



## CLEAN ENERGY RESOURCE TEAMS

### CASE STUDY: GEOTHERMAL | CENTRAL REGION

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# Geothermal Livestock Water Heating System at Azariah Acres Farm

By Lucy Rahn, *The Minnesota Project*

Suzanne Peterson runs Azariah Acres Farm, a sustainable farm in Morrison County that raises pasture-fed sheep, yak, goats, pigs, chickens, ducks, turkeys, and guinea hens. The large number of sheep and yak require a constant-supply of water that must be heated in the winter. In winters past, water was piped to each barn or stockyard and heated conventionally with electric keep-warm (Ritchie) heaters. The average monthly bill for heating livestock during the winter of 2005-2006 was \$300. Typical water heating systems have an average heat transfer rate of 30 percent, which is very inefficient and expensive. Sue went looking for an alternative, and a geothermal system came to mind because of her interest in renewable technologies and engineering. As a member of the Central Clean Energy Resource Team, she learned about the grant available for clean energy projects.

Sue was a mechanical engineer in years before and began her project by doing some research on the internet to learn more about geothermal systems. She also contacted an engineer friend, Don Bohn, P.E., who specializes in geothermal technologies to verify her thermal calculations.

The project began with an economic analysis of a design using direct heat exchange to the ground and a circulation pump, and an analysis of using a heat pump and heat exchanger with the circulation pump. A direct heat exchange piping was determined to be the best choice. Sue chose PEX tubing because it is the most durable and can withstand being below and above ground in sub-zero temperatures. There was a back-order and the tubing did not arrive in time to be installed in the fall, and was instead installed in April of 2007. This past winter, she hauled 75-100 gallons per day rather than using the heaters. The new system, of course, eliminates the need for hauling.

Sue did most of the installation in the spring of 2007, though she hired someone to install the piping below

## Project Snapshot

**Purpose:** To determine the feasibility of and install a geothermal system for heating livestock drinking water during the winter months

**Technology:**

- 1/3 HP submersible pump
- PEX direct heat exchange piping
- 75 gallon covered, insulated stock tank

**Grants:** \$500 CERTs

**Total cost:** \$1,500

**Benefits:** Energy savings, heating cost savings, and various educational opportunities

ground. She used a 75 gallon covered, insulated stock tank with a 1'x 2' opening for the animals. The piping was run underground just north of the livestock barn to the heat exchange piping buried 8' below the surface of the ground. The average ground temperature at this depth is 50-55° F.

The geothermal system is meant to keep the water from freezing when the temperature is above 0° F. Since the tank is in the barn with the animals, the temperature will go below 0° F only 3-5 days per year (at the most). An in-the-tank heater is available for sub-zero temperatures.

Sue's rough calculations indicated a need for the water to be heated at 3500 Btu per hour in order to keep it from freezing (this will be tested this winter). Based on Sue's research, the amount of piping needed for her heating system would vary significantly depending upon the assumptions made for soil temperature and thermal conductivity. Based on the best engineering data available, the calculated length needed for sufficient heating for a 2" high density (PEX) plastic pipe using a 1/3 HP submersible pump was 200 feet. The data were verified with Don Bohn, a registered professional engineer with experience in geothermal system design. The underground part of

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the piping was installed by Arthur Rueckert, a local contractor. The above-ground part of the system can easily be dismantled during the spring, summer, and fall to facilitate barn cleaning, and allow limited movement of the tank.

Next steps include preparing a display to post near the geothermal system and gathering data over the next winter on air and water temperatures to determine the overall efficiency of the system. Next winter, data will be gathered on air and water temperature on a twice-daily basis by David or Rebecca Staneslow. They are eleven and nine years old, respectively, and already take care of chickens and rabbits on a daily basis. They will also be involved in presenting their data as a 4H project at the Morrison County Fair.

Sue is excited about the project because it saves energy and makes good financial sense. In the end, the total project cost was \$1,500 (not including her labor), \$500 of which came from CERTs. A typical payback time frame is three years—depending on how cold it is. Though the pipes weren't installed until spring 2007, Sue anticipates reducing her water heating cost to \$10-\$15 per month in winter of 2007-2008. If her project works, she sees it as an opportunity for others who raise livestock to free up a good amount of capital.

Sue wants her project to be a venue through which information is shared. In the summers, Sue sells meat and wool products at the Mill City Market in Minneapolis to customers who appreciate her sustainable farming practices, and she will also be using this venue in the coming year to talk about her geothermal system and about CERTs. Those who are interested should also keep their ears open for field days Sue will be conducting in 2008!

### February 2008 Update

The system has been up and running since November 2007. "I save about \$400 a month heating my water," Sue says. "If I wanted to manually supply hot water when it gets below 20 degrees I could, but that would be a half hour of labor a day hauling 40-60 gallons out to the barn. Now I don't have to do that either." The downside of the system? "I underestimated how curious the yaks would be," Sue says with a chuckle. "The yaks like to investigate it with their horns and have tore the system apart a few times. I'm going to make it 'yak-proof' later this spring."



Sue kneels next to the geothermal system in her livestock barn

Photo: Rin Porter

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To learn more and to contact Sue, visit the farm's Web site at [www.azariahacres.com](http://www.azariahacres.com).