

# UNIVERSITY OF LAKKI MARWAT



## SOLARIZATION FOR EXISTING BUILDINGS OF UNIVERSITY OF LAKKI MARWAT

### TECHNICAL SPECIFICATIONS

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DIRECTORATE OF WORKS  
UNIVERSITY OF LAKKI MARWAT, LAKKI MARWAT

## **A. SPECIFICATIONS FOR SOLAR SYSTEM COMMON PART**

### **1. SOLAR PANELS:**

- The PV module(s) shall contain mono crystalline silicon Grade-A Solar Cells. (N-Type Mono PV Cell Modules and Bifacial Double Glass Modules due to its better performance will be given preference).
- The PV module should work well with high-voltage input Inverters / charge controllers (1000 Vdc).
- The PV panel must have clear anodized aluminum frame with Anti-reflective, hydrophobic, low-iron tempered cover glass.
- The Solar Modules shall meet the following valid IEC Standards or latest:
  - IEC 61215-1, IEC 61215-1-1, IEC 61215-2: 2016 (Design Qualification)
  - IEC 61730-1: 2016 (Safety – Requirements for construction)
  - IEC61730-2: 2016 (Safety – Requirements for testing)
  - IEC TS-62804-1, (i.e. TUV PPP-58042 or Equivalent) Anti-PID Certification.
  - IEC 61701 Salt Mist Corrosion Resistance Test (Latest)
  - IEC 62716 Ammonia Corrosion Resistance Test (Latest)
  - IEC 60068-2-68 Sand and Dust Erosion Resistance Test.
- Unique Serial number, name / Logo of manufacturer and separate date of manufacturing (DD/MM/YYYY) should be laminated inside the module so as to be clearly visible from the front side.
- A properly laminate sticker containing the following details should be available at the back side of the module.
  - Name of the manufacturer / distinctive logo.
  - Model Name and Type of Cell Technology.
  - Peak Watt Rating (Wp) and Power Tolerance Range.
  - Voltage ( $V_{mp}$ ) and current ( $I_{mp}$ ) at STC
  - Open Circuit Voltage (VOC) and Short Circuit Current (ISC)
  - Maximum System Voltage ( $V_{dc}$ ) (i.e. This should not be less than 1000  $V_{dc}$ )
  - Dimensions of PV Module
  - Test Standard(s) to which the module has been tested and certified.
- Following essential technical parameters of solar panel / modules should be provided with each panel supplied as well as in the technical proposal.
  - I-V curve for the solar photovoltaic module / panel
  - Date and year of obtaining IEC PV module standardization qualification certificate.
  - Electrical Data (i.e. Pmax, Voc/Vmp, Isc/Imp at nominal Cell Operating Temperature (NOCT)).
  - PV Module efficiency at STC
  - Working temperature range of PV Module.
- Each panel should have factory equipped weather proof terminal junction box having at least IP67 protection with provision of opening for replacement of DC cables, blocking diodes and easy debugging if necessary.

- Limited performance guarantee: panel power, in standard conditions, will not be less than 90% of nominal power by the end of 10 years of operation and at least 80% at the end of 25 years of operation with 25-years limited power warranty.
- The PV module should have at least 10-years warranty for any defects and efficiency as mentioned above. It should be provided on stamp paper signed and sealed by contractor at the time of Handing / Taking over.
- The PV Module should have at least 17.50% module efficiency with positive power Tolerance.
- The PV modules offered should not be more than 12 months old from the date of issue of work order.
- PV Module should have a Snow Load bearing of 5400 Pa and Wind Load Bearing of at least 2400 pa however if department deem appropriate may go for 3800 pa wind load depending upon their requirement.
- The Solar Module should be free from visual and cosmetics defects.
- The department/consultant on the expense of contractor/supplier shall verify Flash test reports with serial numbers from manufacturer for each panel (at the time of supply).
- All information regarding solar panel with above mentioned featured data should be accessible and verifiable online on the manufacturer website.
- IEC accredited lab test for solar panels is mandatory.
- EL (Electro-luminous) test will be performed randomly for each individual project at the cost of contractor/supplier.

### **Batteries**

- The battery should be Deep Cycle, GEL, OPzV/OPzS, Lithium LiFePO<sub>4</sub>, Lead Carbon Type or equivalent. (Note: Battery type shall be specified in the bidding documents.)
- The battery must ensure safe and reliable operation in the whole range of ambient temperatures from -5°C to + 50°C.
- The maximum permissible self-discharge rate should not be more than 5 percent of rated capacity per month at 25°C.
- The battery shall have a certificate of compliances, issued by a recognized laboratory.
- The Batteries should have three years Comprehensive replacement warranty.
- The battery shall meet the requirements and recommendations given in IEC 61427, IEC 60896 21/22 (For VRLA) or equivalent. Lab Test Reports for battery cycle life should be provided.
- The Battery must support parallel connection to increase capacity in case of future expansion. Each Battery should have following minimum information printed on battery:
  - Model Number, Serial Number and Type of battery.
  - Rated Voltage and Capacity (AH) at discharge rate of 10 Hours. Origin of made.
  - Manufacturer Name with distinct logo.
- The following information must be provided in the data sheet while submitting technical bid.
- Certification/Test Standard(s) of the battery.

- Information regarding cycles & self-discharge rate.
- In case of rechargeable battery bank (having more than one battery), the interconnection shall be made using lead plated copper bus bars or properly insulated flexible copper conductors.
- Battery disconnect switch / breaker of suitable size should be installed between batteries and inverter / charge controller.
- The Battery must have Low self-discharge rate, No memory effect and No gassing.

#### **Gel Batteries**

- Cycle life of the GEL battery (12V) before 80% capacity of Initial capacity must be minimum 1000 cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours
- Cycle life of the GEL battery (2V Cell) before 80% capacity of Initial capacity must be minimum 1300 cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours.

#### **Lead Carbon**

- Cycle life of the Lead Carbon battery (12V) before 80% capacity of Initial capacity must be minimum 2000 cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours.
- Cycle life of the Lead Carbon battery (2V) before 80% capacity of Initial Capacity must be minimum 2500 cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours.

#### **OPzV / OPzS Batteries**

- Cycle life of the OPzV / OPzS battery (12V) before 80% capacity of Initial capacity must be minimum 2000 cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours
- Cycle life of the OPzV / OPzS battery (2V Cell) before 80% capacity of Initial capacity must be minimum 2500 cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours

#### **Lithium Batteries (LiFePO4)**

- Cycle life of the Lithium LiFePO4 battery before 80% capacity of Initial capacity must be minimum 5750 cycles @ 50% depth of discharge (DOD) at discharge rate of 10 Hours.
- The battery must have Integrated Battery Management System (BMS) to ensure battery safety and reliability.
- The BMS of the battery must have the following specifications:  
 Temperature protection Over  
 charge protection Low voltage  
 disconnect High Voltage  
 Disconnect  
 Short circuit alarm function Self-  
 balancing function
- The LiFePO4 Battery must have LED status and alarm indication.

- The charge and discharge rate of the battery must be designed at 0.2C minimum but capable of handling 0.5C charge and discharge currents.

Note: Product brochure, catalogue and certificates must be attached with the Technical Bid.

#### **Box / Stand for batteries, SHS-Inverter & Charge Controller**

- The batteries should be housed in a vented compartment/stand that prevents users from coming in contact with battery terminals. This compartment/stand should be strong enough to accommodate the weight of the battery.
- A mechanism to prevent opening and entry of the battery should be provided.
- This compartment should be manufactured of mild steel of at least 18 SWG.
- The compartment should be powder coated paint.
- The entire enclosure/stand must be constructed to last at least twenty years without maintenance and should be protected against corrosion. The enclosure should have a clean and neat appearance. Battery Box /stand should be installed at a place in accordance with user's preference

#### **CABLE & WIRING:**

- The AC / DC cables should be made of 99.9% copper strands and Flexible.
- From PV Panel to Junction Box, XLPE or XLPO insulated & XLPE/PVC Sheathed, UV single core, Double Insulated. Stranded /flexible cables (Conforming preferably to EN 50618 or IEC FDIS 62930) be used.
- From JB to Inverter, the DC cable must have Single Core, double insulated and suitable for minimum 1000 Vdc transmission.
- From Inverter to batteries, the DC cable can be single insulated, Single Core and suitable for minimum 300 Vdc transmission.
- DC circuit breakers (not fuse) of Voc of String Voltage and suitable ampere rating (1.25 to 1.50 Times of Rated Current of all strings connected) must be installed between PV modules and controller / inverter.
- AC Circuit Breaker (s) of suitable rating (1.25 to 1.50 Times of connected Load) must be installed between Controller / inverter to Load and Grid to Controller / Inverter.
- AC / DC breakers should be marked with the manufacturer model number, rated voltage, ampere rating and batch/serial number.
- DC / AC breakers rating should be approved from Engineer In-charge before installation at site.
- To prevent solar panels from damage an appropriate size of DC Breaker / Fuse should be installed for each PV string and Surge Protection should be installed for combined Array (before Main DC Breaker / Inverter).

- DC Breaker,, AC Breaker Change overs should be placed in an enclosure. All Enclosures / Junction boxes should be made from Hot Dipped Galvanized Sheets of minimum 16 SWG.
- Cables shall be clearly labelled with essential electrical parameters including manufacturer name, Voltage Range, standards etc.
- All 'DC Wiring shall be aesthetically neat and dean, over all wiring / connection losses shall not exceed 1% of the total rated output power.
- All connections/ socket outlet among array, controller, inverters, batteries, and pumping set etc. must be made in junction boxes of adequate level.
- All wires/cables should be in flexible UV-Resistant conduits / HDPE of PN12, SDR 13.6, PEIOO for outdoor installation & (2-3 feet deep) for underground wiring / Cabling and PVC ducts for indoor installation.
- File DC Combiner Junction Box should be properly earthed including Earthing of door as well.
- The DC Combiner should contain proper bus bars of adequate size each for Positive, Negative and Earthing.
- The Inverter Junction Box should be properly earthed as well as per vetted design of the Engineer in charge.
- All wiring should be in proper conduit of capping casing. Wire should not be hanging loose.
- All wires should be terminated properly by using tugs / thimble / sleeves.
- Distribution board must be installed with proper screws.
- Electrical Hazards Safety Labels should be pasted on DC Combiner /VFD Enclosure I Charge Controller /Battery Enclosures.
- Following lab tests are mandatory.  
Conductor resistance test, Insulation resistance test, Pressure test, Spark test.
- DC Cable from PV Module to Junction Box / Inverter for each string should be minimum size 6 mm<sup>2</sup>.
- DC Cable sizing (For Pumping Schemes) from Junction Box to Inverter as per details below:

S. No	Nos of Strings	Cable size (mm <sup>2</sup> )	Remarks
1	1	6	If cable length is > 200ft (one sided) then cable size should also be increased accordingly
2	2	10	
3	3	16	
4	4 – 5	25	
5	6 – 8	35	

## **PANEL MOUNTING & STRUCTURE:**

- a. The panes mounting and structure should be made of hot dipped (80 microns Average) galvanized steel of minimum thickness of 12<sup>t</sup> SWG / 2.64 mm Channel / Pipe or 8 SWG / 4.06 mm Angle (Profile of channel and Sketch Attached for Reference).
- b. A sketch of the mounting frame (As per Actual Site Requirements) showing dimensions of the frame parts should be provided at the time of supply.
- c. PV to ground clearance must not be less than 1.5 feet. The height of the upper edge of the structure should not exceed 10 feet above the ground and 6 Feet for Roof Top Installations.
- d. To avoid Shading, Distance between two rows of PV panels and from walls should be maintained at a minimum of 1.6 times the height of structure/walls.
- e. The pit size for concrete works should be minimum 1.5x1.5x2 feet for each individual leg or they should be extended at least 1 foot above the ground. The ratio should be 1:2:4.
- f. The Surface azimuth angle of PV Module 180<sup>0</sup> and the Tilt angle (slope) of PV Module should be 33<sup>0</sup>
- g. The PV modules will be mounted on metallic structures of adequate strength and appropriate design, which can withstand load of modules and high wind velocities up to 150 km per hour.
- h. Due to land Non-availability or any other problem, Structure design can be modified as per site requirement. Pole Mounted or manual Tracker Structure can be provided with the approval of Engineer In-charge.
- i. Array fasteners (nut/bolts/washers) between PV Module and Structure shall be stainless steel. Washers should be installed on both sides of Module frame
- j. The minimum space between two PV Modules should be 2.54 cm (1 inch), to avoid air push over PV Modules.
- k. Mechanism / arrangement for cleaning of PV Panels should be provided. i.e. Space and ladder between panels or at the back side of structure, so that the operator can safely climb and clean the panels.
- l. All other array fasteners Structure shall be stainless steel or galvanized steel that provides the required mechanical strength.
- m. The PV modules will be mounted on metallic structures at the inner holes for cantilevered installation, which will evenly distribute the load of the panel around the support structure on both sides and in the middle.

## **EARTHING / GROUNDING:**

- a. The PV Panel frame and structure should be connected by the shortest practical route to an adequate earth contact (of Less than 5 Ohms Resistance) as per requirement of equipment manufacturer and site earth conditions, using an uninterrupted conductor. Grounding can reduce the risks of damage from lightning-induced surges.
- b. The Sizing of Earthing conductor will be done as per NEC Table 250.122

- c. The grounding conductor should be 99% Copper and PVC insulated /Bare Copper if installed underground along a defined path where size & Design shall be approved from Engineer In-charge before installation at site.
- d. Motor, inverter, Battery / Battery Box (if required), Main distribution Board should be connected to an adequate earth contact / grounding.
- e. Ground enhancement material (GEM) shall be used below and above the Earthing plate for proper grounding. Gravel or coarse sand shall be pour along with soil in the pit
- f. Grounding / Earthing plate should be made of Copper - ate of 4mm thickness & Size minimum 1.0 x 1.0 Ft.
- g. Grounding / Earthing conductor should be connected to the plate / Rode / GI Pipe by proper connector of minimum depth of 6 feet.
- h. Alternatively, Earthing Rod of suitable size and length can be (Instead of Plate). If given / mentioned in the BOQ/Design and Engineer In-Charge Approval
- i. All nut / bolt and Earthing clamp shall be stainless steel or galvanized steel.

#### **PVC CHANNEL DUCTS & PIPES:**

- a. A product of good quality standard material standardized by the provincial standardization Committee with suitable size to be provided / used, as per direction / approval of Engineer In-charge.
- b. Ducting must be done with proper steel nails and clips.
- c. All ducting (wiring) must be align.

#### **CIVIL WORK:**

The following Civil Works should be carried out for ground installation of SPV Modules/mounting structures.

- a. Minor cutting and clearing of trees / plantation to avoid shadows.
- b. Civil work for Earthing system as per the statutory requirements.

#### **WARRANTY / AFTER SALE SERVICE:**

Three Years comprehensive free replacement, repair and maintenance warranty at site (free of cost) should be provided for all the components of solar system (if not mentioned separately otherwise).



## SPECIFICATIONS FOR SOLAR HOMES & BUILDING SYSTEMS

### Grid Tie Inverter (ON-Grid without battery backup / Hybrid with battery backup)

- UL-1741 Certified or IEC 62109-1 and IEC 62109-2 or Equivalent Certificates.
- Minimum 95% Conversion Efficiency at Rated Capacity (High Frequency Inverters).
- Minimum 87% Efficiency for Transformer based inverters (Low frequency Inverters).
- The inverter should have built-in MPPT controller
- The Priority of the inverter should be set that load will be running from the solar energy then Grid and in the end will be running from the Battery Backup.
- Inverter (Hybrid Only) must be capable of configuring for Charging GEL, Lead Carbon, OPzV/OPzS Batteries and Lithium Iron Phosphate batteries (LiFePO4).
- Hybrid Inverter (If Quoted along with Lithium Batteries) must be capable of communication with the BMS of Lithium Batteries.
- Rated output voltage of inverter / Controller shall be pure sine wave AC.
- Total harmonic distortion (THD) in AC output should not exceed 3% at rated capacity.
- The degree of protection of the ON-Grid inverter Installation should be IP-65 rated and for indoor Hybrid Inverter installation, the IP rating should be IP-20 or above.
- Wide input voltage range capability. (i.e.: Voltage Range can be adjustable / selectable)
- Natural convection cooling for maximum reliability
- Outdoor enclosure for unrestricted use under any environmental conditions
- Capability to connect external sensors for monitoring environmental conditions.
- The output of the inverter must synchronize automatically its AC output to the exact AC voltage and frequency of the grid.
- The Inverter should have the capability of Parallel operation up to three units. (Only For projects, where more than one inverter should be installed).
- Inverter should have active RS232/485 etc. communication port, the Data available through this port can be used for Remote Monitoring.
- Liquid crystal display should at least be provided on the inverters front panel or on separate data logging/display device to display following:
  - DC Input Voltage
  - DC Input current
  - AC Power output (kW)
  - Current time and date
  - Temperatures (C)
  - Converter status
- Inverter circuit must include protection against:
  - Over or Low voltages and currents beyond critical level of the inverters circuits.
  - Protection against accidental short circuits.
  - Protection against lightning induced transients. Over load protection.

**Battery and Controller Box**

- The battery box should be made of Hot Dipped Galvanized Sheet of average 80 Microns.
- The battery box must have vented compartment having inverted louvers.
- For Pole Mounted batteries Battery boxes must be made of minimum 16 SWG sheet and must have proper locking arrangement for protection against theft.
- For underground battery installation, the battery box should be made of minimum 16 SWG sheet and should be properly sealed to ensure protection against water. Proper cable glands and packing material should be used to ensure water proofing of the box.
- The battery and Controller Box should be at least IP65 ingress protection.