

**TECHNICAL SPECIFICATION FOR SOLAR POWER EQUIPMENT TO BE REQUIRED**

Solar PV system should consist of following equipment:

- i. Solar Power Generation system consisting of required number of PV Modules.
- ii. Efficient On-Grid/Hybrid Inverters
- iii. Mounting structures
- iv. Cables and hardware
- v. Miscellaneous Item
  - a. Junction box and distribution boxes
  - b. Earthing kit
  - c. Lightning arrestors
  - d. PVC pipes and accessories
  - e. Control room and civil pedestals

The supplied equipment must comply the below mentioned specifications:

**PANEL MOUNTING STRUCTURE**

- (i) The PV solar panel mounting metallic structure should be fixed mount L2 or L3 structure where required with 12 Gauge thickness, mounted on concrete base 6 inches above ground level. The tilt angle should set to year round compromise (Equal to latitude).
- (ii) The entire mechanical structure should be hot dipped galvanized and powder coated for longer life of the structure. Structure should be hot dip galvanized upto 90 micrones.
- (iii) The Surface azimuth angle of PV Module 180° and the Tilt angle (slope) of PV Module should be according to the site location.
- (iv) The mounting structure must be engineered for wind resistance and safety as per geographical location of site.

- (v) Module should be fixed with the frame through SS bolts. The bolts should be tightened at the required angle.
- (vi) The Nuts, Bolts & Washers for modules & Mounting structures must be stainless steel material with appropriate gauge.
- (vii) Shading shall be avoided all over the year (around) from 30 minutes after the sunrise to 30 minutes before sunset (For installation purpose only).
- (viii) To allow regular cleaning of the solar modules, they should be easily accessible for personnel (For installation purpose only).

### **PV MODULE**

- (i) The provided PV Module should be of best quality available in market. The PV module should have over nineteen percent (19%) cell efficiency.
- (ii) The PV module(s) shall contain Mono crystalline (PERC) silicon solar cells.
- (iii) The PV module have an ability to Works well with high-voltage input Inverters/ charge controllers
- (iv) The PV Panel must have clear anodized aluminum frame with Anti-reflection cover glass.
- (v) The power output of the module(s) under STC should be at optimum level.
- (vi) The operating voltage corresponding to the power output must be mentioned.
- (vii) The open circuit voltage of the PV modules under STC must be mentioned.
- (viii) The terminal box on the module should have a provision for opening for replacing the cable, if required and it should be waterproof
- (ix) The Solar Panel shell meet the requirement set in IEC 61215:2000, IEC61730, IEC TS 62941.
- (x) A specification sheet containing the following details should be laminated on module so as to be clearly visible from front/back side.
  - (a) Name of the manufacturer or distinctive logo.
  - (b) Model or Type No.

- (c) Serial number
  - (d) Year of manufacturing
  - (e) Peak Watt Rating
  - (f) Voltage and Current at Peak Power
  - (g) Open Circuit Voltage
  - (h) Short Circuit Current
  - (i) Maximum input voltages
- (viii) Limited performance guarantees: panel power, in standard conditions, should not be less than 90% of nominal power for first 10-years of operation and at least 80% for the 20 years of operation with 12-year product warranty and 25-year linear power warranty.
- (ix) Solar panel should have to pack for safe transportation on non-metallic roads.

**Note: Bidder should justify the specs with appropriate lab test reports/certifications from the principle manufacturer.**

### **POWER AND CONTROL CABLES**

Power Cables of adequate rating as per IEC standard shall be required for interconnection of:

- Modules/panels within array
  - Array & Hybrid Inverter
  - Charge Controller & Battery
  - Automatic Distribution Box & Loads
- i) The cable shall be A grade, heavy duty, stranded flexible copper conductor, PVC type A insulated, galvanized steel wire/strip armored, flame retardant low smoke (FRLS) extruded PVC type ST-1 outer sheathed. The cables shall, in general conform to IS-1554 P+I & other relevant standards.

- ii) External cables should be specifically adapted to outdoor exposure (see IEC 60811). Especially the outer insulation must be sunlight (UV)-resistant, weatherproof and designed for underground installation. Preferably rubber-coated and PE-coated cables shall be used.
- iii) The temperature resistance of all interconnecting wires and cables should be > 75° C. The minimum acceptable cross-section of the wire in each of the following sub-circuits is as in ISO IEC prescription:
- iv) Notwithstanding the ISO /IEC requirements, all wires must be sized accordingly to keep line voltage losses to less than 3% between PV generator and battery, less than 1% between battery and charge regulator, and less than 3% between battery and load, all of them at the maximum current conditions. (specifically for service providers)
- v) All wiring shall be color-coded (and/ labeled in case of service providers)
- vi) All supplied wires must be in UV-resistant conduits or be firmly fastened to the building and/or support structure. Cable binders, clamps and other fixing material must also be UV-resistant, preferably made of polyethylene.(for the case of service providers)
- vii) All connections should be properly terminated, soldered and/or sealed using MC4 connectors for outdoor and indoor elements. Relevant codes and operating manuals must be followed.

### **Inverters**

The DC power produced is fed to inverter for conversion into AC. In a grid interactive system AC power should be fed to the grid at three phase bus. Inverter should comply with IEC 61683/IS 61683 for efficiency and measurements and should comply IEC 60068-2 (1, 2, 14, 30) / Equivalent BIS Standard for environmental testing. Inverter should supervise the grid condition continuously and in the event of grid failure (or) under voltage (or) over voltage, Solar System should be disconnected to share with National Grid circuit Breaker / Auto switch provided in the inverter. Two types of

inverters i.e. Grid Tie and Hybrid Inverters has been recommended based on the site design. Technical specifications of both the inverters has been mentioned below:-

### **Grid-Tied Inverters/ On-Grid Inverters**

Important Features/Protections required in the Grid-Tie Inverter are-

- i) The grid-connected inverters shall comply with UL 1741 standard.
- ii) Power generated from the solar system during the day time is utilized fully by powering the all building loads and feeding excess power to the grid as long as grid is available. In cases, where solar power is not sufficient due to more demand or cloud cover etc. the building loads should be served by drawing power from the grid. The inverter should always give preference to the Solar Power and will use Grid power only when the Solar Power is insufficient to meet the load requirement.
- iii) The output of the inverter must synchronize automatically its AC output to the exact AC voltage and frequency of the grid.
- iv) Inverter equipped with array ground fault detection option.
- v) Grid voltage should also be continuously monitored and in the event of voltage going below a pre-set value and above a pre-set value, the solar system should be disconnected from the grid within the set time. Both over voltage and under voltage relays should have adjustable voltage (50% to 130%) and time settings (0 to 5 seconds).
- vi) Metal Oxide Visitors ( MOVs) should also be provided on DC and AC side of the inverter.
- vii) The inverter control unit should be so designed so as to operate the PV system near its maximum Power Point (MPP), the operating point where the combined values of the current and voltage of the solar modules result in a maximum power output.
- viii) The inverter should be a pure sine wave inverter for a grid interactive PV system.

ix) The degree of protection of the outdoor inverter panel should be at least IP-65.

x) Typical technical features of the suggested inverters must mention as per following sequence.

- Continuous output power rating (1.1 times for 60seconds)
- Nominal AC output voltage and frequency
- Accuracy of AC voltage control  $\pm 1\%$
- Accuracy of frequency control  $\pm 0.5\%$
- Grid Frequency Control range  $\pm 3$  Hz
- Maximum Input DC Voltage range
- MPPT Range DC
- Ambient temperature -10 deg C to 55 deg C
- Humidity 95 % non- condensing
- Protection of Enclosure IP-65 (minimum)
- Grid Voltage tolerance -20 % and + 15 %
- Power factor control 0.95 inductive to 0.95 capacitive
- No-load losses < 1% of rated power
- Inverter efficiency (minimum) plus 97%
- Liquid crystal display should at least be provided on the inverters front panel or

on separate data logging/display device to display following

- a. DC Input Voltage
- b. DC Input current
- c. AC Power output(kW)
- d. Current time and date
- e. Time active
- f. Time disabled
- g. Time Idle
- h. Temperatures (C)
- i. Converter status

- Following should also be displayed like Protective function limits, Over voltage, AC under voltage, Over frequency, under frequency, ground fault, PV starting voltage, PV stopping voltage, over voltage delay, under voltage delay over frequency, ground fault delay, PV starting delay, PV stopping delay.)

xi) Nuts & bolts and the inverter enclosure should have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.

xii) Dimension and weight of the inverter should be indicated by the bidder in the offer.

xiii) All doors, covers, panels and cable exits should be gasketed or otherwise designed to limit the entry of dust and moisture. All doors should be equipped with locks.

xvi. Operation Mode:

a. Night or sleep mode: where the Inverter is almost completely turned off, with just the timer and control system still in operation, losses shall be less than 2 W per 5 kW.

b. Standby mode: where the control system continuously monitors the output of the solar generator until pre-set value is exceeded (typically 10 W).

c. Operational of MPP tracking mode: the control system continuously adjusts the voltage of the generator to optimize the power available. The power conditioner should automatically re-enter standby mode input power reduces below the standby mode threshold. Front panel should provide display of status of the inverter.

### **GRID TIED HYBRID INVERTER**

Hybrid inverter(s) (system configuration) with provision for net-metering and battery back-up, should convert DC power produced by SPV modules in to AC power and adjust the voltage & frequency levels to suit the local grid conditions. Pure Sine wave output. Ground Fault Protection. Residual Current Detection (RCD) protection. Monitoring software for real-time status display and fault control. The unit should be able to operate in a high ambient temperature environment. Efficiency must be 96% or above at full load. The inverter must conform to the latest edition of IEC 61727, IEC

61000-6-1, IEC 610006-2, IEC 62109 and IEC 62116 standards

Other important Features/Protections required in the INVERTER

- i) The grid-connected hybrid inverters shall comply with UL 1741 standard.
- ii) Power generated from the solar system during the daytime should be utilized fully by powering the critical building loads and feeding excess power to the grid as long as grid is available. In cases, where solar power is not sufficient due to more demand or cloud cover etc. the building loads should be served by drawing power from the grid. The inverter should always give preference to the Solar Power and will use Grid/DG power only when the Solar Power is insufficient to meet the load requirement.
- iii) The output of the hybrid inverter must synchronize automatically its AC output to the exact AC voltage and frequency of the grid.
- iv) Inverter equipped with array ground fault detection option.
- v) The offered On-Grid Inverter must be of Hybrid type has an ability to synchronize with battery bank as backup system.
- vi) On-grid hybrid Inverters should have anti-islanded features built in and should continuously monitor the condition of the grid and in the event of grid failure; the inverter automatically switches to off-grid supply within 20-50 milliseconds and synchronize with battery bank and fulfil shortcoming from battery bank as PV-Battery hybrid system. The solar system should be resynchronized with the grid within two minutes after the restoration of grid or DG set.
- vii) Grid voltage should also be continuously monitored and in the event of voltage going below a pre-set value and above a pre-set value, the solar system should be disconnected from the grid within the set time. Both over voltage and under voltage relays should have adjustable voltage (50% to 130%) and time settings (0 to 5 seconds).
- viii) The inverter control unit should be so designed so as to operate the PV system near its maximum Power Point (MPP), the operating point where the combined



values of the current and voltage of the solar modules result in a maximum power output.

- ix) The inverter should be a true sine wave for a grid interactive PV system.
- x) The degree of protection of the outdoor inverter panel should be at least IP-65.
- xi) Typical technical features of the suggested inverters must mention as per following sequence.

- Continuous output power rating (1.1 times for 60seconds)
- Nominal AC output voltage and frequency
- Accuracy of AC voltage control  $\pm 1\%$
- Accuracy of frequency control  $\pm 0.5\%$
- Grid Frequency Control range  $\pm 3$  Hz
- Maximum Input DC Voltage range
- MPPT Range DC
- Battery Input voltages + 48 VDC or Plus
- Ambient temperature -10 deg C to 55 deg C
- Humidity 95 % non- condensing
- Protection of Enclosure IP-55 (minimum)
- Grid Voltage tolerance -20 % and + 15 %
- Power factor control 0.95 inductive to 0.95 capacitive
- No-load losses < 1% of rated power
- Inverter efficiency (minimum) plus 97%
- Following should also be displayed like Protective function limits, Over voltage, AC under voltage, Over frequency, under frequency, ground fault, PV starting voltage, PV stopping voltage, over voltage delay, under voltage delay over frequency, ground fault delay, PV starting delay, PV stopping delay.)

**Note: Bidder should justify the specs with appropriate lab test reports/certifications from the principle manufacturer.**

## **SYNCHRONIZING EQUIPMENT**

Solar PV systems should be provided with synchronizing equipment having three input for comparison i.e. grid supply vs. solar output, DG output vs solar output so as to connect the Solar PV systems in synchronism with grid or DG. In case of grid failure, solar PV system should be disconnected from the grid and out of synchronization for a period DG supply is not restored. PV system should be synchronized with the DG supply after DG is started.

## **PROTECTIONS AND CONTROL**

- i. PV system software and control system should be equipped with islanding protection as described above. In addition to disconnection from the grid (islanding protection i.e. on no supply) , under and over voltage conditions , PV systems should be provided with adequate rating fuses, fuses on inverter input side (DC) as well as output side (AC) side for overload and short circuit protection and disconnecting switches to isolate the DC and AC system for maintenances are needed. Fuses of adequate rating should also be provided in each solar array module to protect them against short circuit.
- ii. A manual disconnect switch and change over switch beside automatic disconnection to grid should also be provided at utility end to isolate the grid connection by the utility personal to carry out any maintenance. This switch should be locked by the utility personal.

## **INTEGRATION OF PV POWER WITH GRID:**

The output power from Solar PV system would be fed to the Hybrid inverter which feed some portion to battery bank for backup in case of grid failure and major portion 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 and feed power to the load as PV-Battery backup hybrid system. Once the DG set comes into service

PV system shall again be synchronized with DG supply and load requirement would be met to the extent of availability of power. The connection of the grid connected SPV power plant with the existing power supply system is shown in the diagram stated below

### **HARMONICS STANDARD:**

As per the standard of IEEE 519, the permissible individual harmonics level shall be less than 3% (for both voltage and current harmonics) and Total Harmonics Distortion (THD) for both voltage and current harmonics of the system shall be less than 5%.

### **BATTERY BOX**

- i) The battery bank should be housed in a vented compartment that prevents users from coming in contact with batteries terminals. This compartment should be strong enough to accommodate the weight of the batteries. A mechanism to prevent opening and entry of the batteries should be provided.
- ii) The entire enclosure must be constructed to last at least twenty years without maintenance and should be protected against corrosion. The battery Bank enclosure should have a clean and neat appearance.

### **BATTERY**

Lithium-ion batteries of appropriate capacity with complete battery management system should be used in hybrid and off grid system where required.

The following testing information must be provided by the bidders:

- i) Charge/Discharge Efficiency
- ii) Self-Discharge
- iii) The batteries must conform to the latest edition of IEC 62133 and/or IEC 61960 (whichever is applicable).
- iv) The battery bank should provide backup to a critical load of building.
- v) The battery must ensure safe and reliable operation in the whole range

of ambient temperatures from -10° C to + 50° C.

- vi) The maximum permissible self-discharge rate is 5 percent of rated capacity per month at 25 C.
- vii) Cycle life of the batteries must be greater than 6000 when discharged down to depth of discharge (DOD) of 80% percent discharge rate.
- viii) The battery shall have a certificate of compliances, issued by a recognized laboratory.
- ix) Batteries should be packaged in order to withstand transportation on non-metallic road.
- x) The performance guarantee shall cover at least 05 years.

**Note: Bidder should justify the specs with appropriate lab test reports/certifications from the principle manufacturer.**

## **MISCELLANEOUS ITEMS FOR INSTALLATION**

### **EARTHING MATERIAL:**

- i. Earthing is essential for the protection of the equipment & manpower. Two main grounding must be used for power equipment protection are:
  - DC Earthing.
  - AC Earthing.
- ii. DC and AC earthing should be installed separately where required as per standard.
- iii. In case of equipment earth all the non-current carrying metal parts are bonded together and connected to earth to prevent shock to the man power & also the protection of the equipment in case of any accidental contact.
- iv. To prevent the damage due to lightning the terminal of the lightning protection must be earthed separately. The provision for lightning & surge protection of the solar PV power source is required to be made as per standard.

- v. In case the solar PV Array could not installed close to the equipment to be powered & a separate earth has been provided for solar PV Panel.
- vi. Earth resistance shall not be more than 3 ohms. It shall be ensured that all the earths are bonded together to make them at the same potential.
- vii. The Earthing conductor rating shall be rated for the maximum short circuit current. & shall be 1.56 times the short circuit current. The area of cross-section shall not be less than 2.5 sq. mm in any case.
- viii. The array structure of the PV modules shall be grounded properly using adequate numbers of earthing pits. All metal casing/ shielding of the plant shall be thoroughly grounded to ensure safety of the power plant.

#### **WIRING PVC/GI CHANNEL DUCTS**

A product of good quality standard material with suitable size to be provided / used.

#### **FLEXIBLE PVC PIPE**

The flexible PVC pipe should be of good quality material with suitable size should be used.

#### **COMBINER BOX**

Combiner Box should be manufactured through GI material with 100% copper strip in it for termination of PV Arrays must be IP65 for outdoor installation.

#### **JUNCTIONS BOXES OR COMBINERS**

Dust, water and vermin proof junction boxes of adequate rating and adequate terminal facility made of fire resistant Plastic (FRP) shall be provided for wiring.

Each solar shall be provided with fuses/ Circuit breakers of adequate rating to protect the solar arrays from accidental short circuit.

#### **CIVIL WORKS**

The following civil works should be carried out.

- i. Site grading, levelling, drilling exploratory bore holes and consolidation of the area pertaining to the installation of SPV modules.
- ii. Embedment of structures suitable for mounting PV modules.
- iii. Laying of earthing equipment /structures and connecting to the main ground as per the statutory requirements.
- iv. Construction of control room
- v. Cutting of cable trenches etc. wherever necessary

**OTHER FEATURES:**

- (i) The PV Module(s) should be warranted for a minimum period of 10 years from the date of supply, inverter with five years and the battery should be warranted for a period of 5 years from the date of installation. The warranty card to be supplied with the system must contain the details of the system. The manufacturers can also provide additional information about the system and conditions of warranty as necessary.
- (ii) Adequate space should be provided behind the PV module/array for allowing unobstructed airflow for passive cooling.
- (iii) Cable of appropriate size should be utilized to keep electrical losses to a bare minimum.
- (iv) The control electronics should not be installed directly with the battery. All wiring should be in proper conduit of capping casing. Wire should not be hanging loose.
- (v) Instruction and O&M manuals
  - ✓ Two copies of Instruction and Operation and Maintenance Manual in English and the local language should be provided with the system.
  - ✓ The manual shall be furnished at the time of dispatch of the equipment and shall include the following aspects:
    - a. Precautions during unpacking
    - b. Instructions for handling at site.

- c. Erection drawings with written assembly instructions that would enable the Purchaser to carry out erection with his own personnel if opted by him.
- d. Detailed instructions and procedures for the installation operation and maintenance.
- e. Pre-commissioning tests.
- f. About solar PV system – its components and expected performance.
- g. Principle of Operation of various equipment
- h. Safety and reliability aspects
- i. About power conditioning unit's software and controls
- j. Clear instructions on regular maintenance and trouble shooting of solar power plant.
- k. Name and address of the person or service centre to be contacted in case of failure or complaint.
- l. Outline dimension drawings showing relevant cross sectional views, earthing details, constructional features. Rated voltages and current etc.

**Technical and interconnection requirements**

<b>Overall conditions of service</b>	<b>State Distribution/Supply Code</b>	<b>State Distribution/Supply Code</b>
<b>Overall Grid Standards</b>	Central Electricity Authority (Grid Standard) Regulations 2010	Central Electricity Authority (Grid Standard) Regulations 2010
<b>Equipment</b>	BIS / IEC / IEEE	BIS / IEC / IEEE
<b>Meters</b>	Central Electricity authority (Installation & operation of meters) Regulation 2006 as amended time to time	Central Electricity authority (Installation & operation of meters) Regulation 2006 as amended time to time
<b>Safety and supply</b>	Central Electricity Authority(measures of safety and electricity supply) Regulations, 2010	Central Electricity Authority(measures of safety and electricity supply) Regulations, 2010
<b>Harmonic Requirements Harmonic Current</b>	IEEE 519 CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013	IEEE 519 CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013
<b>Synchronization</b>	IEEE 519 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.
<b>Voltage</b>	IEEE 519 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% to 110% of the nominal connected voltage. Beyond a clearing time of 2 second, the photovoltaic system must isolate itself from the grid.
<b>Flicker</b>	IEEE 519 CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013	Operation of Photovoltaic system should not cause
<b>Frequency</b>	IEEE 519 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.

<b>DC injection</b>	IEEE 519 CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013	Photovoltaic system should not inject DC power more than 0.5% of full rated output at the interconnection point or 1% of rated inverter output current into distribution system under any operating conditions.
<b>Power Factor</b>	IEEE 519 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.
<b>Overload and Overheat</b>	IEEE 519 CEA (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations 2013	The inverter should have the facility to automatically switch off in case of overload or overheating and should restart when normal conditions are restored.
<b>Paralleling Device</b>	IEEE 519 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.

Any minor equipment and material may not be specifically mentioned in this

specifications but are required to make the system complete in a every respect in accordance with technical specification shall be deemed to have been covered under the scope of this specification and shall be provided by the tenderer/supplier within the quoted