

**Ministry of New and Renewable Energy**  
**Jawaharlal Nehru National Solar Mission**  
**SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEMS**

(2015-16)

**I. INTRODUCTION**

A Solar Photovoltaic (SPV) Water Pumping System consists of:

- PV Array :

Capacity in the range of ***200 Wp to 10 KWp. These ranges of Solar Photovoltaic (SPV) Water Pumping Systems are basically for “Irrigation” applications. However, these may also be used for “Drinking Water Applications wherever such capacities are required”.***

PV Array should be mounted on a suitable structure with a provision of tracking the sun.

- Motor Pump Set (Surface or submersible) :
    - D.C. Motor Pump Set (with Brushes or Brush less D.C.)
- OR
- A.C. Induction Motor Pump Set with a suitable Inverter
- Electronics :
    - Maximum Power Point Tracker (MPPT)

- Inverter for A.C. Motors (Appropriate Electronic Controller in case of B.L.D.C.)
- Electronic Protections.
- Interconnect Cables and
- “On-Off” switch.

## II. PERFORMANCE SPECIFICATIONS AND REQUIREMENTS

Solar PV Water Pumps with PV module capacity in the range of 900 Watt to 5 KWp may be installed on a suitable bore-well / open well / Water Reservoir / Water stream etc.

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 with Brushes or Brush Less D.C.(B.L.D.C. ) :**

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

- (vi) 9.5 liters of water per watt peak of PV array, from a Total Dynamic Head of 100 metres and the shut off head being at least 150 metres.**

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 I.

**For A.C. Induction Motor Pump Set with a suitable Inverter :**

- (i)** 90 liters of water per watt peak of PV array, from a Total Dynamic Head of 10 metres (Suction head, if applicable, minimum of 7 metres) and with the shut off head being at least 12 metres.
- (ii)** **45** liters of water per watt peak of PV array, from a Total Dynamic Head of 20 metres (Suction head, if applicable, up to a maximum of 7 metres) and with the shut off head being at least 25 metres.
- (iii)** 32 liters of water per watt peak of PV array, from a Total Dynamic Head of 30 metres and the shut off head being at least 45 metres.
- (iv)** 19 liters of water per watt peak of PV array, from a Total Dynamic Head of 50 metres and the shut off head being at least 70 metres.
- (v)** 13 liters of water per watt peak of PV array, from a Total Dynamic Head of 70 metres and the shut off head being at least 100 metres.
- (vi)** **8.5 liters of water per watt peak of PV array, from a Total Dynamic Head of 100 metres and the shut off head being at least 150 metres.**

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.

### III. PV ARRAY

The SPV water pumping system should be operated with a PV array capacity in the range of **200 Watts peak to 10000 Watts peak**, measured under Standard Test Conditions (STC). Sufficient number of modules in series and parallel could be used to obtain the required PV array power output. The power output of individual PV modules used in the PV array, under STC, should be a minimum of 125 Watts peak, with adequate provision for measurement tolerances. Use of PV modules with higher power output is preferred.

Indigenously produced PV module (s) containing mono/ multi crystalline silicon solar cells should be used in the PV array for the SPV Water Pumping systems.

- Modules supplied with the SPV water pumping systems should have certificate as per IEC 61215 specifications or equivalent National or International/ Standards.
- Modules must qualify to IEC 61730 Part I and II for safety qualification testing.
- The efficiency of the PV modules should be minimum 14% and fill factor should be more than 70%.
- The terminal box on the module should have a provision for “Opening” for replacing the cable, if required.
- There should be a Name Plate fixed inside the module which will give:
  - a. Name of the Manufacturer or Distinctive Logo.
  - b. Model Number
  - c. Serial Number
  - d. Year of manufacture

### IV 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 Test Centers of the Ministry.
- The “Motor Pump Set” should have a capacity in the range of **0.2 hp to 10 hp and** should have the following features:
    - 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.
    - The motor of the capacity ranging from 0.2 hp to 10 hp should be AC, PMDC or BLDC type. The suction and delivery head will depend on the site specific condition of the field.
    - Submersible pumps could also be used according to the dynamic head of the site at which the pump is to be used.
  - It is recommended that all parts of the pump and the motor of the submersible pumps should be made of stainless steel.
    - The manufacturers of pumps should self certify that, the pump and **all external parts of motor used in submersible pump which are in contact with water, are of stainless steel.** The pumps used for solar application should have a 5 years warranty so it is essential that the construction of the pump be made using parts which have a much higher durability and do not need replacement or corrode for at least 5 years.
  - ***Provision for remote monitoring of the installed pumps must be made in the controllers or the inverters either through an integral arrangement or through an externally fitted arrangement. It should be possible to ascertain the daily water output, the power generated by the PV array, the UP TIME of the pump during the year, Number of days the pump was unused or under breakdown/repairs.***

- The following details should be marked indelibly on the motor pump set
  - a) Name of the Manufacturer or Distinctive Logo.
  - b) Model Number.
  - c) Serial Number.
- The suction/ delivery pipe (GI/HDPE), electric cables, floating assembly, civil work and other fittings required to install the Motor Pump set.

#### V. **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 support structure used in the pumping system should be hot dip galvanized iron with minimum 80 micron thickness.

To enhance the performance of SPV water pumping systems, manual or passive or auto tracking system **must** be used. For manual tracking, arrangement for seasonal tilt angle adjustment and three times manual tracking in a day should be provided.

#### VI. **ELECTRONICS AND PROTECTIONS**

- Maximum Power Point Tracker (**MPPT**) should be included to optimally use the Solar panel and maximize the water discharge.
- Inverter could be used, if required, to operate an A.C. Pump. The inverter must have IP 54 protection or must be housed in a cabinet having at least **IP54** protection.
- Controller for BLDC motor driven pumps, if required be used. The controller must have **IP 54** protection or must be housed in a cabinet having at least IP 54 protection.

- Adequate protections should be incorporated against dry operation of motor pump set, lightning, hails and storms.
- Full protection against open circuit, accidental short circuit and reverse polarity should be provided.

## VII. **ON/OFF SWITCH**

A good reliable switch suitable for DC use is to be provided. Sufficient length of cable should be provided for inter-connection of the PV array, Controller / Inverter and the motor pump set.

## VIII. **WARRANTY**

The PV Modules must be warranted for output wattage, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years. The whole system including submersible/ surface pumps shall be warranted for 5 years. Required Spares for trouble free operation during the Warrantee period should be provided along with the system.

## IX. **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. Name and address of the person or Centre 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.

## **X. NOTES**

- Wherever the “Water table” or the level of water in the reservoir or the water source (e.g. Diggie) from which the water is to be pumped, is within 10 metres depth, ‘Surface Motor Pump sets” should be preferred.
- The type of pump set used must match the total dynamic head requirement of the site (i.e. the location at which it is installed). Moreover, it should be appropriately tested and certified by the authorized test centres of the Ministry to meet the performance and water discharge norms specified in section II above.
- There should not be any compulsion to use only one or the other type of Motor-pump set. The beneficiary may select an appropriate Model (i. e. Capacity of PV Array and Type of Motor Pump Set) as per site requirement.

## ANNEXURE – I

Indicative Technical Specifications of Shallow Well (Surface) Solar Pumping Systems ,

With D.C. Motor Pump Set with Brushes or Brush Less D.C.(B.L.D.C.)

Description	Model-I	Model-II	Model-III
PV array	900 Wp	1800 Wp	2700 Wp
Motor capacity	1 hp	2 hp	3 hp
Shut Off Dynamic Head	12 metres	12 metres	25 metres
Water output *	90,000 litres per day from a total head of 10 metres	180,000 litres per day from a total head of 10 metres	135,000 litres per day from a total head of 20 metres

\* Water output figures are on a clear sunny day with three times tracking of SPV panel, 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)**.

Notes:

1. Suction head, if applicable, minimum 7 metres.
2. For higher or lower head / PV capacity, or in between various models; water output could be decided as per the clause II. (i.e. performance specifications and requirements) specified earlier.
3. If submersible pumps are used in lieu of surface pumps, the water output must match that of the surface pumps as specified in this table.
4. Module mounting structure shall be MS hot dipped galvanised, with a facility of manual tracking at least three times a day.

## ANNEXURE – I (CONTD.)

Indicative Technical Specifications of Solar Deep well (submersible) Pumping Systems:

With D.C. Motor Pump Set with Brushes or Brush Less D.C.(B.L.D.C.)

Description	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII
PV array	1200 Wp	1800 Wp	3000 Wp	3000 Wp	3000 Wp	4800 Wp	4800 Wp	4800 Wp
Motor capacity	1 hp submersible with controller	2 hp submersible with controller	3 hp submersible with controller	3 hp submersible with controller	3 hp submersible with controller	5 hp Submersible with controller	5 hp Submersible with controller	5 hp Submersible with controller
Shut Off Dynamic Head	45 metres	45 metres	45 metres	75 metres	100 metres	70 metres	100 metres	150 metres
Water output*	42,000 litres per day from a total head of 30 metres	63,000 litres per day from a total head of 30 metres	105,000 litres per day from a total head of 30 metres	63,000 litres per day from a total head of 50 metres	42,000 litres per day from a total head of 70 metres	100,800 litres per day from a total head of 50 metres	67,200 litres per day from a total head of 70 metres	45,600 litres per day from a total head of 100 metres

\* Water output figures are on a clear sunny day with three times tracking of SPV panel, 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)**.

Notes:

1. For higher or lower head / PV capacity, or in between various models; water output could be decided as per the clause II. (i.e. performance specifications and requirements) specified earlier.
2. If surface pumps are used in lieu of submersible pumps, the water output must match that of the submersible pumps as specified in this table.
3. Module mounting structure shall be MS hot dipped galvanised, with a facility of manual tracking at least three times a day.

## ANNEXURE – I (CONTD.)

Indicative Technical Specifications of Solar Deep well (submersible) Pumping Systems:

With D.C. Motor Pump Set with Brushes or Brush Less D.C.(B.L.D.C.) **(Contd.):**

Description	Model-IX	Model-X	Model-XI	Model-XII	Model-XIII	Model-XIV
PV array (minimum)	6750 Wp	6750 Wp	6750 Wp	9,000 Wp	9,000 Wp	9,000 Wp
Motor capacity	7.5 hp Submersible with controller	7.5 hp Submersible with controller	7.5 hp Submersible with controller	10 hp Submersible with controller	10 hp Submersible with controller	10 hp Submersible with controller
Shut Off Dynamic Head	70 metres	100 metres	150 metres	70 metres	100 metres	150 metres
Water output*	141,750 litres per day from a total head of 50 metres	94,500 litres per day from a total head of 70 metres	64,125 litres per day from a total head of 100 metres	189,000litres per day from a total head of 50 metres	126,000 litres per day from a total head of 70 metres	85,500 litres per day from a total head of 100 metres

\* Water output figures are on a clear sunny day with three times tracking of SPV panel, 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)**.

Notes:

1. For higher or lower head / PV capacity, or in between various models; water output could be decided as per the clause II. (i.e. performance specifications and requirements) specified earlier.
2. If surface pumps are used in lieu of submersible pumps, the water output must match that of the submersible pumps as specified in this table.
3. Module mounting structure shall be MS hot dipped galvanised, with a facility of manual tracking at least three times a day.

## ANNEXURE – II

Indicative Technical Specifications of Shallow Well (Surface) Solar Pumping Systems ,

With A.C. Induction Motor Pump Set and a suitable Inverter:

Description	Model-I	Model-II	Model-III	Model-IV	Model- V	Model- VI
PV array	900 Wp	1800 Wp	2700 Wp	2700 Wp	4800 Wp	4800 Wp
Motor capacity	1 hp	2 hp	3 hp	3 hp	5 hp	5 hp
Shut Off Dynamic Head	12 metres	15 metres	15metres	25 metres	15metres	30 metres
Water output *	81,000 litres per day from a total head of 10 metres	162,000 litres per day from a total head of 10 metres	243,000 litres per day from a total head of 10 metres	121,500 litres per day from a total head of 20 metres	432,000 litres per day from a total head of 10 metres	216,000 litres per day from a total head of 20 metres

\* Water output figures are on a clear sunny day with three times tracking of SPV panel, 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)**.

Notes:

1. Suction head, if applicable, minimum 7 metres.
2. For higher or lower head / PV capacity, or in between various models; water output could be decided as per the clause II. (i.e. performance specifications and requirements) specified earlier.
3. If submersible pumps are used in lieu of surface pumps, the water output must match that of the surface pumps as specified in this table.
4. Module mounting structure shall be MS hot dipped galvanised, with a facility of manual tracking at least three times a day.

## ANNEXURE – II (CONTD.)

Indicative Technical Specifications of Solar Deep well (submersible) Pumping Systems:

With A.C. Induction Motor Pump Set and a suitable Inverter:

Description	Model-I	Model-II	Model-III	Model-IV	Model-V	Model-VI	Model-VII	Model-VIII
PV array	1200 Wp	1800 Wp	3000 Wp	3000 Wp	3000 Wp	4800 Wp	4800 Wp	4800 Wp
Motor capacity	1 hp submersible with controller	2 hp submersible with controller	3 hp submersible with controller	3 hp submersible with controller	3 hp submersible with controller	5 hp Submersible with controller	5 hp Submersible with controller	5 hp Submersible with controller
Shut Off Dynamic Head	45 metres	45 metres	45 metres	75 metres	100 metres	70 metres	100 metres	150 metres
Water output*	38,400 litres per day from a total head of 30 metres	57,600 litres per day from a total head of 30 metres	96,000 litres per day from a total head of 30 metres	57,000 litres per day from a total head of 50 metres	39,000 litres per day from a total head of 70 metres	91,200 litres per day from a total head of 50 metres	62,400 litres per day from a total head of 70 metres	40,800 litres per day from a total head of 100 metres

\* Water output figures are on a clear sunny day with three times tracking of SPV panel, 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)**.

Notes:

1. For higher or lower head / PV capacity, or in between various models; water output could be decided as per the clause II. (i.e. performance specifications and requirements) specified earlier.
2. If surface pumps are used in lieu of submersible pumps, the water output must match that of the submersible pumps as specified in this table.
- 3.** Module mounting **structure shall** be MS hot dipped galvanised, with a facility of manual tracking at least three times a day.

## ANNEXURE –II (CONTD.)

Indicative Technical Specifications of Solar Deep well (submersible) Pumping Systems:

With A.C. Induction Motor Pump Set and a suitable Inverter **(Contd.)**:

Description	Model-IX	Model-X	Model-XI	Model-XII	Model-XIII	Model-XIV
PV array (minimum)	6750 Wp	6750 Wp	6750 Wp	9,000 Wp	9,000 Wp	9,000 Wp
Motor capacity	7.5 hp Submersible with controller	7.5 hp Submersible with controller	7.5 hp Submersible with controller	10 hp Submersible with controller	10 hp Submersible with controller	10 hp Submersible with controller
Shut Off Dynamic Head	70 metres	100 metres	150 metres	70 metres	100 metres	150 metres
Water output*	128,250 litres per day from a total head of 50 metres	87,750 litres per day from a total head of 70 metres	57,375 litres per day from a total head of 100 metres	171,000 litres per day from a total head of 50 metres	117,000 litres per day from a total head of 70 metres	76,500 litres per day from a total head of 100 metres

\* Water output figures are on a clear sunny day with three times tracking of SPV panel, 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)**.

Notes:

- 1) For higher or lower head / PV capacity, or in between various models; water output could be decided as per the clause II. (i.e. performance specifications and requirements) specified earlier.
- 2) If surface pumps are used in lieu of submersible pumps, the water output must match that of the submersible pumps as specified in this table.
- 3) Module mounting structure shall be MS hot dipped galvanised, with a facility of manual tracking at least three times a day.