

**2.8 Pump 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.

**2.9 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

#### 3.1 General

**3.1.1 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.

**3.2 A SPV Water Pumping system** typically consists of:

**3.2.1 Motor Pump Set** see 3.4.

**3.2.2 SPV Controller**

Note: Some controllers are inbuilt in the motors

#### **Specifications of Controller/Drive for Solar Water Pumping Systems**

S.No.	Requirement	Specifications
1.	<i>Controller Power Capacity to drive the Pump</i>	Controller Power Capacity should match to Solar Panels Power Capacity, not Pump Capacity. Example: For <b>5HP</b> Project, As per MNRE Specs, Panels should be minimum <b>4800W</b> , Controller capacity also should be minimum <b>4800W</b> only.
2.	<i>Point Tracking (MMPT)</i>	Should track power only and not Voltage at Maximum power point
3.	<i>Enclosure</i>	The Controller must have <b>IP65</b> protection or must be housed in a cabinet having at least <b>IP65</b> protection.
4.	<i>Isolator Switch</i>	Should be between Solar panels and controller
5.	<i>GSM/GPRS</i>	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

**3.2.3 Remote Monitoring System (RMS)**

The detailed Specification of RMS is Attached as **Annexure V**.

### **3.3 Solar Photo Voltaic (SPV) Array**

**3.3.1** SPV arrays contains 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 13500Watts 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 **300 Watts peak**, with adequate provision for measurement tolerances. Use of PV modules with higher power output is preferred.

**3.3.2** 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.

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

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

**3.3.5** 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)

**3.3.6** 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.

**3.3.7** The name plate shall conform the IS 14286/IEC 61215

**3.3.8** Module to Module wattage mismatch in the SPV array mismatch shall be within  $\pm 3$  percent.

**3.3.9** Any array capacity above the minimum array wattage requirement as specified in these specifications for various models of solar pumping systems is allowed.

**3.3.10** 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.

**3.3.11 The RFID must be inside of module lamination. The module laminate, but must be able to withstand harsh environmental conditions.**

### **3.4 Motor-Pump Set**

**3.4.1** 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.

**3.4.2** The “Motor-Pump Set” should have a capacity in the range of 1 HP to 15 HP and should have the following features:

- a) The closed loop or mono block DC/ AC centrifugal motor pump set 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.

**3.4.3** 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.

**3.4.5** 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.

### **3.5 Module Mounting Structures and Tracking System**

**3.5.1** 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 822. 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.

**3.5.2** 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.

**3.5.3** 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 piling, it should be decided as per the site and relevant IS i.e. IS 6403 / 456 / 4091 / 875 should be referred for foundation design.

**3.5.4** 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.

### **3.6 SPV Controller**

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

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

**3.6.3** 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.

**3.6.4** A DC switch as per IS/IEC 60947-1 suitable for switching dc power ON and OFF shall be provided in the SPV Pump Controller.

**3.6.5** All cables used shall be as per IS 694 or IS 9968(Part 1). 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.

**3.6.6** 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.

### **3.7 Earthing Arrangement**

**3.7.1** 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.

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

**3.7.3** 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.

**3.7.4** A lightening arrestor shall be provided with every SPV Water Pumping System.

### **3.8 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**

**4.1** 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, minimum of 7 meter static suction lift corrected for atmospheric pressure and water temperature) 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, minimum of 7 meter static suction lift corrected for atmospheric pressure and water temperature ) 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 Broad worked-out Specification by the MNRE for the 12.5HP and 15HP BLDC solar pumps is attached as *Annexure IV*.**

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, minimum of 7 meter static suction lift corrected for atmospheric pressure and water temperature ) 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, minimum of 7 meter static suction lift corrected for atmospheric pressure and water temperature ) 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**

**5.1** 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

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

## **6. GUARANTEE OF PERFORMANCE**

**6.1** 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/m<sup>2</sup> 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.

**6.2** 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.

**6.3** 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**

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

### **7.1.1** Motor Pump-set

- a) Manufacturer's name, logo or trade-mark;
- b) Model, size and SI No of pump-set(To be engraved/laser marked on the motor frame);
- 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 ( $W_p$ )
- m) Country of origin

Note: -In addition, a metal name plate containing the above details shall be fixed on the module mounting structure for the information of user.

#### **7.1.2 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)
- g) Country of origin

## **8. OPERATION AND MAINTENANCE MANUAL**

**8.1** 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.

## **9. COMPREHENSIVE OPERATION AND MAINTENANCE**

- i. The Contractor should provide 5 years comprehensive maintenance of the Solar Photovoltaic Water pumping system set, which shall include corrective maintenance as well as routine service visits during guarantee period.
- ii. AMC shall be in line with KUSUM guidelines and it's amendment (if any). The report has to be maintained. Apart from the monitoring, regular periodical maintenance of system has to be done. The report has to be maintained in a prescribed table format in a register maintained at the site which should contain Month, Inspection Date, Action taken against the Defects found in the System and Remarks of the representative of households along with signatures of both service Engineer and the farmer/ beneficiary.