Solar-powered Livestock Watering Systems

Remote or off-grid pumping (including solar, windmill, and generator-power) provides cost-effective livestock watering sources far from the utility grid. These systems give livestock greater access to forage. They also reduce livestock pressure on stream banks, preventing nutrient loading, damage to streamside vegetation, erosion and pollution.

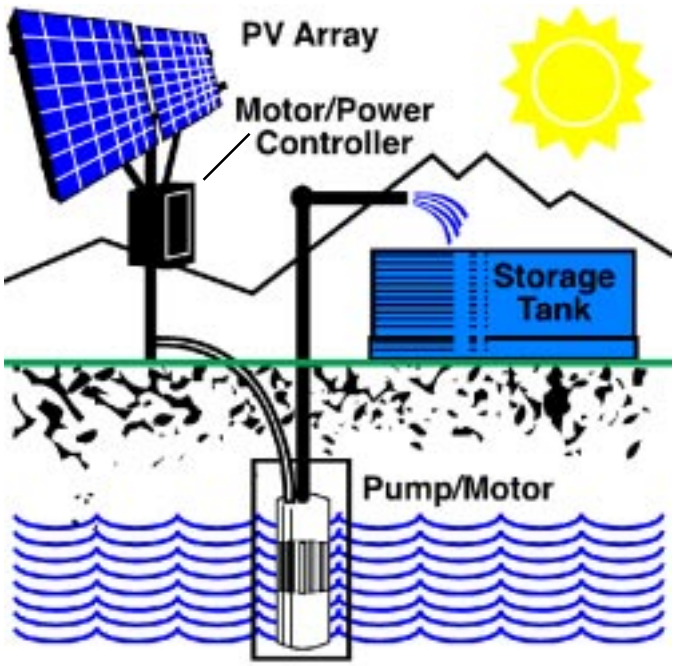
Why should you consider installing a solar-powered livestock watering system on your farm or ranch? These factors may affect your decision:

- Utility line extension costs versus solar power
- Maintenance costs of a solar system versus a windmill or gasoline, propane, or diesel generator
- The uncertainty of future electricity prices
- Rising costs of propane, gasoline, and diesel fuel
- Season of use — summer versus winter

Cost

Many people considering installing a solar water pumping system are put off by the expense. Viewing the expense over a period of 10 years, however, gives a better idea of the actual cost. By comparing installation costs (including labor), fuel costs, and maintenance costs over 10 years, you may find that solar is an economical choice. A solar-powered pumping system is generally in the same price range as a new windmill but tends to be more reliable and require less maintenance. A solar-powered pumping system generally costs more initially than a gas, diesel, or propane-powered generator but again requires far less maintenance and labor. NCAT estimated likely costs for six demonstration projects over a 10-year period. The cost of solar-pumped water per cow ranged from $0.03 to $0.15 per day. The cost per gallon of water pumped ranged from $0.002 to $0.007 per gallon.

Twenty-four solar panels on the Sauerbier Ranch power a system that pushes water uphill to a storage tank over two miles away.



A typical solar-powered stock watering system includes a solar array, pump, storage tank and controller.

Solar Pumping Technology — What You Need to Know

Before talking to a dealer, it's helpful to become acquainted with the terms and equipment:

Solar Modules - Solar electric systems are sometimes called *photovoltaic* systems. The word "photovoltaic" is often abbreviated "PV." Most solar panels, or *modules*, generate direct current (DC) electricity. A group of modules is called an *array*.

Mounting Structures - There are two ways to mount solar modules: either on a fixed structure or on a tracking structure. Fixed mounts are less expensive and tolerate

higher wind loading but have to be carefully oriented so they face true south (not magnetic south). An array can easily be mounted on a trailer to make it portable. A tracking array follows the sun across the sky. A tracker will add at least $400 to $800 to the cost of a system, but can increase water volume by 25 percent or more in the summertime, compared to a fixed array.

Pumps - DC water pumps in general use one-third to one-half the energy of conventional AC (alternating current) pumps. DC pumps are classed as either *displacement* or *centrifugal*, and can be either *submersible* or *surface* types.

Displacement pumps use diaphragms, vanes or pistons to seal water in a chamber and force it through a discharge outlet. Centrifugal pumps use a spinning impeller that adds energy to the water and pushes into the system, similar to a water wheel. Submersible pumps, placed down a well or sump, are highly reliable because they are not exposed to freezing temperatures, do not need special protection from the elements, and do not require priming. Surface pumps, located at or near the water surface, are used primarily for moving water through a pipeline. Some surface pumps can develop high heads and are suitable for moving water long distances or to high elevations.

Storage - Batteries are usually not recommended for solar-powered livestock watering systems because they reduce the overall efficiency of the system and add to the maintenance and cost. Instead of storing electricity in batteries, it's generally simpler and more economical to install three to 10 days' worth of water storage.

A tracking PV array replaced an old and unreliable windmill on the Ballard Ranch near Lavina.

Controller or Inverter

The *pump controller* protects the pump from high- or low-voltage conditions and maximizes the amount of water pumped in less than ideal light conditions. An AC pump requires an *inverter*—an electronic component that converts DC electricity from the solar panels into AC electricity to operate the pump.

Solar pumping replaced a gas-powered generator on the Tomlinson Ranch near Gold Creek.

Other equipment - A *float switch* turns a pump on and off when filling the stock tank. It's similar to the float in a toilet tank but is wired to the pump controller. *Low water cut-off electrodes* protect the pump from low water conditions in the well.

Designing and Installing Systems

Every pumping and stock-watering situation is unique. The average consumer is likely to be intimidated by the prospect of sizing and designing a solar pumping system, and most people need the assistance of a qualified solar dealer. In general dealers are eager to help. Many will provide a no-cost proposal based on a few simple questions that can be asked over the phone. If the price seems too high, you can easily get bids from other dealers.

In order to size and design a system correctly, the dealer will want to know:

- how much water you need
- when you need the water
- whether your water source is a stream, pond, spring, or well
- water available in gallons per minute (gpm)
- well depth
- how far the water needs to be pumped, and with what elevation gain
- water quality problems (e.g., silt or high mineral content) that may damage the pump
- how much volume is available in storage tanks and how the tanks are arranged

This solar pumping system on the Hirsch Ranch near Deer Lodge is protecting stream banks along Racetrack Creek, an important trout spawning stream.

Based on these factors, the dealer will recommend a system, putting together a list of suitable components. This is one area where the dealer's experience and familiarity with systems is essential. A dealer can also save you time and aggravation by providing the correct hardware: clips, screws, nuts, bolts, washers, cable (cut to correct lengths), and assorted wiring and connectors. The customer usually provides peripheral material, such as water piping and fittings, tanks, mounting structure support post, concrete, and grounding materials.

Installing a solar pumping system is generally something the landowner can do. A few words of caution are necessary, however. Installing a solar pump is a complex task, combining elements of electrical work, plumbing, and heavy construction (often including earthmoving, pouring concrete, and welding). Written instructions are not always as complete as they should be. A backhoe or tractor with a front-end loader is almost a necessity for some larger projects.

Project Descriptions

Tomlinson Ranch, Gold Creek

Jim Tomlinson installed a solar-powered pumping system on his 160-foot deep well to provide water for 25 cow/calf pairs. The system uses two 120-Watt PV modules, a passive tracking rack, and a submersible diaphragm pump with a maximum flow rate of just under one gpm. Water is pumped to a 1350-gallon underground cistern and flows by gravity into two 700-gallon stock tanks, with a float valve ensuring that the flow stops once the tanks are full. The system produces between 750 and 950 gallons per day (gpd) during the summer months. Solar component costs: $3,200.

Ballard Ranch, Lavina

Jim and Adele Ballard installed a solar pumping system to replace an old windmill that pumped water from a 65 foot deep well to a pair of stock tanks holding about 4000 gallons. The new system employs four 80-Watt PV modules on a tracking rack and a submersible piston pump with a maximum flow rate of 5.5 gpm to water 100 cow/calf pairs. The system produces average flows of 2000 to 3000 gpd during the summer months. Solar component costs: $5,500.

Ueland Ranch, Anaconda

Don and Dan Ueland drilled a 50-foot deep well near the stack yard of their ranch to water cows that are moved into the feeding area after spring calving. Twelve 64-Watt PV modules on a tracking rack and a submersible centrifugal pump produce a maximum flow rate of 17 gpm. The pump is set at 43 feet in the well and connected to low water cutoff electrodes that will shut the pump down if the pumping rate exceeds the well capacity. The water is pumped into a concrete tank with an overflow drain that leads to a drainfield. The system is designed to produce flows from 7800 gpd in March to 10,500 gpd in May. Solar component costs: $7,700.

Hirsch Ranch, Racetrack

Rick and Pam Hirsch installed a solar pumping system on a 10-foot-deep backhoe-dug well on their property to water 36 cow/calf pairs. The pumping system uses two 64-Watt PV modules, a passive tracking rack, and a submersible diaphragm pump equipped with a sand shroud and low water cut-off electrodes to protect the pump. The system is designed to produce flows of 2600 to 2800 gpd during the summer months. Solar component costs: $2,400.

Painted Robe Watershed Group, Lavina

The Painted Robe Watershed Group has been working to develop off-stream sources of drinking water for cattle along Painted Robe Creek, a tributary to the Musselshell

A trailer-mounted PV system is improving range management and water quality along Painted Robe Creek near Lavina.

Solar pumping systems aren't just for summer use, as this project on Ueland Ranch near Anaconda demonstrates.

River with water quality problems. The group received a trailer-mounted solar pumping system from the Montana Department of Environmental Quality. It was first installed on the Leo Schraudner Ranch to water 150 cattle at the site of a 60-foot-deep well. Seven 60-Watt panels on a fixed trailer-mounted rack use an inverter to convert solar-produced DC to the AC electricity needed by the submersible centrifugal pump. Water is pumped into two 1100-gallon tanks. The system is designed to produce average flows of 2880 to 4000 gpd during the summer months. Solar component costs: $10,650.

Sauerbier Ranch, Sweetwater Basin

(between Sheridan and Dillon)

Dan Doornbos installed an ambitious solar pumping system to water about 300 cow/calf pairs on a remote pasture in the Sweetwater Basin. The Natural Resources Conservation Service engineered 12,000 feet of pipeline to pump water from Sweetwater Creek up to an 8000-gallon water storage tank at a high point in the northeast corner of the pasture. A valve on the tank allows firefighters to fill tanker trucks. Other smaller watering tanks are located at lower elevations in the pasture. Twenty-four PV modules on two passive tracking racks provide power to a three-horsepower surface piston pump. The pump is set in a sump near the stream and is equipped with low-water cut-off electrodes. Total dynamic head is 421 feet, and the design flow is 11 gpm during the summer months. The system produces flows averaging 6600 to 7500 gpd during the summer. Solar component costs: $24,500.

More information

To learn more about solar water pumping, or to find a directory of solar equipment dealers and installers, visit www.montanagreenpower.com or call NCAT at 800-275-6228 (800-ASK-NCAT).

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