

Solar and Wind Powered Water Pumping Systems for Rotational Grazing Systems



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Narrative Description of the Project

Background

Modern agriculture is very dependent on fossil fuels for the production and transportation of farm products. This is especially true for livestock farms where crops are grown, transported and consumed on the farm in order to produce a saleable commodity. Fuel dependent agriculture worked very well through the 50's and 60's and continues to be the preferred system to produce agricultural commodities despite higher fuel costs. However, these high costs combined with unfavorable weather over several growing seasons, has taken its toll on many small farms. Since farmers can neither control the weather nor the price of the products they produce, their best alternative has been to return to the old time practice of letting livestock harvest their own feed from pastures.

Intensive rotational grazing systems maximize forage utilization while maintaining the regenerative capabilities of forages. The greatest limiting factor to optimum use of this system is the availability of water. Intensive grazing systems can be competitive from a production stand point only if an adequate water supply is available in or near each paddock. Since it is cost prohibitive to run water lines or electricity to the far reaches of most farms, it is necessary to develop water supplies in these remote areas. A very promising technology and the focus of this proposal is the use of solar pumps to charge underground reservoirs (tanks) which in turn will supply drinking water to livestock in the paddocks. The use of solar or wind power, in lieu of diesel and other fossil fuels, as part of our ongoing intensive grazing management program will allow a livestock producer to put water within their grazing system where it is needed. When this is accomplished the livestock more effectively utilize the forage throughout the entire field. By grazing the entire field, it substantially reduces the amount of diesel fuel used to mechanically harvest or clip the pastures. The placement of water in every pasture also leads to better animal manure distribution throughout the paddocks due to better forage utilization. This in turn results in less need for fertilizer spreading, which requires diesel fuel usage and it also leads to reductions in environmental pollution, increased water quality and all the societal benefits associated with these reductions.

The Solar and Wind Powered Water Pumping Systems for Rotational Grazing Systems project was developed to improve rotational grazing systems which would reduce the usage of fossil fuels. The expansion and enhancement of the grazing systems would also result in the improvement of water quality through better nutrient management, erosion control, soil structure, and stormwater uptake/recharge.

The objectives are:

- (1) To set up solar or wind powered watering system demonstrations in the Project Grass Northeast Chapter area, for field days and/or meetings;
- (2) To Educate/train NRCS and Conservation District staff about solar and wind powered livestock watering systems.
- (3) To improve nutrient management and pasture management by excluding cattle from riparian buffers and improving pasture utilization by watering in the paddocks using solar powered pumps;
- (4) To improve/promote carbon sequestration by reducing row crops and encouraging permanent grass stands which also reduces soil erosion.
- (5) To evaluate soil quality on each of the solar water system sites in an effort learn how water facility locations affect soil quality.

Project Implementation/Plan

The project implementation or work plan was developed early on in the conceptual design of the project, and the plan was followed throughout the project which allowed the project to be implemented according to the original plan submitted to DEP.

The project partners established a technical steering committee for the project to help provide technical guidance and insight on the project. The technical steering committee assisted with the development of a "call for projects" which was distributed by project partners to interested landowners that may be interested in installing a solar or wind powered water pumping system to reduce on-farm fuel consumption and

improve environmental conditions. The technical steering committee developed ranking or scoring criteria in order to determine which projects would provide the largest decrease in fuel usage and improve the environment. The scoring process resulted in the committee then selecting the 15 project sites that would provide the most benefit.

The 15 landowners selected to participate with the project were contacted and were required to sign contracts to proceed with the project. The landowners are required to provide data about the project, allow representatives of the different project partners on their property to evaluate the project, and provide in-kind match towards the installation of the solar or wind powered water pumping system. Once the landowners signed and provided the necessary documentation then they worked with NRCS to develop designs for the water pumping system for their property. After the designs for their watering system were complete and provided to each landowner they were then allowed to proceed with a selecting a contractor to furnish and install the solar or wind powered water pumping system.

Project Grass Northeast and Pocono Northeast RC&D Council have purchased and are constructing a demonstration solar water system pump that will be used for education and outreach purposes. Due to two landowners backing out of the project at the last minute, a demonstration pump will be constructed to utilize at field days and pasture pie meetings that cannot be held at a project site. This will allow landowners to see what the solar water pumping system entails on a small, demonstration scale, but will serve to show that it is an application that is available to them to improve their rotational grazing system.

Successes

The project resulted in the successful design and installation of 12 solar and 1 wind powered water pumping system throughout the 13 county Project Grass Northeast area. The water systems were installed in 13 counties which are as follows: Tioga County-2 systems; Bradford County- 3 systems; Wayne County- 3 systems; Susquehanna, Lackawanna, Wyoming, Sullivan and Columbia County each have one watering system installed. All of the systems installed have reduced the amount of fuel consumed on each of the farm, KWH of renewable electricity being generated, and improved water quality through prevention of erosion, better nutrient management, and more water infiltration/uptake. A summarization of the total project results are as follows:

Gallons of Fuel Saved:	2,733
Miles per Year by Farm Equipment Saved:	2,074
KWH produced:	1,087
Acres converted to Grazing (improved water quality):	303

The educational/outreach component of the project was a large success as well. The 2006 Annual Pennsylvania Statewide Project Grass Conference was held in the October 2006 at PennCollege in Williamsport. The conference highlighted rotational grazing practices as part of the two-day event, which included a presentation on the project and how renewable energy can assist with expanding and improving upon current grazing systems. Attendance at the conference was very close to 200 people. Other educational success include the 3rd Annual Northeast PA Grazing Conference: Making Green with Green: Direct Marketing Your Pasture Raised Products, which included a discussion on the project and how renewable energy options were an option for landowners to compliment savings on the grazing operation. The Northeast PA conference had over 175 people in attendance.

Problems Encountered/Solutions

Problems encountered with the project were not substantial, but included time delays in the completion of project designs, inclement weather for construction, and landowners declining to participate with the project. NRCS completed the watering systems designs for each of the landowners participating with the project. The designs were in addition to the current workload of the NRCS engineers and field staff, which resulted in the designs taking longer than anticipated and a delay in the implementation of the project. The NRCS Grazing Specialist worked with the engineers and field staff to assist with the completion the designs as soon

as the workload allowed. Therefore all of the designs were in fact completed and approved in time for the projects to be completed with the timeline of the grant extension.

The water pumping systems needed to be installed according to the NRCS design plans. Many of the design plans used underground water lines for the systems to prevent freezing and other problems to the water lines. This required that the installation of the watering systems had to involve earth moving activities which require acceptable weather for it to be completed. This delayed the implementation of some of the projects because the designs were completed in the late fall or winter, so the landowners had to wait until good construction weather the following spring or summer.

The largest obstacle to the project was landowners declining to participate with the project once they had gone through the selection, contracting, and/or design process. Several landowners backed out of the project well after their project was selected and designed due to several reasons, but mostly due to lack of financial means to complete the project. The landowners were allowed to be released from their contracts, but then new landowners needed to be selected and had to be run through the whole process mentioned. This is what caused the largest problem and delay with the project.

Project Results Dissemination

The results from the project will be disseminated by various different methods. Project Grass Northeast will disseminate the results of the project to the groups members via meetings and written reports. Project Grass Northeast along with the Pocono Northeast & Endless Mountains RC&D Councils are involved with a grazing initiative which includes hosting “pasture walks” and “pasture pie” meetings where the information will be distributed. The walks and meetings are targeting landowners to inform them about rotational grazing opportunities along with discussing ideas and methods to improve grazing operations. This forum will be a great opportunity to provide information on the project.

The Pocono Northeast RC&D Council is planning to coordinate field days and presentations with Project Grass Northeast and Endless Mountains RC&D that will take place at some of the project sites to highlight the opportunities with solar and wind water pumping systems. A demonstration pump has been purchased and is being constructed to utilize at presentations, meetings, and field days which will help to disseminate the results of the project. This will be utilized by all three organizations to promote the use of renewable energy to reduce the use of fossil fuels and improve the environment. The Pocono Northeast RC&D Council also has a biannual newsletter that gets distributed to over 200 people within the RC&D Area, which will be used to highlight the accomplishments of the project.

Project Spending Summary

The project budget that as submitted to DEP was followed very closely, and did not vary from the original submission. The project spending was in the contractual, construction, and administrative categories. The project was completed with not spending all the grant funding that was allotted due to two landowners backing out of the project at the last minute. This did not allow enough time for the project partners to select another landowner to participate with the project.

Project Summary (50 words or less):

The Solar and Wind Powered Water Pumping Systems for Rotational Grazing Systems project succeeded in promoting rotational grazing practices to local producers, and assisted with the installation of 13 watering systems. The watering systems are utilizing renewable energy and significantly reducing the use of fossil fuels from the operations.

Performance Outcome Data

The performance outcome data for the project resulted in the successful design and installation of 12 solar and 1 wind powered water pumping system throughout 8 of the 13 counties in the Project Grass Northeast area. A mobile demonstration pump unit has also been constructed which will be used as an education/outreach tool for presentations, meetings, field days, etc. The following table shows the outcome data for each farm:

Farm	County	Days Solar/Wind Pump in Use	KWH Generated	Acreage converted for grazing	Gallons of Fuel Saved	Miles saved per Year from Farm
Farm #1	Bradford	510	306	45	1,467	824
Farm #2	Bradford	150	24	DNP	DNP	DNP
Farm #3	Bradford	DNP	DNP	DNP	DNP	DNP
Farm #4	Columbia	120	144	15	90	69
Farm #5	Lackawanna	DNP	DNP	DNP	DNP	DNP
Farm #6	Sullivan	225	51	20	120	92
Farm #7	Susquehanna	57	17	15	90	69
Farm #8	Tioga	3	2	15	180	138
Farm #9	Tioga	270	324	42	252	192.36
Farm #10	Wayne	25	8	62	372	284
Farm #11	Wayne	DNP	DNP	20	120	92
Farm #12	Wayne	240	115	65	390	298
Farm #13	Wyoming	120	96	4	24	18
TOTALS		1,720	1,087	303	2,733	2,074

* DNP= data not provided/available at this time

Utilizing the estimated 1,087 KWH generated for this power using the 2004 Pennsylvania State average of 8.27 cents/ kwh value from http://www.eia.doe.gov/cneaf/electricity/st_profiles/pennsylvania.html the calculator produced the following pollution reductions:

Pollution	CO2	NOx	SO2	Mercury
Total Reduction (lbs.)	1,428	2	11	27 mg

However, using the estimated cost for this power using the 2004 Pennsylvania State average of 8.27 cents/ kwh value plus a \$20.00 monthly service charge for residential customers from http://www.eia.doe.gov/cneaf/electricity/st_profiles/pennsylvania.html the calculator produced the following pollution reductions:

Pollution	CO2	NOx	SO2	Mercury
Total Reduction (lbs.)	16,665	25	128	316 mg

According to the vehicle pollution calculator at: <http://www.cabq.gov/airquality/vehiclepollution.html> A heavy truck classification was used due to no classification for farm equipment, and 100 mile odometer reading was used. The estimated pollution reductions from using 2,074 miles less of fuel for farm equipment is:

Pollution	Non-Methane Hydrocarbons (NMH)	CO	NOx	Particulate Matter (PM)
Total Reduction (lbs.)	1.8	22.8	5	0.5

All of the pollution reduction data are results of this project from renewable electricity generated and reduction in gas and mileage used on the farm. These pollution reductions will continue in subsequent years as a result of this project. Depending upon whether the landowners run the solar or wind powered water

pumping system for more days than what was originally reported, then the reductions will be increased. If the landowners decide to convert more acreage to rotational grazing, then that will result in greater amounts of fuel saved and thus, greater reductions in pollution associated with fuel consumption.

The project also resulted in better nutrient management, soil structure, and water quality improvement. These results are hard to quantify, but soil samples were taken as well as the evaluation of soil respiration rates and infiltration capacity. A student intern collected soil quality samples during the summer and fall of 2005 and 2006 on farms where grant projects have been implemented. He sampled water infiltration rate, soil respiration rate, soil sampling, organic matter, and pH. Our initial intention was to look at the sites two consecutive years to see if there were any notable changes in soil quality at the solar/wind powered watering system sites. What we found after analyzing our data collected was that the soil quality tests that we selected were dependent on weather and rainfall conditions. For instance two main indicators of soil quality we looked at were infiltration and soil respiration. A high quality soil would have a fairly rapid infiltration rate and a high amount of soil respiration due to large populations of soil microorganisms.

As the project played out many of the farms were behind on their installation schedule so therefore when the second year's soil sampling occurred, the water system was either just implemented or was not complete yet. This, in combination with variations in time of the year that sampling was done, and coupled with a fairly dry year next to a wet year made it difficult to compare pre and post watering system soil data. In the future, i.e. 5 years down the road it would be interesting to take a look at soil quality on each of these farms and then do a comparison of soil quality. As row crop agriculture has found out with no-till crop production it takes several years to increase organic matter levels and improve soil quality, especially in areas that have been abused.

See attached soil sampling data.

Operation, Maintenance, and Replacement Plans

Each of the landowners that were selected to participate with the project were provided with detailed designs from NRCS on the water system. Therefore, as part of the plans provided by NRCS maintenance and upkeep of the systems was discussed. If there are any questions or concerns with maintaining the solar and/or wind portion of the system, the landowners should have all received instructions on the solar and/or wind system as well as a troubleshooting guide from the vendor.

Financial Report

The financial report for the project was developed and submitted as follows in the DEP Energy Harvest Grant application:

Pennsylvania Energy Harvest Funds Requested

Construction

15 solar pumping systems @ \$6,000	<u>\$90,000.00</u>
Total Construction	\$90,000.00

Contractual

Education, Field Days, Meetings	\$5,000.00
Summer Intern and Expenses	<u>\$5025.00</u>
Total Contractual	\$10,025.00

Administration

\$1,800.00

Total Grant Funds Requested: **\$101,825.00**

Proposed Matching Funds

Minimum 25% Match from 15 Farmers	\$22,500.00
Technical Assistance from Coop. Agency	\$15,000.00 (\$1,000 in TA estimated per project)
Assistance from Endless Mt. RC&D	\$1,000.00 (planning and facilitating meetings)
<u>Soil Quality Test Kits (2) Endless Mt. RC&D</u>	<u>\$1,000.00 (allowing Project to use the kits)</u>
Total In-Kind Match	\$39,500.00

Total Project Cost: **\$141,325.00**

Actual Financial Expenditures

Pennsylvania Energy Harvest Funds Requested

Construction

14 solar pumping systems	<u>\$81,003.75</u>
Total Construction	\$81,003.75

Contractual

Education, Field Days, Meetings	\$5,000.00
Summer Intern and Expenses	<u>\$5025.00</u>
Total Contractual	\$10,274.96

Travel

	<u>\$85.80</u>
Total Travel	\$85.80

Administration

\$1,883.87

Total Grant Funds Expended: **\$93,248.38**

Actual In-kind Matching Funds

Minimum 25% Match from 14 Farmers	\$101,289.10
Technical Assistance from Coop. Agency	\$28,768.47
Endless Mountains RC&D Council	\$16,787.82
<u>Soil Quality Test Kits (2) Endless Mt. RC&D</u>	<u>\$1,000.00 (allowing Project to use the kits)</u>
Total In-Kind Match	\$147,845.39

Total Project Cost: **\$241,093.77**

The final financial report has all documentation attached as a Quickbooks spreadsheet & in-kind contributions.