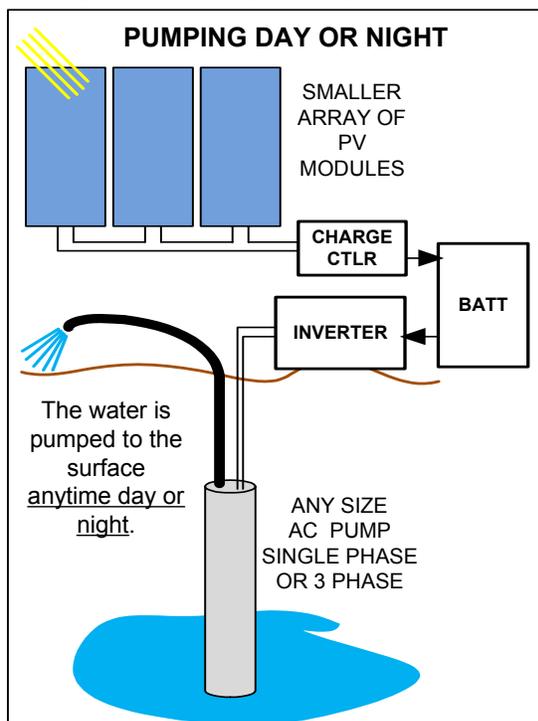


## Water Pumping with Solar Power

Of all the ways solar electricity benefits the people on Earth, none makes as much difference in the daily lives as pumping water. By providing water for irrigation, or potable water has obvious benefits for people in rural areas and especially for those in developing nations.

There are 3 different ways that water pumps can be connected to PV modules. The proper choice is determined by application specific factors like how much water is required and whether the water should be available at night or just during high sun hours. This paper provides a simplified overview of these 3 different systems for general education.

### DAY OR NIGHT PUMPING



This method uses a battery for energy storage for easy pump starting and so water can be pumped at any time.

This method has some significant advantages. Water can be pumped during the day or night, in any weather. This can be critical for such applications as diverting flood waters, or providing potable water during emergencies.

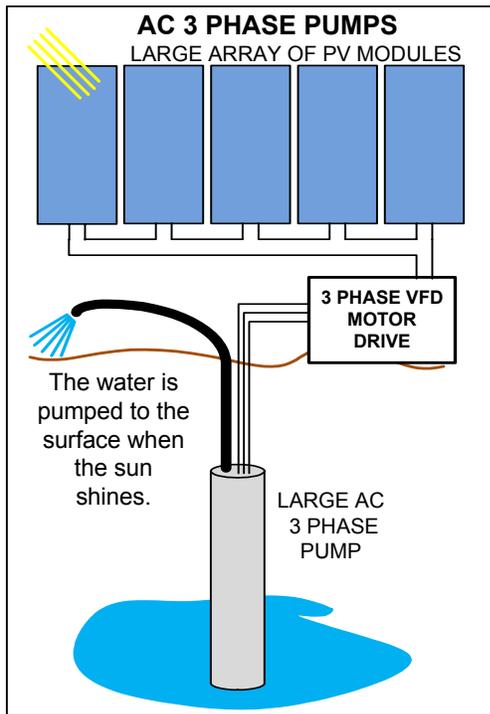
The battery adds some cost, but since the PV array does not have to be large enough to start the pump, the system cost can actually be lower. An MPPT solar charge controller optimizes the energy harvest from the array and the inverter converts the DC to solid AC power for almost any pump. The pumps can be any size and single phase or 3 phase.

Designing this system starts with selecting the pump to meet the water needs. The inverter and battery are sized to provide enough power to

drive the pump. The PV array must simply recharge the battery in the daytime.

Apollo Solar manufacturers systems that include the MPPT Charge Controller, the Inverter and all the circuit breakers and connection points to make installation fast and easy. These Pre-Wired Panel (PWP) systems are modular by design so they can be stacked up to provide from 3.2kW to 32kW of power for a variety of pump sizes. The fact that one size can provide the wide spectrum of needs means that the local distributor need only stock and support a single product.

## AC MOTOR DRIVE AND AC PUMPS

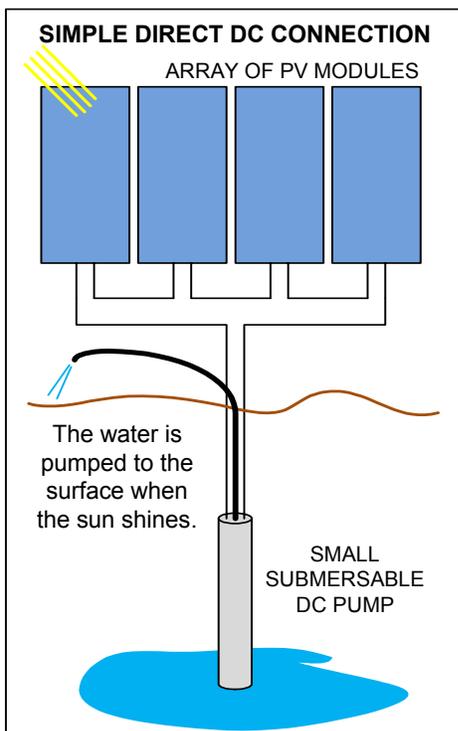


For high amounts of water, a large AC pump is usually required. These pumps require well regulated 3 phase AC voltage and current.

By using an AC variable speed controller called a Variable Frequency Drive (VFD), the pump motor will have the proper voltage and current. The trick is to supply DC from the PV array directly into the DC bus inside the VFD. The normal AC input is not used. As the sun rises and PV voltage and current increase, some VFD products will accept the input and when the power is high enough, it will start the pump. The PV array must be large enough to provide enough power to start the pump with including the head of water. The size of the PV array required for this method can be very expensive.

This method will only pump when there is plenty of sunshine, but large pumps can be driven by large PV arrays. Selecting the right pump and the VFD are critical factors then they will dictate the size of the PV array.

## DIRECT CONNECT



The most basic (and most elegant) system is a Direct Connection from the PV Array to the DC Pump. As long as there is good sunshine, the pump will work. The water is either used as it is pumped from the ground, or it is stored in a pond or tank that is higher than the eventual need for the water. When the sun goes down, or during dark days, the stored water is available for use because gravity will deliver it.

The limitation is that the direct connect pumps are rather small. And since the pump must work over a wide range of voltage and current, they can be expensive.

The direct connect plan is difficult to beat for rural areas or developing nations where keeping things simple is the key to long life and easy support.

Designing the system is a matter of selecting the proper pump which will provide the amount of water required. Then the pump specs will dictate how many PV modules are required.