Final progress report for ACRE solar project for Tony and Marvella Maldarella
012110

*Project overview

*See attachment from Nunatak AES.
System is working; all equipment involved in the water pumping is working to expectations.

*Key findings
Ground heat culverts seem to be providing a lot of consistent temps for tank. Heat tape and timer have proved to work, but finding the most efficient time and application of tape in the tank is experimental and progress continues.

*Problems/Recommendations
Cold temperatures and ice are the challenge. But ice has not shut the system down at all. There is some management with ice in the tank and around the float. I have been able to find the warmest areas in the tank and with the heat tape it has made it easily manageable. The timer for the heat tape is difficult to get exact with turning on and off. I think that only time and observations of the most efficient use will make the system even better.

Recommendations;
Pump test provided good data to give us a baseline for energy demand.
Sealed batteries for this climate seem to be the best.
The tire used for a water tank has proved to heat up easily in direct sunlight.
The inverted culverts beneath the water tank have helped with tank temps.
The frost protection around the tank and water line has helped with tank temps .
There has been no ice in the bottom of the tank at all even with temps below minus 20.
Use of a "clock timer" instead industrial type timer.

*Next Steps
Continue to monitor system and energy demands. The timing of energy use with sunlight and place of heat tape is a work in progress. But by observing the demand and tweaking things just a little bit has a big change in the use/demand and production of energy. Work on developing passive or thermal solar to remove surface ice in water tank. Possibly add another water tank to the system.

*Success and accomplishments
We are pumping water and storing it for livestock use and keeping that water system functioning in a cold climate. The system provides timed heat to critical plumbing that gives assurance to function of system when temps are extreme. This is being done completely with off grid produced power. The system has autonomy for 3 days, and has the ability for a generator to provide back up when weather is bad for extended time. The water line can be drained when system is not going to be functioning for long periods of time.
We are providing reliable water for livestock and human use away from a stream bank.
We feel like these are great accomplishments and we are thankful to the Colorado Dept. of Ag and Nunatak AES for resources and experience that has made this project possible.

*Photos-attached/ emailed
* Request for reimbursement. There will be 2 requests by March 1.
(012610 $6580.28) attached.
I am expecting another bill from Nunatak within the next few weeks for somewhere around $4-5000.

Final Summary of Colorado Dept. of Agriculture/ Advancing Colorado's Renewable Energy (ACRE) solar project for Tony and Marvella Maldarella

This report is to show the process, equipment, success, failures and cost of the project.

We started with a 300 ft deep well. In the winter we have been watering our cattle out of a hole in the ice on the creek. This is not real reliable in the late winter when stream flows are at a minimum and ice is at a maximum. It also is tough on stream banks to water out of the creek in the winter. The cost for grid energy to this location was very high.

I recommend if you are not skilled in the installation of PV power systems you involve an alternative energy professional.

Baseline/
Quantity of water needed on a daily basis.
Pump test to find the amount of lift and the amount of energy needed.

Energy audit/ Autonomy/System

We based our demand from amount of water needed daily on PV power and the system being able to run for a period of time without the sun. The key requirement on your energy is" how much lift is needed on average". Based on the audit we installed (4)175W solar panels. Our Batteries (4) 12V sealed batteries are for back up and heat to the waterline where it is at a higher risk of freezing. We chose the sealed batteries for a couple of reasons. They require no maintenance, venting and they perform well in cold temps. (See attached system info)

We installed a Grundfos 11SQF-2 well pump to pump the water. This is a quality pump with the ability to work from AC or DC power.

We built a shed for batteries and components of the system. I recommend the building be built with enough room to have all your batteries, wiring, controllers etc... I recommend all systems have the ability for back up power (power converter/charger). The way the back up power is used in the system can vary from it being direct power or having in go into your batteries.

Water delivery

Our system was going to work without a pressure tank. The system had to be frost protected in many aspects. We ran our waterline 7ft deep. We ran conduit for electrical at 3.5ft. We used gravel to aid in the water draining and placed blue board above to retain heat and prevent frost from creeping down. Also all vertical water components are cased with culverts. The line has one frost free hydrant at the well along with a drain in front of hydrant meant to be able to completely remove water from the line.

We cased the water line where we anticipated vehicle and livestock traffic.

Water Tank

The water tank is a loader tire set in concrete. Tires absorb a lot of solar heat (on a cold sunny day when the air temp was -10F and the snow covered ground was 27F, the surface temp of the tire was 102F!). We also buried an 8’x18” culvert vertical under the tank (covered w/plastic barrel). This was done to gain ground heat, and used as a drain and we installed a stub line for an additional tank if we wanted in the future. We also did a lot of frost protection with blue board and concrete to keep the frost from being driven down by livestock. It also will direct ground heat to the tank.

More on the water tank

In an effort to get every advantage possible we tried to have everything around the tank black. Where the water line comes to the tank the line has heat tape and is insulated (the heat tape is on a timer and has a timer override to send heat on demand). We also have the float mechanism (made by Grundfos).

We also made an insulated cover for the tank that can be left on with a flap on one side or removed completely depending on how the tank is being used and what the weather is like. For example on cold clear days with bright sun having the cover off keeps the tank relatively free of ice, on cold cloudy days the cover is better left on(with drinking flap open). At night having the cover on completely make a significant difference in the amount of ice.

Additional recommendations

Tank orientation/ we placed the water tank so that it’s two areas of use were North/South. This gives the tank unobstructed sunlight. If there was a fence running N/S it would obstruct the tank from sunlight.

Active System Design

The general design of this water pumping system is a solar power source driving a well pump and active heating system. Since power needs are often needed during night or low sun conditions, a battery bank is included the system, as well as a back-up AC battery charger that can be powered by a portable generator should batteries get low and sun isn't available.

Load Analysis:
Critical to system design was a load analysis. Although there were many uncertainties in estimating the power needs, we were able to reduce size of the original design, after having a well test. With more certain well head levels, we could decrease power storage needs, and ultimately cost of the system. The well test was a smart move for the success of the project. A more difficult load was determining how much energy we would need to keep surface piping from freezing, and float switch in the tank free of ice.

Power:
Power is delivered to the system via (4) 175-watt Sharp PV pole mounted modules charging a 225 Amp Hour sealed battery bank at 48 volts with an Outback PV charge controller monitoring battery health. Also wired in is a low voltage disconnect feature that will disconnect all loads from the batteries should levels get below 50% of capacity, ultimately insuring long life from the battery investment. We chose sealed batteries over flooded ones given their better tolerance to cold temperatures, and also that they will need no maintenance (watering).

Pump:
Pump selection was critical not only for appropriate size, but also given we were powering with a straight DC system (to negate the cost and inefficiency of having an inverter). We chose a Grundfos SQ Flex series pump. Minimum voltage needed to pump is 30 volts, which dictated a 48-volt battery bank design. We control tank water levels with a float switch in the tank.

Heat Tape:
Heat tape is used to help keep surface water lines free of ice, and keep tank ice from inhibiting float switch performance. It was difficult to find adequate heat tape that ran at 48 volts DC, so we had to step down the voltage to 24 volts to power the heat tape and a couple of lights in the power shed. An industrial relay timer controls the heat tape. The ability to control time-on/ time-off is imperative to balance out the delivery of energy when it is needed to re-fill tank after stock have drank water down to re-fill level. Strategic timing and placement of heat tape best insures energy will only be used when and where needed.

System Information for Water Pumping

PV Array: (4) Sharp NT-175UC1 (24V nominal modules)

Pmax: 175.0W
Voc: 44.4V
Isc: 5.40A
Vmp: 35.4V
Imp: 4.95A
Series fuse: 10A

2 modules in series
2 series strings in parallel

Charge Controller: Make/Model: Outback FM60

Batteries: Make/Model: (8) DEKA 8G8d 225Ah 12V each
Bank: 225Ah at 48V DC
Charging Notes (per manufacturer):

Initial charging current: about 12A (C/20)
Bulk V: 54.8V @ 68 deg. F
Absorb V: 53.6V
Absorb Time: 3 hrs.
Float V: 54.4V
Equalization V: No Equalize!
Equalization Time: No Equalize!
Low Voltage Disconnect: 47.2V
Reconnect Volts: 48.4V

Well Pump: Grundfos 11SQF-2 with CU 200 pump controller

Care and Maintenance Notes

Check system specs and record them if you can. This is the best way to see how well your system is performing, and to troubleshoot if anything goes wrong. Overall, your system should not need much maintenance or attention. Periodically inspect your batteries to make sure terminals are clean of corrosion, and connections are secure. You also may want to ensure your batteries are fully charged. Here are some guidelines for what you should be seeing in terms of battery voltage:

Battery State of Charge*,** (how full batteries are):

Fully Charged -	51.4V
About 75%-	50.6V
About 50%-	49.4V
About 25%-	48.0V
Discharged-	under 47.2V

*These voltages are when batteries have been at rest for at least ½ hour. Voltage will vary when batteries are charging (higher voltage) or discharging (lower voltage).

**Try to keep batteries at or above 48V at all times, and fully charged at least twice a week! You will significantly reduce the life of your battery bank if you drop them below this value for any length of time.

BATTERY CARE:

Watering: These are sealed maintenance free batteries. They do not need to be watered. Do not attempt to remove the vent caps.

Equalization: Sealed batteries should never be equalized!

COST BREAKDOWN FOR SYSTEM

300ft well drilled----------$11,000.00

Pump test----------$775.00

PV system, pump and all associated
materials and components----------$15,000.00

Labor paid---------- $9,000.00

Labor (owner provided, for matching)-110hrs----------$3,400.00

Material (owner provided, for matching)----------$1,650.00