# Solar Water Pump Solution

## For

## Gram Seva Kendra

## Village : Khadsali

## Designed, supplied, Installed and commissioned by

**Topsun Energy Limited**

**B-101, Sector-25, Electronic Estate, Gandhinagar, Gujarat, India**

**Telephone : +91 79 232 88804 , Fax : +91 79 232 88805**

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## 1. Introduction

Solar water pumps can supply water to locations which are beyond the reach of power lines. Commonly, such places rely on human or animal power or on diesel engines for their water supply or where the frequent power cuts are observed and the power when available is not pure and enough (Indian Conditions in Rural). Solar water pumps can replace the current pump systems and result in both socio-economic benefits as well as climate related benefits as well as the existing pump can also be driven using highly efficient Control Electronics with MPPT which maximize the Solar Power extraction. The water supplied by the solar water pump can be used to irrigate crops, water livestock or provide potable drinking , cooking and sanitation water.

A solar water pump system is essentially an electrical pump system in which the electricity is provided by one or several Photo Voltaic (PV) panels. A typical solar powered pumping system consists of a solar panel array that powers an electric motor, which in turn powers a bore or surface pump. The water is often pumped from the ground or stream into a storage tank that provides a gravity feed, so energy storage is not needed for these systems. A typical installation is illustrated in Figure 1.

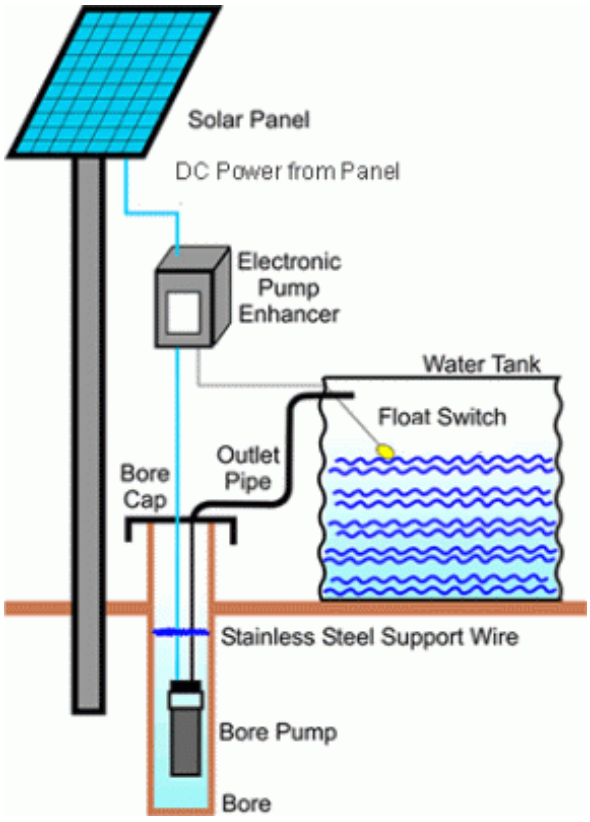



Figure 1: A solar water pump system

## 2. Feasibility of technology and operational necessities

There are two main types of solar water pump technologies:

a) The centrifugal pump, which uses high speed rotation to suck water in through the middle of the pump. Most conventional Alternating Current (AC) pumps use such a centrifugal impeller. However, when operating at low power the performance of the pump drops dramatically. This makes centrifugal pumps less suitable for solar applications, since low power due to cloudy weather is to be expected; and

b) The positive displacement pump, which usually uses a piston to transfer water. Many solar water pumps use the positive displacement pump, which brings water into a chamber and then forces it out using a piston or helical screw. These types generally pump slower than other types of pumps, but have good performance under low power conditions and can achieve high lift. Since PV is expensive and is an intermittent power supplier, solar pumps need to be as efficient as possible. Efficiency of the pump is measured in the amount of water pumped per watt of electricity used.

Two types of pump exist

a) Submersible pumps and
b) surface pumps.

It depends on the water source which pump type is more suitable. In the case of a well, the pump needs to be placed underwater. Surface pumps can be placed at the side of a lake or, in the case of a floating pump, on top of the water. Surface pumps are less expensive than submersible pumps, but they are not well suited for suction and can only draw water from about 6.5 vertical meters. Surface pumps are excellent for pushing water over long distances.

Other options for remote watering exist. In Table 1 the option of solar water pumping is compared to several other remote watering options.

**Table 1**

| Pumping Technology | Advantages | Disadvantages |
|---|---|---|
| Solar | - Low maintenance<br>- No fuel costs or spills<br>- Easy to install<br>- Simple and reliable<br>- Unattended operation<br>- System can be made to be mobile | - Potentially high initial costs<br>- Lower output in cloudy weather<br>- Must have good sun exposure between 9 AM and 4 PM<br>(Indian conditions are good and Gujarat has added advantages with 322 Days clear sunlight with 5.5KWH to 6.5KWH Energy /day) |
| Diesel or gas | - Moderate capital costs<br>- Can be portable<br>- Extensive experience available<br>- Easy to install | - Needs maintenance and replacement<br>- Maintenance often inadequate, reducing lifetime of system<br>- Fuel often expensive and supply intermittent<br>- Noise, dirt and fume problems<br>- Site visits necessary |
| Windmill | - Potentially long lasting<br>- Works well in windy site | - High maintenance and costly repair<br>- Difficult to find parts<br>- Seasonal disadvantages<br>- Need special tools for installation<br>- Labor intensive<br>- No wind, no power |

## 3. Need of Solar Water pump Solution at Gram Seva Kendra, Village- Khadsli

Being a NGO running a school aggregating 400 Nos people in campus the vital need of water is to be served. Also it was intended to serve the aim to contribute in the use of non-conventional energy by deploying a few feasible solutions as an NGO.

Moreover the conventional power is also not pure being at a remote location during day due to high demands in agriculture, industries & residential during summer and also frequent power cuts are observed. So from the above feasibility & reliability study of technology Solar Operated Pump is concluded as a suitable solution with optional change over to Grid in case of failure or when solar is insufficient making it a most suitable model for the use of organization for its need.

## 4. Details of Beneficiary, Geographical Location & requirement

A careful study has been taken for the Khadsali Site for adequate inputs on requirements of beneficiary (customer) to support suitable design and installation , which is located at below address.

Beneficiary : Gram Seva Kendra
Location : Village Khadsali
Taluka : Savarkundla,
District : Amreli

Geographical Location : This village is located in the area where the clear sun light is available for at least 322days per year and the irradiance level is for 5KWH to 5.5KWH. This is a vital parameter for the design.

## 5. Understanding the water requirement

This trust is involved in educational activity. Water is required for the more use in drinking, sanitation, cooking , gardening and of the organization (NGO). Approximately 150 Nos people including students and staff are living within the campus.

Solar Water pump Design requires 2 basic parameters to design a system feasible to meet the requirements .

**Details on Need of Water**

| | | |
|---|---|---|
| No of water Tanks | 2 Nos | |
| Capacity of water Tanks | Tank 1 | = 22000 Liters |
| | Tank 2 | = 20000 Liters |
| | Total | = 42000 Liters which are filled 2 times in a day. |

So **total water need** is 42000 x 2 times = **82000 Liters /day** .

1. Need of water per day - **82 ,000 liters** ( from above study) &
2. Depth of water from which the water is to be drawn - **400 feet** OR almost **120 Meters** as shared by customer.

## 6. Selection of solution and details of System Constituents

As per its geographical location the sunlight is available 322 days and irradiance is 5KWH to 5.5 KWH peak. Other diffused or low sun light is available for 3 more hours.

**Pump Selection**

Considering the need of daily water requirement it has been visualized that during the monsoon season and at the time Solar is not performing let us have a pump which is suitable to Run on conventional power as well and select Electronics & controls to align with Solar power with MPPT and extract o/p to meet the high efficient pump with 3 phase.

Considering the water need and depth of water 10HP with 13 stages is decided to install. Our Electronic and controls is capable of performing up to 30% to 110% of power availability of power from sunlight before complete shutdown.

From the interaction with different manufacturers we concluded a pump which is from FLOWTECH, Rajkot who is one of the reputed pump manufacturers with better quality efficient pumps. A Model highlighted in the table is selected.

**Electronic with MPPT will operate** the pump from

| | |
|---|---|
| Summer | : 8 AM to 6.00PM |
| Winter | : 8.30 AM to 5.30 PM |

| | |
|---|---|
| **Model of Pump** | : F6S1013 |
| Capacity | :10 H.P. = 7500 Wp Capacity |
| Stages | : 13 |
| Heads in Meter | : 120 Meters from above details on depth of water OR 400 feet |

**Solar Panel Selection**

| | |
|---|---|
| Motor/pump Set Requirement | : 9000 Wp |
| Solar Panel capacity to achieve the requirement | : 9600 Wp |
| Solar Panel Model | : 240 Wp x 40 Nos |
| Make | : Topsun Energy Ltd. |
| Certifications | : IEC 61215-II, IEC 61730-I & II, CE, RoHS |

## Electronics Control System Selection

Capacity : 12 KW
Make : Topsun Energy Limited

## Specifications

I/P Voltage DC Range- (Solar Panel) :450V to 650 V wide range acceptance

O/P Voltage : 380 to 415 V 3 phase 3 wire

Capacity : 15HP or 11KW

## Features

- Soft start
- Capable of taking care of high inrush current
- Variable frequency driving from Solar power i/p
- DC to 3 phase conversion
- MPPT control on the Solar side to maximize the Solar Power
- Wide MPPT range allows Solar Panel acceptability in wide range and enables a flexible selection
- Controls the o/p to motor pump set till 30% of power i/p available from Solar
- Self recovery on sensing suitable parameters
- Constant polling of Solar i/ps and Drive o/p to Motor and self reconnect
- Fully Automatic control and completely interlocked system

## Protections

- Over current control tripping
- Under voltage control tripping

## Specifications

I/P Voltage DC Range - (Solar Panel) **:** 450V to 650 V wide range acceptance

O/P Voltage : 250V- 415V AC RMS 3 phase 3 wire

Operating Power Range : 30% to 110%

Capacity **:** 12KW

Ampere Capacity : 25A

**Details of Pump Manufacturer**

## FLOTECH ENGINEERING PVT. LTD.

Opp. Kaneria Oil Mill, Shapar Main Road,
At Shapar (Veraval), Rajkot.
Gujarat - INDIA

**Manufacturer Pump Data (Performance Chart):-**

| MODEL: FTS-80 OUTLET - 2.0 ” | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sr.No. | Model | H.P. | Stage | | DISCHARGE IN L.P.M. | | | | | | | | | |
| | | | | | **120** | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | |
| 1 | F6S34 | 3.00 | 4 | Total Head in Metres | 58 | 55 | 50 | 48 | 46 | 40 | 35 | 30 | 20 | |
| 2 | F6S45 | 4.00 | 5 | | 72 | 68 | 65 | 60 | 58 | 55 | 45 | 40 | 30 | |
| 3 | F6S56 | 5.00 | 6 | | 88 | 80 | 75 | 65 | 69 | 60 | 58 | 45 | 40 | |
| 4 | F6S68 | 6.00 | 8 | | 115 | 112 | 100 | 98 | 92 | 80 | 75 | 70 | 60 | |
| 5 | F6S710 | 7.50 | 10 | | 145 | 140 | 130 | 120 | 115 | 100 | 90 | 80 | 70 | |
| 6 | F6S1012 | 10.0 | 12 | | 175 | 170 | 165 | 150 | 144 | 135 | 125 | 100 | 90 | |
| **7**** | **F6S1013** | **10.0** | **13** | | **200** | **190** | **185** | **170** | **156** | **145** | **135** | **125** | **110** | |
| 8 | F6S1215 | 12.5 | 15 | | 225 | 200 | 195 | 180 | 172 | 165 | 155 | 135 | 120 | |
| 9 | F6S1518 | 15.0 | 18 | | 260 | 250 | 225 | 200 | 207 | 180 | 175 | 155 | 140 | |
| 10 | F6S1519 | 15.0 | 19 | | 275 | 265 | 255 | 240 | 218 | 200 | 190 | 180 | 170 | |
| 11 | F6S1722 | 17.5 | 22 | | 300 | 290 | 280 | 270 | 253 | 225 | 210 | 200 | 190 | |
| 12 | F6S2024 | 20.0 | 24 | | 350 | 340 | 320 | 310 | 287 | 270 | 260 | 240 | 200 | |
| 13 | F6S2530 | 25.0 | 30 | | 425 | 400 | 380 | 360 | 345 | 310 | 300 | 280 | 240 | |

****From Above our Model data as per Sr No 7 in Table shows that at 120 Meters of depth(Head) pump can deliver 200 liters/minute. Pl. see Throughput Analysis derived from above i/ps to justify the need of water required by NGO/day.**

## 7. Throughput Analysis

a. Water o/p – Liters/min : 200 Liters (corresponding to the depth 120 meters from Table )
b. Water in Liters/ Hours : 200 liters/minute x 60 = 12000 liters/hour
c. Peak Sunlight available for 6 hrs Water /day in peak hours = 12000 x 6 =**72000 Liter/day/peak sun hour**.
d. Rest **3 hours** considering average 50% o/p = 100 liters/minutes x 180 minutes (3Hrs) = **18000 liters/Day/ average sun light.**
e. Adding water from C hours & water from D hours the Total Water/Day = 72000 + 18000 = **90000 liters/Day**

## 8. Design and system Block Diagram

System Voltage i/p : 600 V DC

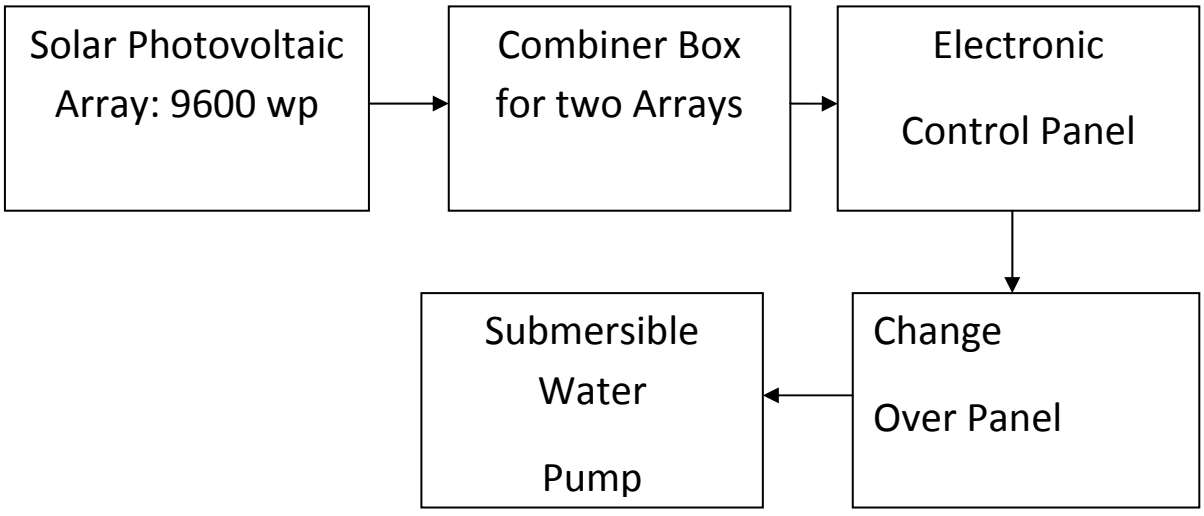
System voltage o/p : 250V to 415V RMS till 30% Power available

Solar Panels Strings : 2 Nos

Solar Panels in series : 20 Nos

String in Parallel : 2 Nos

Total Voltage of String : Vmax = 600V, Imax = 16 Amp, Pmax = Imax x Vmax = 9600 Wp



## 9. Bill of Material & Cost of Project

| Sr No | Item Name | Description | Model | Qty / Unit |
|---|---|---|---|---|
| 1 | Solar Photovoltaic Modules | Multi crystalline Type | 240Wp | 40 Nos |
| 2 | Electronic Control Panel | with MPPT , IP-65 Panel | 15 HP | 1 No. |
| 3 | Change Over Panel - 63 Amp. | From Solar To Grid and Solar with Centre off | 25 HP | 1 No |
| 4 | Solar Module Mounting Structure- SET for 40 Modules | C Channels and Frames made from Galvanized steel | | 1 SET |
| 5 | Cable single Core 4 Sq mm | PVC insulated with Red/Black cores | | 50 Meter |
| 6 | Cable 2 core 4 sq mm | PVC insulated with Red/Black cores | | 20 Meter |
| 7 | Cable 4 core 4 Sq mm | PVC insulated with R/Y/B/G cores | | 50 Meter |
| 8 | Junction Box AJB | IP65 Class certified- Make - HanSEL Germany | | 1 No |
| 9 | DC Disconnect S/W 25A | MCB 2 Pole | | 1 No |
| 10 | Ear thing SET | Maintenance free PIPE Earth for Modules | | 1 No |
| 11 | Hardware and other accessories for structure and cabling | As required | | |
| 12 | Civil work for foundation | For Frame Structure | | |

## 10. Operation & Maintenance - (Separate document Provided)

A separate manual is given for the clear understanding of operation and maintenance for the ease of maintaining the Installed Solution.

## 11. Warranty Conditions

1. **Manufacturing warranty:** The Solar Panels will correspond with their specification at the time of delivery and will be free from defects in material and workmanship for a period of 10 years from the date of delivery. If the Buyer makes a claim under this warranty Topsun Energy Limited shall replace the Goods. Topsun Energy Limited shall be under no liability in respect of any defect in the Goods arising from any drawing, design or specification supplied by the Buyer.
2. **Limited Warranty:** A 2 years warranty against defects in materials and workmanship, and a 25-years warranty against reduced acceptable power output 10% after 10Years and 20% after 25 Years.
3. **Performance Warranty:** If, within twenty-five (25) years from date of array commissioning or the calendar date 6-months after the manufacturing date of the modules (whichever comes first), any PV module(s) >30wp exhibits a power output less than 80% of the Minimum Peak Power as specified in the Product datasheet revision active for the serial number date of the module, provided that such loss in power is determined by Topsun Energy Limited will replace, repair or compensate as deem fit.
4. **Electronic Items:** 1 year standard warranty term for other electronic items.

## 12. Contribution of the technology to social development

Solar water pumps contribute to social development in several ways. Since other remote water supply systems are less reliable than solar water pumps. The use of solar water pumps therefore provides a reliable, safe and adequate water supply which improves the community's health. Other benefits to social development are the improvement of social cohesion within the community, reduced migration out of the community, and increased community interaction in social events due to increased time availability.

In addition, in many developing countries there is a strong link between gender and water. In many developing countries, women are responsible for the water supply, spending a large portion of their time to gather the water. The use of solar water pumps can have considerable positive effects for women in these communities. The scope of these benefits is very broad. For instance, the adequate water supply improves the personal hygiene of women but also allows them to allocate more of their time to the other activities. After installation of solar water pumps women in these communities might allocate more time to activities such as education or food gathering.

## 13. Contribution of the technology to protection of the environment

Solar PV systems, once manufactured, are closed systems, during operation and electricity production they require no inputs such as fuels, nor generate any outputs such as solids, liquids, or gases (apart from electricity). They are silent and vibration free and can broadly be considered, particularly when installed on brown field sites, as environmentally benign during operation. In regards to pollutants released during manufacturing, summarizes that indicates that solar PV has a very low lifecycle cost of pollution per kilowatt-hour (compared to other technologies). Furthermore they predict that upwards of 80% of the bulk material in solar panels will be recyclable; recycling of solar panels is already economically viable. In terms of land use, the area required by PV is less than that of traditional fossil fuel cycles and does not involve any disturbance of the ground, fuel transport, or water contamination.

While the use of PV technology provides several environmental benefits compared to traditional technologies, care should be taken that the installation of the solar water pump does not increase the use of groundwater so that supplies are depleted. Especially in the case where the initial capital costs are covered by a grant or other financial arrangement, the water supplied is more economical to the users compared to the original situation. This might increase water use. One approach to reducing this possible problem is to maintain water price for the users on the original level, and invest the extra money into a community development fund. This is taken in DESIGN.

## 14. Climate

When solar water pumps replace either diesel generated electricity or grid based electricity, there are certain climate related benefits. A diesel generator emits CO2 during operation and grid based electricity is usually generated with either coal, oil or natural gas which also emits considerable quantities of CO2. In contrast. a solar based water pump system does not result in greenhouse gas emissions. Extensive use of solar water pumps would therefore lead to substantial greenhouse gas emission reductions.

----------End of Report----------