

All the cables required for the installation provided by the Contractor. All cable schedules/ layout drawings shall be submitted by the Contractor for approval of the Discom or TPIA prior to installation.

Multi-strand, annealed high conductivity copper conductor PVC type 'A' pressure extruded insulation. Overall PVC insulation for UV protection Armoured cable shall be used for underground laying (if required). All cable trays including covers to be provided. All cables conform to latest edition of IEC/ equivalent BIS Standards as specified below: BoS item / component Standard Description Standard Number Cables General Test and Measuring Methods, PVC insulated cables for working Voltage up to and including 1100 V ,UV resistant for outdoor installation IS/IEC 69947.

Technical Specification of LT PVC Cables: General Constructional Features

(a) The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in original drums with manufacturer's name, size, and type, clearly written on the drums.

(b) Material: The conductor shall be composed of plain aluminium or copper wires complying with IS:8130/1984 with latest amendments.

(c) Conductor: Uncoated, annealed aluminium, of high conductivity upto 4 mm² size, the conductor shall be solid and above 4 mm², conductors shall be concentrically stranded as per IEC: 228.

(d) Insulation: Insulation shall be LT PVC Type-C conforming to the requirements given in Table-I of IS: 5831/1984 with latest amendments.

(e) Core Identification:

Two core	:	Red and Black
Three core	:	Red, Yellow and Blue
Four core	:	Red, Yellow, Blue and Black
Single core	:	Green cable with Yellow strips for earthing

Black shall always be used for neutral. Solar DC cable shall be black with red strip for positive and black for negative in colour.

Armour: All cables laid underground shall be armoured. And laid in ground at a minimum depth of 0.5 meter. Armour shall be of galvanised steel flat strip/ round wires applied helically in single layers complete with covering the assembly of cores.

(a) For cable size up to 25 Sq. mm. Armour of 1.4 mm dia G.I. round wire

(b) For cable size above 25 Sq. mm. Armour of 4 mm wide 0.8 mm thick G.I strip.

Sheath: The cable shall be rated extruded for PVC 90°C. Inner sheath shall be extruded type and shall be compatible with the insulation provided for the cables. Outer sheath shall be of an extruded type layer of suitable PVC material compatible with the specified ambient temp 50°C and operating temperature of cables. The sheath shall be resistant to water, ultraviolet radiation, fungus, termite and rodent attacks. The colour of outer sheath shall be black. Sequential length marking required at every 1.0 meter interval on outer sheath shall be available. The Contractor shall furnish resistance/ reactance/ capacitances of the cable in the technical datasheet. Packing and marking shall be as per Clause No. 18 of IS 7098 (part I)/1988 amended up to date.

Cable terminations shall be made with suitable cable lugs and sockets, crimped properly and passed through brass compression type cable glands at the entry and exit point of the cubicles.

All cable/wires shall be provided with Punched Aluminium tags only. The marking on tags shall be done with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.

The wiring for modules interconnection shall be in the GI/ HDPE/DWC Pipe of reputed make.

The RS-485 cable from inverter to the metering box shall be armoured and may be laid along with the AC power cables only if there is no mutual interference. In case any interference is found between the power cables and the RS-485 cable, the RS-485 cable shall be separated by the contractor from AC power cable with a clearance of 300mm.

Lightening Protection for PV Array

All PV systems shall have lightning protection.

The source of over voltage can be lightning or other atmospheric disturbance. Main aim of over voltage protection is to reduce the over voltage to a tolerable level before it reaches the PV or other sub-system components as per IS: 2309 – 1989 (Reaffirmed-2005), Edition 3.1 (2006-01).

Necessary foundation/ anchoring for holding the lightning conductor in position to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future.

The lightning conductor shall be earthed through flats and connected to the earth mats as per applicable Indian Standards with earth pits. Two earth pits shall be provided for each lightning arrester. Each lightning conductor shall be fitted with individual earth pit as per required Standards including accessories, and providing masonry enclosure with cast iron cover plate having locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS & Earth Resistance of Lightning System must be less than one (1) Ohm.

If necessary more numbers of lightning conductors may be provided. The Contractor is also free to provide franklin rod/ early streamer type of lightning arrestors on the MMS structure designed in such a way not to cast shadow on the next row of solar PV modules.

The Contractor shall submit the drawings and detailed specifications of the PV array lightning protection equipment to the Discom or TPIA for approval before installation of system.

Contractor shall provide dedicated earth pits for Lightning Arrester as per relevant IS standard.

Power evacuation

Individual plant shall be connected to grid as per guidelines of CEA, RERC and Chief Electrical Inspector.

The output power from PV array would be fed to the inverters which converts DC produced by PV 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.

Contractor shall follow the maximum capacity for interconnection with the grid at a specific voltage level shall be as specified in the Distribution Code/Supply Code of the State and amended from time to time.

Interconnection Voltage level: All solar plant interconnection voltage level shall be at LT 415VAC, 3-phase, 50 Hz.

Earthing

Each array structure of the PV yard, LT power system, earthing grid for switchyard, all electrical equipment, inverter, all junction boxes, etc. shall be grounded properly as per IS 3043-1987. All metal casing/ shielding of the plant shall be thoroughly grounded in accordance with Indian Electricity Act/ Rules.

Each string/ array and MMS of the plant shall be grounded properly. The array structures are to be connected to earth pits as per IS standards. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

The complete earthing system shall be mechanically and electrically connected to provide independent return to earth.

Earthing bus bar shall be terminated at both ends of the switchgear to suit the connections to outside earthing conductor. All components and the module are required to be earthed individually and are to be looped and connected to the earthing grid.

There will be three separate earthings viz. one for Lightning Arrester, another for all mounting structure and third earthing for inverter and all electrical circuit.

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings/rooms to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons.

All the bolts of earthing system shall be of Stainless steel (SS) type.

Minimum earthing conductor size shall be 25 x 6 Sq. mm for aluminium strips.

The earthing system shall be designed with consideration of the earth resistivity of the project area. The earth resistivity values shall be measured prior to designing the earthing system. Unless otherwise specified, earthing system shall be in accordance with IS: 3043 and IEEE 80-2000, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed.

The earthing shall be maintenance free Gel with Pipe in pipe/pipe in strip technology filled with anti corrosive conductive compound (CPRI Tested) below the ground in 150-200 mm dia.

- a) Gel earthing & Chemical compound should be type tested from Govt. approved / Govt. recognized / NABL Accredited laboratory / ILAC i.e. International Laboratory Accredited Laboratory (in case of foreign laboratory).
- b) 50 mm dia GI pipe should be B class and strip of 25x6mm should be inserted top to bottom with no joint.
- c) GI strip should be top to bottom inserted & welded on bottom part of electrode.
- d) GI strip should be hot dip galvanized as per IS-3043 standard 80-100 micron zinc coating.
- e) CCM (crystalline conductive mixture) should be anticorrosive & to be filled top to bottom in electrode.
- f) Chemical compound PH value should not be less than 8.
- g) With 3/6 mtr electrode 2 bags (25kg each)/4 bags chemical compound has to be filled in bore.
- h) For semi rocky & rocky area 8 bags (25 kg each) chemical compound has to be filled in open bore.
- i) Chemical compound has to mixed with water to make it in paste form and pour surrounding area of electrode.
- j) For 50mm dia electrode bore size should be 6 inch x 3.5/6.5 mtr depth.
- k) Earth resistance for single earth should be less than 2 ohms
- l) All body connections should be connected with gi earthing
- m) Supply & Erection of Maintenance free Gel earthing with strip in pipe technology filled with anti corrosive conductive compound (CPRI Tested) below the ground in 150-200 mm dia. Earth pit & surrounding filled with required mineral filling compound (MFC should have hygroscopic property to retain the moisture for long time to create low resistance zone) and C.C. finished chamber covered with hinged type with locking arrangement C.I. Cover, C.I. Frame of size 300mm X 300mm complete testing of earth resistance as required G.I Pipe (IS : 1239 marks) GI pipe 3000/6000 mm long, 50 mm Dia, GI/Cu Strip. Earthing as per IS:3043-1987 and its latest amendments.

Low voltage (LV) Switchgears

LV switchboard shall be IP 21 for indoor and IP 65 for outdoor application made with heavy duty PVC/ metal enclosure.

LV switchboard with metal enclosure shall be minimum 2mm thick and with properly coated.

MCB/MCCB/ RCCB and cables shall be rated as per rated current of the circuit, application voltage class, short circuit capacity.

All switchboards shall be supplied completely wired internally upto the terminals, ready to receive external cables.

No extra holes shall be allowed in the gland plate. Proper vermin proofing of the panel is required.

Suitable cable entry shall be provided considering bending radius of the incoming and outgoing cable.

All cables, MCB, MCCB, RCCB shall be of reputed make.

Solar Meter

17.1.1. Uni-directional Smart Energy Meters to log the actual value of Energy generated by the PV system be provided, as per relevant specifications by MNRE/ CEA/Discom. Detailed indicative specifications shall be shared with successful bidder.

Net-Meter

The bi-directional Smart energy meter shall be installed for the measurement of import/Export of energy, as per relevant specifications by MNRE/ CEA/Discom. Detailed indicative specifications shall be shared with successful bidder.

Old meter of the existing Agriculture consumer shall be replaced by the Contractor after issue of Meter Change Order by concerned AEN (O&M) of Discom on the same day of installation of net-meter. The old meter is to be deposited by the Contractor on behalf of CEL in the concerned Office of AEN (O&M) of Discom.

Net-meter shall be installed in the presence of the Contractor, CEL representative, the Agriculture Consumer, concerned AEN (O&M), AEN (M&P) and Nodal Officer jointly with preparation of "Joint Inspection Report" (JIR) in prescribed format.

Civil Work

Specification of civil work shall be in line with specifications for SPV water pumping systems of MNRE vide Circular No. F. No. 41/3/2018-SPV Division dated 17.7.2019 enclosed in this tender documents and any further amendment(s) issued by MNRE.

The scope works shall cover for all services required for completion of civil works in all respect for PV plant. All machineries, tools and designs to be arranged by Contractor.

Contractor shall carry out geotechnical survey prior to design and installation of the PV system.

The work shall be executed according to the specifications and good standard practice necessary to fulfill the objective of the survey work, strictly in accordance with the instructions and satisfaction of the CEL/Discom.

Foundations:

(a) The Contractor is responsible for the detailed soil investigation and subsequent foundation design of the structures in the plant. Minimum 5 (five) numbers of soil exploration is to be carried out for each feeder. The foundation of the module mounting structures foundation and other important equipment foundation must be approved through CEL/Discom or TPIA prior to construction. The Contractor shall provide the detailed design report with calculations of the proposed foundation. Pedestals over the MMS foundation shall be projected minimum 150 mm above the finished ground level.

(b) The foundations shall be designed considering the weight and distribution of the load of structure and its assembly. The foundation shall be design in accordance to recommendation and results of soil investigation reports and mounting structure shall be designed for maximum wind speed as per the wind zone of the location and relevant IS. Seismic effect relevant to the seismic zone of the area and highest water logging level has to be considered while making the design of the foundation.

(c) The MMS foundation shall be constructed using RCC concrete pile foundation of required diameter and depth based on approved design.

(d) The elevated structure has to be securely anchored to the supporting surface, also bolted with anchor bolts of appropriate strength for elevated structures mounted on RCC surfaces.

Caution Signs

In addition to the standard caution and danger boards or labels as per Indian Electricity Rules, the AC distribution box near the solar grid inverter and the distribution board to which the AC output of the solar PV system is connected shall be provided with a noncorrosive caution label with the following text:

WARNING – DUAL POWER SOURCE SECOND SOURCE IS SOLAR SYSTEM

The size of the caution label shall be 105mm (width) x 20mm (height) with white letters on a red background.

Sign Boards

The sign board containing brief description of various components of the power plant as well as the complete power plant in general shall be installed at appropriate location near the PV system.

The Signboard shall be made of MS angle or pipe for vertical post with ACP (Aluminium Composite Panel) sheet of not less than 3 mm. The Contractor shall provide detailed specifications of the sign boards as per requirement of the CEL/Discom.

Name Plate: Name Plate in Hindi language of size 600 mm x 600 mm x 2 mm on iron plate is required to be prepared (format shall be provided by CEL after award of contract) separately and required to be fixed on the system for every installation.

Drawings & Manuals

Two sets of engineering, electrical drawings and Installation and O&M manuals are to be supplied. Bidder shall provide complete technical data sheets for each equipment giving details of the specifications along with make/makes in their bid along with basic design of the PV Installation setup and power evacuation, synchronization along with protection equipment.

The Contractor shall furnish the following drawings (in line with MNRE specifications) after PO and obtain approval:

- (a) General arrangement and dimensioned layout.
- (b) Schematic drawing showing the requirement of PV panel, Power conditioning Unit(s)/ inverter, Junction Boxes, AC and DC Distribution Boards, meters etc.
- (c) Routing diagram of cables and wires.
- (d) Data sheets and user manuals of the solar PV panels and the solar grid inverter.
- (e) Structural drawing along with foundation details for the structure.
- (f) Itemized bill of material for complete SV plant covering all the components and associated accessories.
- (g) Layout of solar Power Array
- (h) Shadow analysis of the site
- (i) Maintenance register.

Approved ISI and reputed makes for equipment be used.

For complete electromechanical works, Contractor shall supply complete design, details and drawings for approval to CEL, Discom and TPIA before progressing with the installation work.

Planning & Designing

CEL reserves the right to modify the layout and specification of sub- systems and components at any stage as per local site conditions/requirements.

The Contractor shall submit preliminary drawing for approval and based on any modification or recommendation, if any. The Contractor shall submit three sets and soft copy in CD of final drawing for formal approval to proceed with construction work.

Safety Measures

The Contractor 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, as well as applicable rules & regulations of Rajasthan State, etc.

Maintenance & Generation Guarantee

Comprehensive Maintenance (CMC)

- a) The Contractor shall undertake comprehensive maintenance of the PV system including all its equipment and subsystems for a period of 5 (five) years from the date of commissioning of the last system of total awarded work or, 9 month from the date of purchase order (PO), whichever is later.
- b) This shall also include free replacement warranty on spare parts against manufacturing defects for five years from the date installation.
- c) The Contractor shall attend to any complaint from the Agriculture Consumer and rectify any faults or breakdown within a timeframe of 72 (seventy two) hours from such complaint. In case of theft, the complaint is to be resolved within 15 calendar days provided theft is duly certified by the nodal officer.
- d) If the down time period for any beneficiary complaint exceeds 72 hours (15 calendar days in case for theft cases) and the contractor fails to make the plant operational, a penalty for the time period exceeding 72 hours (15 calendar days in case for theft cases), as per the below mentioned schedule shall be deposited by the contractor to CEL (as decided by CEL).

Water pump capacity (in HP)	Penalty applicable (in INR per day)
3	140
5	235
7.5	355

- e) The loss in generation shall be decided on daily basis.
- f) For any system / consumer complaint, the maximum applicable amount as penalty against loss of generation shall not be more than 10% of the respective cost of the SPV system installed at the consumer premises.
- g) The Contractor shall be issued a notice to pay the applicable penalty within 7 days to CEL. If the Contractor fails to pay the penalty within notice period, the CEL shall encash the Performance Bank Guarantee immediately.
- h) CMC will include submission of monthly /quarterly inspection report of the installation as per prescribed format of CEL & DISCOM. Quarterly report as per CEL format shall be prepared and submitted to CEL after providing necessary services.
- i) To ensure timely maintenance of the systems the vendor shall have one Office-cum-service centre in each operational district and a helpline in local language in each operational State.
- j) CEL/Discom gives great importance to maintenance of the systems & it is felt that without proper maintenance after installation of system, consumers may be deprived of the benefits of this Scheme. To achieve this objective, Contractor shall proceed to first establish office-cum-service centre in each operational district for installation of systems. Contractor shall be bound to provide after sales service to the beneficiaries in the vicinity of the area of the installed systems or at least at tehsil level /at district to facilitate CMC services. The beneficiaries shall be well informed about the CMC centre of the Contractor, call centre/toll free numbers. This may consist of office cum service centre at a convenient place to be reached by a beneficiary. Such office cum service centres shall have spares for the system and repair facility. The CEL & Concerned Nodal officer of Discom shall verify this fact and only then Contractor shall be allowed to install the systems.

- k) The Contractor will educate the Beneficiaries on the process for registering the complaints on Call Center/toll free nos. The details of office cum after sales service centers along with telephone numbers & contact persons of firm & details of CEL & Discom offices, address and telephone numbers must be provided to each beneficiary. Beneficiaries shall also be educated through brochures about dos & don'ts on the system. Contractor will update the status of fault rectification to CEL /call centre for online monitoring of the complaints registered and services being provided by the Contractor.
- l) It may be carefully noted that maintenance of SPV Systems includes maintenance of all items including all accessories.

Generation Guarantee

- a) The Contractor shall provide a minimum generation guarantee corresponding to a capacity utilization factor (CUF) of 15% (the "Guaranteed CUF") with respect to the AC capacity of the PV system.
- b) This Guaranteed CUF shall be calculated on an annual-basis and shall be verified by the CEL & Discom at the end of each year during the 5 (five) year guarantee period.
- c) There shall be no year-on-year reduction on the Guaranteed CUF during the 5 (five) year guarantee period.
- d) In case of energy generation corresponding to the average of surrounding 10 such locations is less or less than the Guaranteed CUF, whichever is higher, the CEL shall recover an amount at the rate of Rs. 7.00 per kWh on back to back basis from the Contractor for such shortfall at the end of the contract year to compensate the same to the Agriculture Consumer.
- e) In case of theft (duly certified by the CEL representative/nodal officer) or, non-availability of grid due to fault in feeder, the CEL reserves the right to consider appropriate adjustment in CUF for the corresponding period.
- f) In case of energy generation corresponding to less than the Guaranteed CUF, it is clarified that the penalty for loss in generation shall not be duplicated with the penalty for delay in rectification of fault beyond 72 hours of complaint.

Project Management

Testing and Third-Party Inspection

- a) The Contractor shall provide all relevant plant and equipment specifications, data sheets, certificates, designs, drawings, etc. to the CEL, Discom and TPIA for approval prior to commencement of installation. Structural designs shall be provided to the TPIA & CEL in STAAD Pro format for verification and approval.
- b) The CEL, Discom and the TPIA shall have, at all times, access to the Contractor's premises and also shall have the power to inspect and examine the materials and workmanship of project work during its manufacturing, shop assembly and testing. If part of the equipment is required to be manufactured in the premises other than the Contractor's, the necessary permission for inspection shall be obtained by the Contractor on behalf of the CEL, Discom and the TPIA.
- c) The CEL, Discom and the TPIA shall have the right to serve notice in writing to the Contractor on any grounds of objections, which they may have in respect of the work. The Contractor shall have to satisfy the objection, otherwise, the CEL, Discom at its liberty may reject any or all components of equipment or workmanship connected with such work.
- d) The Contractor shall issue request letter to CEL for testing of any component of the plant, which is ready for testing at least 15 (fifteen) days in advance from the date of actual date of testing at the premises of the Contractor or elsewhere. When the inspection and the tests have been satisfactorily completed at the Contractor's works, CEL/Discom or the TPIA shall issue a certificate to that effect. However, CEL at its own discretion may waive the inspection and testing in writing. In such case, the

Contractor may proceed with the tests which shall be deemed to have been made in the CEL & Discom or the TPIA's presence, and it shall forthwith forward 6 (Six) sets of duly certified copies of test results and certificates to the CEL, Discom and the TPIA for approval of CEL, Discom. The Contractor, on receipt of written acceptance from CEL, may dispatch the equipment for erection and installation.

- e) For all tests to be carried out, whether in the premises of the Contractor or any subcontractor or the supplier, the Contractor shall provide labour, materials, electricity, fuel, water, stores, apparatus and instruments etc. free of charge as may reasonably be demanded to carry out such tests of the equipment. The Contractor shall provide all facilities to CEL, Discom and the TPIA to accomplish such testing.
- f) The CEL, Discom or the TPIA shall have the right to carry out inward inspection of the items on delivery at the Site and if the items have been found to be not in line with the approved specifications, shall have the liberty to reject the same.
- g) Neither the waiving of inspection nor acceptance after inspection by the CEL & Discom or the TPIA shall, in anyway, absolve the Contractor of the responsibility of supplying the equipment strictly in accordance with requisite standards and specifications.
- h) CEL and Discom and/ or the TPIA shall undertake final commissioning test of the PV system including its design, specification, safety and performance.

Other Key Responsibilities

MNRE/ CEL Discom Inspection & Reporting

- a) The Ministry officials or designated agency may inspect the ongoing installation or installed plants. In case the installed systems are not as per standards, non-functional on account of poor quality of installation, or non-compliance of AMC, the Ministry reserves the right to blacklist the Contractor. Blacklisting may inter-alia include the following:
 - (a) The Contractor will not be eligible to participate in tenders for Government supported projects.
 - (b) In case, the concerned Director(s) of the Contractor joins another existing or starts/ joins a new firm/company, the company will automatically be blacklisted.
- b) The Contractor shall be responsible for providing daily / weekly / monthly or customized information regarding progress of projects required by CEL/Discom / MNRE, online or in hard copy. For which the Contractor is also responsible for maintaining online & off-line records.
- c) Assist Discom & CEL with a real-time monitoring dedicated web-portal.
- d) Providing training to the locals.

Net-Metering of Power

- a) Net metering is the concept which records difference between export of generated energy and import of energy from Discom grid during billing cycle.
- b) Rajasthan Electricity Regulatory Commission (RERC) has issued "Regulation for net metering and grid connectivity" on 26th February, 2015. The Agriculture Consumers / Contractor going for installation of SPV Power units under this scheme will also be governed by the rules & regulations of Net Metering scheme as notified by RERC and amended time to time.
- c) The Contractor shall bear the entire cost of metering arrangement (including meter testing fee) and its accessories. The fee and other charges, if applicable, such as

security deposit payable to office of CEL/Discom & Electrical inspector will be payable by the beneficiary separately prior to the system installation.

- d) The installation of meters including CTs & PTs, wherever applicable, shall be carried out by the supplier as per the procedures in line with CEL & Discom(s) guidelines and with their permission.

“Tender for Design, Survey, Supply, Installation, Testing, Commissioning & 5 Years Comprehensive Maintenance of Distributed Grid Connected Solar PV Systems for Solarization Of Grid Connected Agriculture Consumers Under “Kusum Scheme – Component C (LOT-4)”

Price-Bid

<u>Sr. No.</u>	<u>Particulars</u>	<u>Unit</u>	<u>Qty.</u>	<u>Basic Price (in INR)</u>	<u>T Amount (without GST) (in INR)</u>	<u>Applicable GST %</u>
1	Supply of BOS for 4.5 KWp Solar Power generating system as per tender documents	Sets	14			
2	Design, Survey, Installation, Testing, Commissioning, & 5 years comprehensive maintenance for 4.5 KWp Solar Power generating system as per tender documents	Sets	14			
3	Supply of BOS for 7.5 KWp Solar Power generating system as per tender documents	Sets	829			
4	Design, Survey, Installation, Testing, Commissioning, & 5 years comprehensive maintenance for 7.5 KWp Solar Power generating system as per tender documents	Sets	829			
5	Supply of BOS for 11.25 KWp Solar Power generating system as per tender documents	Sets	33			
6	Design, Survey, Installation, Testing, Commissioning, & 5 years comprehensive maintenance for 11.25 KWp Solar Power generating system as per tender documents	Sets	33			
	Total Amount					

Note:

1. GST shall be paid extra on actual as applicable.
2. Prices should be inclusive of P & F charges and inland transportation charges including loading, unloading and transfer to site, insurance and other incidental to delivery.
3. Prices will remain firm till the execution of the contract.

(Signature of Bidder with Seal)

MNRE Specifications of Remote Monitoring System (RMS)

State Implementing Agency (SIA) will have a common SWPS (Solar Water Pumping System) Management platform for monitoring of operation and performance of SWPS installed under PM KUSUM Scheme.

Remote Monitoring System (RMS) of SWPS should have following minimum features or modules:

- a) Solar System Performance: DC Voltage, DC current, AC output Current, Power, Drive frequency, Energy, etc.
- b) Pump Performance: Running Hours, Water Discharge (Output), etc.
- c) RMS Performance: %Device Connectivity, %Data Availability, etc.
- d) Geo Location: Real time latitude and longitude should be captured. This is required to ensure that system is not moved from its original location.
- e) Events and Notifications: Faults related to Pump Operation, Solar generation, Controller/Drive faults like overload, dry run, short circuit, etc.
- f) Consumer Management: Name, Agriculture details, Service No. Contact Details, etc.
- g) Asset Management: Ratings, Serial Number, Make, Model Number of Pump, Panel and Controller, Geo Location, IMEI number (of communication module) and ICCID (of SIM).
- h) Complaint and Ticket Management: Complaint management system is a part of centralized monitoring software platform – State Level Solar Energy Management Platform to be operated and maintained by the State implementing agency (SIA).
- i) Consumer Mobile Application: Generation, Running Hours, Water Discharge, Complaint logging, etc.

RMS provided by all bidder's should connect to State Level Solar Energy Data Management platform, which will have interface with National Level Solar Energy Data Management platform i.e. SIA will provide server infrastructure as well as software. SIA will maintain the same. All vendors should provide SIM card of suitable ISP having maximum Signal Strength in the respective location of SWPS and ensure connectivity as well as pushing of data to centralized platform as mentioned in specifications.

Communication Architecture should be as per following:

- a) Communication Connectivity:
 - i. Pump Controller Connectivity: Communication between RMS and Pump Controller should be on UART/RS485 MODBUS RTU protocol to ensure interoperability irrespective of make and manufacturer
 - ii. Remote Connectivity: RMS of SWPS should be using GSM/GPRS/2G/3G/4G cellular connectivity
 - iii. Local Connectivity: Ethernet/Bluetooth/Wi-Fi connectivity to configure parameters, notifications, communication interval, set points etc. or to retrieve locally stored data.
 - iv. Sensor Connectivity: RMS should have provision for at least two Analog/Digital inputs with 0.1% accuracy to address the requirement of local sensors connectivity if required by SIA/Consumer for applications such as irradiation, flow meter for water discharge, moisture sensor for micro irrigation, etc. Analog/digital sensor inputs will be required for integration of

flow meter for water discharge, moisture sensor for micro irrigation, level sensor for overhead tank water storage etc. Only provision for Analog/digital inputs with 0.1% accuracy of Full Scale Range is required. Sensors will not be in scope of bidder.

- v. RMS should have provision to give remote On/Off command to pump through farmer mobile app. to save ground water.
- b) Communication Modes:
 - i. Push Data on Event/Notification: such as pump on, pump off, protection operated, etc.
 - ii. Push Data Periodically: important parameters of solar pump (as mentioned above) should be pushed to central server on configurable interval. Interval should be configurable for 15 mins. However, if required, it should be possible to configure the periodic interval in multiple of 1 minute starting from 1 minute and up to 15 minutes. Further, in case of any abnormalities or event, RMS should push on event immediately.
 - iii. Command On Demand : It should be possible to send commands via GSM or GPRS to RMS either to control pump operations or to update configuration
- c) Communication Protocol: RMS should provide data on MQTT protocol to establish communication with thousands of systems.
- d) Security:
 - i. Communication between RMS and Server should be secured and encrypted using TLS/SSL/X.509 certificate etc.
 - ii. As a part of IoT protocol, Authentication and Authorization should be implemented using token/password mechanism.
- e) Message Format: RMS should provide data in a JSON message format as required by respective SNA.
- f) Data Storage: In case of unavailability of cellular network, RMS should store data locally and on availability of network it should push data to central Server. Local data storage should be possible for at least one year in case of unavailability of cellular network.
- g) Configuration update over the Air of multiple parameters such as IP, APN, Data logging Interval, Set Points etc. is essential. Software updating should be possible with 2G and even without the presence of SD card. Software updating process and/or failure to update software shouldn't disrupt pumping operations.

MNRE Specifications of SPV water pumping systems
Annexure-I of Circular No. F. No. 41/3/2018-SPV Division dated 17.7.2019
MINISTRY OF NEW AND RENEWABLE ENERGY
SPECIFICATION FOR SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEMS

1. SCOPE

These specifications covers design qualifications and performance specifications for Centrifugal Solar Photo Voltaic (SPV) Water Pumping Systems to be installed on a suitable bore-well, open well, water reservoir, water stream, etc., and specifies the minimum standards to be followed under New Scheme for Farmers launched by Government of India on 8.3.2019.

2. TERMINOLOGY

In addition to the terminology specified in 3 of IS 5120 and IEC 62253, the following shall also apply.

Static Water Depth — It is the depth of water level below the ground level when the pump is not in operation.

Draw-Down — It is the elevation difference between the depth of static water level and the consistent standing water level in tube well during operation of pump set.

Submergence — It is the minimum height of water level after drawdown above the pump suction casing.

Manometric Suction Lift — Manometric suction lift is the vacuum gauge/suction manometer reading in meter of water column when pump operates at suction lift.

Static Suction Lift — Static suction lift/head is the vertical distance between sump water level and center of pump inlet.

Daily Water Output — It is the total water output on a clear sunny day with three times tracking SPV panel, under the “Average Daily Solar Radiation” condition of 7.15 KWh / m² on the surface of SPV array (i.e. coplanar with the SPV Modules).

Wire to Water Efficiency — It is the combined system efficiency of SPV Converter/Controller with Inbuilt MPPT mechanism, Pump set and piping.

SPV Controller — Pump Controller converts the DC voltage of the SPV array into a suitable DC or AC, single or multi-phase power and may also include equipment for MPPT, remote monitoring, and protection devices.

Maximum Power Point Tracker (MPPT) — MPPT is an algorithm that is included in the pump controller used for extracting maximum available power from SPV array under a given condition. The voltage at which SPV array can produce maximum power is called 'maximum power point' voltage (or peak power voltage).

3. CONSTRUCTIONAL FEATURES

General

SPV Water Pumping System set uses the irradiance available through SPV array. The SPV array produces DC power, which can be utilized to drive a DC or an AC pump set using pump controller.

A SPV Water Pumping system typically consists of:

Pump Set

Pump set may be of any one of the following types:

- i) Mono-set pump;
- ii) Open well submersible pump;
- iii) Submersible pump;

Motor

The motor of the pump set may be of the following types:

- i) AC Induction Motor.
- ii) DC Motor [PMSM/BLDC/SRM (with brush or brushless)].

SPV Controller See 2.8

Note: Some controllers are inbuilt in the motors

Provision for remote monitoring for the pumps must be made in the pump controller through an integral arrangement having following basic functions:

- Controller must be assigned with a unique serial number and its live status must be observed remotely on online portal through login credentials.
- Live status must indicate whether controller is ON/ OFF
- The parameter i.e. the water output, water flow rate, in fault condition, array input voltage/ current, power and motor frequency should be logged at an interval of 10 minutes
- Controller must have a back up to store the data locally (at least for 1 year).

Solar Photo Voltaic (SPV) Array

SPV arrays contain specified number of same capacity, type and specification modules connected in series or parallel to obtain the required voltage or current output. The SPV water pumping system should be operated with a PV array minimum capacity in the range of **900 Watts peak to 9000 Watts peak**, measured under Standard Test Conditions (STC). Sufficient number of modules in series and parallel could be used to obtain the required voltage or current output. The power output of individual PV modules used in the PV array, under STC, should be a minimum of 200 Watts peak, with adequate provision for measurement tolerances. Use of PV modules with higher power output is preferred.

Modules supplied with the SPV water pumping systems shall have certificate as per IS14286/IEC 61215 specifications or equivalent National or International/ Standards. STC performance data supplied with the modules shall not be more than one year old.

Modules must qualify to IS/IEC 61730 Part I and II for safety qualification testing.

The minimum module efficiency should be minimum 15 percent and fill factor shall be more than 70 percent.

Modules must qualify to IEC TS 62804-1:2015 for the detection of potential-induced degradation - Part 1: Crystalline silicon (Mandatory in case the SPV array voltage is more than 600 V DC)

In case the SPV water pumping systems are intended for use in coastal areas the solar modules must qualify to IEC TS 61701:2011 for salt mist corrosion test.

The name plate shall conform to the IS 14286/IEC 61215

Module to Module wattage mismatch in the SPV array mismatch shall be within ± 3 percent.

Variation in overall SPV array wattage from the specified wattages shall be within zero percent to +10 percent.

The PV Modules must be warranted for output wattage, which should not be less than 90% of the rated wattage at the end of 10 years and 80% of the rated wattage at the end of 25 years.

Motor-Pump Set

The SPV water pumping systems may use any of the following types of motor pump sets:

- a) Surface mounted motor-pump set
- b) Submersible motor-pump set
- c) Floating motor-pump set
- d) Any other type of motor pump set after approval from Ministry.

The “Motor-Pump Set” should have a capacity in the range of 1 HP to 10 HP and should have the following features:

- a) The mono block DC/ AC centrifugal motor pump set with the impeller mounted directly on the motor shaft and with appropriate mechanical seals which ensures zero leakage.
- b) The motor of the capacity ranging from 1 HP to 10 HP should be AC/DC. The suction and delivery head will depend on the site specific condition of the field.
- c) Submersible pumps could also be used according to the dynamic head of the site at which the pump is to be used.

The pump and all external parts of motor used in submersible pump which are in contact with water, should be of stainless steel of grade 304 or higher as required. The motor- pump set should have a 5 years warranty and therefore, it is essential that the construction of the motor and pump should be made using parts which have a much higher durability and do not need replacement or corrode for at least 5 years of operation after installation.

The suction/ delivery pipe shall be of HDPE or uPVC column pipes of appropriate size, electric cables, floating assembly, civil work and other fittings required to install the Motor Pump set. In case of HDPE pipes the minimum pressure rating of 8 kg/sqcm-PE100 grade for pumps up to 3 HP, 10 kg/sqcm-PE100 grade for 5 HP pumps and further higher minimum pressure rating for above 5 HP as appropriate shall be used.

Module Mounting Structures and Tracking System

The PV modules should 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. The raw material used and process for manufacturing of module mounting structure including welding of joints should conform to applicable IS. The module mounting structure should be hot dip galvanized according to IS 4759. Zinc content in working area of the hot dip galvanizing bath should not be less than 99.5% by mass.

To enhance the performance of SPV water pumping systems arrangement for seasonal tilt angle adjustment and three times manual tracking in a day should be provided. In order to make structure rigid, the gap between Telescopic pattern supports should be minimal, further, for bearing of center load of whole structure only pins should be used instead of threaded bolts.

The general hardware for structure fitment should be either SS 304 or 8.8 grade. Modules should be locked with antitheft bolts of SS 304 Grade. Foundation should be as per the site condition, based on the properties of Soil. Foundation can be done either with the help of 'J Bolt' (refer IS 5624 for foundation hardware) or direct pilling, it should be decided as per the site and relevant IS i.e. IS 6403 / 456 / 4091 / 875 should be referred for foundation design.

Details of Module Mounting Structure for different capacity of SPV pumps are attached at Annexure-I. These are indicative of minimum standards and an Implementing Agency may specify higher standards.

SPV Controller

Maximum Power Point Tracker (MPPT) shall be included to optimally use the power available from the SPV array and maximize the water discharge.

The SPV Controller must have IP (65) protection or shall be housed in a cabinet having at least IP (65) protection.

Adequate protections shall be provided in the SPV Controller to protect the solar powered pump set against the following:

- a) Dry running;
- b) Open circuit;
- c) Accidental output short circuit;
- d) Under voltage;
- e) Reverse polarity;
- f) SPD to arrest high current surge; and
- g) Lightning arrestor.

A good reliable DC Circuit Breaker as per IS/IEC 60947-2 suitable for switching DC power ON and OFF shall be provided in the SPV Controller.

All cables used shall be as per IS 694. Suitable size of cable shall be used in sufficient length for inter-connection between the SPV array to SPV Controller and the SPV Controller to solar powered pump set. Selection of the cable shall be as per IS 14536. Controller shall be integrated with GSM/GPRS Gateway with Geo tagging. GSM/ GPRS Charges to be included in the Costing till the end of Warranty period of the Pump set.

Earthing Arrangement

Earthing of the motor shall be done as per IS 9283 in accordance with the relevant provisions of IS 3043. Separate earthing shall be provided for Controller, pump and SPV array.

For safety purpose, it shall be ensured during installation that the earthing is capable of taking care of leakage current.

In case of uPVC/HDPE pipes used as discharge pipe, a separate non-corrosive, low resistance conductor from motor earth terminal to control panel earth terminal shall be provided for earthing.

A lightning arrester shall be provided with every SPV Water Pumping System.

Use of indigenous components

It will be mandatory to use indigenously manufactured solar modules with indigenous mono/multi crystalline silicon solar cells. Further, the motor-pump-set, controller and balance of system should also be manufactured indigenously. The vendor has to declare the list of imported components used in the solar water pumping system.

4. PERFORMANCE REQUIREMENTS

Under the “Average Daily Solar Radiation” condition of 7.15 KWh / sq.m. on the surface of PV array (i.e. coplanar with the PV Modules), the minimum water output from a Solar PV Water Pumping System at different “Total Dynamic Heads” should be as specified below :

For D.C. Motor Pump Set:

- i) 110 liters of water per watt peak of PV array, from a Total Dynamic Head of 10 meter (Suction head, if applicable, maximum of 7 meter) and with the shut off head being at least 12 meter.
- ii) 55 liters of water per watt peak of PV array, from a Total Dynamic Head of 20 meter (Suction head, if applicable, up to a maximum of 7 meters) and with the shut off head being at least 25 meter.
- iii) 38 liters of water per watt peak of PV array, from a Total Dynamic Head of 30 meters and the shut off head being at least 45 meter.
- iv) 23 liters of water per watt peak of PV array, from a Total Dynamic Head of 50 meter and the shut off head being at least 70 meter.
- v) 15 liters of water per watt peak of PV array, from a Total Dynamic Head of 70 meters and the shut off head being at least 100 meter.
- vi) 10.5 liters of water per watt peak of PV array, from a Total Dynamic Head of 100 meters and the shut off head being at least 150 meter.

The actual duration of pumping of water on a particular day and the quantity of water pumped could vary depending on the solar intensity, location, season, etc.

Indicative performance specifications for the Shallow and Deep well SPV Water Pumping Systems are given in the Annexure II.

For A.C. Induction Motor Pump Set:

- i) 99 liters of water per watt peak of PV array, from a Total Dynamic Head of 10 meter (Suction head, if applicable, maximum of 7 meters) and with the shut off head being at least 12 meter.
- ii) 49 liters of water per watt peak of PV array, from a Total Dynamic Head of 20 meter (Suction head, if applicable, up to a maximum of 7 meters) and with the shut off head being at least 25 meter.
- iii) 35 liters of water per watt peak of PV array, from a Total Dynamic Head of 30 meter and the shut off head being at least 45 meter.
- iv) 21 liters of water per watt peak of PV array, from a Total Dynamic Head of 50 meter and the shut off head being at least 70 meter.
- v) 14 liters of water per watt peak of PV array, from a Total Dynamic Head of 70 meter and the shut off head being at least 100 meter.

- vi) 9 liters of water per watt peak of PV array, from a Total Dynamic Head of 100 meter and the shut off head being at least 150 meter.

The actual duration of pumping of water on a particular day and the quantity of water pumped could vary depending on the solar intensity, location, season, etc.

Indicative performance specifications for the Shallow and Deep well SPV Water Pumping Systems are given in the Annexure III.

5. TESTS FOR HYDRAULIC AND ELECTRICAL PERFORMANCE OF PUMPSET

The motor-pump set shall be tested independently for hydraulic and electrical performance as per the relevant IS specification including following test

- a) Constructional requirements/features
- b) General requirements
- c) Design features
- d) Insulation resistance test
- e) High voltage test
- f) Leakage current test

Testing of SPV Water Pumping Systems shall be done as per procedure specified by the MNRE.

6. GUARANTEE OF PERFORMANCE

The SPV Water Pumping Systems shall be guaranteed for their performance of the nominal volume rate of flow and the nominal head at the guaranteed duty point as specified in 7.1 under the “Average Daily Solar Radiation” condition of 7.15 KWh/m² on the surface of SPV array (i.e. coplanar with the Photo Voltaic (PV) Modules). The actual duration of pumping of water on a particular day and the quantity of water pumped could vary depending on the solar intensity, location, season, etc.

Solar Photo Voltaic Water Pumping Systems shall be guaranteed by the manufacturer against the defects in material and workmanship under normal use and service for a period of at least 60 months from the date of commissioning.

Sufficient spares for trouble free operation during the Warrantee period should be made available as and when required

7. MARKING AND PARAMETERS TO BE DECLARED BY THE MANUFACTURER

The motor pump-set and Controller used in SPV Water Pumping Systems shall be securely marked with the following parameters declared by the manufacturer:

Motor Pump-set

- a) Manufacturer's name, logo or trade-mark;
- b) Model, size and SI No of pump-set;
- c) Motor Rating (kW / HP);
- d) Total head, m, at the guaranteed duty point;
- e) Capacity (LPD) at guaranteed head;
- f) Operating head range, m;
- g) Maximum Current (A);
- j) Voltage Range (V) and;
- k) Type - AC or DC Pump set; &
- l) Photo Voltaic (PV) Array Rating in Watts peak (W_p)

Controller

- a) Manufacturer's name, logo or trade-mark;
- b) Model Number;
- c) Serial Number;
- d) Voltage Range;
- e) Power Range in kW for Controller; and
- f) Current rating (A)

8. OPERATION AND MAINTENANCE MANUAL

An Operation and Maintenance Manual, in English and the local language, should be provided with the solar PV pumping system. The Manual should have information about solar energy, photovoltaic, modules, DC/AC motor pump set, tracking system, mounting structures, electronics and switches. It should also have clear instructions about mounting of PV module, DO's and DONT's and on regular maintenance and Trouble Shooting of the pumping system. Helpline number and Name and address of the Service Centre and contact number of authorized representative to be contacted in case of failure or complaint should also be provided. A warranty card for the modules and the motor pump set should also be provided to the beneficiary.

Annexure-I

**Specifications for Dual Axis Manual Tracking Type
Module Mounting Structure (MMS) for Solar Water Pumping System**

