MICROGRID FEASIBILITY STUDY

Middleton Business Park

June 30, 2022

HGA

Executive Summary

The project concept investigated in this feasibility study will use primarily renewable energy sources, including solar PV and battery storage, to create an emergency microgrid to power critical economic, industrial, and public safety infrastructure in the event of a catastrophic power outage, like the emergency Middleton experienced during the flooding of 2018.

The purpose of the Middleton Business Park (BP) Microgrid is to provide backup power to a selected area of the City of Middleton during extended outages to Madison Gas & Electric (MG&E) feeder Pheasant Branch 1321. This outage could be the result of distribution system events, transmission system events, or area-wide blackouts. This emergency backup power will allow the industrial area and buildings within it to continue to function as critical infrastructure, including businesses necessary for logistics, public health, and storage, as well as serving as a Community Resilience Center (CRC) for emergency shelter and other resources.

The project study team has considered microgrids implemented at the business park in 3 different configurations (scenarios), and evaluated the best microgrid case in each scenario based on the following goals:

1. Meet the resilience criteria
2. Save on utility costs
3. Run specific parts of the industrial area from the microgrid
4. Provide utility grid services
5. Ease of implementation

Scenario 1- Microgrid at Utility Feeder Level

In this scenario, the local utility (MG&E) would utilize existing electric infrastructure to create a 'Mini Grid' within Pheasant Branch 1321 feeder that serves a majority of the businesses in the microgrid study area.

All buildings in the microgrid would receive power in the same manner as they currently do on Pheasant Branch feeder 1321. In a local electrical power outage, utility providers could isolate Pheasant Branch feeder 1321 from the larger electric grid and operate it as a microgrid. This would enable all businesses on the feeder to receive power, though some demand shedding, and curtailing might need to occur to prolong the microgrid resilience.

Case	Solar PV	Battery Energy Storage	Back-Up Generator	Capital Expenditure	Confidence @ 4hr	Confidence @ 24 hr
Case 1B: No additional solar	5MW	1MW/2MWh	5 MW	$5.8M	98%	89%

While this scenario is the most ambitious in terms of load served by the microgrid, it relies heavily on MG&E to own and operate the microgrid in front of the business park utility meters. The economic advantages of this system would need to be negotiated between the utility and rate paying customers that would receive resilience benefits.

Next Steps

1. Discuss microgrid study results with MG&E, determine if scenario 1 is attractive to implement from the utility standpoint
2. Determine financial and rate structures that would allow BP customers and other resilience beneficiaries to participate in community microgrid hosted by the local utility.

Scenario 2- Microgrid at Building Campus Level

In this scenario, several of the buildings in the business park (including a Community Resilience Center) would be powered from a central microgrid hub. This microgrid hub can switch from normal utility power to internal microgrid forming power resources. This electric architecture is similar to campuses that have utility and local sources of power.

Select businesses would be converted to receiving medium voltage power from a central utility hub that could switch power sources from utility to microgrid during a local utility outage.

Case	Solar PV	Battery Energy Storage	Back-Up Generator	Capital Expenditure	Confidence @ 24hr	Confidence @ 168 hr
Case 2A: No additional solar	5.5MW	500kW/2MWh	750 kW	$3.95M	99.99%+	99.99%+

This scenario would require close partnership and investment by those businesses wishing to partake in a campus microgrid within the business park. Several examples of this style exist in higher education and industrial campuses, and communities across the county are starting to test this arrangement as well as in new construction scenarios. Several coordination hurdles remain in the existing building case to determine who would own and operate the microgrid assets as well as what property they would be housed on.

Next Steps

1. More community engagement is needed to determine if a campus style microgrid is an attractive option given the other options described in this study.
2. Work with local utility on determining design and rate considerations regarding changing individual buildings to a campus style primary feeder.

Scenario 3- Microgrid at Community Resilience Center (CRC) Level

This concept would convert a single building in the business park to a community resilience center by installing a building level microgrid. In this case we would consider using local community energy resources (renewable and emergency power) to assist in achieving the resilience goals and criteria of the CRC.

Case	Solar PV	Battery Energy Storage	Back-Up Generator	CapX	Confidence @ 24hr	Confidence @ 168 hr
Case 3C: Community solar + BESS	680 kW	120 kW / 480 kWh	250 kW	$2.1M	99.83%	91%

The building level CRC microgrid represents the easiest implementation, as it involves a singular entity installing the microgrid and receiving the financial benefits. CRC operation and benefits would need to be negotiated with local authorities planning to utilize this building in a prolonged outage scenario.

Next Steps

1. Beneficiaries of the community resilience center should reach out to potential host sites/businesses in the study area with the results of this study to see if a partnership could be formed.
2. Financial investment, behind the meter benefits and CRC operations would need to negotiate between all parties interested in this scenario, as well as an interconnection agreement with the utility.

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Introduction- Project Description

Background

The Middleton Business Park is an approximately 1.3 square mile area in the northwest portion of the city which houses over 60 businesses of varying sizes. The City of Middleton was awarded funds through the Wisconsin Public Service Commission Office of Energy Innovation's Critical Infrastructure Microgrid and Community Resilience Center Pilot Grant Program to study the feasibility for the development of a microgrid and Community Resilience Center (CRC) in Middleton's Business Park (BP).

A microgrid system is a self-sufficient energy system including energy generation and energy storage serving a defined area. A robust electrical generation system may include a combination of generating technologies such as solar PV, wind, fossil fuel generators, and battery storage.

Microgrids incorporate sophisticated controls that allow the system to be either grid connected or operated independent of the grid in events such as a grid outage. Depending on the level of resilience needed, a microgrid may be capable of operating independently of the grid for only a few hours or indefinitely. Systems can also be designed with building automation systems controls and smart breakers that curtail building load as required when operating off grid and generation constraints are reached.

This study focuses on primarily renewable energy sources, including solar PV and battery storage, to create an emergency microgrid to power critical economic, industrial, and public safety infrastructure in the event of a catastrophic power outage, like the emergency Middleton experienced during the flooding of 2018. The focus for the BP Microgrid would follow the model of a town center or community microgrid and encompass approximately 60 businesses served primarily by Madison Gas & Electric's (MGE) Pheasant Branch feeder 1321.

The intended purpose of the BP Microgrid is to provide emergency backup power to allow selected facilities in the industrial area to continue to function as critical infrastructure, including the CRC for emergency shelter, businesses necessary for public health, logistics, and food storage.

The microgrid's overarching goals are to:

- Increase resiliency community-wide by keeping power on for necessary emergency services.
- Save money through peak shaving and demand reduction.

- Create opportunity to run specific parts of the industrial area from the BP microgrid.
- Establish a Crisis Plan to utilize power generation and storage within the microgrid to maintain essential services for the greater part of western Dane County, including emergency utilization of the Middleton Airport, health services, pharmacy services, mental health services, warehousing, communications centers, distribution centers, and large recreation centers that could be converted into Community Resilience Centers.
- Provide grid services such as kW savings, frequency modulation, and potential network stabilization.
- Train city staff on project management, bid preparation, and operations to make replicable.
- Create communications deliverables to share knowledge and data performance with our networks such as Green Tier Legacy Communities, LEED for Cities national certification cohort, Urban Sustainability Directors Network, local municipal collaborative workgroups and the City's website.

The purpose of this study is to evaluate the viability and functionality of a microgrid in the City of Middleton's Business Park. Key components of the study include:

- Analysis of historical energy use and cost in the study area,
- project identification, sizing and scaling, physical site/facilities due diligence and communication with the diverse ownership of potential solar hosts and,
- projected financial and resilience benefits for the project.

Some key next steps include:

- Community and utility engagement to present study findings and determine feasibility for implementation,
- a phasing strategy for growing the project in the future and,
- a comprehensive baseline, a climate change and natural hazard vulnerability study.

Microgrid analysis was performed utilizing muGrid's in-house mathematical optimization platform, Redcloud Planning. Cost-optimal solutions for solar and battery storage that meet the resiliency objectives above were investigated for each scenario.

Project Study Area

This feasibility study focuses on a microgrid that would potentially serve more than 60 businesses in the Middleton light-industrial area located in the city's northwest side.

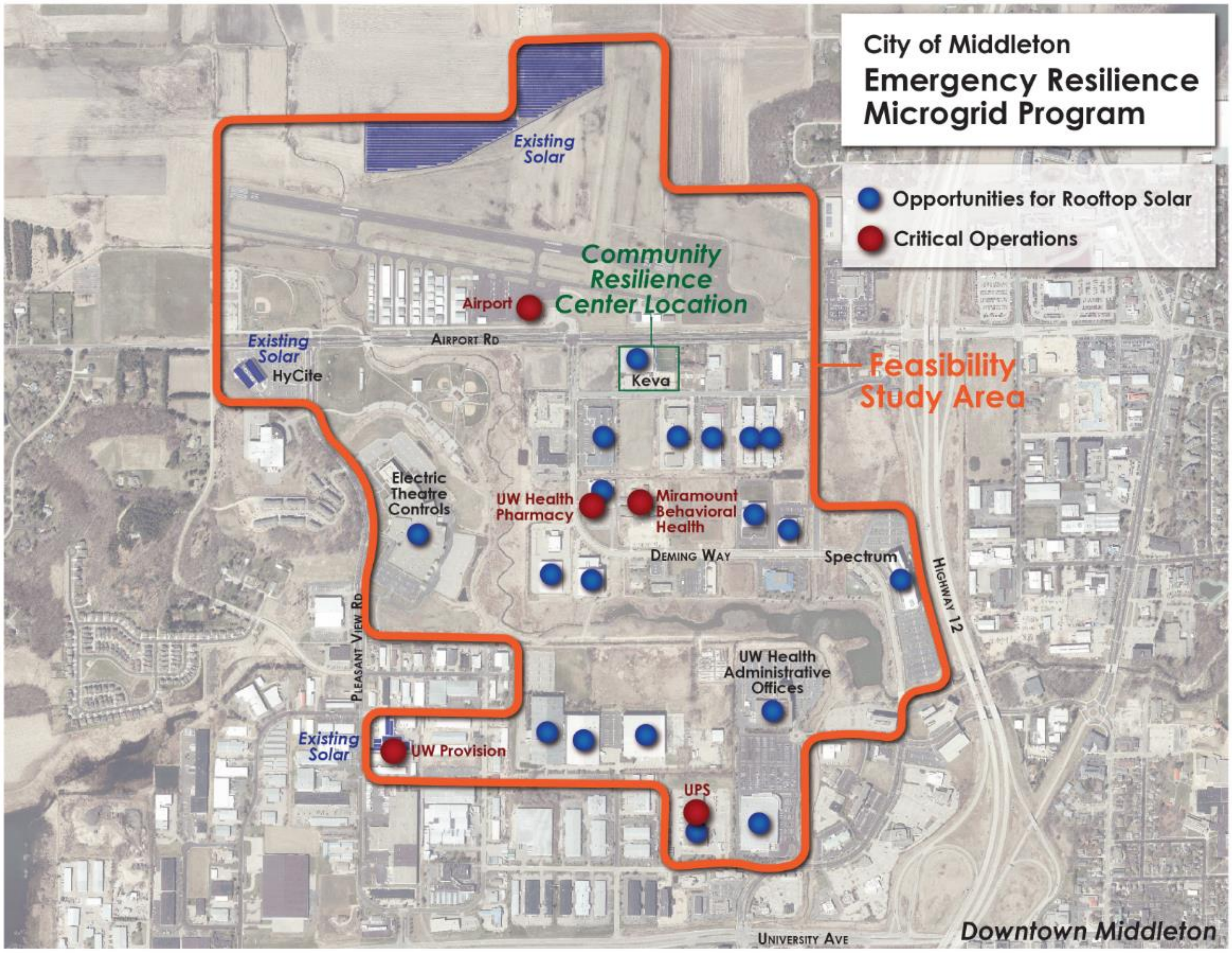

Figure 1 – Approximate boundary of the Middleton business park

Key Partners and Stakeholders

Business Participation

A cost-effective way to implement a microgrid is to start with a collection of buildings that are served by a common utility feeder. This eliminates the need to re-configure the utility distribution to the facilities and simplifies the disconnect equipment needed to separate the facilities from the grid in islanded mode. The City of Middleton and HGA worked together to reach out to all businesses within the business park served by the Pheasant Branch feeder 1321 and also some businesses that were not fed by the feeder, but may show support for a microgrid in their area. Sixty-three businesses that met these criteria were identified in 2021 at the time of the grant application writing.

Five businesses and MG&E wrote letters of support of the microgrid study during the grant application phase in 2021.

During the study, the City of Middleton and HGA gathered contact information including a name and email address or phone number from 41 businesses. An informational letter was sent to all businesses along with a request to attend an information session hosted by HGA describing the purpose of the study and how the businesses can participate. Representatives from four businesses attended the information session.

Through MG&E, 15-minute interval demand data from January 2021 through December 2021 for the Pheasant Branch Feeder 1321 serving the majority of the business park was collected. Six businesses also allowed HGA to collect 15-minute interval data from March 2020 through May 2022. This study explores the implementation of a Critical Resilience Center (CRC) incorporated into the microgrid. The demand profile for a suitable facility was estimated using the load profile of one of the businesses that fit the approximate size, EUI, and facility type that a CRC may possess.

What is a microgrid?

As defined by the "Microgrid Knowledge" website, a microgrid is a self-sufficient energy system that serves a discrete geographic footprint, such as a college campus, hospital complex, business center, or neighborhood. A microgrid system typically uses a variety of generating technologies to provide a robust electrical generation system and typically includes fossil fueled generators, solar PV, and some type of battery storage.

Microgrids incorporate sophisticated controls that allow the system to be either grid connected or operated independent of the grid, such as during a grid outage. Depending on the level of resilience needed, a microgrid may be capable of operating independently off the grid for only a few hours or indefinitely.

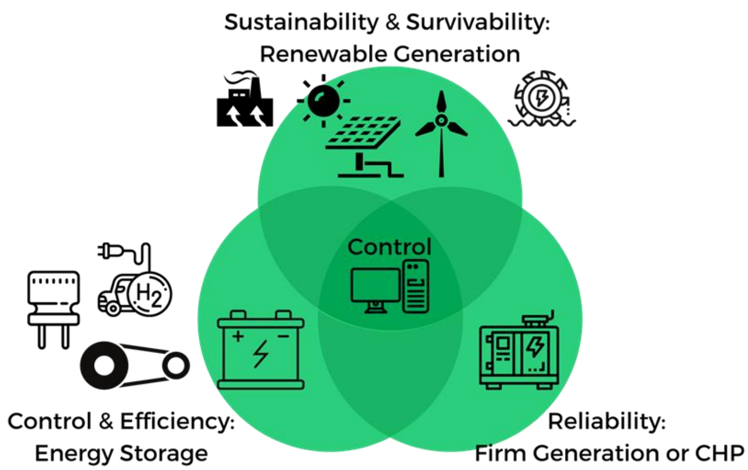

Figure 2- microgrid technology diagram

Unlike emergency power systems that typically only power critical emergency loads, a microgrid can power the facility's entire electrical load. However, systems can also be designed with building automation systems controls and smart breakers that curtail building load as required when operating off grid and generation constraints are reached.

When a building is isolated from the grid and operating independently it is referred to as being "islanded." An islanded building is using its own power generation and energy storage to deliver the exact amount of electricity that is needed. When the building is connected to the grid, it is referred to as "grid-tied" and can utilize as much or little grid electricity as needed to balance the loads or optimize the economic performance of the entire system. For example, if a building has high peak electric charges, the amount of grid electricity being used can be reduced at these times and onsite generation or storage can provide the required amount of electricity.

Microgrids may rely on a combination of technologies or a single technology. If sustainability or clean energy is a desired outcome of the microgrid, all or part of the energy generated on site may come from renewable energy sources such as solar PV or wind, thereby creating what is sometimes called a *hybrid* microgrid.

Onsite batteries are commonly incorporated into modern microgrids due to the ongoing cost declines in battery technology and the amount of flexibility they can provide. Additionally, the battery storage can often be utilized to provide economic benefits when the system is grid tied as well, such as load shedding and demand response. All of the benefits of energy storage are realized by using intelligent controls to decide when to charge and discharge energy from the storage device. Fuel-based generation may be used to provide dispatchable power as needed and reliability to the microgrid. Renewable generation, fuel-based generation, and energy storage work together in symbiosis so that the whole microgrid is greater than the sum of its parts

– that is, the microgrid as a whole will deliver more economic and resilience benefits than any of the technologies could do alone.

To tie all of the microgrid assets together, a controller provides the “brain” that makes decisions on what to do with each asset based on conditions at the site, including building demand, current weather and solar production, along with anticipated future conditions at the site. Some controllers use very simple algorithmic or logic-based control schemes, while others are more advanced, using artificial intelligence techniques. The complexity of the microgrid system, rate tariffs, and revenue stream environment dictates how “intelligent” a controller must be to derive maximum economic and resilience benefits.

Resilience Objective and Metrics

The microgrid study defined the resilience objectives and metrics as follows:

1. Increase resilience community wide by keeping normal operations for at least 4 hours without onsite fuel replenishment with 98% confidence
2. Maintain emergency, critical loads or CRC operations for at least 24 hours without onsite fuel replenishment with 98% confidence
4. Utilize existing and future renewable energy resources during both grid connected and islanded operation
5. Leverage microgrid resources to reduce utility costs through multiple stacked revenue streams such as energy arbitrage, demand charge reduction, demand response, and other grid interactive services, as available
6. Maintain EV charging capabilities during grid outage to support regional charging network during grid outage

These goals were decided upon because the current utility feeder has limited ability to provide these services in its current configuration. The purpose of the study is to see how microgrid arrangements can accomplish these objectives.

The results of this preliminary study can be used in future planning efforts to further define "emergency", "critical", and "basic facility operation" in conjunction with the project team, City of Middleton and Business Park building owners, and emergency preparedness representatives.

Outage Data Sample Since 2010:

3230 DEMING WA Apt.150

PHARMACEUTICAL PRODUCT DEV., LLC

Date	Customer	Outage Duration	Cause
7/1/20	PHARMACEUTICAL PRODUCT DEV., LLC	31 min	Human Interference
8/20/18	PHARMACEUTICAL PRODUCT DEV., LLC	25 Hr 26 min	STORM
9/22/11	PHARMACEUTICAL PRODUCT DEV., LLC	7 min	Transmission Outage

8155 FORSYNTHIA ST

ROCKWELL AUTOMATION

Date	Customer	Outage Duration	Cause
7/1/20	ROCKWELL AUTOMATION	31 min	Human Interference
8/20/18	ROCKWELL AUTOMATION	24 Hr 32 min	STORM
10/10/17	ROCKWELL AUTOMATION	51 min	Human Interference
9/22/11	ROCKWELL AUTOMATION	7 min	Transmission Outage

Site-Specific Microgrid Architecture

Because of the site's location, existing electrical infrastructure, and diverse private ownership, 3 separate scenarios were chosen for microgrid consideration and analysis.

Scenario 1- Microgrid at Utility Feeder Level

In this scenario, the local utility (MG&E) would utilize existing electric infrastructure to create a 'Mini Grid' within Pheasant Branch 1321 feeder that serves a majority of the businesses in the microgrid study area.

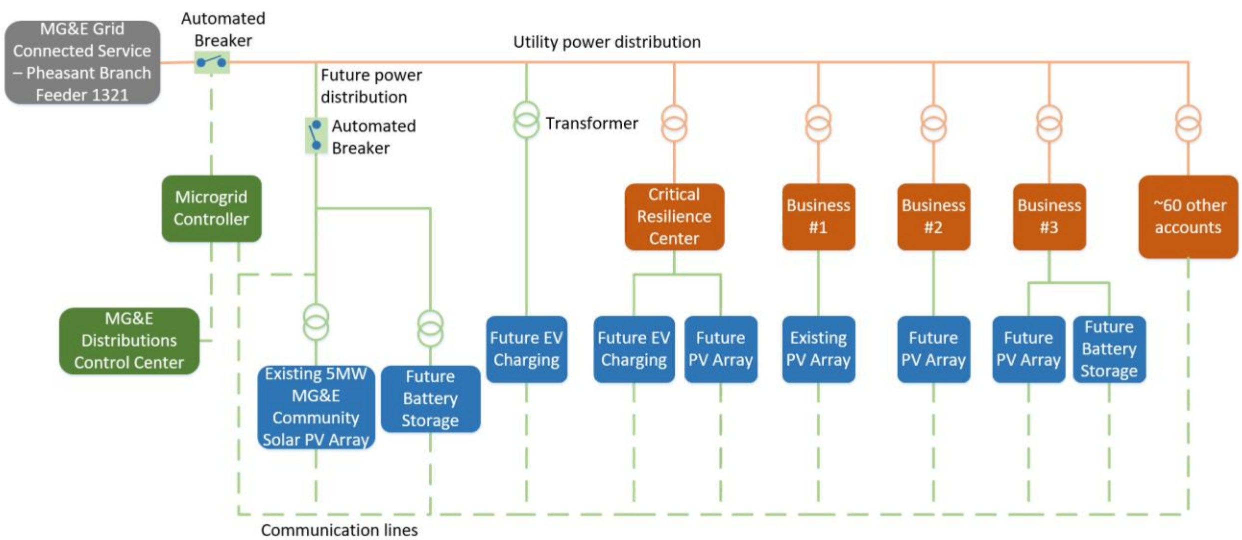

Figure 3 – One line diagram – microgrid scenario 1

All buildings in the microgrid would receive power in the same manner as they currently do on Pheasant Branch feeder 1321. In a local electrical power outage, utility providers could isolate Pheasant Branch feeder 1321 from the larger electric grid and operate it as a microgrid. This would enable all businesses on the feeder to receive normal power, though some demand shedding and curtailing might need to occur to prolong the microgrid resilience.

Scenario 2- Microgrid at Building Campus Level

In this scenario, several of the buildings in the business park (including a CRC) would be powered from a central microgrid hub. This microgrid hub can switch from normal utility power to internal microgrid forming power resources. This electric architecture is similar to campuses that have utility and local sources of power.

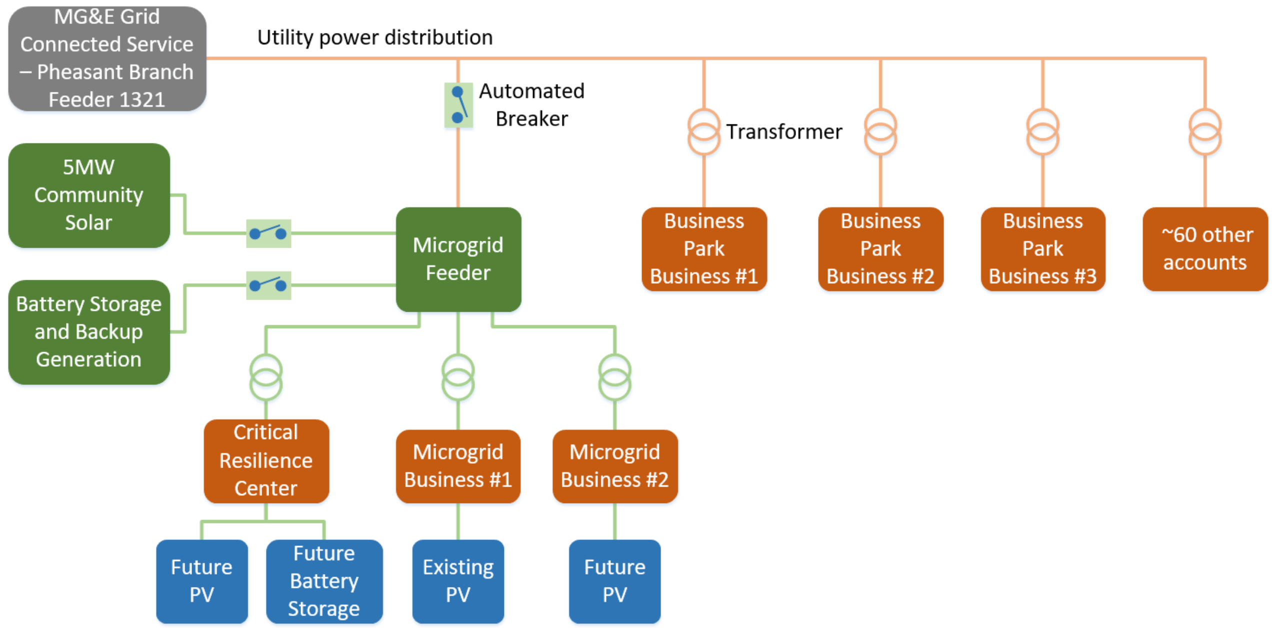

Figure 4 – One line diagram – microgrid scenario 2

Select businesses would be converted to receiving medium voltage power from a central utility hub that could switch power sources from utility to microgrid during a local utility outage.

Scenario 3- Microgrid at Community Resilience Center (CRC) Level

This concept would convert a single building in the business park to a community resilience center by installing a building level microgrid. In this case we would consider using local community energy resources (renewable and emergency power) to assist in achieving the resilience goals and criteria of the CRC.

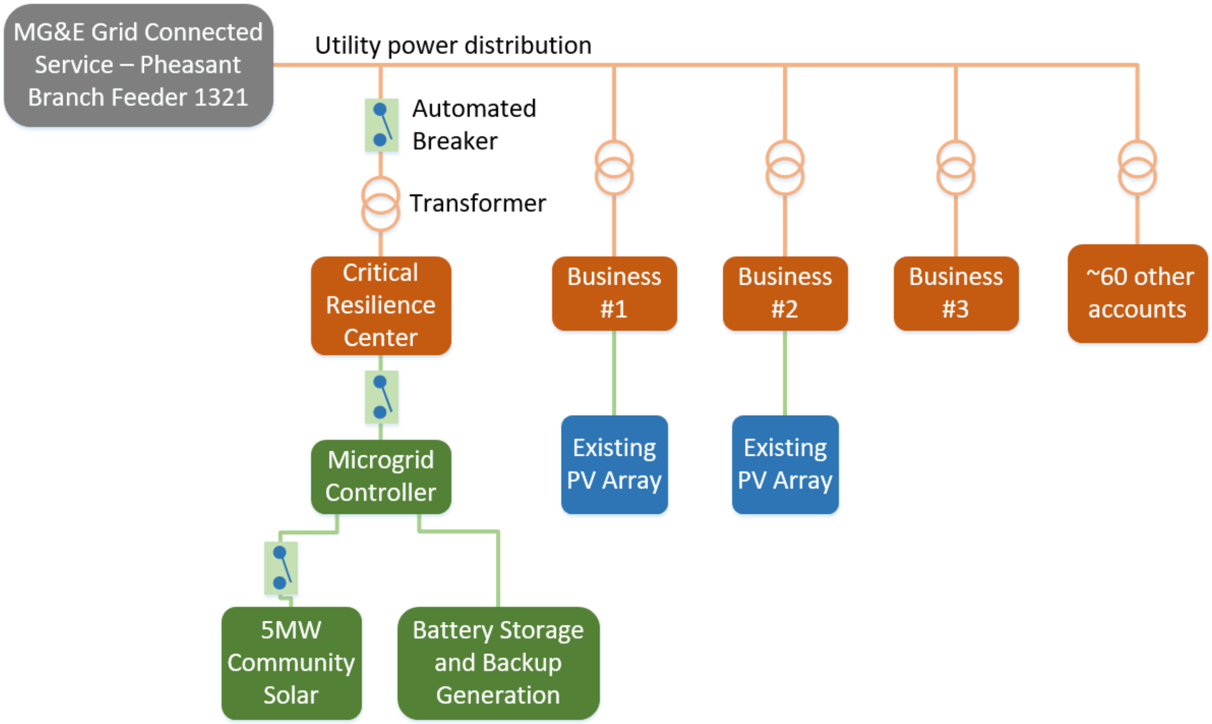

Figure 5 – One line diagram – microgrid scenario 3

The analysis will focus on the viability of utilizing adjacent local resources versus installing new building level systems to power a CRC microgrid.

Technologies Under Consideration

Solar Photovoltaics

Solar PV is a widely used microgrid technology to generate renewable energy and reduce utility cost and demand charges. Roof mounted solar photovoltaic panels are the most cost effective, compared to high first costs for ground mount systems. Many of the buildings within the business park feature flat or low-slope roofs which are ideal for rooftop solar PV. Figure 6 below shows roof mounted panels at a 10-degree tilt.

Figure 6 – Roof mounted solar at a 10-degree tilt

Two businesses within the business park have roof mounted solar PV – Approximately 324 kW at UW Provision Company and approximately 92 kW at Hy Cite Enterprises. Figure 7 below shows an image of the solar PV at UW Provision Company.

Existing Solar Sizes:

- Hy-Cite existing solar – 92.3 kW
- UW Provision existing solar – 323.8 kW

Figure 7 – UW Provision solar PV

Ground mount systems can be installed either in green space or over parking lots. They tend to have high first costs to implement the structural foundation. An existing MG&E owned and operated 5MW ground mount solar PV system is located just north of the business park at the Middleton Municipal Airport (Morey Field). Figure 8 below is an example of a ground mount system.

Figure 8 – Ground mount solar PV

Utility Scale Solar Photovoltaics

Madison Gas and Electric's (MGE) 5-megawatt (MW) Morey Field Solar array at Middleton Municipal Airport is fully operational (2020) and delivering locally generated, sustainable, carbon-free energy to the electric grid.

Morey Field Solar is located on the north side of the Middleton Airport and is in close proximity to the microgrid area as part of this study.

The array has 17,000 panels over 21 acres and serves MGE’s Shared Solar Program, from which the City of Middleton and the Middleton-Cross Plains Area School District purchase a combined total of 1.5 MW of power through a Renewable Energy Rider (RER) agreement with MGE.

Morey Field Solar is the second array in MGE's popular Shared Solar program. The community solar program provides residential and business customers throughout MGE's electric service territory an easy, convenient way to power their home or business with local solar (source: mge.com).

Figure 9 – Morey Field Solar Array next to Middleton Municipal Airport (Image source oneenergyrenewables.com)

Batteries Energy Storage

Lithium-ion battery storage systems are the most widely used and therefore a mature battery technology. As a result, lithium-ion has experienced improved manufacturing and increased competition. It has superior energy density and cycle lifetime compared to other present technologies. As the field of stationary, building-level battery storage is still nascent, we expect other chemistries and/or storage technologies to evolve in the coming years. These storage technologies help improve a facility's ability to increase electric reliability, generate utility grid revenue, store excess renewable energy, and lower utility demand charges.

STORE AND TIME-SHIFT EXCESS SOLAR ENERGY

During a sunny day, the battery system can be used to store excess solar energy production that would normally be sold back to the utility at a reduced rate. This stored energy can be used later during the night or at peak utility cost times. Figure 11 below shows a building's electric usage in blue and the solar production in orange. During this particular day the Solar PV production from 10am to 6pm is greater than the building's energy use allowing the excess to be stored on the battery. This is sometimes also referred to as energy arbitrage because the battery is being charged when energy prices are lower (daytime) and discharged when energy prices are higher (evening).

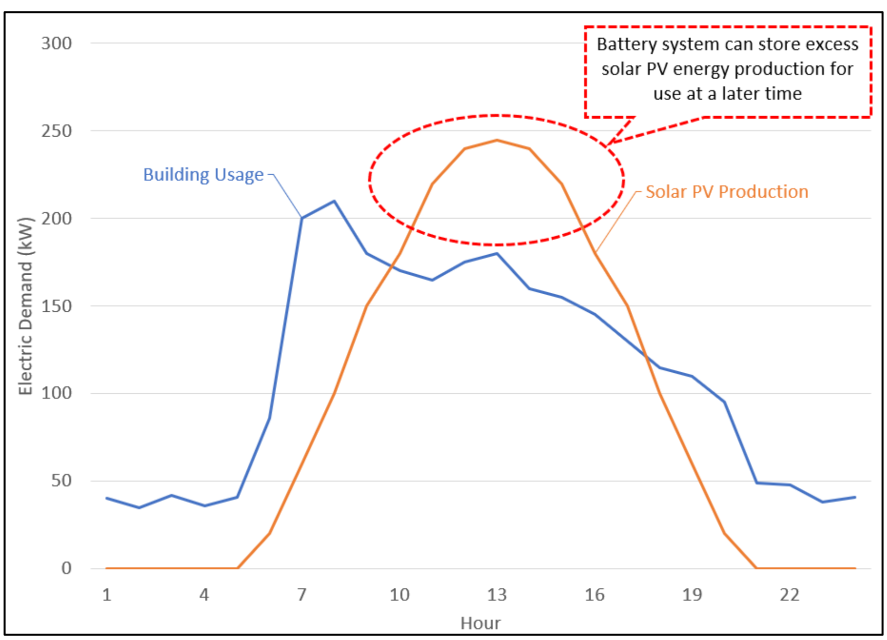

Figure 10 – Example building usage and solar production graph during a typical sunny day

PEAK SHAVING

The battery system can also be used to shave the peak load at the facility that would otherwise increase demand charges.

Figure 12 below has the peak demand for the building's energy use circled. When the Solar PV production is not enough to cover the peak demands, the battery system can use the excess energy stored to reduce the peak demands and therefore perform demand charge reduction.

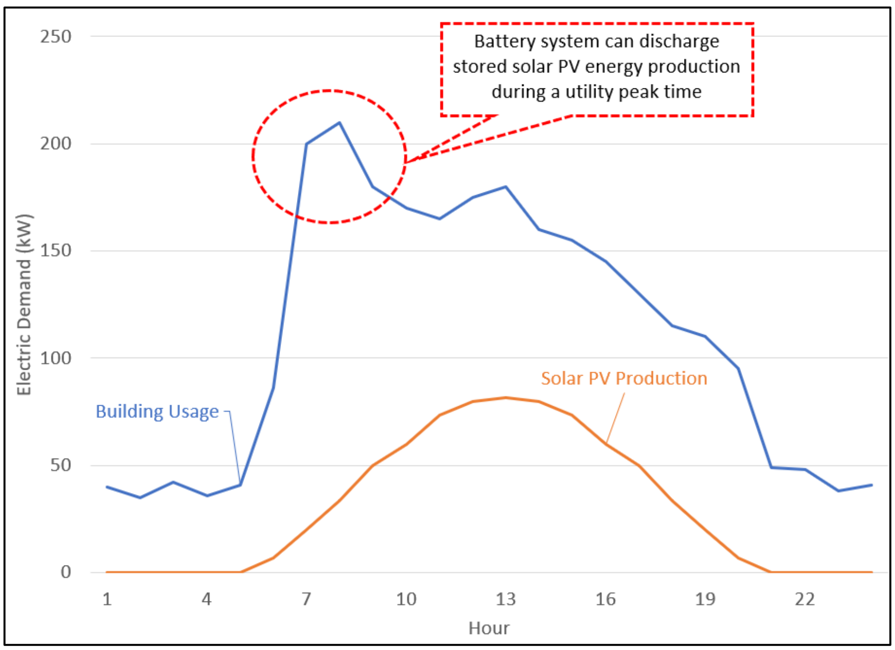

Figure 11 – Example building usage and solar production graph during a typical cloudy day

BATTERY POWER BACKUP

Batteries can increase electric resiliency by providing back-up electric power during loss of building utility connection. These battery systems can be used in tandem with a conventional dual fuel gas generator, or as a standalone means of providing emergency power in an electric utility outage. When used in tandem with a generator, batteries can mediate fluctuations in the solar PV production, allowing the generator to work simultaneously alongside the solar PV. Batteries can also make generator usage more fuel efficient, since they can be charged alongside building load to help the generator run at its optimal fuel consumption.

Depending on the emergency backup requirements of the CRC and the electrical design of the system, a battery storage system could be incorporated to provide backup power or the ability to generate solar energy during utility outages. Without an integrated battery storage system, any solar PV will not be usable during utility outages.

DEMAND RESPONSE

Batteries can also be used to participate in utility Demand Response programs. Demand Response programs are programs or riders offered by utilities that pay customers to reduce their building electrical load during predicted periods of high electrical usage. Customers can participate in these programs to either shed non-critical loads during these events, or use energy stored in their batteries to continue normal operations – but in either case, the demand on the utility grid is lowered, which reduces the chances of a grid failure (blackout), and also reduces the costs for the utility to supply high-value electricity.

We are not aware of any Demand Response programs offered by Madison Gas and Electric at this time. However, utility rate structures and programs are rapidly evolving and such programs may be offered in the future. Battery storage installed now may be able to participate in these future programs.

APPLICATION STACKING

Each of the aforementioned battery applications can provide value to the customer and be used to cost-justify the installation of the battery. Even more value can be derived by using the battery for multiple applications throughout the course of its lifespan, though perhaps not at the same time. For example, storing excess energy and peak shaving are not mutually exclusive operations – the excess energy that is stored during periods when the solar is producing more energy than the building needs can be used later to shave the building peak. Therefore, it lowers utility costs by using the excess solar production to offset electricity that would otherwise be purchased from the grid, and, by carefully scheduling the time that this stored energy is used (i.e. during periods of peak building loads), it can lower demand charges.

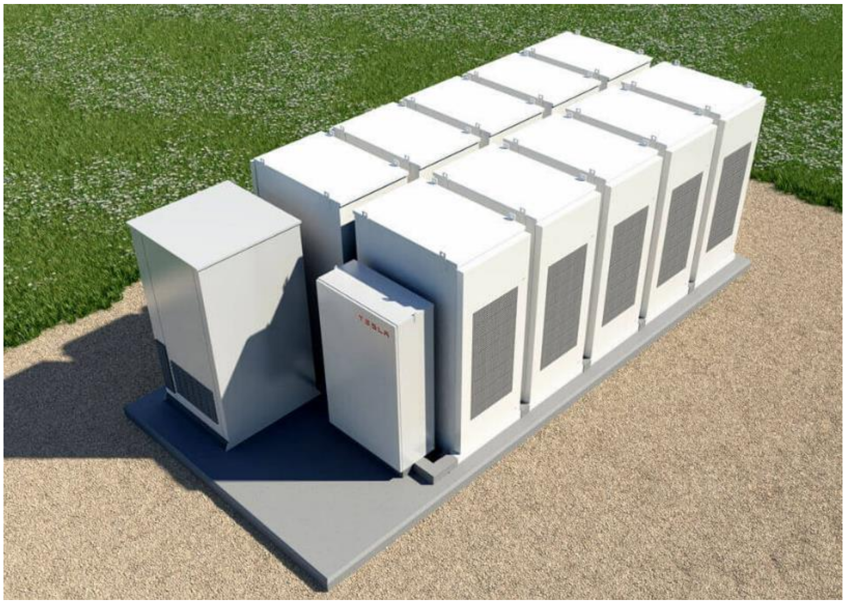

Figure 12 – Example of a building battery storage system

Diesel Back Generators

Fossil fuel generators may be needed to meet the long-term resiliency needs of the microgrid. These generators could work with renewable systems to keep critical loads operational in a long-term emergency.

Fortunately, there are a few generators already in usage for back-up loads in the business park:

- Spectrum brands has a 1.8MW Diesel Generator
- Pharmaceutical Product Dev has a 900kw Diesel Generator

Wind Generation

Wind generation was not considered for this study because of the site's proximity to an airport and the density of the buildings within the business park, which are not suitable for large scale on-site wind generation.

Data Collection

MG&E Pheasant Branch Feeder 1321

Madison Gas and Electric (MG&E) services both electricity and natural gas to the Middleton business park. MGE's Pheasant Branch electrical feeder #1321 serves the majority of the business park and is the primary focus area of this microgrid feasibility study. Utility data from this feeder for the 1-year period of 1/1/2021 – 12/31/2022 has been compiled and analyzed.

Electric utility data is available in one-hour intervals and is a summation of all electricity consumption within the business park area for approximately 60 businesses. Two facilities within the business park have a behind-the-meter solar PV array which is accounted for in the total peak.

Existing One-Line Diagram

The existing service to the business park is through the Pheasant Branch Feeder #1321, owned and operated by Madison Gas and Electric. Nearly all facilities within the park are fed through this service. Two facilities within the business park, UW Provision Company and Hy Cite Enterprises have a behind-the-meter rooftop PV array.

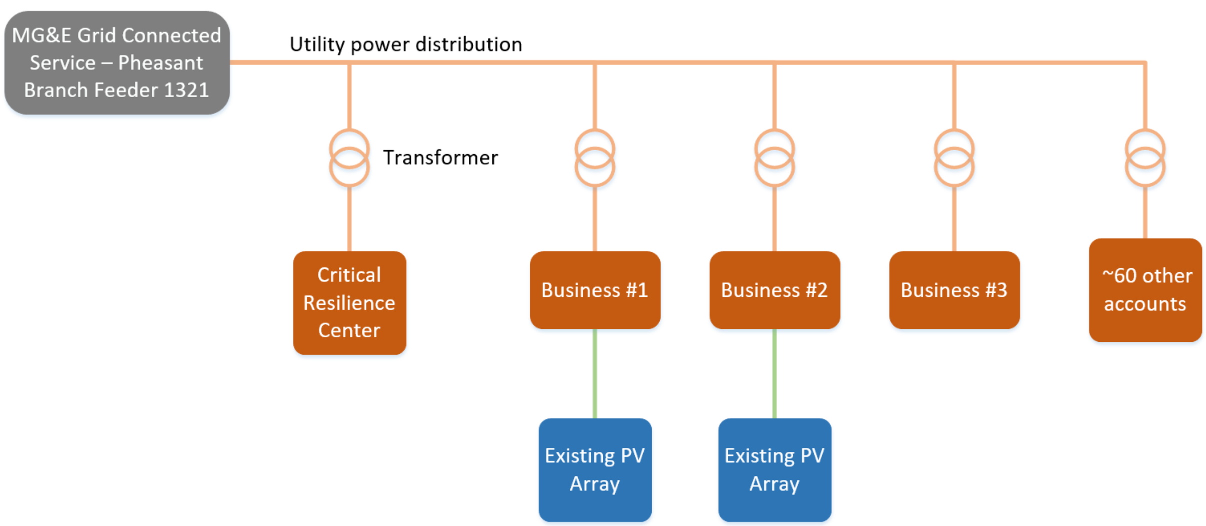

Figure 13 – Diagram of current MG&E feeder connection to the business park customers

Monthly Electric Use – Pheasant Branch Feeder 1321

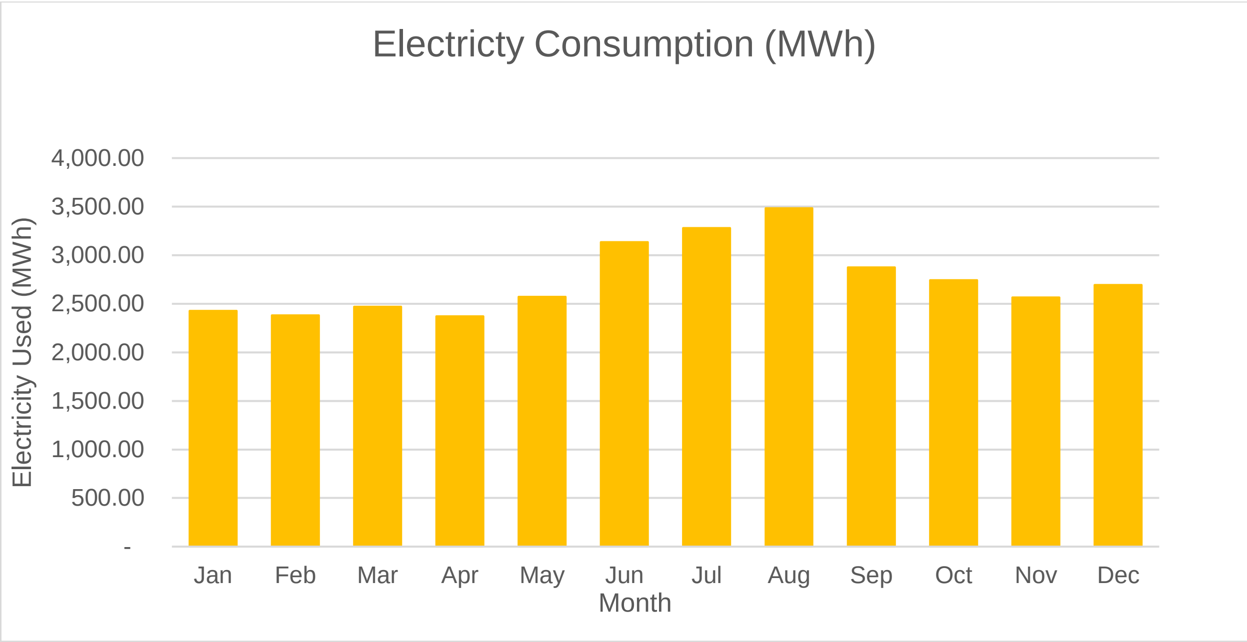

Figure 14 – Monthly electrical use is relatively consistent between October and May with an increase from June through September coinciding with the peak cooling season.

The business park saw a peak demand of 8.054 MW on August 10th at 3:00 PM. If the existing solar generation is removed from this equation (a truer assessment of the business park's loads and performance), then the peak demand was 8.101 MW on 8/10/2021 at 3:00PM.

Average Daily demand profile – Pheasant Branch Feeder 1321

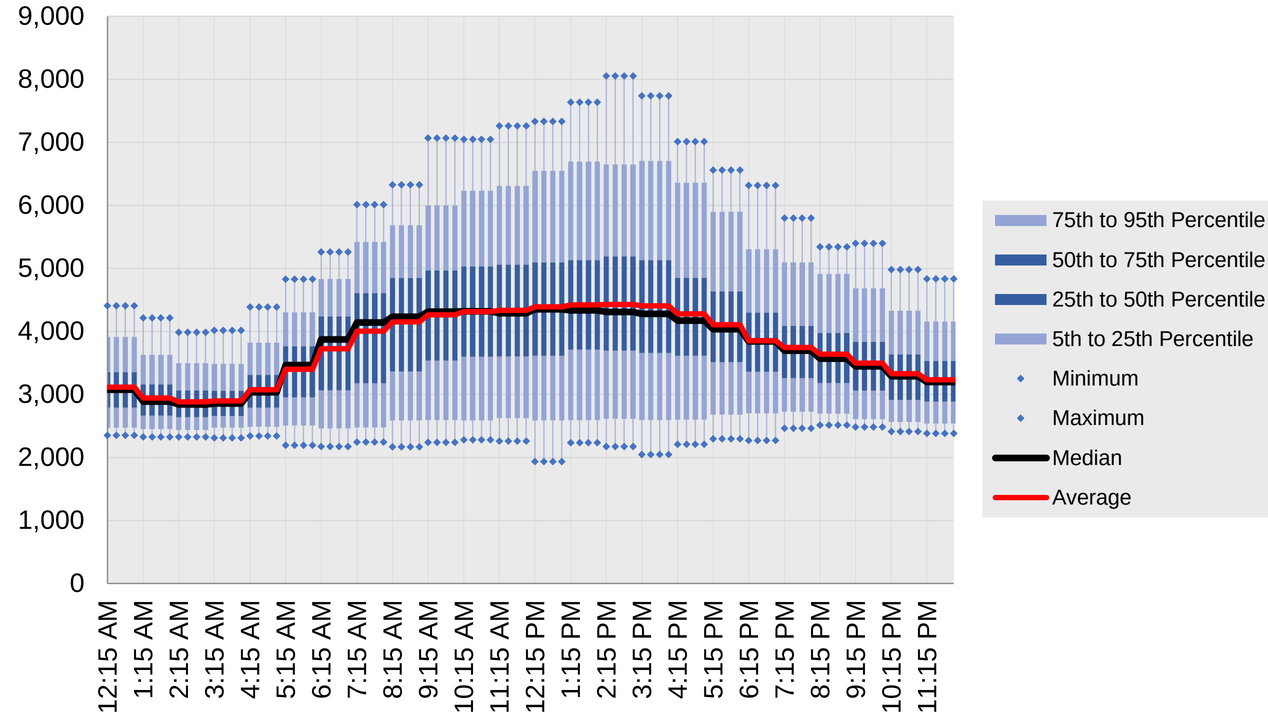

Figure 15 – Box plot showing the average daily demand profile. The daytime demand has a wide variance while the nighttime demand shows a much smaller, more predictable variance.

For a more granular look at the business park's demand, HGA requested building-level energy consumption data for a sampling of businesses within the park. Forty-one businesses with contact information were approached by HGA asking for permission to obtain approximately two years of 15-minute interval data from MG&E. Six businesses allowed the use of their interval data from MG&E. Customer data authorization release forms were sent to and signed by the businesses and then forwarded to MG&E. An example of this authorization release form is available in the appendix. The data that MG&E provided to HGA was energy consumption data in 15-minute intervals from approximately March 2020 through May 2022 for five of the facilities. For one facility, which was built in 2020, 15-minute interval data from September 2020 through May 2022 was provided. The six facilities varied in size and end uses with peak kW ranging from 15.5 kW to 669.9 kW and yearly energy consumption ranging from 20,151 kWh to 2,192,105 kWh. Despite representing only about ten percent of the total number of businesses, HGA viewed this as a reasonably representative sample of the mix of businesses and energy use profiles within the business park.

The six businesses with 15-minute interval data were chosen to represent an example facility mix for the scenario 2 – campus level microgrid. All energy consumption data was compiled, and the data timestamps synced for these six facilities using the

Universal Translator 3 data analysis tool. The average daily demand profile for each of the six businesses are presented in the chart below. Year 2021 data was used in this chart because it was the only year with a full 12 months of data for all six facilities.

Average Daily Demand Profile – Six Individual Facilities

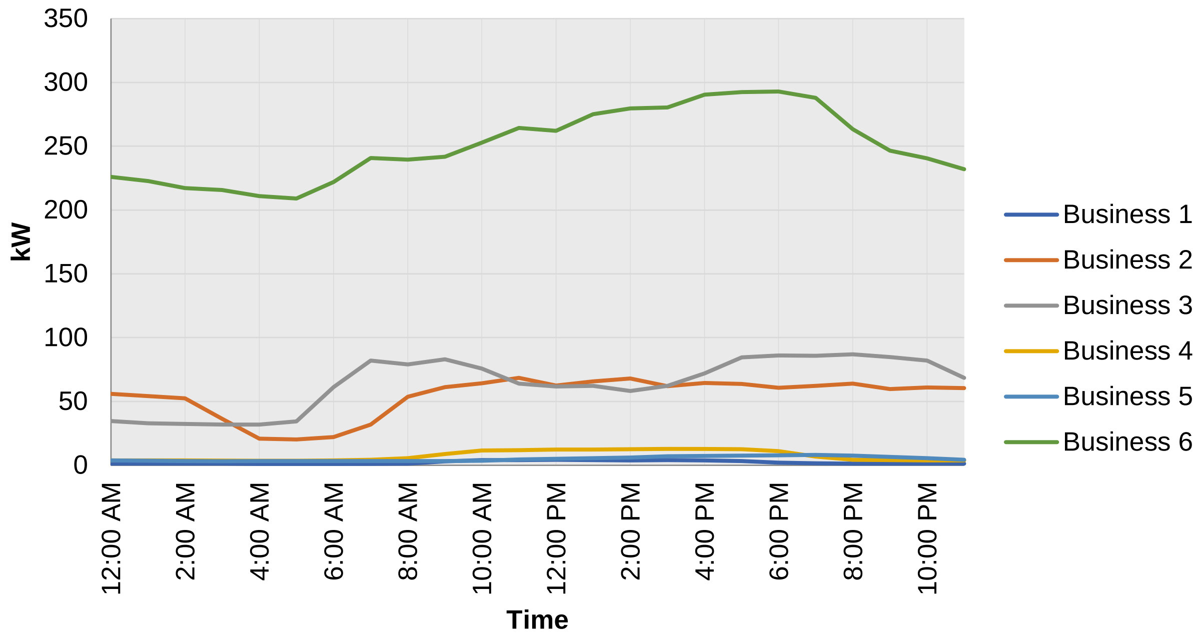

Figure 16 – Average daily demand profile for the six business used to represent the campus microgrid scenario

The six facilities' loads were summed to show an average daily demand for the campus microgrid. Year 2021 data was used in this chart because it was the only year with a full 12 months of data for all six facilities.

Average Daily Demand Profile – Combined Facilities

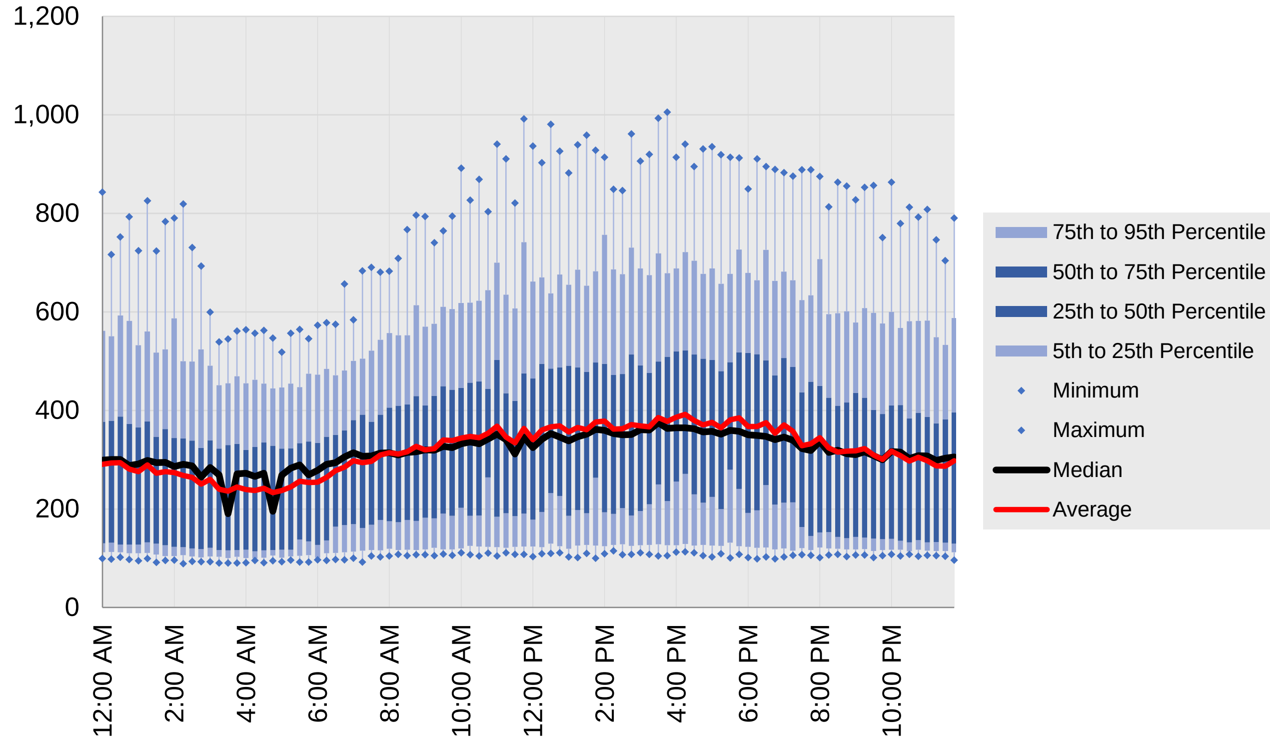

Figure 17 – Box plot showing the average daily demand profile for the example critical loads

For scenario 3 – community resilience center level microgrid, in the original grant application, a 64,000 square foot indoor sports complex was chosen as a preliminary CRC location. Fifteen-minute data was not able to be collected from this facility in time for this analysis, so one of the facilities with available data was chosen as a representative building most like the one envisioned to operate as the CRC. Interval data from a warehouse and factory of a similar size was chosen as a stand-in load profile for the CRC. Below is a box plot showing the average, median, and percentile ranges demand (kW) for this facility. Two full years of data spanning March 2020 through February 2022 was used to create this chart.

Average Daily demand profile – Critical Resilience Center

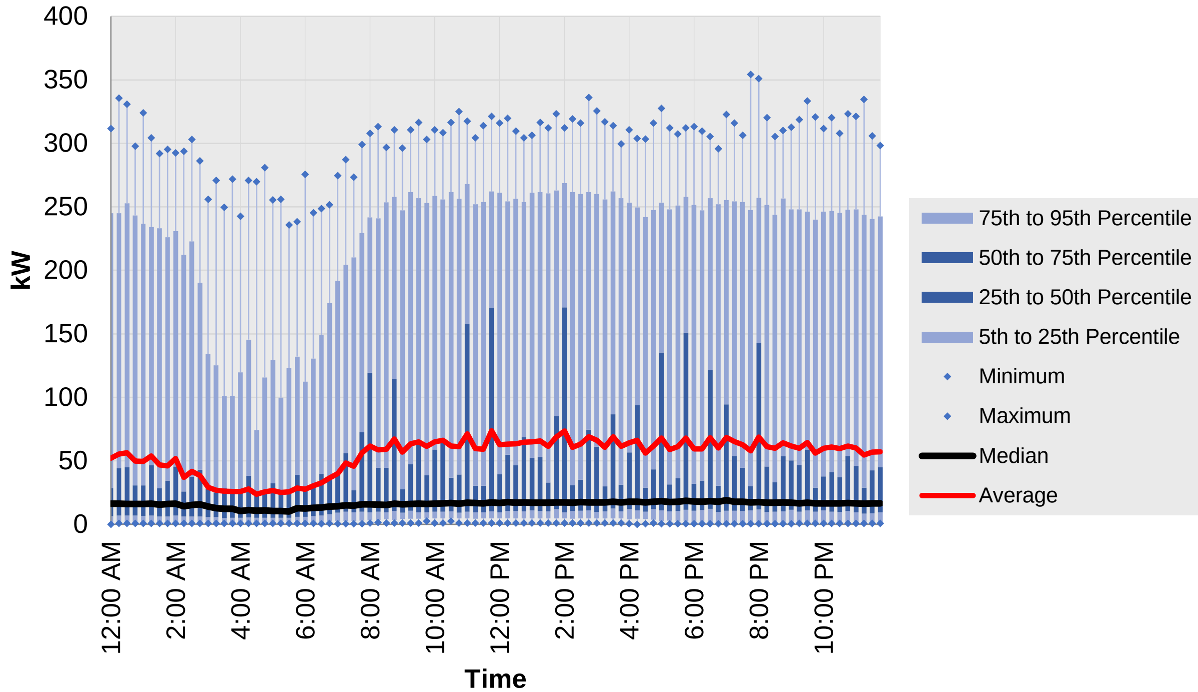

Figure 18 – Box plot showing the average daily demand profile for the example CRC

System Sizing and Financial Analysis

Analysis Methodology

MuGrid Analytics performed the system sizing analysis using their proven Resilience First methodology. They performed resilience and economic modeling, optimization, design sizing, and grid-connected dispatch strategy using their in-house, mathematical optimization platform, Redcloud. Redcloud is a best-in-class energy optimization tool of the same genre as 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. This type of thinking is holdover from the fossil-fuel backup generator days. (Though it really wasn't true then either.)

However, muGrid views resilience performance as stochastic, and characterizes 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, muGrid analyzes multiple descriptors of resilience performance, including probability, or confidence, for a given duration.

MuGrid defines resilience duration as the amount of time the microgrid can support the critical load (which may be the full load) after a grid outage. Virtually every hybrid microgrid will eventually fail 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 time-to-first failure is the primary resilience metric.

Other important resilience metrics that may be considered include the time to recover 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

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

paired with confidence levels in order to be valuable analysis 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 graphic capturing the dependency on these dependent variables.

MuGrid conducted resilience performance analysis for a variety of combinations of energy technologies, seeking in each case to show the required mix of assets to achieve the resilience requirements set for the study. Based on the forecasted building loads, they calculated the appropriate system sizing for the microgrid components to meet the resilience requirements of each scenario.

Specifically, muGrid looked for solutions able to achieve the short duration of resilience at near-100% confidence with each potential generator size. They then compared the estimated capital costs of each configuration to answer the question: what is the lowest cost way to achieve this requirement? A short duration requirement at high or near-100% confidence is almost always the driving requirement over a longer duration at lower confidence, so they used the short duration to set the system and then observed the performance at the longer duration.

It should be noted that these analysis runs were conducted with one year of load data (some of which may have been estimated by HGA) and with one year of estimated solar production based on scaling the production for the existing arrays (which may have been estimated by HGA or actual production data.) As such, both load and solar production for these resilience estimates are based on one single year of data, which may or may not be a typical year and may or may not have any outliers in the data. The analysis was conducted using a single outage simulation at each time step (every hour of the year) and statistics collected were based on the modeled performance of the system over that particular year. A more rigorous analysis would include Monte Carlo runs to statistically vary the weather and load conditions (which may be correlated.) This is why muGrid lists all extremely-high confidence systems as "near-100%" or "99.99%+" instead of simply "100%." When their modeling results return "100%" successful, it means that the simulation was successful at achieving the desired duration at every one of the 8760 time steps that were run under the conditions described above.

It should also be noted that the load interval data provided was at 15-minute intervals. 15-minute load data typically average the load over that 15-minute period. This means that the demand at the 1-minute, 1-second, or even subsecond time-scales may be significantly higher due to short-duration equipment usage and/or inrush currents at power up. As a gross estimation of these effects, muGrid recommends grossing up the 15-minute peak by at least 25%. Ideally, before any microgrid is finally designed, the site should install data loggers capable of measuring and recording load data at the 1-second scale or shorter. The same affect can be said for short-duration variations in the solar production. However, installing a battery with the solar can smooth those effects sufficiently that micro-variations in the solar are less noticeable at the system level.

Installed cost assumptions:

- Solar PV: $1.75/W
- Battery storage (assuming Li-ion): $1000/kWh
- Backup generators: $1000/kW
- Electrical infrastructure to bring electrical solar or generators into microgrid technology: $1,000,000/mile
- Microgrid Controller: $500,000 multiple building, $200,000 single building

CapX = Capital expenditure. For the purposes of this study,

Many of the backup generators proposed could be replaced by combined heat and power (CHP) or cogeneration systems and create additional revenue streams. However, due to the issues previously mentioned, the revenue and returns are difficult to model without a more defined architecture and strategy.

Scenario 1- Microgrid at Utility Feeder Level

In this scenario, the local utility (MG&E) would utilize existing electric infrastructure to create a 'Mini Grid' within Pheasant Branch 1321 feeder that serves a majority of the businesses in the microgrid study area.

All buildings in the microgrid would receive power in the same manner as they currently do on Pheasant Branch feeder 1321. In a local electrical power outage, utility providers could isolate Pheasant Branch feeder 1321 from the larger electric grid and operate it as a microgrid. This would enable all businesses on the feeder to receive power, though some demand shedding, and curtailing might need to occur to prolong the microgrid resilience.

While this scenario is the most ambitious in terms of load served by the microgrid, it relies heavily on MG&E to own and operate the microgrid in front of the business park utility meters. Further discussion would be needed with the utility on the hurdles to implementing a microgrid at the feeder level, though we suspect that this is of interest to the utility for a variety of reasons.

The economic advantages of this system would need to be negotiated between the utility and rate paying customers that would receive resilience benefits. Since the microgrid is located in front of the business park utility meters, no direct energy cost savings would result from the microgrid implementation in the manner. The benefit for the business park customers would come when a large utility grid outage occurs, and the microgrid is able to support the electric load (or part of it) during this larger outage. The utility may seek compensation from the microgrid customers for this service, similar to how a back-up generator has been implemented in partnership with the local utility.

Figure 19 - Resilience performance modeling for total generator capacity of 5 MW (2.7 MW of existing included)

Shown above and below are parametric modeling runs showing the resiliency confidence on the Y-axis over time in hours on the X-axis. The chart's labeling "bp" refers to the battery pack size in kW and "pv" refers to the solar PV array size also in kW given a constant size of fossil fuel generator.

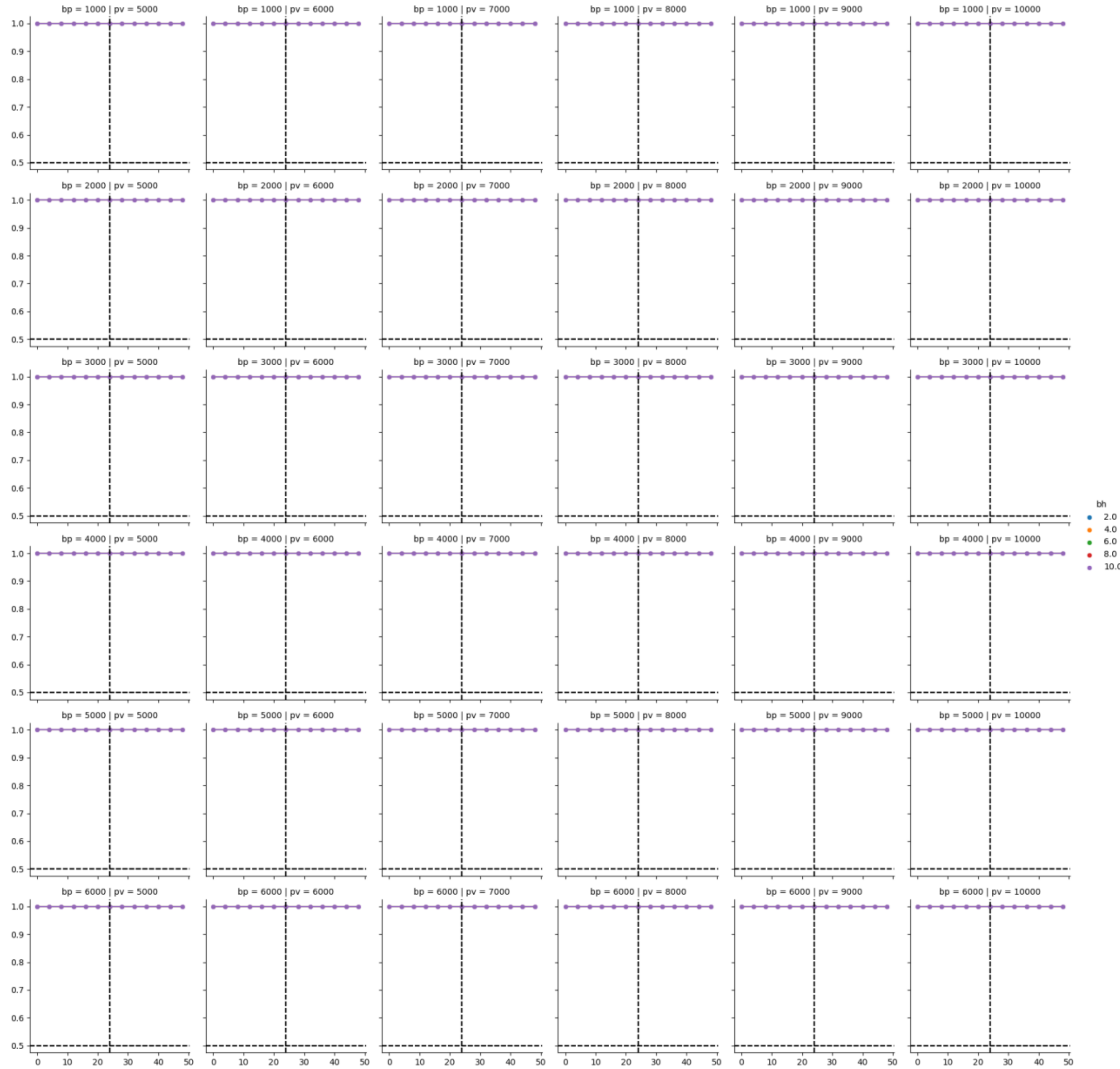

Figure 20 - Resilience performance modeling for total generator capacity of 8 MW (2.7 MW of existing included)

Case	Solar PV	Battery Energy Storage	Back-Up Generator	CapX	Confidence @ 4hr	Confidence @ 24 hr
Case 1A: Existing Assets	None					
Case 1B: No additional solar	5MW	1MW/2MWh	5 MW	$5.8M	98%	89%
Case 1C: No additional Generators	9MW	6MW / 60 MWh	2.7 MW	$38.5M	99.99%+	55%
Case 1D: "Best" Resilience Solution – 4HR	5 MW	1.5MW/6MWh	5 MW	$9.8M	99.6575%	92%
Case 1E: "Best" Resilience Solution – 24HR	5MW	1MW/ 2MWh	5 MW	$5.8M	98%	89%

Design Cases

Case 1A - Use only existing solar and generators: To answer the question "can we create the desired resilience with the existing 5MW solar and the existing 2.7 MW generators?" we looked for a battery that would achieve this. Even with a 15 MWh battery, resilience was less than 60% at 4 hours. We really need more generation.

Case 1B - Add battery to existing Solar: If we don't build additional solar, a moderately sized 1 MW / 2 MWh BESS paired with an additional 2.3 MW of fuel-based generation for a total of 5 MW would achieve 98% confidence at 4 hours.

Case 1C - Add solar and battery to existing generators: If we don't add to the existing 2.7 MW of generators, we can add 4MW to the existing 5MW of solar for a total of 9 MW and pair it with a large 6 MW / 60 MWh battery to achieve near 100% resilience at 4 hours. This solution is quite expensive and the confidence of achieving 24 hours of resilience rolls off fairly quickly to 55%.

Case 1D- "Best" 4-hr solution: We believe that the best "bang for your buck" to get to near 100% confidence at 24 hours is to pair the existing 5 MW of solar with a 1.5 MW / 6 MWh battery and add 1.3 MW to the existing generators for a total of 5MW of fuel-based generation. This also gets high confidence (92%) at 24 hours and potentially some economic opportunity for the battery at a reasonable cost.

Case 1E: "Best" 24-hour solution: We believe the best "bang for your buck" at a "high" confidence of supporting a 24-hour outage is to use the first solution of a 1 MW / 2 MWh BESS and a total of 5MW of fossil-based generation.

Questions for Analysis

1. Can the reliance goals be met with the existing assets (solar + generators)?

   Based on Case 1A, the resilience goals cannot be met with the existing solar and generators, even with a large battery added.

2. What is the benefit of adding the 'future solar' and/or a battery system in this scenario? Benefits in either the financial or resilience case.

   Based on Cases 1B-E, we can see that additional solar does not provide much benefit from a resilience perspective. We can see that the system can meet its resilience goals with the addition of a battery and additional back-up generator capacity.

   This is likely the most cost-effective way of creating a microgrid at the utility feeder level, and the grid connected benefit would likely be the result of peak shaving, demand shifting and utility usage of the added battery asset to the utility feeder.

Scenario 2- Microgrid at Building Campus Level

In this scenario, several of the buildings in the business park (including a CRC) would be powered from a central microgrid hub. This microgrid hub can switch from normal utility power to internal microgrid forming power resources. This electric architecture is similar to campuses that have utility and local sources of power.

Select businesses would be converted to receiving medium voltage power from a central utility hub that could switch power sources from utility to microgrid during a local utility outage.

This scenario would require close partnership and investment by those businesses wishing to partake in a campus microgrid within the business park. Several coordination hurdles remain to determine who would own and operate the microgrid assets as well as what property they would be housed on.

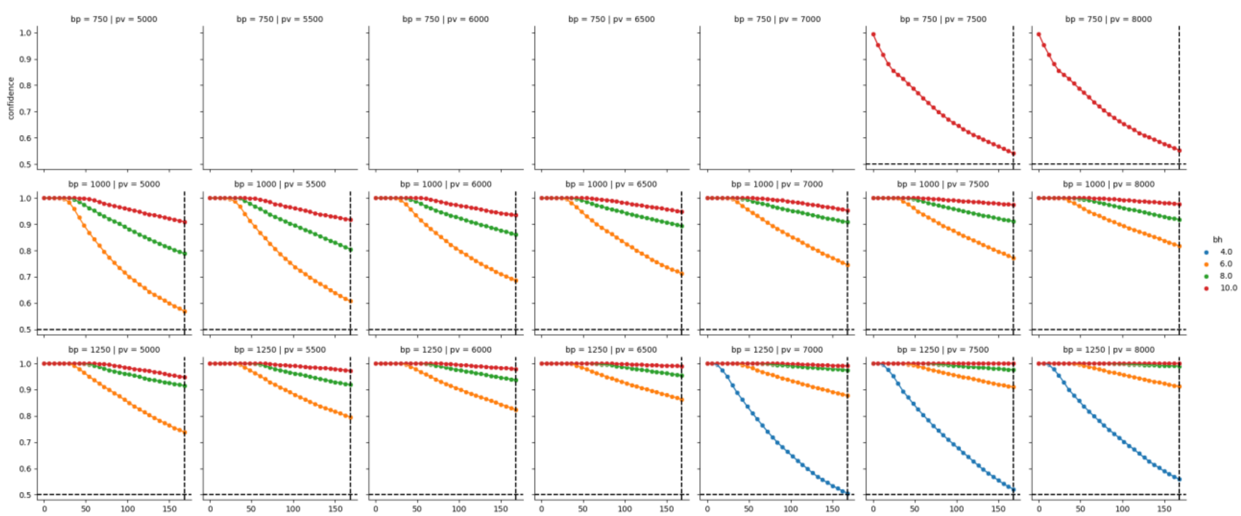

Figure 21 - Resilience performance modeling for solar plus storage, no fossil fuel generators

Shown above and below are parametric modeling runs showing the resiliency confidence on the Y-axis over time in hours on the X-axis. The chart's labeling "bp" refers to the battery pack size in kW and "pv" refers to the solar PV array size also in kW given a constant size of fossil fuel generator.

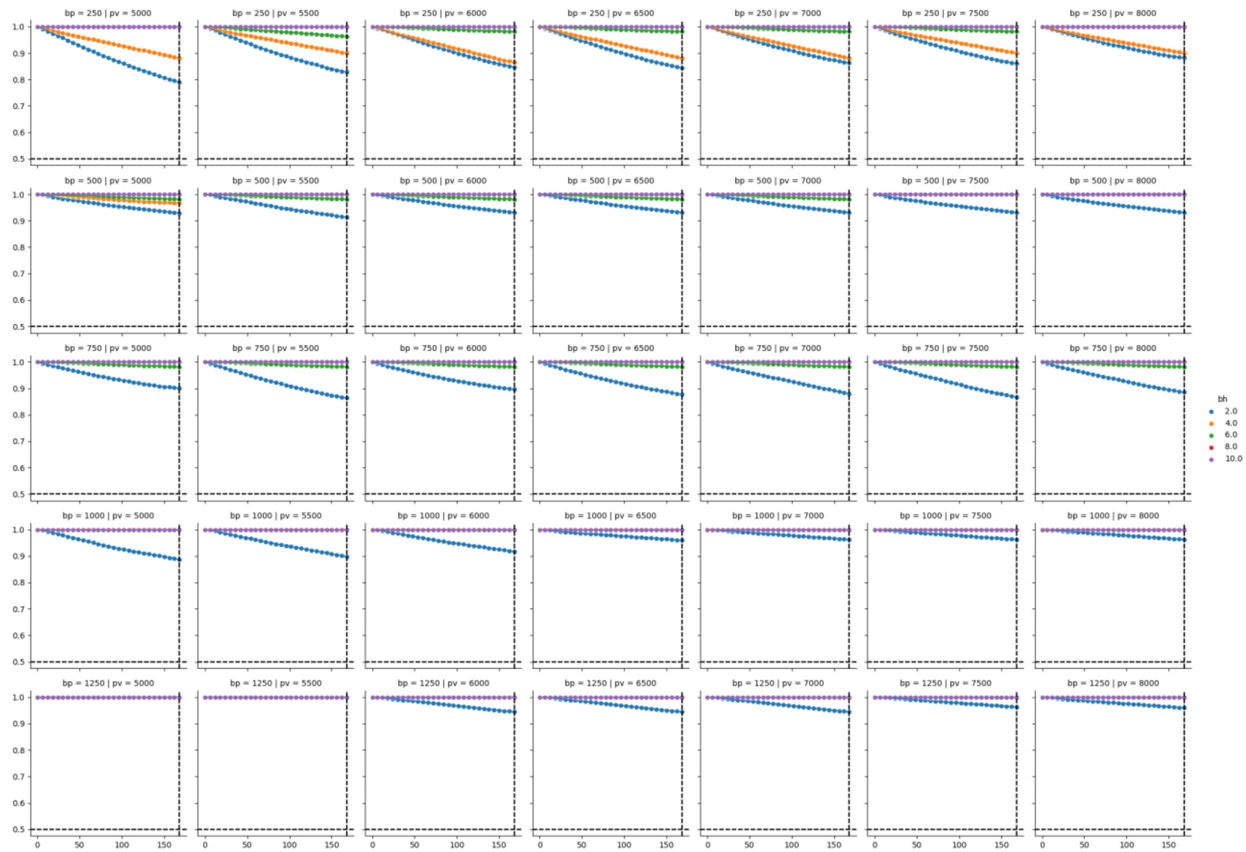

Figure 22- Resilience performance modeling for solar plus storage, with the addition of a 750 kW fossil fuel generators

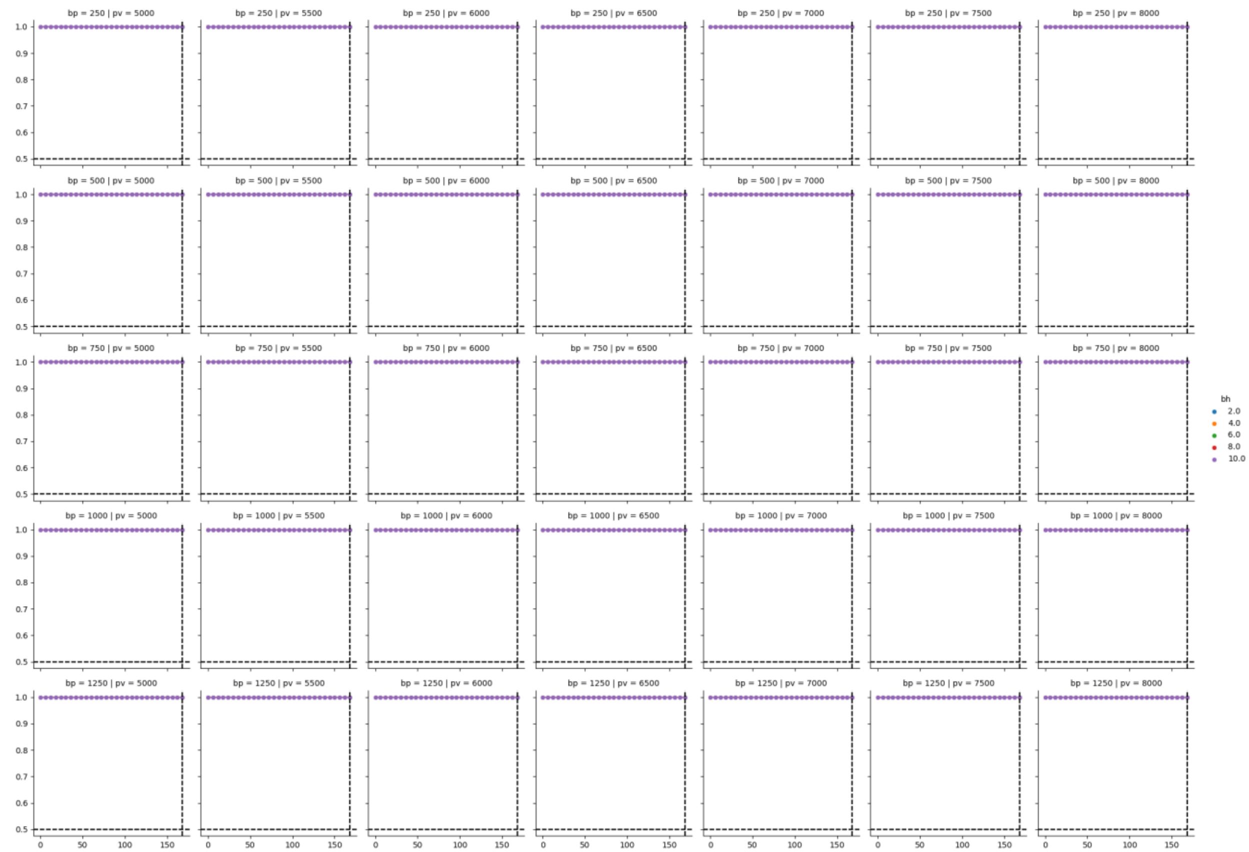

Figure 23 - Resilience performance modeling for solar plus storage, added 1.25 MW fossil fuel generators

Case	Solar PV	Battery Energy Storage	Back-Up Generator	CapX	Confidence @ 4hr	Confidence @ 24 hr
Case 2A: No additional solar	5.5MW	500kW/2MWh	750 kW	$3.5M	99.99%+	99.99%+
Case 2B: Solar+Storage Only	7MW	1MW / 6 MWh	--	$10.1M	99.863%	76%
Case 2C: "Best" Resilience Solution – 24HR	5.5MW	500kW/2MWh	750 kW	$3.5M	99.99%+	99.99%+
Case 2D: "Best" Resilience Solution – 168HR	5.5MW	500kW/2MWh	750 kW	$3.5M	99.99%+	99.99%+

In the cases where a fossil fuel generator was considered, a tank size of 2500 gal was used.

Design Cases

Case 2A – No additional solar: If we don't build additional solar beyond the 5MW community solar and 415kW of existing rooftop solar, a moderately sized 500 kW/ 2 MWh BESS paired with 750 kW of fuel-based generation for a total of 5MW would achieve near 100% confidence at 4 hours and at 1 week.

Case 2B - Solar + Storage Only: In order to provide near 100% resilience at 24 hours without a fuel-based generator, we recommend adding 1.5 MW of solar to bring the total to 7MW and pairing it with a moderately large 1MW / 6 MWh BESS. While this solution is large and expensive, it is not outside the realm of possibility and would make a good pilot for a solar + storage only microgrid, compared to other sites we have analyzed. We acknowledge that without a generator, the confidence of supporting a 1-week outage drops to 76%, which is lower than the generator cases, but not very low. It is likely that system will be able to support outages a week or longer in spring, summer, and early fall, but will fall short of a week in late fall and winter.

Case 2C/2D - "Best" 24 hour and 1-week solutions: The best "bang for your buck" to get near 100% confidence of supporting a 24 outage and high confidence at a week is to use the "No Additional Solar" solution of a 500 kW / 2 MWh BESS and 750 kW of fuel-based generation.

Questions for Analysis

1. How much solar is needed to meet resiliency goals and can the resiliency goals be met with the existing assets (solar + generators)?

   With the addition of a modest battery system, the existing solar (including the airport solar PV) and generators in the business park can support the example critical loads resilience goals.

2. What is the benefit of adding the 'future solar' and/or a battery system in this scenario? Benefits in either the financial or resilience case.

   Resilience: no benefit to additional solar. If additional solar is added for economics or sustainability, this might assist in the resilience case. Battery would be beneficial to be able to utilize existing solar and shrink size of generator needed.

   Financial: It's unclear what the benefits would be since it's not determined who would own / receive the benefits. If there was additional solar, there could be energy offset that could be spread between the buildings, community-solar-style. Batteries could be used for demand response behind of the meter, to generate revenue for those buildings served by the microgrid.

3. Would a new generator be needed to meet resiliency goals?

   If the existing behind the meter generators could be utilized by the microgrid system, then additional generator capacity would likely not be needed. This would depend on who participated in the campus style microgrid.

Scenario 3- Microgrid at Community Resilience Center (CRC) Level

This concept would convert a single building in the business park to a community resilience center by installing a building level microgrid. In this case we would consider using local community energy resources (renewable and emergency power) to assist in achieving the resilience goals and criteria of the CRC.

The building level CRC microgrid represents the easiest implementation, as it involves a singular entity installing the microgrid and receiving the financial benefits. CRC operation and benefits would need to be negotiated with local authorities planning to utilize this building in a prolonged outage scenario.

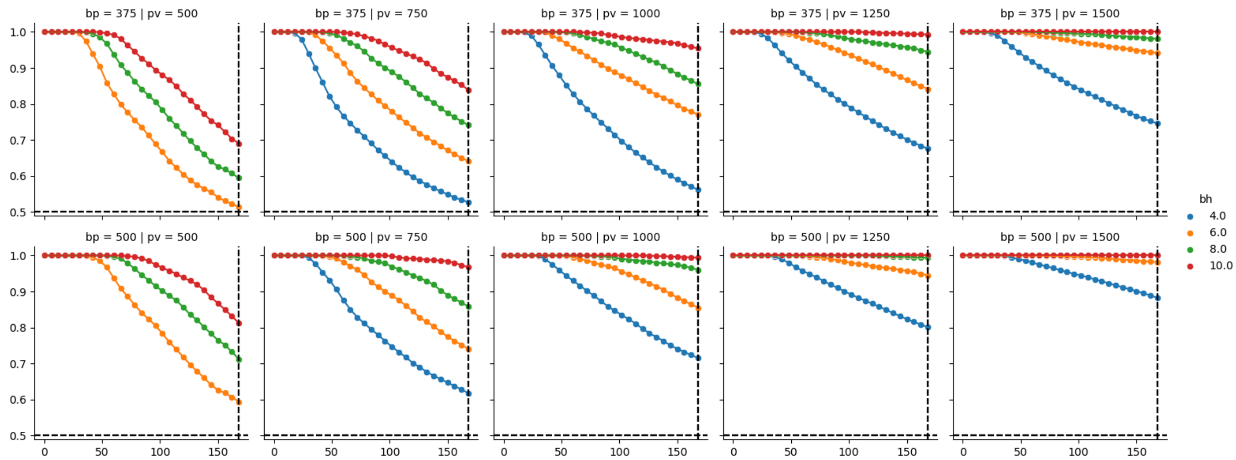

Figure 24- Resilience performance modeling for solar plus storage only

Shown above and below are parametric modeling runs showing the resiliency confidence on the Y-axis over time in hours on the X-axis. The chart's labeling "bp" refers to the battery pack size in kW and "pv" refers to the solar PV array size also in kW given a constant size of fossil fuel generator.

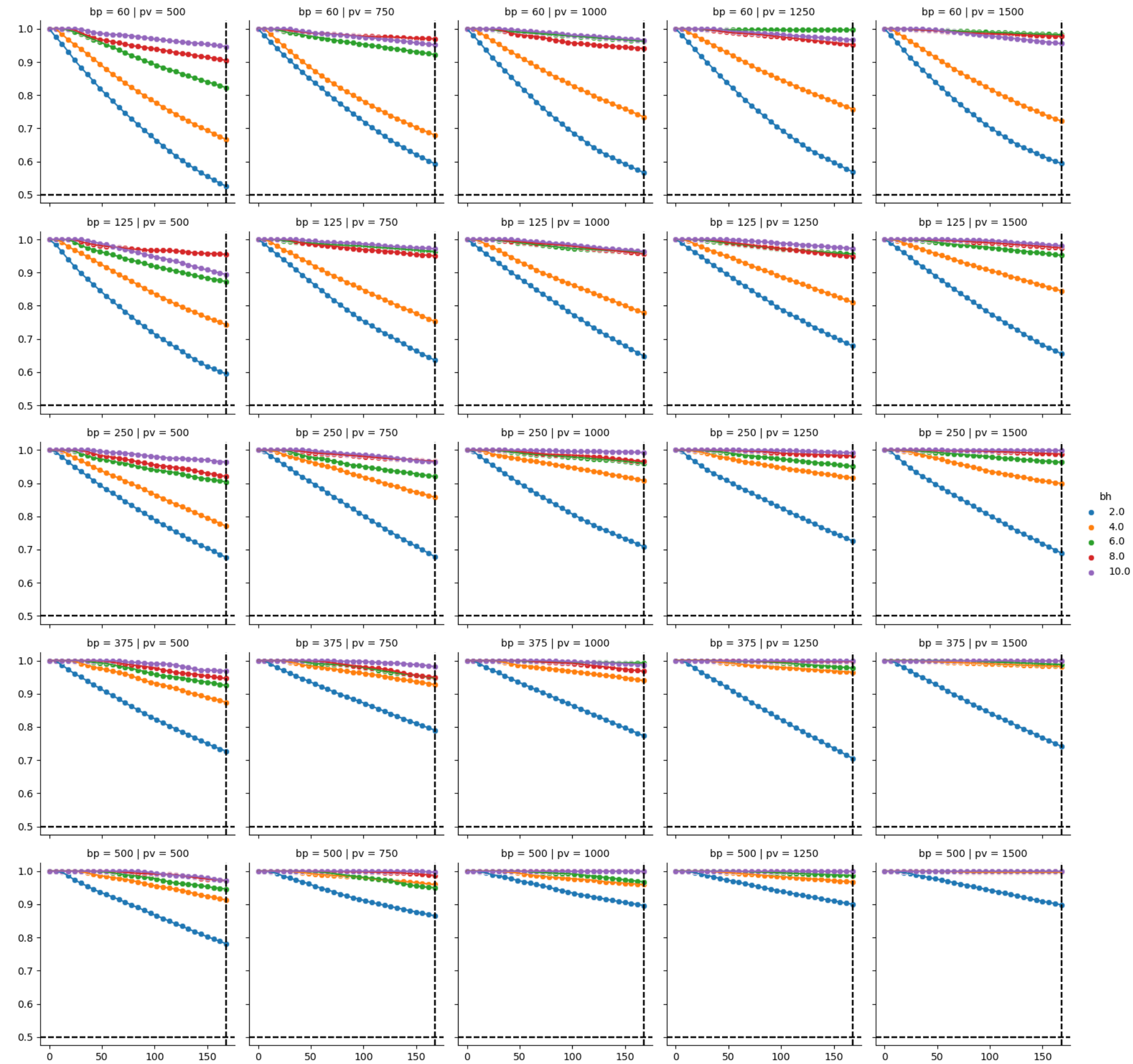

Figure 25 - Resilience performance modeling for solar plus storage, added 250 kW fossil fuel generator

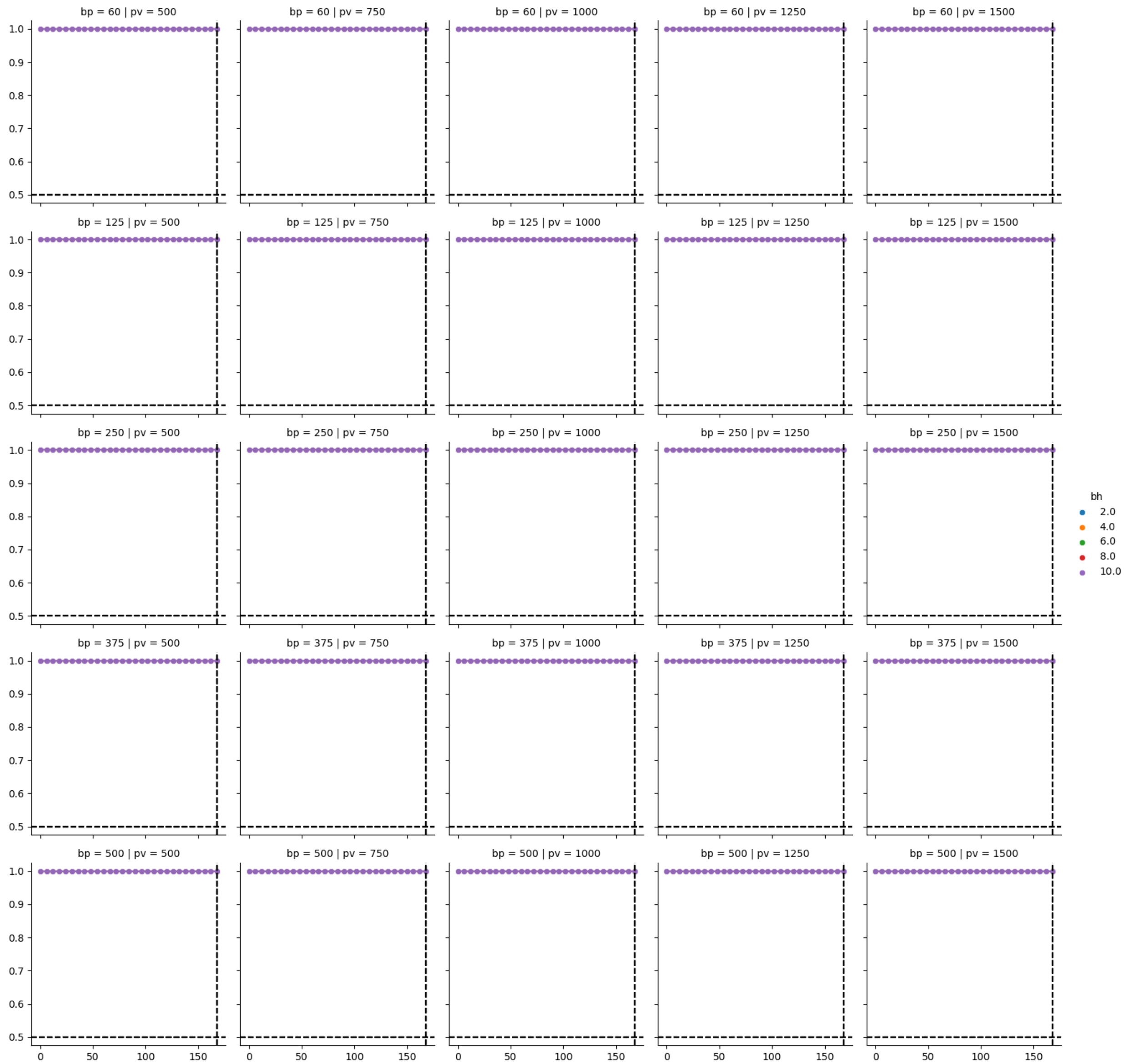

Figure 26 - Resilience performance modeling for solar plus storage, added 500 kW fossil fuel generator

Case	Solar PV	Battery Energy Storage	Back-Up Generator	CapX	Confidence @ 4hr	Confidence @ 24 hr
Case 3A: CRC Solar only 680.4 kW + BESS	680 kW	500 kW / 2 MWh	--	$3.39M	99.9658%	56%
Case 3B: Existing Solar only 415kW + BESS	415 kW	500 kW / 2 MWh	--	$3.7M	99.8630%	30%
Case 3C: Community solar + Existing + BESS	5000 kW	375 kW / 1.5 MWh	--	$2.7M	99.8973%	98%
Case 3D: Community solar + CRC Solar + BESS	6096 kW	375 kW / 1.5 MWh	--	$3.89M	99.8973%	98%
Case 3E: New Solar 680.4 kW plus gen	680 kW	120 kW / 480 kWh	250 kW	$2.12M	99.8288%	91%
Case 3F: Existing Solar 415kW plus gen	415 kW	60 kW / 120 kWh	500 kW	$2.32Mk	99.99%+	99.99%+
Case 3G: Community solar + Existing + gen	5415 kW	60 kW / 360 kWh	250 kW	$3.81M	99.99%+	99.99%+
Case 3H: Community solar + CRC Solar + gen	6096 kW	60 kW / 360 kWh	250 kW	$3.00M	99.99%+	99.99%+

Design Cases

Case 3A - CRC solar only + BESS: With the CRC solar only and without installing a generator, we should install a 500 kW / 2 MWh BESS to achieve near 100% confidence at 24 hours. Confidence of supporting a 1-week outage drops to 56%.

Case 3B - Existing rooftop solar only + BESS: With the existing solar only and without installing a generator, we should install a 500 kW / 2 MWh BESS to achieve near 100% confidence at 24 hours. This is the same BESS size as in the 680 kW case, as there's not too big of a difference in these sizes. Where we see the impact is at longer durations -- confidence of supporting a 1-week outage drops all the way to 30% with only 415 kW solar.

Case 3C - Community solar + Existing solar + BESS: Assuming we can use all 5415 kW of existing solar and do not want to install a generator, we can install a moderately sized 375 kW / 1.5 MWh Case 3D - BESS to get near 100% confidence at 24 hours and very high 98% confidence at 1 week. At CapX in the range of $1.5M, this may make a surprisingly affordable resilient solar-plus-storage solution at this load size and desired duration compared to a generator case, particularly if there were a revenue stream for the battery in grid-connected mode, such as demand response. At the very least, it could make a very intriguing resilient solar + storage only pilot project.

Case 3E - CRC solar only + BESS + gen: With the CRC solar only, we should install a 120 kW / 480 kWh BESS and pair it with a 250 kW generator to achieve near 100% confidence at 24 hours. Confidence of supporting a 1-week outage is still quite high at 91%.

Case 3F - Existing rooftop solar only + BESS + gen: With the existing solar only, we should install a 60 kW / 120 kWh BESS and pair it with a 500kW generator to achieve near 100% confidence at 24 hours. The smaller solar is not able to provide enough generation to allow the smaller generator. With the generator sized up, the battery can be smaller. Because of the larger generator, confidence of supporting a 1-week outage stays near 100%.

Case 3G - Community solar + Existing solar + BESS + gen: It is slightly less expensive to install a 60kW / 360 kWh BESS paired with a 250kW generator to achieve near 100% confidence at both 24 hrs and 1-week than the solar + storage only solution. But it also makes a more complex microgrid to add the generator. The BESS could use a 60kW inverter or a 120kW inverter. The price difference may be minimal.

Case 3H - Community solar + CRC solar + BESS + gen: The battery and generator would be the same as the previous case and all the same comments apply. There is not enough difference between 5415kW and 6096kW of solar to change how we would size the BESS and generator to support the same load.

Questions for Analysis

1. How much solar is needed to meet resiliency goals and can the reliance goals be met with the estimated future assets on the CRC?
2. What is the benefit of adding the 'future solar' and/or a battery system in this scenario? Benefits in either the financial or resilience case.

Resilience: no benefit to additional solar beyond the existing assets as suggested. If additional solar is added behind the meter on this particular building for economics or sustainability, we'd factor that in. Battery would be beneficial to be able to utilize existing solar and shrink size of generator needed or eliminate the generator all together.

Financial: The batteries in this scenario may have the best chance at being financially useful than the other scenarios. If we assume that the battery is installed behind the meter at the CRC, then the battery may be used to reduce demand charges (aka peak shave) and time shift solar (depending on the structure of the rate tariff the site would be on,) as well as participate in grid services programs such as demand response. We cannot estimate what this financial benefit might be without a description of the anticipated rate tariff.

HGA recommends Cases 3C or 3E as the best options for resiliency and balanced cost. Case 3C offers 99.90% confidence of resiliency for 24 hours and maintains a 98% confidence for 168 hours at one of the lowest option first costs of $2.7M. HGA explored this option further by modeling the CRC's estimated energy consumption with the specified battery using the System Advisor Model (SAM) program and found this option could save the facility approximately $30,500 per year - largely from demand savings. However, this results in still a very high simple payback of over 88 years. This high payback is because under normal operation, the 5 MW community solar array would not provide any energy curtailment and would only be connected and providing power to the CRC in instances where MG&E grid connected service would be lost. This option would also require a possibly complicated interconnect between the existing 5 MW community solar PV and the CRC. Running a new electrical connection half a mile or more from the community solar is not only an expensive endeavor, but could be further complicated by running this across or around airport land.

For these reasons, Case 3E was also explored further by HGA. This case offers a lower capital cost of $2.12M which includes a 680 kW behind-the-meter solar PV array, a 120 kW / 480 kWh battery, and a 250 kW fossil fuel generator. The primary benefits to this system are the lowest capital cost amongst all cases and a sizeable behind-the-meter solar PV array which would provide year-round energy and cost savings benefits to the CRC. The tradeoff to this case is lower 24-hour and 168-hour resiliency confidence of 99.83% and 91% respectively. System Advisor Model was also used to model this case. The behind-the-meter solar PV array coupled with the battery was determined to save an estimated $74,600 per year and a payback of 18 years when factoring in the PV array's ability to provide energy to the facility at all times and even sell energy back to the grid when solar production exceeds consumption.

Appendices

These are included in a separate file attachment, lists here for reference.

1 - Stakeholder Letter for Microgrid.pdf

2 - MG&E Customer Data Authorization Release Form.pdf

3 - Middleton Microgrid Study Application.PDF

4 - 15 Minute Data - Scenario 1 - Feeder Load.xlsx

5 - 15 Minute Data - Scenario 2 - Campus Loads.xlsx

6 - 15 Minute Data - Scenario 3 - CRC Load.xlsx

DEPARTMENT OF PLANNING AND COMMUNITY DEVELOPMENT

CITY OF MIDDLETON
7426 HUBBARD AVENUE
MIDDLETON, WI 53562-3118

PH 608.821-8362
E-MAIL: khilyard@cityofmiddleton.us
WEB: www.CityofMiddleton.us

FAX 608.827.1080

City of Middleton, Wisconsin
Business Park Participation in the
Microgrid Feasibility Grant Program (EIGP 2021)

April 15, 2022

Dear _____,

The City of Middleton and local partner HGA Engineering invite you to an informational meeting about a microgrid feasibility study that will serve the Middleton business park. This grant funded study is supported by the State Office of Energy Innovation and will investigate using primarily renewable energy sources, including solar PV and battery storage, to create an emergency microgrid to power critical economic, industrial, and public safety infrastructure in the event of a catastrophic power outage, similar to the emergency experienced during the flood of 2018, or in the event of a cyber threat which can disrupt the grid.

A microgrid can be used to cut energy costs, provide utilities and energy users reliability and islanded sources of power in the event of grid outages, and can help manage loads efficiently as more renewable energy comes online. The City supports developing a community microgrid in its Comprehensive Plan and as an important piece of the city's 100% Renewable Energy Goal for 2050.

Your involvement is this study is voluntary. The City believes that the information we gain from this study may be helpful to individual business owners to understand options for future energy savings, grid reliability, and solar generation potential. We are working closely with our utility MGE on this project as well as MuGrid, a leader in the development of microgrids around the county.

This study's intent is to address the energy and safety needs of the citizens/businesses in the City of Middleton. The City values your involvement in this project, and wants to understand your needs and concerns. We aim to stay at the forefront of the latest technologies that keep Middleton innovative. The following items will be covered in the meeting:

Meeting Logistics: zoom, in-person info, time, date, contact information
Kelly Hilyard, Sustainability Coordinator, khilyard@cityofmiddleton.us

CUSTOMER AUTHORIZATION FOR RELEASE OF INFORMATION

Complete this form to allow Madison Gas and Electric Company (MGE) to release energy use data to the third party named below. This request will be valid for two years from the effective date unless stated below. Return the signed form by mail to **Madison Gas and Electric Company, PO Box 1231, Madison, WI 53701-1231.** If you prefer, you may email a scanned copy of the signed form to **mge@mge.com** or fax to **(608)-252-7098**.

If you have any questions, contact MGE at (608) 252-7000.

Requested Effective Date	Expiration Date of this Authorization (if longer than 2 years)		
Name on MGE Account			
Service Address	City	State	ZIP
Phone Number			

Address (if different from above)	MGE Account Number

Third Party to Receive Information

Company Name			
Mailing Address	City	State	ZIP
Contact Name	Phone Number		
Comments			

Approval

Madison Gas and Electric Company has my permission to share account energy data information with the third party named above. I understand that this release is voluntary. I understand that I may revoke this authorization in writing at any time, except for that information that has already been released prior to my revocation. If this authorization is on behalf of a commercial customer, I hereby represent that I am authorized to execute this document on behalf of the customer.

Customer Signature ______________________ Date ______________________

Printed Name ______________________ Title (if applicable) ______________________

PSC REF#:418254

Public Service Commission of Wisconsin
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PSC of WISCONSIN

Public Service Commission of Wisconsin Office of Energy Innovation
Critical Infrastructure Microgrid and Community Resilience Center Pilot Grant Program

OEI Wisconsin Office of Energy Innovation

ATTACHMENT A - COVER SHEET

SECTION I - Provide information summarizing the project proposal.		
Project Title:	City of Middleton Business Park Microgrid & CRC	
PSC Grant Request ($):	**Applicant Cost Share ($):**	**Project Total ($):**
$100,000	$9,232	$109,232
Choose one Eligible Activity		
☐ Critical Infrastructure Microgrid Feasibility Study Level 1 and 2	☐ Critical Infrastructure Microgrid Feasibility Study Level 3	✓ Community Resilience Center Feasibility Study

SECTION II - Provide information for your organization, signatory, and primary contact for the project.			
Applicant Type:	✓ City	☐ Village	☐ Town / ☐ County
☐ Tribal Nation		☐ Wisconsin Technical College System	
☐ University of Wisconsin System	☐ K-12 School District	☐ 501(c)(3) nonprofit	
☐ Municipal Utility (water, wastewater, electric, naturalgas)		☐ Hospital (public or nonprofit)	

Name (on W-9):	City of Middleton, WI
Address (on W-9):	7426 Hubbard Avenue, Middleton, WI 53562
County or Counties Served by Project:	Dane County
DUNS Number or CAGE Code:	054266010
NAICS Code:	921190

Authorized Representative/Signatory (Person authorized to submit applications and sign contracts)	**Primary Contact** (if different from Authorized Representative)
Name: Gurdip Brar	**Name:** Kelly Hilyard
Title: Mayor	**Title:** Sustainability Coordinator
Phone: (608) 821-8350	**Phone:** (608) 821-8362
E-mail: mayor@cityofmiddleton.us	**E-mail:** khilyard@cityofmiddleton.us
Signature of the Authorized Representative	Gurdip S Brar

City of Middleton
Business Park Microgrid & CRC

Summary of Project Budget				
Line	**Description**	**PSC Grant Request**	**Applicant Cost Share**	**Total Project Cost**
1	Personnel		$9,232	$9,232
2	Fringe			$0
5	Travel			$0
6	Contractual	$100,000		$100,000
7	Other			$0
8	Indirect			$0
	Totals	$100,000	$9,232	$109,232
	% of Total	**92%**	**8%**	

Applicant Comments: N/A

3.3 Application Narrative

Project Description

City Background

The City of Middleton proposes to use the Wisconsin Public Service Commission Office of Energy Innovation Critical Infrastructure Microgrid and Community Resilience Center Pilot Grant Program to fund a feasibility study for the development of the Business Park (BP) Microgrid and emergency Community Resilience Center in the City's critical industrial area. The BP Microgrid will follow the model of a town center or community microgrid, which is developed in an area of a community that delivers power to a physically non-contiguous group of critical facilities, often involving multiple distributed energy resources and crossing multiple public right of ways (RoW).[1]

The project concept to be investigated by this feasibility study will use primarily renewable energy sources, including solar PV and battery storage, to create an emergency microgrid to power critical economic, industrial, and public safety infrastructure in the event of a catastrophic power outage, similar to the emergency Middleton experienced during the flooding of 2018. This application will fall under Activity 3 according to the grant guidelines as a Level 3 Microgrid and Community Resilience Center (CRC) and therefore is requesting $100,000 in grant funding.

The purpose of the BP Microgrid is to provide backup power to a selected area of the City of Middleton during extended outages to Madison Gas & Electric (MGE) feeder Pheasant Branch 1321. This outage could be the result of distribution system events, transmission system events or wide area blackouts. This emergency backup power will allow the industrial area and buildings within it to continue to function as critical infrastructure, including businesses necessary for logistics, public health, and storage, as well as serving as a CRC for emergency shelter and other resources.

The proposed feasibility study will include analysis of historical energy use and cost in the study area, project identification, sizing and scaling, physical site/facilities due diligence and communication with the diverse ownership of potential solar hosts, a comprehensive baseline, a climate change and natural hazard vulnerability study, projected financial and environmental benefits for the project, a phasing strategy for growing the project in the future, and financial analysis to determine funding sources for implementation.

The project's overarching goals are to:

- **Increase resiliency community-wide** by keeping power on for necessary emergency services.
- **Save money** through peak shaving and demand reduction.
- Create opportunity to **run specific parts of the industrial area from the BP microgrid.**
- **Establish a Crisis Plan to utilize power generation and storage** within the microgrid to maintain essential services for the greater part of western Dane County, including emergency utilization of the Middleton Airport, health services, pharmacy services, mental health services, warehousing, communications centers, distribution centers, and several large recreation centers than can be converted into Community Resilience Centers, starting with the KEVA Sports Center.
- Provide **grid services** such as kW savings, frequency modulation, and potential network stabilization.
- **Train city staff** on project management, bid preparation, and operations to make replicable.

[1] https://dev.microgrids.io/wp-content/uploads/Local_Govt_Resilient_Microgrids_Report.pdf

- **Create communications deliverables to share knowledge and data performance** with our networks such as Green Tier Legacy Communities, LEED for Cities national certification cohort, Urban Sustainability Directors Network, local municipal collaborative workgroups and the City's website.

This project represents a continuation of the City of Middleton's commitment to sustainability and reaching its renewable energy goals. Middleton received an Energy Innovation Grant in 2018 for Comprehensive Energy Planning. The City partnered with six other Dane County municipalities to form a Seven City Comprehensive Energy Planning collaborative. Community specific energy plans were prepared by Slipstream, our consultant for that grant, as well as an overall Energy Plan Report. The Middleton Police Department has an existing 100 kW solar PV installation on its rooftop that produces 25% of the building's energy. And the City was recently awarded the PSC Energy Innovation Grant for a solar and battery storage system at the Police Department. The city also installed, with partner MGE, the first community-solar installation in the area, a 5 MW array on 21 acres just north of the airport. The City is committed to obtaining a 100% renewable energy goal for the city.

The preliminary concept for the BP Microgrid would be to include the 5 MW array into the microgrid, if possible, along with an additional 35 acres of rooftop space available for distributed solar arrays throughout the microgrid. This will allow for greater redundancy, shifting of power generation to critical needs during a crisis, development of a community-based resilience concept, as well as allowing each individual business to participate in energy savings throughout the program.

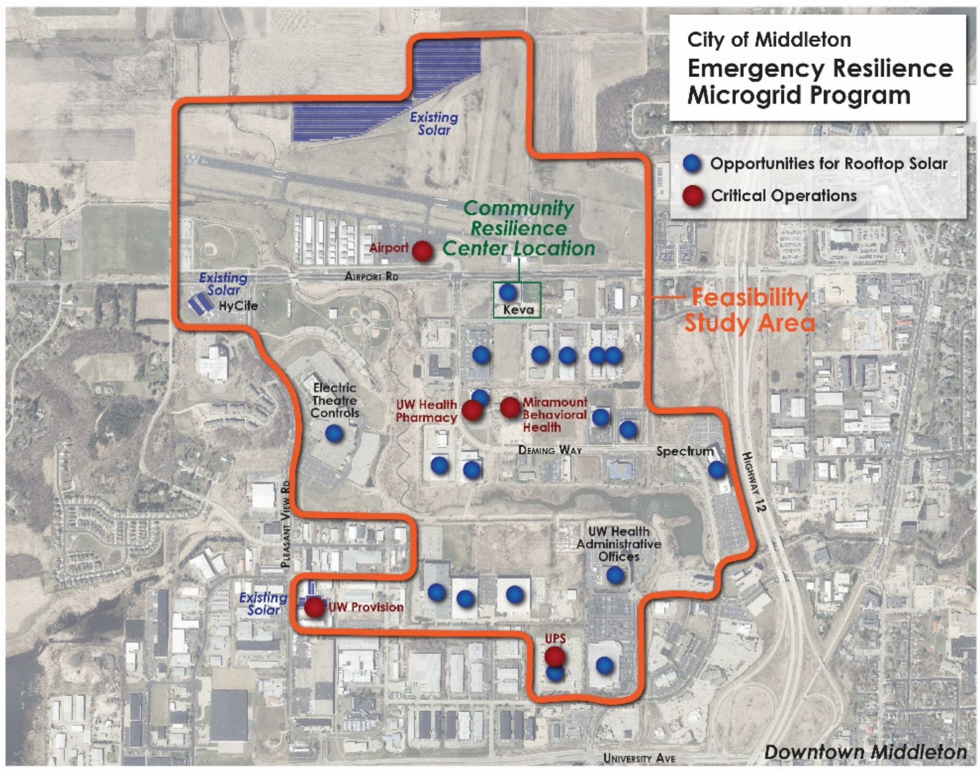

Figure 1: Proposed Business Park Microgrid & CRC Study Area, Middleton, WI

<u>Project Study Area</u>

In August 2018, almost a foot of rain fell on Middleton in 24 hours, causing massive flooding – including of the proposed project area industrial district. This flooding lead to a Federal Disaster Declaration and many businesses were without power for more than 24 hours and experienced extensive flooding and cessation of business. This event revealed that the city's emergency infrastructure was based on pre-climate change calculations, and that an entirely new level of preparedness would be required going forward. Since that time, the City of Middleton has taken many significant steps to become a more resilient community, particularly around its energy systems and emergency preparedness.

Middleton has a well-defined light industrial district with a number of large warehouses and offices. These businesses, whose large rooftops would host the proposed BP Microgrid, include the Middleton Municipal Airport, Costco, UW Provisions (meat distribution), Frank Beverage (distributor), KEVA Sports Center, Hitters SportsPlex, UW Hospitals Pharmacy, UPS, and the new Miramont Behavioral Health facility. These businesses and organizations comprise a significant percentage of the essential service infrastructure for western Dane County, as well as providing extensive space for emergency lodging. The BP Microgrid project will also help address some of the business community's concerns caused when the City's green infrastructure was unable to mitigate the 500+ year flood of 2018 which lead to substantial flood damage, power outage, and loss of productivity. This project will create a new approach to resilience that serves the needs of both the business park and the community.

Project Description

The project proposed for this feasibility study includes a community microgrid that will be planned to potentially serve the more than 60 businesses in the Middleton light-industrial area located on the city's northwest side. Specific sizing, business involvement, and scaling will be determined as part of the study. The emergency BP Microgrid will help establish the area and a number of businesses within the industrial district, in particular the KEVA Sports Center, as a CRC for emergency shelter and resources in the event of power outages or other disasters.

The feasibility study will also include an evaluation of existing and new solar energy capacity (approximately 35 acres of existing rooftops have been identified as potential solar installations) to feed into the microgrid as well as an evaluation of potential energy storage methods – including using electric car batteries as overnight storage (particularly at locations like UPS, Frank Beverage, UW Provisions). The study will include a phasing plan to determine how the project could potentially grow and expand in the future to incorporate additional businesses as well as explore integrating new green infrastructure to mitigate future flood events. While the project proposes to use technology that is readily available and well known to the community (as described in Section 3.4.1.), its size and scope will require extensive planning.

By building a TC-style microgrid powered primarily through renewable resources (possibly including the existing airport 5MW solar array and new solar installations on the extensive rooftops and open spaces of our industrial customers), Middleton will be able to prepare for ongoing energy needs during a general power shutdown, emergency housing for residents, and securing the food distribution infrastructure for the area. The airport will be used to provide any necessary relief supplies, including ensuring the continuity of organ transplant transportation to Madison hospitals.

The KEVA Sports Center is youth sports and indoor recreational facility that has been located in Dane County for more than 20 years. The large facility is over 130,000 square feet and was identified as a strong possibility for a CRC which could provide emergency services to the City of Middleton and its residents. Many of the building's features make it a contender for a CRC. Its expansive interior space has the potential to shelter significant numbers of people or serve as a critical personnel area in an emergency. The building has significant infrastructure for heating and cooling in times of dramatic weather; it is highly accessible, located just off of the Beltline; its core business function includes food and beverage service and therefore could accommodate emergency food and cold storage needs. The building's large footprint also includes a large rooftop to serve as a host site for rooftop solar. The KEVA Sports Center's large parking area also presents opportunities for emergency staging, tents, drive through resource delivery and other critical outdoor services. The KEVA Sports Center is a committed Middleton corporate resident and has provided a letter of support for the City's application.

This area also contains a large drainage confluence that forms a large wetland/settlement pond that eventually flows into Pheasant Branch conservancy and Lake Mendota. This public land provides opportunities in future project phases to create a combination of flood mitigation efforts, nutrient reduction practices, and recreational opportunities while building out the microgrid and energy storage platform.

In addition to energy management, associated cost savings, and resiliency, the City embraces its demonstrated role as an early adopter of new and innovative sustainable technology, utility partnerships, energy planning, and city-wide climate change mitigation policies. This project would give us an opportunity to learn best practices from start to finish about cutting edge community microgrid design and development in order to replicate future projects that serve the public, and also to share out what we have learned with other Wisconsin communities our size. Education will be a key aspect of this proposal both internally between departments within the city, and externally with local, state, and national cohorts with which we are currently engaged.

<u>Populations and Lifelines Served</u>

Completion of the feasibility study will further identify populations and lifelines served by the TC microgrid and will allow for further engagement with project stakeholders. However, at this time, the project concept will serve the following populations and lifelines:

- **Middleton Residents** The businesses and facilities involved in the BP Microgrid project represent critical infrastructure to the City and its residents and their continued function in the event of a power outage or emergency will allow the critical economic, logistical, public health lifelines included in the project to continue functioning and serving residents. The benefits of the BP Microgrid will be experienced community-wide by all residents. Residents of particular locations within the City might also benefit from emergency shelter and resiliency resources within the CRC if an adverse event impacts their homes.

- **Industrial Businesses** Businesses within the study area provide critical lifeline services to the City of Middleton and greater Dane County region. These businesses are in numerous fields and industries, from retail to manufacturing, pharmaceuticals to food supply chain, and medical services to entertainment. Not only does the continuation of their business in times of emergency and during power outages enable life in the area to continue to function, but their facilities, following examination in the feasibility study, could be used as emergency resource locations for the City of Middleton's essential services and by residents.

Reference Materials List

1. Study Area Map
2. Business Park Solar Sites List
3. City of Middleton Resolution
4. Letters of Support
   4.1. MG&E
   4.2. KEVA Sports Center

4.3. Additional Business Park Businesses
5. Sustainable City Plan (Linked in Document)
6. 2021 Comprehensive Plan Update (Linked in Document)

3.4 Merit Review Criteria

3.4.1 Identification of Critical Infrastructure

This section is N/A as we are applying under Activity 3.

3.4.2 Key Partners and Stakeholders

The City of Middleton has a history of working with partners to explore different ownership models, including with MGE on the Police Department solar project. Given the size, scope and diversity of sites for the intended rooftop solar installations, MGE intends to own the future microgrid components that are "in-front" of the customer meters and is committed to working as a partner with the City on the design, installation, and operation of the BP Microgrid. The City has worked closely with MGE in the initial scoping of the concept project and has received a letter of support and commitment from MGE.

The City of Middleton will serve as the administrator and organizer of the project. Kelly Hilyard is the Sustainability Coordinator and she will work with the Planning, Police, Fire, Public Works, and Building Inspection Departments as a project manager to coordinate work with HGA Architects and Engineers and MGE for completion of the feasibility study.

HGA Architects and Engineers will serve as engineering partners in completion of the feasibility study. HGA has a strong history of designing and implementing complex solar and storage projects and has worked with the City on numerous occasions to develop its existing solar footprint. HGA will be a partner with the City of Middleton on this feasibility study and determine the size and conceptual design of the system, size the battery, determine needs for creation of the CRC at participating businesses, and identifying phasing opportunities for future installations. HGA will bring on additional resources as needed to support the technical nature of this project such as a consultant specializing in distribution engineering with an existing relationship with MGE as well as a microgrid techno-economic modeler.

As detailed in the project description, this project has the capacity to touch many different populations and stakeholder groups. Additional project stakeholders for this application include:

Industrial Area Businesses Over 60 businesses in the study area could potentially host rooftop solar (~ 35 acres) to implement the BP Microgrid and serve as an emergency resilience center location for the City in the event of a disaster. Businesses including the KEVA Sports Center have the ability to power emergency equipment, cellphones, computers, and communication equipment, temporarily house residents, and provide refrigeration for emergency food and supplies. UW Provisions could also utilize existing refrigeration and freezers for necessary emergency supplies. Connecting them to the BP Microgrid will allow them to maintain power in the event of an outage. Other businesses in the microgrid will be able to maintain power and continue their essential businesses services in the event of an emergency like UPS and the UW Hospital Pharmacies. Letters of support from a number of these businesses are included in this application.

Middleton Municipal Airport As part of the BP Microgrid, the airport will be able to maintain its role as critical infrastructure, continuing to operate in the event of a power outage or natural disaster. The airport serves a particularly crucial role not only for Middleton but for Dane County as a Medflight location, enabling essential medical services to continue in emergency situations.

Middleton Fire Department and Emergency Services The project team will engage with Middleton's first response emergency services, including the Fire Department, to establish the CRC and ensure it can serve an important public safety role in the event of an emergency.

3.4.3. Project Resilience Objectives and Metrics

Middleton is committed to sustainability and energy innovation and has taken numerous steps in project implementation, staffing, and planning to advance its sustainability goals. Middleton formed a Sustainability Committee to establish a sustainability lens for all municipal decisions in 2010. That same year the City joined the Wisconsin Green Tier Legacy Communities Charter and adopted its first Sustainable City Plan. The Sustainable City Plan lists a variety of indicators, targets, actions, and performance measures pertaining to energy. The original plan called for 25% of the City's electric power and transportation fuels to be generated from renewable resources by 2025 (a goal established through the Energy Independent Communities program). The City has already met this goal. In 2016, the City worked with MGE to install a 500 kW "shared solar" array at the Middleton Operations Center and a 100 kW solar array at the Middleton Police Station. The police station solar powers 25% of the building's energy needs. In 2018, Middleton passed a resolution setting a 100% renewable energy goal community-wide by 2050 and won a grant from the Office of Energy Innovation for comprehensive energy planning. At the same time, Middleton partnered with MGE to purchase ½ megawatt (MW) of 5 MW available in a second "shared solar" array at Middleton Municipal Airport. The City is now implementing the energy plan produced from our 2018 OEI energy planning grant, and we hope to implement resiliency along with energy savings.

The City of Middleton's 2021 Comprehensive Plan Update includes a number of sustainability and energy savings goals and initiatives that align with the BP Microgrid project. A key strategy of the Plan is to "Adapt to climate change effects, community emergencies, economic downturns, and unforeseen events that challenge our City through robust resiliency planning that will reduce risks, mitigate ecological degradation, and provide equitable disaster response for all citizens, businesses, and industry." (p. 94) The feasibility funded by this grant will be a direct step in advancing this strategy and will provide the City with essential planning to be more resilient in its response to and anticipation of the effects of climate change. The vision for this project specifically addresses one of the central actions in the Plan's Green City Chapter, which is "Middleton will partner with MG&E to pilot and plan for future microgrid networks that can connect to one another to reduce risk, increase resiliency, and optimize energy distribution." (p. 98)

The BP Microgrid will expand this commitment to energy innovation and savings and will add to the goals the City hopes to meet in the future.

Specific resilience and objectives for the TC microgrid include:

1. Prevent sustained power outages within the study area and provide emergency power for the duration of an outage.
    a. Metric: Track utility data and power usage to measure outages and events that trigger the emergency microgrid
2. Establish CRC facilities within the study area to adequately serve the City's needs in an emergency
    a. Metric: Establish at least one location for CRC and identify and communicate the emergency resiliency facilities within the study area to residents, businesses, and emergency personnel
    b. Metric: Establish a communication protocol for deploying the CRC in an emergency

    c. Metric: Track all usage of the CRC as well as populations (total numbers, duration of services, etc.) served during emergency events
3. As the City's fleet of electric vehicles (EV) expands, establish the CRC as an EV charging location, particularly in emergencies.
    a. Metric: As part of the feasibility study, determine an appropriate number of EV charging stations and construct them within the study area

3.4.4 Evaluation of Site-Specific Information

Middleton's industrial district and this project's study area is located on the northwest side of the city north of University Avenue and west of US12 (the Beltline). The area extends north to include the Middleton Municipal Airport and the western edge of the business park. The area includes over 60 businesses including Costco, KEVA Sports Center, UPS, UW Hospital Pharmacy Services, and PPD, Inc. A full list of businesses is included in the reference materials. The area encompasses 650 acres and 35 acres of rooftops. Due to the large potential scale of this project, the feasibility study seeks to determine the appropriate size and scale of the project, determining the optimal size to meet the demand needs as a CRC and the economic feasibility to accomplish implementation. The study will also include consideration of project phasing, potentially starting the project with 4 hours of battery storage with associated solar and expanding into other areas of the business park, adding more businesses into the BP Microgrid.

Site Opportunities and Challenges

The study area was chosen for a number of the advantages it presents and its ability to serve as an emergency energy backup to critical businesses, efficiently creating a microgrid capitalizing on the availability of rooftops and creating of a CRC to serve the City and residents in an emergency. Colocation of the generation sites, particularly the rooftop solar arrays on industrial businesses, provides an opportunity to build efficiency across generation sites. These businesses represent critical economic, logistic, and public health infrastructure. This site allows the BP Microgrid to serve businesses close to transportation infrastructure like the airport and US12, which are key logistical resources. The area's large business facilities also provide expansive rooftop space for solar generation and parking areas for the potential installment of EV charging locations. Increasing EV charging stations in an employment center like the industrial district will not only encourage employees to have EVs but will allow them to charge their vehicles during the workday.

The City owns a significant portion of the land through and around this study area, including additional land around the airport, along the drainage ditch, two large public parks, and the drainage wetlands running through the industrial park. These areas will be explored as potential joint-use siting for both solar arrays and water quality/water quantity developments.

While the site is well suited to the BP Microgrid project, there are some constraints. The diverse private ownership of the potential host sites could pose challenges to getting use agreements. However, the project partners have strong relationships with the industrial district's businesses, many of whom have provided letters of support, and the project team intends to engage these stakeholders to participate in the project. These businesses were also impacted heavily by the 2018 flooding and are working on individual resilience planning and overall hardening of the infrastructure of the area.

Existing Generation Assets

The City of Middleton owns a number of existing solar and self-generating assets in the community. These include:

- Solar and Battery Storage at Middleton Police Department
- Solar Array at Lakeview Park (shelter rooftop)
- Solar Array at Middleton EMS Station
- Solar Array at Middleton Recycling Center

Self-generation assets owned by other customers and MGE located within the study area include:

- MGE: 5MW Solar Array located at the Middleton Municipal Airport/Morey Field
- Hy Cite: 92kW Solar Array
- Spectrum Brands: 1.8MW Diesel Generator
- PPD: 900kW Diesel Generator

As the specific BP Microgrid is designed and scoped during the feasibility process, permitting requirements will be determined. At this time, the project team does not expect that permitting requirements will have a negative impact on the feasibility study or on project implementation.

3.4.5. Technologies Under Consideration

As previously mentioned, the City of Middleton is home to numerous solar projects and is a leader in the region and in the state in adoption of energy savings and sustainability initiatives.

The feasibility study will ultimately determine the appropriate technologies for the BP microgrid. At this time, the following technologies are under consideration. Each technology is readily available and already being used within the City.

- Rooftop Solar PV
- Ground Mount Solar PV
- Utility Solar
    - Potentially the 5MW array at Middleton Municipal Airport. Additional study will determine if it can be included.
- Battery Storage
- Project Controls
- Diesel Backup Generator(s) – to keep critical loads operational in long-term emergencies that extend beyond the renewable system's capacity.

While this proposal may seem to be a "far fetched" idea, there are examples of TC microgrids being implemented in the United States. Redwood Coast Airport Microgrid[2] in Humboldt County, CA is one example of a project that is currently underway.

[2] http://schatzcenter.org/acv/

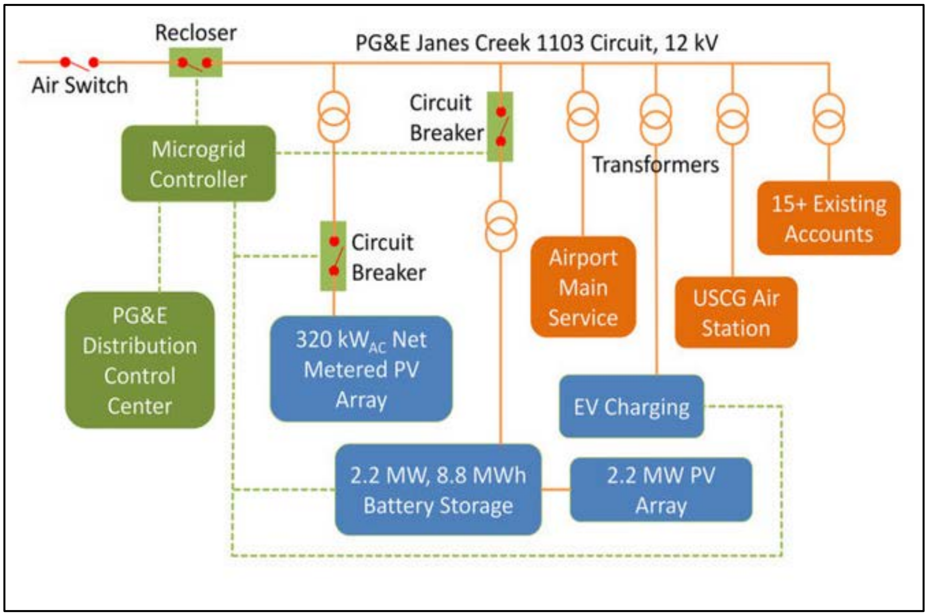

Figure 2: Redwood Coast Airport Microgrid (Source: http://schatzcenter.org/acv/)

3.4.6. Cost Match

The City of Middleton and its partners are committed to the completion of this feasibility study and the ultimate implementation of the BP Microgrid. This project is considered an implementation of its Sustainability Plan and Comprehensive Plan and is a continued effort to reach its energy independence goals and expand its resiliency. This grant is essential to the completion of the feasibility study as it is unlikely to be accomplished without grant funds.

This project is not likely to move forward without funding for the following reasons:

- The City budget is constrained by property tax levy limits and generally flat state aids.
- It is difficult to fund new capital project studies that need to compete with limited resources to maintain existing infrastructure and assets.
- The COVID-19 pandemic has put additional strain on City finances. This includes both reductions in revenue in areas such as interest income, program fees, and room taxes. At the same time the City has higher operating costs to safely maintain essential services.

To further demonstrate its commitment to the BP Microgrid project and completion of the feasibility study, all City personnel hours in this proposal are designated Match funds for this grant. These Match funds will cover training time and project management.

Name	Position	Fringe	Direct Comp.	Hours	Total	Match Contribution
Kelly Hilyard	Sustainability Coordinator	$2.20	$32.55	120	$4,170	$4,170
Abby Attoun	Director of Planning	$11.82	$47.12	40	$2,358	$2,358
Shawn Ulsrud	Engineering Technician III	$11.00	$34.94	20	$919	$919
Shawn Stausky	City Engineer	$12.63	$59.14	20	$1,435	$1,435
Bill Burns	Finance Director	$12.06	$58.01	5	$350	$350
				Total	$9,232	$9,232

3.4.7. Data Collection Plan

Due to the large number of facilities located in the site area, a thoughtful data collection plan is critical to the development of the microgrid equipment selection and sizing. The project team will work with facility owners to have MGE release historical 15-minute interval electricity data for the facilities' 2020 electrical use. BP Microgrid aggregate 15-min consumption data will also be used.

15-minute metering data from the MGE feeder Pheasant Branch 1321 will also be used to inform the project system sizing and design. Preliminary project analysis indicates that there is approximately 6MW of maximum on-peak load for the project area.

In situations where utility data is not released by the customer, the consultants will simulate 15-min interval data for those facilities based on similar building types and usage. Gas data will not be evaluated as part of the microgrid study. A site survey of all the buildings will be completed to identify existing on-site generation and main switchgear configuration. Generator information will be gathered to determine if the existing generators may be capable of operating in parallel with other generators on the system.

HGA will work with MGE to map the existing electrical infrastructure in the site area and identify additional equipment that will be required for the safe and reliable operation of the microgrid, including telemetry and other control and monitoring equipment.

Based on the flexible data collection plan described above, the study will be able to be completed within the grant period (June 30, 2022).

3.4.8. System Sizing Analysis

As part of the feasibility study, the consultant will utilize a combination of spreadsheet tools and energy modeling software such as Homer Energy, NREL reOPT or other custom software, to develop operational and economic modeling for the project.

Based on the forecasted building loads, the consultant will determine the appropriate system sizing for the microgrid components to meet the resiliency requirements identified in section 3.4.3. The BP Microgrid will consist of a combination of behind the meter resources and in-front of the meter resources. Existing customer sited generation will be evaluated to determine how it may interface with the microgrid. The existing 5MW MGE owned solar installation will also be evaluated to determine how it can be integrated into the BP Microgrid.

Project Assumptions:

- Renewable resources and storage resources located within the Middleton Microgrid (primarily rooftop solar) will be integrated into the microgrid. Individual resource controllers will be reconfigured or replaced to work in synergy with the microgrid controllers.
- Distribution protection systems within the microgrid can be reconfigured such that they do not reduce the reliability to customers when the microgrid is not operational.
- Separating the MGE distribution system into a microgrid is not a simple task. Part of the feasibility is to understand whether this can be completed effectively. Additionally, given that this is probably the first of its kind in Wisconsin, we will need to work with the PSCW to understand the regulatory complexities.

- Due to the number of facilities served by the microgrid and potential limitations on the emergency power generation, it is likely that each of the buildings will have their grid connection remotely controlled such that when the system is in microgrid mode, buildings can be energized to match the available power available. The critical buildings would be prioritized before the non-critical buildings. Additional demand/response protocols are anticipated to be explored within the feasibility study

The sequence of operation for the microgrid will be as described below.

Stage One - Identification of grid failure and isolation from failed grid

Upon an outage to MGE feeder Pheasant Branch 1321 and after determining that the outage cause is not within the area served by the Middleton Microgrid, the Middleton Microgrid separates from the utility grid and re-establishes electrical service to the customers located within the microgrid. Upon establishment of the Middleton Microgrid, controllers begin autonomous control of stored energy resources, variable renewable generation resources, and demand response resources. The controllers will balance generation and load and maintain proper power quality until the stored energy resources and variable renewable generation resources are depleted (minimum of 4 hours, maximum only limited by renewable resource availability).

Stage Two – Island mode with no load or facility shedding

If the storage and variable renewable resources become unable to maintain the power requirements of the microgrid (for example at night and after an extended outage), existing traditional backup generation will be activated to ensure the integrity of the microgrid. The traditional backup generation will provide the minimal energy necessary to maintain the microgrid until such time that the variable renewable resources are completely able to supply the energy needs of the microgrid. The modular design of the system will allow additional renewable resources and storage to be added into the microgrid at any time reducing reliance on any traditional generation resources.

Stage Three – Island mode failure with transition to local building emergency power

If the storage and variable renewable resources become unable to maintain the power requirements of the microgrid (for example at night and after an extended outage), critical resources within the community will separate from the microgrid and continue to operate using traditional energy resources, local renewable resources and local storage. The traditional backup generation will provide the minimal energy necessary to maintain the critical facilities until such time that the variable renewable resources are completely able to supply the energy needs of the critical load. The modular design of the system will allow additional renewable resources to be added to the critical load at any time reducing reliance on any traditional generation resources.

3.4.9. Financial Analysis

Due to the ambitious scope of this project, a simple single customer/single owner type model financial analysis is not possible to complete. Prior to any financial analysis, the project team will work together to identify component ownership and potential tariff structures that can be utilized for this type of microgrid. A significant part of this analysis will be developing innovative ownership and payment models that can be used to support the microgrid. The following questions would need to be answered prior to any financial analysis:

1) What equipment is owned by MGE and what equipment can be customer owned?
2) How do customers served by the microgrid pay for the service?
3) How are cross subsidization issues addressed?
4) How can the MGE owned microgrid resources be leveraged for additional value generation, such as demand response or other grid services that benefit all ratepayers served by MGE?
5) How can customers be compensated for hosting utility owned-customer sited solar PV installations?
6) Is it possible for existing customer generation to interact with multiple generation sources in the islanded microgrid configuration? If not, what are the costs to modify equipment to operate in a microgrid environment?

Once the ownership and tariff structures are developed, the financial analysis can be performed from the customer perspective. The study will look at a sample of facilities, such as those with no on-site generators, those with solar PV only, those with storage only and those with a combination of generation and storage. MGE will provide costs for their required microgrid equipment and develop potential ideas for incorporating these costs into customer tariffs.

In addition to the financial analysis, alternative project financing options will be evaluated including:

- State or Federal Grants The City of Middleton is highly experienced in tracking state and federal funding priorities, applying for and administering grant funds and would look to any potential state or federal grant funds to aid in completion of the BP Microgrid project.

- TID Funds The BP Microgrid study area is located in Tax Increment District #3. There is potential to fund design and infrastructure work with TID funds.

- Battery Cost Sharing The City of Middleton could work with MGE on a cost sharing scenario on the project's battery storage. A potential scenario could include MGE ownership of the system while the City of Middleton pays for battery backup service.

- Middleton Area Development Corporation A Middleton-focused loan program to support local businesses and develop economic opportunity. The BP microgrid concept is ideally suited for the fund, as each business can obtain favorable loan packages to support individual solar installation.

- Tax Credit Monetization The City of Middleton has experience working with state and federal tax credit programs to accomplish renewable energy projects and would explore all possible opportunities to monetize tax credits to finance this project, including opportunities for customer sited solar PV installations to recoup 26% of system install costs as a federal tax credit.

The BP Microgrid seeks to not only serve critical logistic and public health infrastructure but will enable critical economic contributors to remain operational even in times of distress. Keeping businesses open and operational stabilizes the Middleton and greater Dane County economy. Unlike in the flooding of 2018, businesses and employers will be able to stay open or at least maintain functioning heating, cooling, refrigeration, and other essential functions to prevent major inventory and resource losses. This will help the economy better respond to and recover from potential shocks.

3.4.10. Environmental Impact

Through the feasibility study, the consultant will estimate the total environmental impact resulting from the implementation of the microgrid. The most significant emissions reduction strategy will be from the solar PV panels which would replace existing grid power. At this time, the total solar PV capacity is not known so an estimated emission reduction cannot be determined. Other microgrid technology such as batteries also have the potential to reduce GHG emissions from existing fossil-based resources depending on the dispatch method. Traditional generation included in the project concept will be used in rare situations, only to keep the most critical infrastructure in the BP Microgrid powered, and therefore present a minimal environmental impact.

3.5 Reference Materials

1. Study Area Map
2. Business Park Solar Sites List
3. City of Middleton Resolution
4. Letters of Support
    4.1. MG&E
    4.2. KEVA Sports Center
    4.3. Additional Business Park Businesses
5. Sustainable City Plan (Linked in Document)
6. 2021 Comprehensive Plan Update (Linked in Document)


City of Middleton
Emergency Resilience Microgrid Program
Opportunities for Rooftop Solar
Critical Operations
Existing Solar
Community Resilience Center Location
Airport
Airport Rd
Existing Solar
HyCite
Keva
Feasibility Study Area
Electric Theatre Controls
UW Health Pharmacy
Miramount Behavioral Health
Deming Way
Spectrum
Highway 12
Pleasant View Rd
UW Health Administrative Offices
Existing Solar
UW Provision
UPS
University Ave
Downtown Middleton

	Business Name	Address	Solar Opportunity	Existing Solar
1	360 Athletics	8155 Forsythia St	X	
2	A2 Security Systems	3308 Nursery Dr		
3	ACD Distribution	3129 Deming Way	X	
4	Alan Boehmer Design	8120 Forsythia St		
5	American Girl	8400 Fairway Pl	X	
6	Automation Components Inc	2305 Pleasant View Rd		
7	Beacon Athletics	8233 Forsythia St	X	
8	Big Block Midwest	3304 Nursery Dr		
9	Bob Suter's Capitol Ice Arena	2616 Pleasant View Rd		
10	Boley Tree & Landscape Care Inc	2305 Parview Rd		
11	Burn Boot Camp	8233 Forsythia St	X	
12	Caliber Collision	8026 Forsythia St		
13	Clubhouse for Kids II	3150 Deming Way		
14	Costco	2150 Deming Way	X	
15	Costco Gasoline	2400 Deming Way		
16	Distinctive Road Creations	7919 Airport Rd		
17	Dybdahl Design Group	8120 Forsythia St		
18	Economy Transmission	7912 Forsythia Ct		
19	Electronic Theatre Controls	3031 Pleasant View Rd	X	
20	ePac Flexible Packaging	8233 Forsythia St	X	
21	Fickett Structural Solutions	3148 Deming Way		
22	Fiskars Brands Inc	7800 Discovery Dr		
23	Fix'm Home Repairs	7919 Airport Rd		
24	Genetic Visions	8137 Forsythia St	X	
25	Gilmour Garden & Watering	7800 Discovery Dr		
26	Gold Medal Performance	2616 Pleasant View Rd		
27	Gretchen Collins, MD	3146 Deming Way		
28	Hall Lumber Sales Inc	2314 Parview Rd		
29	Happy Dogz	3148 Deming Way		
30	Hart DeNoble Builders	7923 Airport Rd		
31	Hitters SportsPlex	3170 Deming Way	X	
32	Hy Cite Enterprises	3252 Pleasant View Rd		X
33	Infinity Martial Arts	8233 Forsythia St	X	

34	Kehl School of Dance	8152 Forsythia St		
35	Keva Sports Center	8312 Forsythia St	X	
36	Knight Hollow Nursery	7911 Forsythia Ct		
37	Loren Imhoff Homebuilder	7919 Airport Rd		
38	Madison Pavement Maintenance	8123 Forsythia St	X	
39	Middleton -Cross Plains Area School District Transportation Center	3180 Deming Way	x	
40	Middleton Gymnastics Academy	8152 Forsythia St		
41	Miramont Behavioral Health	3169 Deming Way	X	
42	Morey Airplane Company	8300 Airport Road		X
43	Name Badge Productions	3220 Deming Way		
44	Network Engineering Technologies	3140 Deming Way		
45	Paramount Residential Mortgage Group	3308 Nursery Dr		
46	PPD Inc	3230 Deming Way	X	
47	Primrose School of Middleton	3000 Deming Way		
48	Rainbow Group LLC	8233 Forsythia St	X	
49	Rockwell Automation	8155 Forsythia St	X	
50	RTI Donor Services	8120 Forsythia St		
51	Silver Lining Taekwon-do	3170 Deming Way		
52	Specialty Insurance Solutions	3220 Deming Way		
53	Spectrum Brands Corporate Campus	3001 Deming Way	X	
54	The Mattel Toy Store	8400 Fairway Pl	X	
55	TNT Window Tinting	7927 Airport Rd		
56	TownePlace Suites by Marriot Madison West/Middleton	3055 Deming Way		
57	UPS Customer Center	8350 Murphy Dr	X	
58	USA Mortgage	3308 Nursery Dr		
59	UW Health Administrative Office Building	3185 Deming Way	X	
60	UW Health Pharmacy Services	7974 UW Health Ct	X	
61	UW Provision Company	2315 Pleasant View Rd		X
62	Varigen BioSciences Corporation	3220 Deming Way		
63	Wisconsin Fertility Institute	3146 Deming Way		

2021-39

Supporting a Public Service Commission of Wisconsin Office of Energy Innovation Grant Application to Explore the Feasibility of a Renewable Electricity Microgrid to Serve Buildings in Middleton

WHEREAS, In August 2018, almost a foot of rain fell on Middleton in 24 hours, causing massive flooding – including of the industrial district – leading to a Federal Disaster Declaration. Many businesses were without power and experienced extensive flooding and cessation of business; and

WHEREAS, The 2018 flood event led to a realization that the city's emergency infrastructure was based on pre-climate change calculations, and that an entirely new level of preparedness would be required going forward; and

WHEREAS, Middleton has a well-defined light industrial district with a number of large warehouses and offices. These businesses and organizations comprise a significant percentage of the essential service infrastructure for western Dane County, as well as providing extensive space for emergency lodging; and

WHEREAS, By building a microgrid in this area powered primarily through renewable resources, Middleton will be able to prepare for ongoing energy needs during a general power shutdown, emergency housing for residents, and securing the food distribution infrastructure for the area; and

WHEREAS, A microgrid powered through renewable resources would be an important step towards achieving the City's goals for meeting 25 percent of its electric needs for City operations through renewable energy resources by 2025, 80 percent by 2030, and 100 percent by 2035; and

WHEREAS, Madison Gas and Electric supports this effort in order to create resiliency and sustainability in our light industrial district; and

NOW, THEREFORE, BE IT RESOLVED BY THE MIDDLETON MAYOR and COMMON COUNCIL, that the Mayor and members of the Council support the preparation and filing of an application for a Public Service Commission of Wisconsin Office of Energy Innovation grant to explore the feasibility of a renewable electricity microgrid to serve critical infrastructure in Middleton.

City of Middleton, Mayor

Gurdip Brar

ATTEST:

Lorie J. Burns, City Clerk

AYES: 8
NOES: 0
ADOPTED: 8/3/2021

Madison Gas and Electric Company
P.O. Box 1231
Madison, WI 53701-1231
608-252-7000
your community energy company

August 4, 2021

Sent Via Email
jmaloney@vandewalle.com
aattoun@cityofmiddleton.us

Mr. Jeff Maloney
Vandewalle and Associates
120 East Lakeside Street
Madison WI 53715

Ms. Abby Attoun
City of Middleton
7426 Hubbard Avenue
Middleton WI 53562

Dear Sir and Madam:

Madison Gas and Electric Company (MGE) is pleased to provide this letter to support the City of Middleton microgrid study.

The project application will support a stakeholder engaged process for evaluating and conducting a microgrid feasibility study. The team will study and identify potential deployment strategies for solar photovoltaics (PV), energy storage, and other microgrid technologies to bolster resilience of a portion of the distribution system identified in the City of Middleton against power outages. The study will also model and analyze load profiles, microgrid designs, and project costs/benefits.

MGE understands the value of this project and looks forward to contributing as a strategic and technical partner of the applicant. Please contact me with questions or concerns at (715) 323-1686 or alindgren@mge.com.

Sincerely,

Aaron Lindgren

Aaron Lindgren
Engineer IV Energy Products and Services

dsh

August 4, 2021

Greetings,

I am the owner of KEVA Sports Center, and I am writing to express my strong support for awarding an Energy Innovation Grant to explore the feasibility of a renewable electricity microgrid to serve critical infrastructure in Middleton.

It is never too early to prepare for a disaster. Middleton is all too aware of the need to prepare for the unexpected after nearly a foot of rain fell in 24 hours in 2018, causing massive flooding and leading to a Federal Disaster Declaration. My business experienced some water damage from the flood, and many other businesses in the Airport Road Business Park area experienced major flooding and power outages. I think it is a great idea to explore the option of installing a renewable energy microgrid in a critical area of our city.

My business is located near an exit from the beltline highway, an airport, and is minutes away from Police, Fire, and EMS. In the event of a major disaster, our facility could serve as a community resource. It would give me peace of mind to know that there is an emergency energy backup available to allow my facility to serve our community during a disaster.

I am excited for the potential for this project. I stand in strong support for awarding an Energy Innovation Grant to the City of Middleton.

Sincerely,

Eric Fritz
Owner
KEVA Sports Center

UWHealth

Energy Management & Sustainability
7974 UW Health Ct
Middleton, WI 53562

608.265.6847
uwhealth.org

August 5, 2021

Public Service Commission of Wisconsin
Office of Energy Innovation
4822 Madison Yards Way
Madison, WI 53705

Dear PSC Staff and Commissioners,

UW Health is pleased to share this letter of support for the Middleton community microgrid study at the Middleton industrial park. UW Health currently has two facilities in the project area including the Administrative Office Building and the Pharmacy Services Building, a mission critical pharmacy compounding and distribution facility serving our area hospitals and clinics.

As part of this study, the City of Middleton, MGE and their consultants will evaluate how a community or Town Center (TC) Microgrid could be developed in the project area to provide for a more resilient and renewable power system using solar PV, battery storage and innovative microgrid control strategies. UW Health is excited to be part of such an ambitious effort to explore the feasibility of the proposed microgrid. As an active member of Practice Greenhealth, we are continually focused on improving our sustainability and this project provides an opportunity to apply these efforts on a community level.

Additionally, one of the proposed consultants, HGA Architects and Engineers, has worked on both facilities and is familiar with our building systems and operation which will be useful when evaluating how these buildings would potentially tie in and operate in the microgrid configuration.

We look forward to participating in this project and hope that a grant is awarded to explore this unique and ambitious opportunity.

Sincerely,

Mary Statz, MS
UW Health
Program Director Energy Management & Sustainability

Cc: Abby Attoun, Director of Planning and Community Development

Spectrum Brands

August 4, 2021

Wisconsin Public Service Commission
Office of Energy Innovation

Greetings,

I am writing to express my strong support for awarding an Energy Innovation Grant to explore the feasibility of a renewable electricity microgrid to serve critical infrastructure in Middleton.

Spectrum Brands is one of the largest employers in Middleton, and our headquarters is located immediately adjacent to the location of this proposed project. We built, and expanded, our building to the point it now holds almost 4000 employees with extensive telecommunication infrastructure. We also have a strong sustainability mission with our company, and are constantly looking for innovative ways to improve our environment.

In 2018, Middleton suffered catastrophic flooding and was declared a Federal Disaster. Our building was surrounded by floodwaters, and we were stunned by the power of a single (albeit large) storm that was able to overwhelm the existing systems in the area. Since then, we have redoubled our efforts to secure our building from damage, to improve our ability to respond to crises, and to integrate more fully with our surrounding community. We purchased a very large diesel generator to provide power to our building in the event of another power outage – although we hope we do not have to use it.

This idea of a microgrid supporting the businesses in this park is one we fully support. We have the airport a few blocks away, are immediately adjacent to two on-ramps to the interstate highway, and are close to a child care center, medical centers, and distribution warehouses. While our immediate focus in any project will be to ensure the continuity of our power to protect our international business operations, we will also be interesting in how we can help the greater community in the event of a longer-term crisis situation.

I am excited for the potential for this project. I stand in strong support for awarding an Energy Innovation Grant to the City of Middleton.

Sincerely,

David D Hanson AIA, LEED AP
Facilities Leader
Spectrum Brands
3001 Deming Way
Middleton, WI 53562

David.Hanson@Spectrumbrands.com
Phone: (608) 278-6469
Spectrum Brands

August 4, 2021

Greetings,

I am the President/CEO of Electronic Theatre Controls, Inc. ("ETC"), and I am writing to express ETC's support for awarding an Energy Innovation Grant to explore the feasibility of a renewable electricity microgrid to serve critical infrastructure in Middleton.

It is never too early to prepare for a disaster. Middleton is all too aware of the need to prepare for the unexpected after nearly a foot of rain fell in 24 hours in 2018, causing massive flooding and leading to a Federal Disaster Declaration. Many businesses in the Airport Road Business Park area experienced major flooding and power outages. I think it is a great idea to explore the option of installing a renewable energy microgrid in a critical area of our city.

It is exciting that we may be able to expand the renewable energy in the Airport Road Business Park. The business park has a lot of critical infrastructure that will play a key role in any disaster response. This is an excellent opportunity to ensure that local businesses can transition to renewable energy while increasing our resilience in the face of a natural disaster.

We are excited for the potential for this project. ETC supports awarding an Energy Innovation Grant to the City of Middleton.

Sincerely,

Richard L. Titus
President/CEO
Electronic Theatre Controls, Inc.

ETC Inc | 3031 Pleasant View Rd | PO Box 620979 | Middleton WI 53562 0979 | 608 831 4116 | etcconnect.com

August 4, 2021

Greetings,

I am the manager of the Middleton Municipal Airport, and I am writing to express my strong support for awarding an Energy Innovation Grant to explore the feasibility of a renewable electricity microgrid to serve critical infrastructure in Middleton.

It is never too early to prepare for a disaster. Middleton is all too aware of the need to prepare for the unexpected after nearly a foot of rain fell in 24 hours in 2018, causing massive flooding and leading to a Federal Disaster Declaration. I think it is a great idea to explore the option of installing a renewable energy microgrid in a critical area of our city.

In the event of a major disaster, the airport would likely play a critical role in the disaster response. UW MedFlight uses the airport as a reliever airport and organ/tissue transplant flights by RTI Donor are flown from the airport. Our proximity to the business park, the beltline highway, Police, Fire, and EMS means we are well situated to move people and supplies in and out of the area. It would give me peace of mind to know that there is an emergency energy backup available to allow my facility to serve our community during a disaster.

I am excited for the potential for this project. I stand in strong support for awarding an Energy Innovation Grant to the City of Middleton.

Sincerely,

Rich Morey
Airport Manager
Middleton Municipal Airport