Installing a Solar Powered Livestock Watering System

Written by Keith Reid

INTRODUCTION

An adequate supply of clean, fresh water is essential for livestock on pasture. There are a number of ways to accomplish this, depending on your individual circumstances, as outlined in the factsheet "Livestock Watering Systems for Pastures in Nova Scotia." For many paddocks where electrical power is not readily available, solar-powered systems can be a viable option.

The basics of every system will include solar panels to generate power, an electric pump to move water to the watering location, and a trough for the livestock to drink from, along with associated pipes and controls. Planning the system requirements and layout will ensure reliable and economical operation.

WATER REQUIREMENTS

The core of any watering system is adequate capacity to meet the requirements of the livestock that will be grazing the pasture since thirsty livestock will not gain as well and are more likely to damage watering equipment as they try to find water. Table 1 indicates the average daily water requirements for several types of livestock. (Adapted from "Livestock Watering Systems for Pastures in Nova Scotia")

Livestock Type Intakes§	Litres	Gallons
Cow-calf pairs	55	12
Dry cows (dairy and beef)	45-55	10-12
Growing Cattle* (150-350kg)	20-40	5-10
Growing Cattle*(350-550kg)	30-55	7-13
Dairy Cows	75-95	12-20
Sheep, Goats	10	2
Horses	30-45	6-10

Table 1 Average daily water intake by livestock

*Finishing cattle may require more.
§ On days over 25°C, intake can increase by 50-100%

These daily requirements are starting points, but the supply must also account for livestock behaviour within the grazing system and the storage capacity required to meet livestock needs during cloudy conditions when the solar panels are not operating at peak efficiency. The goal should be to provide each head of livestock with an adequate supply of water in a reasonable amount of time. With a system where water is always available in close proximity to where livestock are grazing, as in a managed grazing system with troughs in each paddock, livestock will drink individually, so the system can be sized to supply water as the livestock drink it. Remember that drinking activity will be concentrated in the daylight hours, so to estimate the hourly demand, the daily requirements should be divided by 12 rather than 24.

More commonly, the water trough will be in a central location, so livestock will tend to travel there as a herd rather than individuals. The dominant animals will drink first, and if there is insufficient supply, the "followers" may not get adequate water before the herd begins to move away. To avoid this, the design guideline for "surge capacity" is to have enough water available at one time to meet half of the herd's daily needs minus what can be replenished within one hour (Taylor, 2010). This can be in the water trough or as supplemental storage that can rapidly replenish the water trough by gravity flow.

Along with the immediate needs of the livestock, there must be storage capacity in the system to supply water when the solar panels are not generating electricity. This includes both nighttime and cloudy conditions when the panel output is reduced. In addition, for systems that are in remote areas where the livestock may not be checked daily, there should be sufficient capacity to supply three days of water requirements to the livestock in case of mechanical or electrical failure. A battery storage system, where the solar panels charge lead-acid storage batteries, which then power the water pump on demand, may be suitable for pastures that are checked daily. This may be supplemented or replaced by a water storage tank that can meet both the surge and storage capacity requirements. The water storage system is often more economical, despite the cost of the storage tank, because the expense for batteries is eliminated, and a smaller pump (which can use a smaller solar panel) can be used to pump water whenever there is adequate light.

A marine switch powers a bilge pump which will draw water into the tub.

FCAF ON-FARM CLIMATE ACTION FUND for Nova Scotia and Newfoundland and Labrador

Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada

WATER SUPPLY

Water may be pumped from an existing drilled or dug well, but more commonly, the water source is a pond or stream. Ensure that the supply is adequate during mid-summer when demand is generally highest and supply lowest. Surface water may contain sediment or aquatic plants that could impair drinking water quality and also plug pumps and valves. Fixing the water inlet 20-30 cm below the water surface will avoid fouling by any floating debris, but ensure it is far enough above the bed of the pond or stream to keep sediments from being sucked into the system. In some cases, a pump set made with PVC pipe, a five-gallon pail and some concrete to provide a secure platform for the installation of a submersible pump will be desirable (Buschermohle and Burns, 2015). The addition of a screen around the pipe will exclude aquatic plants and sediment.

PUMP CAPACITY

There are a wide range of pumps for solar-powered systems to meet the needs of different operation sizes and physical situations. The majority of these pumps use direct current (DC) rather than the alternating current (AC) used in on-grid applications. Power generated by photovoltaic (solar) panels is DC, so using DC avoids the power loss in an inverter to convert to AC as well as being more energy efficient.

Pumps may be either positive displacement or centrifugal. Centrifugal pumps can move large volumes of water at low pressures, but the volume of water delivered drops off rapidly as the head (elevation change) increases. They also only operate efficiently at maximum RPM, so they do not tolerate fluctuations in power supply that are inherent in solar panel output. Positive displacement pumps, often of the helical type, are much more commonly used in livestock watering systems. The pumped volumes are lower, but the pumps will operate over a range of power inputs and suffer a little drop in delivery rate as the head increases.

In designing your system, the pump must be sized to deliver the correct flow rate to the watering location after accounting for reductions in flow due to elevation and friction in the supply lines. Accurate measurement of the elevation difference from the water supply to the point where water enters an elevated storage tank is critical. The pumping rate per hour must meet the daily water requirements divided by the hours of useful sunlight in systems with water storage tanks. If the goal is to meet the demand for water as livestock are drinking, greater flow rates will be required as cattle can drink up to two gallons per minute, so you would need to multiply this flow by the number of heads that can drink at one time (Taylor, 2010). Your pump supplier will be able to calculate the pump output needed with this information.

SOLAR PANEL AND POWER MANAGEMENT

The solar panels must be sized to meet both the voltage and amperage requirements of the pumps used in the system. As a rule, the rated voltage for the solar panel should be greater than the pump requirements since the voltage output from the panels will drop under less than optimal light conditions. For systems using battery storage, the voltage of the panels must match the batteries being used; this is often two twelve-volt batteries wired in series for a system operating at 24V. There must also be a charge controller between the solar panels and batteries to maintain the voltage in the proper range and to prevent over-charging of the batteries.

Each system will also require a pump controller. In most systems, this will be an electronic float switch that turns the pump off when the storage or stock tank is full and then on again when the water level drops. Some systems will also include a pressure tank and a mechanical float valve, so as the water level drops and the valve opens, the drop in pressure at the tank will signal the start of pumping.

The pump controller will also turn the pump on and off in response to fluctuations in available power from the solar panels. Many of the newer positive displacement pumps will operate over a wide range of voltage with speed varying with the available power, so the pump controller will turn the pump on as soon as a minimum voltage is met to use the full day's sunlight.

Solar panels are most efficient when they are positioned perpendicular to the incoming sunlight. They should be facing as close to directly south as possible. If the tilt angle is adjustable, it should be set to your degrees latitude minus 15 for operation in the summer (i.e. about 30˚ from horizontal for most of Nova Scotia) and degrees latitude plus 15 for operation in the winter.

A DIY solar watering system moving water from a nearby stream into a tub. Keeping cattle out of watercourses protects riparian and animal health.

FCAF ON-FARM CLIMATE ACTION FUND for Nova Scotia and Newfoundland and Labrador

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

SITING AND INSTALLATION

The three considerations for siting the watering system will be the location of the water source (and hence the pump), the solar panels and the water trough. As the distance between these components increases, there are increased costs for wire and pipe and also issues with power loss in long wires and pressure drop in long pipes. Part of planning is optimizing the location of each component, including consideration for whether a heavier gauge wire or larger diameter pipe will be needed to handle the distances involved.

Solar panels should have an unobstructed view of the sky without shading from trees or buildings. This is particularly important for the mid-day period when the sunlight intensity is greatest. Solar panels are also susceptible to damage by lightning, so they should not be located at the highest point in the landscape.

Water troughs should be located in well-drained areas with a firm surface surrounding the trough to avoid the development of mud holes. For permanent watering systems, a concrete or gravel apron around the trough may be needed, and this should extend beyond the length of the livestock drinking from the trough. A concrete curb around the trough can also help to keep livestock from fouling the water in the tank with manure.

Portable systems should be located on well-drained soils and moved regularly to prevent trampling damage.

There needs to be a check valve between the pump and the water storage to prevent backflow when the pump is not operating.

SECURITY AND MAINTENANCE

It is an unfortunate reality that solar power systems can be attractive to thieves, and their location in isolated areas can increase the temptation. Some of this can be addressed during the planning phase by locating the panels where they are not easily visible and accessible from roadways. Installation should also be done to make removal of the panels and other components challenging; this will not stop a determined thief but will reduce the number of opportunists who are only interested in "easy pickings".

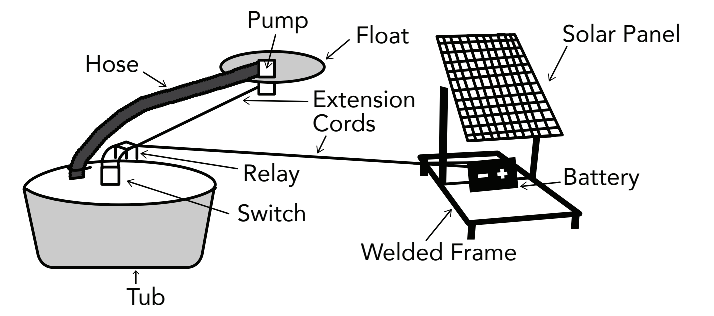
Regular maintenance is important to the trouble-free operation of your watering system. Check the tightness of all the electrical connections and watch for water damage or corrosion. Look for cracks in the insulation of any exposed wiring, particularly where they enter junction boxes. Check that the mounting hardware for the solar panels is tight, and remove any weeds or tree branches that might be shading the panels. Check if the panel glass is clean, and if necessary, clean it with a soft cloth, water and detergent, followed by a rinse with clean water. Check the operation of all switches and valves.

TYPICAL COSTS FOR A SIMPLE DO-IT-YOURSELF SOLAR WATERING SYSTEM

This table gives typical costs in 2023 for a watering system that can be built using items from local hardware and marine stores. Costs will vary depending on items you may already have on hand and welding skills.

Item	Estimated Cost ($)
Solar Pumping System	
12V marine bilge pump	$250
Solar panels	$250-$400
Solar panel frame	Varies, depending on skill
External switch	$20-$70
Relay	$30
Outdoor extension cord (2)	$15 each
Shrink tube	$10
Deep cycle battery	$250
Fuse	$6
Fuse holder	$10
Flex hose	$1.19/foot
Stock tank	$250
Thick Styrofoam panel (to float bilge pump)	Varies
Ring terminals	$7
Zip ties	$7
Total	**$1170- $3370***

***The higher end of the estimate assumes having a welder build a heavy-duty solar panel frame**



A simple homemade solar-powered watering system can be built out of items from hardware and marine stores.

FCAF ON-FARM CLIMATE ACTION FUND for Nova Scotia and Newfoundland and Labrador
Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

WINTER WATERING SYSTEMS

The planning for a solar-powered water system that will operate during the winter poses additional challenges. The shorter day length means more solar panel area is required to supply the same amount of water. Batteries are less efficient at cold temperatures, so they should be in some form of insulated enclosure. Some form of insulated water trough is required with a covered top with floating balls or flaps allowing access to the water. These will have a smaller storage capacity than an open trough, so a larger pump capacity will be required to meet the water requirements of livestock and to keep the trough full so cold air cannot get into the trough from the surface. Storage tanks can freeze and burst, so they are not appropriate for winterized systems. All pipes must be buried below the frost line to prevent freezing. It is possible to use solar power to provide water during the winter, but careful planning and regular maintenance are required.

REFERENCES

Buschermohle, Michael J. and Burns, Robert T. 2015. Solar Powered Livestock Watering Systems. Agricultural Extension Service, The University of Tennessee PB 1640.

Taylor, Ken; 2010. Watering Facility Design Criteria for Cattle. South Dakota Technical Guide, Design Technical Note SD2006-1.

FCAF ON-FARM CLIMATE ACTION FUND for Nova Scotia and Newfoundland and Labrador

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada