

## **Environment and Natural Resources Trust Fund**

## 2026 Request for Proposal

## **General Information**

Proposal ID: 2026-417

Proposal Title: Roadmap to Decarbonize Livestock Farms

## **Project Manager Information**

Name: Erin Cortus Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences Office Telephone: (612) 625-8288 Email: ecortus@umn.edu

## **Project Basic Information**

**Project Summary:** This project will develop a roadmap for decarbonizing energy use on Minnesota livestock farms by electrifying farm operations, reducing carbon emissions, and enhancing sustainability through techno-economic assessments.

**ENRTF Funds Requested:** \$184,000

Proposed Project Completion: June 30, 2028

LCCMR Funding Category: Small Projects (G) Secondary Category: Energy (E)

## **Project Location**

What is the best scale for describing where your work will take place? Statewide

What is the best scale to describe the area impacted by your work? Statewide

When will the work impact occur? During the Project and In the Future

## Narrative

#### Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Minnesota is a leading producer of livestock, including turkeys, pigs, and dairy, making livestock farming a significant economic driver in the state. However, livestock production contributes to carbon emissions through four primary sources: feed production, animal emissions (especially from ruminants), manure management, and energy use. Among these, energy use on farms—such as transportation and barn environment support—provides an opportunity for decarbonization, as farms have decision-making power to transition from fossil fuels to renewable energy sources like wind, solar, and biomass.

Current reliance on fossil fuels for farm operations presents environmental and economic challenges, as farmers face rising energy costs and growing pressure to reduce their carbon footprints. While renewable energy could play a crucial role in decarbonizing farms, the integration of renewable energy technologies on livestock farms remains underexplored. A comprehensive roadmap is needed to demonstrate the technical, economic, and environmental feasibility of electrifying farm operations, considering factors like energy reliability, infrastructure, and regulatory frameworks. This proposal aims to create such a roadmap by assessing energy use and electrification opportunities on three Minnesota livestock farms, providing critical insights for reducing carbon emissions and enhancing sustainability in the state's agricultural sector.

# What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

We propose to develop a comprehensive roadmap for decarbonizing energy use on Minnesota livestock farms through electrification. This project will focus on three case study farms, including a dairy, a poultry barn, and a swine site. By evaluating the current energy usage and fossil fuel consumption on these farms, we aim to identify opportunities for replacing existing equipment with electric alternatives, including machinery for transportation, barn environment management, and manure treatment.

The roadmap will involve a techno-economic assessment to analyze the feasibility of electrification under different electricity pricing scenarios and the potential savings or costs associated with transitioning to electric machinery. Additionally, we will conduct a partial life-cycle analysis to quantify the carbon footprint of electrifying farm operations, comparing scenarios using renewable energy sources versus fossil fuels.

The resulting roadmap will guide farmers in adopting electric solutions tailored to their specific needs while considering reliability, cost, and environmental impact. This work will also provide valuable insights into how renewable energy generation, such as on-farm biogas from manure digesters, can contribute to energy independence and sustainability. Ultimately, this project will empower Minnesota's livestock farmers to make informed decisions about electrification and carbon reduction.

# What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

This project will help reduce carbon emissions from Minnesota's livestock farms by promoting electrification and the use of renewable energy sources. By providing a roadmap for decarbonization, it will support the state's goals for environmental protection and sustainability. The expected outcomes include reduced reliance on fossil fuels, lower greenhouse gas emissions, and the advancement of cleaner energy solutions in agriculture. Additionally, the project will offer farmers actionable insights into electrification, enhancing the long-term conservation of natural resources and contributing to the preservation and enhancement of the state's environment through more sustainable farming practices.

## Activities and Milestones

## Activity 1: Inventory of farm machines and equipment using fossil fuels and/or electricity

Activity Budget: \$60,000

#### **Activity Description:**

Through an on-farm interview and hypothetical inventory with participating farms, we will document the machines and equipment that require fossil fuels (gasoline, diesel, natural gas, etc.) and/or electricity, including but not limited to the following categories: 1) tractors and fleet for on-farm transportation activities (e.g., feed, bedding, livestock transportation, etc.), including worker transportation to and from the farm; 2) barn environment (e.g., ventilation, lighting, water pumps, manure scrapers, etc.); 3) manure storage & treatment (e.g., pumps, agitators, liquid-solid separators, digesters, etc.); and 4) product processing (e.g., milking equipment, egg processing, etc.). The inventory will detail the current types and numbers of machines and equipment, power and use frequency, and energy sources. Previously published inventories of electrical use on Minnesota swine and dairy farms will supplement this inventory. With the data collection, the total consumption of fossil fuels currently in the farms can be calculated. Subsequently, a selection of possible (current and potential) electric farm machine alternatives to replace current fossil fuel-powered ones while meeting reliability and power needs will be presented. We will estimate the change in diurnal and annual electricity consumption patterns with the use of alternatives to fossil fuel-powered machinery.

#### **Activity Milestones:**

Description	Approximate Completion Date
Inventory of farm machines and equipment using fossil fuels and/or electricity	September 30, 2026
Selection of possible electric farm machines alternatives to replace fossil fuel-powered ones	December 31, 2026
Calculation of electricity consumption patterns using electric farm machines	March 31, 2027

## Activity 2: Techno-economic assessment of electrifying a livestock farm under various scenarios

#### Activity Budget: \$62,000

#### **Activity Description:**

Techno-economic assessment (including a risk and pinch analysis) of electrifying these livestock farms will be conducted, considering three different price scenarios for electricity. The main capital costs are from the replacement of the existing fossil fuel-powered farm machines with new electric ones. As the operating costs of these electric machines and equipment will shift to the electricity bill, we will consider three different electrical supply price structures, in addition to regular maintenance of these electrified equipment. Hence, we will be able to calculate the annualized operation cost together with return on investment by using any possible savings in shifting to electric machinery . In addition, for the farm scenario with means of power generation on farm, i.e. from a digester, two conditions need to be considered: 1) if the electricity generated from the combined heat and power (CHP) unit is sufficient to power the whole farm, the power surplus will be sold to the power grid as a renewable power source; 2) if not sufficient, electricity from the current power grid will be the supplement. The assessment will consider possible incentives through the production/generation of renewable energy as a bonus revenue for the applicability of farm electrification.

#### **Activity Milestones:**

Description	Approximate Completion Date
Techno-economic assessment of livestock farm electrification under three scenarios	June 30, 2027
Risk and pinch analysis under three scenarios	June 30, 2027
Refinement of scenario with possible incentives/credits from electricity from renewable biogas	September 30, 2027

## Activity 3: Partial life cycle assessment of electrifying a livestock farm

Activity Budget: \$62,000

#### **Activity Description:**

This activity will conduct a partial life cycle assessment (LCA) to evaluate the carbon footprint of electrifying the selected livestock farms. We will assess three electricity sourcing scenarios: 1) electricity entirely from fossil fuels; 2) electricity from the current power grid, including a mix of renewable and nuclear sources; and 3) electricity sourced entirely from renewable resources, such as wind, solar, or on-farm biogas produced through anaerobic digestion. The LCA will measure the greenhouse gas emissions associated with these different power sources, accounting for both the energy consumed by farm operations and the indirect emissions from electricity generation.

This assessment will focus on the carbon dioxide emissions from electricity generation, excluding other emissions from feed production, manure management, and animal emissions, which will remain consistent across the scenarios. The functional unit of analysis will be the farm's primary product, such as milk, eggs, or pork, produced and leaving the farmgate. By comparing the carbon footprints of electrified farms with conventional farms using fossil fuels, we will highlight the environmental benefits of adopting renewable energy. The results will be compiled into a comprehensive report, which will be shared with farmers, policymakers, and stakeholders to inform decision-making.

#### **Activity Milestones:**

Description	Approximate
	Completion Date
Mapping the whole process of electrifying a farm with appropriate system boundaries	December 31, 2027
Collecting data from inventory and calculating detailed carbon footprint	March 31, 2028
Evaluating and comparing total carbon footprint of electrified farms with conventional energy sources	June 30, 2028

## **Project Partners and Collaborators**

Name	Organization	Role	Receiving
			Funas
Bo Hu	University of Minnesota	Co-Principal Investigator	Yes

## Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

After the desired outcomes are achieved, the data will be available for interpretation and implementation by farming community and state legislatures. Through peer-reviewed publications and professional society conferences, the data and comparison results become available for replicating the methodology on more farms. This ensures that future estimates for Minnesota and region farms account for climate and management differences. Ultimately, the results inform environmental sustainability decisions by producers, but also policy makers. If additional study is needed, funding may be pursued through alternative sources like Conservation Innovation Grants or USDA Rural Development Grant.

## Project Manager and Organization Qualifications

#### Project Manager Name: Erin Cortus

Job Title: Associate Professor and Extension Engineer

#### Provide description of the project manager's qualifications to manage the proposed project.

Erin Cortus joined the Department of Bioproducts and Biosystems Engineering at the University of Minnesota in August 2017. As an Associate Professor and Extension Engineer, she provides engineering expertise in sustainable animal agriculture systems. She earned her Bachelor of Agricultural and Bioresource Engineering degree and PhD at the University of Saskatchewan. Dr. Cortus also has eight years of experience in a similar Research and Extension role at South Dakota State University. The broad mission of Dr. Cortus' program is to work with producers and communities to understand and continually improve the quality and productivity of livestock environments. This mission is accomplished through on-farm research and Extension platforms that expose her to the range of swine, dairy, poultry and beef cattle systems in Minnesota. Dr. Cortus led or currently leads projects sponsored by USDA-NIFA, Midwest Dairy and National Pork Board to understand the technical and social needs of local farms with interest to explore ways to decarbonize their operations.

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

#### **Organization Description:**

In the College of Food, Agricultural and Natural Resources Sciences (CFANS) at the University of Minnesota, we look at the bigger picture. When we envision a better tomorrow, it includes disease-resistant crops, products that protect our health, lakes free from invasive species, and so much more. We use science to find answers to Minnesota and the world's grand challenges and solve tomorrow's problems. Almost 93 percent of students who earn CFANS undergraduate degrees find jobs in their career field or enter graduate school within six months of graduation.

The Department of Bioproducts and Biosystems Engineering, in CFANS, discovers and teaches solutions for the sustainable use of renewable resources and the enhancement of the environment. We discover innovative solutions to address challenges in the sustainable production and consumption of food, feed, fiber, materials, and chemicals by integrating engineering, science, technology, and management into all degree programs.

We have a public impact through community engagement and extension efforts. We develop and deliver high quality,

regionally and nationally-recognized research-based programs to meet current and emerging needs of industry and communities. We also have a long-standing tradition of close partnerships with alumni, industry professionals, organizations, government agencies, donors and community members.

# Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineli	% Bene	# FTE	Class ified	\$ Amount
				gible	fits		Staff?	
Personnel								
Erin Cortus,		Project Manager			26.8%	0.08		\$17,664
professor								
summer salary								
Post Doctoral		Advanced student, working on model development			20.6%	1.6		\$128,796
Researcher		and data collection						
Bo Hu,		Work on model development and data analysis			26.8%	0.08		\$19,179
professor								
Undergraduate		Process samples			0%	0.2		\$7,591
Student								
Research								
Assistant								
							Sub	\$173,230
							Total	
Contracts and								
Services								
							Sub	-
							Total	
Equipment,								
Tools, and								
Supplies								
							Sub	-
							Total	
Capital								
Expenditures								
							Sub	-
							Total	
Acquisitions								
and								
Stewardship								
							Sub	-
							Total	
Travel In								
Minnesota								
	Miles/ Meals/ Lodging	Farm visits (15 day trips for two years; est 248 miles @ \$0.7/mile = \$2665	Visit site for information collection					\$2 <i>,</i> 665

				Sub Total	\$2,665
Travel Outside Minnesota					
				Sub Total	-
Printing and Publication					
	Publication	1 publication of results in year 2	to disseminate results		\$2,000
				Sub Total	\$2,000
Other Expenses					
		Farm participation	Incentive or consultant fees to enable consistent farm participation (\$1000 x 3 farms X 2 years; 3.5% inflation in yr 2)		\$6,105
				Sub Total	\$6,105
				Grand Total	\$184,000

# Classified Staff or Generally Ineligible Expenses

Category/Name Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
--------------------------------------	-------------	--

## Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	Since this project does not charge any indirect cost, therefore University of Minnesota matches the in kind service F&A. The current indirect cost rate is 55% of the direct total project cost without capital equipment.	UM F&A	Secured	\$106,668
			State Sub	\$106,668
			Total	
Non-State				
			Non State	-
			Sub Total	
			Funds	\$106,668
			Total	

#### Total Project Cost: \$290,668

## This amount accurately reflects total project cost?

Yes

## Attachments

## **Required Attachments**

*Visual Component* File: <u>91829416-e66.pdf</u>

#### Alternate Text for Visual Component

Six people around a table, looking at a map of a farm. Accompanying text: Explore opportunities for alternatives to fossil fuel use on livestock farms while supporting food production, identifying alternative and needed technologies, studying economic implications based on regional energy sources, quantifying the reduction in carbon emissions....

#### Supplemental Attachments

#### Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
Letter of Authorization to Submit	<u>3f39bba2-88e.pdf</u>
Cooperator - Poultry	<u>4f7289fb-b20.pdf</u>
Cooperator - Dairy	<u>6e428d2b-505.pdf</u>
Audit	9ffbb635-add.pdf

## **Administrative Use**

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF? N/A

Does your project include original, hypothesis-driven research?

No

Does the organization have a fiscal agent for this project?

No

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing \$10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Bo Hu and Wendy Moylan, University of Minnesota

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A