Why Solar Water Pumping?

A Practical Introduction

If you need to supply water beyond the reach of power lines, then solar power can solve the problem. Photovoltaic powered pumps provide a welcome alternative to fuel-burning engines, windmills, and hand pumps. Thousands of solar pumps are working throughout the world. They produce best during sunny weather, when the need for water is greatest.

How It Works

Photovoltaic (PV) panels produce electricity from sunlight using silicon cells, with no moving parts. They have been mass-produced since 1979. They are so reliable that most manufacturers give a 10-year warranty, and a life expectancy beyond 20 years. They work well in cold or hot weather.

Solar water pumps are specially designed to utilize DC electric power from photovoltaic panels. They must work during low light conditions at reduced power, without stalling or overheating. Low volume pumps use positive displacement (volumetric) mechanisms which seal water in cavities and force it upward. Lift capacity is maintained even while pumping slowly. These mechanisms include diaphragm, vane and piston pumps. These differ from a conventional centrifugal pump that needs to spin fast to work efficiently. Centrifugal pumps are used where higher volumes are required.

A surface pump is one that is mounted at ground level. A submersible pump is one that is lowered into the water. Most deep wells use submersible pumps.

A pump controller (current booster) is an electronic device used with most solar pumps. It acts like an automatic transmission, helping the pump to start and not to stall in weak sunlight.

A solar tracker may be used to tilt the PV array as the sun moves across the sky. This increases daily energy gain by as much as 55%. With more hours of peak sun, a smaller pump and power system may be used, thus reducing overall cost. Tracking works best in clear sunny weather. It is less effective in cloudy climates and on short winter days.

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Storage is important. Three to ten days' storage may be required, depending on climate and water usage. Most systems use water storage rather than batteries, for simplicity and economy. A float switch can turn the pump off when the water tank fills, to prevent overflow.

Compared with windmills, solar pumps are less expensive, and much easier to install and maintain. They provide a more consistent supply of water. They can be installed in valleys and wooded areas where wind exposure is poor. A PV array may be placed some distance away from the pump itself, even several hundred feet (100 m) away.

What is it used for

Livestock Watering: Cattle ranchers in the Americas, Australia and Southern Africa are enthusiastic solar pump users. Their water sources are scattered over vast rangeland where power lines are few, and costs of transport and maintenance are high. Some ranchers use solar pumps to distribute water through several miles (over 5 km) of pipelines. Others use portable systems, moving them from one water source to another.

Irrigation: Solar pumps are used on small farms, orchards, vineyards and gardens. It is most economical to pump PV array-direct (without battery), store water in a tank, and distribute it by gravity flow. Where pressurizing is required, storage batteries stabilize the voltage for consistent flow and distribution, and may eliminate the need for a storage tank.

Domestic Water: Solar pumps are used for private homes, villages, medical clinics, etc. A water pump can be powered by its own PV array, or by a main system that powers lights and appliances. An elevated storage tank may be used, or a second pump called a booster pump can provide water pressure. Or, the main battery system can provide storage instead of a tank. Rain catchment can supplement solar pumping when sunshine is scarce. To design a system, it helps to view the whole picture and consider all the resources.

Thinking Small

There are no limits to how large solar pumps can be built. But, they tend to be most competitive in small installations where combustion engines are least economical. The smallest solar pumps require less than 150 watts, and can lift water from depths exceeding 200 Feet (65 m) at 1.5 gallons (5.7 liters) per minute. You may be surprised by the performance of such a small system. In a 10-hour sunny day it can lift 900 gallons (3400 liters). That's enough to supply several families, or 30 head of cattle, or 40 fruit trees!

Slow solar pumping lets us utilize low-yield water sources. It also reduces the cost of long pipelines, since small-

sized pipe may be used. The length of piping has little bearing on the energy required to pump, so water can be pushed over great distances as low cost. Small solar pumps may be installed without heavy equipment or special skills.

The most effective way to minimize the cost of solar pumping is to minimize water demand through conservation. Drip irrigation, for example, may reduce consumption to less than half that of traditional methods. In homes, low water toilets can reduce total domestic use by half. Water efficiency is a primary consideration in solar pumping economics.

A Careful Design Approach

When a generator or utility mains are present, we use a relatively large pump and turn it on only as needed. With solar pumping, we don't have this luxury. Photovoltaic panels are expensive, so we must size our systems carefully. It is like fitting a suit of clothes; you need all the measurements.