



Environment and Natural Resources Trust Fund

2024 Request for Proposal

General Information

Proposal ID: 2024-197

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

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Project Basic Information

Project Summary: This project will inventory opportunities for decarbonizing livestock farms based on current fossil fuel needs and explore the economic and environmental implications for these opportunities while supporting food production.

Funds Requested: \$200,000

Proposed Project Completion: June 30, 2026

LCCMR Funding Category: Small Projects (H)

Secondary Category: Air Quality, Climate Change, and Renewable 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 one of the top ten producing states of turkeys, pigs, and milk. Livestock (including poultry) production is an economic driver, but also one of the contributors to carbon emissions. There are four main sources of carbon emissions on livestock farms: feed production, the animals (particularly ruminants), manure management and energy use/production. The relative contribution of each source is highly variable given the range of livestock systems and management in the state of Minnesota. Furthermore, the decision-making power of individual farms may be limited for one or more of these sources. Energy use is one source wherein farms have decision-making power for the fossil fuel use on their farms for transportation and supporting the barn environment. It is possible that the electricity can be wholly supplied with renewable sources, like wind, solar and biomass energy. This provides a unique pathway that farm operations can reach greater decarbonization by replacing fossil fuels with zero emission electricity to curb the impacts of climate change. There is a need for a roadmap that demonstrates technical and economic implications for existing and potential opportunities to meet the needs of farms to supply energy considering reliability, seasonality, infrastructure changes, and regulatory frameworks.

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 roadmap to decarbonize energy use on livestock farms through electrification. Our study will focus on three case farms: one dairy operation in central MN, one poultry farm in central MN; and one swine facility in southern MN (supporting letters attached). Each collaborator is interested in studying technology that supports the next generation. This roadmap will consider a hypothetical inventory of energy uses on the case study farms, including frequency and reliability needs, drawing from years of production experience. Alternative equipment, both existing and potential, will be considered in a techno-economic assessment. Furthermore, a partial life-cycle analysis will demonstrate the environmental implications for combinations of equipment, energy production, and electricity cost structures. The roadmap will admittedly not encompass all farm scenarios in MN, but initiates a charting process for adding more farm scenarios and expanding to other sources of carbon emissions. Also, the sensitivity of the assessments to farm parameters will help focus future work.

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?

Outcome 1. A methodology that initiates a roadmap for opportunities that support decarbonizing livestock farms, while retaining decision-making power at the farm level.

Outcome 2. Reduced economic risk and associated environmental implications for livestock farms that are considering electric alternatives to fossil fuel sources.

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, 2024
Selection of possible electric farm machines alternatives to replace fossil fuel-powered ones	December 31, 2024
Calculation of electricity consumption patterns using electric farm machines	March 31, 2025

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

Activity Budget: \$70,000

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, 2025
Risk and pinch analysis under three scenarios	June 30, 2025
Refinement of scenario with possible incentives/credits from electricity from renewable biogas	September 30, 2025

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

Activity Budget: \$70,000

Activity Description:

A partial life cycle assessment will be conducted to identify the carbon footprint of the three price scenarios in Activity 2. These three scenarios represent the following situations: 1) all electricity from fossil fuels; 2) all electricity from current portfolio of power grid (including a portion from nuclear power plants and renewable sources); and 3) all electricity from renewable sources like solar, wind, and a CHP unit that burns biogas generated from an on-farm digester treating manure. The carbon dioxide emissions from electricity generation are in addition to the greenhouse gases from feed production, manure storage and the animals that will generally remain unchanged in this preliminary roadmap. The functional unit of product will be the product (i.e. milk, egg, or mass of pig) leaving the farmgate. We will compare all these electrified farms with different power generation scenarios with corresponding conventional farms regarding their carbon emissions. Then we will draft a report including the techno-economic analysis data and carbon emissions for farmers and law makers to evaluate.

Activity Milestones:

Description	Approximate Completion Date
Mapping the whole process of electrifying a farm with appropriate system boundaries	December 31, 2025
Collecting data from inventory and calculating detailed carbon footprint	March 31, 2026
Evaluating and comparing total carbon footprint of electrified farms with conventional energy sources	June 30, 2026

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
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. Dr. Cortus serves as an ex-officio member of the Midwest Rural Energy Council.

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. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Erin Cortus, professor		Project Manager (Primarily Activity 3)			36.8%	0.08		\$16,315
Researcher		Scientific staff, working on model development and data collection			36.8%	1.5		\$151,985
Bo Hu, professor		Work on model development and data analysis			36.8%	0.08		\$17,716
Undergraduate Research Assistant		Process samples for analysis (Activity 1)			0%	0.5		\$6,060
							Sub Total	\$192,076
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 190 miles @ \$0.655/mile = \$1864	Visit site for information collection					\$1,864
							Sub Total	\$1,864

Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
		Farm participation	Incentive or consultant fees to enable consistent farm participation (\$1000 x 3 farms X 2 years; 2% inflation in yr 2)					\$6,060
							Sub Total	\$6,060
							Grand Total	\$200,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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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 Total	\$106,668
Non-State				
			Non State Sub Total	-
			Funds Total	\$106,668

Attachments

Required Attachments

Visual Component

File: [91829416-e66.pdf](#)

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....

Optional Attachments

Support Letter, Photos, Media, Other

Title	File
Authorization UMN	7ff29054-74f.pdf
Swine Collaboration	f2d5b4fa-274.pdf
Dairy Collaboration	b504feb0-eed.pdf
Poultry Collaboration	3be29098-9de.pdf
2022 Audit	4aa164b0-751.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

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

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 design, construction, or renovation of a building, trail, campground, or other capital asset costing \$10,000 or more?

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?

No

