

Project: Portosol

Portable Lightweight Solar Power Plant for irrigation.

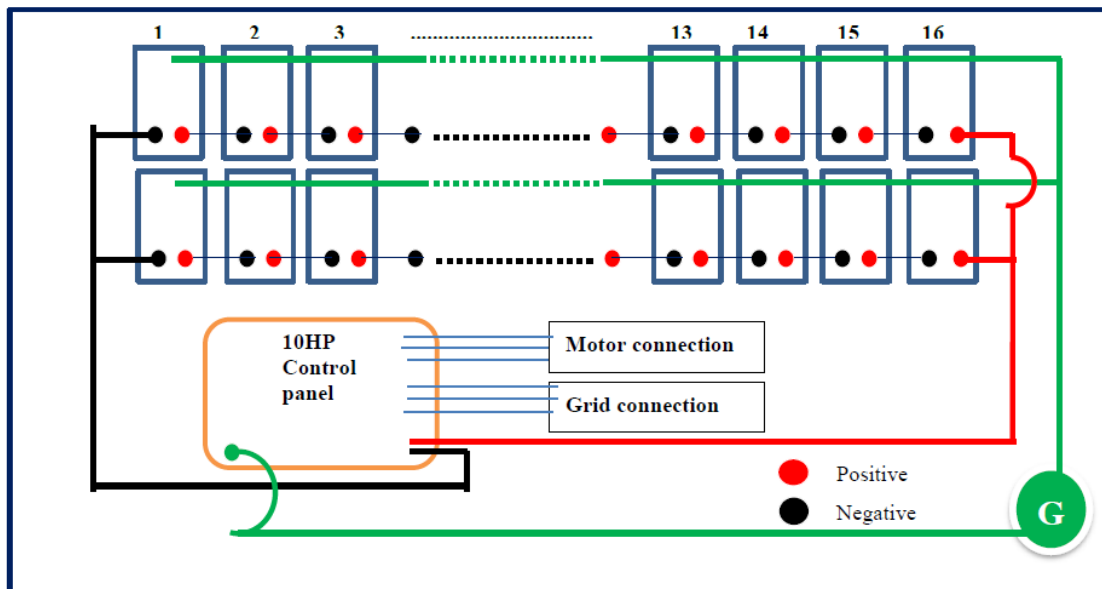
Water pumping for irrigation is a bare minimum necessity for farming. In the absence of stable, consistent and quality power source, Smallholder farmers often forced to rely on expensive diesel fuel-based generators to power their pumping systems. Diesel generators are source of toxic emissions which are responsible for not only global greenhouse gases but also health-risks such as carcinogens, the very cause of cancer.

Solar Water Pumping systems are here since around year 2000. So far these systems have been deployed by Assembly on Site model with heavy reliance on installers to come to site and put together different components of the system on site. These are also fixed on ground and more often than naught non-movable power plants for solar water pumping systems. Since they operate with Variable Frequency Drives (VFDs) these systems don't require any power storage mechanism in the form of batteries. Series connection of solar panels can create voltage enough to start the VFD so that the system with inbuilt MPPT controller and various electrical protections, can directly power a pumpset. Because these systems are usually required to be assembled by engineers on site, requiring lot of labour, it becomes an expensive proposition to smallholder farmers, with prices ranging from 1200 USD to 1500 USD per Horsepower of system capacity.

Traditional System 10HP

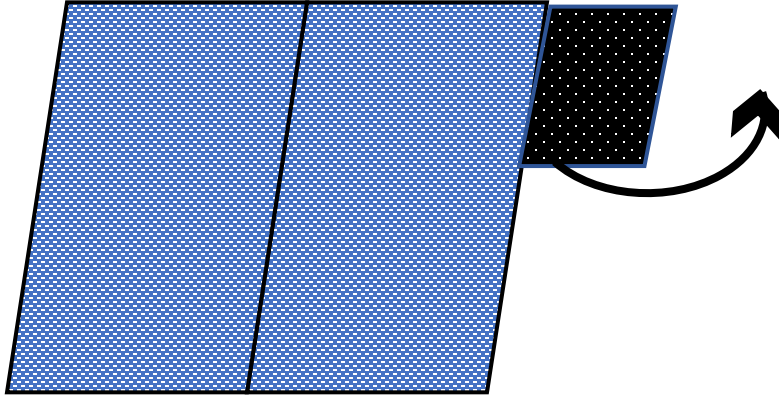
Wiring Diagram for 10HP

Solar Panels Wiring with Controller: 325 watt x 16 panels in one string. 2 strings Parallel.

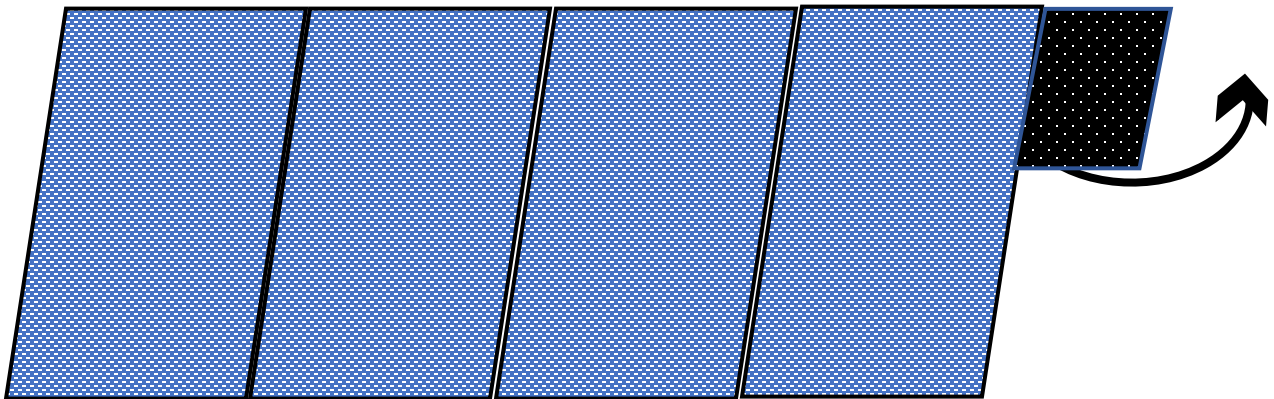


Future of Solar Powered Water Pumping.

Portosol 500 : With 2 x 240Wp PERC Solar Panels + controller (drive) to run 0.25HP and 0.5HP Single Phase AC synchronous motor based pumps on Solar Power.



Portosol 1000: With 4x240Wp PERC Solar Panels + Controller (drive) to run 0.75HP and 1 HP Single Phase AC synchronous motor-based pumps on Solar Power.



The system will be protected in nylon bag for safety when not in use or on shelf. Folded Solar Panels + Drive will be mounted on a trolley.

Our Innovation.

- 1. Solar Panels:** High efficiency monocrystalline PERC solar panels with following changes. Solar panel datasheet of our choice of panels is given below for technical overview.
- 2. Frames:** In our design, as illustrated in image of portosol 150 below, based on our decades of experience working with solar water pumping systems, we have made it a total plug and play system. Because frames add extra weight, we have removed aluminum frames and opted for PVF frames. PVF, a.k.a. Tedlar is Dupont's one of the most durable weatherproof material with excellent fire safety properties which is why it is also used as aircraft interiors. PVF material are nothing new for a solar panel, since they have been used as a no.1 choice (and hence expensive) for the solar panel backsheets for utility scale solar projects. These frames allow for bulky solar panels to become really slim without altering it's photovoltaic properties. Frames will also be designed with interlocking hinges to lock one solar panel with it's neighbor one. This design has already been tested in mini solar panels for mobile charging application but so far not yet on a larger one for higher power applications. One of our 2015 trial model picture of portable solar power plant of single module **Portosol 150** with a trolley design has been given below for a better perspective. This innovation greatly reduces the weight of the solar panel array to below 10kg per panel making total weight of the complete system below 45kg, which can be rolled down using a trolley by a single person. Reduced solar panel thickness is 10mm vs 40mm.
- 3. Cables:** In traditional solar panel design, DC cables can be spotted behind the solar panel coming out of a junction box with an MC4 Connector. This is so done to offer flexibility in design. In our design the number of panels are fixed numbers, hence we can do away with requirement of MC4 connectors and put straight connecting 6sq.mm DC cables inside a pvc sheath glued on the PVF backsheet. Thus we can fix the connections of 2 or 4 solar panels for permanently, there by doing away with tedious works of connecting solar panels. Only output of the solar array is a 3 pin plug out of which 1 is DC Positive, 1 is DC negative and 1 is Solar Panels Earthing cable. This will plug directly into Controller input, eliminating the traditional multiple wiring connection. User will not have to find out which cable to plug in at which input. All they will need to do is just do one plug into one single socket of controller device.

4. **Controller:** Solar water pumping controllers are available in market with variety of power class and input voltage selections. The controller device allows a water pump to run directly on solar power from morning to evening without the need for power storage or battery bank. These are boxy shaped electronic devices with electrical, weather related, and fire related protections built inside them. We have recently come up with a patentable design of the controller in which we have managed to spread an existing circuit board with bulky irregular shaped appearance into a 140mm slim better organized, better spaced apart components which eliminates the requirement of fan-based cooling. The backside Aluminium heatsink on a larger area allows for better heat transfer. We have also included, *Thin Heat Pipe Technology* developed by Fujitsu, which offers 5 times better heat transfer. The technology originally meant for smartphones, will allow the controller device to work in extreme hot or cold weather, eliminating wear and tear caused to device circuitry because of overheating issues.
5. **Inverter-Bypass with Built in Charger:** Charge controllers are devices to regulate fluctuating DC input voltage from solar panels into a more controllable and stable output voltage. Integrating the charger in to inverter is nothing new and has been carried out for decades to manufacture devices called solar power conditioning units and solar hybrid inverters. Building integrated charger into the controller devices allows for bypassing the Inverter to charger, there by allowing the steady DC output voltage from a fluctuating voltage source. This makes it possible to use the same portosol controller device, to charge batteries or run DC appliances like DC fans and DC LED lights. This makes it possible for use at home and farm.

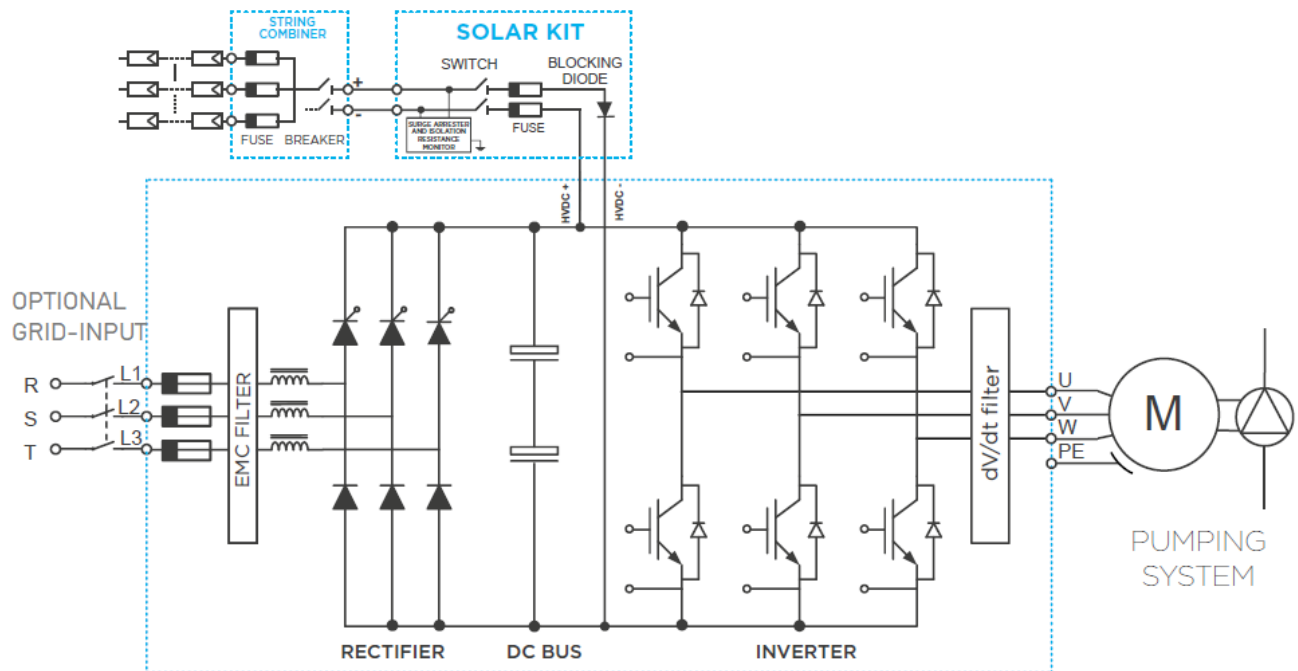
Reason to choose AC over DC.

Currently the form of electricity received by a household is AC power and AC devices are easily available everywhere. For the same reason, AC Water pumps are predominantly used by farmers and due to their easy availability and large spread in the market, they are cheaper than their DC counterparts and easy to repair or replace if some malfunction occurred to them. Most farmers based on their experience, themselves know the workarounds of AC pumps and can solve minor issues like sands trapped in impellers, all by themselves. DC water pumping technology is still not that widely spread. On top of that DC pumpsets are in most cases irreparable because of unavailability of skilled / trained servicemen with knowhow of DC pump working. DC pumpsets are also between 5 to 10 times expensive except some Chinese manufactured products which don't last as much. With our portosol portable power plant, farmers can use their exiting single-phase AC synchronous centrifugal pumpsets and operate them on solar power directly. This saves them of any other hassle of buying a separate DC pump.



Figure **Portosol 150**: PVF framed Solar Panel on a trolley with controller at the top part of the handle, developed by **Bati Energy** in year **2015**.

Controller Operational Diagram

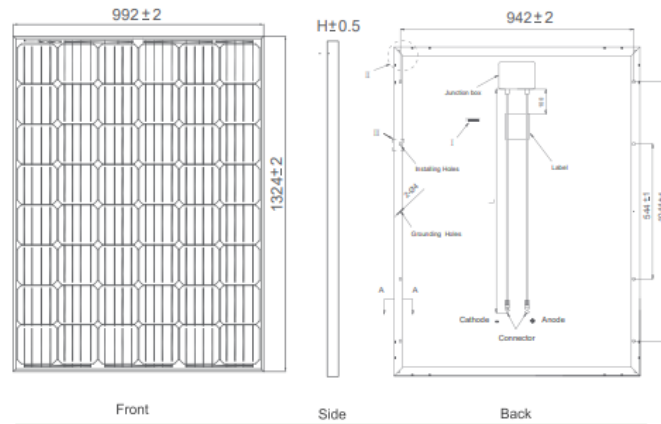


SPECIFICATIONS

240Watt Mono PERC Solar Modules

Module Type	JKM240M-48	
	STC	NOCT
Maximum Power (Pmax)	240Wp	177Wp
Maximum Power Voltage (Vmp)	26.1V	24.5V
Maximum Power Current (Imp)	9.20A	7.23A
Open-circuit Voltage (Voc)	32.1V	29.6V
Short-circuit Current (Isc)	9.72A	8.05A
Module Efficiency STC (%)	18.27%	
Operating Temperature(°C)	-40°C~+85°C	
Maximum system voltage	1000VDC (IEC)	
Maximum series fuse rating	15A	
Power tolerance	0~+3%	
Temperature coefficients of Pmax	-0.39%/°C	
Temperature coefficients of Voc	-0.29%/°C	
Temperature coefficients of Isc	0.05%/°C	
Nominal operating cell temperature	45±2°C	

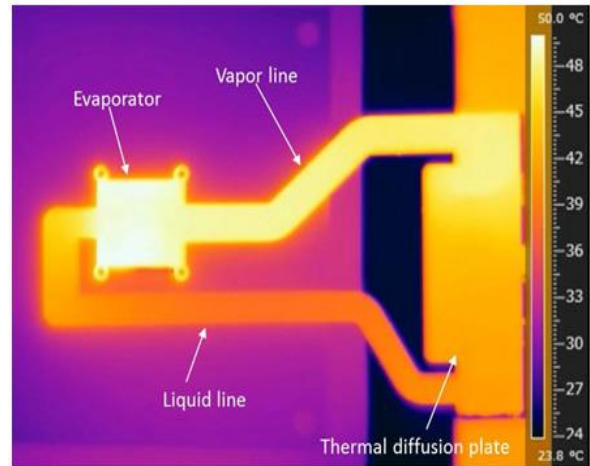
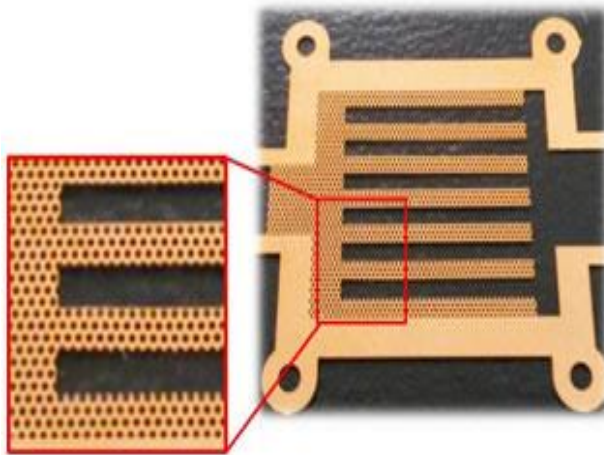
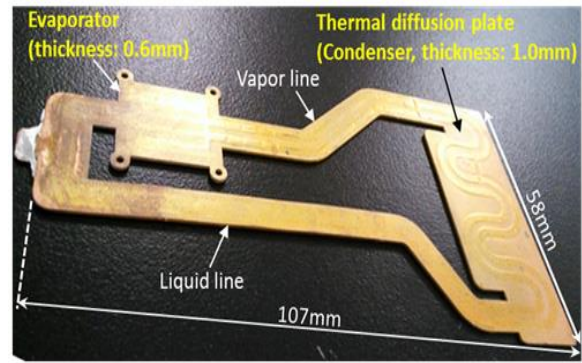
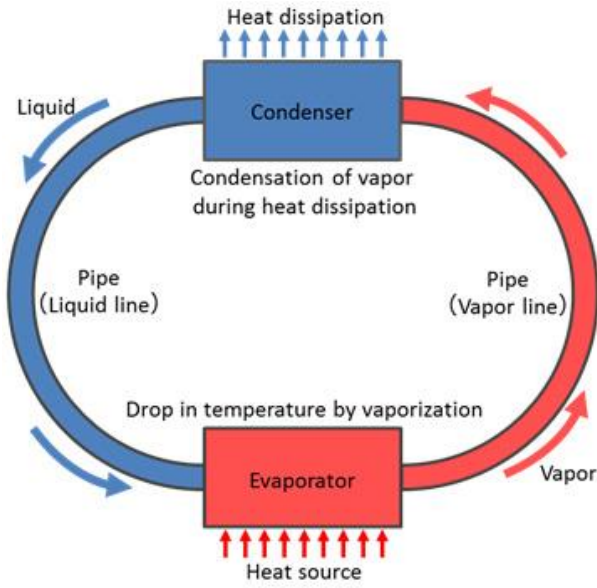
Engineering Drawings



Mechanical Characteristics

Cell Type	Mono-crystalline PERC	156×156mm (6 inch)
No. of cells	48 (6×8)	
Dimensions	1324×992×40mm	
Weight	14.8 kg	
Front Glass	3.2mm, Anti-Reflection Coating, High Transmission, Low Iron, Tempered Glass	
Frame	Anodized Aluminium Alloy	
Junction Box	IP67 Rated	
Output Cables	TUV 1×4.0mm ² , Length: 900mm or Customized Length	

Fujitsu Heat pipe Technology : Bati Energy will be the first company to utilize and extend application of Fujitsu Heat pipe technology into power electronics to develop compact solar drives.



Source: <http://www.fujitsu.com/global/about/resources/news/press-releases/2015/0312-01.html>

Controller Specifications

0.75 hp (0.55 kW) Model	
Controller Model No.	Portosol 1000
Output	
Output Voltage, Max	220V AC Max, 1-phase
Max Amps (RMS)	4.0 Amps
Output Frequency	30-50Hz
Efficiency at Max Power	96%
PV Source	
Input Voltage, at mpp	*95 - 330 V DC
Max Amps Input	8.7 A DC, continuous
Power at mpp	1000 Watts Max

Performance of different pumpsets of Shakti Brand with our solar Drive

PERFORMANCE CHART

MODEL: QF-2 - V4

Motor	Pump OD 97 MM	M3/Hr	1.00	1.40	1.80	2.00	2.40	2.8
Rating	Del Size 1.25"	LPH	1000	1400	1800	2000	2400	2800
HP	Stage	LPM	17	23	30	33	40	47
0.50	6	Head (M)	32	29	25	23	16	11
0.50	9		48	44	38	34	24	17
0.75	14		75	68	59	53	37	26
1.00	19		101	93	80	72	51	36

PERFORMANCE CHART

MODEL: QF-5 - V4

Motor	Pump OD 97 MM	M3/Hr	1.40	1.80	2.40	3.00	4.00	4.40
Rating	Del Size 1.25"	LPH	1400	1800	2400	3000	4000	4400
HP	Stage	LPM	23	30	40	50	67	73
0.50	6	Head (M)	34	32	30	26	15	12
0.75	10		57	54	50	43	25	21
1.00	13		74	70	64	56	33	27

PERFORMANCE CHART

MODEL: QF-6 - V4

Motor	Pump OD 97 MM	M3/Hr	1.80	2.80	4.00	5.00	6.00	6.70
Rating	Del Size 1.50"	LPH	1800	2800	4000	5000	6000	6700
HP	Stage	LPM	30	47	67	83	100	112
0.50	4	Head (M)	23	21	19	16	12	8
0.75	6		35	32	29	24	18	12
1.00	8		46	42	38	32	24	16

Commercial Case and Viability

In our opinion, with mass production of the portosol devices, it will be possible to gradually bring down prices. The Portosol device will be a multipurpose solution for following applications.

1. Power for water pumping
2. Power for running aerators for fish farms
3. Power for running drier cum dehumidifiers for crops
4. Power for running a flour mill
5. Power for running DC Fan, DC LED lights, during day time

#	Portosol 500	Portosol 1000
1	2 x 240 W mono crystalline solar panels, 48 cell structure. PVF Frames, connected by interlocking hinges, with separate supporting Trolley-interlocking pipes, safely packaged inside Nylon bag.	4 x 240 W mono crystalline solar panels, 48 cell structure. PVF Frames, connected by interlocking hinges, with separate supporting Trolley-interlocking pipes, safely packaged inside Nylon bag.
2	0.55KW Slim-Drive with Fujitsu Heat-Pipe Technology modified for power electronics, micro-AC combiner box, plugs and cables.	0.75KW Slim-Drive with Fujitsu Heat-Pipe Technology modified for power electronics, micro-AC combiner box, plugs and cables.
3	Total Weight: 20kg	Total Weight: 44kg
4	Package dimension: 1340mm x 1000mm x 80mm	Package dimension: 1340mm x 1000mm x 140mm
5	Max Retail Price: US\$ 3490	Production cost US\$ 5790
6	Water Pumping Performance: Upto 10000 Liters per day from 100 feet head on a sunny day.	Water Pumping Performance: Upto 20000 Liters per day from 100 feet head on a sunny day
7	Marketing: US\$ 34 /- off for bringing a new farmer to try and buy Portasol 500. Maximum 100 farmers can be introduced by the buyer, thereby earning up to US\$ 3400/- from the introduction program. Enabling first buyers to get the system effectively free of charge.	Marketing: US\$ 57 /- for bringing new a farmer to try and buy Portasol 1000. Maximum 100 farmers can be introduced by the buyer, thereby earning up to US\$5700/- from the introduction program. Enabling first buyers to get the system effectively free of charge.
8	Can be implemented with creating Solar Entrepreneurs/ We will train free of charge 100 Technicians in 2 years to allow them to be available for on-site service, repairs and replacement of system parts. They will be directed by a dedicated customer service helpline to visit nearest farming site.	
9.	Pay-as-you-go and EMI options will be offered to farmers in association with funding partners to make it easy for them to go solar.	

Bigger versions shall be developed after implementation of smaller ones. Prices can be discounted for Bulk Installation.