g. Connection – The structure connection should be bolted completely. Leg to rafter should be connected with minimum 12 diameter bolt. Rafter and purlin should be connected with minimum 10 diameter bolt. Module mounting fasteners should be SS-304 only and remaining fasteners either SS-304 or HDG 8.8 Grade.
h. For single portrait structure the minimum ground clearance should be 500MM.

B. Medium Ground clearance (1000MM – 2000 MM) (for reference only)

a. Base Plate – Base plate thickness of the Structure should be Minimum 6MM for this segment.
b. Column – Structure Column should be minimum 2MM in Lip section / 3MM in C-Channel section. The minimum section should be 80MM in Web side and 50MM in flange side in Lip section.
c. Rafter - Structure rafter should be minimum 2MM in Lip section / 3MM in C-Channel section. The minimum section should be 70MM in Web side and 40MM in flange side in Lip section.
d. Purlin - Structure purlin should be minimum 2MM in Lip section. The minimum section should be 70MM in Web side and 40MM in flange side in Lip section.
e. Front/back bracing – The section for bracing part should be minimum 2MM thickness.
f. Connection – The structure connection should be bolted completely. Leg to rafter should be connected with minimum 12 diameter bolt. Rafter and purlin

should be connected with minimum 10 diameter bolt. Module mounting fasteners should be SS-304 only and remaining fasteners either SS-304 or HDG 8.8 Grade.

C. Maximum Ground clearance (2000MM – 3000 MM) (for reference only)

a. Base Plate – Base plate thickness of the Structure should be minimum 8 MM for this segment.
b. Column – Structure Column thickness should be minimum 2.6MM in square hollow section (minimum 50x50) or rectangular hollow section (minimum 60x40) or 3MM in C-Channel section.
c. Rafter - Structure rafter should be minimum 2MM in Lip section / 3MM in Channel section. The minimum section should be 80MM in Web side and 50MM in flange side in Lip section.
d. Purlin - Structure purlin should be minimum 2MM in Lip section. The minimum section should be 80MM in Web side and 50MM in flange side in Lip section.
e. Front/back bracing – The section for bracing part should be minimum 3MM thickness.
f. Connection – The structure connection should be bolted completely. Leg to rafter should be connected with minimum 12 diameter bolt. Rafter and purlin should be connected with minimum 10 diameter bolt. Module mounting fasteners should be SS-304 only and remaining fasteners either SS-304 or HDG 8.8 Grade.

D. Super elevated structure (More than 3000 MM) (for reference only)

D.1. Base structure

a. Base Plate – Base plate thickness of the Structure should be 10MM for this segment.
b. Column – Structure Column minimum thickness should be minimum 2.9MM in square hollow section (minimum 60x60) or rectangular hollow section (minimum 80x40).
c. Rafter - Structure Rafter minimum thickness should be minimum 2.9MM in square hollow section (minimum 60x60) or rectangular hollow section (minimum 80x40).
d. Cross bracing – Bracing for the connection of rafter and column should be of minimum thickness of 4mm L-angle with the help of minimum bolt diameter of 10mm.

D.2. Upper structure of super elevated structure –

a. Base Plate – Base plate thickness of the Structure should be minimum 5MM for this segment.

b. Column – Structure Column should be minimum 2MM in Lip section / 3MM in Channel section. The minimum section should be 70MM in Web side and 40MM in flange side in Lip section.
c. Rafter - Structure rafter should be minimum 2MM in Lip section / 3MM in Channel section. The minimum section should be 70MM in Web side and 40MM in flange side in Lip section.
d. Purlin - Structure purlin should be minimum 2MM in Lip section. The minimum section should be 60MM in Web side and 40MM in flange side in Lip section.
e. Front/back bracing – The section for bracing part should be minimum 2MM thickness.
f. Connection – The structure connection should be bolted completely. Leg to rafter should be connected with minimum 12 diameter bolt. Rafter and purlin should be connected with minimum 10 diameter bolt. Module mounting fasteners should be SS-304 only and remaining fasteners either SS-304 or HDG 8.8 Grade.

D.3. If distance between two legs in X-Direction is more than 3M than sag angle/Bar should be provide for purlin to avoid deflection failure. The sag angle should be minimum 2MM thick, and bar should be minimum 12Dia.

D.4. Degree - The Module alignment and tilt angle shell be calculated to provide the maximum annual energy output. This shall be decided on the location of array installation.

D.5. Foundation – Foundation should be as per the roof condition; two types of the foundation can be done- either penetrating the roof or without penetrating the roof.

a. If penetration on the roof is allowed (based on the client requirement) then minimum 12MM diameter anchor fasteners with minimum length 100MM can be used with proper chipping. The minimum RCC size should be 400x400x300 cubic mm. Material grade of foundation should be minimum M20.
b. If penetration on roof is not allowed, then foundation can be done with the help of 'J Bolt' (refer IS 5624 for foundation hardware). Proper Neto bond solution should be used to adhere the Foundation block with the RCC roof. Foundation J - bolt length should be minimum 12MM diameter and length should be minimum 300MM.

Material standards:

i. Design of foundation for mounting the structure should be as per defined standards which clearly states the Load Bearing Capacity & other relevant parameters for foundation design (As per IS 6403 / 456 / 4091 / 875).

ii. Grade of raw material to be used for mounting the structures so that it complies the defined wind loading conditions (As per IS 875 - III) should be referred as follows (IS 2062 – for angles and channels, IS 1079 – for sheet, IS 1161 & 1239 for round pipes, IS 4923 for rectangular and square hollow section)
iii. Test reports for the raw material should be as per IS 1852 / 808 / 2062 / 1079 / 811.
iv. In process inspection report as per approved drawing & tolerance should be as per IS 7215.
v. For ascertaining proper welding of structure part following should be referred:
   a. D.P. Test (Pin Hole / Crack) (IS 822)
   b. Weld wire grade should be of grade (ER 70 S - 6)
vi. For ascertaining hot dip galvanizing of fabricated structure following should be referred: -
   a. Min coating required should be as per IS 4759 & EN 1461.
   b. Testing of galvanized material
      - Pierce Test (IS 2633)
      - Mass of Zinc (IS 6745)
      - Adhesion Test (IS 2629)
      - CuSO4 Test (IS 2633)
      - Superior High-Grade Zinc Ingot should be of 99.999% purity (IS 209) (Preferably Hindustan Zinc Limited or Equivalent).
vii. Foundation Hardware – If using foundation bolt in foundation then it should be as per IS 5624.

Solar Array Fuse

The cables from the array strings to the solar grid inverters shall be provided with DC fuse protection. Fuses shall have a voltage rating and current rating as required. The fuse shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

BATTERY- Lithium ferro Phosphate:

The battery should Lithium Ferro phosphate (Lifepo4) having capacity as motioned below at standard conditions. The battery Voltage & AH can be changed keeping the overall KWH same. The voltage selection should be close to Vm of combinations of modules having 72/144 cells. The configuration of battery assembly should be as per requirement of capacity. The cell should be prismatic type having capacity not less than 40 Ah The other feature of the battery should be:

Sr No.	Description	Specification
1	Battery Configuration minimum cell capacity	3.2V- 40 AH; LiFePO4
2	Working Temperature Range (both for charging & discharging)	0-60 Deg C
3	Storage Temperature Range	@ 0-40 Deg- 6 months

4	Cycle Life (Full charge to full discharge @ 25 deg C before capacity of battery falls below 75%)	more than 3000 Cycles
5	Battery Warranty	The LFP batteries shall be warranted for at least 7 years. The cost for a one-time replacement of the battery after 7 years shall be included in the quoted rate. It will be mandatory to replace the entire battery system after 7 years till the completion of the O&M period. The specification of replacement battery shall be the same or higher. The successful bidder shall submit an invoice for the installed battery system after the commissioning of the project. An additional performance bank guarantee (PBG) of the same invoice amount shall be furnished before the release of 85% of the project cost. validity of additional PBG shall be 10 years. This additional PBG will be released after the replacement of the battery system.
6	Type of Cell	Prismatic

Depth of Discharge: minimum 90%
Maximum Discharging rate: up to C/3 rate of battery Capacity
Maximum Charging Rate: upto C/2 rate of battery capacity

- **The battery capacity in Watt Hour shall be calculated as 3840 Whr per kW. This capacity has been derived considering all derating factors, DoD, temp.correction factor, aging factor etc.**
  Example-1:- For 1 kW Solar Rooftop Plant, Battery capacity of minimum 3840 Whr shall be considered.
  Example-2:- For 2 kW Solar Rooftop Plant, Battery capacity shall be 3840 x 2 = 7680 Whr (Min) and so on till 75 kW.

- **The Voltage of the battery system shall be according to requirement of Hybrid Inverter/ DC input voltage of PV module string.**

- **The Ampere Hour (AH) rating of battery shall be calculated as Whr divided by Voltage of the Battery System.**
  Example-1:- For 1 kW Solar Rooftop Plant, with 25.6 V Battery System & 3840 Whr Battery

Capacity the AH capacity shall be 3840 / 25.6 = 150 AH (min).
Example-2:- For 2 kW Solar Rooftop Plant, with 51.2 V Battery System & 7680 Whr Battery Capacity the AH capacity shall be 7680 / 51.2 = 150 AH (min) and so on till 75 kW.

The Lithium Ferro phosphate battery needs a very good "Battery Management Systems" BMS to ensure the proper charging and discharging of each cell of battery with temperature compensation. This battery also needs constant current and constant voltage charging methodology related to upper voltage limit of battery. BMS primary focus is therefore on the safety and the protection of the battery pack, to minimize the risk of sudden failure and to maximize the life cycle of the battery. The secondary function of the BMS is to perform battery diagnosis, such as state of charge (SOC) estimation, state of health (SOH) estimation and state of power (SOP) estimation. Hence a very good battery management system to be incorporated and got it tested with battery from MNRE/NABAL accredited lab as per IEC/BIS standard. The BMS of the LFP battery must also communicate with PCU in some standard protocol like RS485/ 232 or CAN so that PCU can adapt to requirements of battery and extend its life. Communication between PCU and BMS and the compatibility of 2 should be ensured.

The Valid test report as BIS of at least 3.2-volt 40 Ah cell from MNRE/NABAL accredited lab should be submitted along with tender.

Hybrid Inverter

A Hybrid Solar PV power plant system comprises of C-Si (Crystalline Silicon) Solar PV modules with intelligent Inverter having MPPT technology and Intentional Islanding feature and associated power electronics, which feeds surplus generated AC power to the Grid and islands when the Grid is not available. During grid supply outage the system operates in off-grid mode using battery. Other than PV Modules and Inverter/Inverters, the system consists of a Battery Bank, Module Mounting Structures, appropriate DC and AC Cables, Array Junction Boxes (AJB) / String Combiner Boxes (SCB), AC and DC Distribution Box, Lightning Arrester, Earthing Systems, Net meter, etc.

The system should be capable for exporting surplus generated solar power into the Grid, whenever the Grid is available and islands/disconnect whenever the grid is not available. The Hybrid power plants shall be capable of giving a battery backup of minimum three hours considering full load operation. The capacities of battery are defined above.

Hybrid Inverter Specifications:

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.

g. The inverter kW rating shall be equal to the plant capacity in kW.

The Hybrid inverter output shall be 415 VAC, 50 Hz, 3 phase or 230 VAC, 50 Hz, 1 phase as per client requirement.

The hybrid inverter should fulfill all technical requirements for grid connection, including the option to enable/disable export to the grid. Additionally, it should provide intentional islanding capabilities and have the facility to connect to a battery bank.

The Hybrid 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.

The Technical Specification of Hybrid 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 >90%
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
Recommended LED indications	ON Grid ON Under/ Over voltage Overload Over temperature
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)

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 frequency synchronization device, if the system is using synchronizer inherently built in to the inverter then no separate synchronizer is required.	Relevant CEA (Technical Standards for Connectivity of 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 isolated 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.	
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.	Relevant CEA regulations 2013 and subsequent if any, (Technical standards for connectivity of the Distributed generation resource)

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 grid failure or voltage or frequency variations must Island/disconnect from the Grid.	
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	

The IEC Certifications of Inverters are summarized below:

Standard	Description
IEC 61683	Photovoltaic systems – Power conditioners – Procedure for measuring efficiency
IEC 61727 or VDE-AR-N 4105	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
*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 /IEEE 1547 or IEEE 1547.1 / UL 1741	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**

The operation of this solar system is summarized below with presenting some common scenarios:

Operation of the system according to different supply scenarios

Condition	**Operation Philosophies**
• Solar available • Grid available • Battery fully charged	• Normal On-grid operation • Loads supported by solar and grid as necessary
• Solar available • Grid available • Battery not fully charged	• Normal On-grid operation • Solar used first for charging battery • Excess solar used to support loads in combination with grid
• Solar available at low capacity • Grid available • Battery not fully charged	• Normal On-grid operation • Solar used for charging battery • Grid charges battery in combination with solar • Loads supported by grid
• Solar available at high capacity • Grid available • Battery fully charged	• Solar used for all loads • Excess solar exported to grid • Battery stored energy cannot export to the grid
• Solar available • Grid not available • Battery fully charged	• Solar used for all loads • Battery stored energy used to support loads till battery gets discharged
• Solar not available • Grid available • Battery fully charged	• Grid supports loads
• Solar not available • Grid available • Battery not charged	• Grid supports loads and charges the battery to pre-designed level
• Solar not available • Grid not available • Battery charged	• Battery supports loads
• Solar not available • Grid not available • Battery not charged	• DG set may operate to support loads (DG set not included in scope of work)

REMOTE MONITORING SYSTEM

Remote Monitoring system with per minute logging of data, GPRS based, viewable on desktop and smart phones. Data must be accessible to UPNEDA.

Remote Server and Software for centralized Internet monitoring system shall be also provided for download and analysis of cumulative data of all the plants and the data of the solar radiation and temperature monitoring system.

Remote Monitoring and data acquisition through Remote Monitoring System software at the owner location with service connectivity for online / real time data monitoring / control complete to be supplied and operation and maintenance / control to be ensured by the bidder.

POWER CONSUMPTION:

Regarding the generated power consumption, priority need to give for internal consumption first and thereafter any excess power can be made open.

PROTECTIONS

The system should be provided with all necessary protections like earthing, Lightning, and grid islanding as follows:

LIGHTNING PROTECTION

The SPV power plants shall be provided with lightning & overvoltage protection. The main aim in this protection shall be to reduce the over voltage to a tolerable value before it reaches the PV or other sub system components. The source of over voltage can be lightning, atmosphere disturbances etc The entire space occupying the SPV array shall be suitably protected against Lightning by deploying required number of Lightning Arrestors. Lightning protection should be provided as per IEC 62305 /IS 2309 standard. The protection against induced high-voltages shall be provided by the use of metal oxide varistors (MOVs) and suitable earthing such that induced transients find an alternate route to earth.

SURGE PROTECTION

Surge protection shall be provided on both the DC and the AC side of the solar system. The DC surge protection devices (SPDs) shall be installed in the DC distribution box adjacent to the solar grid inverter. The AC SPDs shall be installed in the AC distribution box adjacent to the solar grid inverter. The SPDs earthing terminal shall be connected to earth through the above mentioned dedicated earthing system. The SPDs shall be of type 2 as per IEC 60364-5-53.

EARTHING PROTECTION

(a) Each array structure of the PV yard should be grounded/ earthed properly as per IS:3043- 1987. In addition the lighting arrester/masts should also be earthed inside the array field. Earth Resistance shall be tested in presence of the representative of Discom /UPNEDA as and when required after earthing by calibrated earth tester. PCU, ACDB and DCDB should also be earthed properly.

(b) Earth resistance shall not be more than 5 ohms. It shall be ensured that all the earthing points are bonded together to make them at the same potential.

CABLES

The rate quoted by the bidder shall be inclusive of required AC and DC Cables Length.

Cables of appropriate size to be used in the system shall have the following characteristics:

a) Shall meet IEC 60227/IS 694, IEC 60502/IS1554 standards Temp. Range: –10oC to +80oC.
Voltage rating 660/1000V

b)For the DC cabling, Solar cables with multi stranded copper conductors XLPE or XLPO insulated and sheathed with the voltage rating of 1000 V DC or higher UV stabilised single core flexible copper cables shall be used. Multi-core cables shall not be used.

c) For the AC cabling, PVC or XLPE insulated and PVC sheathed single or multi-core flexible copper/ aluminium cables shall be used. Outdoor AC cables shall have a UV-stabilised outer sheath.

d)The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 1.0%.

e) The total voltage drop on the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%

f) The DC cables from the SPV module array shall run through a UV-stabilised PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm or through a High Density Poly Ethylene (HDPE) conduit. The conduits shall not run across the path way of the terrace. Flexible corrugated PVC conduits shall not be used.

g)Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers.

h)All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings with thermo-plastic clamps at intervals not exceeding 50 cm. The minimum DC cable size shall be 4.0 mm2copper. The minimum AC cable size shall be 4.0 mm2 copper for up to 10kWp and 16.0mm2 for above 10kWp / required standard size. In three phase systems, the size of the neutral wire shall be equal to the size of the phase wires. The following colour coding shall be used for cable wires

i) DC positive: red (the outer PVC sheath can be black with a red line marking)

j) DC negative: black

k)AC single phase: Phase: red; neutral: black

l) AC three phase: Phases: **red, yellow, blue**; neutral**: black** Earth wires: **green**

m) Cables and conduits that have to pass through walls or ceilings shall be taken through a PVC pipe sleeve.

n)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.

o)Cable lugs and end –ferrules for all cable conductor and wire terminations shall be crimped with crimping pliers and end-ferrule pliers

p)All cable ties shall be UV resistant.

q)The Cable should be so selected that it should be compatible up to the life of the solar PV panels i.e. 25years

r) The ratings given are approximate. Bidder to indicate size and length as per system design requirement. All the cables required for the plant provided by the bidder. Any change in cabling sizes if desired by the bidder/approved after citing appropriate reasons. All cable schedules/layout drawings approved prior to

installation.

TOOLS & TACKLES AND SPARES:
After completion of installation & commissioning of the power plant, necessary tools & tackles are to be provided free of cost by the bidder for maintenance purpose.

DANGER BOARDS AND SIGNAGES:
Danger boards should be provided as and where necessary as per IE Act. /IE rules as amended up to date. Three signage shall be provided one each at battery –cum- control room, solar array area and main entry from administrative block. Text of the signage may be finalized in consultation with UPNEDA/ owner.

FIRE EXTINGUISHERS:
The firefighting system for the proposed power plant for fire protection shall be consisting of: Portable fire extinguishers in the control room for fire caused by electrical short circuits Sand buckets in the control room The installation of Fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing PCUs as well as on the Roof or site where the PV arrays have been installed.

DRAWINGS & MANUALS:
Two sets of Engineering, electrical drawings and Installation and O&M manuals are to be supplied.

PLANNING AND DESIGNING:
The bidder should carry out Shadow Analysis at the site and accordingly design strings & arrays layout considering optimal usage of space, material and labor.

SOLAR PV SYSTEM ON THE ROOFTOP FOR MEETING THE ANNUAL ENERGY REQUIREMENT

The Solar PV system on the rooftop of the selected buildings will be installed for meeting the annual energy requirements depending upon the area of rooftop available and the remaining energy requirement of the office buildings will be met by drawing power from grid at commercial tariff of DISCOMs

SAFETY MEASURES:

The bidder shall take entire responsibility for electrical safety of the installation(s) including connectivity with the grid and follow all the safety rules & regulations applicable as per Electricity Act, 2003 and CEA guidelines etc.

DC Combiner Box

A DC Combiner Box shall be used to combine the DC cables of the solar module arrays with DC fuse protection for the outgoing DC cable(s) to the DC Distribution Box.

DC Distribution Box

A DC distribution box shall be mounted close to the solar grid inverter. The DC distribution box shall be of the thermo-plastic IP65 DIN-rail mounting type and shall comprise the following components and cable terminations:

Incoming positive and negative DC cables from the DC Combiner Box;

DC circuit breaker, 2 pole (the cables from the DC Combiner Box will be connected to this circuit breaker on the incoming side);

DC surge protection device (SPD), class 2 as per IEC 60364-5-53;

Outgoing positive and negative DC cables to the solar grid inverter.

As an alternative to the DC circuit breaker a DC isolator may be used inside the DC Distribution Box or in a separate external thermoplastic IP 65 enclosure adjacent to the DC Distribution Box. If a DC isolator is used instead of a DC circuit breaker, a DC fuse shall be installed inside the DC Distribution Box to protect the DC cable that runs from the DC Distribution Box to the Solar Grid Inverter.

AC Distribution Box

An AC distribution box shall be mounted close to the solar grid inverter. The AC distribution box shall be of the thermos plastic IP65 DIN rail mounting type and shall comprise the following components and cable terminations:

Incoming 3-core / 5-core (single-phase/three-phase) cable from the solar grid inverter

AC circuit breaker, 2-pole / 4-pole AC surge protection device (SPD), class 2 as per IEC 60364-5-53

Documentation

The Installer shall supply the following documentation:

- System description with working principles.
- System single line diagram.
- Solar PV array lay-out.
- Routing diagram of cables and wires.
- Data sheets and user manuals of the solar PV panels and the solar grid inverter.
- A system operation and maintenance manual.
- Name, address, mobile number and email address of the service centre to be contacted in case of failure or complaint.
- Warranty cards.
- Maintenance registers.

Test Certificates and Reports to be Furnished

Test Certificates / Reports from IECQ / NABL accredited laboratory for relevant IEC / equivalent BIS standard for quoted components shall be furnished. Type Test Certificates / reports shall be provided for the solar modules and solar grid tied inverters up to 20kW to provide evidence of compliance with standards. For solar grid tied inverters above 20kW, self- certification by the manufacturer of the said inverter is acceptable.

General Instructions

Security, safety, watch, and ward of all materials at sites shall be the responsibility of the Contractor/Bidder

Expenses for any other works, supply of material, and providing services required for the successful commissioning and operation of the plant, but not specifically mentioned in this document.

Safety management to be strictly complied with by the Contractor/Bidder throughout implementation activity.

First-aid medical facilities at the Site during construction to be provided by the Contractor/ Bidder(s)

All local labour, employment, and other issues shall be handled independently by the Contractor/ Bidder(s)

The entire responsibility and risk relating towards the workforce working at the Site, and compliance of different statutory regulations like Workman Compensation Act, Employees‟ State Insurance Corporation (ESIC), Factory Act 1948, Contract Labour Regulation, and Abolition Act 1970, Shop and Establishment Act 1948, and other Statutory regulatory bodies shall solely lie with the Contractor/ Bidder(s).

The Contractor/ Bidder(s) shall also be solely responsible for payment of wages, provident fund, bonus, retrenchment compensation leave, etc. applicable as per various statutory regulations to their entire workforce,

The following Statutory Clearances shall be obtained by the/Bidder(s) wherever applicable:

- Drawings approvals from UPNEDA .
- Electrical Safety approval for system more than 10 KW (Chief Electrical Inspector)
- All equipment, accessories, materials, civil construction & erection works should comply with statutory requirements, BIS and required and highlighted IEC standards

.The Contractor/ Bidder(s) should not misuse the area and/or assign responsibility for the safety of machinery within the premises.

Term

The term for operation and maintenance of the plant may be extended for another five years on mutually agreed terms and conditions and charges.

Electricity Generation

The Contractor/Bidder shall be solely responsible for the performance of the plant(s) and shall make all necessary efforts to maximize the electricity generation of the plant.

Metering and associated facilities

The metering of electricity shall be carried out as per the regulations stipulated by Uttar Pradesh Electricity Regulatory Commission and/or Central Electricity Authority.

Failure to rectify the problem

If the Contractor/ Bidder(s) fails to rectify the plant downtime within seven (7) days from the date of identification of such defect, unless the extension in time is mutually discuss and agreed between the bidder and the respective Beneficiary.

If the Contractor/Bidder(s) fails to rectify the problem, the respective Beneficiary shall/may rectify the problem at the expense of the Contractor/ Bidder(s), in such case on genuine complaint, UPNEDA will take appropriate action including forfeiture of PBG and blacklisting/debarring of the firm.

Completion of Term

On completion of the term of Operation and Maintenance the Contractor/ Bidder(s) shall apply to the respective Beneficiary for the issue of power plant performance certificate. Such document is required for release of PBG of the firm.

NET METERING AND UTILITY INTERCONNECTION:

As per UPERC Notification No. U.P.E.R.C./Secretary/RSPV Regulations/002 Dated: November 17, 2023, U.P.E.R.C. (Rooftop Solar PV Grid Interactive System Gross/Net Metering) Regulation, 2019 (Second Amendment) has kept provision of Net metering scheme shall also be available to following consumer categories mentioned in Rate Schedule for FY 2023-24 in Tariff Orders dated May 24, 2023 of Distribution Licensees (MVVNL, PVVNL, PuVVNL, DVVNL, KESCO & NPCL).
(I) All Public Institutions covered under LMV-4A consumer category of the Rate Schedule except such consumers which are covered under LMV-4A(c) as provided in the Rate Schedule.
(II) Private research institutes, and schools /colleges/educational institutes covered under Private Institutions under LMV-4B consumer category of the Rate Schedule.
(III) Public Institutions akin and similar to those mentioned in (I) above but covered under HV-1 consumer category of Rate Schedule.
(IV) Private Institutions akin and similar to those mentioned in (II) above but covered

"Net Metering" means an arrangement for measurement of energy in a system under which rooftop solar PV system installed at eligible consumer's premises [as above] delivers surplus electricity, if any, to the Distribution Licensee after off-setting the electricity supplied by Distribution License during the applicable billing period.

Energy Accounting and Settlement shall be as per the UPERC Regulation 2019 and amendment thereof.

Standards and Limits

Following specifications shall be applicable for the activities related to meters and grid interconnection.

Standards and Limits

PARAMETER	REFERENCE	REQUIREMENT
Service conditions	Relevant regulation/order by Uttar Pradesh Electricity Regulatory Commission	Compliance
Overall Grid Standards	Central Electricity Authority (Grid Standard) regulations 2010	Compliance
Equipment	BIS / IEEE / IEC	Compliance
Meters	Central Electricity Authority(Installation and Operation of Meters) Regulation 2013 & relevant regulations by Uttar Pradesh Electricity Regulatory Commission	Compliance
Safety and Supply	Central Electricity Authority(Measures of Safety and Electricity Supply) Regulation 2010	Compliance
Harmonic Current	IEEE 519 and CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013	Harmonic current injections from a generating station shall not exceed the limits specified in IEEE 519

Synchronization	IEEE 519 and CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013	Photovoltaic system must be equipped with a grid frequency synchronization device. Every time the generating station is synchronized to the electricity system. It shall not cause voltage fluctuation greater than +/- 5% at point of connection.
Voltage	IEEE 519 and CEA(Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013	The voltage-operating window should minimize nuisance tripping and should be under operating range of 80% to110% of the nominal connected voltage. Beyond a clearing time of 2 second, the photovoltaic system must isolate itself from the grid.
Flicker	IEEE 519 and CEA (Technical Standards for Connectivity of the Distributed Generation Regulations 2013 Resources)	Operation of Photovoltaic system should not cause voltage flicker in excess of the limits stated in IEC 61000 standards or other equivalent Indian standards, if any.
Frequency	IEEE 519 and CEA (Technical Standards for Connectivity of the Distributed Generation Resources). Regulations 2013	When the Distribution system frequency deviates outside the specified conditions(50.5 Hz on upper side and 47.5 Hz on lower side), There should be over and under frequency trip functions with a clearing time of 0.2 seconds
DC injection	IEEE 519 and CEA (Technical Standards for Connectivity of the Distributed Generation Resources). Regulations 2013	Photovoltaic system should not inject DC power more than0.5% of full rated output at the interconnection point under any operating conditions
Power Factor	IEEE 519 and CEA (Technical Standards for Connectivity of the Distributed Generation Resources). Regulations 2013	While the output of the inverter is greater than 50%, a lagging power factor of greater than 0.9 should operate.
Islanding and Disconnection	IEEE 519 and CEA (Technical Standards for Connectivity of the Distributed Generation Resources). Regulations 2013	The photovoltaic system in the event of fault, voltage or frequency variations must island / disconnect itself within IEC standard on stipulated period
Overload and	IEEE 519 and CEA (Technical Standards for Connectivity of the	The inverter should have the facility to automatically switch off

Overheat	Distributed Generation Resources). Regulations 2013	in case of overload or overheating and should restart when normal conditions are restored
Paralleling Device	IEEE 519 and CEA (Technical Standards for Connectivity of the Distributed Generation Resources). Regulations 2013	Paralleling device of photovoltaic system shall be capable of withstanding 220% of the normal voltage at the interconnection point.

Notes for Bidder:

1. The installation should not be protruding outside the building and there should not be overhang type structure on any terrace.
2. Location and area for inverter and other interconnection equipment should be located in suitable and secure place and this should be approved by the respective Beneficiary.
3. Installation diagram and wiring from array to proposed location of inverter and interconnection should be clearly presented by the Bidder before work starts to UPNEDA.

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/IS 14286	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 site condition like dairies, toilets)
IEC 61730-1,2	Photovoltaic (PV) module Safety Qualification- Part 1: Requirements for Construction Part 2:- Requirements for Testing
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	Photovoltaic Systems – Power conditioners: Procedure for Measuring Efficiency (10%,25%, 50%, 75% & 90-100% Loading Conditions)
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 / IEC 62093 (as applicable)	Environmental Testing of PV System – Power Conditioners and Inverters
Fuses	
IS/IEC 60947 (Part 1, 2 & 3), EN 50521	General safety requirements for connectors, switches, circuit breakers (AC/DC): Low-voltage Switchgear and Control