Livestock Watering
FACTSHEET

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USING SOLAR ENERGY TO PUMP LIVESTOCK WATER

This Factsheet looks at two projects using photovoltaics to pump livestock water. **Imperial units** are used.

Project #1 - A Livestock Watering System - Medium Lift

A field installation of a photovoltaic (PV) powered livestock water pumping system is described. The system is designed to supply water to two locations; 3,200 US gal a day at 55 feet lift, or 1,000 US gal a day at 164 feet lift, or a combination of these two lifts and flows. This is sufficient to water approximately 200 or 65 beef cattle respectively. The system was originally funded by Energy, Mines and Resources Canada, together with the B.C. Ministry of Agriculture, Fisheries and Food, and was located in Cache Creek, B.C. in August 1986. The system was moved to Savona, B.C. in the spring of 1989.

Figure 1 **500 Watt PV Water Pumping System**

INTRODUCTION

Bob Haywood-Farmer runs a commercial cattle herd using Crown lease rangeland at Savona, B.C. Stock water distribution is a common problem on these low elevation grasslands. At this site, a good spring is available but pumping is required for water distribution. The site is remote from utility electricity and engine driven pumping was considered too costly and inconvenient. An existing demonstration PV system was available and suitable for this site. It was installed in May 1989. See Figure 1, left.

SYSTEM DESIGN

Water is pumped only when solar energy is available. The system was sized to deliver sufficient water on sunny days to allow some excess water to be stored for cloudy days. In this manner, energy is stored as pumped water rather than stored in batteries. The PV array powers the pump directly through a maximum power point device, a Wardun WD700 DC-DC converter (transformer). This device ensures sufficient motor starting current and maximum operating power throughout the day.

The pump is a Mono P32 progressive cavity unit submerged in the water and shaft driven by a 2 HP permanent magnet DC motor mounted above water level. The Mono pump is well suited for a PV system as it will deliver the full lift over a wide range of speeds. This is important because with a panel-direct design, pump speed varies as sunlight intensity varies on the panels. Both the motor and pump were chosen for their high operating efficiencies.

The array consists of 10 ARCO M-75 panels rated at 50 watts (peak) each. They are wired in series for a nominal output of 165 volts at 3 amps. The array is mounted on a rigid frame with provision for manual adjustment to match the seasonal changes of the sun.

WATER SOURCE

The water source is a spring fed pond into which 3 foot diameter steel pipe, 12 feet long was vertically submerged 8 feet. The motor and converter are mounted near the top of this pipe (above the water level) with the pump submerged approximately 7 feet. Pond overflow is available for cattle watering.

WATER STORAGE

Pumped water is stored in two steel tanks, each at a different elevation and sized for more than a three day requirement. The lower tank (55 feet lift) is 1,000 feet from the pump; the upper tank (164 feet lift) is 1,600 feet away. Polyethylene pipe (1 ¼ inch) was used for the delivery system.

LIVESTOCK USE

Water from the lower storage tank is gravity fed approximately 2 miles to three float-controlled stock troughs. This allows the grazing use of a large, under used, grass hillside. Water from the upper storage tank is gravity fed to a nearby float-controlled trough to increase grazing on an upper bench area. See Figure 2, below.

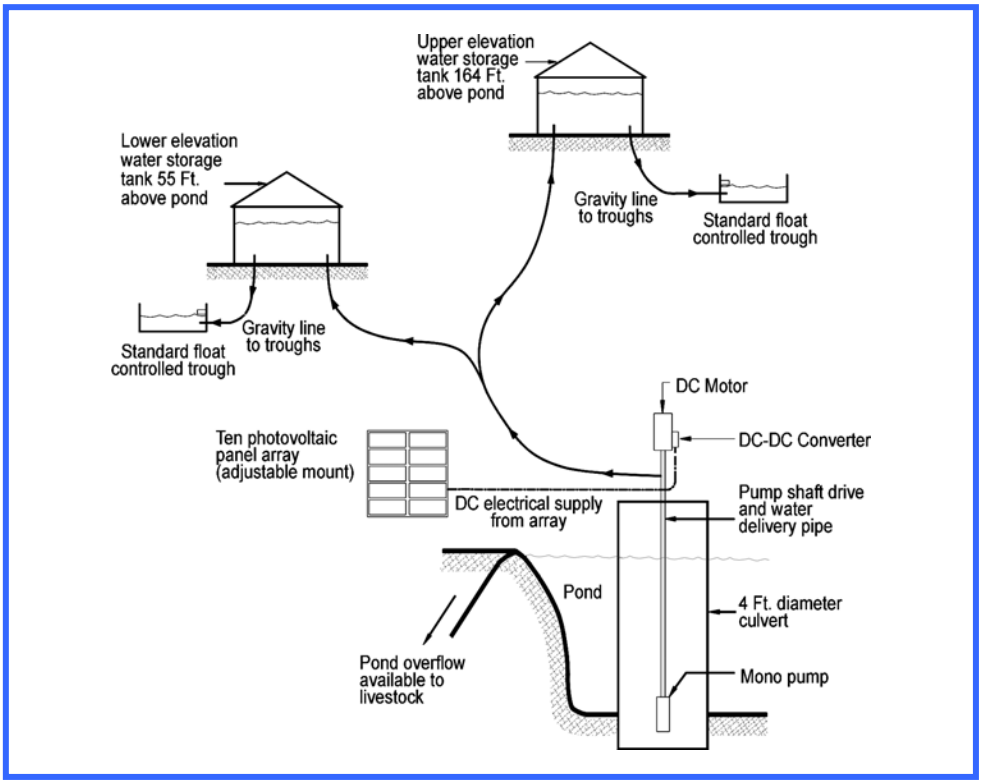

Figure 2 Schematic Drawing of a Livestock Watering System - Medium Lift

RESULTS

The first year of operation ran from 4 May to 2 June, 1989. Pumping to the lower lift only, 88,760 US gal of water was delivered in 29.5 days. This is an average daily volume of 3,000 US gal. Peak daily rate was measured for a full sunny day (10 May) at 3,600 US gal.

The upper lift tank had not been completed as of June 1989, so no data was taken. However, this pump system was previously installed at Cache Creek, B.C., approximately 40 miles west of the Savona site. At that location, during May 1987, an average 1,600 US gal per day was pumped a lift of 141 feet. The full season daily average (April-October) was 1,450 US gal. This is very similar to the upper lift at the Savona site so similar results are expected.

SYSTEM COSTS

The pumping system costs (1989) totaled $8.000. This includes 10 panels, the array frame, converter, motor, pump, mounting assembly and wiring. The delivery pipe and water storage costs will vary between sites; the total cost is approximately $5,000 for the Savona site.

Project #2 - A Livestock Watering System - Low Lift

A field installation of a photovoltaic (PV) powered livestock water pumping system is described. The system is designed to supply an average daily volume of 525 US gal pumped to a maximum lift of 32 feet. This is sufficient to water approximately 35 beef cattle. This project was funded by the B.C. Ministry of Agriculture, Fisheries and Food, the D.A.T.E. program and the cooperating rancher, Hugh Fallis, Monte Creek Herefords. It has been operating since 1989.

Figure 3 100 Watt PV Water Pumping System

INTRODUCTION

Monte Creek Herefords is a purebred cattle operation using deeded rangeland. Two adjoining sections of their range are divided by a public road with the main water source near this road. Water distribution is required to utilize the grazing potential. To achieve this, some pumping is required. Because of the distance to utility electricity, and the cost of maintenance of engine driven pumping, a photovoltaic system was chosen to pump this livestock water. See Figure 3, above.

WATER REQUIREMENT

Beef cattle require water ranging from 8 to 15 US gal per day. For this site, 35 cows are to be watered, requiring a daily maximum volume of 525 US gal. Because of the daily variations in solar radiation, energy must be stored to ensure livestock water will be available on cloudy or low solar energy days.

SYSTEM DESIGN

Energy stored in the form of pumped water was chosen over chemical storage in batteries. With adequate water storage, water need only be pumped during the hours of bright sunlight simplifying the design. The PV array powers the pump directly through a transformer (a linear current booster) that ensures sufficient motor starting current. This device transforms the panel output in low light conditions (e.g. morning) and is commonly used in PV water pumping systems.

The motor/pump is a low-cost unit manufactured by Flojet. A 12-volt permanent magnet DC motor drives a diaphragm pump capable of 1.9 US gal per min @ 10 psi. The motor draws a maximum of 7 amps and has a fan for cooling under continuous operation.

The array consists of 2 ARCO M-75 panels rated at 50 watts (peak) each. They are wired in parallel with one linear current booster per panel for a 100 watt (peak) output. Panels are mounted stationary at approximately 50% (the latitude of the site) with no seasonal angle adjustment.

WATER SOURCE

The water source is a shallow dug well with a 4 foot diameter culvert pipe 12 feet long, set in place vertically. The culvert is capped with a box to mount the array and to secure the system. To accommodate the changing water level, the motor/pump unit is mounted on a floating plywood/styrofoam raft guided by a centrally fixed pipe. This also ensures a low suction lift. Extra lengths of both supply wires and delivery pipe are provided to accommodate a maximum 10 foot movement of the raft.

WATER STORAGE

A round corrugated steel grain bin was converted for water storage using a 20 mil vinyl liner. It is located 150 feet from the spring (22 feet above). This provides a low cost storage tank and with the bin roof in place, ensures both clean water as well as a long liner life. At 14 feet in diameter and 4.6 feet deep, the total available storage is 5, 200 US gal. The delivery is into the top of the tank. The required lift into the tank varies from a minimum of 22 feet (spring full) to a maximum of 32 feet (spring empty).

LIVESTOCK USE

Water from the storage tank is gravity fed to standard float-controlled stock troughs. With ample storage, livestock can water regardless of the pumping conditions. See Figure 4, below.

RESULTS

In initial tests during May 1989, the system performed well. During days of full sun, 900 US gal a day were pumped into the tank. The average daily volume over a three week period was approximately 525 US gal a day. Peak flow rate was 1.9 US gpm. Operating until October each year, the volume pumped in 1989 was 44,500 US gal, and in 1990 was 29,000 US gal.

SYSTEM COSTS

The pumping systems costs (1989) totaled $1,350. This includes 2 panels, 2 linear current boosters, motor/pump, suction screen, wiring, switch and miscellaneous wood and steel materials. The polyethylene delivery pipe and storage tank costs were approximately $1,000. The water well development costs were approximately $450. These last two costs are site specific and will vary depending on the water source and the distribution required.

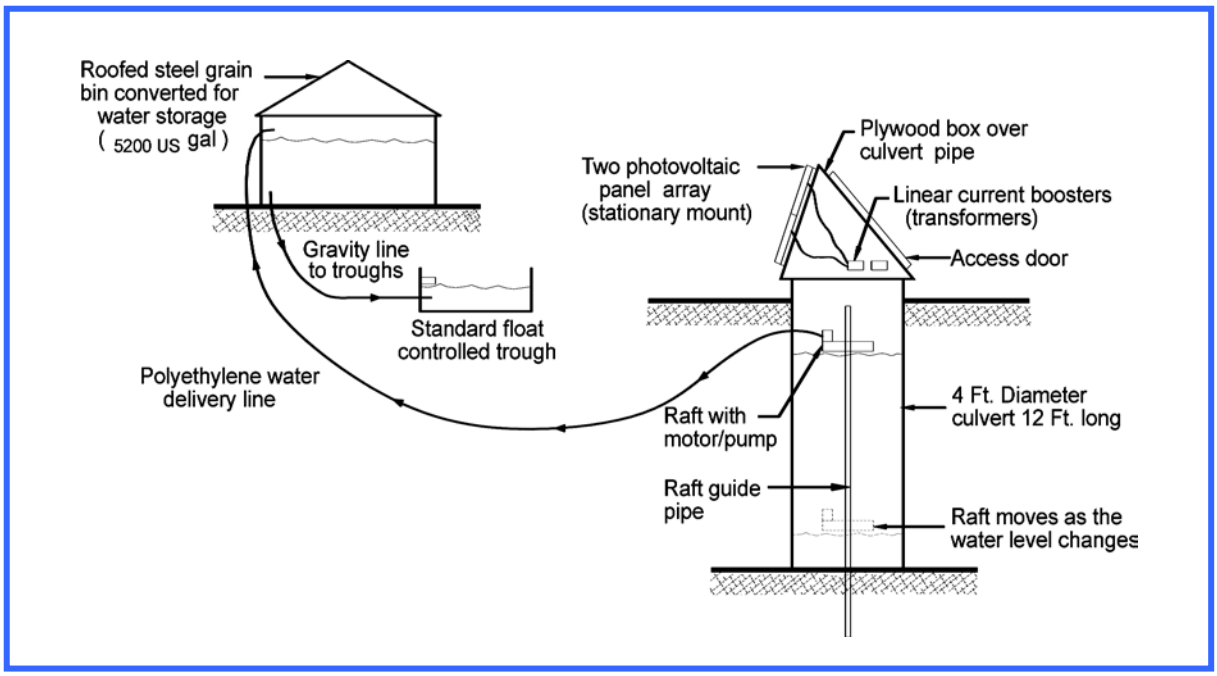

Figure 4 **Schematic Drawing of Livestock Watering System - Low Lift**

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