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Solar Pumping

With the increasing cost of energy from the grid, the option of using renewable energy for pumping is becoming more attractive. Renewable energy driven systems have been installed for applications as varied as household pressure pumps to large cotton farms (with diesel backup). Careful analysis of system requirements must be made to ensure energy generation capabilities of the system are sufficient, and that the installation is cost effective. Renewable energy driven systems incur higher capital expenditure, but can provide savings in the long term from reduced energy and maintenance costs.

As with all irrigation system design, the first step in installing a solar powered pumping system is determining the system duty (pressure and flow rate) required. Once the system duty is known, an appropriate solar generating package can be designed to meet the pumping requirements. Off the shelf systems come as a complete package, but it is important to know what system duty is required before considering these. Even if the pump is only used to fill a tank, the flow and pressure requirement must be met by the pumping system. Solar powered pumping systems lend themselves well to situations where flow rate isn't critical, as long as total daily flow meets the overall requirements e.g. filling tanks. Water storage is generally more economical than energy storage in batteries. If applicable to the application, a storage tank should be sized to supply a minimum of 5-10 days water supply, depending on climate and application.

Some of the considerations to be taken into account in the decision to use solar pumping are:

- *How much it would cost to have grid power installed.*
- *Lifetime costs of a grid versus solar powered system.*
- *Solar pumping systems can operate on a wide range of voltages 30-300 volts or 90-240 volts, making them ideal for filling tanks where flow rate and pressure aren't critical.*
- *Submersible pumps can be mounted on floating platforms to pump from surface water supplies.*
- *Direct pumping only occurs during daylight hours, and this must be factored into the calculations, and/or a backup energy system installed for out of hours pumping.*
- *Batteries reduce the efficiency of the overall system, with the solar modules operating voltage being dictated by the battery bank. Overall efficiency is reduced substantially from levels which are achieved by operating the pump directly. Batteries also require additional maintenance and under and over-charge protection circuitry, adding to the cost and complexity of the system.*

System Components

- *Pump*
- *Solar panels*
- *Pump controller - Low level probe, float/remote switch terminals, overload and high temperature indicators*
- *Charge controller*
- *Backup – battery or generator*
- *Remote management (optional)*
- *Level switches (if required)*
- *Dry running protection*
- *Solar tracker option*

A solar tracker automatically aims the solar array at the sun. In clear weather, tracking can increase the daily water volume pumped by about 40% in summer and 15% in winter. Fixed mount structures are less expensive and tolerate higher

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wind loading, but less water is pumped than a tracking system, which orients the modules towards the sun as it arcs across the sky. Tracking mount structures keep the modules at a 90-degree angle to the sun all day long. This provides more power to the pump over a longer period of the day, which produces 20 to 40 percent more water daily in the summertime. However, the additional pumping capacity needs to be balanced against the higher capital cost of these systems. Single axis trackers take very little power from the system as they operate (4 watts). The heavy duty actuator is operated by some simple electronics that measure the length of the previous day by the time that the panels are producing voltage. This time span is then split into 6 equal periods and the array is moved from east to west in 15 degree intervals. At night the array is moved to the horizontal position to minimize wind loading.

Single and multistage centrifugal pumps and positive displacement e.g. helical rotor, can be used on pumping systems, with each being suitable for different applications. Helical rotor pumps are particularly suited to filling tanks, as they continue to pump water at very low speeds.

When comparing systems consider the following:

- *Is the pump controller included, or does it have to be installed separately?*
- *Some systems are direct drive, or can run off 12 or 24 volt batteries, or 230 volt AC (generator or grid).*
- *Overload protection.*
- *Floating pumps may require special pontoons and protection from rain.*
- *Battery high run function, which only pumps when charging current from the solar array is available. Cycling of the battery is reduced and battery life increased.*
- *Motor control and monitoring systems.*
- *Integrated Maximum Power Point Tracking (MPPT) to maximise power extraction under all conditions.*
- *Low Voltage Disconnect (LVD) to provide battery protection for 12 and 24 volt batteries.*
- *Check and display of the operating states.*
- *Control inputs for float switches, pressure switches and remote control, etc.*
- *Motor and controller efficiency.*
- *Adjustable maximum RPM setting.*

It's possible for solar powered systems to be used on all sizes of pumps, providing sufficient generating capacity can be installed. Battery or generator backup can give the reliability to the system that is required to allow it to meet all water requirements.

Financial incentives such as small-scale technology certificates (STCs) are available, that may help to reduce the cost of installation.

System Performance

For off the shelf systems, performance charts can be used to give an indication of the volumes of water that can be pumped, to assist in sizing both pump and solar arrays. Decline in performance also needs to be factored into account for inherent losses in the power generating system caused by heat, dust on the solar array, and decline in array efficiency over time – add at least 25% to account for these.

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