Irrigation with solar systems

Giokas Aris
Tei of Patras
mechanical engineering department

How Does a Solar Water Pumping System Work?

Solar water pumps *are electrically powered using DC current that is generated directly from the solar panels themselves. The photovoltaic panels generate electricity from the sun's light.* ***Solar water pumps*** *are specifically designed to operate using the direct current (DC) supplied from the panel array throughout the day. Solar panel output will vary throughout the day based on the number of sunlight hours the panels receive each day.*

As mentioned above, solar panels generate energy in the form of direct current. DC current is considerably different than the conventional current supplied from the utility grid or a generator. The utility grid and generators supply electricity in the form of alternating current, otherwise referred to as AC current. Virtually all household appliances are powered via AC current. To use solar energy, the pumping system must utilize energy generated during the day to pump water. The window of opportunity for pumping water directly corresponds with sunlight hours received each day. If you needed to pump 500 gallons of water each day and live in an area that receives on average 6 sunlight hours each day, your water pumping system would be much different than another system that required 500 gallons per day but only received an average of 3 sunlight hours per day. The system only receiving 3 sunlight hours per day would need to accomplish the same task in ½ the time

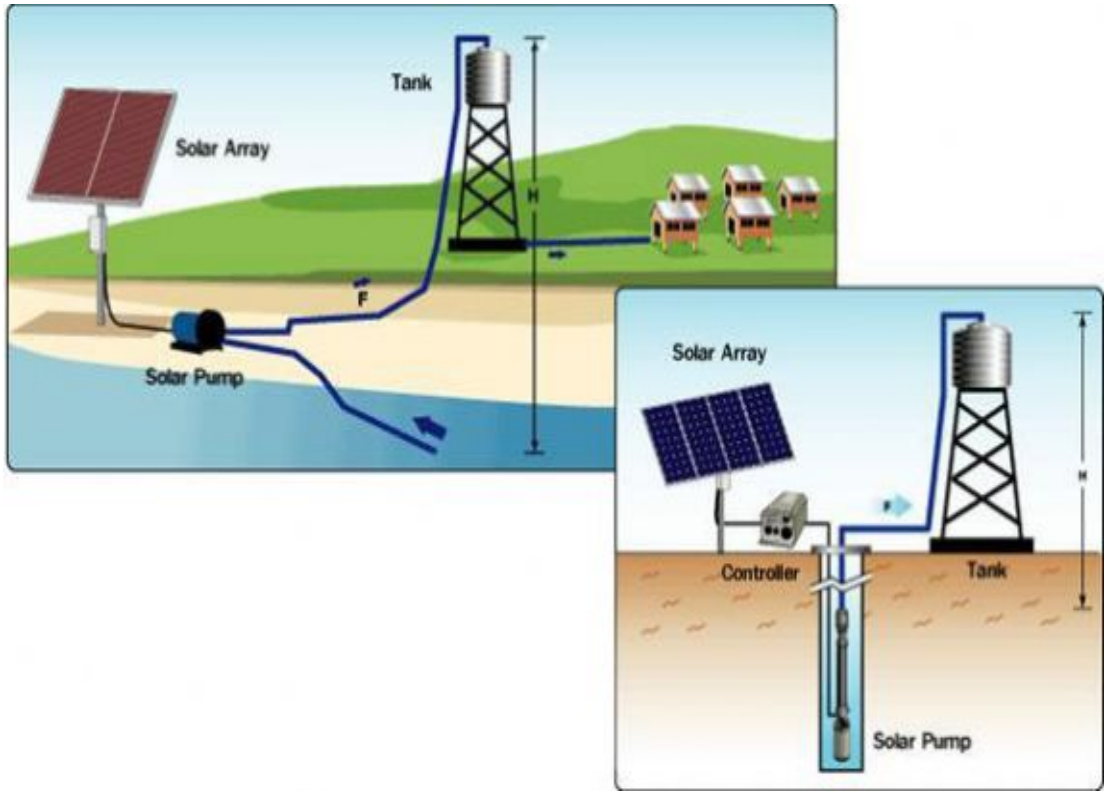
Common solar water pumping applications

Solar water pumps *are most often applied when utility power isn't readily available. In these type of situations solar power is much more affordable than the cost of running power lines and poles. When you take into consideration all the costs associated with running power lines, such as installation, fuel, and maintenance, using solar power for your remote water needs is by far the most economical choice. Solar power is also more affordable than using a generator. There is always the upfront cost of the generator itself, furthermore you will continue to incur out of pocket expenses for maintenance and fuel. Some of the most common applications for* ***solar water pumping systems*** *include, pressurizing small water systems in homes, RV's, and boats. Others include pulling water from a tank, spring, and cistern. Solar water pumps are also used to water livestock and wildlife, supply water to remote cabins and in crop irrigation.*

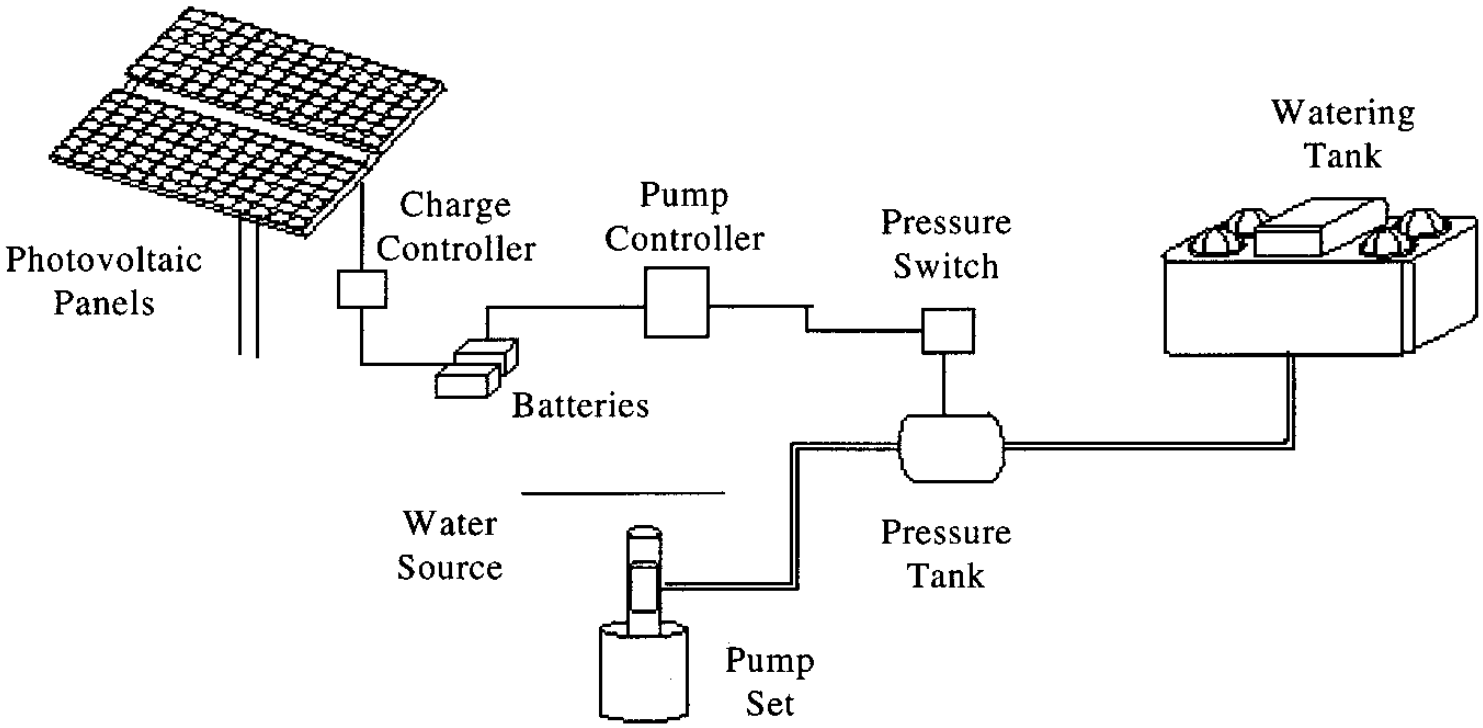
Components of irrigation system

The system comprises of :

- *Pv panels*
- *Solar (DC) Water Pumps*
- *Pump controllers*
- *Pressure switch*
- *Pressure tank*
- *Watering tank*



The case of battery-coupled solar pumping systems



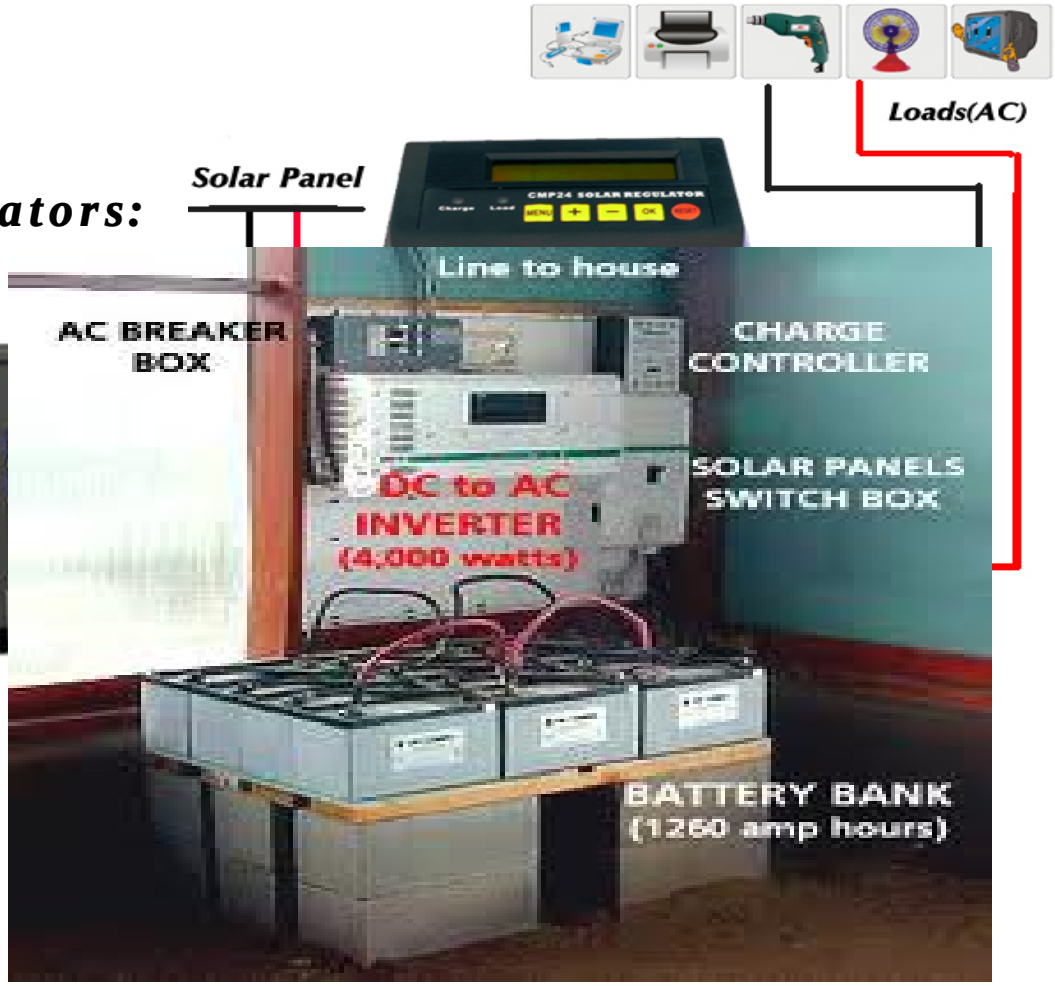
The case of battery-coupled solar pumping systems

Battery-coupled water pumping systems consist of photovoltaic (PV) panels, charge control regulator, batteries, pump controller, pressure switch and tank and DC water pump .The electric current produced by PV panels during daylight hours charges the batteries, and the batteries in turn supply power to the pump anytime water is needed. The use of batteries spreads the pumping over a longer period of time by providing a steady operating voltage to the DC motor of the pump. Thus, during the night and low light periods, the system can still deliver a constant source of water for livestock.

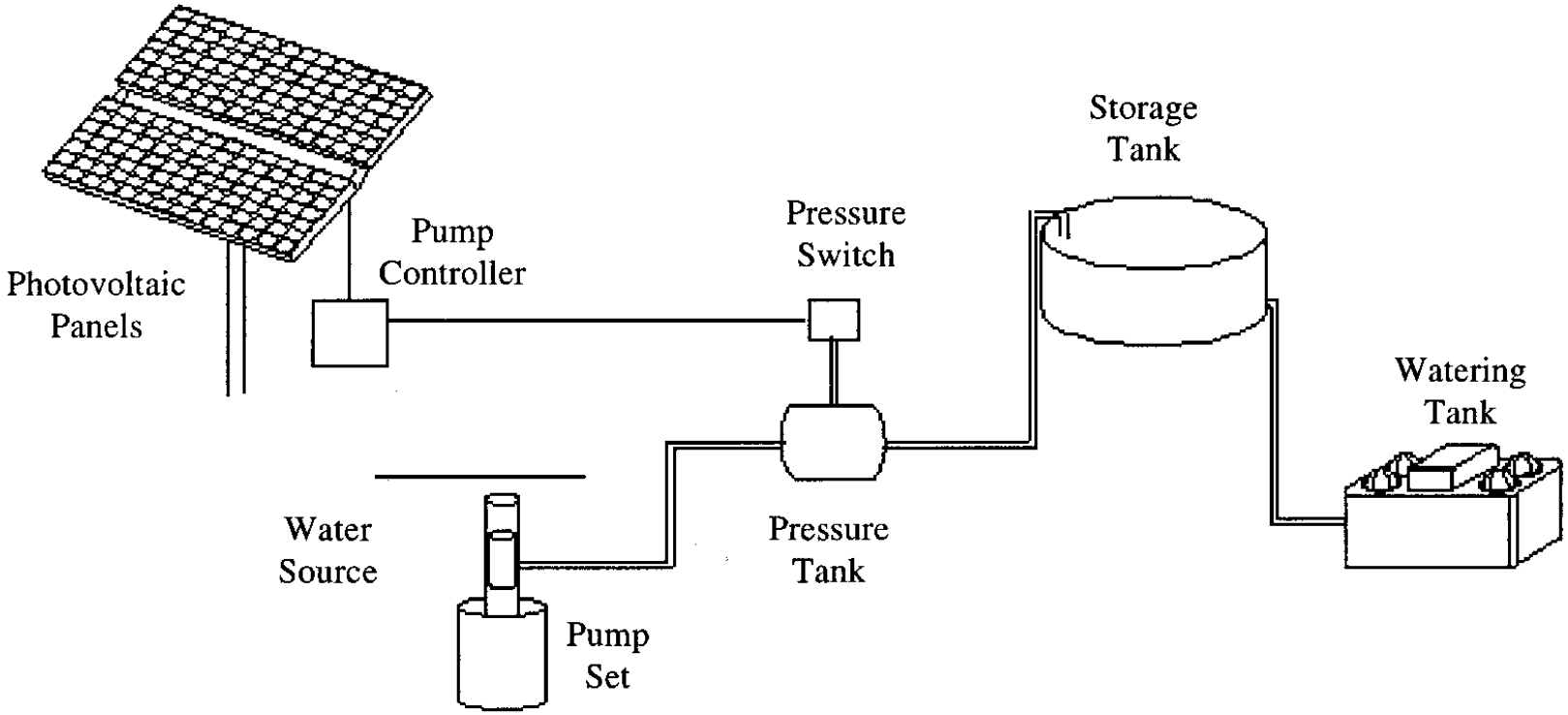
The use of batteries has its drawbacks. First, batteries can reduce the efficiency of the overall system because the operating voltage is dictated by the batteries and not the PV panels. Depending on their temperature and how well the batteries are charged, the voltage supplied by the batteries can be one to four volts lower than the voltage produced by the panels during maximum sunlight conditions. This reduced efficiency can be minimized with the use of an appropriate pump controller that boosts the battery voltage supplied to the pump.

System Components

- ***Pump Controller:***
- ***Charge Control Regulators:***
- ***Batteries:***



The case of Direct-Coupled Solar Pumping System



System Component

Power Controllers:

The efficiency of a direct-coupled water pumping system is sensitive to the match between the pump and the PV system. PV panels produce a fairly constant voltage as the light intensity changes throughout the day; however, amperage changes dramatically with light intensity. During low-light levels, such as early morning and late evening, the PV array may be producing 30 volts at 1 amp. The pump motor needs current to start; however, it can run on a lower voltage. A pump controller's circuitry trades voltage for current, which allows the pump to start and run at reduced output in weak-sunlight periods. Matching pump motor performance to the available sunlight with a properly sized controller can increase the amount of water pumped in a day by 10 to 15 percent.

What we need know to design a solar water pumping system

*Prior to designing any **water pumping system** we need to know a few standard things about the project in order to give you an accurate estimate for the cost of the system.*

We need to know, what the water will be used for, the dept of the well, your static water level, the horizontal distance from well head to water discharge, the vertical distance from the well head t water discharge, the inside diameter of the well and the amount of gallons required each day. As you can see there are several variables that must be considered prior to designing a solar water pumping system. SunTron Solar has the engineering support and field experience required to design water pumping solutions from small watering systems to highly specialized applications.

Livestock Water Requirements

The daily livestock water requirement is one of the key factors in the design of the solar water pumping system. Size of the herd, pregnancy, lactation, animal weight, type of feed, physical activity and time of year all have to be considered when determining the minimum volume of water the solar pumping system must supply each day. The daily water intake by various types of beef cattle for each month of the year, gives a good estimate of the daily water needs that must be met by the solar pumping system. For example, an average cow/calf operation in Tennessee may need to water 30 cows and one bull year round. If the cows have nursing calves from February through June and the calves are sold in October for finishing, the pumping system must be designed to supply a maximum of roughly 740 gallons per day during July, the

hottest month of the year

Sizing the System

Many reputable solar equipment dealers provide technical assistance free of charge. The dealer will combine the information you provide about your water requirements and livestock operation with the information on solar energy available in your area, and help you select the solar pumping system that best fits your livestock watering needs and budget. The type of information you will need to supply to the vendor to have your system designed or to solicit a price quote includes:

- *• The maximum number of gallons of water needed daily for each month of the year.*
- *• Description of water source.*
- *• Total vertical distance that water is to be pumped, as measured from the lowest level from the*
- *water source to the highest level of the watering tank, including the pipe outlet.*
- *• Quality of water. Is it clear, silty, high in mineral content or does it contain a lot of algae*
- *growth?*
- *• Solar access: Is unobstructed sunlight available near the water source? If not, how far away?*
- *• Information on any water-pumping equipment, distribution system and storage capacity*
- *presently being used.*
- *• A sketch of how you want to lay out your watering system. Include the distances from the*
- *solar panels to the pump and from the pump to the watering tank(s).*

Installing the System

Mounting PV Panels

The PV panels should be mounted facing due south in a location where they receive maximum sunlight throughout the year. For installations where the solar panels are permanently mounted, they should be tilted for maximum winter output. As a rule, if the power output is sufficient in the winter, it will be totally satisfactory during the rest of the year. Locating the PV modules close to the water source is important to keep voltage loss in the system wiring to a minimum. A fence around the PV modules is required to protect the PV panels from damage due to animals. After installation, the area inside the fence must be maintained. Shading from weeds or a single tree branch can limit power output.

Installing the System

Wiring

Selecting the correct size and type of wire when connecting the pump to the batteries or solar panels increases the performance and reliability of the system. If possible, keep the PV panel and pump sets within 100 feet of each other. The use of direct-burial wire (UF) simplifies installation, since the wire can be buried under the water pipe in the same trench without conduit. Make all connections in water-tight junction boxes and attach all wires to support structures with wire ties. Use PVC conduit to protect the wires anytime they are above ground. Solar water pumping systems attract lightning because of the excellent ground they provide. If possible, do not locate the pump system, which includes the PV array, wiring and pump, on high ground. Ground the PV panel frame and all equipment boxes to metal well casings or to a driven ground rod. You might have to install lightning rods on higher terrain around the pump if lightning is a problem.

Installing the System

- ***Water Delivery System***

The pump can be operated using either a standard pressure switch and recharged pressure tank commonly used with home well pumps or an electronic float switch. The recharged pressure tank prevents the continuous on/off cycling of the pump when cattle drink from a nearly full watering tank. When the float valve closes in a recharged pressure tank system, the pump continues to run until the pressure tank is charged with water at the preset off-pressure. As the level in a near-full tank fluctuates when animals are drinking and the float valve opens and closes, water is supplied from the charged pressure tank and the pump does not cycle. When animals drink enough to lower the water level and the float valve remains open, the pressure tank water charge is exhausted and the pressure switch then turns on the pump. A check valve placed in line upstream from the pressure switch location prevents the water line from draining when the pump is not operating. Electronic float switches can be used to turn the pump on and off when the livestock watering and/or storage tank is low or full. Control wires from the livestock watering tank and/or storage to the pump controller must be run to make the system operate.

Maintenance

Most failures of solar pumping systems are caused by pump problems. Sand and silt pulled in by the pump are the primary cause of failure. Filtering out silt or sand at the pump intake with fine mesh screen will prolong the life of the pump. The amount of maintenance required by solar pumping systems depends on the type and complexity of the system. PV panels generally require very little maintenance; however, pumps, batteries and other components require periodic routine maintenance. Solar pumping systems failures can be avoided with the following preventative maintenance:

• Check the tightness of all electrical connections in the system. Battery connections should be cleaned and treated with a corrosion inhibitor available from any auto parts store.

• Follow the manufacturer's recommended maintenance procedures for all batteries. Check the electrolyte level and specific gravity of each cell in the battery. Do not overfill batteries.

• Check system wiring. Look for cracks in the insulation of exposed wires. Inspect wires entering and exiting junction boxes for cracks or breaks in the insulation. Replace as necessary.

• Check all junction boxes for water damage or corrosion. Check the tightness of the terminal screws and the general condition of the wiring. After inspection, make sure covers on junction

- *boxes are closed and sealed. • Inspect the array-mounting frame to be sure that all mounting hardware is tight. Loose bolts*
- *could result in a damaged panel. Maintain any tie-down anchors. Remove any weeds, tree*
- *branches or any other objects that may be shading the PV panel.*
- *• Check to see if the panel glass is clean. If it is dirty, simply clean it with a soft cloth, mild*
- *detergent and water. Rinse with clean water to prevent the detergent from forming a film on*
- *the panel.*
- *• Check the operation of switches. Make sure the switch movement is solid. Look for corrosion*
- *or charring around contacts. Check fuses with ohmmeter after removing; look for*
- *discoloration at their ends.*

Cost of the system

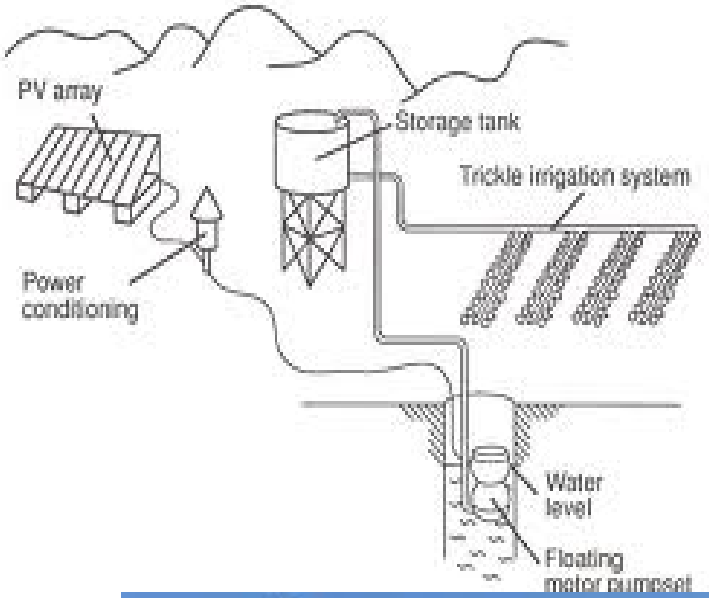
Cost is a factor that must be considered when selecting a solar pumping system. Total cost depends on many factors, such as the type of system (direct-coupled or battery-coupled), daily water requirements, pressure the pump must work against to supply the required water flow, complexity of the water delivery system, etc. For example, low-volume solar pumping systems keep costs down, when compared to higher output solar pumping systems, by using a minimum number of solar panels and by using the entire daylight period to charge batteries or pump water.

Typical example for system cost

Item	Cost($)
Solar pumping system	
24-volt submersible pump	500
2, 51-watt PV panels	525
Mounting bracket	150
Pump controller	150
Charge controller	35
2 deep-cycle batteries	125
100 ft., #12 UF wire	20
Watertight enclosure for batteries, system circuitry and pressure tank	100

Water Lines	
300 ft., 1-in PVC pipe 60	60
Fittings/glue	35
Check valve	15
Trenching	75
Pressure tank and switch	125
Watering Tank	
Freeze proof stock tank	500
Concrete	30
Geotextile fabric	65
Crushed stone	200
Site preparation	150
Total	**$2860**

Typical photos



Thank you for your attention!!