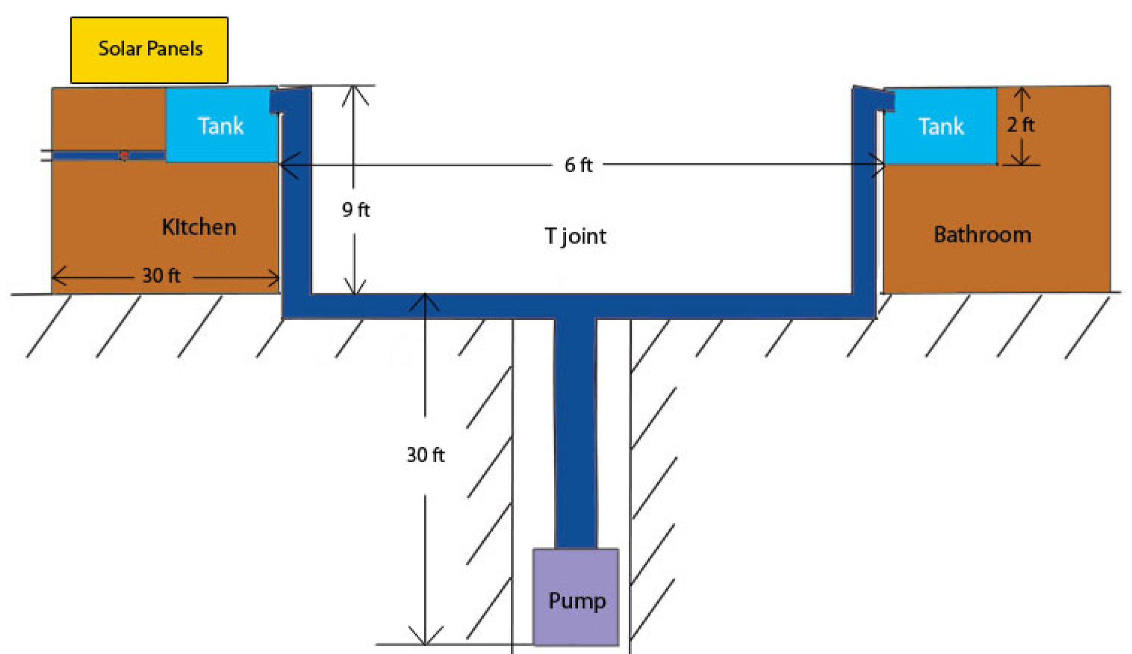
IPRO 323

Low-Cost Sustainable Water Pump Design to Serve Rural Villages

Solar Powered Pump Prototype

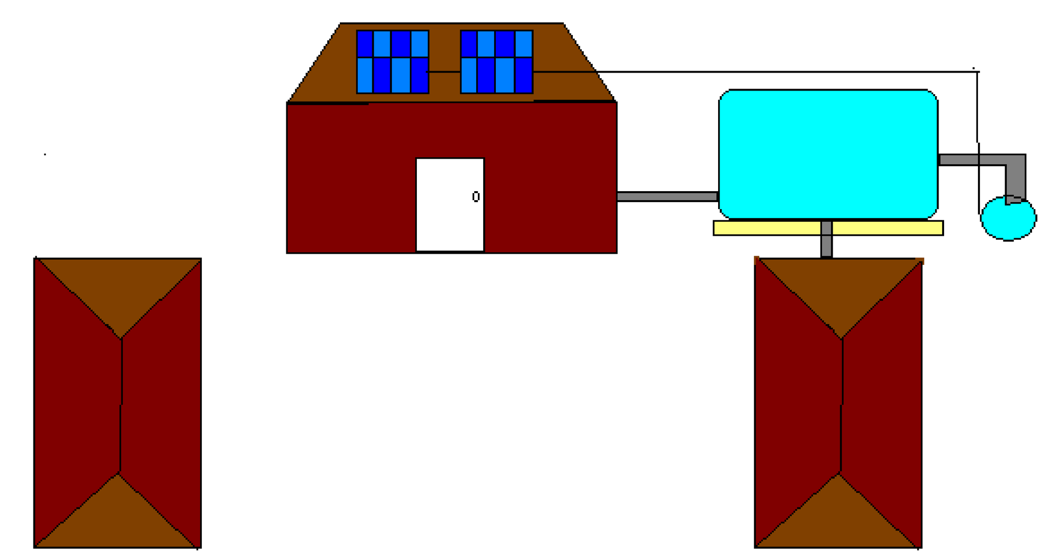
The test pump used with the DC inverter was then tested with a solar panel. The setup shown above has the solar panel connected to the pump which is submersed in the garbage can full of water. The water in pumped up through the PVC pipe to the cup at the top and returns to the garbage can via the clear tubing. This system allowed for continuous testing without fear of burning the pump out if the water supply ran dry.

Final Kankakee Design



Our final design for the test site in Kankakee incorporates one solar powered pump that splits into two branches. The water flows up through the pipes into each cabin where there are storage tanks in the lofts. This design maintains the simplicity desired for developing nations, but also allows for water to accessed indoors. Since the water is stored in the loft, gravity is used to supply water to the faucets and showers. This design was then slightly modified and split into two phases to be implemented in Kankakee.

Kankakee Farm Phase 1



Phase one of the Kankakee implementation will focus on the pumping system, while not incorporating distribution. A well will be dug, and Solar panels will be installed on the roof, which will power the pump inside the well. Water will be pumped into a storage tank which will be at ground level on top of a concrete slab. The performance of the system can then be analyzed and any necessary changes can be made. During this phase, water must be obtained from a faucet on the storage tank outside.

Cost Benefit Analysis

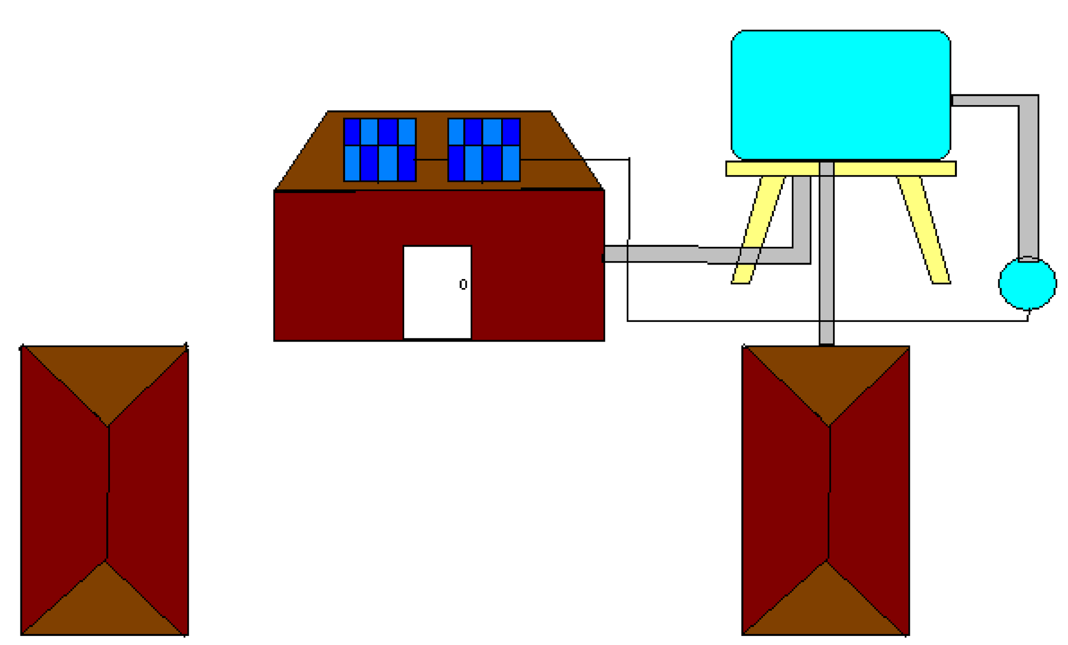
The proposed cost of the Kankakee system is $9,972. Based on a 10 year period, laying 20 miles of piping to reach the utility water supply, and the assumption that 1000 gallons of water in Chicago is $2, the Net Present Value comes out to about $1,800,000. This analysis concludes that our design will have a payback period of 0.0311 years. It should be noted that this is similar to other design options, however it is sustainable and low maintenance making it the best financial option.

Moreover, in rural areas of developing countries where water is not as plentiful, the cost of this system is far less than the cost of importing water over a 10 year period. The initial investment by the community is higher, but the savings over time will offset the initial expense. In addition, having water available also allows local agriculture to thrive which lowers food costs and brings income to the community.

Pump Performance with Solar Panels in Chicago

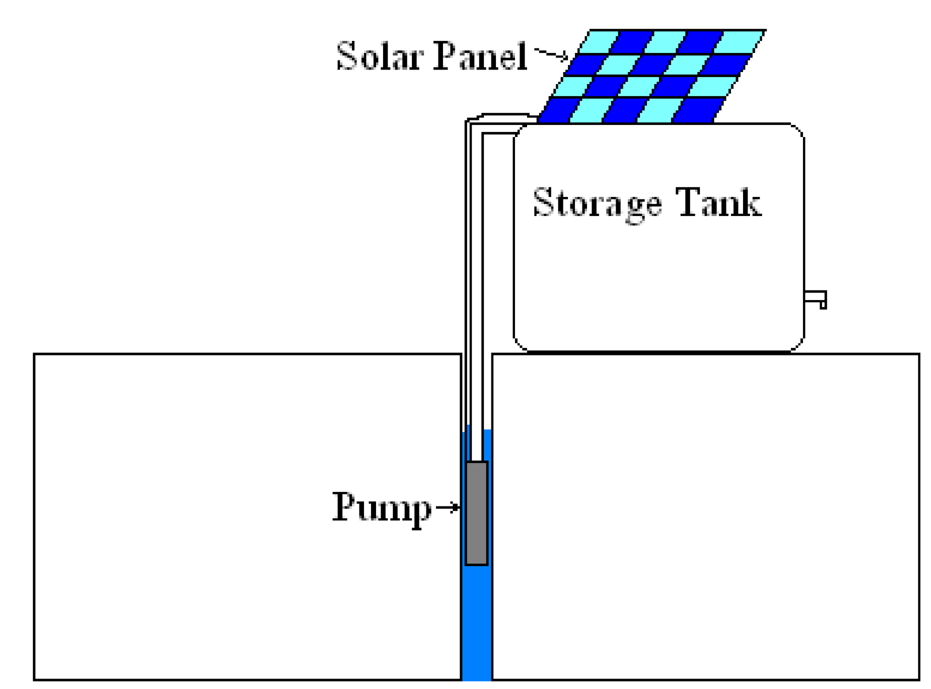
When the Voltage and Current supplied by the panel produced at least 40W of power, the pump flow rate ranged from 6 to 7.5 GPM, which exceeded expectations. On cloudy days, when the power was less than 30W, the pump did not run. We were unable to obtain data between 30 and 40W. It is unclear at what point the pump begins to work, however this behavior is typical. The DC pump will only turn on when there is sufficient power to avoid damage due to under powering. When the pump did turn on, we more than doubled our goal of 3 GPM, finding that we often exceeded even the rated performance of the pump. This could also be due to the fact that the solar panel was selected at the maximum rating given for the DC pump. We concluded that, due to the greater levels of solar energy in Monterrey that components may be selected based on manufacturers ratings.

Kankakee Farm Phase 2



Phase two of the Kankakee project will focus on the distribution of water, though modified from the original design. The water storage tank will be raised onto a platform to be built higher than the lofts inside the cabins. Gravity and piping will then be used to carry water from the main tank to the kitchen and bathrooms. This will provide greater water pressure than the original design, and the weight of the water will not be placed on the cabins structure. However, this construction requires permits that must be obtained before phase two is started.

Proposed Solution for Developing Nations



The proposed solution for developing countries is similar to phase one of the Kankakee implementation, except that the solar panel will be secured to the top of the storage tank instead of a roof. Since communities are spread out in rural areas, distribution is not considered to be cost effective. The required length of piping requires the pump size to be increased, which in turn increases all other component costs. The system should be placed in an area equally accessible to all members of the community and water will be accessed via a faucet on the storage tank.

Calculating the Water, Pump, and Energy Requirements

1. Determine the best local source of potable water. (Ground water, fresh water lake, etc.)
2. Determine the water needs of the community. (Typically 100L per person per day)
3. How much sunlight do you get? Find out the amount of sun energy available based on your latitude and the number of hours of sunlight per day.
4. Select a DC water pump that provides the required flow rate under the conditions provided above.
5. Select solar panels that will provide the power necessary to operate the pump.
6. Determine the method of water storage and distribution.