

**Environment and Natural Resources Trust Fund
2020 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 173-E

Storing Renewable Energy in Flow-Battery for Grid Use

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

Sub-Category:

Total Project Budget: \$ 3,271,229

Proposed Project Time Period for the Funding Requested: June 30, 2023 (3 yrs)

Summary:

The University of Minnesota Morris, Otter Tail Power Company, business and project partners will install a large flow-battery for storing renewable energy and grid optimization, and research the batteries performance.

Name: Bryan Herrmann

Sponsoring Organization: U of MN - Morris

Job Title: UMN Morris Vice Chancellor Finance and Facilities

Department: University of Minnesota Morris

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Morris MN 56267

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Web Address: morris.umn.edu

Location:

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Representation of wind and solar power feeding a flow battery for campus demand or grid. Two images of flow batteries in production. Map representing potential location of battery and solar.

<input type="checkbox"/>	Funding Priorities	<input type="checkbox"/>	Multiple Benefits	<input type="checkbox"/>	Outcomes	<input type="checkbox"/>	Knowledge Base	
<input type="checkbox"/>	Extent of Impact	<input type="checkbox"/>	Innovation	<input type="checkbox"/>	Scientific/Tech Basis	<input type="checkbox"/>	Urgency	
<input type="checkbox"/>	Capacity Readiness	<input type="checkbox"/>	Leverage	<input type="checkbox"/>		TOTAL	<input type="checkbox"/>	%



PROJECT TITLE: Storing Renewable Energy in Flow-Battery for Grid Use

I. PROJECT STATEMENT

Our project team proposes to implement a rural, community-scale project, investigating how a large flow-battery in combination with solar and wind generation can simultaneously improve the stability of the electrical grid and enhance the resilience of rural communities. On a cost-per-unit-energy basis, Minnesota’s wind and solar resources now outcompete traditional fossil fuel generation. However, in the absence of energy storage technology to address the temporal mismatch between generation and demand, the intermittency of sun and wind has strongly constrained progress towards inexpensive, carbon-free electricity. Storage battery technologies have advanced greatly in recent years, both in technological and economic terms, such that integrating intermittent wind and solar generation with storage solutions has now become a highly promising avenue of investigation. Flow batteries hold the greatest potential for large-scale storage, as they use less expensive materials than lithium-ion batteries, need significantly less energy for ventilation and cooling, perform better at low-temperature, and can cycle continuously without degradation. This proposal adds a 1MW/4MWh flow battery and 500 kW of solar PV generation to UMN Morris’s existing unique, renewable-energy-intensive microgrid, in a research/demonstration project aimed at accelerating the pace of Minnesota’s transition to clean, reliable, and local energy.

UMN Morris, as a nexus of research, implementation and outreach in renewable energy, is an ideal host site for this project. The campus has experience working successfully with various federal funding agencies (e.g., Department of Agriculture, National Energy Technology Laboratory (NETL) and the State of Minnesota, as well as with private partners, to help fund a vigorous energy research program. The UMN Morris microgrid implementation is an ideal test bed with which to explore optimization of battery charging and dispatch as part of a dynamic, intermittent system, the efficiency of which will be a major determinant of the economic viability of an installation. The campus is a member of the award-winning community initiative called the Morris Model, designed to enhance energy efficiency and community resilience and inspired in part by our close alliance with the carbon-negative village of Saerbeck, Germany. Other Morris Model partners include the City of Morris, UMN West Central Research Outreach Center, Morris Area School District, Stevens County, Stevens Community Medical Center, and Otter Tail Power Co. There is large potential in rural microgrids for islanding and balancing power, but the information requirements for operating such systems may introduce more uncertainty than communities are willing to bear. This demonstration project is situated to resolve much of that uncertainty, and to provide rural communities with the data to move new projects forward.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Install, test and analyze flow battery initial performance

ENRTF BUDGET: \$ 1,300,000

Description: UMN Morris and OTPCO will select, install, and test the initial performance of a flow battery at UMN Morris, which has the capacity to implement a Request-For-Proposal process to solicit competitive bids for equipment, meeting bi-weekly during the planning and install, moving to monthly meetings in the test/analysis-phase.

Table with 2 columns: Outcome, Completion Date. Rows include Project Planning, Acquisition of Flow Battery (Dec 2020), Installation and Commissioning of Flow Battery (June 2021), and Flow Battery Testing and Initial Experimentation (Dec 2021).



**Environment and Natural Resources Trust Fund (ENRTF)
2020 Main Proposal Template**

Activity 2: Install, test and analyze solar PV system and initial performance

ENRTF BUDGET: \$ 1,250,000

Description: 500kW of solar PV will be installed at UMN Morris. The system scale will allow for research into how wind and solar work integrally with battery storage. Wind is stronger at night and solar is strong in the daytime, allowing battery storage across a 24-hr period.

Outcome	Completion Date
<i>1. Project Planning, Acquisition of Solar PV system</i>	December 2020
<i>2. Installation and Commissioning of Solar PV system</i>	June 2021
<i>3. Solar PV Array Testing and Experimentation</i>	December 2021

Activity 3: Flow-battery and renewable integration research, optimization, and report production

ENRTF BUDGET: \$ 141,000

Description: A large-scale demonstration of a flow battery will be the first of its kind in Minnesota. The team will analyze the performance of the combined system (battery/solar/wind), conduct an economic analysis of the combined system, prepare a final report, and disseminate the report broadly. The Energy Transition lab has capacity to help disseminate this information across MN. An Energy Transition Lab led delegation to California and Washington visited microgrid/battery installations and leadership at the California Public Utilities Commission and California ISO. Like MN, CA regulators work with universities and utilities to support pilot projects to increase regulatory confidence as new technologies are integrated into their regional grid.

Outcome	Completion Date
<i>1. System Analysis (of combined battery/solar/wind integration)</i>	<i>June 2022</i>
<i>2. Economic Analysis (of combined battery/solar/wind integration)</i>	<i>December 2023</i>
<i>3. Final Data Analysis and Report completed -- dissemination to public/presentations</i>	<i>June 2023</i>

III. PROJECT PARTNERS AND COLLABORATORS:

A. PROJECT PARTNERS RECEIVING ENRTF FUNDING

Name	Title	Affiliation	Role
<i>Bryan Herrmann</i>	Vice Chancellor, Finance and Facilities	UMN Morris	Project Manager
<i>Arne Kildegaard</i>	Professor of Economics	UMN Morris	Economic Consultant
<i>TBD</i>	Project Engineer	UMN Morris	Project Engineer

B. PROJECT PARTNERS NOT RECEIVING ENRTF FUNDING

Name	Title	Affiliation	Role
<i>Jason Grenier</i>	Manager, Market Planning	Otter Tail Power Company	Utility Partner
<i>Ellen Anderson</i>	Director, Energy Transition Lab	University of Minnesota	Project Consultant
<i>Blaine Hill</i>	City Manager, Morris Model Team	City of Morris	Project Consultant
<i>David Heim</i>	Chief Strategy Officer	OATI/USA Microgrids	Controls Partner

IV. LONG-TERM IMPLEMENTATION AND FUNDING:

This 3-year project is another step in a multi-stage project, testing the feasibility and performance of flow batteries in a Minnesota climate and how they can integrate with renewable energy sources, resulting in a thorough, publicly available cost-benefit analysis and system integration study.

V. TIME LINE REQUIREMENTS: This 3-year project will begin July 1, 2020 and end June 30, 2023.

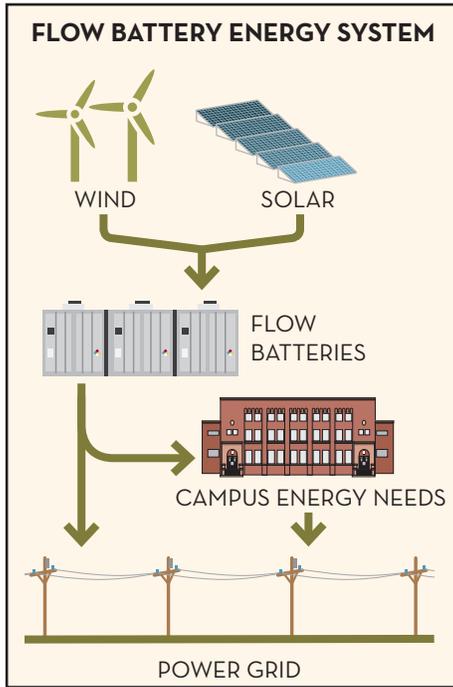
Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet
Legal Citation: Regents of the University of Minnesota (Morris campus)
Project Manager: Bryan Herrmann
Project Title: Storing Renewable Energy in Flow-Battery for Grid Use
Organization: University of Minnesota Morris
Project Budget: \$3,271,229
Project Length and Completion Date: 3 years, June 30, 2023
Today's Date: April 10, 2019



ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	\$ 409,337	\$ -	\$ 409,337
\$313,714 to fund a Project Engineer for three years as follows (1 FTE, 3 years, 36% fringe benefit rate, 2.5% cost of living adjustment): \$102,000 in Year 1, \$104,550 in Year 2, \$107,764 in Year 3.			
\$95,623 to fund a Project Economist Part-Time Appt for three years as follows (.20 FTE, 3 years, 36% fringe benefit rate, 2.5% cost of living adjustment): \$31,091 in Year 1, \$31,867 in Year 2, \$32,665 in Year 3.			
Professional/Technical/Service Contracts			
Installation contract for battery with selected flow battery manufacturer including Engineering support for startup. The cost to install the battery is 25% in addition to the total battery cost.	\$ 550,000	\$ -	\$ 550,000
Operations & Maintenance for year 1, 2, 3 from flow battery manufacturer, \$50,000 per year	\$ 150,000		\$ 150,000
Microgrid controls contract for Microgrid and grid tie optimization, OATI selected as leading provider in Minnesota and partner on project. Founded in Minnesota and operating since 1995, OATI has provided technology and software solutions to the energy industry in transmission and reliability management, energy trading and risk management, and smart grid applications. More than 98% of North American energy industry organizations use OATI solutions. USA Microgrids, an OATI company, provides a broad array of professional services related to DER and microgrid project development and implementation including DER/microgrid controls design expertise and integration.	\$ 300,000		\$ 300,000
Equipment/Tools/Supplies			
Power conversion system - 10 inverters @ \$30,000 each	\$ 300,000	\$ -	\$ 300,000
Site Controller for battery integration	\$ 50,000		\$ 50,000
Capital Expenditures Over \$5,000			
500 KW solar array to demonstrate large scale solar supply to flow battery storage, \$2.50 per watt	\$ 1,250,000		\$ 1,250,000
10% of flow battery purchase price selected through competitive bid, UMN Morris portion of the battery cost. (OTPCO has committed to 90% of purchase price.)	\$ 250,000	\$ -	\$ 250,000
Printing			
\$2,000 for printing "Storing Renewable Energy in Flow-Battery for Grid Use and Resiliency" guide targeted at communities, researchers and utilities. (\$8/copy x 250 copies) \$500 for large printed posters to present research at public events. \$1000 for printing educational diagrams and banners on the battery to describe the project for visitors to the site.	\$ 3,500	\$ -	\$ 3,500
Travel expenses in Minnesota			
In-state travel for project engineer and economist to conduct outreach and attend meetings with partners. \$3,897 for mileage (12 trips per year (8 average round trip of 120 miles, 4 average round trip of 320 miles) x 3 years x \$.58/mile); \$2,400 lodging (4 nights per year x 2 employees x 3 years x \$100 per room); and \$2,094 for employee meals (4 overnight trips, 1st/1st day @\$41.25 * 2 people; 8 day trips over 12 hours @\$23 for dinner for 2 people)	\$ 8,392	\$ -	\$ 8,392
COLUMN TOTAL	\$ 3,271,229	\$ -	\$ 3,271,229

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State: Otter Tail Power Company investment in flow battery	secured	\$ 2,200,000	\$ -	\$ 2,200,000
State:		\$ -	\$ -	\$ -
In kind: Unrecovered U of M indirect costs	secured	\$ 469,006	\$ -	\$ 469,006
Non-State In kind: Open Access Technology International (OATI) and USA Microgrids	secured	\$ 120,000	\$ -	\$ 120,000
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	Amount legally obligated but not yet spent	Budget	Spent	Balance
		\$ -	\$ -	\$ -

B. Visual Component or Map



exterior of flow batteries



interior of flow battery



University of Minnesota Morris campus and surrounding area

BATTERY BENEFITS

- Builds resiliency of energy supply
- Demand-reduction
- Provides for time-shifting of energy
- Improves grid services

FLOW BATTERY BENEFITS

- Improved cold weather performance
- Reduced need for HVAC for cooling
- Unlimited number of cycles—no degradation over time
- Reduced end-of-life challenges
- Less need for rare earth metals
- Workforce development and serviceability

WHY MORRIS?

Morris is the ideal location for a large scale flow-battery project.

- UMN Morris campus functions as a city within a city
 - Campus is 1 million square feet, powered by renewable-energy
 - 5,349 residents of Morris and about 2,000 people each day on campus
- Main industries of the region: agriculture, manufacturing, education, and healthcare.

The award-winning Morris Model partnership provides for natural collaboration among its members:

- UMN Morris
- UMN West Central Research and Outreach Center
- USDA ARS North Central Soils Conservation Research Lab
- Morris Area School District
- Stevens Community Medical Center
- Otter Tail Power Company

UNIVERSITY OF MINNESOTA
MORRIS





2020 Environment and Natural Resources Trust Fund (ENRTF) Proposal

Project Title: *Storing Renewable Energy in Flow-Battery for Grid Use*

F. Project Manager and Team Qualifications and Organizational Description

Bryan Herrmann, Project Manager, UMN Morris: Herrmann has an 18 year record of service, including as Vice Chancellor for Finance and Facilities since July 2015, Director of Admissions, and in other positions. He holds a BA in economics and management from UMN Morris and an MBA from UMN Duluth. Under his leadership the campus has undertaken a diverse renewable energy platform model as a key part of the campus community's plan to achieve carbon neutrality.

Organization: University of Minnesota Morris

UMN Morris is the public liberal arts campus of the University of Minnesota located in west-central MN, serving 1700 students. The campus recently was recognized by the Department of Education as one of nine first-ever ED Green Ribbon Schools Postsecondary Sustainability Awardees and by the Environmental Protection Agency for its demonstration-model of renewable energy production—nearly 70 percent of its electrical needs are met by onsite renewable energy sources. The collaboration with the *Morris Model* and the Climate Smart Municipalities program creates opportunities to learn about the future of energy through the climate protection agreement with Saerbeck, Germany.

Team Members

Jason Grenier, Manager, Market Planning, Otter Tail Power Company (OTPCO): Grenier has over 15 years in the electric utility industry, including 11 years with OTPCO. He oversees the development and marketing of OTPCO's energy conservation, demand response, e-business, small-scale solar, and electric vehicle customer offerings across the company's ND, SD and MN service areas. Recent efforts include establishing a program to change-out the company's MN streetlights to LEDs, a solar incentive program focused on schools and community properties, and efforts to expand EV charging facilities.

Dr. Arne Kildegaard, Professor of Economics, UMN Morris: Kildegaard has extensive experience in energy systems analysis and modeling particularly with respect to integrating distributed energy resources (DERs). His research also extends to the economic development consequences for rural areas of the energy transition to low-density wind and solar. He was a 2015 Official Observer at the United Nations Framework Convention on Climate Change, Paris, France, and holds a PhD in Economics, University of Texas at Austin, a MS, University of Chicago, and a BA, Gustavus Adolphus College.

Ellen Anderson, Director, Energy Transition Lab, UMN: Anderson is Director of the Energy Transition Lab (ETL), Institute on the Environment, University of Minnesota, which works to catalyze solutions to reduce carbon emissions and create a clean energy economy. ETL founded the Minnesota Energy Storage Alliance, and has been a recognized thought leader in energy storage since 2015. Anderson has more than 20 years of experience in Minnesota energy policy and state government.

Blaine Hill, City Manager, Morris MN: Hill leads the climate protection partnership agreement with the city of Saerbeck, Germany and has begun implementing projects to reduce energy use, identify renewable energy sources and look at ways to protect the environment. He has 38 years of experience in city finance and administration. He holds a bachelor's degree in political science from UMN Morris. Hill served as the president of the League of Minnesota Cities in 1997.

David Heim, Chief Strategy Officer: Heim holds the positions of Associate Vice President and Chief Strategy Officer at USA Microgrids (USA MG) and Open Access Technology International, Inc. (OATI), with professional experience of over 20 years in the field he is currently guiding strategic activities and business development. He is responsible for overseeing OATI's Strategic Initiatives, including development of new and emerging hardware, software, and security technologies, and was the Program Manager for the development and construction of the new OATI Microgrid Technology Center.