2018 Project Abstract
For the Period Ending June 30, 2022

PROJECT TITLE: Demonstrations for Community-Scale Storage System for Renewable Energy
PROJECT MANAGER: Melissa Kenney
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 07b as extended by M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18

APPROPRIATION AMOUNT: $550,000
AMOUNT SPENT: $550,000
AMOUNT REMAINING: $ 0

Sound bite of Project Outcomes and Results

The University of Minnesota's Institute on the Environment with Renewable Energy Partners, Red Lake Tribal Government Center, and University of Minnesota-Morris, demonstrated community-scale storage for renewable energy, including microgrids and battery systems. This project expanded our knowledge of leading-edge technology, shared lessons learned on battery acquisition, permitting, and installation, and advanced energy justice.

Overall Project Outcome and Results

More cities, campuses, nonprofit entities, and businesses across Minnesota are using wind and solar technology to produce cleaner energy. To reach high levels of renewable energy, significantly reduce their emissions, and achieve energy independence, they will need to include energy storage in their energy systems. Currently there are few examples of "community scale" energy storage projects, and often these entities lack the technical knowledge needed to select and optimize the best energy storage system. The overall goal of this project is to expand community-based, locally-produced renewable energy and reduce air emissions to improve the environment, under LCCMR funding priority "Air Quality, Climate Change, and Renewable Energy".

This project included three activities. First, we produced an "Community-Scale Energy Storage Guide" that describes both the operation of the US electricity grid with renewable energy and battery storage and different battery storage technologies and installation steps, using the sites as case studies. Second, we selected sites - Renewable Energy Partners, Red Lake Tribal Government Center, and University of Minnesota-Morris - and worked with them, using the guidebook research, to identify and acquire the optimal battery technology to meet site needs and provide technical assistance on design, permitting, and battery installation. At this stage, Renewable Energy Partners has a fully functional and tested battery - it will be complete when insurance is registered with Xcel Energy, Red Lake Tribal Government Center is completed, and University of Minnesota-Morris has the battery and installation components finalized and will proceed with installation once it receives permits. Third, given COVID-19, this project pivoted to develop a virtual site that includes highlights of the 3 demonstration sites, interviews on the benefits of battery storage, and webinars on battery storage lessons learned. Overall, this project expanded our knowledge of leading-edge technology, shared lessons learned on battery acquisition, permitting, and installation, and advanced energy justice.

Project Results Use and Dissemination

- **Virtual Site Visit:** The virtual site visit consists of highlighting the 3 demonstration sites and interviewing the Project Partners to get the full scope of how the storage system was implemented. UMN Institute on the Environment-Energy Transition Website
- **CERTs events:** This two part webinar took a deep-dive into battery storage by conducting paneling discussion with industry experts, seminars and workshops. This was organized by University of Minnesota Clean Energy Resource Teams (CERTs) and the Institute on the Environment.
    - *The future of energy storage in Minnesota*, February 23, 2021
    - *Piloting community-scale energy storage systems in Minnesota*, April 14, 2021
    - *Community-Scale Battery Storage Workshop*, July 19, 2021
- **Published an Energy Storage guidebook** and highlighted this downloaded, user friendly publication at the CERTS events, Energy and Equity workshop, and with the Energy Storage Advisory Committee.
    - Community-Scale Energy Storage Guide: How Community Groups and Small Businesses Can Employ Energy Storage to Save Money and Contribute to Minnesota's Clean Energy Transition
- **Published Videos on the IonE YouTube page:**
    - Community-Scale Battery Energy Storage in Minnesota https://www.youtube.com/watch?v=RpNs6rvGKCI
    - Community-Scale Energy Storage: How does it work? https://www.youtube.com/watch?v=QjTjuJAtrxA

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2018 ENRTF Work Plan (Main Document)

Today's Date: August 15, 2022

Date of Next Status Update Report: Final Report

Date of Work Plan Approval: 06/05/2018

Project Completion Date: June 30, 2022

PROJECT TITLE: Demonstrations for Community-Scale Storage Systems for Renewable Energy

Project Manager: Melissa Kenney

Organization: University of Minnesota

College/Department/Division: Institute on the Environment

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Location: Statewide

Total Project Budget: $550,000

Amount Spent: $550,000

Balance: $0

Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 07b as extended by M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18

Appropriation Language: $550,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to install, demonstrate, and evaluate three community-scale storage systems for renewable energy and develop a guidebook on storing renewable energy for statewide use. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18. ENVIRONMENT AND NATURAL RESOURCES TRUST FUND; EXTENSIONS. [to June 30, 2022]

I. PROJECT STATEMENT: More and more cities, campuses, nonprofit entities, and businesses across Minnesota are using wind and solar technology to produce cleaner energy. To reach high levels of renewable energy, significantly reduce their emissions, and achieve energy independence, they will need to include energy storage in their energy systems. Currently there are few examples of "community scale" energy storage projects, and often these entities lack the technical knowledge needed to select and optimize the best energy storage system. We propose a Community-Scale Energy Storage Guide and 3 exemplar Demonstration Projects to provide the tools and knowledge for community-scale energy customers to choose the best energy storage solutions. For this project, we will:

1) create a research-based, user-friendly print and web-based guide to energy storage in Minnesota;
2) select 3 representative small-scale local energy customers with renewable energy installation and provide them with a battery energy storage system;
3) assess results and share the results broadly through public engagement, site tours, and dissemination of web and print knowledge tools.

Our criteria for selecting the Demonstration Projects are:

1) geographically dispersed (1-northern MN, 1-rural agricultural MN, 1-metro),
2) on-site renewable energy,
3) local-scale, customer-controlled energy system (examples: hospital, municipal buildings, college campus);
4) project funds will cover the cost of a battery storage system up to approximately 50 kW (with market changes, prices may be lower, allowing larger systems by the time of purchase in 2017).

The overall goal is to expand community-based, locally-produced renewable energy and reduce air emissions to improve the environment, under LCCMR funding priority E.

Energy storage is a linchpin to a more innovative, clean, and efficient energy system, but its many uses and technology choices are complicated. Only a few, mostly large-scale projects exist in Minnesota, and virtually all are utility-funded and utility-scale projects. Community-scale energy users need the knowledge tools created by this project to achieve important outcomes: 1) community-scale renewable energy projects will be more productive and valuable, 2) community-scale customers will understand how to use storage to reduce their energy costs and emissions (for example, by reducing peak demand), and 3) community-scale customers with high-ambition goals for carbon-neutrality or 100% renewable energy will have a crucial tool to achieve them. Many community-scale sites could be microgrids with the addition of storage. Our definition of microgrid for purposes of this project is that the community-scale sites are grid-connected, produce on-site renewable energy, and have the ability to "island" or function independently of the grid if needed.

Our goal is to use these 3 demonstration projects and the accompanying guide and knowledge advancement to create models that community-scale energy users across the state of Minnesota can adopt. Dissemination of the information and tools is a critical part of the project. Besides individual local energy customers and community members, we will invite stakeholders such as utilities, policymakers, regulators, and local governments to provide input and participate in site visits for these projects.

The Energy Transition Lab (ETL) founded and convenes the statewide Minnesota Energy Storage Alliance (MESA), which includes more than 100 stakeholders from the public, private, nonprofit, and community sectors along with University experts, with the mission of accelerating smart deployment of energy storage in Minnesota and the Midwest. ETL and MESA will provide expert advisors, host the web-based tool, and broadly disseminate results. Please see the Energy Transition Lab website for more information about ETL and MESA: www.energytransition.umn.edu.

II. OVERALL PROJECT STATUS UPDATES:

First Update January 30, 2019

In the summer of 2018, we worked with the University of Minnesota's General Counsel and the Sponsored Projects Administration (SPA) to establish the rules for host sites who are receiving battery installations. The University will be the owner of the battery throughout its useful life, but the host will need to sign a Memorandum of Understanding (MOU) that states that the University will purchase and install the battery (through a vendor). In the MOU, the site host will agree to use the battery for the purpose of the project, in compliance with the approved LCCMR work plan. The site host will be responsible for the maintenance and operation of the battery through its useful life, and for disposal at the end of its life.

We hired a combined Post-Doc/Graduate Research Assistant, who holds a PhD in Chemistry, and is a Masters Student in the Humphrey Science, Technology, and Environmental Policy (STEP) program. He is conducting research pursuant to Activity 1. We changed our personnel component slightly to make our second hire a Research Project Coordinator, who will assist the Project Manager with all project logistics. We worked with Director Becca Nash to ensure that this personnel change was allowed, given that the overall personnel budget did not change. Due to some institutional delays, this hire will take place in March 2019.

We have tentatively selected 3 host sites and have discussed the details with the potential site hosts. Pursuant to the work plan, one is in rural Minnesota (the University of Minnesota-Morris campus); one is in northern Minnesota (the Red Lake Nation); and the third is in the metropolitan area (a renewable energy job training center in North Minneapolis). Our next step with these partners is to finalize their battery storage usage plan, and get written agreements signed.

Second Update June 30, 2019

The new Research Project Coordinator was hired mid-March 2019 and was quickly on-boarded. The Post-Doc/ Graduate Research Assistant and Research Project Coordinator met and developed strategies for completing the work plan deliverables. The team developed a list of potential ESAC group participants and plans to convene the first Energy Storage Advisory Committee (ESAC) were developed. Invitations went out to stakeholders, collaborators and project partners who champion energy storage work in a variety of ways to join the ESAC. The ESAC then convened for the first time on April 18th.

The Post-Doc has developed a website with preliminary tools for evaluating battery storage feasibility and cost based on modeling of housing type and cost. At the meeting, the online tools were introduced to ESAC members and the 3 Host site partners presented project updates to the group. The ESAC group received updates on the progression of the overall project. The ESAC group contributed comments and advice on foreseen barriers presented in the project, and gave feedback for further development of the web-based tool which also informs the guide. From the larger advisory group, four smaller sub-committees emerged that will aid areas in the project that need more support and advisement in between quarterly advisory group meetings.

The Research Project Coordinator also completed check-in/update meetings with the 3 host sites to ensure that projects were progressing and to determine if technical assistance was needed. The North Minneapolis site was the first scheduled meeting held on May 17, 2019. In this meeting the site hosts gave updates on their finance barriers, as well as their timeline projection for this summer's solar installation. The Morris Campus site hosts have had three meetings with our Graduate Research Assistant and Project Coordinator. The first meeting happened May 23, 2019 where we discussed the updates to the Morris site and also battery vendor options.

The second discussion, held on May 29, 2019, was a follow up on the previous discussion of battery vendors and types of batteries but also the load profile for the site. The Morris site submitted a load profile analysis methodology and a marginal load-smoothing capability document for review and discussion with the Post-Doc. The follow-up meeting held on June 5, 2019 gave Post-Doc information and direction to input the load profile into models for analysis of different battery options.

Third Update January 30, 2020

The Energy Storage Advisory Committee quarterly meeting convened on July 11, 2019. The discussion was centered on engagement and project installation timelines with the Project Partners. Project Partners gave updates on their sites and (if necessary) solar PV installation timeline.

The Energy Transition team has completed all host site visits. On July, 17, 2019, the Energy Transition team completed a tour of the University of Minnesota Morris Campus-Green Prairie Residence Hall. This will be the host site for one of the community scale demonstration projects. The team's discussion centered around priorities for energy usage which are peak-shaving, optimization of solar generation and time-of use management. We also scoped out a location and developed a plan to prepare for a flow battery installation with the Lead Electrician. Energy Researcher maintains updated communication with Morris Campus Project Partners about progress. Energy Researcher has also gone through great strides to open up communication with several different battery vendors in order to research their price point, technologies and various chemisties that will suit the needs of the host sites. On August 15, 2019, the Energy Transition team met with the Tribal Council and Project Partners to tour the Red Lake Government Center and the Oshkiimaajitahdah Workforce Center. The Red Lake Government Center has solar PV installed and has prioritized their needs for the energy storage battery as resiliency and data security in response to frequent power outages. The Red Lake Tribe Council is ultimately seeking energy sovereignty and this demonstration will assist in that goal. On September 24, 2019, the team completed its tour with Renewable Energy Partners in North Minneapolis. The team met with the Project Partners, their master Electrician and solar PV installer to discuss the technical assistance and physical needs of the project. We also confirmed a timeline for the installation of the solar PV at the site.

Our timelines for publishing our first version of the energy storage guide, and having it reviewed by a focus group, have hit some unexpected obstacles. Project Manager Anderson negotiated a Memorandum of Understanding (MOU) with the Sponsored Projects Administration (SPA) and Office of the General Counsel (OGC) at the University of Minnesota in 2018, early in the project. The MOU was to be signed by each project host site lead. However, the Institute on the Environment required us to revisit the MOU in 2019. Our team has had ongoing communications and meetings with the University of Minnesota's Controller and SPA offices for guidance on the Memorandum of Understanding (MOU) language since early fall 2019. The final MOU was just approved for a second time, so we are now close to proceeding with the Red Lake project. There are also several other forms that need to get approval from the University before procedurement of a capital purchase. The other two projects will require a Request for Proposal (RFP) so they will take a little longer. Similarly there were delays within the University in getting the web-based tool downloaded onto a website to be able to be shared with our Advisory Committee and focus group. We are confident we will have the web-based tool and draft guide ready for review by both groups in approximately the next month.

On November 11, 2019, the Energy Transition Advisory Committee convened and received updates on the progress of the installation of the energy battery projects from the Project Partners and the Energy Transition team. The committee was also introduced to a new collaborative partner, NextEra Analytics. NextEra Analytics offers renewable energy consulting services using industry-leading scientific analysis for planning, siting, forecasting and optimizing renewable energy projects. NextEra has offered to provide the control systems that will interface with the batteries for all three host sites.

Fourth Update June 30, 2020

As the procurement of the batteries progresses, the project has hit a global supply and chain issue due to the Covid-19 pandemic. Our team was also displaced from the University of Minnesota and is currently working remotely to complete the project.

After determining the energy needs of the host sites, we were able to research different battery vendors. We analyzed the pros, cons and chemical makeup of the different batteries and invited several different suppliers to meet with our team to answer any questions that we had about their product. On February 17,2020, the University of Minnesota released a Request for Proposal (RFP) to the public for battery suppliers and vendors. Among the suppliers that accepted our invitations were UniEnergy Technology (UET), VisBlu, Werner Electric/Sonnen, and ESS Inc.

On March 4, 2020, we conducted a meeting with Gene Larson of UniEnergy Technologies (UET). In this meeting we were given the opportunity to view the specs of the batteries and investigate the battery's cutting edge chemical technology. There continues to be a multitude of meetings with UET as we persevere through UMN administrative systems and documentation. We have also run into challenges regarding shipping with UET's fabrication company located in China. We have been notified by UET that Customs will include a 25% tariff to the battery shipment leaving China. We are in the final stages of getting our documentation for this site approved by the Purchasing Department to obtain the battery from UET for the Red Lake Site.

VisBlu, a battery company located in Denmark, also submitted a proposal but had to rescind their offer due to the COVID-19 pandemic and their lack of capacity to fulfill the order. When this vendor withdrew, Werner Electric accepted the invitation to send a proposal that could fulfill the energy requirements at the Renewable Energy Partners (REP) site. Werner Electric is located in Cottage Grove, MN and has Sonnen batteries in stock to fulfill the order. We will use an outside vendor to deliver the batteries from Cottage Grove to North Minneapolis. We are currently in the final stages of getting our shipping documentation approved by UMN's purchasing office.

On March 16, 2020, we were ready to discuss the options for battery vendors with the Morris Campus site. There was a separate RFP release for the Morris campus site and the ESS battery was selected for this site. Details are currently being negotiated by the vendor, battery installation company (IPS) and UMM for pricing within our budget and delivery date.

With all of our setbacks due to COVID-19 and the community unrest of the Floyd killing, I believe that we will be able to meet our final deadline with this project.

Amendment Request October 12, 2020

Amendment 1 PM Change

The PI on this project is currently Ellen Anderson; however, as of July 2020, Ms. Anderson retired from, and is no longer employed by, the University of Minnesota. We are requesting to assign the PI role to Dr. Melissa Kenney, with Akisha Everett and Dr. Alex Venning serving as Senior Personnel.

Amendment 2 Rebudget

We are submitting this concurrently with a budget modification request that will reflect the personnel changes.

- Travel budget would be reduced by $12,000 to a revised budget of $6,085
- Personnel budget would be increased by $12,000 to a revised budget of $274,846

These changes are being requested because travel is limited to in-state forfield days due to COVID-19 restrictions and additional personnel time is needed to transition to deliver outcomes using remote engagement methods. The site tours, slated for spring 2021, will include a hybrid of small stakeholder tours and virtual tours; noting that alternative arrangements may be necessary depending on state and university restrictions due to COVID-19. As a result of a transition to remote engagement, the travel budget has been reduced given the new plan for a hybrid site tour model. See the attached budget amendment for further details.

Amendment Approved October 12, 2020

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Fifth Update January 30, 2021

We have met a major milestone with battery selection completed for all 3 demonstration sites.

Renewable Energy Partners (REP) completed the installation of the solar panels on their rooftop and is ready to include the energy storage battery along with the inverter. Renewable Energy Partners and the Energy Storage team chose a Sonnen Lithium Ion battery from Werner Electric for their energy needs. The Sonnen battery was delivered to the REP site on July 17, 2020. The preparation for the installation started with the Sundial team working with Xcel to complete the interconnection application. Once the interconnection application was submitted and approved by Xcel, the inverters and other supporting equipment were purchased and delivered to REP on January 19, 2021. The installation of the energy storage batteries and the inverter is scheduled to be completed in February 2021. This is the first site that will have a fully functioning battery system.

Red Lake Tribal Government Center already has solar installed. The Energy Team and Red Lake project partners choose the UniEnergy Technology (UET) Vanadium Flow battery. This battery has been ordered and is scheduled to be delivered to Red Lake before the end quarter one. Red Lake has been proactive in anticipation for the batteries and have started the interconnection process with their local utility company.

The University of Minnesota Morris Campus site released a Request for Proposal in July 2020 to procure their battery from the most competitive bid. Through this process an ESS Iron Flow battery was chosen but the battery was over budget. Through an "Exception to Bid" process, the Morris team was able to obtain a quote for the UET vanadium flow batteries. The team decided that this was a comparable choice for the Morris site. The proposal for an installer has been secured. With this information we have now escalated this information to our Purchasing Department within the University for procurement.

COVID-19 impacts: Because of COVID-19, there are significant supply-chain delays from our battery vendors due to COVID-19 related closures and/or decreased staff. COVID-19 impacts both on the battery procurement and installation as well as transitioning in-person partner engagement to virtual activities has additionally increased the personnel time, beyond the current budget, that is required to complete the project deliverables. We applied for and received an extension for this LCCMR project and the budget will be adjusted to account for the additional personnel time needed (and travel and in-person convening expenditures saved) to run an effective virtual site visit.

Amendment Request March 29, 2021

Amendment 1 Rebudget

We are submitting a budget modification request that will reflect a change in the travel and in-person engagement needs and an increase of Professional Services time to support virtual engagements and a virtual site visit.

- Travel budget would be reduced by $5,498 to a revised budget of $587.
- Printing budget would be reduced by $3,251 to a revised budget of $610.

- Capital equipment would be reduced by $35,124 to a revised budget of $225,784
- Equipment/Tools/Supplies would be increased by $2,700 to a revised budget of $3,000.
- Professional Services budget would be increased by $38,612 to a revised budget of $42,612.
- Personnel budget would be increased $2,561 to a revised budget of $277,407

These changes are being requested because travel has been restricted until at least June 30, 2021 due to directives from Joan Gabel, President of the University of Minnesota and the COVID-19 restrictions. Additional personnel time is needed to transition to deliver outcomes using remote engagement methods. The site tours, slated for spring/summer 2021, will include virtual tours given current state and university restrictions due to COVID-19. Professional services and non-capital equipment budgets also need to be increased because of the engineering and installation labor required for installation and interconnection of the energy storage batteries. The capital expenditures budget is reduced and moved into professional services to properly categorize the battery installation and interconnection expenditures. As a result of a transition to remote engagement, the travel budget and print publications budget has been reduced given the new plan for online dissemination of energy storage project information including increased online access to the energy storage site visit resources and pdf report. See the attached budget amendment spreadsheet for further details.

Project extended to June 30, 2022 by LCCMR 6/30/21 as a result of M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18, legislative extension criteria being met.

Sixth Update June 30, 2021:
We have met three major milestones with 1) the battery installation started at the Renewable Energy (REP) site, 2) the release of the final guidebook "Community-Scale Energy Storage Guide: How Community Groups and Small Businesses Can Employ Energy Storage to Save Money and Contribute to Minnesota's Clean Energy Transition", and 3) virtual site visit materials.

Renewable Energy Partners (REP) installation of the battery system connected to the building's solar array and will be the first demonstration site completed. Four Sonnen Lithium Ion batteries were installed, working with Sundial on the interconnection. Since this installation was very complex, REP worked extensively with engineers from their electricity utility provider, Xcel Energy, to develop wiring diagrams and complete their interconnection application. We are working on closing out invoice payments and this site, for the purposes of this project, will be completed. Site leaders have also given small tours of the system during the installation processes with additional small tours planned. The site team was also involved in the development of the Energy Storage Guidebook, videos produced for the virtual site visit, and seminars and workshops on battery storage organized by the University of Minnesota Clean Energy Resource Teams (CERTs) and the Institute on the Environment (IonE).

Red Lake Tribal Government Center already has solar installed. There have been delays in receiving the ordered UniEnergy Technology (UET) Vanadium Flow battery due to UET undergoing a restructure. We are meeting weekly with the UET CEO to manage the process of acquiring batteries by the end of the calendar year and to obtain documentation to allow the installation team to start planning the interconnection with solar installed on the site with their local utility company.

The University of Minnesota Morris Campus already has wind turbines installed. There have been delays in receiving the ordered UniEnergy Technology (UET) Vanadium Flow battery due to UET undergoing a restructure. We are meeting weekly with the UET CEO to manage the process of acquiring batteries by the end of the calendar year and to obtain documentation to allow the installation team to start planning the interconnection with wind installed on the site with their university engineers and local utility company.

Virtual Site Visit: The virtual site visit consists of highlighting the published Energy Storage Guidebook through high production summary videos and and deep-dive seminars and workshops (recorded and will be available) on

battery storage organized by the University of Minnesota Clean Energy Resource Teams (CERTs) and the Institute on the Environment (IonE). These resources will be included on the website under construction to feature battery storage and to serve as a landing page for our virtual site visit.

The CERTs events included:

- *The future of energy storage in Minnesota:* On February 23, 2021 we hosted a webinar that had an audience of hundreds of Minnesotans to talk about energy storage. The first event in this two-part series focused on the big picture of energy storage, what that expansive term can include, and what the future of energy storage may look like here in Minnesota and the Midwest. https://www.cleanenergyresourceteams.org/future-energy-storage-minnesota
- *Piloting community-scale energy storage systems in Minnesota:* On April 14, 2021 we hosted a webinar to talk about community-scale deployment of energy storage technologies, specific applications, workforce development, and growing the market. It featured the reason that the Regional Apprenticeship Training Center in North Minneapolis and the Red Lake Nation included battery storage at the community scale, from solar integration to stabilizing load to providing resiliency and backup power. Each site also has had to think about different battery technology and sizing and the necessary equipment and management systems. https://www.cleanenergyresourceteams.org/piloting-community-scale-energy-storage-systems-minnesota?mc_cid=86375532a2&mc_eid=4db62009c1
- *Community-Scale Battery Storage Workshop:* On July 19, 2021 we hosted a virtual workshop with over 130 attendees geared toward helping participants understand the key factors that influence the type of storage project they pursue and how to get started. It was aimed at helping entities dive into their motivation to use a battery storage system—their "use case"—and how those factors will drive the type of battery storage system they need. It featured the LCCMR-funded Minnesota Community-scale Energy Storage Guide as a primer and resource and highlighted a discussion of financing led by our Red Lake and REP site partners. LINK

The videos have been published on the IonE YouTube page:

- Community-Scale Battery Energy Storage in Minnesota https://www.youtube.com/watch?v=RpNs6rvGKCI
- Community-Scale Energy Storage: How does it work? https://www.youtube.com/watch?v=QjTjuJAtrxA

Guidebook: A final version of the web-based guidebook "Community-Scale Energy Storage Guide: How Community Groups and Small Businesses Can Employ Energy Storage to Save Money and Contribute to Minnesota's Clean Energy Transition" was copyedited and formatted by our communications department in June 2021. The guidebook will be published on the IonE website and available as a PDF download publicly. A printed copy of the guidebook is available upon request. The first public dissemination of the guidebook happened at the CERTs + IonE energy storage workshop held on July 19, 2021. Our team plans feature the guidebook at the IonE Annual Meeting 2021 and at the IonE Energy Equity Workshop 2021. Additionally, we are in the process of obtaining a DOI for the guidebook and it will be included on the website under construction to feature battery storage resources.

- Venning, A., A. Everett, M.A. Kenney. (2021) Community-scale Energy Storage Guide: How Community Groups and Small Businesses Can Employ Energy Storage to Save Money and Support Minnesota's Clean Energy Transition. University of Minnesota, Institute on the Environment. Saint Paul, MN, USA.

COVID-19 impacts: Because of COVID-19, there are significant supply-chain delays from our battery vendors due to COVID-19 related closures and/or decreased staff. UET, the battery vendor for the Red Lake Tribal Government Center and the University of Minnesota Morris campus sites, is also undergoing a restructure which has caused significant delays in battery acquisition. COVID-19 impacts both on the battery procurement and installation as well as transitioning in-person partner engagement to virtual activities has additionally increased the personnel time, beyond the current budget, that is required to complete the project deliverables. We applied for and received an extension for this LCCMR project and the budget will be adjusted to account for the

additional personnel time needed (and travel and in-person convening expenditures saved) to run an effective virtual site visit.

Seventh Update January 31, 2022:
We have released the community-scale battery storage website, made progress on the installation of batteries at REP and acquisition of batteries at Red Lake Tribe and UMN-Morris. The materials produced are being shared through the website and during engagements.

Renewable Energy Partners (REP) has installed a 174 kW solar array on their Regional Apprenticeship Training Center (RATC). Four Sonnen Lithium Ion batteries have been purchased from Werner Electric and will be online this spring and connected to this solar array. Our partnering installation company, Sundial, has undergone a leadership change, lost their Electrical Engineer and is unable to complete the battery installation project at REP. We are in the final stages of negotiating the completion of the REP site install with Billy Parson of Blue Sky Electric, a minority owned business that has previous experience installing batteries. A proposal from Blue Sky will be submitted and we will have to go through this itemized proposal with our Project Partners to make a final decision. Site leaders have also given small tours of the system during the installation processes with additional small tours planned. The Institute on the Environment in collaboration withREP is also planning Community EngagemREP as a resilience hub and a virtual power plant with the community's microgrid project.

Red Lake Tribal Government Center already has solar installed. UniEnergy Technology UET went out of business. UMN voided the contract, and thus, we were unable to acquire the Vanadium Flow battery. We pivoted to the purchase and acquisition of lithium ion batteries from Gray Bar Electrical Supply Company. These batteries have been ordered and shipped to Minneapolis, MN where they were picked up and transported to the Red Lake Government Center. The batteries are on schedule to be installed by Innovative Power Solutions (IPS) this spring.

The University of Minnesota Morris Campus (UMN-Morris) already has wind turbines installed. UniEnergy Technology UET went out of business. UMN voided the contract, and thus, we were unable to acquire the Vanadium Flow battery. We pivoted to the purchase and acquisition of lithium ion batteries from Simpliphi Electrical Supply Company. The Morris Team along with the electrical engineers from PSI have collaborated on the installation details so that the process can move swiftly.

Virtual Site Visit and Guidebook: The virtual site visit consists of highlighting the published Energy Storage Guidebook through high production summary videos and and deep-dive seminars and workshops (recorded and will be available) on battery storage organized by the University of Minnesota Clean Energy Resource Teams (CERTs) and the Institute on the Environment (IonE). These resources are now available on our website and serve as a landing page for our virtual site visit. http://environment.umn.edu/energy-transition

COVID-19 impacts: Because of COVID-19, there are significant supply-chain delays from our battery vendors due to COVID-19 related closures and/or decreased staff. UET, the battery vendor for the Red Lake Tribal Government Center and the University of Minnesota Morris campus sites went out-of-business causing the team to shiftplanning for the purchase and installation of lithium ion batteries, requiring a budget amendment. COVID-19 impacts both on the battery procurement and installation as well as transitioning in-person partner engagement to virtual activities has additionally increased the personnel time, beyond the current budget, that is required to complete the project deliverables. We applied for and received an extension for this LCCMR project and the budget will be adjusted to account for the additional personnel time needed (and travel and in-person convening expenditures saved) to run an effective virtual site visit.

Amendment Request February 28, 2022

Amendment 2 Rebudget

We are submitting a budget modification request that will reflect a change in the battery acquisition costs and installation at the sites given that the flow battery vendor was not able to complete their contract.

- Professional Services budget would be increased by $74,176 to a revised budget of $116,788.
- Capital equipment would be reduced by $73,876 to a revised budget of $151,908.
- Printing budget would be reduced by $300 to a revised budget of $0.

UniEnergy Technology UET went out of business. UMN voided the contract, and thus, we were unable to acquire the Vanadium Flow battery. As a result, we switched battery technologies that will be deployed at Red Lake Tribal Government Center and the University of Minnesota Morris to lithium batteries, which is a lower cost technology. This cost savings allows us to redeploy these funds to the installation costs to ensure they will be installed this spring; installation costs are significantly higher than originally budgeted because this is a new technology that requires additional personnel time for engineering design and installation time. Printing of the Community Scale Storage guidebooks is no longer needed as all requests have been satisfied through PDF delivery of the document; thus, this cost has been removed.

Overall Project Outcome and Result

More cities, campuses, nonprofit entities, and businesses across Minnesota are using wind and solar technology to produce cleaner energy. To reach high levels of renewable energy, significantly reduce their emissions, and achieve energy independence, they will need to include energy storage in their energy systems. Currently there are few examples of "community scale" energy storage projects, and often these entities lack the technical knowledge needed to select and optimize the best energy storage system. The overall goal of this project is to expand community-based, locally-produced renewable energy and reduce air emissions to improve the environment, under LCCMR funding priority "Air Quality, Climate Change, and Renewable Energy".

This project included three activities. First, we produced an "Community-Scale Energy Storage Guide" that describes both the operation of the US electricity grid with renewable energy and battery storage and different battery storage technologies and installation steps, using the sites as case studies. Second, we selected sites - Renewable Energy Partners, Red Lake Tribal Government Center, and University of Minnesota-Morris - and worked with them, using the guidebook research, to identify and acquire the optimal battery technology to meet site needs and provide technical assistance on design, permitting, and battery installation. At this stage, Renewable Energy Partners has a fully functional and tested battery - it will be complete when insurance is registered with Xcel Energy, Red Lake Tribal Government Center is completed, and University of Minnesota-Morris has the battery and installation components finalized and will proceed with installation once it receives permits. Third, given COVID-19, this project pivoted to develop a virtual site that includes highlights of the 3 demonstration sites, interviews on the benefits of battery storage, and webinars on battery storage lessons learned. Overall, this project expanded our knowledge of leading-edge technology, shared lessons learned on battery acquisition, permitting, and installation, and advanced energy justice.

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1:

Description: Community Scale Energy Storage Guide Preparation, Testing, & Publication Develop the Minnesota Energy Storage Guidebook, a plain English, user-friendly print and web-based information resource, including a decision-making flowchart tool for selecting the most appropriate, cost-effective technologies for energy users' proposed goals. The Beta version will be evaluated by an expert advisory

group and focus groups and tested by users. The final version will be broadly disseminated and hosted on ETL's website.

ENRTF BUDGET: $135,650

Outcome	Completion Date
1. Research completed on technology, economics, value streams of storage	Dec. 31, 2018
2. Beta version of guidebook with print and basic web version of user-friendly information resources and decision flow process graphics completed	March 31, 2019
3. Expert advisory group convened; expert review comments incorporated into guidebook	May 31, 2019
4. Representative energy customers focus groups convened; guidebook information and decision tools evaluated	Oct. 31, 2019
5. Print and Web-based guide and decision flow tools revised and published/online	Jan. 15, 2021

First Update January 30, 2019
We have completed the preliminary research on technology options, economics, and value streams of energy storage. This research will create the foundation for the energy storage guide, which we will focus on drafting the first version of in February and March 2019. The research will continue throughout the project to provide more in-depth information.

Second Update June 30, 2019
The ESAC convened on April 18, 2019 at the University of Minnesota's Learning and Environmental Sciences building. The convening was a robust group of 24 participants including 4 Energy Transition Lab staff members. The agenda included an introduction to the web guidebook and online tool. The prototypes were available for the experts to review and give suggestions for improvement to the developer. There was also a follow up comment tool sent to each participant to ensure them all voices were considered in revisions of the tools. ESAC members provided suggestions to the Post- Doc/ Graduate Research Assistant for guidebook and online tool revisions.

Third Update January 30, 2020
A Beta version of the decision flow online tool is completed but the team has had challenges with uploading this tool to a host server and publishing it online. The team has contacted the Minnesota Supercomputing Institute and other university-based resources for guidance in the online publication of the tool, and expects to have it functioning online within weeks. A full draft of the print version of the guide has also been completed. The team has decided to solicit feedback on both the online decision support tool and the print version of the guide before making them available to the public, and both versions will be shared with our Energy Storage Advisory Committee at our next quarterly convening in February 2020. We have a cohort of community energy stakeholders who will populate our energy users focus group, and we will convene that after the Advisory Committee meeting in February.

Four Update June 30, 2020
A draft of the print version of the energy storage guide was shared with the Energy Storage Advisory Committee at the quarterly meeting in February 2020. Members were invited to review the document and submit feedback to revise and improve the document. This feedback was incorporated into a new draft of the document, which was then shared with Clean Energy Resource Teams (CERTS), which distributed it throughout their organization. Further feedback will be solicited to improve the final version of the guide. We are also continuing to update the document as we complete the process of purchasing and installing the battery systems. We have continued to face challenges with publishing the online decision support tool and sharing it with members of our advisory committee. After communications with the Minnesota Supercomputing Institute failed to result in the successful

launch of the tool, we contacted the University's Office of Information Technology (OIT). OIT has created a virtual private server at our request in order to host the tool, and we are in the process of configuring the server and uploading the necessary files to publish the tool.

Fifth Update January 2021
A draft version of the web-based Energy Storage Guide was successfully launched online and hosted by a UMN-based server set up by the Office of Information Technology. The web guide is publicly available at http://134.84.24.77:3838/Energy-Storage-Guide/. The draft was shared with the advisory committee during a meeting in November 2020 along with a request for feedback. This feedback received from the advisory committee was incorporated into the web tool final version which will be shared with the advisory committee during their scheduled meeting in February 2021. The print version of the Energy Storage Guide is currently being copyedited and formatted for publication; it will be made available in both pdf and print format, by request. We are currently working on a dissemination plan for the official release of these materials and for distribution to the public in the first and second quarter of 2021.

Sixth Update June 30, 2021:
We met a major milestone with the release of "Community-Scale Energy Storage Guide: How Community Groups and Small Businesses Can Employ Energy Storage to Save Money and Contribute to Minnesota's Clean Energy Transition". It was copyedited and formatted by our communications department in June 2021. The guidebook will be published on the IonE website and available as a PDF download publicly. A printed copy of the guidebook is available upon request. The first public dissemination of the guidebook happened at the CERTs + IonE energy storage workshop held on July 19, 2021. Our team plans feature the guidebook at the IonE Annual Meeting 2021 and at the IonE Energy Equity Workshop 2021. Additionally, we are in the process of obtaining a DOI for the guidebook and it will be included on the website under construction to feature battery storage resources.

- Venning, A., A. Everett, M.A. Kenney. (2021) Community-scale Energy Storage Guide: How Community Groups and Small Businesses Can Employ Energy Storage to Save Money and Support Minnesota's Clean Energy Transition. University of Minnesota, Institute on the Environment. Saint Paul, MN, USA.

Seventh Update January 31, 2022:
The guidebook is now available on our website and serves as a landing page for our virtual site visit. http://environment.umn.edu/energy-transition We have shared it with the advisory team and also share it digitally when we meet with stakeholders interested in battery storage. There have not been requests for print versions of the report. We have also deposited the guidebook into the University of Minnesota's Digital Conservancy https://conservancy.umn.edu/handle/11299/223066 and the DOI was obtained https://hdl.handle.net/11299/223066.

Final Report Summary August 15, 2022
This project activity was fully completed. The guidebook is now available on our website and serves as a landing page for our virtual site visit. http://environment.umn.edu/energy-transition The advisory team and different energy user experts evaluated the information. It was broadly disseminated and shared digitally with stakeholders interested in battery storage. There have not been requests for print versions of the report; thus, we have only made it available digitally. We have also deposited the guidebook into the University of Minnesota's Digital Conservancy https://conservancy.umn.edu/handle/11299/223066 and the DOI was obtained https://hdl.handle.net/11299/223066.

- Venning, A., A. Everett, M.A. Kenney. (2021) Community-scale Energy Storage Guide: How Community Groups and Small Businesses Can Employ Energy Storage to Save Money and Support Minnesota's Clean Energy Transition. University of Minnesota, Institute on the Environment. Saint Paul, MN, USA.

ACTIVITY 2:

Description: Community Scale Energy Storage & Renewable Energy Demonstrations

Develop protocol for characteristics of 3 Exemplar Demonstration Projects, which will be examples of representative community scale energy customers with on-site renewable energy resources, control over their microgrid or local energy system, and widely replicable. The Guidebook's tool will help pick the appropriate technology type and applications, and technical assistance will be provided for proper installation and operation.

ENRTF BUDGET: $414,350

Outcome	Completion Date
1. Potential sites for 3 Exemplar Demonstration Projects have been evaluated via research, site visits	Dec. 31, 2018
2. Exemplar Demonstration Projects hosts selected	April 30, 2019
3. *Project team has met with Exemplar Demonstration Projects hosts, presented guidebook and decision tools information*	July 31, 2019; May 31, 2021 (final guidebook shared)
4. Post-Doctoral fellow and Advisory Group provides technical support for installation of storage system and controls	June 30, 2022 (met throughout project bi-weekly)
5. Field Day site tours of 3 projects, presentations by customer and experts, completed	May 31, 2021
6. Demonstration projects assessment report completed	May 31, 2021 (included as part of site visit videos and guidebook; no standalone video was developed)

First Update January 30, 2019

As stated in the overall update, we have preliminary agreements on the 3 host sites. Due to schedules and inclement weather, we have only done a site visit at the Minneapolis site. We intend to visit the Morris and Red Lake sites when the sites are able to be fully accessed, most likely in the early spring. In the meantime, we will work with those host sites via phone and web communication to finalize their proposed battery storage plan, to establish written agreements, and for our researcher to analyze their site energy profiles.

Second Update June 30, 2019

Project Partners from the 3 host sites were present at the Energy Storage Advisory Committee meeting on April 18, 2019. They were introduced to the web guidebook and online tools. They were also given time in the program to give project updates on their respective host sites. The 3 host sites were directed to update the ESAC group with a timeline at the next advisory meeting.

Dates have been selected to visit/tour the Morris and Red Lake campuses to extensively analyze the load profiles and use case scenarios of both sites. This information will help to select a battery for their individual host sites. Post-Doc met with project partners from the Morris host site to discuss priorities for battery system selection, potential use cases for the battery installation, and battery size and cost considerations. Project partners shared energy use data for the building selected to be the battery host site, which the Post-Doc used to conduct an analysis of favored use cases to estimate the range of battery specifications which could effectively perform the desired use case.

Third Update January 30, 2020

The Energy Transition team has had some challenges with University of Minnesota procedures and policy in regards to procurement of capital equipment. The Memorandum of Understanding (MOU) between the University of Minnesota and the host site was sent to our Sponsored Projects Administration (SPA) office for

review and was held up by a transition with new staff in that office and by unfamiliarity with this type of project. The team has completed all other documentation needed to purchase and install the batteries. The process for obtaining approval of the MOUs has taken longer than expected. Even with the setbacks, we are still on target for project completion.

Fourth Update June 30, 2020
The Energy Storage Advisory Committee met virtually on March 28, 2020 to receive updates, give technical support and to assess the project. As we progress through the final stages of procurement, we will need to reevaluate the field days for our stakeholders due to the COVID-19 pandemic. As the country is opening up in phases, our team along with the Energy Storage Advisory Committee will evaluate the steps in which to complete field days while making sure that people remain safe. This may mean a virtual tour of the sites. We also have to follow the directives given from the University of Minnesota in regards to in state travel.

Fifth Update January 2021
As our state begins to re-open slowly, our Energy Storage team continues to discuss the options for field days however we must still follow the directives from our President at the University of Minnesota. There are no in-person events through June 30,2021. Our Energy team is in contact with our communications department to discuss producing a Virtual tour of the sites consisting of interviews from the project partners and installation crews. Our brainstorming/production meeting for the virtual tour resume in February 2021.

Sixth Update June 30, 2021:
We have met major milestones with the battery installation started at the Renewable Energy Partners (REP) site and completing the virtual site visit materials. Red Lake Government Center and the University of Minnesota Morris are still waiting for batteries to be received on site due to COVID delays and the restructuring of UET. We are working closely with UET to ensure delivery of batteries before the end of 2021 to allow ample time for interconnection plan approvals and installation.

The virtual site visit consists of highlighting the published Energy Storage Guidebook through high production summary videos and and deep-dive seminars and workshops (recorded and will be available) on battery storage organized by the University of Minnesota Clean Energy Resource Teams (CERTs) and the Institute on the Environment (IonE). These resources will be included on the website under construction to feature battery storage and to serve as a landing page for our virtual site visit. Links to the materials are included in the summary above.

Seventh Update January 31, 2022:
We are in the final stages of installation at Renewable Energy (REP) site. We are in the process of acquiring lithium ion batteries at both Red Lake Tribal Government Center and the University of Minnesota Morris; both teams have consulted with the installation teams to ensure that the batteries can be installed this spring. If there are not unanticipated delays, we anticipate that all sites will have functioning battery systems before the end of the grant period.

The site visit moved from an in-person engagement to virtual engagement and small group site visits at the locations. With the launch of the website http://environment.umn.edu/energy-transition, we have completed the virtual site visit and are continuing to share information widely through our networks so that it has a long-lasting impact.

Final Report Summary August 15, 2022
This project activity was nearly completed. We selected sites - Renewable Energy Partners, Red Lake Tribal Government Center, and University of Minnesota-Morris - and worked with them, using the guidebook research, to identify and acquire the optimal battery technology to meet site needs, connect them with colleagues to

answer permitting questions, and to support the installation processes through technical assistance. At this stage,

- Renewable Energy Partners has a fully functional and tested battery - it will be complete when insurance is registered with Xcel Energy,
- Red Lake Tribal Government Center is completed and is fully functional, and
- University of Minnesota-Morris has the battery and installation components finalized and will proceed with installation once it receives permits.

All sites will have fully installed and functional batteries, with the remaining two sites completing this final milestone after the submission of this final report. To increase the impact of our stakeholder engagement around these sites and because the batteries were completed or nearly completed towards the end of this grant funding, the demonstration projects assessment report was integrated into the lessons learned engagements with the Clean Energy Resource Teams (CERTS) and as case studies included the energy storage guidebook; a stand alone separate report was not created.

This project was impacted by significant delays due to COVID-19 supply chain issues and canceled battery acquisition contracts, delayed contact with key professional contacts due to COVID-19 illness and personnel impacts, and changes in critical experts needed for design, permitting, and installation. For example, for two of the sites - Red Lake Tribal Government Center and University of Minnesota-Morris - the battery technology originally selected was a vanadium redox flow battery, which was a US created and produced technology. We were not able to acquire these batteries after 3 years of work. After entering into a contract with UniEnergy Technologies (UET), having significant delays in acquisition of the battery due to COVID supply chain impacts, and the company going bankrupt and a new company proposing to take over the contract, we ultimately canceled the contracts (see NPR article describing this company, technology, and sublicensing to China). As a result, the batteries acquired for both of these sites were transitioned to the second choice technology, lithium ion batteries.

After acquiring batteries, the installation design processes required learning by all parties involved - including the engineering designers and utilities personnel - a process that allows other businesses or organizations to more efficiently install these systems in the future. Additionally, it was a similar process for permitting - there were lots of questions and clarifications to get appropriate permits given the nature of this technology - since this is a newer technology where these sites were on the leading edge of installation, our sites experienced challenges due to either inappropriate or nonexistent building and safety codes.

Despite these challenges, all sites are on track to be fully operational this calendar year and we have created extensive lessons learned through these demonstration sites. This meets the project goals of creating models - i.e., representative community scale energy customers with on-site renewable energy resources, control over their microgrid or local energy system, and widely replicable – that community-scale energy users across the state of Minnesota can adopt.

IV. DISSEMINATION:

Description: Broad dissemination is an integral part of the project. Our tangible outcomes--the Energy Storage Guidebook, 3 Exemplar Demonstration Projects, and public "Field Days" will be designed and implemented to reach as many community-scale energy users as possible in Minnesota. In addition, the project work will be disseminated by the Advisory Group of key expert-stakeholders and the Minnesota Energy Storage Alliance, as part of MESA's efforts to accelerate understanding and deployment of energy storage in Minnesota for a cleaner and more efficient grid. We will highlight this project at ETL/MESA's annual Energy Storage Summit, host knowledge tools on our website, and share it with stakeholders and our many partners from across the Midwest. The experience and knowledge gained can be a replicable model for small-scale microgrids and community-based energy customers across our region, and inspire ongoing dissemination, implementation and further research.

First Update January 30, 2019
Dissemination activities will begin later in the project. However, we have met with the Clean Energy Resource Teams (CERTS) and discussed partnering with them in hosting the web version of the energy storage guide, which we think would be very helpful for broad dissemination of the information in communities throughout Minnesota.

Second Update June 30, 2019
A preliminary introduction of the web guidebook and online tools has taken place with the ESAC and other industry stakeholders for evaluation purposes. Our team is in the beginning stages of planning a broader dissemination strategy. The dissemination phases will take place later in the project.

Third Update January 30, 2020
A completed draft of the guidebook is available and will be disseminated to the Energy Storage Advisory committee for review at the next convening in February 2020. The published guidebook will be available online once it has been reviewed by the ESAC. We intend to add revisions as needed after receiving feedback from the Advisory Committee and the focus group. The plan is to have full color copies of the final guidebook for dissemination to persons attending the site tours, stakeholders and to the public. The dissemination phases will take place later in the project.

Fourth Update June 30, 2020
Plans for printing and dissemination of the guidebook have been disrupted by the ongoing work-from-home and social distancing orders due to COVID-19. We will have to reevaluate the dissemination process of the printed materials since our plan to distribute them during public site tours and other potential IonE events will not be possible. A draft of the guidebook was shared with CERTS, who distributed it throughout their organization across the state, but further distribution to the public will occur after installation and assessment of the devices has been completed and information regarding this stage of the project has been added.

Fifth Update January 30, 2021
We are currently working on a dissemination plan for the official release of these materials and for distribution to the public in the first and second quarter of 2021. Given the continued impacts of COVID-19, the in-person engagements have moved to a virtual environment and we are reenvisioning the best way of engaging and disseminating the guidebook and virtual site visits via online convenings or website access. Our target audiences will be stakeholders from the public, private, nonprofit, and community sectors along with University experts, with the mission of accelerating smart deployment of energy storage in Minnesota and the Midwest. Though the dissemination approach has had to be reimagined, the intended impact is the same

Sixth Update June 30, 2021:
The dissemination consists of both the guidebook and virtual events (in lieu of in-person site visits due to COVID). The final guidebook is currently a pdf (print version available upon request) and has been shared through events and with our close partners. The virtual site visit consists of highlighting the published Energy Storage Guidebook through high production summary videos and and deep-dive seminars and workshops (recorded and will be available) on battery storage organized by the University of Minnesota Clean Energy Resource Teams (CERTs) and the Institute on the Environment (IonE). These resources will be included on the website under construction to feature battery storage and to serve as a landing page for our virtual site visit. Links to the materials are included in the summary above.

The guidebook, webinars and virtual workshops, and videos will be widely distributed through IonE, CERTs, and the site partner networks once the DOI has been obtained and the website is finalized. Two more events have been tentatively scheduled in the 3rd and 4th quarters of 2021 for the dissemination of the guidebook.

Additionally, site partners are providing informal on-site, in-person tours of these systems when safe and at their discretion. In all cases, proper attribution of LCCMR funding has been made.

Seventh Update January 31, 2022:
Given the completion of the major dissemination products, including the launch of the website http://environment.umn.edu/energy-transition, we are now working with partners to broadly share this through our networks.

Final Report Summary for Dissemination of Activities August 15, 2022

This project activity was fully completed. Given COVID-19, this project pivoted to develop a virtual site visit (instead of a public "field day") that includes highlights of the 3 demonstration sites, interviews on the benefits of battery storage, and webinars on battery storage lessons learned. This virtual site visit is hosted on IonE's website and is a long-term sharing of the knowledge created as part of this project with stakeholders and our many partners from across the Midwest.

These projects were broadly disseminated through the University of Minnesota's Institute on the Environment (IonE), Clean Energy Resource Teams (CERTs), and the advisory group; the virtual events and website accessibility increased the ability for more people to access and engage in conversations related to community-scale energy storage. The Minnesota Energy Storage Alliance transitioned in 2018 to the Clean Grid Alliance and Energy Transition Lab was retired in 2019; energy storage engagements were hosted by CERTs and IonE after this transition.

Overall the project has succeeded in creating a replicable model for small-scale microgrids and community-based energy customers across our region, and inspire ongoing dissemination, implementation and further research.

Final Major Project Results Use and Dissemination

- **Virtual Site Visit:** The virtual site visit consists of highlighting the 3 demonstration sites and interviewing the Project Partners to get the full scope of how the storage system was implemented. UMN Institute on the Environment-Energy Transition Website
- **CERTs events:** This two part webinar took a deep-dive into battery storage by conducting paneling discussion with industry experts, seminars and workshops. This was organized by University of Minnesota Clean Energy Resource Teams (CERTs) and the Institute on the Environment.
    - *The future of energy storage in Minnesota*, February 23, 2021
    - *Piloting community-scale energy storage systems in Minnesota*, April 14, 2021
    - *Community-Scale Battery Storage Workshop*, July 19, 2021
- **Published an Energy Storage guidebook** and highlighted this downloaded, user friendly publication at the CERTS events, Energy and Equity workshop, and with the Energy Storage Advisory Committee.
    - Community-Scale Energy Storage Guide: How Community Groups and Small Businesses Can Employ Energy Storage to Save Money and Contribute to Minnesota's Clean Energy Transition
- **Published Videos on the IonE YouTube page:**
    - Community-Scale Battery Energy Storage in Minnesota https://www.youtube.com/watch?v=RpNs6rvGKCI
    - Community-Scale Energy Storage: How does it work? https://www.youtube.com/watch?v=QjTjuJAtrxA

V. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview: See attached budget spreadsheet

Explanation of Capital Expenditures Greater Than $5,000: Three community-scale sites will be selected (Northern MN, West/Southwest MN, and Metro); locations such as college campuses, municipal buildings, and nonprofit organizations) to install battery systems. Each will be integrated into the host site's energy system and evaluated during the project. After the project ends, the system will continue to be used for similar energy services, and we will request the sites continue to provide project data for interested researchers. Battery systems degrade over time depending on usage profiles, and our expectation of host sites will be for eventual upcycling or recycling of the components. The cost of the systems may be lower than estimated depending on market changes. Our goal is to provide the best system for the site within budget constraints.

Explanation of Use of Classified Staff:

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 7,400	Divide by 2,080 = TOTAL FTE: 3.56

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours: 424	Divide by 2,080 = TOTAL FTE: .20

Note: The FTE estimate is calculated by taking total cost for professional services divided by $200 as an average cost per hour.

B. Other Funds:

SOURCE OF AND USE OF OTHER FUNDS	Amount Proposed	Amount Spent	Status and Timeframe
Other Non-State $ To Be Applied To Project During Project Period:			
McKnight Foundation	$ 105,000	$ 105,000	Secured grant for Energy Transition Lab energy transition and storage work.
Clean Energy Resource Teams (CERTS)	$ 5723	$ 5723	Grant funding was received to support battery installation equipment and labor for the University of Minnesota-Morris ($4k) and Red Lake Tribe ($1723).
IonE Impact Goal Investments	$ 33,631	$ 33,631	Funding for battery acquisition, design, and installation equipment and costs. Includes deposit to UET for vanadium redox battery which was not delivered due to bankruptcy.
Initiative for Renewable Energy and the Environment (IREE)	$ 45,015	$ 45,015	Akisha Everett's salary and fringe in Year 4 to support continued battery acquisition and installation support to the site teams. Continual battery storage stakeholder engagement.
Other State $ To Be Applied To Project During Project Period:			
Indirect Recovery costs unrecovered	$ 175,077	$ 175,077	The indirect rate is 54.0% for Organized Research based on the modified total direct cost, which exclude equipment,

			tuition, participant support costs and subcontract in excess of $25,000. Capital equipment does not include IDR.
IonE Operations and Maintenance Funds	$ 30,427	$ 30,427	One month time Y1-4 for April Snyder's salary and fringe to support battery storage acquisition and installation materials and administration. One month time Y1-4 for Melissa Kenney's salary and fringe to as project PI to support development of website, guidebook, research products, and stakeholder engagement strategies.
Past and Current ENRTF Appropriation: none			
	$	$	
Other Funding History:			
McKnight Foundation	$ 55,000	$55,000	Energy Storage project work funding.

VI. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Massoud Amin Ned Mohan Alison Hoxie. Lian Shen Jay Coggins	Engineering Professors Economics Professor	University of Minnesota	Advisors
Sean Carroll Todd Olinsky-Paul Steve Clemmer Nitzan Goldberger Kelly Muellman Timothy D.H.-Thomas Lissa Pawlisch Joel Haskard Matt Prorok Lise Trudeau Kristi Robinson Cameron Bailey Will Heegaard Glen Fisher	Stakeholder experts	ReAmp Clean Energy Group Union of Concerned Scien. Energy Storage Alliance City of Minneapolis-Sust. Coop. Energy Futures CERTs CERTs Great Plains Institute Div. of Energy Resources Electric Co-op Greater MN Metropolitan Council Footprint Project OATI Microgrid	Energy Storage Advisor Committee Member
Ralph Jacobson Robert Blake Jamez Staples Michael Krause	Installation Consultant Solar Developer Solar Developer Installation Consultant	IPS SolarBear Renewable Energy Partners Renewable Energy Partners	Site Project Partners

Nate Broadbridge	Installation Consultant	Renewable Energy Partners	
Bryan Herrmann	Vice Chancellor	UMM-Morris Campus	
Troy Goodnough	Sustainability Director	UMM-Morris Campus	

VII. LONG-TERM- IMPLEMENTATION AND FUNDING: Our state's transition to clean energy depends upon broad adoption of local renewable energy resources, but small-scale energy users often lack the resources or knowledge to vet complex technology choices. Community-scale renewable energy producers can add value to their energy production and reduce their grid energy costs if they add an energy storage system. This project will help these community-scale renewable energy generators gain the technical expertise to deploy energy storage, as well as understand how to make the projects cash flow and how to optimize benefits. The projects will be designed to illustrate valuable use cases for energy storage, and where possible, to "stack" multiple value streams to improve the projects' return on investment. For example, the projects will show how to get more value from variable renewable energy generation, by extending or shifting the hours wind or solar energy is available. This project is structured to learn from demonstration projects with community-scale energy customer-producers and to share that knowledge broadly so it can be adopted by many others across Minnesota. Once we can demonstrate the viability of these projects, project financing becomes easier for future projects. With new technology adoption, it's important to have successful, replicable models to help attract financing, develop a robust market, and eventually reach economies of scale. Ultimately, if energy storage is deployed broadly and intelligently across Minnesota in conjunction with distributed renewable energy projects, this will help to expand community-based renewable energy, reduce emissions, and improve air quality.

VIII. REPORTING REQUIREMENTS:

- **The project is for 4 years, will begin on July 1, 2018 and end on June 30, 2022.**
- **Periodic project status update reports will be submitted January 31 and June 30 of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2022.**

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet (attached)
B. Visual Component or Map
C. Parcel List Spreadsheet
D. Acquisition, Easements, and Restoration Requirements
E. Research Addendum
Please see Energy Transition Lab publications:

Modernizing Minnesota's Grid: An Economic Analysis of Energy Storage Opportunities
http://energytransition.umn.edu/wp-content/uploads/2017/07/Workshop-Report-Final.pdf

Energy Storage 101: A Quick-Reference Handbook, 2nd Edition
http://energytransition.umn.edu/wp-content/uploads/2017/07/Energy-Storage-101-2nd-Ed.-FINAL-2.0.pdf

Environment and Natural Resources Trust Fund
M.L. 2018 Project Budget-Final

Project Title: Demonstrations for Community-Scale Storage Systems for Renewable Energy
Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 07b
Project Manager: Melissa Kenney
Organization: Energy Transition Lab, University of Minnesota
College/Department/Division: Institute on the Environment (IonE)
M.L. 2018 ENRTF Appropriation: $550,000
Project Length and Completion Date: 4 years, June 2022
Date of Report: August 15, 2022

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Revised Budget 4/24/22	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits) - Overall*	**$ 277,407**	**$ 277,407**	**$ (0)**
Project Manager (Melissa Kenney: 21 hours / 1% FTE in-kind in Y3) (Ellen Anderson: 144 hours / 6.92% FTE in Y1; 208 hours / 10% FTE in Y2)		*$ 25,006*	
Project Coordinator (Akisha: 472 hours / 22.69% FTE in Y1; 1,931 hours / 92.84% FTE in Y2; 1,733 hours / 83.29% FTE in Y3)		*$ 146,240*	
Energy Storage Researcher (Alex: 72 hours / 3.46% FTE in Y1; 2080 hours / 100% FTE in Y2; 240 hours / 11.54% FTE in Y3)		*$ 82,349*	
Graduate Research Assistant (Alex: 520 hours / 25% FTE in Y1)		*$ 23,813*	
Professional/Technical/Service Contracts	**$ 116,788**	**$ 116,788**	**$ -**
[$4750, Eve Daniels] Following UMN Regents Purchasing Policies, contract for ~73 hours of professional videography and coordination for virtual field day to fulfill final project deliverables.	$ 3,541	$ 3,541.00	$ -
Renewable Energy Partners, North Mpls site: **[$21,757: Sundial Energy]** Following UMN Regents Purchasing policies, contract to include ~256 hours of labor for spec, design, and creation of the technical documents for interconnection, engineering review, installation of microinverters & interconnection equipment, inclusive of city permitting costs.	$ 21,757	$ 21,757	$ -
UMN Morris site: [$10,000: Power System Engineering] Following UMN Regents Purchasing policies, contract to include electrical engineering services, inverter specs, system diagram, conduit & cable specs, power & auxiliary drawings for batteries & inverters. [$46,785 estimate: Contractor TBD] Following Regents policy, contract will be entered into by the UMN for local utility interconnection services or the UMN Facilities Management's professional electrical services team, will be contracted for battery installation and electrical connections of the energy storage system. Cost is estimate at this time. <note: $4000 in-kind from CERTS grant to PSE; $2,245 as in-kind IonE Renewable Energy restricted funds>	$ 56,490	$ 56,490	$ -

Renewable Energy Partners, North Mpls site: [$35,000: Blue Sky] To complete the engineering review, installation of microinverters & interconnection equipment and testing, inclusive of city permitting and associated costs, building on the work previously completed by Sundial.	$ 35,000	$ 35,000.00	$ -
Equipment/Tools/Supplies			
Red Lake Tribal Community site: **[$3k: IPS Solar]** Following UMN Regents Purchasing policies, contract includes the design & install of the energy storage system for the Reflex battery, purchase of the necessary inverter ($3k) and misc. electrical parts required for install, testing, coordination of data monitoring, permits, safety devices, and labeling needed to complete the system install.	**$ 3,000**	**$ 3,000.00**	**$ -**
Capital Expenditures Over $5,000	**$ 151,908**	**$ 151,908**	**$ -**
Renewable Energy Partners, North Mpls site: [$71,799: Werner Electric] Following UMN Regents Purchasing policies, purchase of three (3) Sonnen Eco 10 batteries (8 kW) and one (1) Sonnen Eco 4 (4 kW) battery, and interconnection equipment (i.e.; energy meters, microinverters, split-core current transformers, etc.).	$ 71,799	$ 71,799	**$ -**
Red Lake Tribal Community site: [$8,895: Graybar] Following UMN Regents Purchasing policies, purchase of 16 Symmetra PX Battery Units, 2 Battery Holding Racks.	$ 8,895	$ 8,895	**$ -**
University of Minnesota, Morris site: [$71,214: Simpliphi Electrical Supply Company] Following UMN Regents Purchasing policies, purchase of two PHI 3.8kWh LFP batteries, Three-battery busbar kit, BOSS 12 enclosure w/shelves and three Sol-Ark 12K inverters includes cable assembly package.	$ 71,214	$ 71,214	**$ -**
Printing/copying/mailing			
Courier services ($309).	**$ 310**	**$ 310**	**$ 0**
Travel expenses in Minnesota			
Site visit to Red Lake Tribal Community (including per diem, fleet services vehicle rental, and lodging) for three (3) UMN project personnel in September 2019.	**$ 587**	**$ 587**	**$ 0**
COLUMN TOTAL	**$ 550,000**	**$ 550,000**	**$ 0**