Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **122-E**

Transitioning Minnesota Farms to Local Energy

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

Total Project Budget: $ 1,049,992

Proposed Project Time Period for the Funding Requested: 3 Years, July 2014 - June 2017

Summary:

Agricultures dependence on fossil energy carries economic and ecological risks. Clean energy strategies will be developed for Minnesota farms to significantly reduce fossil energy use while increasing local energy production.

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Location

Region: Statewide

County Name: Statewide

City / Township:

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ Employment	_____ TOTAL _____%

PROJECT TITLE: Transitioning Minnesota Farms to Local Energy

I. PROJECT STATEMENT

The University of Minnesota West Central Research and Outreach Center (WCROC) has a strategic goal to reduce fossil energy consumption within production agriculture. This proposal will leverage current efforts by further developing clean energy strategies for Minnesota swine and dairy farms. The 2008 MN Climate Change Advisory Group Final Report indicates agriculture contributes 14% of the total greenhouse gas emissions in the State; second only to electrical generation. Production agriculture's dependence on fossil energy carries significant economic and ecological risks. Current research at WCROC is focused on lowering the carbon footprint of grains and feeds through renewable synthetic fertilizer production and reduced field tillage. However, research is needed to optimize clean energy strategies for livestock facilities. According to the National Agricultural Statistic Service, Minnesota has 468,000 dairy cows and 7.8 million pigs (2012). The energy consumed within livestock facilities is the equivalent consumption of several large cities. Minnesota farmers historically have adopted technology to efficiently use resources and optimize production. However, implementation of clean energy technologies on farms has been extremely slow. In lieu of proven systems, farmers continue to opt for conventional fossil-based energy. Adoption of clean energy systems in crop and livestock production will position the State's agricultural sector to be globally competitive particularly as consumers are increasingly demanding low carbon footprint products. The overall project goals are to significantly decrease use of fossil energy, reduce carbon emissions within production agriculture, and to increase adoption of locally-produced renewable energy technologies. The project team proposes to evaluate applicability and implementation of clean energy technologies in dairy and swine production. The team will leverage current research by designing and testing integrated clean energy systems, conduct life cycle assessment, and provide producers with tested clean energy designs for livestock facilities. Agricultural producers and secondary students will learn about clean energy strategies through research, demonstration, and hands-on learning experiences. We are pleased to submit this $1,049,992 proposal to develop clean energy strategies for Minnesota farms.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Design clean energy systems for modern swine and dairy facilities $197,146

The team will utilize the model swine and 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 thermal and electrical energy systems into livestock facilities.

Outcome	Completion Date
1. Install energy meters and record energy consumption data for one year	*7/10/2015*
2. Model clean energy alternatives with projected return-on-investment	*7/10/2015*
3. Complete designs of clean energy systems for field testing at the WCROC	*8/1/2015*

Activity 2: Field test on-farm clean energy systems and develop effective control strategies $509,067

A 20 kW wind turbine and a 4 kW solar photovoltaic system will be installed at the WCROC dairy. A 20 kW solar photovoltaic system will be installed on the WCROC swine nursery. Control systems will be installed and tested using three different control strategies. The control of farm-scale clean energy systems is deficient and a barrier to adoption. The energy systems will be tested for two years for production and reliability.

Outcome	Completion Date
1. Install a 20 kW wind turbine and 4 kW photovoltaic solar system at the WCROC dairy	*7/1/2015*
2. Install a 20 kW solar photovoltaic solar system at the WCROC swine nursery	*7/1/2015*
3. Install automated control systems to integrate clean energy systems	*7/1/2015*
4. Conduct field tests on three control strategies at the WCROC swine nursery and dairy	*6/1/2017*

5. Performance test clean energy systems for two years	*6/30/2017*

Activity 3: Perform a life cycle assessment and evaluate basic economics $180,523

A life cycle analysis will performed on the WCROC swine nursery comparing conventional with the clean energy systems. As a life cycle analysis is already in progress for the dairy, the clean electrical energy generation added within this proposal will also be evaluated. The project team will use capital costs, operation and maintenance, and production data to develop basic economic feasibilities.

Outcome	Completion Date
Complete a life cycle assessment of the swine nursery using field data and literature values	*4/1/2017*
Complete an economic evaluation comparing conventional with optimized-energy systems	*6/15/2017*

Activity 4: Educate farmers and students about clean energy strategies for Minnesota farms $163,256

Perhaps the most effective approach to change the way energy is used in crop and livestock systems is to educate agricultural students about clean energy technologies. Based on the research results and literature review, curriculum will be developed for secondary and technical students. Agricultural producers and other key stakeholders will be provided with educational opportunities including an agricultural energy conference and tour, four regional agricultural energy workshops across the State, and the completion of an agricultural energy guidebook. Select livestock farms in the four regions will be modeled and used for case studies within the workshop to demonstrate the opportunities for clean energy technologies.

Outcome	Completion Date
1. Develop agricultural energy curriculum for secondary and technical students	*8/1/2016*
2. Host an agricultural energy conference and tour to showcase clean energy systems	*6/30/2017*
3. Conduct four regional agriculture energy workshops across the State	*4/15/2017*
4. Completion of a "Clean Energy Strategies for Minnesota Farms" Guidebook	*6/15/2017*
5. Submit semi-annual reports and a comprehensive final report	*6/30/2017*

III. PROJECT STRATEGY

A. Project Team/Partners: Michael Reese, U of MN WCROC Renewable Energy Director, will serve as the principle investigator and project manager. He will be responsible for all reports and deliverables. Dr. Lee Johnston (U of MN Swine Scientist) and Dr. Brad Heins (U of MN Dairy Scientist) will be co-investigators managing the activities within their respected livestock specialties. Dr. Larry Jacobson (U of MN Agricultural Engineer) will be a co-investigator and provide guidance on clean energy designs and testing in livestock facilities. He will also participate in the outreach activities. Dr. Joel Tallaksen (WCROC Renewable Energy Scientist) will serve as a co-investigator and be responsible for the life cycle analysis and oversee the basic economic evaluation. Eric Buchanan (WCROC Renewable Energy Scientist) will be the project coordinator assisting in the design, installation, testing, and control strategies of the clean energy 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. Timeline Requirements: The project is proposed for three full years beginning July 1, 2014 and ending June 30, 2017. Ideally, two years of performance data will be collected to account for seasonal and annual variation.

C. Long-Term Strategy and Future Funding Needs: The WCROC has a 10-year strategic plan to reduce fossil energy consumption and the carbon footprint within production agriculture. This proposal will leverage and build upon current projects. Funding has been received through the U of MN Initiative for Renewable Energy and the Environment ($350k) to measure energy consumption within a model dairy and test clean thermal energy systems. The funded project will also evaluate greenhouse gas emissions within portions of crop and dairy production. Long-term funding will be sought to research alternatives to fossil energy within all agricultural crop and livestock enterprises.

Project Title: Transitioning *Minnesota Farms to Local Energy*

IV. TOTAL ENRTF REQUEST BUDGET - 3 years

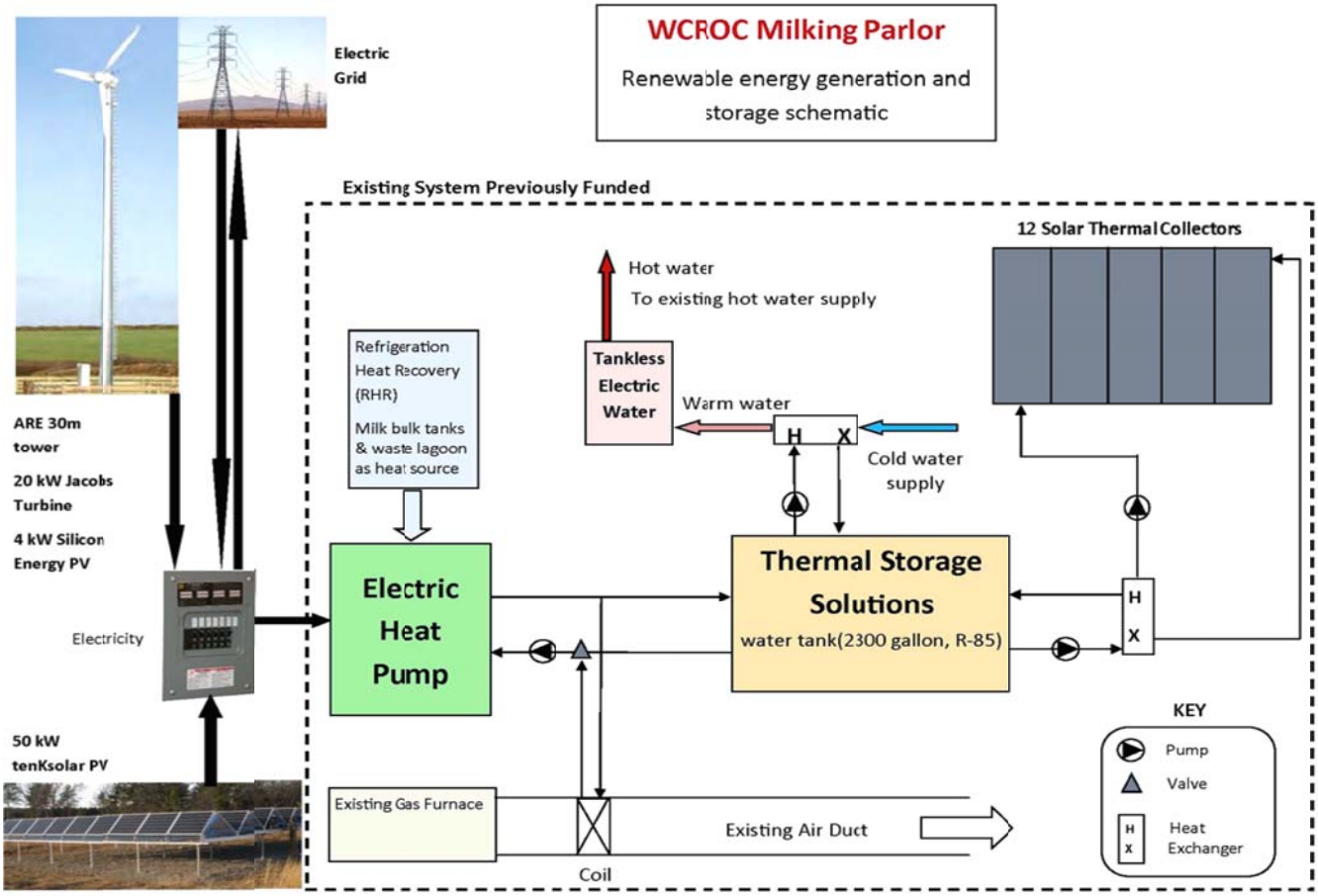
BUDGET ITEM	YEAR 1	YEAR 2	YEAR 3	TOTAL
Personnel:				
Project Coordinator - Eric Buchanan (20% FTE first 6 mo & 80% for remaining 2.5 yrs) 36.8 % fringe rate	$ 33,716	$ 55,294	$ 56,676	$ 145,686
Life Cycle Analysis Researcher - Dr. Joel Tallaksen (50% FTE Yr 1, 60% Yr 2, & 70% Yr 3) 36.8 % fringe rate	$ 39,418	$ 48,482	$ 57,978	$ 145,878
Junior Scientist - Technician for data collection, system testing (100% FTE - 3 Yrs) 36.8 % fringe rate	$ 55,344	$ 56,728	$ 58,146	$ 170,218
Undergrad Student Interns - Clean Energy Technology for MN Dairies (3 Yrs) 7.44% Fringe Rate	$ 5,716	$ 5,716	$ 5,716	$ 17,148
Undergrad Student Interns - Clean Energy Technology for MN Swine Facilities (2 Yrs) 7.44% Fringe Rate		$ 5,716	$ 5,716	$ 11,432
Undergrad Student Interns - Life Cycle and Economic Analysis (2 Yrs) 7.44% Fringe Rate		$ 5,716	$ 5,716	$ 11,432
TOTAL PERSONNEL				**$ 501,794**
Contracts:				
AKF Engineering (or equivalent firm) - Modeling, Pre-design, Design, Commissioning, and Control Optimization Engineering Professional Services	$ 54,000	$ 32,000		$ 86,000
Farmer Contracts -TBD - Monitoring of on-farm systems and supply of system specs	$ 16,000	$ 16,000	$ 16,000	$ 48,000
General Contractor TBD - Installation of farm-scale wind turbine and solar PV systems	$ 42,000			$ 42,000
Mechanical Contractor TBD - Installation of energy meters	$ 4,200			$ 4,200
Mechanical Contractor TBD - Installation of control systems in swine nursery	$ 19,000			$ 19,000
TOTAL CONTRACTS				**$ 199,200**
Equipment/Tools/Supplies:				
20 kW Wind Turbine for Dairy	$ 117,000			$ 117,000
4 kW Solar Photovoltaic System for Dairy	$ 26,500			$ 26,500
20 kW Solar Photovoltaic System for Swine Nursery	$ 132,000			$ 132,000
Control Systems for Swine Buildings	$ 32,600			$ 32,600
Energy Meters for Swine Buildings	$ 3,600			$ 3,600
Data Loggers for Swine Buildings	$ 2,300			$ 2,300
TOTAL EQUIPMENT AND SUPPLIES				**$ 314,000**
Travel:				
Eight trips by Dr. Jacobson from Saint Paul to Morris, MN (330 miles @ $.565 / mi)	$ 559	$ 559	$ 373	$ 1,492
Travel by project team to four regional workshops across the State (4 trips, 400 miles each, $.565 / mi)			$ 904	$ 904
Lodging and meals for WCROC project team at four regional workshops (4 people / 4 nights @ $80 / room and $40 ea for meals)			$ 1,440	$ 1,440
Travel, lodging and meals for Larry Jacobson at four regional workshops (400 miles and 4 trips @ .565, 4 nights @ $80 / room and $40 ea for meals)			$ 1,224	$ 1,224
Travel, lodging, and meals for six ag energy conference speakers (6 @ 330 mi and $80 / room and $40 ea for meals)			$ 1,839	$ 1,839
TOTAL TRAVEL				**$ 6,898**
Additional Budget Items:				
Three buses for Ag Energy Conference Tour ($1800 per tour bus)			$ 5,400	$ 5,400
Publication and printing (Curriculum, Ag Energy Conf, Regional Workshops, and Guidebook)		$ 3,600	$ 6,200	$ 9,800
Software for Life Cycle Analysis		$ 7,500		$ 7,500
Training for Control Systems		$ 5,400		$ 5,400
TOTAL ADDITIONAL BUDGET ITEMS				**$ 28,100**
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$ 583,953**	**$ 242,711**	**$ 223,328**	**$ 1,049,992**
*Matching Funds (Unrecovered U of MN Indirect Costs / ICR)	$ 143,444	$ 126,210	$ 116,130	**$ 385,784**

V. OTHER FUNDS

SOURCE OF FUNDS			AMOUNT	Status
Funding History and *Match: *Funding 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. This proposal leverages past and current work implementing clean energy technologies, life cycle, and economic analysis of energy-optimized crop and dairy production systems. *In addition, the 52% in foregone federally negotiated ICR funding constitutes the University's cost share to the project.*			$ 350,000	Award Jan 2013

Environmental and Natural Resources Trust Fund
2014 Visual Graphics
Project Title: Transitioning Minnesota Farms to Local Energy

Graphics 1. Schematic representation of the energy-optimized WCROC dairy parlor



The project team has received past funding from the U of MN Initiative for Renewable Energy and the Environment to install and test the clean thermal energy systems and energy storage identified within the dashed box in Graphics 1. Additional funding is being requested from LCCMR to install a 20 kW wind turbine and a 4 kW solar photovoltaic system to the dairy. This system depicted in Graphic 1 is intended to provide thermal and electrical energy as well as energy storage for the dairy. The energy storage is an innovative approach using a thermal storage system. When wind and solar electric generation is not needed by the dairy, it can be efficiently converted to stored heat through the use of heat pumps. A similar system will be designed for the WCROC swine nursery except the primary source of electric generation will be from a 20 kW solar PV system. These clean energy systems are intended to be used as models so livestock producers can retrofit conventional swine and dairy facilities. Optimized control strategies will be required as there are more variables to manage in comparison to conventional systems. The project team will utilize Minnesota manufacturers of the solar photovoltaic systems and the small wind turbine.

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2014 Project Manager Qualifications and Organization Description
Project Title: Transitioning Minnesota Farms to Local Energy

Michael Reese, Principle Investigator / Project Manager
For the past twelve years, Mr. Reese has been the Renewable Energy Director at the University of Minnesota West Central Research and Outreach Center – Morris. He has overseen the development of the renewable energy program at Morris and has participated as Project Manager on over $14 million of research and demonstration projects including large scale wind energy, biomass gasification, renewable hydrogen and ammonia, and solar thermal energy systems. Specifically, Mr. Reese has overseen the development of the University's 1.65 MW utility scale wind turbine and is the Principle Investigator for the $3.75 million Wind to Hydrogen to Ammonia system. His biomass energy experience includes serving as WCROC Project Manager on a $1.89 million DOE – USDA biomass research and development project in which a Biomass Gasification Tool Box was developed for deployment of community scale biomass systems. Mr. Reese has also served as the Principle Investigator for solar thermal research initiatives. He has been an invited speaker for numerous national and regional conferences on the topic of renewable energy. In addition to renewable energy, he continues to maintain a strong focus in agriculture and rural economic development. Mr. Reese serves on several boards including the West Central Initiative Foundation (6 years – past year as Chairman) and the White Bear Lake Insurance Company (22 years – last 4 as President). In addition to Mr. Reese, the project team include faculty with over fifty years of experience in livestock production and energy-related research and outreach.

The primary organization is the University of Minnesota with researchers from the West Central Research and Outreach Center (WCROC) and Bioproducts and Bioengineering departments. The WCROC, located near Morris, will serve as the primary project location. The WCROC is a century-old 1,100-acre agricultural experiment station that focuses on applied research. The WCROC has several relevant program areas including renewable energy, swine and dairy production, 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 agricultural energy issues. The staff have considerable experience in developing and effectively implementing applied research, outreach, and extension programs at the farm-level and within agricultural service professions. WCROC has nationally unique facilities and programs that compare conventional and organic / alternative 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 community and farm-scale production systems. The renewable energy program features solar thermal, biomass energy, geothermal, wind energy, and renewable hydrogen and ammonia production systems. These systems are commercially available but have yet to see wide-scale adoption on farms. A primary goal for the renewable energy program is to significantly decrease fossil-fuel consumption in the agriculture sector. One of the main consumers of fossil-fuel in crop and feed production is the use of nitrogen fertilizer. To address this, the WCROC is commissioning a facility which uses wind energy to electro-chemically produce anhydrous ammonia (nitrogen fertilizer). In the next phase, we are looking to lower fossil energy consumption in swine and dairy production facilities and begin the transition of farms to locally-produced energy. The project team strives to optimize energy efficiency, develop effective clean energy strategies, and improve long-term profitability for producers.