



## Environment and Natural Resources Trust Fund

### 2027 Request for Proposal

#### General Information

**Proposal ID:** 2027-607

**Proposal Title:** Demonstrating Innovative Thermal Energy Storage in Cold Climates

#### Project Manager Information

**Name:** Troy Goodnough

**Organization:** U of MN - Morris

**Office Telephone:** (320) 589-6303

**Email:** good0044@morris.umn.edu

#### Project Basic Information

**Project Summary:** UMN Morris proposes to demonstrate a scalable and replicable approach for rural energy development using a thermal energy battery and local energy to provide heat to a district energy system.

**ENRTF Funds Requested:** \$3,104,000

**Proposed Project Completion:** June 30, 2030

**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.**

The thermal energy demand in Minnesota is significant, and we need to demonstrate a scalable and replicable approach for rural energy development. A thermal energy battery (TEB) to provide heat and cooling to a community-based district energy system, coupled with industrial-sized wind turbines and agrivoltaic field (500kW) is an opportunity to demonstrate a solution. Current reliance on natural gas has fiscal challenges due to fluctuating prices and operational risks like gas curtailment in extreme cold, forcing a costly switch to fuel oil. Deploying a heating system that uses local renewable energy is complex and expensive, as UMN Morris's historic campus status makes retrofitting for hot-water piping difficult.

UMN Morris sources 60% of its electricity from on-site renewables from wind and 500kW solar; coupling them with a TEB provides an opportunity to leverage local energy resources. This will allow UMN Morris to use locally generated electricity to produce thermal heat. Importantly, a TEB can integrate with the current system, providing steam for heating and for cooling year-round by using the existing absorption chiller and back-pressure steam turbine. UMN Morris is therefore seeking to demonstrate an affordable and reliable thermal energy solution that integrates with its current facilities and available renewable resources.

**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 solution centers on coupling UMN Morris's existing on-site renewables (wind and solar) with a Thermal Energy Battery (TEB) to address the mismatch between energy production and the immense thermal load, which is three times the campus's electrical need. The TEB will store overproduced renewable electricity, allowing UMN Morris to utilize electricity produced locally vs energy from other parts of the country. This project has large implications for Minnesota's steam-based industries. TEBs create an opportunity for expanding rural energy projects because instead of contributing to grid congestion, TEBs can meet thermal needs and offload overproduced renewable electricity.

Integrating the TEB into UMN Morris's existing central steam system provides a reliable pathway to produce thermal energy without natural gas. This creates crucial cost stability, enhances reliability in stored energy, and mitigates operational risks associated with gas price fluctuations and pipeline curtailment in extreme cold. Our preliminary modeling forecasts a significant reduction in annual average natural gas usage, and the elimination of curtailment concerns. This project will be the first of its kind in Minnesota and the Upper Midwest as it would establish a scalable model for rural energy development by meeting thermal needs and reducing grid congestion.

**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?**

Wind and solar are amongst Minnesota's abundant natural resources, but the state still needs to expand energy storage to fully integrate these renewables into the grid. Demonstrating thermal energy storage helps reduce reliance on fossil fuels by shifting clean electricity to meet heating demand, especially in cold climates. This reduces emissions and conserves natural resources like water that would be used on fossil fuel-based energy systems, helping protect Minnesota's air and natural landscapes. Energy storage also supports more efficient and creative land use in our communities. Thus, energy storage is an economic development opportunity for Minnesota and enhances economic competitiveness.

## Activities and Milestones

### Activity 1: Install, Test and Analyze Thermal Energy Battery Initial Performance

**Activity Budget:** \$2,479,000

**Activity Description:**

UMN Morris will select, install, and test the initial performance of a thermal energy battery in the campus district heating system. UMN Morris has the capacity to implement a Request-For-Proposal (RFP) process to solicit competitive bids for equipment. Our project team will meet regularly during the planning and installation phase and move to monthly meetings in the test/analysis-phase. We will assemble a team of partners with expert knowledge in developing microgrid controls and conducting energy-based financial analyses. We have utility partners that we have strong relationships with and who know how the utility sector operates and want to better understand how to stack multiple-value chains to enhance the benefits of stored energy and utilization for large demands for heating and cooling.

**Activity Milestones:**

| Description                                                | Approximate Completion Date |
|------------------------------------------------------------|-----------------------------|
| Project Planning and Acquisition of Thermal Energy Battery | July 31, 2028               |
| Installation and Commissioning of Thermal Energy Battery   | January 31, 2029            |
| Thermal Energy Battery Testing and Initial Experimentation | June 30, 2029               |

### Activity 2: Thermal Energy Battery and Renewable Energy Integration Optimization Research and Dissemination

**Activity Budget:** \$625,000

**Activity Description:**

A large-scale demonstration of a Thermal Energy Battery (TEB) will be the first of its kind in a district heating system in Minnesota. The team will analyze the performance of the combined system (TEB/ solar /wind), conduct an economic analysis of the combined system, and prepare and disseminate information broadly. Stored thermal energy can be used in a number of different industries and can reduce grid congestion. Thermal storage systems can supply heat and absorb power as needed in response to local demand for heat or overproduction, which enhances the stability of a grid fed by clean energy. UMN Morris has the capacity to help disseminate this information across Minnesota and beyond. Universities and regional partners such as gas and electric utilities have an opportunity to demonstrate pilot projects that increase confidence as new technologies are integrated into the regional grid. This project is modeled on the high demand of thermal energy in Minnesota and develops cutting-edge progress into the future.

**Activity Milestones:**

| Description                                                                                  | Approximate Completion Date |
|----------------------------------------------------------------------------------------------|-----------------------------|
| System Analysis of System Components and Initial Comparisons                                 | December 31, 2029           |
| Economic Analysis of Combined Thermal Battery, Flow Battery, and Renewable Energy Production | March 31, 2030              |
| Final Data Analysis and Report                                                               | 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.**

UMN Morris is uniquely positioned to serve as a demonstration site for this project. Our campus is well connected to the local Morris community, west central Minnesota, and beyond. We regularly host conferences, workshops, and events that provide opportunities to share research and project outcomes with policymakers, industry representatives, students, and community members. Visitors from Minnesota and beyond frequently tour our campus to learn about rural energy systems and sustainability initiatives. We emphasize the visibility of our projects and strive to ensure projects (for example, our recent battery which is to be located along a walking path on the UMN campus), are visible to the public, spark their curiosity and get conversations going.

The Morris Model, a partnership between the UMN Morris, the City of Morris, West Central Research and Outreach Center, and the Morris Area School District, is a trusted messenger in our community to communicate lessons from a project like this. The Morris Model is focused on energy conservation, clean energy, and community resilience. This project thus benefits from being located within an existing ecosystem that already does outreach and demonstration work, which makes it easier to leverage existing partnerships, outreach programs, and visitor networks to share its findings widely.

Findings from the project will be shared through conferences, webinars, presentations, and updates to the campus website. Faculty, engineering staff, and students involved in the economic analysis– which may lead to academic publication– will present their findings to help students, researchers, industry professionals, and community members understand the project and its benefits.

The project will also be shared through the University’s news and outreach channels to ensure results are accessible and useful to communities working to protect and enhance Minnesota’s natural resources. All communications will acknowledge support from the Environment and Natural Resources Trust Fund.

## 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 is focused on testing the feasibility and performance of Thermal Energy Batteries (TEB) in our Minnesota climate. We will learn how TEBs can integrate with renewable energy sources, resulting in a thorough, publicly-available, cost-benefit analysis and system-integration study. As described above, UMN Morris is a national leader in working with partners to demonstrate community-scale energy solutions for the 21st-century. After project completion, we will continue to advance this effort as part of our overall goal of being a model clean-energy-and-storage, research-and-demonstration site in the United States.

## Other ENRTF Appropriations Awarded in the Last Six Years

| Name                                                  | Appropriation                                                       | Amount Awarded |
|-------------------------------------------------------|---------------------------------------------------------------------|----------------|
| Storing Renewable Energy In Flow-Battery For Grid Use | M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 07b | \$2,408,000    |

## Project Manager and Organization Qualifications

**Project Manager Name:** Troy Goodnough

**Job Title:** Sustainability Director

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

Goodnough is the Sustainability Director at the University of Minnesota Morris (UMN Morris), a role he has held since 2012, building upon his previous six years as Sustainability Coordinator. A passionate advocate for environmental stewardship and clean energy, Goodnough has been instrumental in positioning UMN Morris as a national leader in campus sustainability.

His leadership has contributed to numerous accolades for the university, including the U.S. Dept. of Education Green Ribbon Schools Award for Post-Secondary Institutions, the Second Nature Climate Leadership Award, and the National Association of College and Businesses Officers Excellence in Sustainability Award. He holds a B.S. in Chemical Engineering and a B.S. in Chemistry from the University of Minnesota Twin Cities.

Beyond his campus role, Goodnough is highly engaged in regional and statewide initiatives, serving on the steering committees for the West Central Clean Energy Resource Teams (CERTs), the Upper Midwest Association for Campus Sustainability, the Minnesota Climate Adaptation Partnership, and the Morris Model Steering Committee. He is also an Institute on the Environment Fellow. His work and expertise are frequently shared through publications and invited presentations at national conferences.

**Organization:** U of MN - Morris

**Organization Description:**

Founded in 1960, the University of Minnesota, Morris (UMN Morris) is a public liberal arts college that is part of the University of Minnesota system. The campus offers 35 majors and 32 minors spanning natural sciences, humanities, social sciences, mathematics, and education.

UMN Morris is a national leader in green initiatives including wind, solar, and biomass energy. Morris is one of the first public colleges to generate on-site renewable power from local resources, and achieved carbon neutrality in electricity in 2020. 60% of the campus is powered by on-campus agrivoltaics and two 1.65 MW wind turbines. But renewable power is only one part of the campus's sustainability initiatives: other measures include historic building reuse, green building design and construction, conservation, local foods programs, hybrid vehicles, innovative curriculum, and community outreach.

UMN Morris is also part of the Morris Model, an award-winning collaboration of partner organizations working together to advance a shared vision of building a more sustainable community in Morris and across west-central Minnesota.

In 2019, UMN Morris was ranked as the #1 campus in the United States for most renewable electricity generated on campus per full-time equivalent student by Environment America.

## Budget Summary

| Category / Name                             | Subcategory or Type | Description                                                                                                                                                              | Purpose                                                                                                                                                                          | Gen. Ineli gible | % Bene fits | # FTE | Class ified Staff? | \$ Amount        |
|---------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-------------|-------|--------------------|------------------|
| <b>Personnel</b>                            |                     |                                                                                                                                                                          |                                                                                                                                                                                  |                  |             |       |                    |                  |
| Project Coordinator                         |                     | Lead the installation and technical analysis of the project                                                                                                              |                                                                                                                                                                                  |                  | 36.6%       | 93    |                    | \$326,164        |
| Project Economist                           |                     | Part-time role to provide economic analysis of the thermal energy battery for consideration of fiscal benefits to the statewide thermal infrastructure                   |                                                                                                                                                                                  |                  | 36.6%       | 2.25  |                    | \$84,443         |
| Student Intern                              |                     | Interns who are students at the University of Minnesota, Morris would be helpful in conducting research during and after the demonstration.                              |                                                                                                                                                                                  |                  | 0%          | 2.61  |                    | \$121,500        |
|                                             |                     |                                                                                                                                                                          |                                                                                                                                                                                  |                  |             |       | <b>Sub Total</b>   | <b>\$532,107</b> |
| <b>Contracts and Services</b>               |                     |                                                                                                                                                                          |                                                                                                                                                                                  |                  |             |       |                    |                  |
| TBD - Selected Thermal Battery Manufacturer | Service Contract    | Installation contract for battery with selected thermal battery manufacturer including engineering support for startup.                                                  |                                                                                                                                                                                  |                  |             | 0     |                    | \$300,000        |
| TBD - Selected Microgrid Controls           | Service Contract    | Microgrid controls contract for Microgrid for optimization and distributed energy resources (DERs). We would select a company with DER and microgrid controls expertise. |                                                                                                                                                                                  |                  |             | 0     |                    | \$250,000        |
|                                             |                     |                                                                                                                                                                          |                                                                                                                                                                                  |                  |             |       | <b>Sub Total</b>   | <b>\$550,000</b> |
| <b>Equipment, Tools, and Supplies</b>       |                     |                                                                                                                                                                          |                                                                                                                                                                                  |                  |             |       |                    |                  |
|                                             |                     |                                                                                                                                                                          |                                                                                                                                                                                  |                  |             |       | <b>Sub Total</b>   | <b>-</b>         |
| <b>Capital Equipment</b>                    |                     |                                                                                                                                                                          |                                                                                                                                                                                  |                  |             |       |                    |                  |
|                                             |                     | Thermal Battery and Components                                                                                                                                           | This is the energy storage device that would convert excess electricity generated during periods of high renewable energy supply into heating for the campus. It also includes a | X                |             |       |                    | \$2,000,000      |

|                                     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  |                    |                    |
|-------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--------------------|--------------------|
|                                     |                       |                                                                                                                                                                                                    | backpressure steam turbine and possibly transformers.                                                                                                                      |  |  |  |                    |                    |
|                                     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  | <b>Sub Total</b>   | <b>\$2,000,000</b> |
| <b>Acquisitions and Stewardship</b> |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  |                    |                    |
|                                     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  | <b>Sub Total</b>   | -                  |
| <b>Travel In Minnesota</b>          |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  |                    |                    |
|                                     | Miles/ Meals/ Lodging | Travel for project coordinator to meetings with project partners in MN for 3 years of the project: Mileage, Lodging, Meals for 4 overnight trips per year, 8 day trips with only mileage.          | In-state travel for project engineer and economist to conduct outreach and attend meetings with potential vendors.                                                         |  |  |  |                    | \$14,582           |
|                                     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  | <b>Sub Total</b>   | <b>\$14,582</b>    |
| <b>Travel Outside Minnesota</b>     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  |                    |                    |
|                                     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  | <b>Sub Total</b>   | -                  |
| <b>Printing and Publication</b>     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  |                    |                    |
|                                     | Printing              | Produce signage and large printed posters to present research at public events. Printing educational diagrams and banners on the thermal battery to describe the project for visitors to the site. | To describe and provide an explanation of the purpose and functioning of the thermal battery to community members, legislators, students, visitors, and anyone interested. |  |  |  |                    | \$7,311            |
|                                     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  | <b>Sub Total</b>   | <b>\$7,311</b>     |
| <b>Other Expenses</b>               |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  |                    |                    |
|                                     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  | <b>Sub Total</b>   | -                  |
|                                     |                       |                                                                                                                                                                                                    |                                                                                                                                                                            |  |  |  | <b>Grand Total</b> | <b>\$3,104,000</b> |

## Classified Staff or Generally Ineligible Expenses

| Category/Name     | Subcategory or Type | Description                    | Justification Ineligible Expense or Classified Staff Request                                                                                                                                                                                                                                                |
|-------------------|---------------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Capital Equipment |                     | Thermal Battery and Components | <p>Thermal battery will continue to be used after project time period for continued demonstration of this project.</p> <p><b>Additional Explanation :</b> The thermal battery will have a useful life of 20 years. The demonstration of the project will last long after the completion of the project.</p> |

## Non ENRTF Funds

| Category         | Specific Source                               | Use                                                                               | Status                     | Amount           |
|------------------|-----------------------------------------------|-----------------------------------------------------------------------------------|----------------------------|------------------|
| <b>State</b>     |                                               |                                                                                   |                            |                  |
|                  |                                               |                                                                                   | <b>State Sub Total</b>     | -                |
| <b>Non-State</b> |                                               |                                                                                   |                            |                  |
| In-Kind          | Unrecovered U of M indirect costs             | Support provided to the project by Project Manager, overhead from the University. | Secured                    | \$404,780        |
| In-Kind          | Unrestricted State Appropriations and Tuition | 1% Salary and Benefits for Troy Goodnough                                         | Secured                    | \$3,726          |
|                  |                                               |                                                                                   | <b>Non State Sub Total</b> | <b>\$408,506</b> |
|                  |                                               |                                                                                   | <b>Funds Total</b>         | <b>\$408,506</b> |

**Total Project Cost: \$3,512,506**

**This amount accurately reflects total project cost?**

Yes

## Attachments

### Required Attachments

#### *Visual Component*

File: [6f1fee11-3fa.pdf](#)

#### *Alternate Text for Visual Component*

This is an information sheet that summarizes the project's benefits and why Morris is the ideal location for this project. It includes infographics as well as a map of the UMN Morris campus and surrounding areas....

### Supplemental Attachments

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

| Title                                 | File                             |
|---------------------------------------|----------------------------------|
| UMN Morris Submission Approval Letter | <a href="#">1183215a-8be.pdf</a> |

## 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:**

Bryan Herrmann (University of Minnesota, Morris), Nathaniel Steinlicht (University of Minnesota, Morris)

**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