

Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-492

Proposal Title: Agrivoltaics in Minnesota: Enhancing Agriculture and Energy Production

Project Manager Information

Name: Vivian Ferry Organization: U of MN - College of Science and Engineering Office Telephone: (612) 625-7522 Email: veferry@umn.edu

Project Basic Information

Project Summary: Research will be conducted on a utility-scale solar farm to establish the best practices in Minnesota for combining agricultural production with electricity generation on the same land.

ENRTF Funds Requested: \$685,000

Proposed Project Completion: June 30, 2029

LCCMR Funding 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 mandates that all electricity produced in the state must come from carbon-free sources by 2040; solar photovoltaics is expected to play a significant role in this. However, solar energy is known as a land-intensive technology. Minnesota utilities are expected to add several gigawatt of solar energy developments over the next decade, which will require many 1,000s acres of land. Primary concerns with utility-scale solar developments include 1) Increased competition for land between photovoltaics, agriculture, and housing development; 2) Reluctance in rural communities to take prime agricultural land out of production; 3) Aesthetic concerns about how solar developments impact landscapes.

The alternative is to create agrivoltaic systems, where photovoltaic systems are installed symbiotically with agriculture. Using land for both agricultural and electricity production can be mutually beneficial: crop yields may be increased from improved water retention in the soil due to photovoltaic shading, and the efficiency of electricity generation can be enhanced from the cooling provided by evaporation from the crops growing underneath. However, agrivoltaic studies are inherently local and depend on climate and crop choice, warranting studies in Minnesota to establish best practices.

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 a study at the US Solar-owned Big Lake LLC 1 solar farm in Big Lake, MN, enhancing a small program supported by the Institute on the Environment at the University of Minnesota. Our hypothesis is that both electricity generation and crop production can be enhanced in agrivoltaic sites.

We will quantitatively measure the environment at the site, using sensors to retrieve local information about both sunlight radiation and soil environment in the rows between the panels, underneath the panels, and in full sun conditions. Full-sunlight plants such as tomatoes and peppers will be grown within the rows, and shade-tolerant plants such as lettuce and beets will be grown underneath the panels; the crops will be assessed for both yield and morphology. This will allow us to identify the conditions that favor agricultural production in the presence of solar panels specifically in Minnesota and to assess the economic potential for dual land use. Research will also be conducted on solar panel cooling to assess electricity generation on agrivoltaic sites. Collaboration with The Food Group will mentor beginning farmers in best practices for specialty crop growth in these agrivoltaic sites.

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: 1) Produce scientific knowledge of the impact of agrivoltaic installations on both crop production and energy generation, demonstrating economically viable strategies for land use to both protect agriculture and enhance renewable energy generation; 2) Create more resilient agriculture and renewable energy production, with resistance to extreme weather conditions; 3) Educate and develop a workforce trained in agrivoltaic farming.

Activities and Milestones

Activity 1: Agrivoltaic plant growth on existing utility-scale solar farm

Activity Budget: \$265,280

Activity Description:

This activity, a collaboration between UMN-Twin Cities researchers and US Solar, a Minnesota solar developer, will establish agrivoltaic best practices on a utility-scale solar farm (Big Lake LLC 1). We will equip the site with instruments to measure environmental parameters under solar panels and in control plots receiving full sun, including photosynthetically active radiation, soil moisture, and soil and air temperature. The sensors will follow guidelines from the National Renewable Energy Laboratory (Taks #1). Plant growth studies will assess the viability of various crops under agrivoltaic conditions, including crops suited to partial shade (e.g., lettuce, kale) and full sunlight (e.g., tomatoes, peppers), comparing their growth with control plots. Parameters such as biomass production, plant morphology, and yield will be measured to determine the suitability of agrivoltaic crop production in Minnesota (Task #2 - #4). Finally, by comparing the crop values between the agrivoltaic plots and full sun plots, the economic viability of agrivoltaic land use will be compared across multiple years (Task #5).

Activity Milestones:

Description	Approximate
	Completion Date
Site instrumentation based on NREL experimental protocols	March 31, 2027
Site preparation for plant growth studies	March 31, 2027
Replication 1 of plant growth studies for various target crops	December 31, 2027
Replication 2 of plant growth studies for various target crops	December 31, 2028
Data analysis and reporting of findings, development of guidance for agrivoltaics on Minnesota solar	June 30, 2029
farms	

Activity 2: Influence of Crop Growth on Energy Generation Efficiency

Activity Budget: \$269,720

Activity Description:

It is well-known that photovoltaic panels operate considerably hotter than the local temperature, and this increased temperature in turn decreases efficiency of electricity generation. Photovoltaic installations can lead to local "heat islands" that create elevated temperatures, which both diminishes electricity production and potentially impacts agricultural production. At different sites and climate conditions, the agrivoltaic panels could therefore provide needed cooling through shading or elevated temperatures due to this heat island effect. A more resilient solution would incorporate panel cooling, to both reduce the local heating effects and improve electricity generation. We will assess this tradeoff in Minnesota to quantify conditions that lead to elevated panel operating temperatures or suppressed panel operating temperatures due to transpiration (Task #1). These predictions will be compared to data measured at the Big Lake site, measuring factors such as ground albedo and local weather conditions (Task #2). We will develop passive cooling strategies that can be integrated into next-generation panels to reduce operating temperatures, making both electricity generation and crop production more resilient (Task #3).

Activity Milestones:

Description	Approximate Completion Date
Determine effects of heat islands and transpiration on energy generation efficiency	June 30, 2027
Validation of predictions at Big Lake MN site	June 30, 2028
Development of cooling strategies for solar panels to reduce operating temperature	June 30, 2029

Activity 3: Training of Beginning Farmers in Best Practices in Agrivoltaics

Activity Budget: \$150,000

Activity Description:

The knowledge generated in this project will be disseminated directly to farmers via a collaboration with The Food Group, a nonprofit organization focused on education and land access to beginning farmers. Farmers will be given access to land at the Big Lake site, and will be trained in scaling up specialty crop growth while also improving water quality and usage, further protecting Minnesota's natural resources. Farmers who participate in this program will be able to sell their produce into the Food Group's local food sourcing to food shelf partners and affordable grocery programs across the state of MN. Shared networks and resources will increase small-scale farmers' economic and environmental resilience. This collaboration will highlight the mutual benefits of agrivoltaic farming on commercial solar farms both to new farmers and solar developers/utilities who are interested in opening up their developments to farming communities. Assessment data will be collected by interviewing farmers, mentors, and solar developers to identify both successes and challenges of utilizing utility solar farms.

Activity Milestones:

Description	Approximate Completion Date
Training of cohort in farming practices on Big Lake Site	December 31, 2027
Training of second cohort in farming practices on Big Lake Site	December 31, 2028
Survey and assessment of farmers, mentors, and utility solar operators	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving
			Funds
Vivian Ferry	University of	Project Manager/Associate Professor	Yes
	Minnesota		
Uwe	University of	Professor	Yes
Kortshagen	Minnesota		
Nathan	University of	Assistant Professor	Yes
Eylands	Minnesota		
Peter Schmitt	US Solar	Owner of Agrivoltaic Site	No
KaZoua Berry	The Food	Collaborator	Yes
	Group		

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?

This project will establish the potential of agrivoltaics for solar developments. The third activity is specifically devoted to translation practices established by this proposal, for continuing implementation of these findings. These findings will also be communicated to solar developers to inform design of future utility-scale agrivoltaic developments. The team will pursue additional research funding from the US Department of Agriculture, the Department of Energy, and the National Science Foundation. The infrastructure created under this project may also lead to collaborative research projects with solar manufacturers, such as Heliene, Inc., that are interested in evaluating their technologies for agrivoltaic applications.

Project Manager and Organization Qualifications

Project Manager Name: Vivian Ferry

Job Title: Associate Professor

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

Vivian Ferry is an associate professor in the Department of Chemical Engineering and Materials Science at the University of Minnesota. She is an expert in nanostructured optical materials, advanced fabrication, and optoelectronic devices, and leads a research group that uses both experimental and simulation-based techniques to address challenges in light and thermal management. She has collaborated extensively with academics, national laboratories including the National Renewable Energy Laboratory, and industry. She has published more than 70 scientific articles and delivered over 120 invited talks and seminars on her work. For the past 8 years, PI Ferry has taught a course to senior undergraduate Materials Science and Engineering students, connecting students to mentors from local industry to develop technological solutions and assess their economic potential.

PI Ferry has considerable leadership experience with multi-investigator teams and currently leads an interdisciplinary research group of the National Science Foundation-funded UMN Materials Research Science and Engineering Center. She co-leads a College of Science and Engineering initiative on Flexible Electronics and Photonics. She also has management experience, and is currently serving as the Director of Graduate Studies for Materials Science & Engineering at the University of Minnesota Twin Cities.

Organization: U of MN - College of Science and Engineering

Organization Description:

The University of Minnesota is a world-class university and the flagship institution of Minnesota, with more than 50,000 students and nearly 5000 academic staff. Research expenditures in FY 2023 totaled over \$1.35B, ranking 12th in the

United States among public research universities. The University's technology transfer activities are also highly ranked, ranking in the top 20 public research universities across 5 metrics including new patent applications, deals, disclosures, and license income, as facilitated by the University of Minnesota Technology Commercialization office. Faculty in the College of Science and Engineering have decades of experience with renewable energy technologies, including photovoltaics. Through recent collaborations with faculty in the College of Food, Agricultural, and Natural Resource Sciences (CFANS), these activities have expanded to the nascent field of agrivoltaics.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineli gible	% Bene fits	# FTE	Class ified Staff?	\$ Amount
Personnel				8.010				
Vivian Ferry		Associate Professor/Project Manager			26.8%	0.12		\$29,112
Uwe		Professor			26.8%	0.12		\$55,679
Kortshagen								
Nathan		Assistant Professor			26.8%	0.12		\$20,116
Eylands								
Graduate		Graduate Student in Chemical Engineering and			41.4%	1.5		\$196,176
Student		Materials Science						
Graduate		Graduate Student in Horticulture			45%	1.5		\$171,619
Student								
							Sub Total	\$472,702
Contracts and Services								
Big River	Subaward	Education of farmers in best practices for agrivoltaic				0.6		\$150,000
Farms		farming						
							Sub Total	\$150,000
Equipment, Tools, and Supplies								
	Tools and Supplies	Research supplies	Supplies for Activities #1 and #2, including for measurement and assessment of crop yield and morphology					\$62,298
							Sub Total	\$62,298
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-

Travel In Minnesota					
				Sub Total	-
Travel					
Outside Minnesota					
				Sub	-
				Total	
Printing and					
Publication					
				Sub	-
				Total	
Other					
Expenses					
				Sub	-
				Total	
				Grand	\$685,000
				Total	

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				
			State Sub	-
			Total	
Non-State				
			Non State	-
			Sub Total	
			Funds	-
			Total	

Total Project Cost: \$685,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component File: <u>99859787-e70.pdf</u>

Alternate Text for Visual Component

A depiction of photovoltaic panels in a field growing vegetables....

Supplemental Attachments

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

Title	File
Support Letter	d1755cea-724.pdf
UMN	<u>76115272-c0c.pdf</u>

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?

N/A

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?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

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:

Victoria Troxler, 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