

Pennsylvania Energy Harvest Grant

Technical Report

Project Number NW070022EH



Project Grass Solar Energy Pump Initiative

July 8, 2010

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Introduction

Penn Soil Resource Conservation and Development working with Southwest and Northwest Project Grass received and administered \$96,000 in construction grant dollars to demonstrate the use of solar powered water pumps to improve environmental quality and reduce the use of energy from conventional sources on Pennsylvania livestock farming operations. The funds were obtained through the Pennsylvania Department of Environmental Protection's Energy Harvest Grant Program for this project. The views expressed in the following project report are those of the authors and do not necessarily reflect the views of the Department of Environmental Protection.

More and more Pennsylvania livestock graziers are interested in using intensive rotational systems to maximize forage production while lowering input costs on their livestock farming operations. These pasture systems are appropriately designed when they include multiple paddocks with water in each paddock. Such a design is the most effective way of maximizing productivity, lowering input costs and taking full advantage of the environmental benefits inherent in these systems. A major obstacle to more widespread acceptance of this farming practice is the prohibitive expense of providing such an extensive water distribution to remotely located pastures through a reliable and practical delivery system. A very promising technology is the use of solar pumps to facilitate supplying water to livestock in these more intensive rotational paddock systems.

Description

We have installed 13 rather than the 12 solar powered pumping systems outlined in the original Project Grass project proposal. The extra award amount was from surpluses in other grant categories that boosted the total project budget and hence added an extra project.

Solar pump projects were installed in Clarion, Bedford, Butler, Greene, Jefferson, Elk, Indiana, Mercer, and Warren counties. Field days were held to demonstrate the utility of these systems and to educate landowners and the public about the latest technology and economy of these systems. Three solar demonstration display units were updated and a display for winter watering was assembled. These were constructed in order to teach interested parties component installation and arrangement and to point out maintenance issues inherent with solar systems. The following is a summary of the events where these demonstration solar pumps were used for information transfer or training purposes:

| Date | Location Co. | Event | Attendees |
|---------|--------------|---------------------------------|-----------|
| 3/4/08 | Jefferson | DuBois Grazing Conf. | 170 |
| 5/22/08 | Erie | Mill Village Field Day | 110 |
| 8/21/08 | Centre | Ag Progress Days | 50 |
| 8/26/08 | Butler | Solar Pump Workshop (Training) | 46 |
| 3/17/09 | Jefferson | DuBois Grazing Conf. | 255 |
| 5/13/09 | Mercer | PG Solar (Training) Field Day | 25 |
| 8/19/09 | Centre | Ag Progress (Training) | 100 |
| 3/16/10 | Jefferson | DuBois Grazing Conf. (Training) | 210 |

| | | | |
|---------|----------|--------------------|----|
| 5/20/10 | Lawrence | PG Solar Field Day | 45 |
|---------|----------|--------------------|----|

A total of **\$153,968.40** was spent on the construction of demonstration projects across the above counties. This included **\$102,375.80** of the grant award dollars, which was earmarked for this construction and **\$51,592.60** in matching contributions from farm owners. This amount was substantially more than the 25%, or **\$34,125** in matching contributions that were required from them.

This report is a summary of the project. It details assistance that was made available to farmers for solar pumping projects, included is an assessment of the benefits realized as a result of the implementation of the projects. A Project Grass representative visited each of the demonstration farms in order to document those benefits.

Data was collected in the following categories (* Scope of Work Measurable):

Acres Grazed

Watershed Location

Oxides of Nitrogen not Emitted to the Atmosphere Associated with Fuel Savings

Carbon Dioxide not Emitted to the Atmosphere Associated with Fuel Savings

Soil Saved as a Result of Grazing

Reduced Electric Demand - Kilowatt hours produced & BTU equivalent savings per year

Oxides of Nitrogen not Emitted to the Atmosphere from electricity production

Carbon Dioxide not Emitted to the Atmosphere from electricity production

Sulfur Dioxide not Emitted to the Atmosphere from electricity production

Mercury not Emitted to the Atmosphere from electricity production

The above information was collected from 13 demonstration projects. The actual data for each category appears in the appendices at the end of this report. Herein also, are averages for the data and an explanation as to how the information was collected.

* Acres in the Grazing System

This is the amount of land area, measured in acres, that was added into rotational grazing systems by the improvement to the water distribution system.

The total acreage affected is 565 acres. With 13-systems installed the average size per farm is 43 acres, with a range of 10 to 95 acres. From the scope of work, the expected acres were 360 and the number of systems 12.

Watershed Location

This is the watershed where each farm is located. This has been determined using a topographic map and matching the smaller watersheds with the major watersheds listed.

* Soil Saved as a Result of Grazing

This is the amount of soil saved when farmers convert cropland, permanent pastureland, or other prior use land to a rotational grazing pasture system. Calculations for soil loss are made using RUSLE (revised universal soil loss equation) or in some cases RUSLEII. Soil savings result when the ground is covered with vegetation for a greater portion of the growing season, or when the density of vegetation increases. When managed correctly, a grass-based rotational grazing system develops a dense cover that minimizes erosion. The values derived in this section of the report measure the difference between the erosion loss calculation based on the prior use of the land and the subsequent calculation for rotational grazing. The saving of topsoil has a positive impact on farm economics by reducing the loss of the lighter more easily eroded nutrient rich organic particles. Additionally, the reduction in both nutrient and sediment loading of waterways may improve the environment and help to restore ecosystem function.

The total amount of soil saved on the participating farms is 243 tons per year. The

average amount of soil saved per farm is 19 tons per year with the range being from 1.4 to 56 tons per year.

** From the scope of work, the expected measurable environmental result for this category was 720 tons/year. This lower than expected result is due to the projects being, for the most part, implemented on farms where grass-based agriculture is already been being practiced.*

*** Reduced Electricity Demand for Pumping Water to Livestock**

This is the amount of electricity produced and/or saved as a result of the project. The generation is shown based on the year round potential of these systems to produce power. Solar systems cut monthly electricity charges directly and eliminate the high cost of installing power lines to remote locations.

The participating farms showed a reduction in the total need for electricity of 4,226-kwh per year and in lowering the BTU-equivalent requirement by 14,419,112. The average amount saved per farm is 147-kwh and 502,946-BTUs per year.

** From the scope of work, the expected measurable environmental result for this category was a total reduction in electric demand of 1,764kwh/year.*

Oxides of Nitrogen not Emitted to the Atmosphere from electricity production

This is the amount of oxides of nitrogen not emitted to the atmosphere based on electricity demand reduction.

The total amount of oxides of nitrogen saved is 16.9 pounds per year.

Carbon Dioxide not Emitted to the Atmosphere from electricity production

This is the amount of carbon dioxide not emitted to the atmosphere based on electricity demand reduction.

The total amount of CO2 saved is 8,549 pounds per year. ** From the scope of work, the expected measurable environmental result for this category was a total reduction in CO2 of 3,576 pounds/year.*

Mercury not Released to the Environment from electricity production

This is the amount of Hg not emitted to the atmosphere based on electricity demand reduction.

The total amount of Hg reduction is 156 mg. per year.

Money Saved per Project from electricity production

This is the savings in input costs that should result when water is pumped using solar powered pumps. Results are based on average electric rates in Pennsylvania and include an estimated monthly meter charge.

The average amount of money saved per project is \$206 per year with a range being from \$287 per year to \$239 per year. This money yielded total annual savings for participating farmers of \$2,678. The installed hardware has a useful life of at least twenty years, so that savings should accrue year after year throughout the useful life of the practices.

Partners

The farms additionally benefited from participating in the following programs in order to install and implement their systems: The USDA-EQIP and previous Growing Greener initiatives. In addition technical assistance from county conservation districts, PACD and the NRCS has equaled more than 400 hours at an estimated value of over \$15,000.

Operation and maintenance

All grant participants were given basic training about the operation and maintenance of their systems and have agreed to maintain the system for a period of no less than five years following the year they installed their system.

Summary

The information in this report conclusively demonstrates that solar powered water pumping systems can benefit farmers and the populace of Pennsylvania both economically and environmentally. Through Project Grass, **\$102,375.80** in grant money was awarded to implement this project. This is slightly more of the \$96,000.00 earmarked, because some unused money from other categories was switched to construction. Matching funds totaled **\$51,592.60** for a total project cost of **\$153,968.40**.

This report provides evidence that the use of solar power for pumping water to achieve a better distribution of watering locations in rotational grazing systems can be an important tool for farm operators and may allow for wider adoption of this sustainable management strategy while helping to conserve resources and protect the environment. This style of farm livestock management not only reduces the dependency of farm operations on grid-tied power sources, but also reduces erosion by encouraging permanent seeding of tillable cropland and protects of the atmosphere by reducing emissions caused from the burning of fossil fuels. Additionally, it protects natural resources, reduces soil erosion and improves water quality. Trends toward more intensive grazing systems may eliminate or reduce the size of expensive manure storage structures that farmers are installing in order to meet nutrient management objectives. This reduces farm economic inputs and minimizes the need for these high maintenance structures. Rotational grazing has been associated with improved livestock health, thereby reducing veterinary bills. Rotational grazing, when managed correctly, has the potential to shift animal production to a system of farming that protects the environment, increases profitability, and strengthens Pennsylvania agriculture. The equipment installed by this grant that uses renewable energy in remote locations and where the need for portability makes conventional power sources unsuitable is justified to ensure a sustainable, productive and wholesome food source for present and future generations.

Project Grass is changing the way farmers meet economic and environmental objectives in Pennsylvania, but there is much more to do. During the past four years the NRCS grazing specialists have developed over **400** rotational grazing plans for farm operators across the region. These landowners are willing to utilize this farming method. When these systems are implemented, more than **10,000** acres of agricultural land would be using this important BMP, including over **3,000** acres of land presently under cultivation for crop production. However, installing a grazing system is costly. And although implementing a system may be accomplished in stages, some of the steps require considerable time and expense, which may take years for the farm operation to pay for, and which are not offset by any of the many derived environmental benefits. So, if this initiative is to continue apace, additional funding is vital.

Project Grass would like to thank the farmers, conservation district employees, USDA Agencies, the Department of Environmental Protection - especially our grant advisors, and all the others who worked on and participated in this project.

Appendix

Project Photographs

Performance Outcome Data Summary

| Project Grass Energy Harvest NW070022 EH | | | | | | | | | | | | |
|--|-----------|----------|--------|----------|-------------------|-------------------------|--------------------------------|-------------|------------|------------|------------|-----------|
| Solar Water Pump - Cost/Benefit Information Sheet | | | | | | | | | | | | |
| Shown below are projected savings, for solar livestock water pumping systems installed under the Energy Harvest Grant program in western PA. | | | | | | | | | | | | |
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| | | | | | | | | | | | | |
| Economic value of project | | | | | | | | | | | | |
| Per Year | | | | | | | | | | | | |
| Soil Loss | | | | | | | | | | | | |
| Actual Emission Reductions est. | | | | | | | | | | | | |
| Per Year (Through the Grazing Season) | | | | | | | | | | | | |
| Project | County | Watts/sy | kwh/yr | BTU/yr | Meter & line fees | \$ value of electricity | \$ saved includes meter charge | Tons / acre | CO2 - lbs. | Nox - lbs. | SO2 - lbs. | Hq - mgs. |
| 1 | Clarion | 160 | 90 | 307080 | 7800 | 7.20 | 187.20 | 9.00 | 182 | 0 | 1 | 3 |
| 2 | Butler | 320 | 288 | 982656 | 1800 | 23.04 | 203.04 | 26.40 | 583 | 1 | 5 | 11 |
| 3 | Jefferson | 240 | 209 | 713108 | 8000 | 16.72 | 196.72 | 15.00 | 423 | 1 | 3 | 8 |
| 4 | Bedford | 160 | 100 | 341200 | 9000 | 8.00 | 188.00 | 30.00 | 202 | 0 | 2 | 4 |
| 5 | Warren | 400 | 302 | 1030424 | 7200 | 24.16 | 204.16 | 4.20 | 611 | 1 | 5 | 11 |
| 6 | Elk | 480 | 336 | 1146432 | 9600 | 26.88 | 206.88 | 56.70 | 680 | 1 | 5 | 12 |
| 7 | Jefferson | 640 | 547 | 1866364 | 10800 | 43.76 | 223.76 | 20.00 | 1107 | 2 | 9 | 20 |
| 8 | Indiana | 400 | 745 | 2541940 | 7200 | 59.60 | 239.60 | 30.10 | 1507 | 3 | 12 | 28 |
| 9 | Mercer | 400 | 416 | 1419392 | 300 | 33.28 | 213.28 | 6.10 | 842 | 2 | 7 | 15 |
| 10 | Indiana | 320 | 292 | 996304 | 3000 | 23.36 | 203.36 | 18.00 | 591 | 1 | 5 | 11 |
| 11 | Greene | 240 | 196 | 668752 | 2400 | 15.68 | 195.68 | 18.00 | 397 | 1 | 3 | 7 |
| 12 | Bedford | 320 | 430 | 1467160 | 8400 | 34.40 | 214.40 | 8.50 | 870 | 2 | 7 | 16 |
| 13 | Clarion | 320 | 275 | 938300 | 3000 | 22.00 | 202.00 | 1.40 | 556 | 1 | 4 | 10 |
| Total | | 4400 | 4226 | 14419112 | 78500 | 338.08 | 2678.08 | 243.40 | 8549.20 | 16.90 | 67.62 | 156.36 |