# Environment and Natural Resources Trust Fund
# 2017 Request for Proposals (RFP)

**Project Title:** **ENRTF ID: 147-E**

Generation, Storage, and Utilization of Solar Energy

**Category:** E. Air Quality, Climate Change, and Renewable Energy

**Total Project Budget: $** 795,500

**Proposed Project Time Period for the Funding Requested:** 3 years, July 2017 - June 2020

**Summary:**

This project will develop and demonstrate an integrated facility to generate electricity, shade dairy cattle, and provide energy storage and utilization from solar technologies at the WCROC in Morris, MN.

**Name:** Bradley Heins

**Sponsoring Organization:** U of MN

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Morris MN 56267

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**Location**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

**Alternate Text for Visual:**

Schematic representation of the integrated solar electric system, energy storage, and cow cooling system.

_____ Funding Priorities _____ Multiple Benefits _____ Outcomes _____ Knowledge Base

_____ Extent of Impact _____ Innovation _____ Scientific/Tech Basis _____ Urgency

_____ Capacity Readiness _____ Leverage _____ TOTAL _____%

**PROJECT TITLE: Generation, Storage, and Utilization of Solar Energy**

**I. PROJECT STATEMENT**

Through past investments and institutional experience in renewable energy and dairy production research, the University of Minnesota West Central Research and Outreach Center (WCROC) has a globally unique opportunity to lead a new green revolution - a revolution that greens energy currently consumed within the agricultural industry. This proposal will leverage current efforts by further developing solar energy storage and utilization strategies for Minnesota. The agricultural industry consumes an immense amount of fossil-fuel in the production of food, feed, fiber, and energy. From the electricity that cools milk, to the fuel that is burned in combines and tractors in grain fields, to the trucks that bring goods to market, and to the nitrogen fertilizer that nourishes plants; the agricultural industry is captive to large and constant supplies of a wide range of fossil energy. Agriculture's dependence and thirst for fossil-fuel carries significant economic, environmental, and social risks for the nation and world. The overall objective of our project is to integrate solar technologies into dairy production systems to generate, store, and utilize electricity. The project team proposes to evaluate applicability and implementation of solar systems for shading of cattle, as well as generating electricity for storage systems that will be used to power electric vehicles from around western Minnesota. The team will leverage current research by testing clean energy storage systems and provide consumers with an evaluation of tested clean energy vehicles for livestock facilities and the highway system. Additionally, we will evaluate the cow cooling potential of solar systems in the grazing dairy system at the WCROC. The knowledge and information generated will be disseminated to agricultural producers, energy professionals, students, and other stakeholders through Extension websites, social media, and field days hosted at the WCROC.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1: Design solar systems and battery storage for dairy facilities.** **Budget: $520,000**

A 30 kW solar photovoltaic system will be installed in a pasture at the WCROC. Tesla battery storage systems will be installed and tested for powering clean energy vehicles. We will install a DC fast charger that can charge a vehicle's battery from 30% to 80% in about 15 minutes. We will assist to make electric vehicle ownership viable especially in rural Minnesota. The energy and storage systems will be tested for two years for production and reliability.

| Outcome | Completion Date |
|---|---|
| *1. Install a 30 kW photovoltaic solar system in a pasture at the WCROC dairy.* | *7/1/2018* |
| *2. Install Tesla battery storage systems to power clean energy vehicles.* | *7/1/2018* |
| *3. Conduct field tests on electric vehicle charging at the WCROC.* | *7/1/2019* |

**Activity 2: We will evaluate the shade potential of solar systems for pastured-cattle.** **Budget: $144,000**

The team will utilize the solar production system in the pasture to effectively evaluate the cow-cooling and animal welfare benefits of using solar systems for shade potential at the WCROC dairy.

| Outcome | Completion Date |
|---|---|
| *1. Conduct research of solar system for use in cooling cows compared to the natural environment at WCROC dairy.* | *7/10/2019* |
| *2. Graduate student will complete evaluation of shade study and a PhD dissertation.* | *6/30/2020* |

**Activity 3: Field test dairy farm clean energy systems and develop effective control strategies**. **Budget: $81,500**

The team will utilize the dairy facilities at the WCROC to determine baseline energy use. Other on-farm clean energy systems will be monitored to determine production. An engineering firm with experience in modeling and incorporating clean energy systems will use the information to recommend clean energy systems and rank

them based on energy savings and / or return on investment. The engineering firm will complete designs incorporating solar electrical energy systems into dairy facilities.

| Outcome | Completion Date |
|---|---|
| *1. Install energy meters and record energy consumption data for two years at MN dairies.* | *7/10/2019* |
| *2. Model clean energy alternatives with projected return-on-investment.* | *7/10/2019* |
| *3. Complete designs of clean energy systems for field testing at the WCROC.* | *8/1/2019* |

**Activity 4: *Educate consumers, industry representatives, dairy producers and the general public about technology to generate, store, and utilize electricity from solar energy technologies.*** **Budget: $ 50,000**

The most effective way to educate livestock producers and consumers to adopt new technologies is to demonstrate improved solar storage systems. The results from all activities will be used to demonstrate the potential of the electric battery storage systems. The research and outreach center will be used as the demonstration site to educate all of Minnesota about solar energy technologies.

| Outcome | Completion Date |
|---|---|
| *1. Host a tour and demonstration of the site and storage facility during our Midwest Farm Energy Conference at the WCROC.* | *5/30/2019* |
| *2. Conduct energy workshops and webinars across the State.* | *6/30/2020* |
| *3. Prepare Extension factsheets to inform stakeholders of the solar storage technologies.* | *6/30/2020* |
| *4. Submit semi-annual reports and a comprehensive final report.* | *6/30/2020* |

## III. PROJECT STRATEGY

### A. Project Team/Partners

Dr. Bradley Heins, U of MN Dairy Scientist, will serve as PI and project manager. He will be responsible for all reports and deliverables. He will also manage the activities of the dairy production system at the research and outreach center, conduct solar studies, and manage the demonstration site. Michael Reese, U of MN WCROC Renewable Energy Director, and Dr. Lee Johnston, U of MN Swine Scientist, will be co-investigators managing the activities within their respected specialties. They will assist with outreach and dissemination of results. Eric Buchanan, WCROC Renewable Energy Scientist, will be the project coordinator assisting in the design, installation, testing, and control strategies of the solar and battery storage technologies. He will also assist with the outreach and dissemination of results. AKF Engineering (Minneapolis) or equivalent will provide consulting services for clean energy modeling, designing, commissioning, and control strategies.

### B. Project Impact and Long-Term Strategy

The WCROC has a 10-year strategic plan to reduce fossil energy consumption and the carbon footprint within dairy production systems. This collaborative project will build on renewable energy and solar technology activities of the project investigators. Previous funding has been received through the U of MN Initiative for Renewable Energy and the Environment and Xcel Energy RDF funds to measure energy consumption within the WCROC dairy and test clean energy systems. This proposed project will facilitate and demonstrate the need for energy storage systems in an agricultural setting. Additional long-term funding will be sought to conduct research with alternatives to fossil energy within all agricultural crop and livestock enterprises.

### C. Timeline Requirements

This project is proposed for 3 years beginning July 1, 2017 and ending June 30, 2020. This time frame will allow for adequate opportunity for research, data collection, education efforts, and peer-review of the information by the members of the team, industry professionals and consultants, and dairy producers. Research and outreach information will be disseminated after the data are collected, analyzed, and summarized.

# 2017 Detailed Project Budget

**Project Title:***Generation, Storage, and Utilization of Solar Energy.*

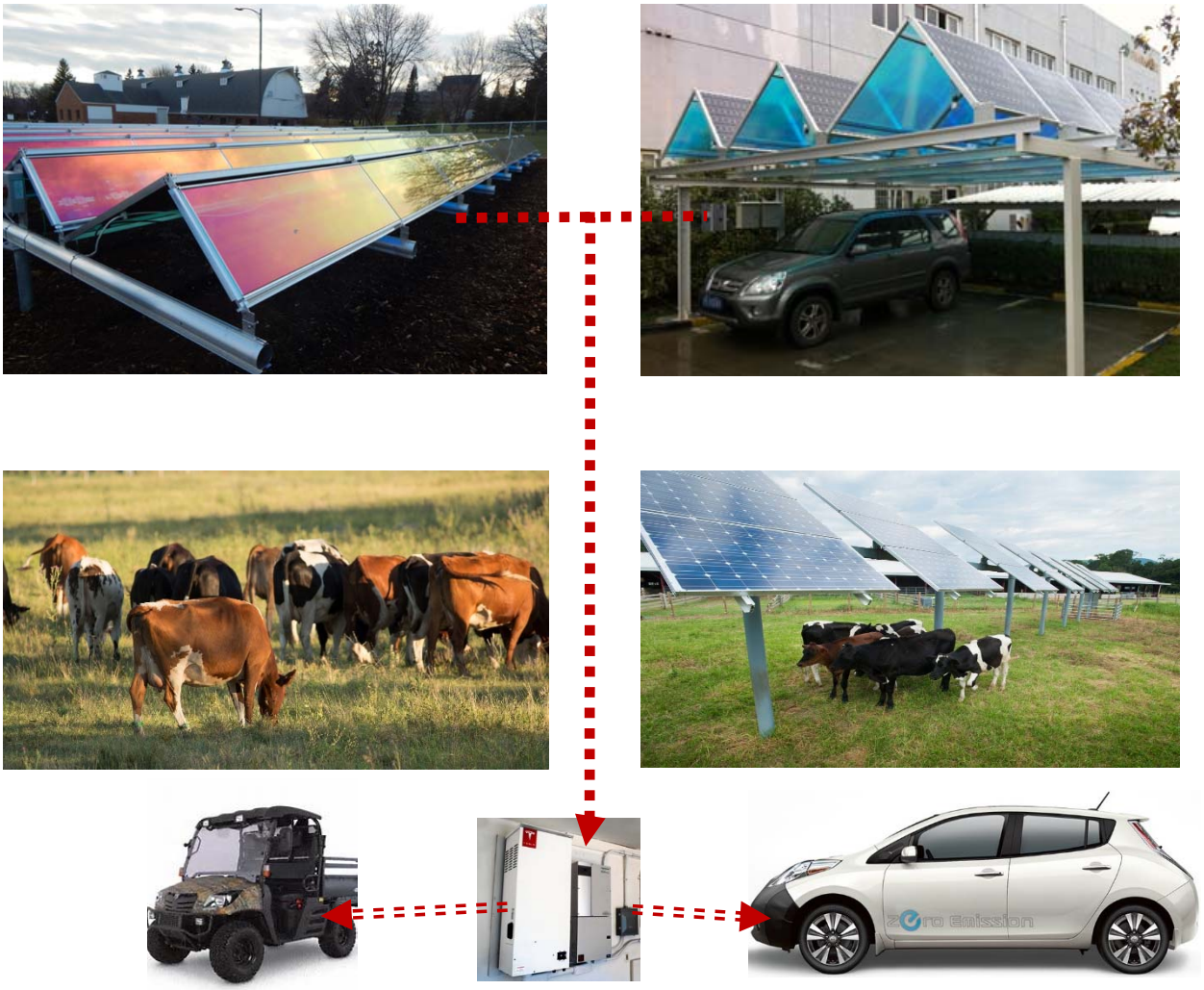
**IV. TOTAL ENRTF REQUEST BUDGET: 3 years**

| BUDGET ITEM | AMOUNT |
|---|---|
| **Personnel:** | $ - |
| PhD Graduate Research Assistant, data collection, monitoring and analysis, 50% FTE for 3 years, the RA fringe rate is 17.6% plus tuition during the academic year | $120,000 |
| Junior Scientist - Technician for data collection, system testing (100% FTE - 3 Yrs) 33.7 % fringe rate | $171,000 |
| Undergrad Student Interns - Clean Energy Technology for MN Dairies (3 Yrs) | $18,000 |
| **Professional/Technical/Service Contracts:** | $ - |
| AKF Engineering (or equivalent firm) - Modeling, Pre-design, Design, Commissioning, and Control Optimization Engineering Professional Services | 86,000 |
| Farmer Contracts -TBD - Monitoring of on-farm systems and supply of system specs | 48,000 |
| General Contractor TBD - Installation of solar systems and battery storage | 65,000 |
| Mechanical Contractor TBD - Installation of energy meters | 5,000 |
| **Equipment/Tools/Supplies:** | $ - |
| 30 kW System and Foundation for Solar for Pasture Cows | $ 130,000 |
| Energy Meters for Dairy Facilities | $ 5,000 |
| Data Loggers for Dairy Facilities | $ 7,500 |
| DC fast charging station | 60,000 |
| Smart level II charging station with 3 Tesla Powerall Batteries | 15,000 |
| ReCoil iS 100% Electric ATV. 72 volt AC electric drivetrain, $15,000/each | 30,000 |
| **Travel:** | $ - |
| Lease of University of Minnesota Nissan Leaf 100% electric vehicle. $600/month X 24 months | 15,000 |
| Travel, Lodging and meals for WCROC project team at four regional workshops | 6,000 |
| **Additional Budget Items:** | $ - |
| Extension Workshops and Field Days | 5,000 |
| Publications of research in Open Access Journals: 5 publications | 9,000 |
| **TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST** | $ 795,500 |

**V. OTHER FUNDS**

| SOURCE OF FUNDS | AMOUNT | Status |
|---|---|---|
| **In-kind Services To Be Applied To Project During Project Period:** *The foregone federally negotiated ICR funding constitutes the University of Minnesota's cost share to the project. Additionally PI and Co-I unpaid effort.* | $ 288,608 | *Pending* |
| **Funding History: F**unding was provided by the U of MN Initiative for Renewable Energy and the Environment (IREE) and the College of Food, Agricultural, and Natural Resource Sciences. The original IREE source of the funding was through Xcel Energy customers through MN Dept. of Commerce. Xcel Energy RDF has also provided funding for research at the WCROC dairy. This proposal leverages past and current work implementing clean energy technologies, life cycle, and economic analysis of energy-optimized crop and dairy production systems. | $ 1,350,000 | Awarded Jan 2013 |
| **Remaining $ From Current ENRTF Appropriation:***2016 Appropriation 148-E, Titled: Utilization of farm wastewater for sustainable dairy production* | $ 500,000 | *Obligated* |

**Generation, Storage, and Utilization of Solar Energy**




Our concept is to evaluate solar PV for multiple uses in a grazing-based dairy. In addition to generating electricity, the panels will be studied for use as livestock shade to improve animal comfort and productivity. The solar generated electricity will be sent to a storage battery bank and charging station. Electric all-terrain utility vehicles will be charged by solar energy and used within the pasture and dairy farm. An electric car will be charged with solar energy and used for travel to small and mid-sized commercial dairy farms to conduct baseline energy audits. This study is the first step to convert fossil-based vehicles used in dairy farms, to clean and locally produced energy.

**Environmental and Natural Resources Trust Fund**
**2017 Project Manager Qualifications and Organization Description**
**Project Title: Generation, Storage, and Utilization of Solar Energy**

**Bradley J. Heins, Principle Investigator / Project Manager**

For the past five years, Dr. Heins has been an Assistant Professor of Dairy Management at the University of Minnesota West Central Research and Outreach Center – Morris. He has overseen the development of the dairy program at Morris and has participated as Principal Investigator on over $2.5 million of research projects including grazing and pasture management, profitability of organic dairies, livestock efficiency, and renewable energy systems for dairy farms. Specifically, Dr. Heins has overseen the development of the University of Minnesota's organic dairy production system and is the Principle Investigator for a $1.93 million dollar UDSA grant that will enhance organic dairy farm efficiency, productivity, and profitability. He is also principle investigator on a University of Minnesota Rapid Agricultural Response Fund grant that will reduce fossil-fuel consumption in dairy and swine production systems through renewable energy generation, energy conservation, and energy optimization. Dr. Heins has also trained 5 graduate students in the areas of dairy cattle management and livestock farm efficiency. He has been an invited speaker for numerous national and international conferences and workshops on the topic of dairy cattle management. Dr. Heins serves on the Minnesota Organic Advisory Task Force. In addition to Dr. Heins, the project team include faculty with over fifty years of experience in livestock production and bioengineering research and outreach.

The primary organization is the University of Minnesota with researchers from the West Central Research and Outreach Center (WCROC) and Animal Science departments. The WCROC, located near Morris, will serve as the primary project location. The WCROC is a 1,100-acre agricultural experiment station that focuses on applied research. The WCROC has several relevant program areas including dairy and swine production, renewable energy, and conventional and organic crop production. The WCROC was selected as the 2011 Outstanding Conservationist for Stevens County by the Stevens Soil and Water Conservation District Board. The WCROC is ideally positioned to address critical dairy production and agricultural water quality issues. The faculty and staff have considerable experience in developing and effectively implementing applied research, outreach, and extension programs at the applied farm-level. The WCROC has nationally unique facilities and programs that compare conventional and organic crop and livestock production systems. The dairy program has the only side-by-side comparison of organic and conventional systems in the nation and the swine program is one of a handful to co-locate conventional and alternative production systems. In addition to agricultural production systems, the WCROC has a robust renewable energy program with farm-scale production systems. The renewable energy program features solar thermal, wind energy, and algal production systems. A primary goal for the renewable energy program is to significantly decrease fossil-fuel consumption in the agriculture sector. The project team strives to optimize energy efficiency, develop effective clean water strategies, and improve long-term profitability for producers.