



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-338

Proposal Title: Solar Powered Container Farm for Local Food Production

Project Manager Information

Name: Eric Buchanan

Organization: U of MN - WCROC

Office Telephone: (320) 589-1711

Email: buch0123@morris.umn.edu

Project Basic Information

Project Summary: Developing a novel crop and energy system in a hydroponic container farm for improved environmental and food supply resiliency.

ENRTF Funds Requested: \$1,018,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Resiliency (A)

Project Location

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

Region(s): SW

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 relies on food production from distant states and countries, increasing the cost and fragility of our food supply - especially in winter. Deep winter greenhouses exist in Minnesota but generally have high heating costs and can only produce cold hardy vegetables, like lettuce, which can also tolerate low light levels but do not have high market value. Consequently, high value vegetable crops sold in MN grocery stores during the winter must be shipped thousands of miles from growing areas in California, Mexico, or South America. Moreover, produce grown far from its final consumers often necessitates practices like early harvesting leading to lower quality produce by the time it gets to its destination - especially rural areas. The Minnesota food supply chain is exposed to climate, economic, and security risks both in places where winter produce is grown and locally. Minnesota vegetable farmers are also under pressure from production farming for land and chemical use. Containerized farming allows food production without the need for long-distance, fossil-fuel based transportation, and is weather/climate independent while using less land and water. However, small-scale commercial ventures in containerized farming often struggle due to high energy costs for lighting and indoor climate control.

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.

The proposed solution is a containerized hydroponic growing system outfitted with a solar array/battery system such that it operates as a Net-Zero food production system that could even operate off-grid. The solution will include a crop rotation and management plan that optimizes the strengths of containerized farming like producing high-value vegetables out of season and complete control of temperature and lighting conditions. Moreover, it will demonstrate a sustainable, resilient, land and water efficient, energy neutral, and non-capital-intensive way to farm in the face of difficult weather and land use conditions - especially for folks that have often been left out of traditional farming. A commercial container outfitted for food production – Freight Farms Greenery – was donated to the WCROC after its use in an energy study conducted for Great River Energy and will be used for this project. Energy use in the container farm is high due to the large number of LED lights needed for growing plants indoors and managing the resulting heat load. A custom mounting system will be designed to adapt a solar array to the container farm. Designing a crop/energy system that can be replicated by others will be a primary goal.

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 has three primary objectives:

- Identify crops and low energy operational protocols.
- Design and install a container-mounted solar/battery array.
- Assess improved container farm systems for productivity, energy usage, carbon footprint, economic viability and compare to alternatives.

Year-round local produce from a container farm can lower the carbon footprint of a cold climate food supply while lessening the environmental burden (land, water, and chemical use) and provide a climate mitigation strategy for food production.

Activities and Milestones

Activity 1: Identify crops and low energy Protocols to Reduce Container Energy Burden

Activity Budget: \$177,000

Activity Description:

Crop and cultivar selections will include those that are ideally suited to an indoor growing environment, offer some market advantage due to traditional seasonal availability and quality, and/or offer some production advantage due to complete control of the growing environment. Flexibility in crop selection and growing techniques will better enable a container farming system to adapt to changing market conditions. Moreover, these systems will reduce water and fertilizer use, decrease crop maturation time, and maximize space use efficiency.

A unique consideration for a solar powered container farm is the energy burden of selected crops, i.e. lighting, water, temperature, and nutrient requirements. Sensors and data loggers will be installed to monitor energy and growth parameters. Low energy crop management protocols will be developed, in addition to peak energy optimization protocols, to help maintain an energy balance between solar energy collected/stored and the container energy load when needed. Beneficial lighting strategies will include frequent plant-density adjustments, pulsed LED duty cycle, and spectral manipulation to facilitate biomass accumulation.

Activity Milestones:

Description	Approximate Completion Date
Develop crop selection protocol and test plan	October 31, 2027
Fully instrument container farm to monitor energy and growth parameters	December 31, 2027
Initiate crop growing test plan	January 31, 2028
Create final crop rotation recommendations based on test results	May 31, 2030

Activity 2: Design, procure, and install solar/battery array on container farm.

Activity Budget: \$691,000

Activity Description:

A thermal model of the container farm leveraged from previous research will be combined with detailed modeling of solar energy production to optimize panel mounting angles for seasonal energy production and structural integrity while also accounting for typical weather patterns in Morris. For example, panels can be mounted at a steeper angle on the south side of the container to increase winter solar energy production while using the container as a wind block from prevailing north winds. Panels on the roof of the container can be mounted at a shallower angle increasing summer solar energy production and decreasing exposed wind loading. Monitored energy use will be used to design a solar/battery system to meet as much of the container's energy load as possible. A unique solar array mounting system will be designed to attach to the container farm. Predicted and actual energy production/storage will be used to optimize a crop production scheme for maximum economic value and minimum energy usage.

Activity Milestones:

Description	Approximate Completion Date
Solar/battery array layout, mounting design and interconnection plan	December 31, 2027
Release RFP for solar/battery array and select vendor(s)	March 31, 2028
Install solar/battery array	July 31, 2028
Monitor energy production/storage/load and write final recommendations	May 31, 2030

Activity 3: Assess crop and energy systems to provide best practices guidebook

Activity Budget: \$150,000

Activity Description:

A comprehensive analysis of all the data collected from this project including energy production, energy storage, and energy loads; crop selections and performance; water and nutrient usage; input costs and crop economic value will be used to develop best practices and a Life Cycle Analysis (LCA). Life cycle assessment is a technique that is well-suited for examining the environmental impacts of the inputs and processes needed for complex production systems, including food production. The LCA for this project will examine water and energy impacts of regionally grown fresh produce in the context of a variety of different production methods. Areas where energy, water, and greenhouse gas impacts can be minimized while increasing productivity will be identified. The LCA will include analyses of a base case and numerous alternative scenarios for examining design and operational enhancements, and it will also compare cool-climate food production in container farms to reference systems based on produce shipped from other locations. Energy and water impacts will be examined in the direct and indirect (embedded) resources needed for container farm food production, including: 1) structural materials and mechanical operation; 2) production methods; and 3) the produce supply chain moving produce to market.

Activity Milestones:

Description	Approximate Completion Date
Collect, assess and analyze container farm data	April 30, 2030
Develop best practices guidebook	June 30, 2030
Perform LCA analysis of container farm and alternatives	June 30, 2030

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

The WCROC will disseminate results from this project at its annual Agrivoltaic Field day, as well as the biennial Midwest Farm Energy Conference (2028 & 2030) and the WCROC annual display at Farmfest as well as producing University of Minnesota Extension bulletins, and inclusion in periodic agrivoltaic webinars. We will also seek to feature this project on the Prairie Sportsman PBS program and present results at indoor AG conferences.

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?

Results will be demonstrated and adopted in the WCROC container farm. The container farm will become a unique and valuable research asset for ongoing research at the nexus of food, water, and energy. The completely controlled and monitored container farm system will provide a one-of-a-kind research environment to the University for horticulture, energy modeling, food production, agrivoltaic, and sustainability researchers. Efforts will be made to assess if produce sales could fund further research and programs.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Agrivoltaics To Improve The Environment And Farm Resiliency	M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 07c	\$646,000
Improving Agricultural Ecosystems through Autonomous Weed Control	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 07c	\$978,000
Agrivoltaics 2.0 Building a Resilient E-Farm	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 07b	\$535,000

Project Manager and Organization Qualifications

Project Manager Name: Eric Buchanan

Job Title: Director, WCROC Renewable Energy Program

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

Mr. Buchanan earned a Bachelor of Science degree in Aerospace Engineering from Purdue University and has proven his leadership skills as an engineering supervisor and project manager with 36 years of experience in the aerospace, automotive, medical device, and renewable energy industries. Mr. Buchanan has been leading innovative projects incorporating renewable energy into agricultural systems since 2010 and now directs the renewable energy program. He has managed the installation and interconnection of 5 solar arrays on the WCROC farm site totaling 131 kW. The WCROC Renewable Energy Program has successfully completed over \$30 million in previous grant funding and is currently managing over \$15 million in funded research activity.

Organization: U of MN - WCROC

Organization Description:

The WCROC is part of the University of Minnesota's College of Food, Agriculture, and Natural Science and is part of a

network of agricultural experiment stations located around the state. The WCROC farm site is located in west central Minnesota, just outside the city of Morris, on just over 1000 acres including about 640 tillable acres (>300 acres certified organic) and 350 acres of certified organic pasture for about 300 milking cows.

We work with farmers, rural leaders, faculty from throughout the University of Minnesota system, other professionals from industry and academia, and citizens to provide research and educational programming. Working with these many partners is our greatest strength. These partnerships keep us connected to the varied and changing needs of the producers and citizens of Minnesota.

Faculty and staff at the WCROC develop solutions to real-world challenges and then share with local and global communities. Our primary research areas include agronomy and soil science; dairy; horticulture; renewable energy; and swine. Each year, we welcome several international scholars, producers and visitors to the WCROC including numerous tours with students from elementary school through college age.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Lead PI - Professional Researcher - FTE dependent on grant funds		Direct all research and personnel			36.6%	1.5		\$182,000
Professional researcher - FTE dependent on grant funds		Design and install solar/battery system			36.6%	3		\$299,000
Professional Technician - FTE dependent on grant funds		Manage container farm operations			32.3%	3		\$200,000
Undergraduate intern		Assist with container farm and conduct summer research project			0%	0.84		\$32,000
graduate student		Assist lead PI, collect container farm data and analyze. Benefits include fringe and tuition.			83.6%	0.75		\$45,000
Professional researcher - FTE dependent on grants		LCA analysis			36.6%	0.4		\$40,000
Professor		Guide crop selection research			36.6%	0.45		\$62,000
							Sub Total	\$860,000
Contracts and Services								
Runestone Electric Association - electric utility	Service Contract	interconnection fees to tie solar array to electricity grid				0		\$2,000
tbd solar installer	Service Contract	Design solar/battery array and install on container farm				0		\$100,000
Mechanical contractor	Service Contract	Fabricating novel solar mounting racks for container attachment				0		\$25,000
							Sub Total	\$127,000

Equipment, Tools, and Supplies								
	Tools and Supplies	Pumps, filters, growing supplies, etc.	Items needed to maintain ongoing container farm production					\$10,000
	Tools and Supplies	Solar/battery balance of system/control hardware	Equipment to integrate and control solar/battery system into container farm operating system.					\$7,500
	Tools and Supplies	environmental sensors and data loggers	Record environmental, energy, and crop production data					\$4,500
	Tools and Supplies	Seeds, starter sets, chemicals, etc.	Supplies needed to grow crops in a hydroponic system					\$4,800
							Sub Total	\$26,800
Capital Equipment								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	6 trips, 350 miles, 2 people, \$700/2 day trip	Trips by professor and grad student to Morris for research coordination					\$4,200
							Sub Total	\$4,200
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
							Sub Total	-

							Grand Total	\$1,018,000
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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: \$1,018,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [fb2fe149-937.docx](#)

Alternate Text for Visual Component

Donated container farm on WCROC farm site...

Supplemental Attachments

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

Title	File
Letter of Approval to Submit	ad234d64-37d.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?

Yes

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

Yes

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

No

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:

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

Yes, I understand