January 16, 2023

Ms. Samantha Laskowski, Vice President
Vernon County Energy District
S8293 Prestergard Road
Readstown, WI 54652

Dear Samantha,

Thank you for the opportunity to support the Village of La Farge and the Vernon County Energy District by producing a preliminary design, sizing, and financial analysis (Microgrid Feasibility Study) for solar + storage at the Village of La Farge, funded by the Wisconsin Energy Innovation Grant Program. muGrid Analytics is pleased to offer you microgrid modeling and analytics services in support of this project, along with general energy advising. This quote shall be valid for one year from the date listed above.

Project Name: Village of La Farge Microgrid and Community Resilience Center Feasibility Study - 2023

Scope of Work: See below

Budget: $77,510, fixed price

Terms and Conditions:

1. The project will be billed upon completion of milestones, as described herein.
2. Net Payment due in 30 days from receipt of invoice

We are ready to begin work immediately and very much looking forward to working with you on this important project.

Sincerely,

Amy

Amy Simpkins
CEO, muGrid Analytics

Village of La Farge Microgrid and Community Resilience Center – 2023
muGrid Analytics Proposed Scope of Work, 1/16/23

Background:

The Village of La Farge, Wisconsin, desires to increase their renewable energy portfolio to 25% by 2025 to fuel the local economy and also reduce electricity charges from out-of-state, Investor-Owned Utilities, or IOU's (Alliant Energy and Xcel Energy) as set forth in the Vernon County Energy District's Comprehensive Energy Plan. With guiding principles of Equity, Resiliency, Innovation, Local energy independence, Cooperation and democracy, they envision a future with 100% locally owned and locally produced renewable energy.

The Village seeks a Microgrid Feasibility Study to investigate a solar plus storage microgrid that can island the village, offering them electricity independence. This would also include the exploration of electric rate restructuring to potentially include time of use and/or demand pricing and assessing other potential opportunities for the Village's municipal electric utility to offer more renewable energy. The Village seeks to create long-term policy recommendations. The Village seeks a consulting team that can help meet these objectives and to prioritize policy changes, as well as to communicate the strategy with stakeholders and citizens. muGrid Analytics is well prepared to support the Village in these objectives.

Project Description

The objective of this phase of the project is to understand the technical requirements of a renewable energy microgrid for the Village of La Farge and approximate the financial implications via a Microgrid Feasibility Study.

The study objectives are:

1. *Coordination*: since operating a community microgrid is a large responsibility with significant risk, the study should work closely with village staff and leaders especially during discussions of specific resilience, economic, and emissions objectives
2. *Load Estimation*: accurately estimate the electrical load since this is a major driver of project cost
3. *Generation Adequacy*: optimally sizing generation and storage assets to serve the load at minimum cost
4. *Distribution Network*: microgrid topologies that serve the Community Resilience Centers, and an interconnection(s) that island the microgrid
5. *Microgrid Operation*: safe, secure, and economic dispatch of generation, fault handling, and load control if implemented

6. *Business and Policy*: evaluate the financial and operational responsibilities that will be incumbent on the Village
7. *Reporting*: present the findings in a clear and concise way

muGrid support in subsequent project phases could include refinement of the microgrid design, recommendation of and coordination with hardware suppliers, development of optimized asset dispatch strategies for grid-connected and islanded modes, continued expert advising throughout the implementation process, and performance monitoring and algorithm adjustment of the installed microgrid through the operational phase.

Resilience Analysis

muGrid Analytics will perform resilient microgrid sizing and performance analysis using our proven Resilience First methodology. We will perform resilience and economic modeling, optimization, design sizing, and grid-connected dispatch strategy using our in-house, mathematical optimization platform, Redcloud, previously used for the county's jail/courthouse microgrid. Redcloud is a best-in-class energy optimization tool validated against NREL's REopt and LBNL's DER-CAM.[1]

Resilience modeling is still nascent across the industry. Many times, resilience performance is assumed to be deterministic – that there is a single number that defines resilience at a site, perhaps as an average or minimum operating duration. However, we view resilience performance as stochastic, and we will characterize it with both expected outage survival duration and probabilistic confidence levels. Resilience performance is dependent upon several stochastic variables, including, but not limited to weather, solar irradiance, cloud cover, time-of-day and time-of-year of the outage, and load at the facility. Some of these variables have characterizable but not fully predictable cross-correlation – solar conditions and building load may both be affected by the time of day or time of year of the outage, for example. But even if the relationships are characterized, the conditions at the beginning of an outage are never fully known enough to calculate a deterministic resilience duration. Therefore, we analyze multiple descriptors of resilience performance, including probability, or confidence, for a given duration.

We define resilience duration as the amount of time the microgrid can support its dedicated loads after a grid outage before the microgrid fails due to lack of power, whether that lack of power is caused by battery depletion, fuel depletion in the generator, or lack of solar irradiance. This is our primary resilience metric. Other important resilience metrics that may be considered include the time to recover of functionality after the first failure (usually enabled by solar power recharging the battery) and the amount of time the microgrid can then run following that recovery, or the secondary resilience duration. All duration values – time to first failure or primary resilience duration, recovery duration, and secondary resilience duration – must be paired with confidence levels in order to be valuable analysis

[1] Simpkins, Travis, and Carey O'Donnell. "Optimizing Battery Sizing and Dispatching To Maximize Economic Return." Battcon International Stationary Battery Conference. 2017.

results. The confidence values are not randomly distributed – they are highly correlated to season of year and load conditions at the building and may also be correlated to the time of day. Therefore, resilience performance is not presented as a deterministic number, but rather, as a full graphic capturing the dependency on these other variables. The following figures show the outputs of this resilience sizing and performance modeling for a similar community microgrid located elsewhere in the United States.

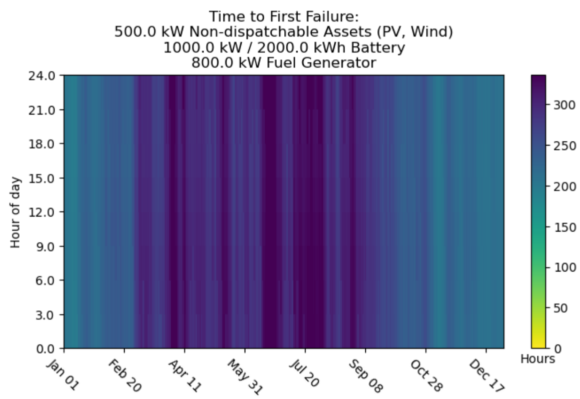


Figure 1. Example time-to-first-failure heat map demonstrating stochastic resilience performance at every hour of the year.

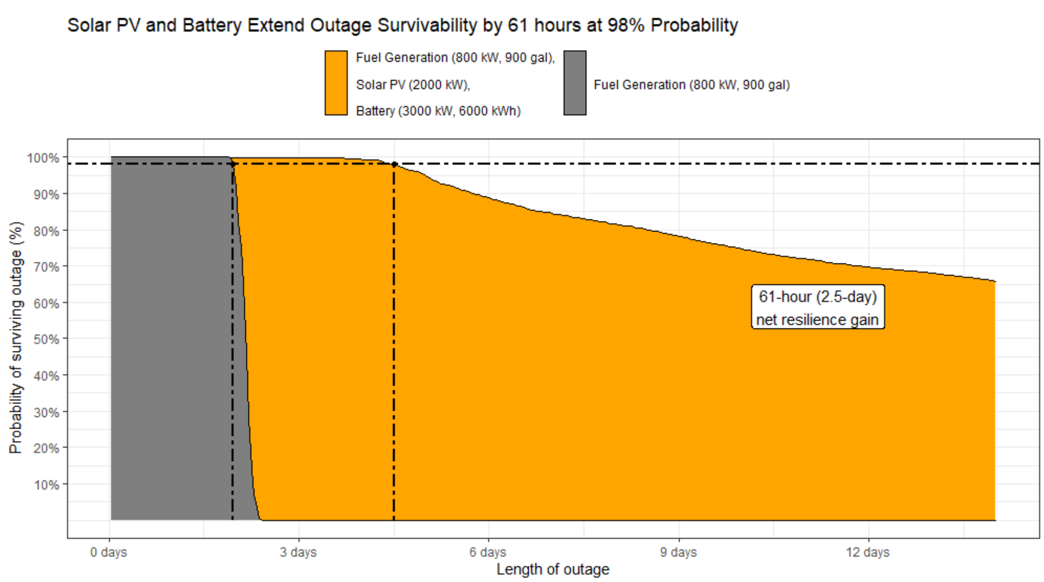


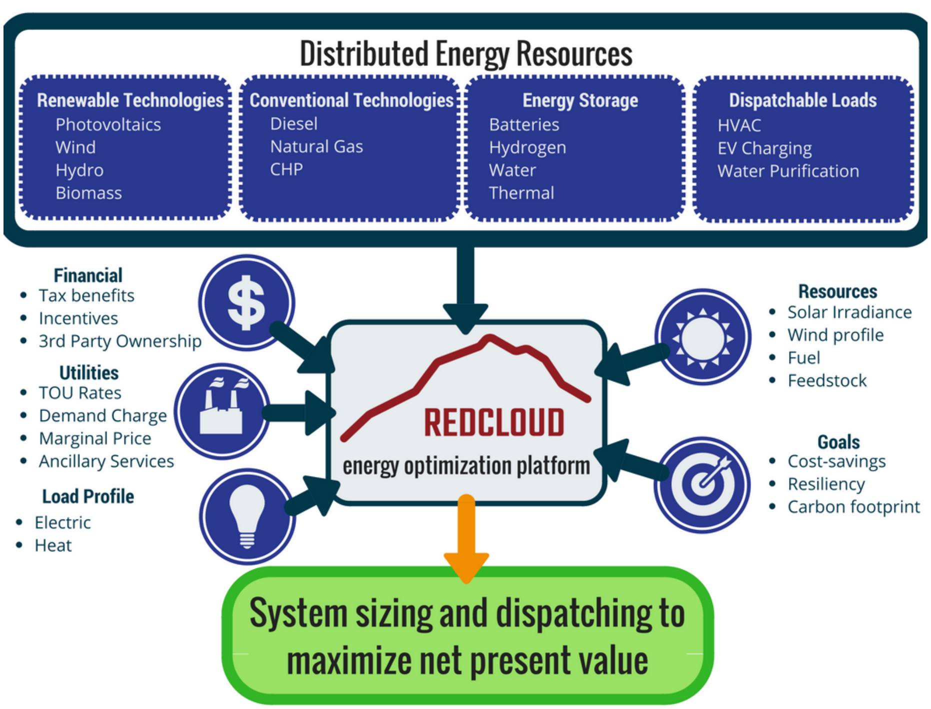
Figure 2. Example of microgrid improving resilience over fossil-fuel generator alone.

Outputs from the resilient capability sizing analysis will include visualizations similar to those above. Based on the forecasted building loads, the consultant muGrid will determine the appropriate system sizing for the microgrid components to meet the requirements we will define with the Village as part of the study.

Economic Analysis

To perform techno-economic modeling, the consultant will provide detailed breakdown of the value stack of the proposed microgrid system accounting for both its grid connected and islanded services. The analysis will utilize actual utility tariffs, bulk energy prices, and customer revenues to determine the economic benefits of the proposed systems. The individual value of the components would also be parsed out to better determine which are the most economic valuable components of the system, although we expect to find that the holistic system works in symbiosis so that the whole is greater than the sum of the parts.

Once the microgrid system's storage and backup generation components are sized for resilience, we will perform an economic optimization using the combined buildings' load profiles, solar generation, and storage potential. The output of this optimization will be the optimized grid-connected dispatch strategy. For financial assessment we will determine the optimized grid-connected operations and calculate the stacked revenue streams, optimizing for the best value dispatch at every given time interval taking into account both costs and benefits. The mathematical optimization tool of choice is muGrid's Redcloud platform, which has been used to optimize microgrids across the US, including Wisconsin. The project team is also familiar with other best-in-class microgrid optimization tools, including NREL's REopt and LBNL's DER-CAM. The advantage of Redcloud is that we control the source code, and therefore may adapt the tool to the project, rather than the project to the tool. We will demonstrate utility bill savings based on saved energy charges from solar generation and self-consumption enabled by the BESS. We can also include revenue from demand response or other network-level incentive programs, if any. We will model any other revenue streams available as determined by the Village's rate structure. We will perform techno-economic optimization for all technologies under consideration.



We plan to conduct initial analysis on both resilience and economic performance, and then iterate the analysis and design with inputs from the Village project team.

Deliverables:

The feasibility study will deliver both (a) actionable recommendations and (b) a rich body of knowledge to facilitate future design implementation. The deliverables are:

1. *Report*: a comprehensive but concise report of the study assumptions, methodologies, findings, and recommendations including assessment of potential future load growth
2. *Microgrid Preliminary Design*: technical drawings and report sections identifying microgrid topology and interconnection(s), operational tools, and equipment selection – including a single top recommendation given the Village's objectives
3. *Database*: all load and modelled generation data with instructions and labels
4. *Financial Models*: pro forma spreadsheets and costing tools for future design excursions
5. *Metering*: eGauge data loggers for the main buildings. Access and instructions will be provided for the eGauge data loggers.
6. *Briefings*: Monthly status and technical interchange meetings to present interim results and iterate on the direction of the study, as well as 1-2 Project Outbrief presentations to Village and County leadership and/or the community

Period of Performance

We anticipate this study requiring 6 months, though the timeline will be driven by availability of data in the initial phases of the study. The period of performance runs from contract execution through CY 2024, as specified by the 2022 WI OEI Energy Innovation Grant Program (Docket 9709-FG-2022.)

Budget:

The project budget shall be a firm-fixed price $77,510. This fee will be billed on the following milestones:

Milestone	Estimated Completion	Invoice
Notice to Proceed (NTP)	Contract execution	$19,377
Initial Resilience Performance Analysis Results Delivered	NTP + 90 days	$19,376
Final Resilience and Economic Performance Results Delivered	Initial Results + 60 Days	$19,377

Final Report Complete	Final Results + 30 days	$19,376

muGrid will be pleased to contribute 10 hours of Principal Consultant time as an in-kind contribution to the project and cost share. This has been accounted for in the project budget.

The Work Breakdown for each task is expected as follows, and this forms the basis of the project budget:

	Task	Principal h	Engineering h	Analyst h	Travel to LaFarge
	Rate ($ per)	*275*	*160*	*100*	*1500*
Infrastructure Assessment	Mapping and identification of existing utility infrastructure within and around the village		12	16	
	Analysis of ownership or operation options of existing lines and transformers	4	8		
	Analysis of future interconnection options with Dairyland	4	8		
	Subtotal Hours	*8*	*28*	*16*	*0*
	Subtotal Budget	$ 2,200	$ 4,480	$ 1,600	$ -
Generation Adequacy	Review feeder and meter load data from utilities / Dairyland / energy purchasing contracts		4	20	
	Perform village to-date load analysis and develop profiles	8	16	16	
	Forecast of 25-year load growth	8	16	16	
	Review to-date assets available within the village		4	8	
	Identify generation and storage technology options	4	4		
	Choose initial generation and storage asset siting based on economics and interconnection considerations	4	8		
	Subtotal Hours	*24*	*52*	*60*	*0*
	Subtotal Budget	$ 6,600	$ 8,320	$ 6,000	$ -
Resilience Performance Analysis	Determine resilience target requirements	4			
	Perform tradespace analysis to identify candidate system configurations	8		24	
	Iterate system configurations and resilience performance analysis based on initial resilience and economic performance results	4		12	
	Subtotal Hours	*16*	*0*	*36*	*0*
	Subtotal Budget	$ 4,400	$ -	$ 3,600	$ -

Economic Performance Analysis	Evaluate existing costs and revenues from supplier and LFMU billing structures	8		4	
	Identify cost-optimal system configurations	8		24	
	Perform techno-economic optimization of initial resilient system configurations	4		12	
	Iterate economic performance analysis based on initial results	4		12	
	Analysis of possible future billing, rate design, and customer policy	8	4	16	
	Subtotal Hours	32	4	68	
	Subtotal Budget	$ 8,800	$ 640	$ 6,800	$ -
Administration and Reporting	Meetings	24	12	12	2
	Project Management	12		12	
	Report writing	16	20	20	
	Subtotal Hours	52	32	44	2
	Subtotal Budget	$ 14,300	$ 5,120	$ 4,400	$ 3,000
	In kind contribution / cost share	-10			
	Total Hours	122	116	224	2
	Total budget	$ 33,550	$ 18,560	$ 22,400	$ 3,000
	TOTAL PROJECT BUDGET	$ 77,510			

Other Conditions and Constraints

1. This phase of the project will result in a preliminary microgrid solar design and analysis. Final engineering design will need to be conducted by a licensed Professional Engineer and is not included in this proposal.
2. muGrid Analytics does not represent or warrant that the execution of definitive documents with respect to any project in the feasibility phase will lead to the achievement of commercial operation of such project. All final decisions are Village of La Farge's and the Village of La Farge bears the responsibility thereof.

About muGrid Analytics

muGrid Analytics LLC solves wicked problems at the intersection of energy and economics using math and modeling. We provide bankable techno-economic optimization of renewable energy, energy storage, and microgrids to project developers, financiers, component manufacturers, utilities, and property owners. With a one-two punch of in-depth experience in the new energy industry and in the modeling, design, and operation of complex technical systems, muGrid provides comprehensive, data-driven advisory and design services to a wide range of energy stakeholders throughout the project life cycle. muGrid was founded by Dr. Travis Simpkins, who previously architected and developed the microgrid modeling capabilities for the National Renewable Energy Laboratory, including the REopt platform.

Sitting at the intersection of technology and finance, muGrid Analytics is uniquely positioned to not only help clients understand how distributed energy technologies work, but also how they will make or save money. muGrid has developed the proprietary Redcloud energy optimization platform which is used to optimize energy generation and consumption at buildings, campuses, feeders, networks, and bases such that clients meet their energy resilience and sustainability goals at minimum life cycle cost. Because muGrid has developed the Redcloud model in-house, we can customize it to reflect the subtleties of each client's particular situation. Redcloud is particularly well suited to energy storage optimization as it can be tailored to consider multiple, stacked revenue streams which are often available to dispatchable assets.

muGrid has also revolutionized resiliency modeling and characterization, embracing the stochastic nature of resilience, and enabling higher-fidelity models. We have characterized the resilience performance of traditional fuel-based generation and assessed how solar+storage symbiotically combine with fuel-based generation to provide superior outage duration survivability at high confidence while providing economic benefits in grid connected mode. muGrid operates in alignment with our core values. They are more than just words on a page – these values are the guiding principles that form the foundation of muGrid's approach to work.

- Integrity. In a world where everybody is trying to sell you something, muGrid isn't interested in getting you anything but the truth. We want you to make decisions that are going to be best for you and to get you the results you need and desire. And that's the truth.
- Curiosity. muGrid is always open to exploring, always open to trying something new, always looking for ways to serve clients better. Sometimes that means trying out new technology. Sometimes it looks like building custom models for individual clients. But it's always about digging deep into clients' true needs, even if they aren't able to articulate them clearly at first.
- Agility. muGrid works with low overhead and moves fast. We are ready when you are to create momentum for your project.
- Collaboration. muGrid works in 360° collaboration. That is, we treat clients, partners, and subcontractors as teammates and not commodities. The team is all in this together, and the more brain power combined, the better the solution will be.

The muGrid team prides themselves on providing technology-agnostic, independent analysis and advisory services to help their clients plan and build the right energy systems and then operate those systems to best advantage. They do this by critically listening to client needs and providing tailored, innovative solutions that fulfill those needs.

Key Personnel: Travis Simpkins, PhD

Dr. Travis Simpkins has over 22 years of experience in the design, modeling, and simulation of complex systems. He is the Chief Technology Officer at muGrid Analytics.

Formally trained as an integrated circuit designer, he has spent most of the past decade helping to solve the world's energy challenge. He joined the National Renewable Energy Laboratory in 2010 and proceeded to reinvent their approach to modeling renewable energy systems. He pioneered a purely quantitative approach to analyzing and optimizing the costs and benefits of solar, wind, batteries, biomass, waste-to-energy, and other renewable technologies. His innovative research in this field led to him creating the REopt energy optimization platform, which has evolved into a webtool that has been used to model thousands of renewable energy projects the world over.

Travis holds a SM and PhD in Electrical Engineering and Computer Science from the Massachusetts Institute of Technology, a certificate of Financial Engineering from the MIT Sloan School of Management, and a BS in Electrical Engineering and Applied Physics from Case Western Reserve University. He is a Senior Member of the IEEE and has published numerous papers in the fields of energy system optimization, applied optics, and integrated circuits.

Travis will lead all technoeconomic modeling and quantitative analysis for this project.

Key Personnel: Amy Simpkins

Amy Simpkins has over 18 years of experience in technical engineering and project management of complex systems and software. She is Chief Executive Officer and Chief System Architect at muGrid Analytics.

Prior to joining muGrid, Amy was an engineer and spacecraft systems architect with Lockheed Martin, where she worked on advanced R&D and design integration for earth observing and manned spacecraft. In this capacity, she assessed architectural choices based on design performance, operational power constraints, and program finance. Amy also spent several years in flight operations for unmanned scientific exploration spacecraft, where she helped monitor and manage the solar array performance, energy storage systems, and power budgets of long duration deep space missions. Her technical expertise includes system and software architecture, system-level performance modeling, and design tradespace analysis.

Amy has coached and consulted on product innovation, business strategy, marketing, and sales for startups and small businesses in the renewable energy, healthcare, and SaaS sales spaces. She is an internationally recognized speaker on innovation and integration for entrepreneurs and is author of the book, *Spiral: A Catalyst for Innovation and Expansion*. She holds an MS in Astronautical Engineering from the University of Southern California and an SB in Aeronautics and Astronautics from the Massachusetts Institute of Technology.

Amy will serve as project manager and manage stakeholder engagement and requirements development for this project.