57 - Village of Malone

Notice

MICROGRID

FEASIBILITY STUDY REPORT

THE VILLAGE OF MALONE, NEW YORK

Final Report
per
NYSERDA Review Comments

June 2016

Submitted on the Behalf of:

The Village of Malone, New York
14 Elm Street
Malone, NY 12953

Prepared By:

Barton & Loguidice, D.P.C.
443 Electronics Parkway
Liverpool, New York 13088

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1.0 Development of Microgrid Capabilities

1.1 Introduction

The Village of Malone, NY, located in Franklin County, with an approximate population of 5,900, is served by an electric utility distribution system that is owned and operated by National Grid (NG). NG operates two (2) substations within the Village that are served by four (4) total feeders. These substations are fed by large 115KV and 34.5kV sub-transmissions lines, which are also owned and operated by NG. The Malone Station is serviced by two (2) 115kV feeders and the Elm Street Station is serviced by two (2) 34.5kV feeders.

The Village has experienced losses of power from the NG electrical distribution system in the past. Because of these past power and service interruptions, the Village wanted to explore mechanisms that could provide a more reliable and redundant electrical system to better serve the residential, public service and commercial customers. The Village chose to investigate and assess the feasibility of the development of a microgrid to provide resilient local sources of power that could operate in parallel and in the absence of power from NG's electric infrastructure system.

The Village has assembled a project team of industry experts to investigate, manage and execute a feasibility study for developing a microgrid within the Village. Refer to **Section 3** for additional information on the Project Team. The feasibility is Stage 1 of the proposed microgrid project. Future stages of project development may include detailed design, economic analyses and permitting as well as bidding, construction and start-up operations. Additional project partners, including contractors and suppliers, would be secured in the future as various Stages of the project are approved and moved forward for implementation.

Electrical service interruptions from NG's distributions system to critical facilities within the Village, and subsequent use of diesel powered backup generators, could potentially be mitigated through the use of a Combined Heat and Power (CHP) system with continuous generation. The critical host site would primarily use the CHP system (e.g. with a natural gas fuel source) to generate on-site power for its facility electric load, while capturing the heat from the CHP system operation to support other on-site processes.

The microgrids are proposed to be powered by two (2) separate CHP systems at the Alice Hyde Hospital (Northern Microgrid) and the Franklin Academy High School (Southern Microgrid). During emergency grid outages, these facilities will have the ability to utilize the CHP systems to provide power to support the microgrids. Potential benefits of such a host site would include:

- Reduced reliance on diesel powered backup generators and cost savings realized from using natural gas powered CHP engines.
- Support of critical emergency facilities within the Village during times of emergency.

1.2 Minimum Required Capabilities

The purpose of this feasibility study is to investigate and assess mechanisms, specifically microgrids, to provide electrical power supply redundancy to critical facilities within the Village of Malone. A primary justification of the need of electrical system redundancy within the Village is to ensure that critical facilities, necessary for the operation of required public service functions within the Village, have electrical power and are operational during grid emergencies. Such emergencies may be caused by natural events (e.g. storms, flooding, earthquakes, etc.) or other events like physical failure of the power supply grid infrastructure that feeds the NG electrical grid within the Village.

At minimum and if feasible, the proposed microgrid must fulfill the following requirements:

- Serve at least one (1) critical facility.
- Provide primary power generation from a source other than diesel back-up generators.
- Be capable of grid connected and island mode operations.
- Operate with automatic controls to separate from and restore connectivity to the grid.
- Comply with the manufacturer's requirements for scheduled maintenance of equipment.
- Ability to follow load while maintaining voltage and frequency in parallel connection to the grid.
- Meet ANSI C84-1 when in island mode.
- Operate with secure two-way communication/control systems between the microgrid and the utility's electric distribution company.
- Provide power to critical facilities and a diverse group of customers, as applicable and available.
- Include an uninterrupted fuel supply or minimum of one (1) week of fuel supply on-site for the generation source.
- Demonstrate system resiliency to forces of nature and other potential service interruptions.
- Allow for black-start capability.

In consideration of these requirements, the proposed microgrid must, at minimum and if feasible, support one (1) of the critical public facilities within or near the Village as presented in **Table 1A**.

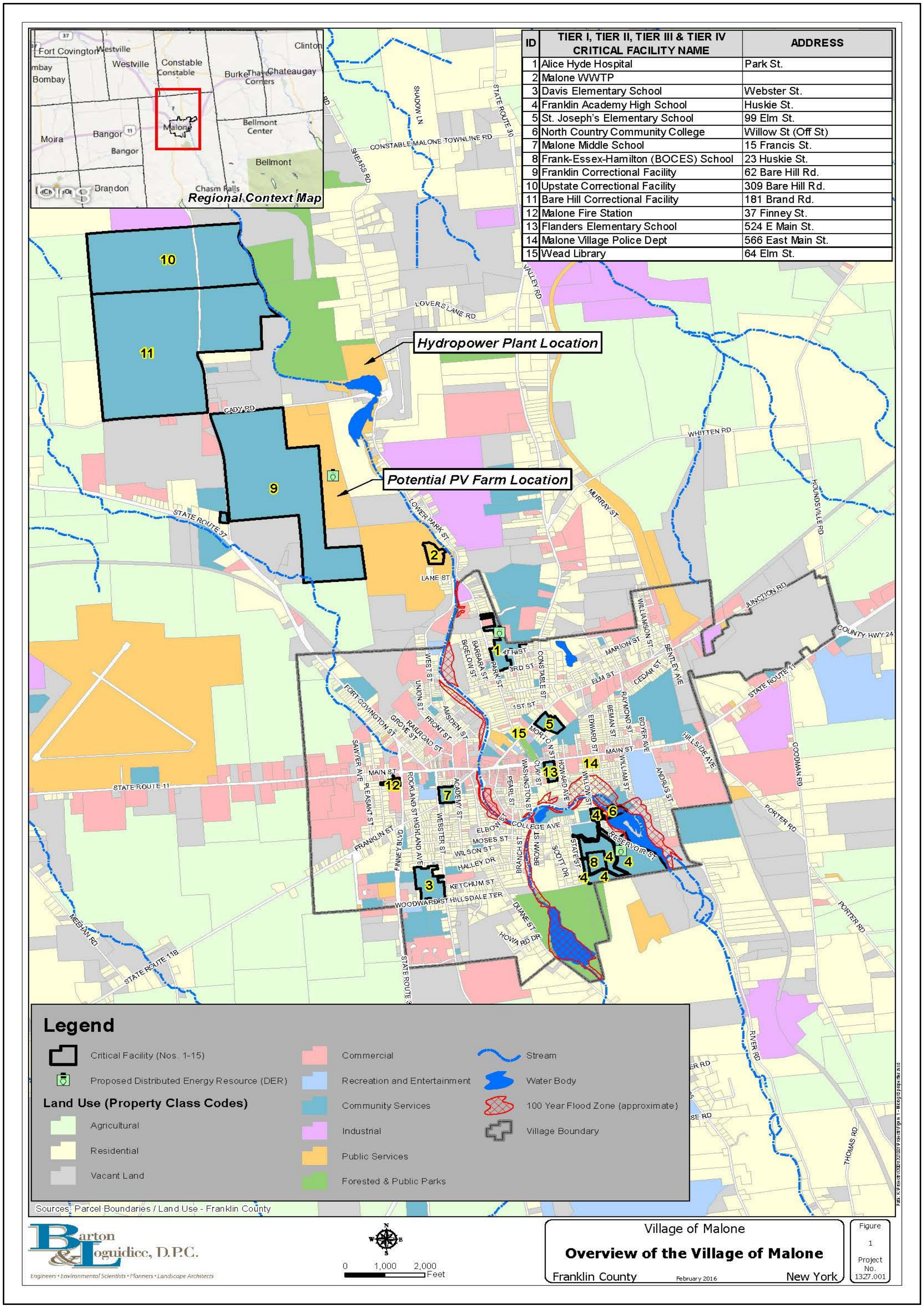
Table 1A
Potential Properties Identified as Critical Tier I – IV Facilities for the Microgrid System

ID	Critical Facility	Land Use Category
1	Alice Hyde Hospital (medical center and nursing home)	Community Services
2	Malone WWTP	Public Services
3	Davis Elementary School	Community Services
4	Franklin Academy High School	Community Services
5	St. Joseph's Elementary School	Community Services
6	Northern Country Community College, Tulloch Campus	Public Services
7	Malone Middle School	Community Services
8	Franklin-Essex-Hamilton BOCES	Community Services
9	Franklin Correctional Facility	Community Services
10	Upstate Correctional Facility	Community Services
11	Bare Hill Correctional Facility	Community Services
12	Malone Fire Station	Community Services
13	Flanders Elementary School	Community Services
15	Wead Library	Community Services

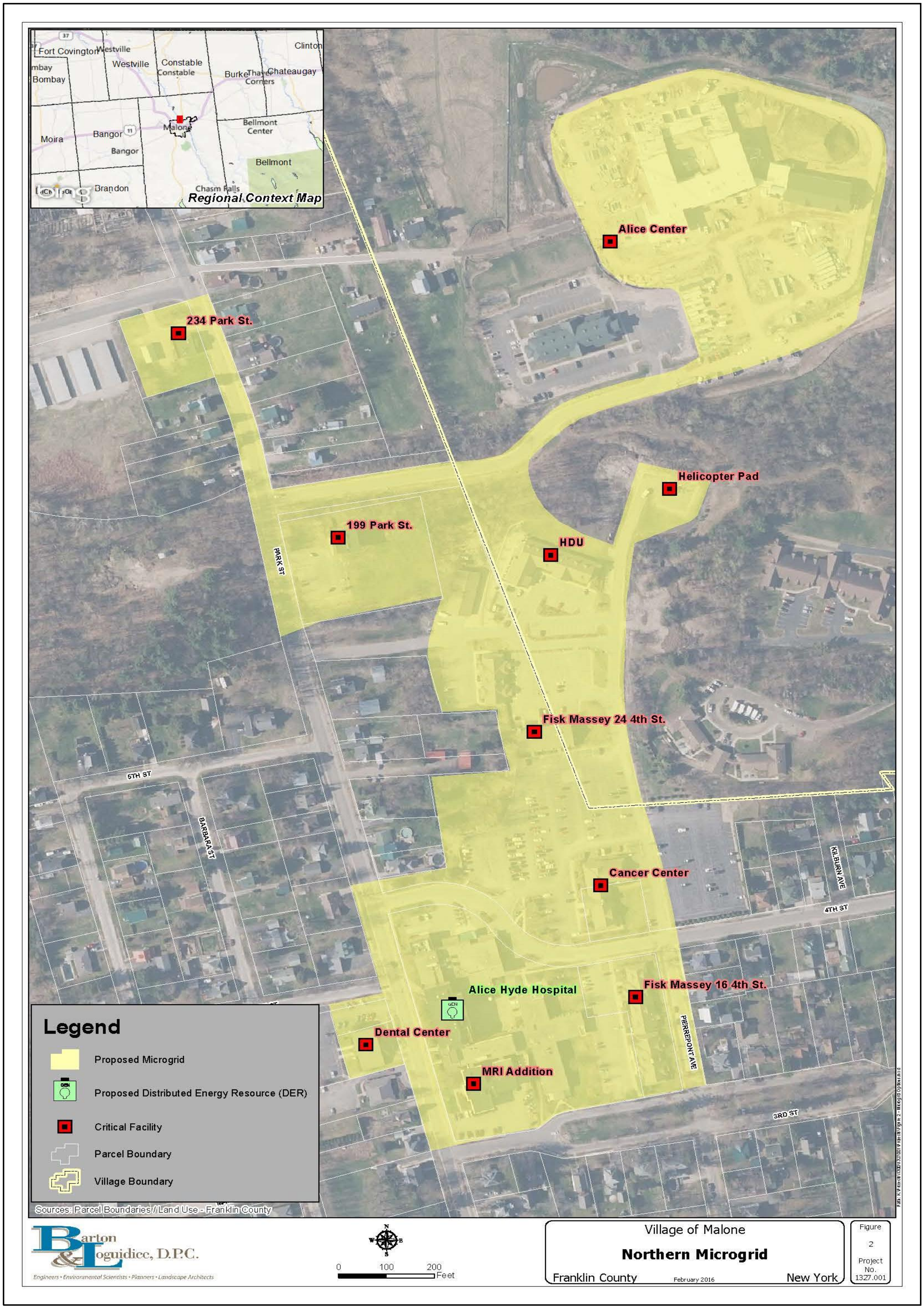
** There may be other critical facilities identified in the future that are beneficial to the Village and/or the microgrid project that are located beyond Village boundaries.*

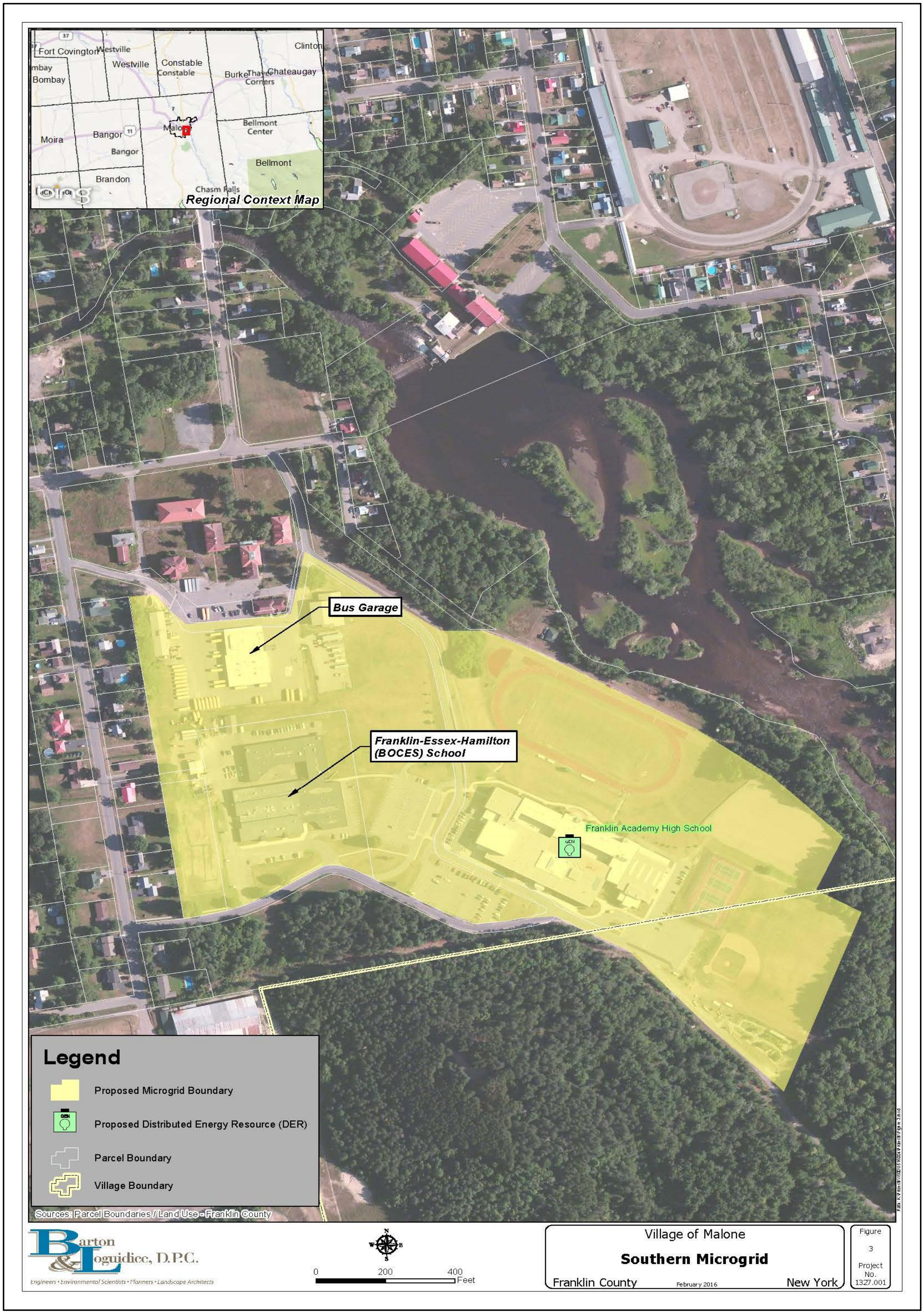
The proposed critical facility end-users within the Village that would potentially utilize the microgrids include: two (2) schools in the Village, a bus garage, and seventeen (17) auxiliary buildings to the main Alice Hyde Hospital, including the hospital building itself. These facilities serve many potential public services during emergencies including: emergency shelter (schools) and medical services (hospital complex).

Refer to **Figure 1** for an overview of the Village of Malone with respect to its critical facilities in Tiers I – IV for the microgrid projects. Refer to **Figure 2** for a delineation of the Northern Microgrid Area and potential microgrid properties. Refer to **Figure 3** for a delineation of the Southern Microgrid Area and potential microgrid properties.



ID	TIER I, TIER II, TIER III & TIER IV CRITICAL FACILITY NAME	ADDRESS
1	Alice Hyde Hospital	Park St.
2	Malone WWTP	
3	Davis Elementary School	Webster St.
4	Franklin Academy High School	Huskie St.
5	St. Joseph's Elementary School	99 Elm St.
6	North Country Community College	Willow St (Off St)
7	Malone Middle School	15 Francis St.
8	Frank-Essex-Hamilton (BOCES) School	23 Huskie St.
9	Franklin Correctional Facility	62 Bare Hill Rd.
10	Upstate Correctional Facility	309 Bare Hill Rd.
11	Bare Hill Correctional Facility	181 Brand Rd.
12	Malone Fire Station	37 Finney St.
13	Flanders Elementary School	524 E Main St.
14	Malone Village Police Dept	566 East Main St.
15	Wead Library	64 Elm St.


Regional Context Map
Fort Covington
Westville
Constable
Burke
Chateaugay
Clinton
Bombay
Moira
Bangor
Malone
Bellmont Center
Bellmont
Brandon
Chasm Falls
Alice Center
234 Park St.
Helicopter Pad
199 Park St.
HDU
PARK ST
Fisk Massey 24 4th St.
5TH ST
BARBARA ST
Cancer Center
KILBURN AVE
4TH ST
Alice Hyde Hospital
Fisk Massey 16 4th St.
Dental Center
MRI Addition
PIERREPONT AVE
3RD ST
Legend
Proposed Microgrid
Proposed Distributed Energy Resource (DER)
Critical Facility
Parcel Boundary
Village Boundary
Sources: Parcel Boundaries / Land Use - Franklin County
Barton & Loguidice, D.P.C.
Engineers • Environmental Scientists • Planners • Landscape Architects
0 100 200 Feet
Village of Malone
Northern Microgrid
Franklin County
February 2016
New York
Figure 2
Project No. 1327.001


Regional Context Map
Fort Covington
Westville
Constable
Burke
Chateaugay
Clinton
Bombay
Moira
Bangor
Malone
Bellmont Center
Bellmont
Brandon
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Bus Garage
Franklin-Essex-Hamilton (BOCES) School
Franklin Academy High School
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Proposed Microgrid Boundary
Proposed Distributed Energy Resource (DER)
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Engineers • Environmental Scientists • Planners • Landscape Architects
0
200
400
Feet
Village of Malone
Southern Microgrid
Franklin County
February 2016
New York
Figure
3
Project No.
1327.001

Overview of Microgrid Design Concept

The proposed project design concept for the microgrid will include the supply of power to support seventeen (17) auxiliary facilities of the Alice Hyde Hospital, including the Hospital itself, and the supply of power to support two (2) schools within the Village of Malone and a supporting bus garage that can also be used for shelter and transportation. The microgrids are proposed to be powered by two (2) separate CHP systems at the Alice Hyde Hospital (Northern Microgrid) and the Franklin Academy High School (Southern Microgrid). During emergency power outages, the microgrid would operate in island mode and provide power to the northern and southern microgrid customers. Metering during emergency power outages and microgrid operation would remain under normal existing conditions, through the use of existing electric meters at individual customer locations.

The DERs/generation sources will include two (2) CHP engine gensets for the northern microgrid and two (2) CHP engine gensets for the southern microgrid that are all fired (i.e. fueled) by natural gas and supplemented by photovoltaic (PV) solar panels. The primary generation source(s) for the microgrids will be the CHP engine gensets, as PV is less consistent and weather dependent. The primary generation source(s) for the microgrid will be sited and designed to meet peak electrical power demand (kW) and usage (kWh) of the northern and southern microgrids (critical loads) while in island mode. Refer to **Sections 2 and 3 and Appendix I** for more detailed information:

Customers who host the CHP engine gensets will have the availability to use these power systems to significantly reduce their daily metered usage and demand behind their primary meters during normal grid operation. Additionally, these customers will have the availability to utilize the excess heat generated from the engine gensets within their facilities, thus offsetting and/or reducing their heating and cooling costs if an absorption chiller is also installed.

Overview of DER/Generation Source Equipment

The DER/generation source equipment will include two (2) General Electric JGS 320 engine gensets (refer to **Figure 4**) with an electrical output of 1,059 kWe each for the northern microgrid and two (2) General Electric JGS 312 engine gensets (refer to **Figure 5**) with an electrical output of 500 kWe each for the southern microgrid. All engines are designed for cogeneration. Cogeneration (i.e. combined heat and power – CHP) systems allow for the generation of both electrical power that can be used during an emergency outage as well as heat that can be used in an institutional process application. The CHP engine genets will be fueled by a dedicated and uninterrupted supply of natural gas from the local utility.

Figure 4
JGS 320 Engine Genset with CHP Capability

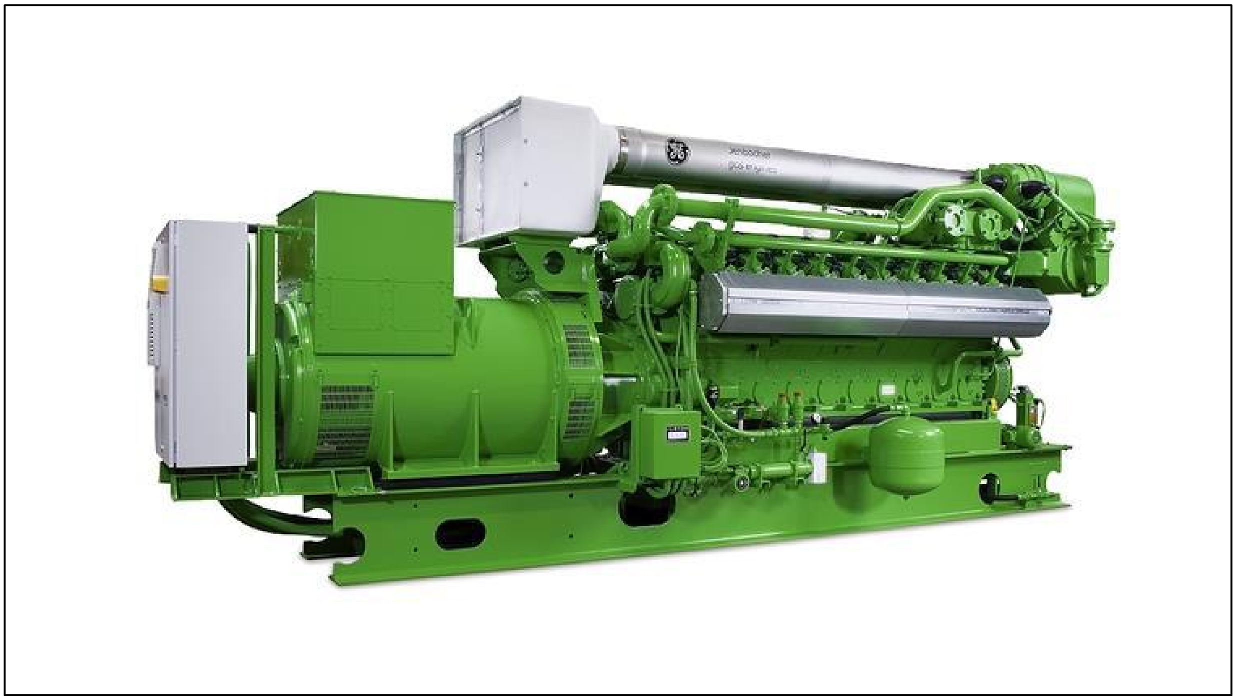


Figure 5
JGS 312 Engine Genset with CHP Capability

Overview of Microgrid System Sequence and Operation

As part of this Feasibility Study Report, the loads of the host locations were characterized using the best available data. Through analyzing this information, a total system capacity for the microgrid system (in island mode) was developed. Note that the electrical demand or usage, or heating or cooling needs may be estimates for this Feasibility Study Report, which would require further detailed analyses and engineering design.

The DERs/generation sources (CHP engine gensets) at the host sites will be designed to operate 24/7/365 excluding scheduled maintenance. Scheduled maintenance does not have to occur during grid emergency/outage conditions. Such maintenance work, given it is not detrimental to the equipment or system, can be scheduled to limit the loss of capacity during microgrid operation.

During normal grid conditions, the generation source at the host location will be used to offset normal demand and usage charges for the host facility. Thus, the proposed generation source will have the capability to provide on-site power in both grid-connected and island mode at a given host location. The microgrid will also be designed to automatically disconnect and reconnect to the National Grid distribution network. This process will also integrate the connecting or disconnecting of the CHP engine gensets so that the microgrid and the primary grid are kept safe for system operators, National Grid utility workers, and customers. The integrated protection equipment may include feeder and generator relay controls to ensure the dedicated systems of the primary grid and the microgrid are completely isolated and cannot backfeed power during times of grid outage, instability, maintenance or new installations.

Additional power generation capacity throughout the microgrid system to account for downtime during scheduled maintenance of CHP engine gensets or other system components will be considered; however, the scheduled maintenance does not have to occur during grid emergency/outage conditions. Thus, significant additional capacity is not required to provide an effective microgrid system, when considering scheduled maintenance requirements of general source components.

The proposed microgrid network will be designed in accordance with NYS Department of Public Service's Standard Interconnection Requirements (SIR) and Institute of Electrical and Electronics Engineers (IEEE) 1547 standards, including technical standards for overcurrent protection, synchronization, voltage and power controls, and metering and monitoring. Once fully connected, the system will follow system load and maintain system voltage in accordance with American National Standards Institute (ANSI) c84-1 during island mode (microgrid) operations. Automatic transfer switches, electrically actuated circuit breakers or reclosers will be utilized to disconnect the microgrid from the surrounding existing grid network and create an intentional island in the event of a failure of the electric grid.

Smart controls and relay protection will be utilized to recognize when outside power is restored to reconnect the microgrid to the existing grid network. All interconnections will be coordinated within the microgrid, to facilitate connection and islanding with as little interruption of service as possible for microgrid users and local utility customers. Any control system communications will be encrypted or protected in accordance with accepted utility standards and homeland security requirements to maintain the integrity of sensitive data.

In order to operate independently of the local external electric supply within the confines of the microgrid, the proposed generation sources (CHP engine gensets) at the host location(s) will require black start capability. Black start capability is necessary during the transition from primary grid power to the microgrid island mode as the CHP engine genset paralleling controls will likely turn off the engines and require a restart. This black start sequence will initiate once the generation sources and the microgrid systems sense instability conditions or an outage from the external primary grid, which will then open the circuits to isolate both the generation source and the microgrid to island mode. Then, the microgrid system will call for power from the generation source for the restart.

1.3 Preferable Microgrid Capabilities

Support of Facilities within the Village of Malone

In addition to minimum requirements for the microgrid referenced in **Section 1.1**, other attributes are desired such as connecting as many critical facilities within the Village as practical and feasible. In addition to the critical public facilities, there are other facilities within the Village that are important. All the power users within the borders of the Village of Malone were evaluated utilizing GIS and census data. To organize and prioritize users, four (4) tiers were used to determine the level of importance of the users. Tier I was considered the most critical facilities in case of an emergency, whereas Tier IV was considered least critical in case of an emergency.

The facilities in Tier I included assisted living facilities, EMS service facilities, hospitals, prisons, wastewater treatment facilities, water treatment facilities, and communication facilities. In the Village of Malone this included the following locations:

- Alice Hyde Hospital, Medical Center & Nursing Home.
- Malone Village Fire Department.
- Malone Village Police Department.
- Valley Ridge Manor (vulnerable population).
- Valehaven Homes for Adults (vulnerable population).
- Malone WWTP.
- Bare Hill, Upstate, and Franklin Correctional Facilities.
- Wireless Internet Now (communications).
- Time Warner Cable (communications).

Tier II facilities included schools, libraries (shelters) and gas stations. In the Village of Malone this included the following locations:

- Malone Central School District (emergency shelter).
- Malone Middle School (emergency shelter).
- Flanders Elementary School (emergency shelter).
- Franklin Essex Hamilton School (emergency shelter).
- Davis Elementary School (emergency shelter).
- Holy Family School (emergency shelter).
- Northern County Community College (emergency shelter).
- Wead Library (emergency shelter).
- JCEO/Head Start (emergency shelter).
- Children's Corner (emergency shelter).
- Five (5) local gas stations (supply fuel for vehicles in case evacuations are necessary).

Tier III facilities included hotels and motels (temporary shelter), grocery stores, pharmacies, and residential buildings. In the Village of Malone this included the following locations:

- Kinney Drugs.
- Walgreens.
- Rite Aid.
- Four Seasons Motel (2 locations).
- Econo Lodge.
- Super 8 Malone.
- Clark's Motel.
- Gateway Motel.
- Dreamland Motel.
- Price Chopper.
- Free B's.
- Yando's Big M Market.
- D&M Elm St. Market.
- Midway Market. And Schwan Food Co.
- 2,904 residential buildings.

Tier IV facilities included commercial and industrial businesses. There are approximately 607 commercial businesses in the Village of Malone.

Initial Evaluation of Microgrid Users

The microgrid was evaluated to support Tier I-III users; however it was determined to be impractical for several factors, which included:

- Large demand: > 10MW.
- The demand load is not centralized, which would require extensive use of the existing National Grid electrical distribution infrastructure.
- The existing National Grid electric services within the Village originates from multiple feeders and substations that are spread throughout the Village, which would require a substantial amount of control and integration equipment as well as upgrades to the existing distribution system.
- The distance between probable generation sources and control locations (substations) would likely require significant communications infrastructure, which could create issues during microgrid island operations.

Overall, the total combined demand of the facilities in the target Tiers I-III was too large to support with a generation source that could be utilized by a limited number of host sites (with thermal needs) during normal grid operation; i.e. there were no large hosts sites that could utilize such a large amount of generation within the Village during normal grid operation. Without heavy reliance on National Grid's distribution equipment, any generation would have to be spread out at most critical facilities, and effectively be standby power for that host sites during an overall grid emergency/outage. Most of the Tier I facilities already have some form of standby generation. Additionally, the location of all the critical facilities (not centrally located) made them difficult to connect via anything beyond the existing National Grid utility lines. As such, any generation at critical facilities would likely only support that facility via a normal interconnected generation source operating in parallel with the grid. This scenario would not create a true microgrid for use by other customers on the grid. Due to these issues, microgrid opportunities at critical facilities adjacent to each other in the northern and southern part of the Village were prioritized to provide supplemental infrastructure for system redundancy and resiliency in lieu of sole reliance on National Grid infrastructure.

Given the complexities of developing useful and cost effective microgrids, a split or dual system consisting of a Northern Microgrid and a Southern Microgrid were analyzed for the Village of Malone. The Northern Microgrid was initially analyzed to support the Franklin Correctional Facility, and the Malone WWTP along with an adjacent property that was slated for a photovoltaic array (adjacent critical facilities). This scenario would allow support of two critical facilities and the potential for integration of renewable generation. However, the facilities already have standby diesel generator power and the WWTP's load is fairly small. Thus, the benefit of a microgrid between these facilities is not a practical investment, especially when considering the minimal benefits to the Village. Regarding the integration of the solar farm currently planned, such an application would require battery storage to make the PV energy reliable during potential emergency usage, and the Village would not have control of the solar farm initially based on its current contractual agreement and PPA. The majority of the microgrid benefit would be to the Correctional Facility instead of supporting the Village.

Another option in the northern area of the Village was to assess the potential to augment power supply to another critical facility in the Village, the hospital (the Alice Hyde Medical Center & Nursing Home). A microgrid around the hospital might be advantageous even though the facility already has some amount of standby backup power generation. A microgrid could make that standby system more resilient in grid emergencies, and could offer multiple benefits to the facility during normal operations (power and heat if CHP was utilized). Providing power resources to make the hospital more resilient during emergencies is important to the community as the hospital is one of the most important facilities in the Village. Refer to **Figures 1 and 2** for the location of facilities and generation sources for the Northern Microgrid.

The Southern Microgrid focused on providing shelter, command and control capabilities, and the potential for emergency mass transportation support with the inclusion of the adjacent Franklin Academy High School (including the bus garage) and the Frank-Essex-Hamilton BOCES, facilities. This scenario would provide power resources to a geographically separate area from the Northern Microgrid to support the Village from two sides. Refer to **Figures 1 and 3** for the location of facilities and generation sources for the Southern Microgrid.

The Northern and Southern Microgrids will incorporate advanced and innovative technologies, to the greatest extent practical, to allow for: customer interaction with the system, increased energy efficiency, better communication and a smoother transition to provide reliable electric service to critical facilities while maintaining economic feasibility. In order to increase the energy efficiency and maximize the reliability of service to facilities and customers within the microgrids, the systems will incorporate technology to allow power generation to seamlessly follow demand during microgrid operations. This could include measures to reduce energy use of non-essential components during times of low generation or during emergencies, communication on both the supply and demand ends to allow energy generation to exactly match users' needs, and automated transfers and relay protections for seamless transitions in and out of island mode.

In order to determine the feasibility of the local microgrids, a cost benefit analysis was be performed on the proposed system, incorporating the public- and private-sector costs to the Village, developers, and customers as well as the economic and other benefits to the community, developer, Village and Utility Cost comparisons will include not only the capital and operational costs to construct new infrastructure and interconnects, but also the costs of the existing backup generation at the critical facilities, the projected costs of continuing service through the utility, and any savings to be realized under the microgrid system. Although most benefits to the developer and end-users will be economic, additional social and environmental values of increased efficiency, reliability, the functionality of critical facilities, and security as well as the use of cleaner energy sources and the implementation of energy conservation measures will be explored.

Overview of Other Preferable Capabilities for the Microgrid System

In addition to the minimum required capabilities for the microgrid as referenced in **Section 1.1**, there are other preferable capabilities of the microgrid system that can benefit the Village. A general list of other preferable capabilities is provided below, which are further detailed in **Section 3.2** of this Feasibility Study.

- Use of an Integrated Communication System.
- Potential Use of Private-Sector Funding for the DERs/Generation Sources.
- Potential Minimization of Local Impacts.
- Creating of Local Temporary and Permanent Jobs.
- Supporting State Energy Initiatives.
- Utilization of Clean Power Sources.

2.0 Preliminary Microgrid Design and Configuration

2.1 Proposed Microgrid Infrastructure and Operations

Under normal operating conditions, the Northern and Southern Microgrids will be connected to the National Grid owned and operated distribution system and operate in parallel. The primary source of power will be via the main grid, and the facilities will receive their electrical service from the current substations and feeders, but will offset their normal demand and usage through utilization of their on-site Distributed Energy Resources (DERs), the CHP engine gensets. Currently, there are existing meters at the facilities located within the proposed microgrids to determine normal usage and billing. The standard metering process would remain under normal operation and microgrid system conditions. The facilities that are host sites for CHP engine gensets will use these generation systems to reduce their metered usage and demand behind their primary meters by offsetting their normal demand and usage costs of electricity during normal grid operation. These facilities include:

- Northern Microgrid – Alice Hyde Hospital and Medical Center (i.e. Alice Hyde Hospital). Two CHP engine gensets are anticipated to be located at the medical complex along with a secondary distribution system to power the other building on the medical campus during emergencies. This includes seventeen (17) auxiliary buildings to the main Alice Hyde Hospital, including the hospital building itself.
- Southern Microgrid – Franklin Academy High School, Bus Garage, and the Franklin-Essex-Hamilton (BOCES). Two CHP engine gensets are anticipated to be located at the Franklin Academy High School with a secondary distribution system to power the local bus garage facility and the BOCES School during emergencies. These facilities serve many potential public services during emergencies such as emergency shelters.

Additionally, these facilities will have the benefit of being able to utilize the excess heat generated from the CHP engine gensets in their existing operations, thus offsetting and/or reducing their heat/cooling purchase requirement. This arrangement can be very beneficial to high energy users such as hospitals and schools. The integration of absorption chillers and chilled water systems may be a way to integrate cooling, or “tri-generation” (power, heating, and cooling) at the host sites to create year round efficient use of the fuel utilized to power the CHP units.

The host sites will be connected to the other facilities within the microgrid with secondary parallel lines to the utility’s normal distribution lines. These secondary lines will make up the islanded distribution system between the facilities within the microgrid when the microgrid is isolated (i.e. in island mode) from the outer utility distribution system, which avoids the need to utilize National Grid infrastructure to operate the microgrids. This secondary islanded distribution system will be connected behind the main service disconnects at each host site, and will serve as the microgrid’s islanded distribution network. Alternatively and with cooperation from National Grid, isolating breakers or switches could be added to National Grid’s distribution system to potentially connect the facilities within a microgrid while the CHP System is in island mode during an emergency.

Infrastructure and General Operation of the Microgrid

A description of the physical function, controls, operating modes and other characteristics of the microgrid system is provided below.

- Physical Function – related to the physical function of the microgrid, upon failure of the primary or main grid (outage, grid not within voltage/frequency, brownout or scheduled maintenance, etc.); the microgrid will detect these types of irregular operating conditions. At these times, electrically actuated breakers or reclosers at any feeder location will island the generation source, the two (2) CHP engine gensets (at 1,059 kWe each for the northern microgrid) and two (2) CHP engine gensets (at 500 kWe each for the southern microgrid), to ensure that power can be safely generated within the microgrid independent of the outside grid status. The DERs/generation sources (CHP engine gensets) at the host sites will be designed to operate 24/7/365 excluding scheduled maintenance.

  Customers with Life Safety loads (Alice Hyde Hospital)that have existing diesel supplied backup generation, will detect the absence of electricity supply from the main grid and will automatically respond to supply the necessary power for those smaller critical loads via their current automatic islanding controls. Once microgrid power is initiated during an emergency grid outage, those entities that were running on automatic diesel powered backup generator will be powered by the CHP Systems and the diesel operated backup system will automatically turn off to conserve those fuel supplies. Thus, customer diesel standby operations would cease, and primary internal power to the microgrid would originate from the islanded distribution lines. Once main grid power is restored, the secondary distribution system would shut down, the CHP engine gensets would restart, and the host sites would then use the CHP System to offset their normal demand and usage from the main grid.

- Protection Controls – The feeder and generator protection controls as well as the switchgear controls at DER host sites will recognize the loss of grid power and will execute an automatic black start plan by opening breakers to facilitate reloading of the CHP engine gensets. DERs will synchronize voltage, frequency and other parameters to a preprogramed reference within the microgrid. Once synchronized, relay controls at each DER point of contact will signal the individual isolation breakers to close, which will allow DER generation to flow back into the microgrid (site loads will remain locked out to ensure generation can support the higher priority loads within the microgrid).

- Loading Controls – To control loading of the CHP engine gensets, based DERs and electrically actuated breakers on each circuit within the switchgear will operate in a designated process order. During a detected power loss, the actuated breakers will open; this includes breakers on the main microgrid connection point and all system feeders. The generation source (CHP engine gensets) will then black-start, the DERs will be engaged to start, and the engine gensets will power essential DER parasitic loads. The actuated breakers will then close sequentially in a controlled way, in order of high priority circuits to block load the generation source (CHP engine genset) and the DERs. This will allow for a controlled and automatic islanding of the microgrid. This sequence will be controlled at each host site. While many steps will take place during a power transition within the microgrid, the actual time elapsed will be very short due to the automatic controls of the system.

- Disconnect to Main Grid – Once the utility's electric service from the main grid is restored and becomes available and stable (at least 15 minutes), the automatic controls of the CHP system will sense this, the feeder breakers will open, and the DER facilities will be disconnected from the microgrid and the secondary distribution system. The DERs will sense the frequency and voltage being supplied by the utility and will synchronize and reconnect in normal parallel operation.. These steps will happen very quickly with minimal interruption to service.

- Parallel and Island Mode – the CHP system will operate in parallel with the main grid to service the host sites. During emergency grid outages, the CHP Systems would have the option to island themselves at the host sites to utilize their own on site power to support the host sites as well as other buildings through the secondary distribution network.

- Metering – Since the metering structure within the microgrid will not be impacted, billing for demand and usage will remain the same during the outage as the microgrid connection will be behind the utility meters for each facility. During grid emergencies, meters on the secondary islanded distribution system will track usage from each facility within the microgrid, and costs for operation will be apportioned by usage based upon previously negotiated rates internal to the entities within the microgrid to offset the cost of fuel, maintenance, etc. During normal main grid conditions, the CHP systems will be used to offset daily power usage at the host sites.

- Public Service Announcements – It is anticipated that prior training efforts and PSAs during a grid emergency/outage will be necessary to inform the residents and businesses in the Village what public-service facilities are anticipated to be open and in operation with power from the microgrids. Such outreach measures will be conducted via: local TV, radio, text message, email, and automated phone calls.

2.2 Load Characterization

To characterize the electric load within the Village's current service grid, questionnaires were sent to most facilities including critical facilities within the grid. The questionnaires were segmented into four (4) different types: General Facilities, Police Department Facilities, Fire Department and EMS Facilities and Water and Wastewater Facilities. Participation was mixed and therefore some loads were estimated for critical facilities that are proposed to be part of the Northern or Southern Microgrids. The data and estimates for each included individual facility were combined for each microgrid and developed into typical one-year demand and usage profiles for the proposed systems. As previously discussed, various iterations of the microgrids were analyzed until the proposed Northern and Southern Microgrid configurations were selected.

Appendix A contains graphs that illustrate electric demand profiles by critical facility/customer type and in aggregate for the Northern and Southern Microgrids. **Appendix B** contains graphs that illustrate electric usage profiles by critical facility/and in aggregate for the Northern and Southern Microgrids. Both sets of profiles include best-available data for hourly demand and usage to model sources of loading and conditions requiring microgrid support within the selected microgrid areas. The Facility Questionnaires that were sent to facilities within the Village and any responses that were received are included under **Appendix C.** **Tables 2A and 2B** present the estimated electric power demand and usage system parameters for the northern and southern microgrids.

Table 2A
Total Annual Usage for the Village of Malone Northern Microgrid

ID	Facility	Average Annual Total Usage (kWh)	Average Monthly Usage (kWh)	Average Weekly Usage (kWh)	Average Annual Total Usage (MWh)
1	Dental Center (2614946102)	37,437	3,120	780	37.44
2	Walk In Clinic (2734946100)	65,009	5,417	1,354	65.01
3	Fisk Massey 24 4th Street (3094946114)	4,355	363	91	4.36
4	Fisk Massey 16 4th Street (3114946112)	3,823	319	80	3.82
5	Fisk Massey (3214946114)	15,602	1,300	325	15.60
6	Fisk Massey 16 4th Street (3234946110)	10,939	912	228	10.94
7	Fisk Massey 16 4th Street (3254946116)	6,400	533	133	6.40
8	MRI Addition (3374946114)	264,560	22,047	5,512	264
9	Alice Hyde Medical Center 133 Park Street (2534946106)	4,009,275	334,106	83,527	4,009
10	HDU (3494946121)	163,733	13,644	3,411	163.7
11	Cancer Center (3574946109)	123,280	10,273	2,568	123.3
12	Fisk Massey 16 4th Street (3154946105)	5,158	430	107	5.16
13	199 Park Street (4116341116)	36,842	3,070	768	36.8
14	Alice Center (6482430004)	1,548,600	129,050	32,263	1,549
15	234 Park Street (4696341058)	54,934	4,578	1,144	54.9

16	Helicopter Pad (1623131001)	2,761	230	58	2.76
17	Dental Center (2834946102)	37,488	3,124	781	37.5
	Total Microgrid Usage	**6,390,196**	**532,516**	**133,129**	**6,390**

Table 2B
Total Annual Usage for the Village of Malone Southern Microgrid

ID	Facility	Average Annual Total Usage (kWh)	Average Monthly Usage (kWh)	Average Weekly Usage (kWh)	Average Annual Total Usage (MWh)
1	Franklin Academy High School	1,696,229	141,352	35,338	1,696
2	Bus Garage	38,760	3,230	808	38.8
3	BOCES School	374,720	31,226	7,807	374.7
	Total Microgrid Usage	**2,109,709**	**175,809**	**43,952**	**2,110**

Based on the information referenced above in **Appendices A-C** and in **Tables 2A and 2B**, the estimated electric power demand and usage system parameters for the Village are as follows:

Northern Microgrid (Alice Hyde Hospital)

- Peak Demand: 1.49 MW.
- Ave. Demand: 1.2 MW.
- Ave. Annual Usage: 6,390 MWh.
- Ave. Monthly Usage: 532.5 MWh.
- Ave. Weekly Usage: 133.1 MWh.

Southern Microgrid (Franklin Academy High School)

- Peak Demand: 0.65 MW.
- Ave. Demand: 0.57 MW.
- Ave. Annual Usage: 2,110 MWh.
- Ave. Monthly Usage: 175.8 MWh.
- Ave. Weekly Usage: 40.6 MWh.

Heat generated by the DERs that will be part of the microgrid will normally be utilized by the host location such as in a boiler substitute, etc. Generally this will consist of heat exchangers connected to the high temperature jacket water cooling circuit on the CHP engine genset, and within the exhaust system to recover the majority of the heat generated from the engine gensets during operation. This heat is then transferred into the facility's hot water system for use throughout the facility, and returned at a lower temperature to absorb more heat from the CHP engines gensets. This makes for a highly efficient use of the BTUs generated by combustion of the natural gas on the site.

At full deployment of the DERs (generation sources) to the microgrid system at the host locations, the total system capacity in island mode is expected to be as follows, assuming 90% annual availability of the CHP engine gensets and 50% recovery of recoverable and useable heat output:

North Microgrid (two (2) JGS 320 CHP engine gensets)

- Annual Heat Output: 89,000 mmBTU (at 90% availability).
  44,500 mmBTU (at 50% heat utilization based on reduced run time to maximize economic efficiency).
- Weekly Heat Output: 1,710 mmBTU (at 90% availability).
  856 mmBTU (at 50% heat utilization based on reduced run time to maximize economic efficiency).

South Microgrid (two (2) JGS 312 CHP engine gensets)

- Annual Heat Output: 77,450 mmBTU (at 90% availability).
  38,725 mmBTU (at 50% heat utilization based on reduced run time to maximize economic efficiency).
- Weekly Heat Output: 1,490 mmBTU (at 90% availability).
  745 mmBTU (at 50% heat utilization based on reduced run time to maximize economic efficiency).

For an individual CHP engine genset, the Exhaust Gas Recovery System and a Hot Water Flow Metering System with a maximum annual availability of 90%. It is estimate that only 50% of the heat output below will be reused (lower heat demand in the summer), with the remainder available if a use if found.

North Microgrid (per unit x2 JGS 320 CHP engine gensets)

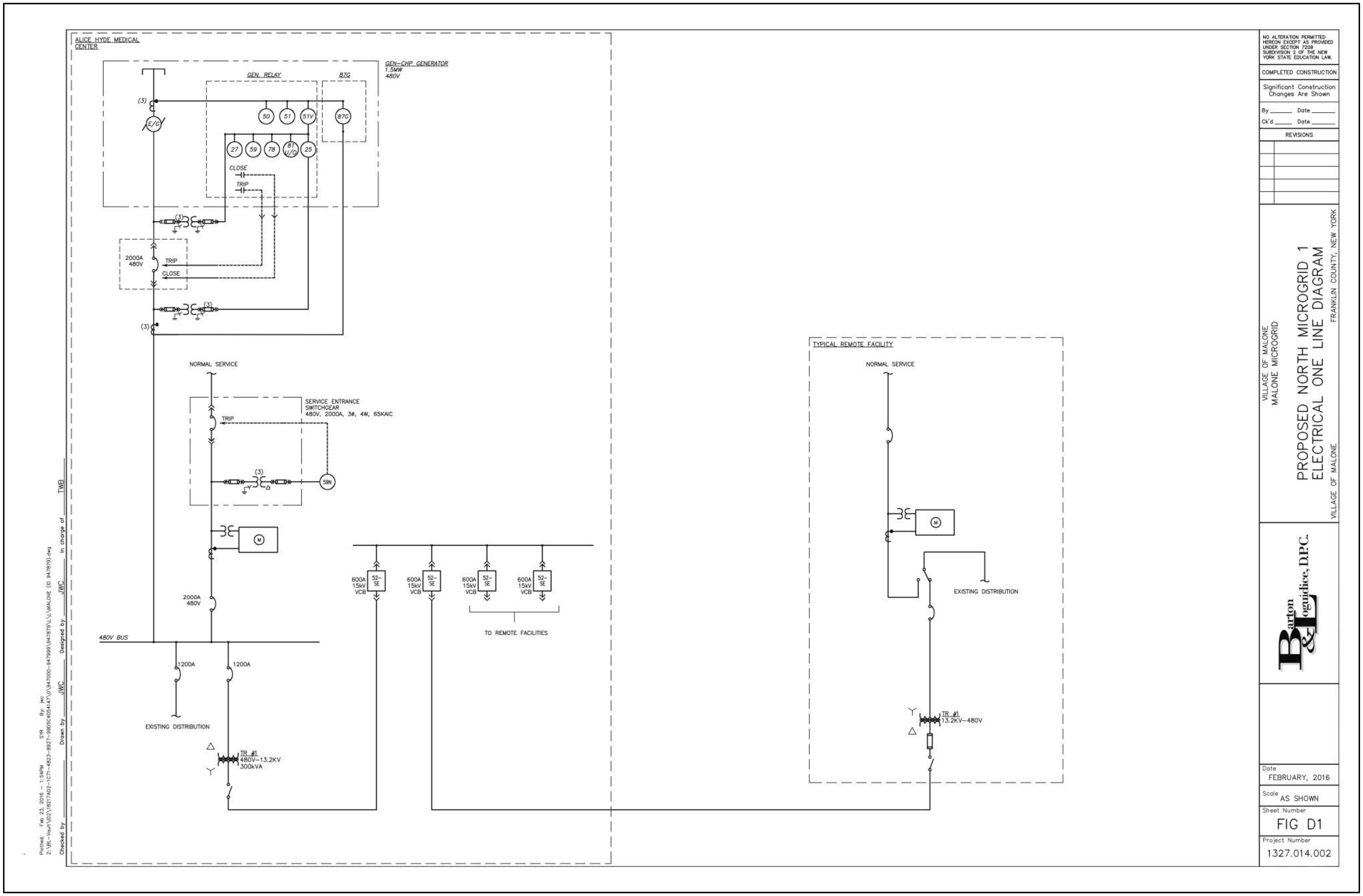
- Engine and Jacket Water 1,269 mmBTU/hr.
- Lube Oil 457 mmBTU/hr.
- Intercooler 1st Stage 657 mmBTU/hr.
- Exhaust Heat Exchanger 3,275 mmBTU/hr.

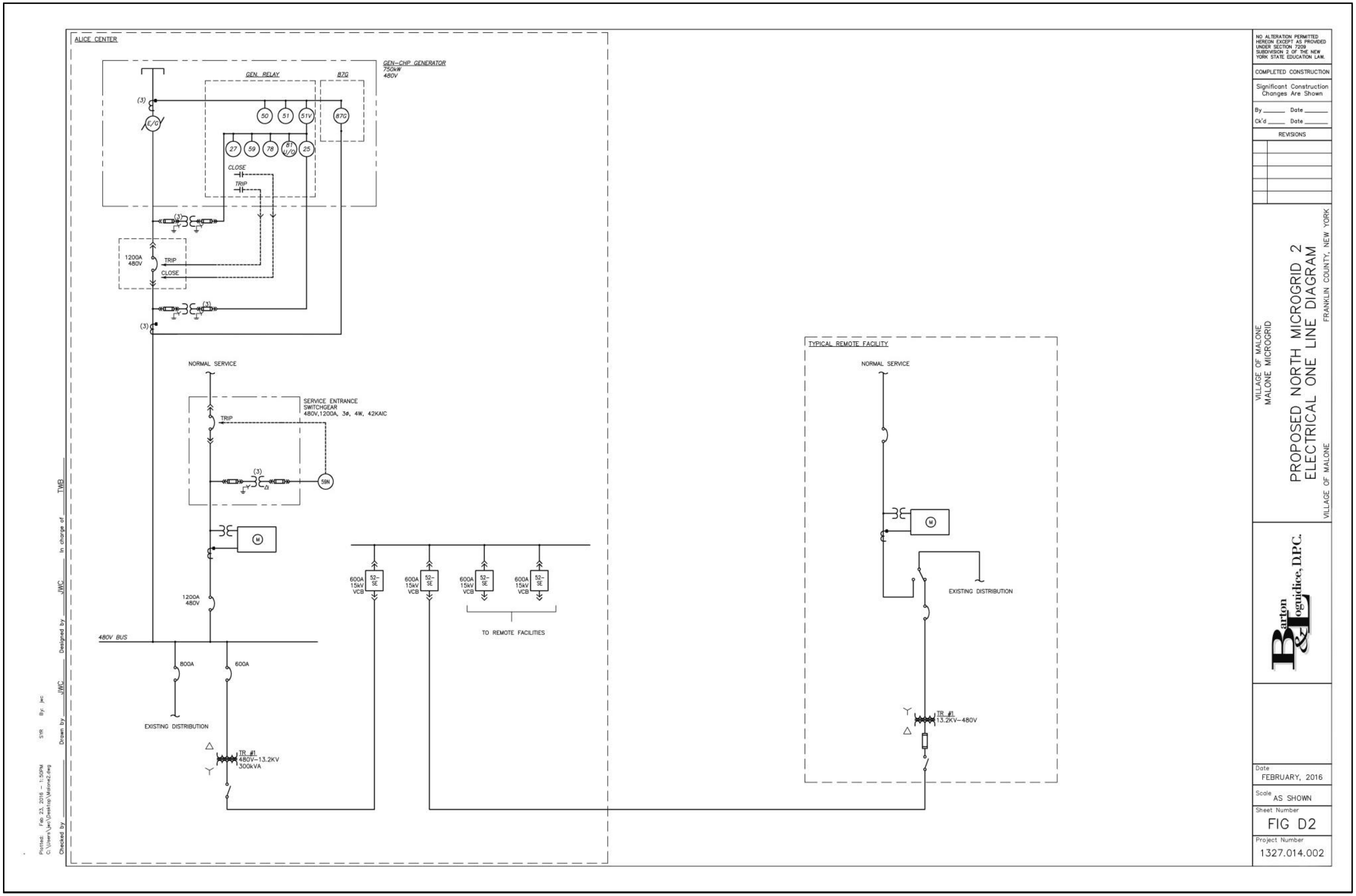
5, 659 mmBTU/hr.

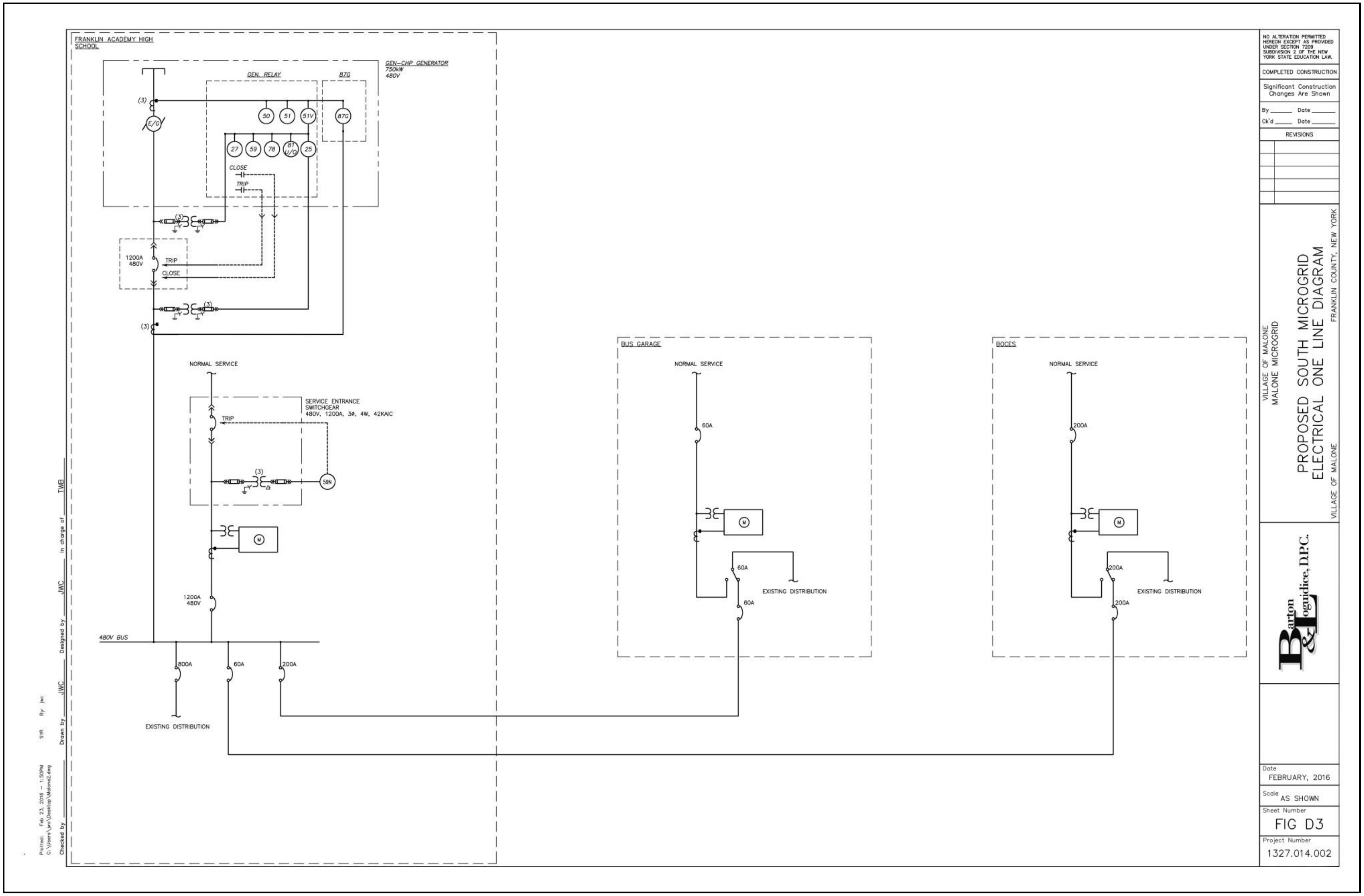
South Microgrid (per unit x2 JGS 312 CHP engine gensets)

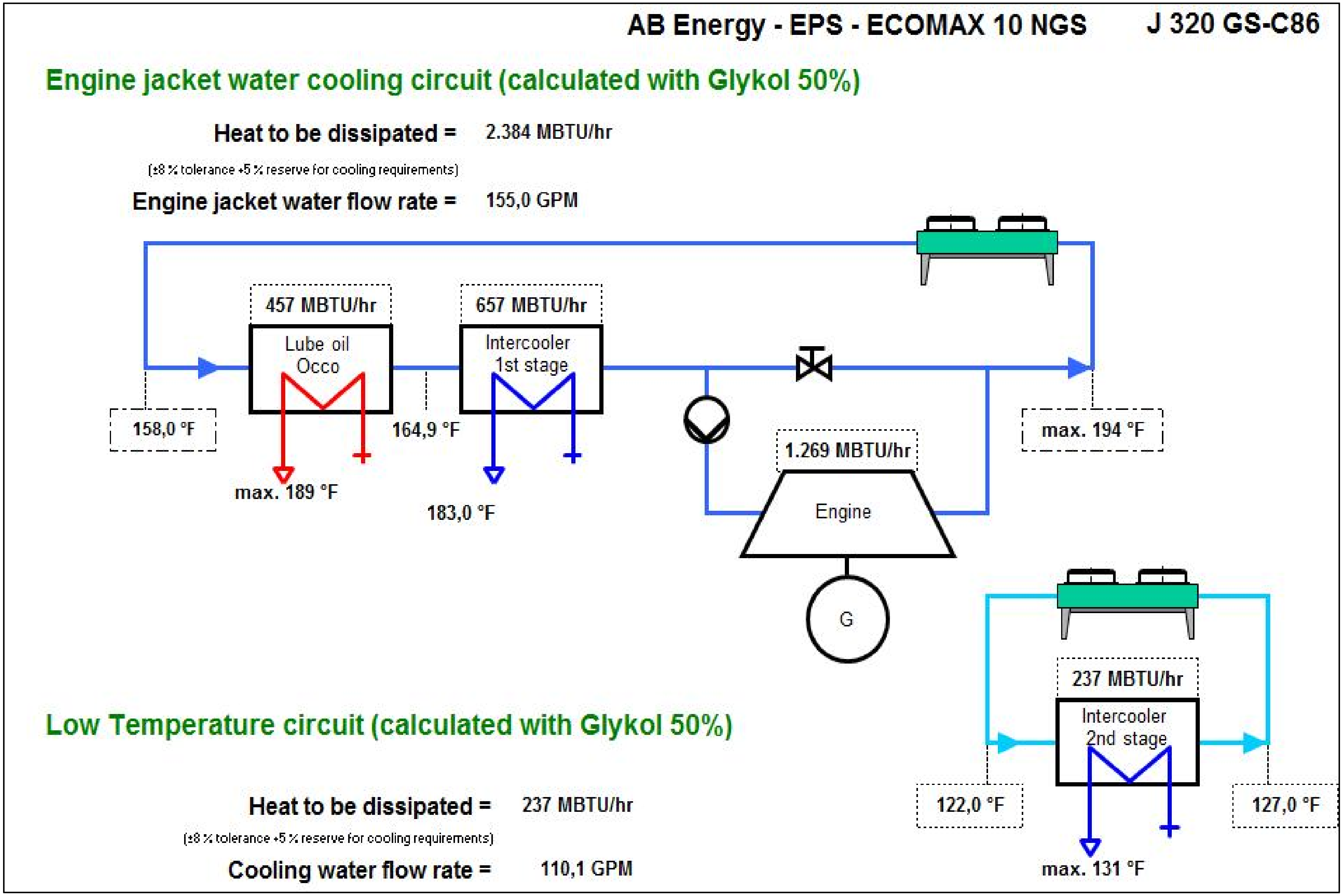
• Engine and Jacket Water	805 mmBTU/hr.
• Lube Oil	249 mmBTU/hr.
• Intercooler 1st Stage	157 mmBTU/hr.
• Exhaust Heat Exchanger	1,245 mmBTU/hr.
	2,456 mmBTU/hr.

Refer to the Electrical One-Line Diagram and the Process/Functional/Layout Diagrams that follow this section, which are also included in **Appendix D** and **Appendix G**, respectively.


ALICE HYDE MEDICAL CENTER
GEN-CHP GENERATOR 1.5MW 480V
GEN. RELAY
87G
50
51
51V
27
59
78
81 U/O
25
CLOSE
TRIP
2000A 480V
NORMAL SERVICE
SERVICE ENTRANCE SWITCHGEAR 480V, 2000A, 3ø, 4W, 65KAIC
59N
M
2000A 480V
480V BUS
1200A
1200A
EXISTING DISTRIBUTION
TR #1 480V-13.2KV 300kVA
600A 15kV VCB
52-SE
TO REMOTE FACILITIES
TYPICAL REMOTE FACILITY
NORMAL SERVICE
EXISTING DISTRIBUTION
TR #1 13.2KV-480V
NO ALTERATION PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW.
COMPLETED CONSTRUCTION
Significant Construction Changes Are Shown
By Date
Ck'd Date
REVISIONS
VILLAGE OF MALONE
MALONE MICROGRID
PROPOSED NORTH MICROGRID 1
ELECTRICAL ONE LINE DIAGRAM
FRANKLIN COUNTY, NEW YORK
VILLAGE OF MALONE
Barton & Loguidice, D.P.C.
Date FEBRUARY, 2016
Scale AS SHOWN
Sheet Number FIG D1
Project Number 1327.014.002


ALICE CENTER
GEN-CHP GENERATOR
750kW
480V
GEN. RELAY
87G
NORMAL SERVICE
SERVICE ENTRANCE SWITCHGEAR
480V,1200A, 3Ø, 4W, 42KAIC
1200A
480V
480V BUS
800A
600A
EXISTING DISTRIBUTION
TR #1
480V-13.2KV
300kVA
600A
15kV
VCB
TO REMOTE FACILITIES
TYPICAL REMOTE FACILITY
NORMAL SERVICE
EXISTING DISTRIBUTION
TR #1
13.2KV-480V
VILLAGE OF MALONE
MALONE MICROGRID
PROPOSED NORTH MICROGRID 2
ELECTRICAL ONE LINE DIAGRAM
VILLAGE OF MALONE
FRANKLIN COUNTY, NEW YORK
Barton & Loguidice, D.P.C.
Date
FEBRUARY, 2016
Scale
AS SHOWN
Sheet Number
FIG D2
Project Number
1327.014.002


FRANKLIN ACADEMY HIGH SCHOOL
GEN-CHP GENERATOR
750kW
480V
GEN. RELAY
87G
E/G
50
51
51V
27
59
78
81 U/O
25
CLOSE
TRIP
1200A
480V
NORMAL SERVICE
SERVICE ENTRANCE SWITCHGEAR
480V, 1200A, 3ø, 4W, 42KAIC
59N
480V BUS
800A
60A
200A
EXISTING DISTRIBUTION
BUS GARAGE
BOCES
NO ALTERATION PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW.
COMPLETED CONSTRUCTION
Significant Construction Changes Are Shown
REVISIONS
VILLAGE OF MALONE
MALONE MICROGRID
PROPOSED SOUTH MICROGRID
ELECTRICAL ONE LINE DIAGRAM
FRANKLIN COUNTY, NEW YORK
Barton & Loguidice, D.P.C.
Date FEBRUARY, 2016
Scale AS SHOWN
Sheet Number FIG D3
Project Number 1327.014.002


AB Energy - EPS - ECOMAX 10 NGS
J 320 GS-C86
Engine jacket water cooling circuit (calculated with Glykol 50%)
Heat to be dissipated = 2.384 MBTU/hr
(±8 % tolerance +5 % reserve for cooling requirements)
Engine jacket water flow rate = 155,0 GPM
457 MBTU/hr
Lube oil
Occo
657 MBTU/hr
Intercooler
1st stage
158,0 °F
164,9 °F
max. 189 °F
183,0 °F
1.269 MBTU/hr
Engine
max. 194 °F
G
Low Temperature circuit (calculated with Glykol 50%)
Heat to be dissipated = 237 MBTU/hr
(±8 % tolerance +5 % reserve for cooling requirements)
Cooling water flow rate = 110,1 GPM
237 MBTU/hr
Intercooler
2nd stage
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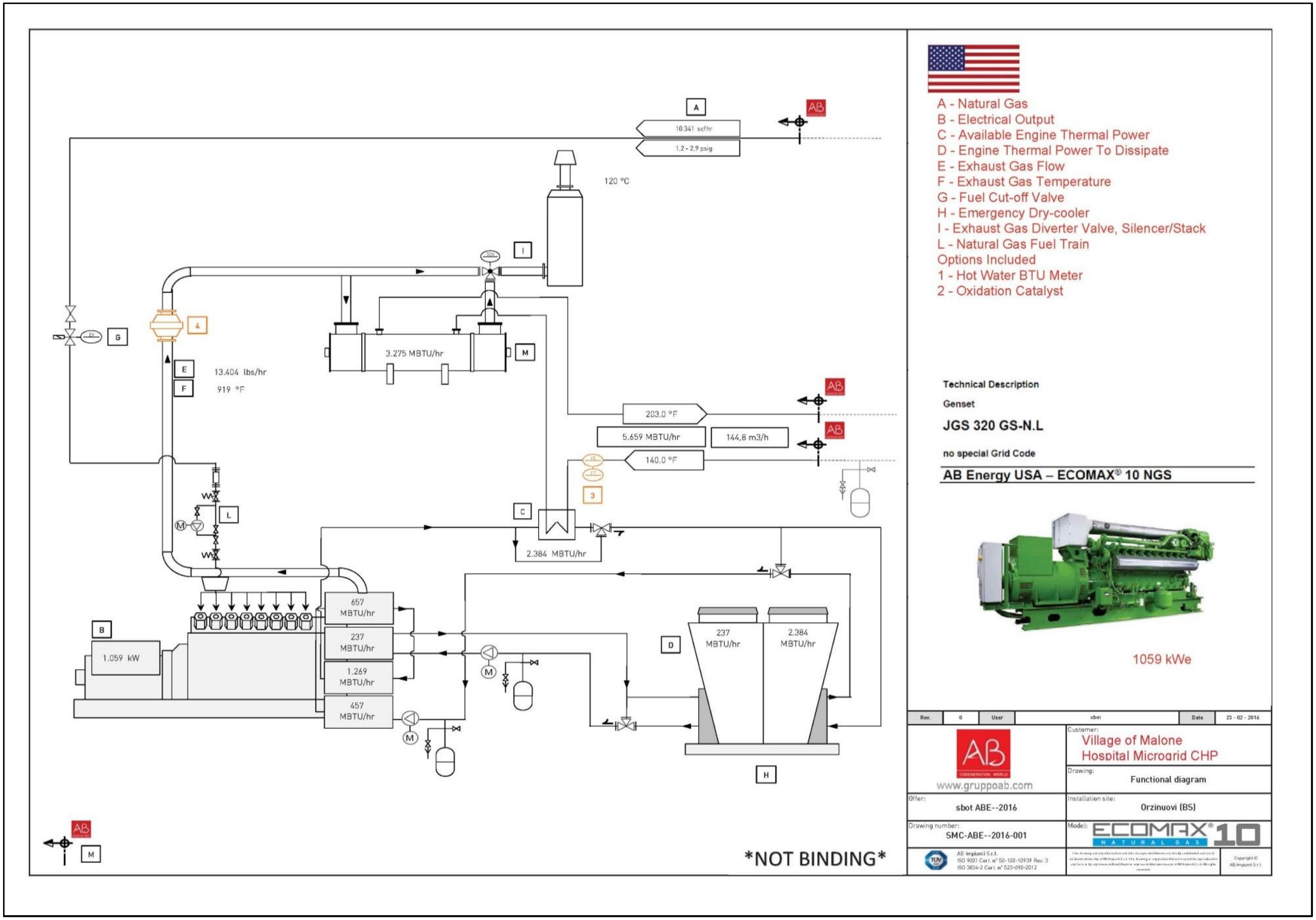
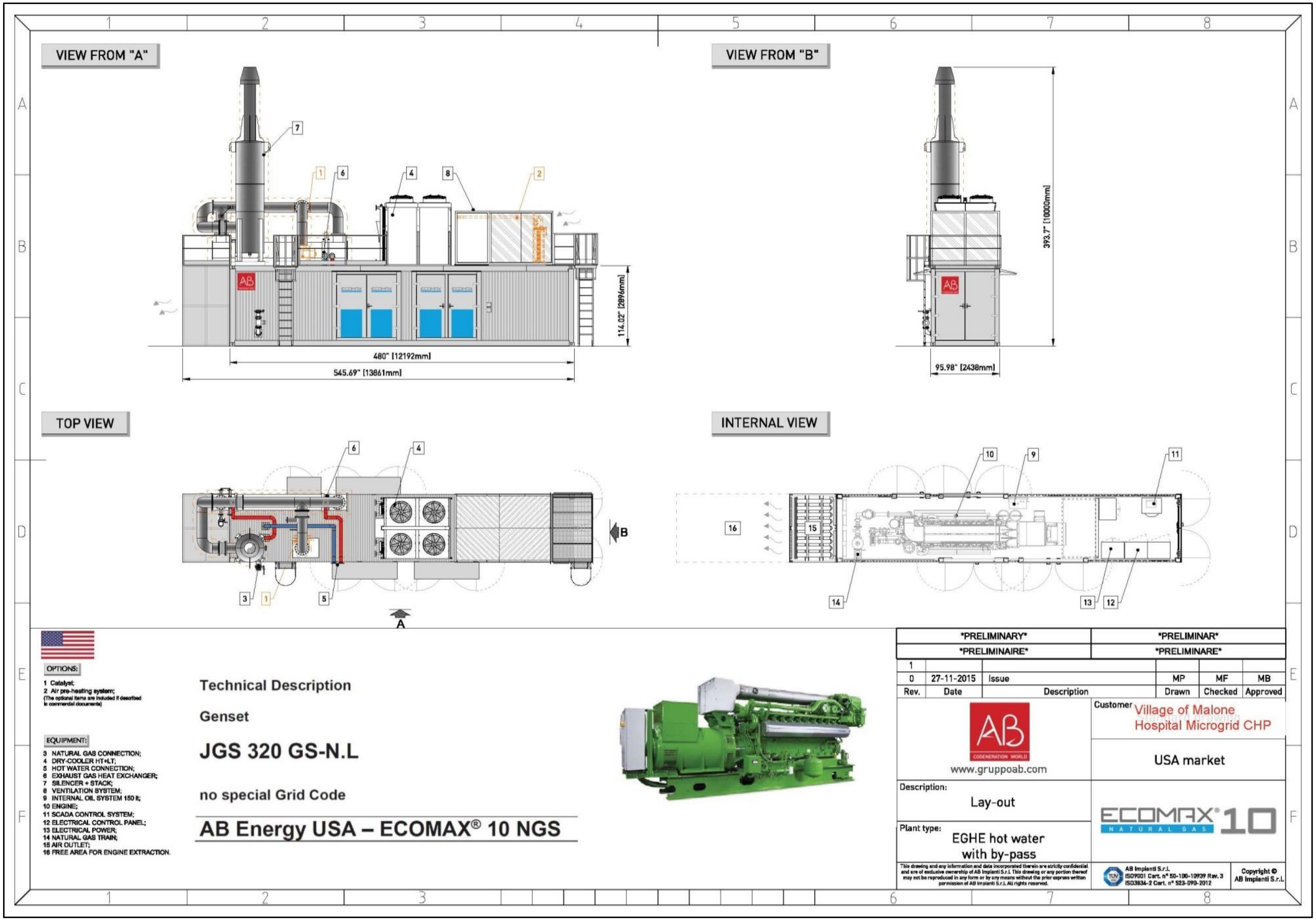
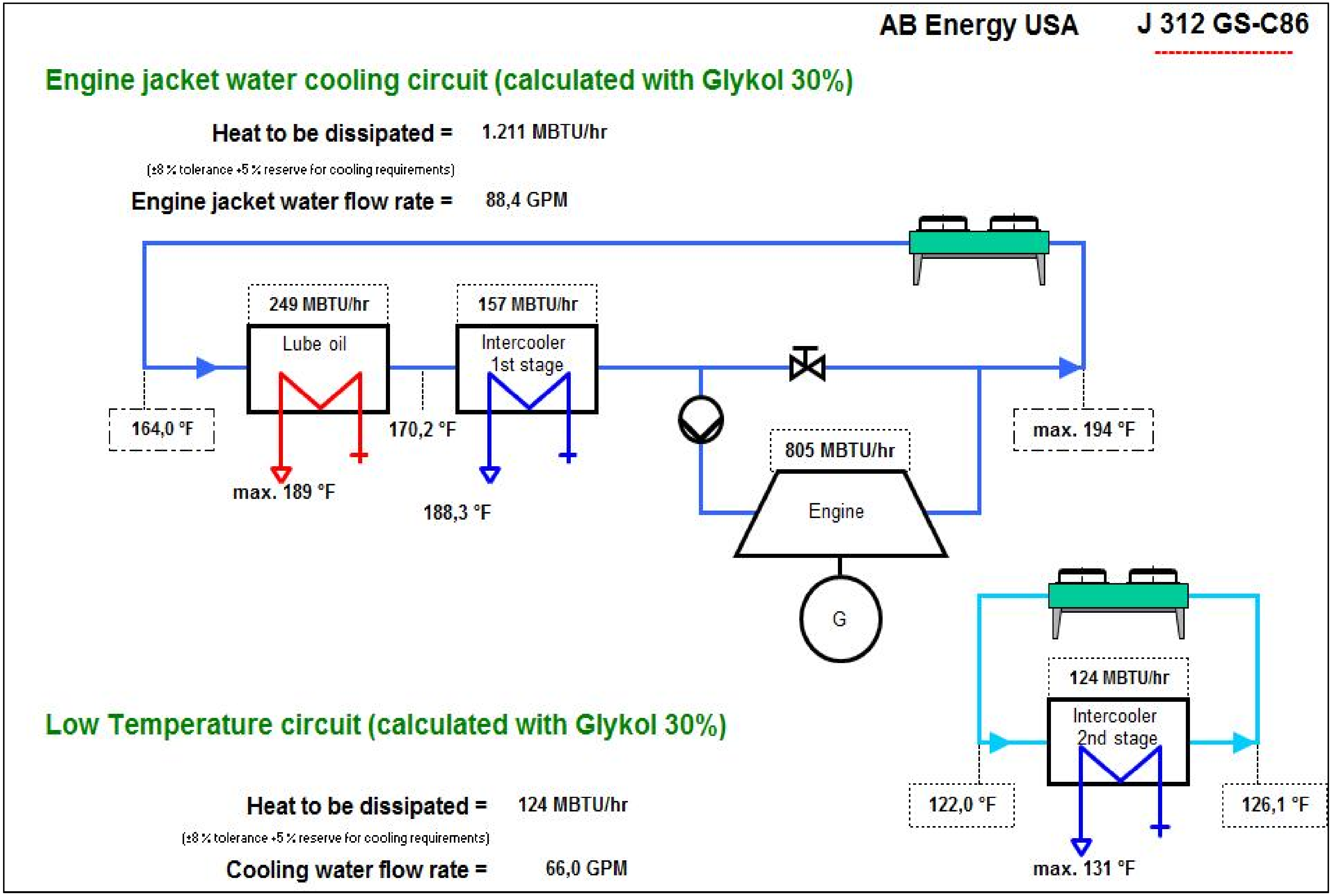
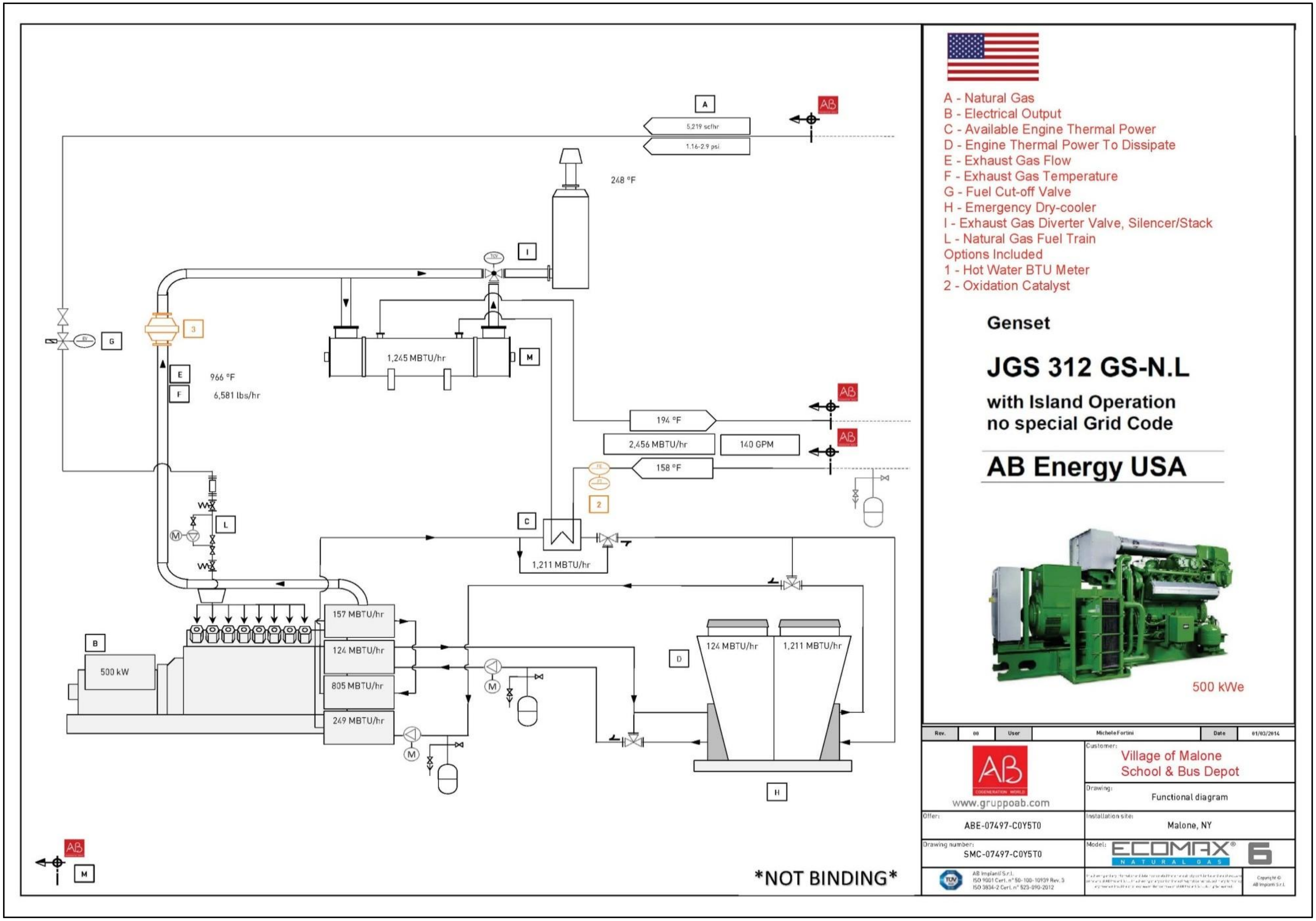
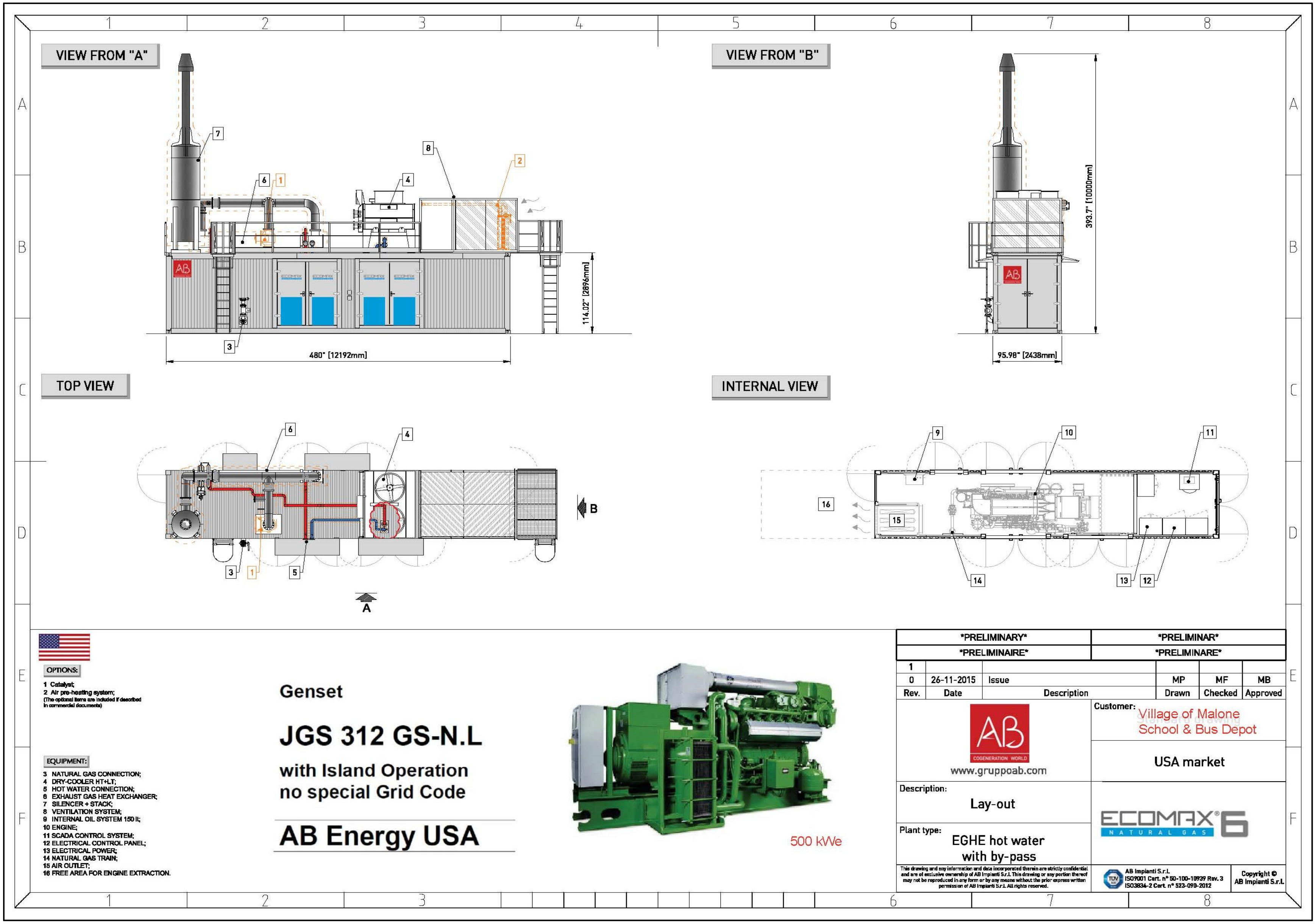
127,0 °F
max. 131 °F


A - Natural Gas
B - Electrical Output
C - Available Engine Thermal Power
D - Engine Thermal Power To Dissipate
E - Exhaust Gas Flow
F - Exhaust Gas Temperature
G - Fuel Cut-off Valve
H - Emergency Dry-cooler
I - Exhaust Gas Diverter Valve, Silencer/Stack
L - Natural Gas Fuel Train
Options Included
1 - Hot Water BTU Meter
2 - Oxidation Catalyst
Technical Description
Genset
JGS 320 GS-N.L
no special Grid Code
AB Energy USA – ECOMAX® 10 NGS
1059 kWe
10.341 scfhr
1.2 - 2.9 psig
120 °C
3.275 MBTU/hr
13.404 lbs/hr
919 °F
203.0 °F
5.659 MBTU/hr
144,8 m3/h
140.0 °F
2.384 MBTU/hr
1.059 kW
657 MBTU/hr
237 MBTU/hr
1.269 MBTU/hr
457 MBTU/hr
237 MBTU/hr
2.384 MBTU/hr
Customer:
Village of Malone
Hospital Microgrid CHP
Drawing:
Functional diagram
Offer:
sbot ABE--2016
Installation site:
Orzinuovi (BS)
Drawing number:
SMC-ABE--2016-001
Model:
ECOMAX 10
NATURAL GAS
www.gruppoab.com
NOT BINDING


VIEW FROM "A"
VIEW FROM "B"
480" [12192mm]
545.69" [13861mm]
114.02" [2896mm]
393.7" [10000mm]
95.98" [2438mm]
TOP VIEW
INTERNAL VIEW
OPTIONS:
1 Catalyst;
2 Air pre-heating system;
(The optional items are included if described in commercial documents)
EQUIPMENT:
3 NATURAL GAS CONNECTION;
4 DRY-COOLER HT+LT;
5 HOT WATER CONNECTION;
6 EXHAUST GAS HEAT EXCHANGER;
7 SILENCER + STACK;
8 VENTILATION SYSTEM;
9 INTERNAL OIL SYSTEM 150 lt;
10 ENGINE;
11 SCADA CONTROL SYSTEM;
12 ELECTRICAL CONTROL PANEL;
13 ELECTRICAL POWER;
14 NATURAL GAS TRAIN;
15 AIR OUTLET;
16 FREE AREA FOR ENGINE EXTRACTION.
Technical Description
Genset
JGS 320 GS-N.L
no special Grid Code
AB Energy USA – ECOMAX® 10 NGS
PRELIMINARY
PRELIMINAR
PRELIMINAIRE
PRELIMINARE
0 27-11-2015 Issue MP MF MB
Rev. Date Description Drawn Checked Approved
www.gruppoab.com
Customer Village of Malone Hospital Microgrid CHP
USA market
Description: Lay-out
Plant type: EGHE hot water with by-pass
ECOMAX 10
Copyright © AB Impianti S.r.L


AB Energy USA
J 312 GS-C86
Engine jacket water cooling circuit (calculated with Glykol 30%)
Heat to be dissipated = 1.211 MBTU/hr
(±8 % tolerance +5 % reserve for cooling requirements)
Engine jacket water flow rate = 88,4 GPM
249 MBTU/hr
Lube oil
157 MBTU/hr
Intercooler 1st stage
164,0 °F
170,2 °F
max. 189 °F
188,3 °F
805 MBTU/hr
Engine
max. 194 °F
G
124 MBTU/hr
Intercooler 2nd stage
Low Temperature circuit (calculated with Glykol 30%)
Heat to be dissipated = 124 MBTU/hr
(±8 % tolerance +5 % reserve for cooling requirements)
Cooling water flow rate = 66,0 GPM
122,0 °F
126,1 °F
max. 131 °F


A
5,219 scfhr
1.16-2.9 psi
248 °F
I
G
3
1,245 MBTU/hr
M
E
F
966 °F
6,581 lbs/hr
194 °F
2,456 MBTU/hr
140 GPM
158 °F
2
L
C
1,211 MBTU/hr
157 MBTU/hr
124 MBTU/hr
805 MBTU/hr
249 MBTU/hr
B
500 kW
D
124 MBTU/hr
1,211 MBTU/hr
H
M
NOT BINDING
A - Natural Gas
B - Electrical Output
C - Available Engine Thermal Power
D - Engine Thermal Power To Dissipate
E - Exhaust Gas Flow
F - Exhaust Gas Temperature
G - Fuel Cut-off Valve
H - Emergency Dry-cooler
I - Exhaust Gas Diverter Valve, Silencer/Stack
L - Natural Gas Fuel Train
Options Included
1 - Hot Water BTU Meter
2 - Oxidation Catalyst
Genset
JGS 312 GS-N.L
with Island Operation
no special Grid Code
AB Energy USA
500 kWe
Rev.
00
User
Michele Fortini
Date
01/03/2016
Customer:
Village of Malone
School & Bus Depot
www.gruppoab.com
Drawing:
Functional diagram
Offer:
ABE-07497-C0Y5T0
Installation site:
Malone, NY
Drawing number:
SMC-07497-C0Y5T0
Model:
ECOMAX
NATURAL GAS
6


VIEW FROM "A"
VIEW FROM "B"
TOP VIEW
INTERNAL VIEW
480" [12192mm]
114.02" [2896mm]
393.7" [10000mm]
95.98" [2438mm]
A
B
OPTIONS:
1 Catalyst;
2 Air pre-heating system;
(The optional items are included if described in commercial documents)
EQUIPMENT:
3 NATURAL GAS CONNECTION;
4 DRY-COOLER HT+LT;
5 HOT WATER CONNECTION;
6 EXHAUST GAS HEAT EXCHANGER;
7 SILENCER + STACK;
8 VENTILATION SYSTEM;
9 INTERNAL OIL SYSTEM 150 lt;
10 ENGINE;
11 SCADA CONTROL SYSTEM;
12 ELECTRICAL CONTROL PANEL;
13 ELECTRICAL POWER;
14 NATURAL GAS TRAIN;
15 AIR OUTLET;
16 FREE AREA FOR ENGINE EXTRACTION.
Genset
JGS 312 GS-N.L
with Island Operation
no special Grid Code
AB Energy USA
500 kWe
PRELIMINARY
PRELIMINAR
PRELIMINAIRE
PRELIMINARE
1
0 26-11-2015 Issue MP MF MB
Rev. Date Description Drawn Checked Approved
Customer: Village of Malone School & Bus Depot
www.gruppoab.com
USA market
Description: Lay-out
Plant type: EGHE hot water with by-pass
ECOMAX® 6 NATURAL GAS
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ISO3834-2 Cert. n° 523-090-2012
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2.3 Distributed Energy Resources Characterization

As discussed in previous sections, the potential for the integration of various DERs was investigated. The proposed DERs in the Village of Malone's microgrids, located at host sites, provide the electricity needed to supply the proposed microgrids. During grid emergencies and outages, the proposed DERs will support the demand and usage of the facilities within the microgrids to create redundancy and provide a resource to supplement the existing electrical distribution system that services these facilities.

There are no proposed renewables such as photovoltaic (PV) or wind energy power as scheduled DERs within the microgrids. More specifically, this means that renewable generation is a project goal, but such power will not be counted toward meeting demand and usage requirements during a grid emergency/ outage. This is due to the fact that PV power by itself is not sufficiently reliable in certain conditions, such as emergency situations that occur after sunset and seasonal conditions (snow, ice, etc.) that may limit the effectiveness of PV power. Wind energy may also be affected by seasonal conditions and atmospheric conditions, therefore wind energy provided power may not be as reliable as other power supplies. These limitations make scheduling of power from PV, wind energy or other intermittent renewables very difficult as demand has to react to supply vs supply reacting to demand.

While UPS battery storage coupled with PV or wind power supply could address this issue to some extent, it can be cost prohibitive. Information regarding battery storage systems was gathered to investigate the potential to utilize more renewables as scheduled power within the microgrids. Other renewables such has hydroelectric generation have not been included as a DER within the microgrid because of their distance to the microgrid locations or complexity of integration.

While they are not scheduled, the proposed renewable generation can be utilized in the microgrid if available in parallel operation during either normal grid operation or during emergencies. In an emergency situation, any renewable generation would then reduce the demand on the CHP units and they would adjust to the lower load but remain capable of picking up that load should the renewable source reduce output. Refer to **Tables 2C and 2D** for DER parameters.

Table 2C
Distributed Energy Resources – Northern Microgrid

Type of DER	Capacity (kWe)	Rating (BTU/kW)	Fuel (Gas, Oil, Etc.)	Location	New or Existing	Space Available
Reciprocating Engines CHP gensets	2,120	8,950	Natural Gas	Medical Center	New	Yes
PV	250*	0	Sun	Center Roof Top	New	Yes

**renewables not counted as part of total available power that can be scheduled on the microgrid during an emergency.*

At full deployment of the DERs (generation sources – CHP engine gensets) to the microgrid system at the host sites, the total system capacity in island mode for the Northern Microgrid is expected to be as follows, assuming 90% annual availability of the CHP Systems:

- Peak Generation Capacity: 2.12 MW.
- Annual Generation Capacity: 16,700 MWh.
- Monthly Generation Capacity: 1,390 MWh.
- Weekly Generation Capacity: 321 MWh.
- Annual Heat Output: 89,250 mmBTU.
- Weekly Heat Output: 1,720 mmBTU.

Table 2D
Distributed Energy Resources – Southern Microgrid

Type of DER	Capacity (kWe)	Rating (BTU/kW)	Fuel (Gas, Oil, Etc.)	Location	New or Existing	Space Available
Recip engines CHP	1,000	9,236	Natural Gas	Open Area	New	Yes
PV	50*	0	Sun	Roof Top	New	Yes

**renewables not counted as part of total available power that can be scheduled on the microgrid during an emergency.*

At full deployment of the DERs (generation sources – CHP engine gensets) to the microgrid system at the host sites, the total system capacity in island mode for the Southern Microgrid is expected to be as follows, assuming 90% annual availability of the CHP Systems:

- Peak Generation Capacity: 1 MW.
- Annual Generation Capacity: 7,880 MWh.
- Monthly Generation Capacity: 657 MWh.
- Weekly Generation Capacity: 152 MWh.
- Annual Heat Output: 38,700 mmBTU.
- Weekly Heat Output: 744 mmBTU.

Since net metering of CHP fired (fueled) non-renewables such as natural gas is not currently allowed by the New York Public Service Commission rules, the CHP engine gensets at the host sites will generally be operated to follow the site's normal load profile so as not to push power to the grid at a low generation value. During grid emergencies/outages, power would be put back onto the microgrid. Heat from the engines may still be used at the host sites either as heating or as the energy source for absorption cooling.

CHP engine gensets have proved to be a reliable source of electricity generation, as well as heat supply. The majority of the microgrid will be supplied using CHP equipment as the engine gensets are easily scheduled and are not impacted by the vast majority of local environmental conditions in the way PV and wind energy may be impacted during emergency situations. CHP engine gensets are virtually unaffected by forces of nature as the units are typically installed inside a weather resistant enclosure or building. The enclosure is typically designed to withstand appropriate wind velocities and snow loads for the site location. The CHP engine gensets will be sited to avoid nearby trees, which may cause a hazard during storm events. CHP engine gensets will typically be installed on a raised concrete pad outside of flood zones which limits rainwater/flood waters from gathering inside or around the enclosure. Proposed generation sources at the host sites would be located and installed to be a minimum of 2-feet above the 100-year floodplain in accordance with FEMA and other recognized codes and standards for critical infrastructure systems. Any structures and or electrical components will be built according to Building Code with any necessary seismic design in order to prevent damage in the event of an earthquake.

The CHP engine gensets will be supplied by a buried natural gas pipeline with compression sources located far away from the microgrid facilities such that local conditions will not have an impact on the supply of gas. Since the pipeline is buried, it is not susceptible to typical forces of nature such as wind, ice, snow, etc. that typically impact above ground infrastructure. Additionally, since the source of the gas and its pressure is not local to the Village of Malone, it is much less likely that both the Village and the remote compressor station will experience the same type of emergency at the same time. As a fuel source, utility supplied pipeline natural gas is a very robust system and is a virtually an uninterruptable fuel supply. It is anticipated that natural gas will be able to be supplied to the Village of Malone during an emergency situation continuously, for the duration of the emergency event. Necessary procedures or agreements will be arranged between the critical host facilities and the natural gas supplier, to guarantee uninterruptable service to the CHP engine gensets during an emergency situation.

Scheduled maintenance required on the natural gas pipeline that would cause a natural gas service outage, if any, would be conducted with prior notification to the critical facilities and the electric utility. Scheduled maintenance would likely be very brief, and will not occur during actual emergency outages through the uninterruptable service agreement between the critical facilities and the gas utility. Because of their resiliency to local environmental conditions, CHP engine gensets are a continuously reliable source of power for the microgrid.

CHP engine gensets will also require scheduled maintenance, but typically the timing of this maintenance can be scheduled and adjusted around emergency events so this is an unlikely potential failure point of the microgrid. Typical routine maintenance may include changing filters (oil, air, etc), changing oil and spark plugs, maintaining batteries and coolant, monitoring system performance parameters to identify potential system problems, etc. Other than in the case of actual failure of equipment, these maintenance tasks can be delayed if an emergency should take place at the time scheduled maintenance. Additionally, excess capacity has been designed into the microgrid systems so that the peak demand of the system should be able to be met at any time should an emergency arise.

The greatest risk of failure for the Northern and Southern Microgrids will be the secondary islanded distribution lines, such as any overhead power lines. The DERs will be able to generate power, but if the rest of the microgrid infrastructure is exposed to the extreme conditions, this would be the most likely point of failure. As such, it is recommended that any new distribution lines for either microgrid be buried or be clear from any vegetation to increase overall reliability of the electrical system.

For more detailed information on the functions and capabilities of the CHP engine gensets, refer to **Section 3.1** and **Appendix I**: Technical Instruction Manual for Isolated Operation of Spark Ignition Gas

Engines with DIA.NE (Type 4 Engines), TA 2108-0029 and Technical Instruction Manual for General Isolated Operation of Plants and Engines, TA 2108-0031 Page 5 of 19.

2.4 Electrical and Thermal Infrastructure Characterization

As outlined in an Electrical One-Line Diagrams included in **Section 2.2** and attached in **Appendix D**, the current Village electrical infrastructure includes feeders to two (2) National Grid substations from electrical sub-transmission lines. One substation generally services the Northern part of the village and the second substation services the rest of the Village. At each substation, has step down transformers that drop the voltage from 115kV and 34.5kV, 3 phase to 4.8kV local distribution lines. Voltage is then stepped down again at the facilities or host sites via on site transformers to 480 or 110/220V.

Currently, there is no district heating within the Village. Most commercial buildings and industrial facilities are heated by oil, natural gas or electric heat. Many residences are heated by electric heat. Those that heat with electricity are most vulnerable if there was an extended power outage during cold weather. The microgrids will safeguard that situation, and community facilities like hospitals will be functional for medical services and schools will be available as shelter locations in such instances.

Heat generated by the DERs that will be part of the microgrids will normally be utilized by the main hospital facility in the Northern part of the Village, and the high school in the Southern part of the Village. Generally these systems will consist of heat exchangers connected to the high temperature jackets water circuits on the CHP engine genset, and within the exhaust system to recover the majority of the heat generated from the engines during operation. This heat is then transferred into the host site facility's hot water system for use throughout the facility, and returned at a lower temperature to absorb more heat from the engines. This makes for a highly efficient use of the BTUs generated by combustion of the natural gas on the host site. As previously mentioned, in warm weather, the heat can be used to power absorption chillers that can provide cooling, thereby providing virtually year round use of the heat from the engine gensets to maximize efficiency of the systems. Regarding the combustion of natural gas through the DERs/generation sources (CHP engine gensets), estimated emissions based on the manufacturer's performance data is provided in **Section 4.3** and in **Appendix E**.

As discussed in previous sections, the generation portion of the microgrids has been envisioned to be fairly impervious to forces of nature. The most likely risks to the system might include:

- High winds
- Snow, ice, and very cold weather
- Lightning
- Transmission line damage in and out of the area (trees/limbs, animals, accidents)

The DER portion of the microgrids will be protected from the above referenced forces of nature by their location, design precautions and the facilities around them. Additionally, generation will be sited outside the flood areas within the Village. Wiring, cables, controls and/or equipment can be protected by direct burial or protected with enclosures or structures placed around them, as feasible and cost effective. Additionally, effective protective equipment and system design will make the microgrid system resilient. Modern solid-state relays and controls on the generation source and the feeder breakers/reclosers allow for fast removal of equipment from the electrical systems during a ground faults and system anomalies, appropriately designed grounding systems, system lightning protection and other protective methods will be utilized.

Avoidance of problems and hazards are essential to the reliability and resiliency of the microgrids. As the Village maintains their own system, they control the staff, equipment, maintenance schedules and supplies to address problems as they arise. Should a portion of the microgrid system require repair, standard preventative and responsive maintenance practices like having a spare parts inventory (materials in stock), following manufacturer's recommended service intervals, maintaining current and correct industry-specific training for staff, utilizing asset management systems, etc. will help ensure that the microgrid system is robust, reliable, and easier to maintain and therefore keep outages to a minimum.

Another potential risk to the microgrids' functionality is the supply of fuel, natural gas. This is addressed both through the general robustness of the natural gas utility system, and the contractual agreements (for completion in the future) that facilitate continuous supply. Because both supply and the energy required to convey the gas through the piping networks are typically not local, weather related issues affecting both of the microgrids and where natural gas compressor station is located (i.e. the delivery system) is unlikely. Additionally, the gas infrastructure is buried further protecting it from wind, snow, ice, etc. With proper protection of the generation sources, secure fuel supply, and protection and maintenance of the grid itself, the Village's system is very resilient and reliable.

2.5 Microgrid and Building Controls Characterization

The controls that will manage the Northern and Southern Microgrid systems will be located at the at the DER locations, the host sites. These controls have to automatically take the microgrid off its normal connection to the utility distribution lines, and island the microgrid in order for it to operate off of internal generation. As referenced in **Section 2.1**, the controls normally included in the parallel interconnection of CHP engine gensets will be utilized at the DER locations. When the external transmission supply goes down or is out of spec and the microgrid is isolated, the DER controls will work the same as in parallel operation except that the facilities within the microgrid will be supplied by the secondary islanded distribution lines.

The microgrid will provide the ability for maintaining voltage and frequency as well as data logging for the microgrid systems during parallel operation and during the use of the secondary distribution system. These functions and capabilities are further described **Section 3** of this Feasibility Study and are summarized below.

- Maintaining Voltage and Frequency – the SCADA System for the CHP engine gensets, the synchronization controllers and other related equipment will help maintain, monitor and adjust the microgrid system to maintain voltage and frequency in accordance with regulatory and industry standards.
- Data Logging – the SCADA System will provide for real-time and archive data logging, which can be used on a daily/weekly/monthly/annual basis or emergency grid outage basis to assess the functionality and performance of the microgrid system.

The Electrical One-Line Diagrams included in **Section 2.2** and in **Appendix D** outline the general connection and control scheme for the Northern and Southern Microgrids. Typical generator and utility protection relays and paralleling gear will be utilized at the DER host sites. These systems interface with PLC controls, HMIs and data logging to control and monitor the systems. Regarding the existing primary power supply to the Village, the National Grid substations and the secondary islanded distribution lines, generally split up the Village in areas of service from specific substations in different parts of the Village (refer to **Appendix F**). To provide local redundancy and resilience, the CHP systems have been designed around a system by AB Energy North American, a world leader and supplier of fully integrated CHP systems.

Appendix G includes the Functional Diagrams and Layouts for the natural gas fired CHP systems that will be combined to provide the necessary generation to support heating and cooling loads during normal operation, or provide microgrid power in grid emergencies. This equipment will allow the facilities to both generate electrical power during both normal and grid emergencies, and will allow facilities to utilize the thermal component year round for heating or cooling. **Appendix G** and **Appendix I** contain technical data sheets for natural gas fired CHP modules and the protection control equipment that will be combined to provide the necessary generation to support the facility's activities during normal operation, or provide microgrid power in grid emergencies. Also included in **Appendix G** is equipment and system process information on the "tri-generation" (power, heating and cooling) equipment.

2.6 Information Technology (IT)/Telecommunications Infrastructure Characterization

The majority of the controls for the microgrid system are utility protection relay systems that can have UPS supply backup power so that they can continuously operate the microgrid's controls system whether externally connected to transmission electricity of the primary or main grid, or operating off of local microgrid power. The intended purpose of UPS supplies is to provide short-term backup power, a few minutes to a few hours until the microgrids DERs provide power to the microgrids and recharge the control system batteries. UPS backup power supplies can be sized for longer durations, but there is little need as it is likely that the DERs will be operating and provide power to charge the UPS batteries and sustain the system indefinitely as long as fuel is available.

Communications between the substation circuit controllers and the DER control systems at the host sites are necessary to facilitate a smooth loading of the engine gensets during a transition to microgrid power so that too much load isn't put onto the engines, which could result in a protective shutdown thereby causing a continuation of an outage. These communication system connections could be facilitated in a number of ways; either through direct fiber or wire connections for point to point, or through cellular connections that would be encrypted and where communications equipment would have backup power storage or generation to ensure uninterrupted communications.

Because the IT system and its potential components (e.g. protective relay controls, HMI, SCADA systems, etc.) can be powered from various sources, and will be appropriately protected, along with the fact that much of the control equipment senses conditions locally so it is not dependent on coordinated communications makes the IT system for the microgrid more resilient and reliable. The communications system mostly serves to monitor the microgrid system rather than provide actual control.

The monitoring system can be designed to provide remote access via a password protected virtual private network connection. This remote monitoring system allows for alarm autodial and troubleshooting by responsible employees who may be on call. The system will allow for monitoring but no control of the system to provide further system security.

3.0 Assessment of Microgrid's Commercial and Financial Feasibility

3.1 Commercial Viability – Customers

The Village of Malone has a population of 5,911 individuals according to the 2010 U.S. census. These individuals would all be affected in the event of a grid emergency or outage that impacts the critical loads within the community in addition to the public-service, the commercial and other electric users within the Village. The development of the microgrids within the Village will have a number of benefits, the greatest being increased emergency service capacity during grid emergencies including: the operation of the Alice Hyde Hospital (medical center), and emergency shelter, emergency command and control, and potential emergency transportation capacity from the School Facilities in the southern part of the Village (Southern Microgrid). At this time there will not be additional microgrid stakeholders indirectly affected positively or negatively by the microgrid.

The proposed critical facility end-users within the Village that would potentially utilize the microgrids include: two (2) schools in the Village, a bus garage, and seventeen (17) auxiliary buildings to the main Alice Hyde Hospital, including the hospital building itself. These facilities serve many potential public services during emergencies including: emergency shelter (schools) and medical services (hospital complex).

- Northern Microgrid – Alice Hyde Hospital and Medical Center (i.e. Alice Hyde Hospital). Two CHP engine gensets are anticipated to be located at the medical complex along with a secondary distribution system to power the other building on the medical campus during emergencies. This includes seventeen (17) auxiliary buildings to the main Alice Hyde Hospital, including the hospital building itself.
- Southern Microgrid – Franklin Academy High School, Bus Garage, and the Franklin-Essex-Hamilton (BOCES). Two CHP engine gensets are anticipated to be located at the Franklin Academy High School with a secondary distribution system to power the local bus garage facility and the BOCES School during emergencies. These facilities serve many potential public services during emergencies such as emergency shelters.

At this time, the specific terms and arrangements between participants/customers of the proposed microgrid and the microgrid owner/operator have not been fully developed nor executed.

Tables 3A1 and **3A2** provide the estimated facility loading requirements for the referenced critical public facilities. It was estimated that the primary medical and shelter facilities will require up to 24-hours of emergency power during an emergency grid outage to sustain emergency medical services as well as shelter services for food and water supply and the prevention of inventory food spoilage at the schools.

Table 3A1
Facility Loading for Potential Properties
Identified as Critical Tier I and II Facilities for the Microgrid System

ID	Critical Facility	Average Annual Electricity Usage per Customer (MWh)	Peak Electricity Demand per Customer (MW)	Percent of Average Usage Microgrid Could Support During Outage	Hours of Electricity Required Per Day During Outage
Northern Microgrid					
1	Dental Center	37.4	0.02	100%	24
2	Walk-In Clinic	65	0.02	100%	24
3	Fisk Massey 24 4th Street	4.4	Not reported	100%	24
4	Fisk Massey 16 4th Street	3.8	Not reported	100%	24
5	Fisk Massey	15.6	0.02	100%	24
6	Fisk Massey 16 4th Street	10.9	Not reported	100%	24
7	Fisk Massey 16 4th Street	6.4	Not reported	100%	24
8	MRI Addition	265	0.05	100%	24
9	Alice Hyde Medical Center	4,009	0.89	100%	24
10	HDU	164	0.05	100%	24
11	Cancer Center	123	0.04	100%	24
12	Fisk Massey 16 4th Street	5.2	Not reported	100%	24
13	199 Park Street	36.8	Not reported	100%	24
14	Alice Center	1,550	0.47	100%	24
15	234 Park Street	54.9	Not reported	100%	24
16	Helicopter Pad	2.8	Not reported	100%	24
17	Dental Center	37.5	0.02	100%	0-10

Table 3A2
Facility Loading for Potential Properties
Identified as Critical Tier I and II Facilities for the Microgrid System

ID	Critical Facility	Average Annual Electricity Usage per Customer (MWh)	Peak Electricity Demand per Customer (MW)	Percent of Average Usage Microgrid Could Support During Outage	Hours of Electricity Required Per Day During Outage
Southern Microgrid					
1	Franklin Academy High School	12	0.492	100%	10-24
2	Bus Garage	283	0.014	100%	10
3	Franklin-Essex-Hamilton (BOCES) School	181	0.166	100%	10-24

The cost of emergency measures to the critical facilities identified, that would be necessary in the event of a widespread power outages are included in **Table 3A3** below.

Table 3A3
Cost of Emergency Measures to Critical Facilities

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When Would These Measures be Required
Northern Microgrid					
Alice Hyde Medical Complex	One-Time	Hooking up additional portable generator	1,500	$	Year round, seven days per week, 24 hours per day
Alice Hyde Medical Complex	On-going	Renting additional portable generator and fuel charges	500	$/day	Year round, seven days per week, 24 hours per day
Southern Microgrid					
Franklin Academy High School	One-Time	Hooking up additional portable generator	1,500	$	Year round, seven days per week, 24 hours per day. Facility used for shelter.
Franklin Academy High School	Ongoing	Renting additional portable generator and fuel charges	300	$/day	Year round, seven days per week, 24 hours per day. Facility used for shelter.
BOCES School	One-Time	Hooking up additional portable generator	1,500	$	Year round, seven days per week, 24 hours per day. Facility used for shelter.

BOCES School	On-going	Renting additional portable generator and fuel charges	300	$/day	Year round, seven days per week, 24 hours per day. Facility used for shelter.
Bus Garage	One-Time	Hooking up additional portable generator	500	$	While school is in session, limited need over summer
Bus Garage	On-going	Renting additional portable generator and fuel charges	50	$/day	While school is in session, limited need over summer

The Village of Malone will likely not own the microgrid components that connect and control generation in the Northern Microgrid where the hospital would likely own and operate the equipment. The school district might take ownership of the same components in the Southern Microgrid. The DERs may also be owned by the Village with various options for either PPAs or equipment lease arrangements of the equipment with normal operation benefits to the host sites. However, each scenario of ownership will depend on the source and mechanism of funding. System and equipment integration will be required at the host sites and with their facilities for both the electrical and thermal components of the microgrid system and generation sources (CHP engine gensets). The host sites will remain grid connected to enable the generation sources to provide various power options and operation in parallel during normal grid operations.

The users of the two (2) microgrids will purchase electricity during normal operation but also utilize the DERs to offset their usage during normal operations. They will rely solely on the engine gensets during islanded operation. Other critical facilities in the Village can be sustained with normal standby power during grid emergencies as their loads are small, and difficult to aggregate in a system secondary to National Grid's existing distribution system.

The Village of Malone, as the project lead for the development of the microgrid, will take responsibility for developing consensus around the proposed plans for each of the microgrids. The Village should approach the Alice Hyde Hospital (medical center) for the Northern Microgrid, and the Franklin Academy High School and Franklin Essex BOCES for the Southern Microgrid to propose the installation of a CHP engine gensets, and secondary islanded distribution at their locations. The benefits of locating a CHP system at prospective hosts' sites will be discussed with the entity along with responsibilities of the entity during emergency situations. The Village intends to have multiple conversations with the desired host sites for the generation sources until an agreement is reached. The Village may also discuss the project with National Grid and explore the potential for a greater cooperation for the use of National Grid's existing distribution system as a part of the microgrid projects. While additional switches and controls may be required, National Grid's participation might reduce costs by eliminating the need for secondary islanded distribution behind the disconnect to the utility at each of the microgrid locations. However, use or any ownership of the system by NG might cause regulatory issues that could negatively impact the project.

Detailed Overview of Microgrid Design Concept

The proposed project design concept for the microgrid will include the supply of power to support seventeen (17) auxiliary facilities of the Alice Hyde Hospital, including the Hospital itself, and the supply of power to support two (2) schools within the Village of Malone and a supporting bus garage that can also be used for shelter and transportation. During emergency power outages, the microgrid would operate in island mode and provide power to the northern and southern microgrid customers. Metering during emergency power outages and microgrid operation would remain under normal existing conditions, through the use of existing electric meters at individual customer locations.

The microgrid has been evaluated to support Tier I and II users at a minimum, with an estimated electric power demand and usage as follows:

Northern Microgrid (Alice Hyde Hospital)

- Peak Demand: 1.49 MW.
- Ave. Demand: 1.2 MW.
- Ave. Annual Usage: 6,390 MWh.
- Ave. Monthly Usage: 532.5 MWh.
- Ave. Weekly Usage: 133.1 MWh.

Southern Microgrid (Franklin Academy High School)

- Peak Demand: 0.65 MW.
- Ave. Demand: 0.57 MW.
- Ave. Annual Usage: 2,110 MWh.
- Ave. Monthly Usage: 175.8 MWh.
- Ave. Weekly Usage: 40.6 MWh.

To meet the electrical demands of the critical facilities and other potential electric users, the microgrid will require distributed energy resources (DERs) or generation sources at the Alice Hyde Hospital, the BOCES school and the Franklin Academy High School. The DERs/ generation sources will include two (2) CHP engine gensets (1,059 kWe each) for the northern microgrid and two (2) CHP engine gensets (500 kWe each) for the southern microgrid that are all fired (i.e. fueled) by natural gas and supplemented by photovoltaic (PV) solar panels. The primary generation source(s) for the microgrids will be the CHP engine gensets, as PV is less consistent and weather dependent. The primary generation source(s) for the microgrid will be sited and designed to meet peak electrical power demand (kW) and usage (kWh) of the northern and southern microgrids (critical loads) while in island mode. At full deployment of the DERs/generation sources, including installation of PV, the total system capacity of the microgrid in island mode is expected to be as follows; assuming 90% annual availability of the CHP engine gensets (refer to **Sections 2 and 3 and Appendix I** for more detailed information):

Northern Microgrid (Alice Hyde Hospital)

- Peak Generation Capacity: 2.37 MW.
- Annual Generation Capacity: 17,000 MWh.
- Monthly Generation Capacity: 1,417 MWh.
- Weekly Generation Capacity: 354 MWh.
- Annual Heat Output: 89,250 mmBTU.
- Weekly Heat Output: 1,720 mmBTU.

Southern Microgrid (Franklin Academy High School)

- Peak Generation Capacity: 1.25 MW.
- Annual Generation Capacity: 8,177 MWh.
- Monthly Generation Capacity: 681 MWh.
- Weekly Generation Capacity: 170 MWh.
- Annual Heat Output: 89,250 mmBTU.
- Weekly Heat Output: 1,720 mmBTU.

As mentioned previously, PV solar panels are highly dependent on weather conditions and are not consistent enough to supply the Village of Malone's critical facilities during a major power outage. Battery backup for these DERs was investigated, but was determined to be cost prohibitive. Economically, it was more feasible to invest in the CHP engine gensets to power the microgrid during a major power outage and use potential PV solar panels as additional backup power generation during a major power outage. With this design in mind, the system capacity of the microgrid in island mode, without PV power generation, is expected to be as follows; assuming 90% annual availability of the CHP engine gensets.

Northern Microgrid (Alice Hyde Hospital)

- Peak Generation Capacity: 2.12 MW.
- Annual Generation Capacity: 16,700 MWh.
- Monthly Generation Capacity: 1,390 MWh.
- Weekly Generation Capacity: 321 MWh.
- Annual Heat Output: 89,250 mmBTU.
- Weekly Heat Output: 1,720 mmBTU.

Southern Microgrid (Franklin Academy High School)

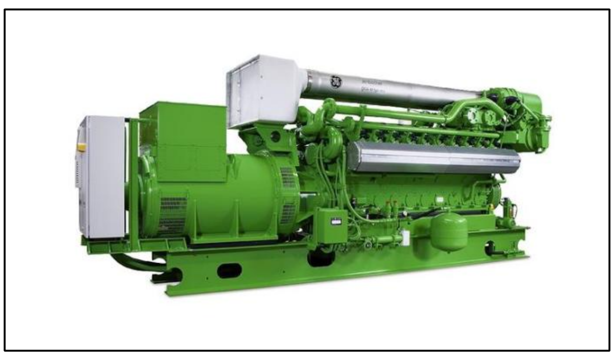
- Peak Generation Capacity: 1 MW.
- Annual Generation Capacity: 7,880 MWh.
- Monthly Generation Capacity: 657 MWh.
- Weekly Generation Capacity: 152 MWh.
- Annual Heat Output: 38,700 mmBTU.
- Weekly Heat Output: 744 mmBTU.

Annual production based on 90% availability, Max daily based on maximum potential output in a 24-hour period. Refer to the Process/Functional/Layout Diagrams included in **Section 2.2 and in **Appendix G**.*

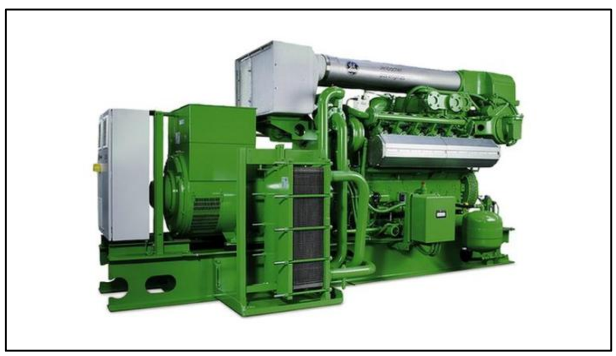
Customers who host the CHP engine gensets will have the availability to use these power systems to significantly reduce their daily metered usage and demand behind their primary meters during normal grid operation. Additionally, these customers will have the availability to utilize the excess heat generated from the engine gensets within their facilities, thus offsetting and/or reducing their heating and cooling costs if an absorption chiller is also installed.

Detailed Overview of DER/Generation Source Equipment

The DER/generation source equipment will include two (2) General Electric JGS 320 engine gensets (as presented below and in **Figure 4**) with an electrical output of 1,059 kWe each for the northern microgrid and two (2) General Electric JGS 312 engine gensets (as presented below and in **Figure 5**) with an electrical output of 500 kWe each for the southern microgrid.



JGS 320 Engine Genset
(Northern Microgrid)



JGS 312 Engine Genset
(Southern Microgrid)

All engines are designed for cogeneration. Cogeneration (i.e. combined heat and power – CHP) systems allow for the generation of both electrical power that can be used during an emergency outage as well as heat that can be used in an institutional process application. The CHP engine genets will be fueled by a dedicated and uninterrupted supply of natural gas from the local utility. The CHP engine gensets will be equipped with:

- Carbon steel casing with noise insulation and a module ventilation system.
- Thermal circuits and a plate heat exchanger.
- Lube oil system, exhaust gas piping and an exhaust silencer.
- Smoke/gas detection system, emergency dry cooler and anti-exposition actuated valves.
- SCADA System for Supervision and Control.
- Exhaust Gas Recovery System and a Hot Water Flow Metering System with heat dissipated at the locations below. However, heat recovery for reuse is not available at all heat sources. Also, it is estimated that only 50% of the available recoverable heat will be recovered for reuse in institutional process systems.
  - Engine and Jacket Water (*Available for heat recovery)*.
  - Lube Oil (*Available for heat recovery)*.
  - Intercooler 1st Stage (*Available for heat recovery)*.
  - Exhaust Heat Exchanger (*Available for heat recovery)*.
- Feeder and generator relay controls to ensure the dedicated systems of the primary grid and the microgrid are completely isolated and cannot backfeed power during times of grid emergencies and outages, system instability, maintenance, repairs or new installations.
- Island Mode and Black Start capability.
- The overall estimated exhaust emissions for these engine gensets per the manufacturer are: NOx: < 0.6 g/bhp.hr (JGS 320), NOx: <500 mg/Nm^3 (JGS 312) and CO: < 1.0 g/bhp.hr for both.

Detailed Overview of DER/Generation Source Capabilities

As previously noted in **Section 1.2**, the proposed microgrid network will be designed in accordance with the a variety of industry standards and requirement, which will be fully assessed and evaluated during the detailed design of Stage 2 of the microgrid project. At this time, the following standards and requirements have been identified:

- NYS Department of Public Service's Standard Interconnection Requirements (SIR) and Institute of Electrical and Electronics Engineers (IEEE) 1547 – for overcurrent protection, synchronization, voltage and power controls, and metering and monitoring.
- American National Standards Institute (ANSI) c84-1 – once the microgrid system is fully connected, it will follow system load and maintain system voltage.
- International Organization for Standardization (ISO) 8528-5 – during design for island mode (microgrid) operations of the engine gensets and related systems.

The DERs/generation sources (CHP engine gensets) include numerous functions and capabilities to meet the requirements of the microgrid. These include, but are not limited to: black start, load-following and part-load operation, maintaining voltage and frequency, the capability to ride-through voltage and frequency events in islanded mode, and the capability to meet interconnection standards in grid-connected mode. These functions and capabilities are further described below.

- Black Start – this capability is necessary to transition the CHP engine gensets from main grid power (National Grid transmission lines) to microgrid island mode. The paralleling controls of CHP engine gensets will likely turn off the engines and require a restart. This black start sequence will initiate once the engine gensets and the microgrid system sense instability conditions or an outage from the main primary grid. Paralleling controls will then open the circuits to isolate both engine gensets and the microgrid to island mode. The engine gensets will likely then turn off. The microgrid system will then call for power from the generation source for the restart. The CHP engine genset would be the prime mover to start-up, close the generator breaker and supply the power using an un-interrupted fuel source (natural gas). A black start can take place on an engine genset that was previously not in operation (cold start) or an engine genset that has been shut-down (hot start).

- Load-Following and Part-Load Operation – this capability is necessary to allow the CHP engine gensets to adjust or adapt their power output as the demand for electricity fluctuates throughout the day or through seasonal variations. This is critical for the microgrids as the peak demand for the northern microgrid is 1.49 MW and the average demand is 1.2 MW along with the rated capacity of the CHP System at 2.12 MW. Likely, the peak demand for the southern microgrid is 0.65 MW and the average demand is 0.57 MW along with the rated capacity of the CHP System at 1.0 MW. Based on the loading conditions, the Supervisory Control and Data Acquisition (SCADA) System and other controls would adjust the output or function of the engine gensets to match the load. Thus, engine gensets may come on and off line, or throttle up and down to match the demand requirements.. The SCADA System will also provide for real-time and archive data logging, which can be used on a daily/weekly/monthly/annual basis or emergency grid outage basis to assess the functionality and performance of the microgrid system.

- Maintain Voltage and Maintain Frequency – the SCADA System of the CHP engine gensets maintain settings for voltage control and distribution during normal operation and load shedding that adjust to any variations in the settings protect the equipment and to ensure maximum power output. The CHP engine genset system also maintains synchronization controllers (that are also connected to the SCADA System) that monitor and adjust the equipment to maintain the required electrical frequency to ensure maximum power output.

- Capability to ride-through voltage and frequency events in island mode – the same systems and equipment referenced above to "maintain voltage and frequency" and monitor operating conditions will be in place for the CHP engine gensets and microgrid during main grid mode as well as in island mode.

- Capability to meet interconnection standards in grid-connected mode – the microgrid system and the CHP engine gensets will be designed and operated in accordance with NYS Department of Public Service's SIR. Feeder protection equipment and smart controls will be in place to separate main grid and microgrid inbound and outbound power at the interconnection point.

- Data Logging – the SCADA System will provide for real-time and archive data logging, which can be used on a daily/weekly/monthly/annual basis or emergency grid outage basis to assess the functionality and performance of the microgrid system.

For more detailed information, refer to **Appendix I**: Technical Instruction Manual for Isolated Operation of Spark Ignition Gas Engines with DIA.NE (Type 4 Engines), TA 2108-0029 and Technical Instruction Manual for General Isolated Operation of Plants and Engines, TA 2108-0031 Page 5 of 19.

Detailed Overview of Microgrid System Sequence and Operation

As part of this Feasibility Study Report, the loads of the Village of Malone's electrical distribution system were characterized using the best available data. To meet the projected power demands and usage of the identified critical facilities, the DERs/generation sources were characterized to match the loading of the critical facilities, but also for use at the host location (during non-emergency and non-grid outage periods). Through analyzing this information, a total system capacity for the microgrid system (in island mode) was developed. Note that the loading estimates and projections for any host locations are theoretical during this Feasibility Study Report, which would require further detailed analyses and engineering design.

The DERs/generation sources (CHP engine gensets) at the host locations will be designed to operate 24/7/365 excluding scheduled maintenance. Scheduled maintenance does not have to occur during grid emergency/outage conditions. Such maintenance work, given it is not detrimental to the equipment or system, can be scheduled to limit the loss of capacity during microgrid operation. The DERs may be operated at a fraction of their peak capacity to maximize economic efficiencies during normal parallel operation that does not currently allow net metering from these units.

During normal grid conditions, the generation source at the host site will be used to offset normal demand and usage charges for the host facility. Thus, the proposed generation source will have the capability to provide on-site power in both grid-connected and island mode at a given host site. The microgrid will also be designed to automatically disconnect from and reconnect to the primary grid power source, which are the transmission lines operated by National Grid. This process will also integrate the connecting or disconnecting of the CHP engine gensets so that the microgrid and the primary grid are kept safe for system operators, electric distribution company and utility workers, and customers. The integrated protection equipment may include feeder and generator relay controls to ensure the dedicated systems of the primary grid and the microgrid are completely isolated and cannot backfeed power during times of grid emergencies and outages, system instability, maintenance, repairs or new installations.

- Microgrid users will see cost savings from the avoided costs of expensive backup generator systems that may have been used to power their own individual essential loads during emergencies, such as microgrid users that currently have diesel back-up generators may see an avoided cost of diesel fuel purchased, as the amount of diesel fuel used in back-up generators will be decreased with the available microgrid. The generation locations proposed within the microgrid will see an upfront capital cost associated with the purchase and installation of the CHP engine gensets on-site. These users will also see a cost savings through the supply of heat from the CHP engine gensets for use as steam, hot water or cooling (adsorption chillers) at their facility, thus offsetting costs they would have normally had should a CHP plant not be available.

During grid emergencies/outages and as feasible, the microgrid system will be operated and controlled to limit the generation source load at the host location. Such measures will allow power generation from the CHP engine gensets to be available to the microgrid and other priority loads, which may vary on the type of emergency/outage event. Also, as the generation sources for the microgrid system will likely be located at host facilities, such load limitations to their essential and mission critical systems should be identified and developed under an emergency and contingency operating plan.

Additional power generation capacity throughout the microgrid system to account for downtime during scheduled maintenance of CHP engine gensets or other system components will be considered; however, as previously mentioned, the scheduled maintenance does not have to occur during grid emergency/outage conditions. Thus, significant additional capacity is not required to provide an effective microgrid system, when considering scheduled maintenance requirements of general source components.

The potential DERs/generation sources (CHP engine gensets) are proposed to be fueled by natural gas. The natural gas pipeline tie-in point to the DER/generation source would be located at the existing service laterals to the host sites. The CHP engine gensets will need to be placed on an uninterruptable natural gas utility tariff to ensure the availability of gas for the operation of these microgrid systems, including operation in emergency conditions. The gas pipeline service can be considered an uninterruptable fuel supply for the purposes of this project, as supply of this fuel source will not be affected during a local electrical outage. Scheduled maintenance required on the natural gas pipeline that could cause a natural gas service outage, if any, will be conducted with prior notification to the host facilities.

Smart controls and relay protection will also be utilized to recognize when outside power is restored to reconnect the microgrid to the primary grid network. All interconnections will be coordinated within the microgrid, to facilitate connection and islanding with as little interruption of service as possible for microgrid users and local electric distribution company customers. Any control system communications will be encrypted or protected in accordance with accepted utility standards and homeland security requirements to maintain the integrity of sensitive data.

In order to operate independently of the local external electric supply (National Grid transmission lines) within the confines of the microgrid, the proposed generation sources (CHP engine gensets) at the host location will require black start capability. Black start capability is necessary during the transition from primary grid power to the microgrid island mode as the CHP engine genset paralleling controls will likely turn off the engines and require a restart. This black start sequence will initiate once the generation source and the microgrid system sense instability conditions or an outage from the external primary grid, which will then open the circuits to isolate both the generation source and the microgrid to island mode. Then, the microgrid system will call for power from the generation source for the restart.

At designated Life Safety facilities, the fast response diesel powered backup generators that may have come on during this sequence, may run for a specified period of time to initiate or continue island mode within the microgrid. Once the generation source at the host location is back in operation to support the microgrid, the existing diesel powered backup generators would be turned off to allow the diesel fuel to remain in reserve for future needs. As a point of clarification, the diesel powered backup generators are pre-existing at the Alice Hyde Hospital, based on verified Life Safety needs. As such, the diesel powered backup generators will be integrated with the CHP engines. The diesel powered backup generators will kick on at the initial loss of power. The CHP engines will black start and once operational, the diesel generators will sense the CHP engines as utility power and turn off. This will save significant amounts of diesel fuel needed on site in case of power loss.

3.2 Commercial Viability – Value Proposition

Regarding the potential value of the proposed microgrid, the Village will realize a number of benefits from the dual microgrid projects, which includes:

- Having electricity provided to critical facilities during an emergency situation; thus, increasing reliability and resiliency of power distribution within the Village.
- Protecting the health and safety of the Village's residents and businesses by having a hospital facility operational for medical services as well as schools with power for emergency shelters, etc. during grid outages.
- The microgrid will also decrease potential future reliance on "dirtier" or high carbon generating-based electricity generation, as the microgrid generation sources are proposed to be a combination of CHP and solar power (PV). Any power from PV sources would be in addition to CHP, which would be above and beyond the Village's demand and usage needs.

<u>*Other Preferable Criteria for the Microgrid System*</u>

In addition to the minimum required capabilities for the microgrid as referenced in **Section 1.1**, there are other preferable capabilities of the microgrid system that can benefit the Village. In order to increase energy efficiency and maximize reliable service to critical facilities and customers, the microgrid system will need to incorporate technology to allow power generation to exactly match demand during microgrid operations. This could include measures to: reduce energy use of non-essential components during times of low generation or during grid emergencies/outages, communication on both the supply and demand ends to allow energy generation to exactly match users' needs, and automated transfer switches for seamless transitions in and out of island mode.

To the greatest extent practical, the microgrid will incorporate advanced and innovative technologies to allow for: integrated communication including customer interaction with the system; the potential for private sector funding for the DERs/generation sources; the potential minimization of local impacts; the creation of local temporary and permanent jobs; and supporting State energy initiatives and utilizing clean power sources. Each of these capabilities and planning measures will aim towards providing efficient and reliable power during emergency grid outages to improve service of the electrical distribution system to its users.

- <u>Potential Private-Sector Funding for the DERs/Generation Sources</u> – Private capital should be considered to the greatest extent possible to fund the microgrid capital investment in order to minimize economic impact on the community, unless substantial grant funding can be obtained. For initial comparison efforts, a scenario with 50% funding by private capital will be used as a metric for comparison. In the case of these two (2) microgrids (northern and southern) serving the Village, since they are tied to public facilities (Alice Hyde Hospital and the Franklin Academy High School), private-sector involvement is less likely unless it is through a PPA arrangement where a private entity owns and operates the DERs and sells energy to the host facilities. In order to determine the feasibility of the local microgrid, an economic analysis was prepared for each microgrid (Refer to **Section 3.5** and **Tables 3B1/3B2 and 3C1/3C2**). A separate third-party benefit-cost analysis (refer to **Section 4.7**) was also performed per NYSERDA requirements as part of this Feasibility Study on the proposed system, incorporating the public- and private-sector costs to the Village, developers, industrial host facilities, and customers as well as the economic and other benefits to the community, developers, and the Village electric distribution company.

- <u>Potential Minimization of Local Impacts</u> – The CHP engine gensets will be sited at existing commercial and public service locations, the Alice Hyde Hospital and the Franklin Academy High School, respectively. In using these locations, land use and social impacts will be minimized.

- <u>Local Temporary and Permanent Jobs</u> – The development and construction of a local microgrid is estimated to create 2-4 permanent full-time jobs to maintain the microgrid system including CHP engine gensets within the Village and an additional 30-50 short-term construction jobs for microgrid and host facility retrofits. Permanent local employees will be required to operate and maintain the new CHP engines at the host facilities and the updates to electrical infrastructure including energy efficiency retrofits, equipment maintenance staff, etc. Short-term construction positions will be required for the construction of the microgrid's distribution and generation systems, which may have a potential duration of 6-12 months.

- <u>Supporting State Energy Initiatives</u> – Reforming the Energy Vision (REV) is an effort by the New York Public Service Commission to address issues stemming from centralized and largely degraded electricity infrastructure within the State. A key component of this program is the decentralization of electricity generation, distribution and transmission to decrease reliance on existing utilities and electric grids. Markets and regulations still favor utilities in New York State, making it difficult to implement distributed energy resources (DER). Revisions to the existing regulatory paradigm as part of the REV process will aid in the implementation of microgrid systems to increase energy security and reliability as well as provide cleaner energy sources that may not currently be competitive. The exact framework under which these goals can be achieved will be determined as the REV effort proceeds; however, the successful operation and maintenance of a local microgrid could provide a stepping stone and/or precedent for other communities to implement similar policies and infrastructure innovations to increase the efficiency and reliability of their generation, distribution and transmission systems. The proposed microgrid to support the Village of Malone matches with the State's REVS goals.

- Utilization of Clean Power Sources – Clean power sources will be implemented to the maximum extent possible and all generation sources will be designed to minimize environmental impacts. The total goal for the microgrid project is to provide a minimum of 10% of the total power generation with non-fossil fuel renewable energy, and with at least 80% of the total project generation with low carbon options. Natural gas fired CHP engine gensets (providing power during primary grid connection or island mode) will provide the majority of the microgrid power. Although not carbon free, CHP systems are more efficient than conventional power generation due to the recovery of heat as well as its proximity to the end user, thereby decreasing distribution and transmission losses. Thus, this technology can be considered a lower carbon generation option. The application of renewable power sources will continue be evaluated in the future, as feasible, but may potentially be limited due to site availability and locational constraints, seasonal and weather-related impacts, and economic feasibility.

The two (2) microgrid projects can also positively benefit National Grid, the electric utility company, which currently provides electricity to residents, businesses and other facilities within the Village. The direct benefit would be reduced demand and usage and demand on the existing electric distribution system, based upon the power generated at the host sites from the CHP engine gensets.

This project is unique in that the microgrids within the Village were selected, and are spaced out to provide strategic benefit to the Village during emergencies while providing day to day benefit to the host locations. The Village of Malone project could be replicable for other facilities within the Village or in other villages with similar needs. This project is important to provide for critical Village functions (medical services, emergency shelter, etc.) during an emergency. The more complete operational capacity of the Alice Hyde Medical Center during emergencies is also beneficial to the surrounding communities as the medical facility provides services to other communities outside the Village of Malone.

Overall, the direct tangible community benefits of the proposed microgrids will include providing some critical facilities with reliable electricity, improving energy efficiency, decreasing the carbon footprint of local electricity generation and use grid, creating both short-term and long-term local jobs, and the reduction in loss of services by critical facilities within the Village during grid emergencies/outages. The use of solar, wind, and CHP engine gensets for primary electricity generation locally could also further decrease the carbon footprint of the Village. Decentralizing electricity production, decreased distribution and transmission losses, and reliance on clean and safer energy sources will displace carbon-dense fossil-fuel derived electricity.

SWOT Analysis

As part of the value proposition for commercial viability of the microgrid project, a SWOT Analysis was prepared (refer to **Table 3A4**). A SWOT Analysis is a structured planning method used to identify internal and external influences of a given project, operation, company or community, etc. SWOT stands for Strengths, Weaknesses, Opportunities and Threats. The strengths and weaknesses are generally considered as internal factors of influence, whereas, the opportunities and threats are generally considered external factors. In using the SWOT Analysis, each of the internal and external factors will be evaluated and considered in determining the path forward, which could affect the success of the venture.

Table 3A4
SWOT Analysis

Strengths	**Weaknesses**
• Available space for generation sources/host sites • Adjacent facilities that could form a microgrid • Short-Term and Long-Term job opportunities • Support REV and RPS policy objectives	• Lack of available funding sources • Difficulties with infrastructure tie-ins • Negotiations with a Private-Sector Utility
Opportunities	**Threats**
• Improved electric service reliability and resiliency • Improved functionality of medical and emergency support services • Decreased carbon footprint of the Village • Commercial partnerships • Model project to be replicated by other local facilities	• Time delays impacting implementation • Environmental and nuisance constraints

3.3 Commercial Viability – Project Team

The current Project Team for the microgrid consists of the Village of Malone, National Grid and Barton & Loguidice, D.P.C. Sufficient support has been secured for Stage 1, to perform the feasibility study. Additional partners including contractors and suppliers will be secured at a later date when the design and permitting are finalized and then advertised for bidding, construction and start-up operation. The Village of Malone will be the Contractor and the applicant for these microgrid projects. They represent the local government and community. Their role in the feasibility study is community outreach to residents and local businesses and industry to garner support and provide input to the project. The Village could also potentially be the owner/operator of the microgrid systems or DERs once the microgrids are developed. The microgrid project is an example of advanced technology to improve service and infrastructure within the Village.

As previously noted, National Grid is the owner and operator of the existing electric distribution system that serves the Village of Malone. National Grid will provide technical advisement relating to existing distribution and transmission capacity, infrastructure, and historical system disturbance data, etc.

Barton & Loguidice, D.P.C. (B&L) has been retained as a subcontractor to the Village as the project lead. B&L is responsible for the overall management of the project and execution of the feasibility study. The functional diagrams and layouts were developed by AB Energy USA and its parent company Gruppo, with coordination by B&L. AB have over 25 years of experience with delivering global solutions with over 1000 reciprocating engine based Combined Heat and Power (CHP) and distributed energy systems totalling over 1,500 MW. Within the market place, AB is unique in that they bring together all the competencies under one organization to design, manufacturer, install, commission and provide complete support of the CHP system over the life of the project. The engine technology AB utilizes is standardized around that of GE Jenbacher. This 'best-in-class' engine manufacturer is configured to unique project requirements through AB's modular CHP system. Marketed as the ECOMAX, this system brings together complete design and balance of plant equipment selection, all packaged and supported in a way that ensures decades of trouble free operation. For detailed information on the Functional Diagrams and Layouts for Combined Heat and Power Systems, refer to **Appendix G**.

Overall, the Village's partners and Project Team have significant experience qualifying them for this feasibility study and potential future project. National Grid has a history of successful operation of electric distribution and transmission systems to support millions of customers in the northeastern United States. B&L has experience in both alternative energy generation and substation and interconnect design, permitting and construction management. No additional contractors or suppliers have been identified at this time. Once the system design has been finalized and the funding obtained, the project will be put out to bid for construction. The contractor and any suppliers necessary will be chosen based on bids received and the contractor's qualifications.

There are currently no public/private partnerships as part of the feasibility study, with the exception of the Village's subcontractors. Additional partnerships with equipment and material suppliers or contractors will be pursued with later stages of the study if necessary.

Project funding, financiers or investors have not been identified at this time. It is envisioned that the host locations will be the financial contributors for the installation of the CHP engines and the islanded distribution system.

The Village's solicitor will serve as legal counsel for the microgrid projects with potential assistance from other Project Team members and outside firms specializing in energy contracts and power generation projects.

3.4 Commercial Viability – Creating and Delivering Value

The Northern and Southern Microgrid projects will create value by generating cost effective electric power and heat that can be utilized by the host sites and their respective facilities within the Village during normal grid operations, and during emergencies. Natural gas fired CHP engine genset units were specifically chosen for these microgrids because they provide easily controllable generation that is resilient during typical conditions that might cause grid emergencies/outages, but also can be easily controlled to match demand. Engine management systems can modulate the output of the CHP systems so that the engine gensets will match the electrical demand that they detect to maintain the system within voltage and frequency requirements. These systems have been well proven across the United States with similar applications at other facilities, hospitals, school campuses and industrial facilities. As such, the successful application of the CHP technology for these microgrid projects greatly reduces the risk to the Village and other project partners, while enhancing the benefits of reliable and efficient power.

The microgrid host sites were specifically chosen to attempt to maximize the benefit to the Village community. During emergencies, the most critical services that may be needed are medical services and emergency shelter. In combination, the Northern (medical services) and Southern (emergency shelter) Microgrids provide these services. Additionally, the potential energy benefits that are provided to the High School within the Southern Microgrid can offset expenses and therefore also provide potential tax relief to the community.

The Village of Malone will benefit from the installation of the microgrid through the availability of uninterrupted power during a major power outage for medical and emergency shelter services to its residents and businesses. It reduces the use and need for backup generators for institutional and public service entities within the Village of Malone, which subsequently reduces the cost burden to these entities when budgeting for backup power. Allowing the critical facilities selected as part of the Northern and Southern microgrids to function on a nearly normal usage level during a major power outage allows residents an option for emergency services through the Alice Hyde Hospital complex and for shelter and supplies at the Franklin Academy High School and the Franklin-Essex-Hamilton (BOCES) School. This scenario will also generally provide a sense of comfort to residents within the Village knowing that their welfare will not be affected by a major power outage.

- At this time, if the host location is responsible for the capital and operational costs of the CHP engine gensets and is responsible for the maintenance of the islanded distribution infrastructure associated with the microgrid, there are minimal costs envisioned to the residents or local community.

Based on the data provided, sufficient generation capacity has been provided to ensure that the generation capacity is not exceeded by demand. If it was somehow exceeded, the system would shut-down in a protective mode, and the system would attempt to reset automatically. However, as noted, there should be more than sufficient system capacity.

Implementation of the microgrid projects will start with solidifying participation of all of the microgrid partners, followed by detailed technical and financial design/planning to ensure that initial project assumptions are current and correct and that the project will achieve the desire outcomes. Any necessary permits or approvals (e.g. utility or non-utility power generation, building permits, use and occupancy, electrical/mechanical and air permitting, etc.) will be applied for as required regarding the installation and integration of CHP equipment and ancillary components. Permitting and approval requirements will continue to be evaluated and assessed during the detailed design stage of the microgrid projects. If public funds were used for the project, a SEQRA approval might be required for the installation of the system.

3.5 Financial Viability

The financial goal of the microgrid projects are to make arrangements that will reduce the rates currently paid by the host sites within the Village as provided by the National Grid distribution system, while still providing the reliability improvements and public-service benefits of the projects. To accomplish this, project host sites that can utilize the heat and electricity of the generation equipment (CHP engine gensets) during regular grid operations is important. In such a scenario, the Village or the host site may be able to support the purchase of the generation equipment or enter into an agreement with the project partners. Such an agreement will specify the sale of the electricity and recovered heat from the generation equipment at an advantageous rate that makes it fair, reasonable and beneficial for the host(s).

A key component of the viability of the microgrid systems is if the projects can either provide economic benefit during normal operations to the host sites, and/ pay for the up-front capital investment of system installation and construction. The proposed microgrids have been compared against the current energy costs of the host sites during normal operations to determine if the microgrids can be financially competitive during regular operations. If this is possible, then the projects can proceed and provide benefit not just during grid emergencies/outages, but also during normal operations, which would improve ROI to the point where the projects have the potential to pay for themselves over time. The economic analysis was based on offsetting existing electrical and heating needs with on-site power generation. Since the host site facilities will remain grid connected, standby rates/tariffs will be applicable. This means that customer charges, demand charges, and usage charges will still apply. Thus, electric generation behind the meter has to be able to maximize the reduction of demand and usage, which would create the opportunity to maximize the economics of the project, i.e. “revenue” or avoided/offset electric and heat costs.

The costs of fuel, operation, maintenance and other factors were also considered against “revenue” or the avoided/offset electric or heat costs at the host location to generate the projected cash flow for the microgrid project. The NYSERDA Third Party Review by IEc estimated that the capital cost for the development of the microgrid will be approximately $4,410,000, which includes the CHP engine gensets and PV panels. The initial planning and design costs were estimated to be approximately $392,000 and included engineering and permitting for the project. Operation and maintenance costs for the microgrid project were estimated to be approximately $93,000 annually. This was estimated to be a fixed O&M cost over the life of the project. This included engine and PV maintenance and interconnection maintenance. The project should be cash positive with reasonable project pay back periods to be considered viable. In the case of the Village of Malone’s two microgrids, conservative electric and heat values were assumed and evaluated at a twenty (20) project life with a 6-year simple project payback period assuming no grant funding. Costs were annualized on a project basis, not entity or project-partner basis.

Economic analyses were generated in tabular format for each microgrid project based on the required generation capacity along with the potential for avoided/offset electric and heat costs. **Tables 3B1 and**

3B2 as well as 3C1 and 3C2 provide an estimate of the projected economics for Northern and Southern Microgrid projects, with and without grant funding. These Tables demonstrate that the projects can be economically favorable with conservative avoided cost assumptions, which generate positive cash flow (annual revenues exceed expenses) and reasonable project payback periods. This would indicate that the projects have economic merit. Refer to **Section 4** for a detailed third-party cost-benefit analysis.

3.6 Legal Viability

The regulatory structure under which microgrids exist is dependent upon the ownership structure of the system. New York is an energy-deregulated state, and utilities are discouraged from owning generation assets to provide for better price competition for electric supply which might not be the case if the utility controlled supply and distribution assets. Although project partnerships and agreements are not finalized, it is proposed that the host locations will be the owner of the proposed microgrid, and will continue to be responsible for the operation and maintenance of the CHP System and the secondary electric distribution system. If non-utility owned distribution energy resources operate in the microgrid, the microgrid operation must address how utility and the DER owner interact with the existing grid and electric distribution system with regards to how electricity is bought and sold. More specifics on the regulatory structure of the microgrid will be defined after the ownership structure of the microgrid is determined, during Stage 2 of the project development. However, it is envisioned that the Northern and Southern Microgrids will be non-utility owned (both DERs and the islanded distribution systems) and not considered a public utility as the entities served by the microgrid will either own the DERs or will have private contracts in place for the power generated by the DERs. The facilities would seek to be considered “qualifying facilities” (QF) by the PSC, and fall under the QF exemption as the electricity is generated by a co-generation facility solely for the “users” within the microgrid “located at or near the project site.”

Since the microgrid secondary islanded distribution systems will cross public rights of way, the Village will most likely have to provide franchise rights or some other form of agreement to allow the secondary islanded distribution lines to cross the public rights of way. Both the Northern and Southern Microgrid will have to cross at least one public right of way with electric and/or hot water lines. Since the proposed facilities serviced by the microgrids are adjacent to each other, the facilities should be considered “located at or near the project site.” In the case of the medical facility in the Northern Microgrid, the system might qualify under the Landlord-Tenant Exemption depending on the ownership of the land at each of the connected facilities; i.e., if the medical center owns all the land and buildings being serviced by the system, then this exemption might apply.

On the thermal side of the system, since the projects are envisioned to generate hot water and not steam, regulatory issues related to distribution steam systems potentially would not apply. Additionally, there are accepted exemptions from the steam system oversight by PSC where the steam is made or produced and distributed by the maker. If the entities within the microgrids have ownership in the system, then they may be considered the “maker” of the thermal and potentially be exempt from utility regulations. It is the goal of the microgrids to not be considered utilities either on the electric or thermal side to avoid costly regulatory compliance requirements. Additional legal analysis and potential meetings with PSC may be required to ensure that the systems will be exempt.

Northern Microgrid
Alice Hyde Medical Facilities, Malone, NY

Table 3B1
Economic Analysis of 2MW Electric Production with Heat Recovery (With Grant Funding)

	Year															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Products															**TOTAL**
Gas from NG Pipeline (Mcf)		108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	1,524,959
Gas to Engines (2.12MW) (Mcf)*		(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(1,524,959)
Gas to Engines (2.12MW) (mmBTU)		(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(1,524,959)
Engine Electrical Output (MW)	2.12	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	
Engine Electrical Output (MWh)	16,714	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	163,798
Unmet Eledtric Usage (MWh)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(89,460)
Net Excess Generation (MWh)		5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	74,338
Microgrid Demand (kW)	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	
Expenses	**Expenses ($)**															
2.12MW Tri Generation (equipment, installation and maintenance)	($2,544,000)	($50,000)	($50,000)	($50,000)	($169,600)	($50,000)	($1,272,000)	($50,000)	($169,600)	($50,000)	($50,000)	($50,000)	($1,441,600)	($100,000)	($50,000)	(6,146,800)
Distribution System Upgrades & Maintenance	($840,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	(910,000)
Pipeline Natural Gas		($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	(8,433,025)
Total	($3,384,000)	($657,359)	($657,359)	($657,359)	($776,959)	($657,359)	($1,879,359)	($657,359)	($776,959)	($657,359)	($657,359)	($657,359)	($2,048,959)	($707,359)	($657,359)	(15,489,825)
Revenue	**Revenue ($)**															
Grant Funding (NYSERDA PON 2701)	$1,692,000															
Electric Production Avoided Cost		$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	6,262,200
Demand Avoided Cost		$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	
Net Excess Generation to Grid		$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	4,088,589
Waste Heat Value		$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	3,977,023
Total	$1,692,000	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	18,539,812
Pre-Tax Cashflow	**Total**															
Annual Net Revenue	($1,692,000)	$546,056	$546,056	$546,056	$426,456	$546,056	($675,944)	$546,056	$426,456	$546,056	$546,056	$546,056	($845,544)	$496,056	$546,056	3,049,988
Running Total		($1,145,944)	($599,887)	($53,831)	$372,625	$918,681	$242,738	$788,794	$1,215,250	$1,761,306	$2,307,363	$2,853,419	$2,007,875	$2,503,931	$3,049,988	

Return on Investment (ROI)	**19.69%**
Simple Payback	**3.1**

Assumptions:

Assumes 90% up time on engine
Assumes $55/MWh for wholesale cost of any net excess generation
Assumes $70.00/MWh for discounted retail offset of electric power based on local pricing
Assumes demand charge of $10/kW as avoided cost
Unmed usage based on aggregate medical facility annual usage
Engine Output and fuel usage based on typical CHP leanburn NG engines, 8.95 mmBTU/hr per 1MW @ 100% load, 9.31mmbtu/hr @ 75% load gen set
Assumed HHV of natural gas = 1,000 BTU/cf
Mcf = 1,000 cf of gas
Assumes top end changeout ~ every 3yrs, and bottom end rebuild every 6yrs
Major engine maintenance costs estimated and may vary (top end, in frame, major overhaul)
Distribution system upgrades include 1,000' of new cable w/ control wire, transformers, and automatic switches
Assumed average .68MW net electric demand 24/7 unmet electric demand
Pipeline NG cost assumed at $5.53/mmBTU from NG pipeline
No price escalator has been assumed for any of the comodites
Waste heat value assumed at $5.53/mmBTU at @ 85% boiler efficiency for an adjusted value of $6.36/mmBTU
Useful waste heat recovery assumed HT and exhaust jacket heat loops and to be 11.32mmBTU/hr recoverable from the 2.12 MW installation
Assumes 50% usage of recoverable useful waste heat (>190F) through Tri Generation

Northern Microgrid
Alice Hyde Medical Facilities, Malone, NY

Table 3B2
Economic Analysis of 2MW Electric Production with Heat Recovery (Without Grant Funding)

	Year															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Products															**TOTAL**
Gas from NG Pipeline (Mcf)		108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	108,926	1,524,959
Gas to Engines (2.12MW) (Mcf)*		(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(1,524,959)
Gas to Engines (2.12MW) (mmBTU)		(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(108,926)	(1,524,959)
Engine Electrical Output (MW)	2.12	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	
Engine Electrical Output (MWh)	16,714	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	11,700	163,798
Unmet Eledtric Usage (MWh)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(6,390)	(89,460)
Net Excess Generation (MWh)		5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	5,310	74,338
Microgrid Demand (kW)	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	
Expenses	**Expenses ($)**															
2.12MW Tri Generation (equipment, installation and maintenance)	($2,544,000)	($50,000)	($50,000)	($50,000)	($169,600)	($50,000)	($1,272,000)	($50,000)	($169,600)	($50,000)	($50,000)	($50,000)	($1,441,600)	($100,000)	($50,000)	(6,146,800)
Distribution System Upgrades & Maintenance	($840,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	($5,000)	(910,000)
Pipeline Natural Gas		($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	($602,359)	(8,433,025)
Total	($3,384,000)	($657,359)	($657,359)	($657,359)	($776,959)	($657,359)	($1,879,359)	($657,359)	($776,959)	($657,359)	($657,359)	($657,359)	($2,048,959)	($707,359)	($657,359)	(15,489,825)
Revenue	**Revenue ($)**															
Grant Funding (NYSERDA PON 2701)	$0															
Electric Production Avoided Cost		$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	$447,300	6,262,200
Demand Avoided Cost		$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	$180,000	
Net Excess Generation to Grid		$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	$292,042	4,088,589
Waste Heat Value		$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	$284,073	3,977,023
Total	$0	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	$1,203,415	16,847,812
Pre-Tax Cashflow	**Total**															
Annual Net Revenue	($3,384,000)	$546,056	$546,056	$546,056	$426,456	$546,056	($675,944)	$546,056	$426,456	$546,056	$546,056	$546,056	($845,544)	$496,056	$546,056	1,357,988
Running Total		($2,837,944)	($2,291,887)	($1,745,831)	($1,319,375)	($773,319)	($1,449,262)	($903,206)	($476,750)	$69,306	$615,363	$1,161,419	$315,875	$811,931	$1,357,988	

Return on Investment (ROI)	**8.77%**
Simple Project Payback	**6.2**

Assumptions:

Assumes 90% up time on engine
Assumes $55/MWh for wholesale cost of any net excess generation
Assumes $70.00/MWh for discounted retail offset of electric power based on local pricing
Assumes demand charge of $10/kW as avoided cost
Unmed usage based on aggregate medical facility annual usage
Engine Output and fuel usage based on typical CHP leanburn NG engines, 8.95 mmBTU/hr per 1MW @ 100% load, 9.31mmbtu/hr @ 75% load gen set
Assumed HHV of natural gas = 1,000 BTU/cf
Mcf = 1,000 cf of gas
Assumes top end changeout ~ every 3yrs, and bottom end rebuild every 6yrs
Major engine maintenance costs estimated and may vary (top end, in frame, major overhaul)
Distribution system upgrades include 1,000' of new cable w/ control wire, transformers, and automatic switches
Assumed average .68MW net electric demand 24/7 unmet electric demand
Pipeline NG cost assumed at $5.53/mmBTU from NG pipeline
No price escalator has been assumed for any of the comodites
Waste heat value assumed at $5.53/mmBTU at @ 85% boiler efficiency for an adjusted value of $6.36/mmBTU
Useful waste heat recovery assumed HT and exhaust jacket heat loops and to be 11.32mmBTU/hr recoverable from the 2.12 MW installation
Assumes 50% usage of recoverable useful waste heat (>190F) through Tri Generation

Southern Microgrid
School Facilities, Malone, NY

Table 3C1
Economic Analysis of 1 MW Electric Production with Heat Recovery (With Grant Funding)

	Year															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Products															**TOTAL**
Gas from NG Pipeline (Mcf)		37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	528,260
Gas to Engines (1MW) (Mcf)*		(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(528,260)
Gas to Engines (1MW) (mmBTU)		(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(528,260)
Engine Electrical Output (MW)	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
Engine Electrical Output (MWh)	7,884	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	55,188
Unmet Eledtric Usage (MWh)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(29,540)
Net Excess Generation (MWh)		1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	25,648
Microgrid Peak Demand (kW)	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	
Expenses	**Expenses ($)**															
1MW Tri Generation (equipment, installation and maintenance)	($1,200,000)	($33,333)	($33,333)	($33,333)	($80,000)	($33,333)	($600,000)	($33,333)	($80,000)	($33,333)	($33,333)	($33,333)	($680,000)	($66,667)	($33,333)	(3,006,667)
Distribution System Upgrades & Maintenance	($226,000)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	(261,000)
Pipeline Natural Gas		($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	(2,921,275)
Total	($1,426,000)	($244,496)	($244,496)	($244,496)	($291,163)	($244,496)	($811,163)	($244,496)	($291,163)	($244,496)	($244,496)	($244,496)	($891,163)	($277,829)	($244,496)	(6,188,942)
Revenue	**Revenue ($)**															
Grant Funding (NYSERDA PON 2568)	$713,000															
Electric Production Avoided Cost		$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	2,067,800
Demand Avoided Cost		$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	
Net Excess Generation to Grid		$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	1,410,640
Waste Heat Value		$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	1,724,091
Total	$713,000	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	7,057,931
Pre-Tax Cashflow	**Total**															
Annual Net Revenue	($713,000)	$208,713	$208,713	$208,713	$162,047	$208,713	($357,953)	$208,713	$162,047	$208,713	$208,713	$208,713	($437,953)	$175,380	$208,713	868,989
Running Total		($504,287)	($295,573)	($86,860)	$75,187	$283,901	($74,052)	$134,661	$296,708	$505,421	$714,135	$922,848	$484,895	$660,275	$868,989	

Return on Investment (ROI)	**14.04%**
Simple Project Payback	**3.4**

Assumptions:

Assumes 90% up time on engine
Assumes $55/MWh for wholesale cost of any net excess generation
Assumes $70.00/MWh for discounted retail offset of electric power based on local pricing
Assumes demand charge of $10/kW as avoided cost
Assumed unmet usage based on the aggregate annual usage of the facilities within the microgrid
Engine Output and fuel usage based on typical CHP leanburn NG engines, 4.786x2 mmBTU/hr @ 100% load 1MW, 3.747x2 @ 75% load 750kW
Assumed HHV of natural gas = 1,000 BTU/cf
Mcf = 1,000 cf of gas
Assumes top end changeout ~ every 3yrs, and bottom end rebuild every 6yrs
Major engine maintenance costs estimated and may vary (top end, in frame, major overhaul)
Distribution system upgrades include 1,000' of new cable w/ control wire, transformers, and automatic switches
Assumed average .68MW net electric demand 24/7 unmet electric demand
Pipeline NG cost assumed at $5.53/mmBTU from NG pipeline
No price escalator has been assumed for any of the comodites
Waste heat value assumed at $5.53/mmBTU at @ 85% boiler efficiency for an adjusted value of $6.36/mmBTU
Useful waste heat recovery assumed HT and exhaust jacket heat loops and to be 4.912mmBTU/hr per 1MW installation
Assumes 50% usage of recoverable useful waste heat (>190F) through Tri Generation
Assumes operating at 50% capacity during normal operations to limit fuel costs, but retain peak demand capacity

Southern Microgrid
School Facilities, Malone, NY

Table 3C2
Economic Analysis of 1MW Electric Production with Heat Recovery (Without Grant Funding)

	Year 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	TOTAL
Products																
Gas from NG Pipeline (Mcf)		37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	37,733	528,260
Gas to Engines (1MW) (Mcf)*		(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(528,260)
Gas to Engines (1MW) (mmBTU)		(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(37,733)	(528,260)
Engine Electrical Output (MW)	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
Engine Electrical Output (MWh)	7,884	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	3,942	55,188
Unmet Eledtric Usage (MWh)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(2,110)	(29,540)
Net Excess Generation (MWh)		1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	1,832	25,648
Microgrid Demand (kW)	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	
Expenses	**Expenses ($)**															
1MW Tri Generation (equipment, installation and maintenance)	($1,200,000)	($33,333)	($33,333)	($33,333)	($80,000)	($33,333)	($600,000)	($33,333)	($80,000)	($33,333)	($33,333)	($33,333)	($680,000)	($66,667)	($33,333)	(3,006,667)
Distribution System Upgrades & Maintenance	($226,000)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	($2,500)	(261,000)
Pipeline Natural Gas		($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	($208,663)	(2,921,275)
Total	($1,426,000)	($244,496)	($244,496)	($244,496)	($291,163)	($244,496)	($811,163)	($244,496)	($291,163)	($244,496)	($244,496)	($244,496)	($891,163)	($277,829)	($244,496)	(6,188,942)
Revenue	**Revenue ($)**															
Grant Funding (NYSERDA PON 2568)	$0															
Electric Production Avoided Cost		$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	$147,700	2,067,800
Demand Avoided Cost		$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	$81,600	
Net Excess Generation to Grid		$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	$100,760	1,410,640
Waste Heat Value		$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	$123,149	1,724,091
Total	$0	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	$453,209	6,344,931
Pre-Tax Cashflow	**Total**															
Annual Net Revenue	($1,426,000)	$208,713	$208,713	$208,713	$162,047	$208,713	($357,953)	$208,713	$162,047	$208,713	$208,713	$208,713	($437,953)	$175,380	$208,713	155,989
Running Total		($1,217,287)	($1,008,573)	($799,860)	($637,813)	($429,099)	($787,052)	($578,339)	($416,292)	($207,579)	$1,135	$209,848	($228,105)	($52,725)	$155,989	

Return on Investment (ROI)	**2.52%**
Simple Project Payback	**6.8**

Assumptions:

Assumes 90% up time on engine
Assumes $55/MWh for wholesale cost of any net excess generation
Assumes $70.00/MWh for discounted retail offset of electric power based on local pricing
Assumes demand charge of $10/kW as avoided cost
Assumed unmet usage based on the aggregate annual usage of the facilities within the microgrid
Engine Output and fuel usage based on typical CHP leanburn NG engines, 4.786x2 mmBTU/hr @ 100% load 1MW, 3.747x2 @ 75% load 750kW
Assumed HHV of natural gas = 1,000 BTU/cf
Mcf = 1,000 cf of gas
Assumes top end changeout ~ every 3yrs, and bottom end rebuild every 6yrs
Major engine maintenance costs estimated and may vary (top end, in frame, major overhaul)
Distribution system upgrades include 1,000' of new cable w/ control wire, transformers, and automatic switches
Assumed average .68MW net electric demand 24/7 unmet electric demand
Pipeline NG cost assumed at $5.53/mmBTU from NG pipeline
No price escalator has been assumed for any of the comodites
Waste heat value assumed at $5.53/mmBTU at @ 85% boiler efficiency for an adjusted value of $6.36/mmBTU
Useful waste heat recovery assumed HT and exhaust jacket heat loops and to be 4.912mmBTU/hr per 1MW installation
Assumes 50% usage of total recoverable waste heat (>190F) through Tri Generation
Assumes operating at 50% capacity during normal operations to limit fuel costs, but retain peak demand capacity

4.0 Benefit-Cost Analysis

To assist with completion of the project's NY Prize Stage 1 feasibility study, Industrial Economics, Incorporated (IEc) conducted a screening-level analysis of the project's potential costs and benefits. Refer to **Section 4.7** and **Table 4.7** for a summary of the Benefit-Cost Analysis. Refer to **Appendix H** for the detailed Third-Party Benefit-Cost Analysis Reports.

4.1 Facility and Customer Description

Tables 4A1 and 4A2 outline the various facilities or groups that will be served by the proposed Northern and Southern Microgrids.

Table 4A1
Facility and Customer Description – Northern Microgrid

Facility Name	Rate Class	Sector	Multiple Meters	Annual Ave Usage (MWh)	Peak Demand (MW)	% of Ave Demand (MW)
Dental Center (2614946102)	small commercial	institutional	no	37.40	0.02	100%
Walk In Clinic (2734946100)	small commercial	institutional	no	65.00	0.02	100%
Fisk Massey 24 4th Street (3094946114)	small commercial	institutional	no	4.40	not reported	100%
Fisk Massey 16 4th Street (3114946112)	small commercial	institutional	no	3.80	not reported	100%
Fisk Massey (3214946114)	small commercial	institutional	no	15.60	0.02	100%
Fisk Massey 16 4th Street (3234946110)	small commercial	institutional	no	10.90	not reported	100%
Fisk Massey 16 4th Street (3254946116)	small commercial	institutional	no	6.40	not reported	100%
MRI Addition (3374946114)	large commercial	institutional	no	265.00	0.05	100%
Alice Hyde Medical Center 133 Park Street (2534946106)	large commercial	institutional	no	4,009.00	0.89	100%
HDU (3494946121)	small commercial	institutional	no	164.00	0.05	100%
	small	institutional	no	123.00	0.04	100%

Cancer Center (3574946109)	commercial					
Fisk Massey 16 4th Street (Figure4946105)	small commercial	institutional	no	5.16	not reported	100%
199 Park Street (4116341116)	small commercial	institutional	no	36.80	not reported	100%
Alice Center (6482430004)	large commercial	institutional	no	1,550.00	0.47	100%
234 Park Street (4696341058)	small commercial	institutional	no	54.90	not reported	100%
Helicopter Pad (1623131001)	small commercial	institutional	no	2.76	not reported	100%
Dental Center (2834946102)	small commercial	institutional	no	37.50	0.02	100%

Table 4A2
Facility and Customer Description – Southern Microgrid

Facility Name	Rate Class	Sector	Multiple Meters	Annual Ave Usage (MWh)	Peak Demand (MW)	% of Ave Demand (MW)
Franklin Academy High School	large commercial	municipal	no	1,696	0.492	100%
Bus Garage	small commercial	municipal	no	39	0.014	100%
Franklin-Essex-Hamilton (BOCES) School	small commercial	municipal	no	374	0.166	100%

4.2 Characterization of Distributed Energy Resources

Tables 4B1 and 4B2 list the proposed distributed energy generation sources within the Northern and Southern Microgrids.

Table 4B1
Northern Microgrid – Characterization of Distributed Energy Resources

Microgrid DER Description	Fuel	Capacity (kW)	Ave. Annual Production (MWh)	Ave. Daily Production (MWh/d)	Heat Rate (mmBTU/MWh)
Recip Engine CHP	Natural Gas	2,120	11,700	32	9.30
PV	Sun	250	300	1	0

Table 4B2
Southern Microgrid – Characterization of Distributed Energy Resources

Microgrid DER Description	Fuel	Capacity (kW)	Ave. Annual Production (MWh)	Ave. Daily Production (MWh/d)	Heat Rate (mmBTU/MWh)
Recip Engine CHP	Natural Gas	1,000	3,942	11	9.24
PV	Sun	250	300	1	0

4.3 Capacity Impacts and Ancillary Services

Tables 4C1 and 4C2 lists the capacity impacts, ancillary services estimated costs and emissions for the proposed generation source(s) within the Northern and Southern Microgrids. The emissions calculations are provided in **Appendix E**.

Table 4C1
Northern Microgrid – Capacity Impacts and Ancillary Services

Peak Load Support (MW/ year)	Demand Response Capacity (MW/ year)	Deferred Transmission (MW/year)	Deferred Distribution (MW/year)	Ancillary Services to Distribution	Estimated Annual Energy Savings MMBTU/ Year	Emissions Allowance Purchase	Emissions (lbs/MWh)			
2.12	0.1	1.5	1.5	Frequency, Voltage, Blackstart Support	49,580	0	2.15	1,073	0.01	0.001
							NOx	**CO2**	**SO2**	**PM**

Table 4C2
Southern Microgrid – Capacity Impacts and Ancillary Services

Peak Load Support (MW/ year)	Demand Response Capacity (MW/ year)	Deferred Transmission (MW/year)	Deferred Distribution (MW/year)	Ancillary Services to Distribution	Estimated Annual Energy Savings MMBTU/ Year	Emissions Allowance Purchase	Emissions (lbs/MWh)			
1.0	0.1	1.5	1.5	Frequency, Voltage, Blackstart Support	18,020	0	2.89	1,022	0.01	0.001
							NOx	**CO2**	**SO2**	**PM**

4.4 Project Costs/Benefit Summary

An initial economic analysis was prepared as part of this Feasibility Study, which is separate from the NYSERDA Third Party review (refer to **Tables 3B1/3B2, Tables 3C1/3C2** and **Section 5**).

Table 4D lists the combined projected benefits and costs for the microgrid system, as determined by the NYSERDA Third-Party evaluating company, IEc. Refer to **Section 4.7** for a summary of the Benefit Cost Analysis.

Table 4D
Northern and Southern Microgrid – Project Costs

Installed System Cost	Service Life (years)	Planning & Design Costs	Annual Fixed O&M Costs ($/year)	Time to run in Island Mode
$4,410,000	20	$392,400	$93,000	indefinite

4.5 Costs to Maintain Service during a Power Outage

Tables 4E1 and 4E2 list the information that was received regarding the existing back-up power diesel generators within the Village.

Table 4E1
Costs to Maintain Service During Power Outage

<table>
<tr><th rowspan="2">Fuel Source of Existing Backup Generators</th><th rowspan="2">Capacity of Existing Backup Generators (kW)</th><th rowspan="2">% of Capacity Generator will run during Emergency</th><th rowspan="2">Ave. Production (MWh/ day)</th><th rowspan="2">Fuel Used (mmbtu/ day)</th><th rowspan="2">One Time Costs to Start Generator</th><th rowspan="2">Daily Ops Costs ($/d)</th><th colspan="2">Facility Costs for Emergency Operations ($/day)</th></tr>
<tr><th>On Backup Power</th><th>W/o Backup Power</th></tr>
<tr><td colspan="9">Alice Hyde Hospital (Medical Center)</td></tr>
<tr><td>Diesel Fuel</td><td>300</td><td>42</td><td>3</td><td rowspan="4">114.2</td><td rowspan="4">NA</td><td rowspan="4">$250</td><td rowspan="4">$900</td><td rowspan="4">NA, most run</td></tr>
<tr><td>Diesel Fuel</td><td>175</td><td>46</td><td>1.93</td></tr>
<tr><td>Diesel Fuel</td><td>100</td><td>30</td><td>0.72</td></tr>
<tr><td>Diesel Fuel</td><td>500</td><td>30</td><td>3.6</td></tr>
</table>

Table 4E2

Costs to Maintain Service During Power Outage

Fuel Source of Existing Backup Generators	Capacity of Existing Backup Generators (kW)	% of Capacity Generator will run during Emergency	Ave. Production (MWh/ day)	Fuel Used (mmbtu/ day)	One Time Costs to Start Generator	Daily Ops Costs ($/d)	Facility Costs for Emergency Operations ($/day)	
							On Backup Power	W/o Backup Power
Franklin Academy High School								
Diesel Fuel	300	100	7.2	10.43	$50	$50	$107	NA, can't run
Bus Garage								
NA	No backup	NA	NA	N/A	$500	$50	$600	NA, can't run
Franklin-Essex-Hamilton (BOCES) School								
Diesel Fuel	45	0.6	0.5	0.70	$0	$50	$54	NA, can't run

4.6 Services Supported by the Microgrid

Regarding the Northern and Southern Microgrids, the proposed critical facility end-users within the Village that would potentially utilize the microgrids include: the medical facilities in the north, to serve the Village and the surrounding community, and the school complex in the south as emergency shelter. The development of the microgrids within the Village will have a number of benefits, the greatest being increased emergency service capacity during grid emergencies including: the operation of the Alice Hyde Hospital (medical center), and emergency shelter, emergency command and control, and potential emergency transportation for an approximate population of 5,900 and other local commercial businesses and industries.

4.7 Summary Results from Industrial Economics, Incorporated's (IEc's) Benefit-Cost Analysis

Table 4F provides the benefit-cost analysis as developed by IEc, a NYSERDA Third-Party Reviewer, of the proposed microgrid project. Refer to **Appendix H** for the Third-Party Benefit-Cost Analysis Reports.

Table 4F
Summary Results of IEc's Third-Party Benefit-Cost Analysis

Cost or Benefit Category	Present Value Over 20 Years (2014$)	Annualized Value (2014$)
Costs		
Initial Design and Planning	$392,000	$34,600
Capital Investments	$4,410,000	$389,000
Fixed O&M	$1,050,000	$93,000
Variable O&M (Grid-Connected Mode)	$0	$0
Fuel (Grid-Connected Mode)	$11,300,000	$992,000
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$9,410,000	$614,000
Total Costs	**$26,500,000**	
Benefits		
Reduction in Generating Costs	$9,890,000	$872,000
Fuel Savings from CHP	$5,240,000	$462,000
Generation Capacity Cost Savings	$2,820,000	$249,000
Distribution Capacity Cost Savings	$621,000	$54,800
Reliability Improvements	$747,000	$65,900
Power Quality Improvements	$0	$0
Avoided Emissions Allowance Costs	$5,510	$486
Avoided Emissions Damages	$12,600,000	$821,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$31,900,000**	
Net Benefits	**$5,380,000**	
Benefit/Cost Ratio	**1.2**	
Internal Rate of Return	**16.5%**	

** The estimate of project benefits is approximately 120 percent of project costs, with a Benefit/Cost Ratio (BCR) of 1.2. A BCR rating above 1.0 typically indicates a revenue positive project, as long as costs as discounted appropriately at the opportunity cost of capital expenditures. The discount rate was 7% per year. Thus, the microgrid project does have the potential to positively impact the Village and improve the reliability and redundancy of their existing electric infrastructure system during an emergency grid outage.*

Benefit - Cost Analysis Summary Report

Site 57 – Village of Malone

PROJECT OVERVIEW

As part of NYSERDA's New York Prize community microgrid competition, the Village of Malone has proposed development of a microgrid that would serve a number of facilities within the village, including:

- The Alice Hyde Medical Complex;
- Franklin Academy High School;
- Franklin-Essex-Hamilton (BOCES) School; and
- A bus garage.[1]

The microgrid would incorporate four new distributed energy resources (DERs): two combined heat and power (CHP) natural gas generators and two solar photovoltaic (PV) arrays. Combined, these DERs have a capacity of approximately 3.6 MW.

To assist with completion of the project's NY Prize Stage 1 feasibility study, IEc conducted a screening-level analysis of the project's potential costs and benefits. This report describes the results of that analysis, which is based on the methodology outlined below.

METHODOLOGY AND ASSUMPTIONS

In discussing the economic viability of microgrids, a common understanding of the basic concepts of benefit-cost analysis is essential. Chief among these are the following:

- *Costs* represent the value of resources consumed (or benefits forgone) in the production of a good or service.
- *Benefits* are impacts that have value to a firm, a household, or society in general.
- *Net benefits* are the difference between a project's benefits and costs.
- Both costs and benefits must be measured relative to a common *baseline* - for a microgrid, the "without project" scenario - that describes the conditions that would prevail absent a project's development. The BCA considers only those costs and benefits that are *incremental* to the baseline.

[1] The project team designates the Alice Hyde Medical Complex as the "northern microgrid" and all remaining facilities as the "southern microgrid." In accordance with the project team's preferences, we evaluate the costs and benefits of both the "northern microgrid" and "southern microgrid" as one project.

This analysis relies on an Excel-based spreadsheet model developed for NYSERDA to analyze the costs and benefits of developing microgrids in New York State. The model evaluates the economic viability of a microgrid based on the user's specification of project costs, the project's design and operating characteristics, and the facilities and services the project is designed to support. The model analyzes a discrete operating scenario specified by the user; it does not identify an optimal project design or operating strategy.

The BCA model is structured to analyze a project's costs and benefits over a 20-year operating period. The model applies conventional discounting techniques to calculate the present value of costs and benefits, employing an annual discount rate that the user specifies – in this case, seven percent.[2] It also calculates an annualized estimate of costs and benefits based on the anticipated engineering lifespan of the system's equipment. Once a project's cumulative benefits and costs have been adjusted to present values, the model calculates both the project's net benefits and the ratio of project benefits to project costs. The model also calculates the project's internal rate of return, which indicates the discount rate at which the project's costs and benefits would be equal. All monetized results are adjusted for inflation and expressed in 2014 dollars.

With respect to public expenditures, the model's purpose is to ensure that decisions to invest resources in a particular project are cost-effective; i.e., that the benefits of the investment to society will exceed its costs. Accordingly, the model examines impacts from the perspective of society as a whole and does not identify the distribution of costs and benefits among individual stakeholders (e.g., customers, utilities). When facing a choice among investments in multiple projects, the "societal cost test" guides the decision toward the investment that produces the greatest net benefit.

The BCA considers costs and benefits for two scenarios:

- Scenario 1: No major power outages over the assumed 20-year operating period (i.e., normal operating conditions only).
- Scenario 2: The average annual duration of major power outages required for project benefits to equal costs, if benefits do not exceed costs under Scenario 1.[3]

[2] The seven percent discount rate is consistent with the U.S. Office of Management and Budget's current estimate of the opportunity cost of capital for private investments. One exception to the use of this rate is the calculation of environmental damages. Following the New York Public Service Commission's (PSC) guidance for benefit-cost analysis, the model relies on temporal projections of the social cost of carbon (SCC), which were developed by the U.S. Environmental Protection Agency (EPA) using a three percent discount rate, to value CO_2 emissions. As the PSC notes, "The SCC is distinguishable from other measures because it operates over a very long time frame, justifying use of a low discount rate specific to its long term effects." The model also uses EPA's temporal projections of social damage values for SO_2, NO_x, and $PM_{2.5}$, and therefore also applies a three percent discount rate to the calculation of damages associated with each of those pollutants. [See: State of New York Public Service Commission. Case 14-M-0101, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision. Order Establishing the Benefit Cost Analysis Framework. January 21, 2016.]

[3] The New York State Department of Public Service (DPS) requires utilities delivering electricity in New York State to collect and regularly submit information regarding electric service interruptions. The reporting system specifies 10 cause categories: major storms; tree contacts; overloads; operating errors; equipment failures; accidents; prearranged interruptions; customers equipment; lightning; and unknown (there are an additional seven cause codes used exclusively for Consolidated Edison's underground network system). Reliability metrics can be calculated in two ways: including all outages, which indicates the actual experience of a utility's customers; and excluding outages caused by major storms, which is more indicative of the frequency and duration of outages within the utility's control. In estimating the reliability benefits of a microgrid, the BCA employs metrics that exclude outages caused by major storms. The BCA classifies outages caused by major storms or other events beyond a utility's control as "major power outages," and evaluates the benefits of avoiding such outages separately.

RESULTS

Table 1 summarizes the estimated net benefits, benefit-cost ratios, and internal rates of return for the scenarios described above. The results indicate that even if there were no major power outages over the 20-year period analyzed (Scenario 1) the project's benefits would exceed its costs by approximately 20 percent.

Since the results for Scenario 1 suggest a benefit-cost ratio greater than one, the report does not present a detailed analysis of the impact of major power outages under Scenario 2. Consideration of Scenario 2 would further increase the project's already positive benefit-cost ratio. The discussion that follows provides additional detail on the findings from Scenario 1.

Table 1. BCA Results (Assuming 7 Percent Discount Rate)

ECONOMIC MEASURE	EXPECTED DURATION OF MAJOR POWER OUTAGES	
	SCENARIO 1: 0 DAYS/YEAR	SCENARIO 2
Net Benefits - Present Value	$5,380,000	Not evaluated
Benefit-Cost Ratio	1.2	Not evaluated
Internal Rate of Return	16.5%	Not evaluated

Scenario 1

Figure 1 and Table 2 present the detailed results of the Scenario 1 analysis.

Figure 1. Present Value Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate)

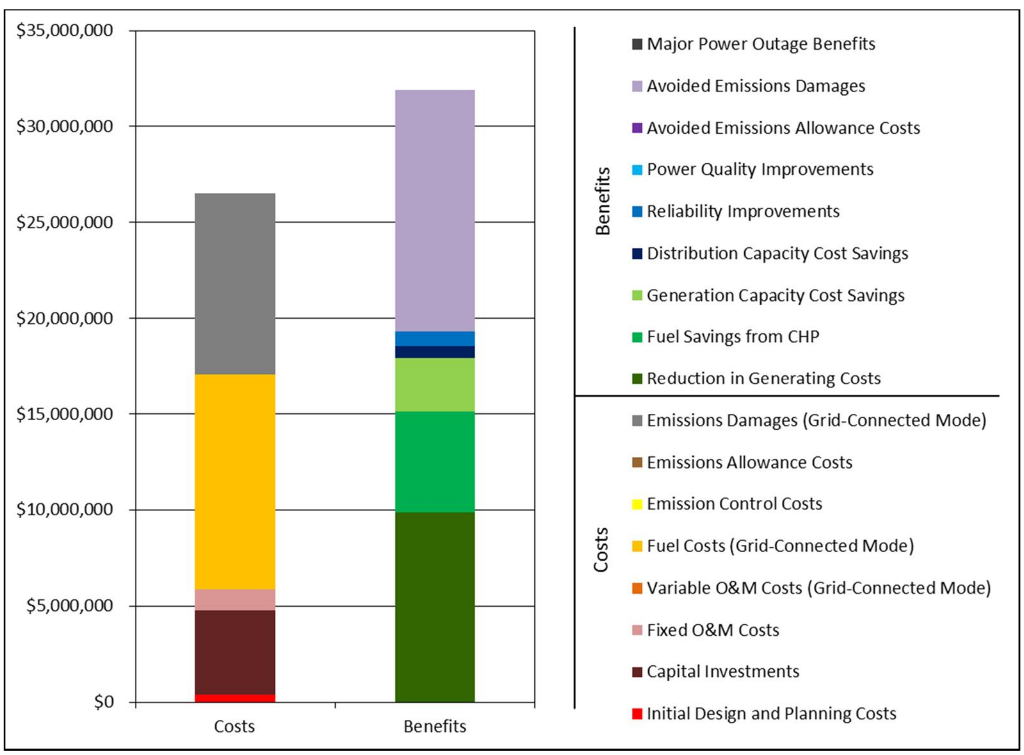


Table 2. Detailed BCA Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$392,000	$34,600
Capital Investments	$4,410,000	$389,000
Fixed O&M	$1,050,000	$93,000
Variable O&M (Grid-Connected Mode)	$0	$0
Fuel (Grid-Connected Mode)	$11,300,000	$992,000
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$9,410,000	$614,000
Total Costs	**$26,500,000**	
Benefits		
Reduction in Generating Costs	$9,890,000	$872,000
Fuel Savings from CHP	$5,240,000	$462,000
Generation Capacity Cost Savings	$2,820,000	$249,000
Distribution Capacity Cost Savings	$621,000	$54,800
Reliability Improvements	$747,000	$65,900
Power Quality Improvements	$0	$0
Avoided Emissions Allowance Costs	$5,510	$486
Avoided Emissions Damages	$12,600,000	$821,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$31,900,000**	
Net Benefits	**$5,380,000**	
Benefit/Cost Ratio	**1.2**	
Internal Rate of Return	**16.5%**	

Fixed Costs

The BCA relies on information provided by the project team to estimate the fixed costs of developing the microgrid. The project team estimates initial design and planning costs to be approximately $392,000. The present value of the project's capital costs is estimated to be $4.4 million, including the costs of the CHP systems and solar PV panels. The project team also estimates $93,000 a year in fixed O&M costs for CHP engine maintenance, solar PV maintenance, and interconnection maintenance. The present value of these costs over 20 years is $1.1 million.

Variable Costs

The most substantial variable cost associated with operation of the Malone microgrid would be the cost of fuel. To characterize these costs, the BCA relies on estimates of fuel consumption provided by the project team and projections of fuel costs from New York's State Energy Plan (SEP), adjusted to reflect recent market prices.[4] The present value of the project's fuel costs over a 20-year operating period is estimated to be approximately $11.3 million.

The analysis of variable costs also considers the environmental damages associated with pollutant emissions from the distributed energy resources that would serve the microgrid, based on the operating scenario and emissions rates provided by the project team and the understanding that none of the system's generators would be subject to emissions allowance requirements. Over a 20-year operating period, the present value of emissions damages is estimated at approximately $9.4 million.

Avoided Costs

The development and operation of a microgrid may avoid or reduce a number of costs that otherwise would be incurred. For the Village of Malone's proposed project, a major source of cost savings would be a reduction in demand for electricity from bulk energy suppliers, with a resulting reduction in generating costs. The BCA estimates the present value of these savings over a 20-year operating period to be approximately $9.9 million; this estimate assumes the microgrid provides base load power, consistent with the operating profile upon which the analysis is based. The CHP units would also provide savings on heating costs due to a reduction in fuel consumption; the present value of these savings is approximately $5.2 million. These changes would curtail emissions of CO_2, SO_2, NO_x, and particulate matter from facility heating systems and bulk energy suppliers, yielding emissions allowance cost savings with a present value of approximately $5,500 and avoided emissions damages with a present value of approximately $12.6 million.[5]

In addition to the savings noted above, development of a microgrid could yield cost savings by avoiding or deferring the need to invest in expansion of the conventional grid's energy generation or distribution capacity.[6] The project team estimates the project's impact on demand for generating capacity to be approximately 3.3 MW per year. Based on these figures, the BCA estimates the present value of the project's generating capacity benefits to be approximately $2.8 million over a 20-year operating period. The project team estimates the project's impact on distribution capacity to be 1.5 MW per year. The BCA estimates the present value of these benefits to be approximately $621,000 over a 20-year operating period.

The project team has indicated that the proposed microgrid would be designed to provide ancillary services, including frequency regulation, reactive power support, and black start support, to the New York Independent System Operator (NYISO). Whether NYISO would select the project to provide these services depends on NYISO's requirements and the ability of the project to provide support at a cost lower than that of alternative sources. Based on discussions with NYISO, it is our understanding that the markets for ancillary services are highly competitive, and that projects of this type would have a relatively

[4] The model adjusts the State Energy Plan's natural gas and diesel price projections using fuel-specific multipliers calculated based on the average commercial natural gas price in New York State in October 2015 (the most recent month for which data were available) and the average West Texas Intermediate price of crude oil in 2015, as reported by the Energy Information Administration. The model applies the same price multiplier in each year of the analysis.

[5] Following the New York Public Service Commission's (PSC) guidance for benefit-cost analysis, the model values emissions of CO_2 using the social cost of carbon (SCC) developed by the U.S. Environmental Protection Agency (EPA). [See: State of New York Public Service Commission. Case 14-M-0101, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision. Order Establishing the Benefit Cost Analysis Framework. January 21, 2016.] Because emissions of SO_2 and NO_x from bulk energy suppliers are capped and subject to emissions allowance requirements in New York, the model values these emissions based on projected allowance prices for each pollutant.

[6] Impacts on transmission capacity are implicitly incorporated into the model's estimates of avoided generation costs and generation capacity cost savings. As estimated by NYISO, generation costs and generating capacity costs vary by location to reflect costs imposed by location-specific transmission constraints.

small chance of being selected to provide support to the grid. In light of this consideration, the analysis does not attempt to quantify the potential benefits of providing these services.

Reliability Benefits

An additional benefit of the proposed microgrid would be to reduce customers' susceptibility to power outages by enabling a seamless transition from grid-connected mode to islanded mode. The analysis estimates that development of a microgrid would yield reliability benefits of approximately $66,000 per year, with a present value of approximately $747,000 over a 20-year operating period. This estimate is calculated using the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator, and is based on the following indicators of the likelihood and average duration of outages in the service area:[7]

- System Average Interruption Frequency Index (SAIFI) – 0.96 events per year.
- Customer Average Interruption Duration Index (CAIDI) – 116.4 minutes.[8]

The estimate takes into account the number of large commercial or industrial customers the project would serve; the distribution of these customers by economic sector; average annual electricity usage per customer, as provided by the project team; and the prevalence of backup generation among these customers. It also takes into account the variable costs of operating existing backup generators, both in the baseline and as an integrated component of a microgrid. Under baseline conditions, the analysis assumes a 15 percent failure rate for backup generators.[9] It assumes that establishment of a microgrid would reduce the rate of failure to near zero.

It is important to note that the analysis of reliability benefits assumes that development of a microgrid would insulate the facilities the project would serve from outages of the type captured in SAIFI and CAIDI values. The distribution network within the microgrid is unlikely to be wholly invulnerable to such interruptions in service. All else equal, this assumption will lead the BCA to overstate the reliability benefits the project would provide.

Summary

The analysis of Scenario 1 yields a benefit/cost ratio of 1.2; i.e., the estimate of project benefits is approximately 120 percent of project costs. Accordingly, the analysis does not consider the potential of the microgrid to mitigate the impact of major power outages in Scenario 2. Consideration of such benefits would further increase the net benefits of the project's development.

[7] www.icecalculator.com.

[8] The analysis is based on DPS's reported 2014 SAIFI and CAIDI values for National Grid.

[9] http://www.businessweek.com/articles/2012-12-04/how-to-keep-a-generator-running-when-you-lose-power#p1.

5.0 Findings and Recommendations

5.1 Feasibility Study Findings

1. The Village of Malone with a population of approximately 5,900 residents is serviced by an electric distribution system that is owned and operated by National Grid. Various microgrid configurations were considered, and the most advantageous configuration appears to be microgrid servicing the Alice Hyde Medical Center (northern microgrid), and a microgrid servicing the Franklin Academy High School, its bus garage, and the Franklin-Essex-Hamilton BOCES (southern microgrid). The maximum annual aggregate peaks of the northern and southern microgrids were projected at 1.5 MW and 0.650 MW, respectively. The total annual usage for the north and south microgrid were estimated to be 6,400 kWh and 2,100 kWh, respectively.

    - ***The size of these microgrids, and its demand and usage are sufficient to support a localized microgrid, provide local generation redundancy, and system resiliency.***

2. The Village has experienced losses of power to the National Grid distribution system in the past.

    - ***The critical nature of the facilities that are proposed to be serviced by the microgrids is sufficient justification to assess the feasibility of development of localized microgrids.***

3. The Village initiated a feasibility study for the development of microgrid/s within the Village area to improve the electric distribution system resiliency especially during emergency events when primary grid power is compromised.

    - ***There are qualifying critical facility locations within the Village of Malone for DERs/ CHP engine gensets to establish multiple microgrids. Host locations are contingent upon various agreements and consent with the Village.***
    - ***The DERs/generation sources to match the requirements of the Village's proposed Northern microgrid would be two (2) JGS 320 CHP engine gensets (1,059 kWe each).***
    - ***The DERs/generation sources to match the requirements of the Village's proposed Southern microgrid would be two (2) JGS 312 CHP engine gensets (500 kWe each).***

4. To support and fuel (i.e. fire) the CHP engine gensets for DERs within the Village for the microgrid, a continuous uninterrupted supply pipeline for natural gas is required.

    - ***There exists the technology and resources for the natural gas supply pipeline by a gas utility, which is contingent on applicable supply agreements.***

5. The project economics were estimated on available information to help determine if the project was economically feasible. With grant support and without grant support for ROI and Simple Project Payback.

    - ***With or without grant support, the microgrid projects are economically viable.***

- ***With grant support, the economics are considerably better, which can utilize the funding differential for any potential and unforeseen conditions during the microgrid project development.***

6. Findings – SWOT Analysis.

- ***Strengths and opportunities are strong, but the microgrid project requires funding, mutual agreements by parties, etc. to be successful and fully viable.***

7. Findings – Economic Analysis.

<u>Northern Microgrid (at Alice Hyde Hospital)</u>

- ***CHP System (2.12 MW) Electric Production with Heat Recovery (With Grant Funding)***
  - ***Capital Expense Cost = $3,384,000.***
  - ***Grant (NYSERDA PON 2701) = $1,692,000.***
  - ***Net Capital Cost = $1,692,000.***
  - ***Return on Investment = 19.69 %.***
  - ***Simple Payback = 3.1 Years.***
  - ***Refer to Table 3B1.***

- ***CHP System (2.12 MW) Electric Production with Heat Recovery (Without Grant Funding)***
  - ***Capital Expense Cost = $3,384,000.***
  - ***Grant (N/A) = $0.00.***
  - ***Net Capital Cost = $3,384,000.***
  - ***Return on Investment = 8.77%.***
  - ***Simple Payback = 6.2 Years.***
  - ***Refer to Table 3B2.***

<u>Southern Microgrid (at Franklin Academy High School)</u>

- ***CHP System (1.0 MW) Electric Production with Heat Recovery (With Grant Funding)***
  - ***Capital Expense Cost = $1,426,000.***
  - ***Grant (NYSERDA PON 2701) = $713,000.***
  - ***Net Capital Cost = $713,000.***
  - ***Return on Investment = 14.04 %.***
  - ***Simple Payback = 3.4 Years.***
  - ***Refer to Table 3C1.***

- ***CHP System (1.0 MW) Electric Production with Heat Recovery (Without Grant Funding)***
  - ***Capital Expense Cost = $1,426,000.***

- ***Grant (N/A) = $0.00.***
- ***Net Capital Cost = $1,426,000.***
- ***Return on Investment = 2.52%.***
- ***Simple Payback = 6.8 Years.***
- ***Refer to Table 3C2.***

8. Findings – Benefit-Cost Analysis by IEc.

- ***The estimate of project benefits is approximately 120 percent of project costs.***

  - ***Total Costs over 20-year period = $26,500,000.***
  - ***Total Benefits over 20-year period = $31,900,000.***
  - ***Net Benefits – Present Value over 20-year period = $5,380,000.***

- ***Benefit/Cost Ratio (BCR) is 1.20.***

  - ***A BCR rating above 1.0 typically indicates a revenue positive project, as long as costs as discounted appropriately at the opportunity cost of capital expenditures.***

- ***Internal Rate of Return is 16.5%***

5.2 Feasibility Study Recommendations

1. Develop a detailed basis for design, equipment, power purchase thresholds, and personnel requirements for O&M for each microgrid.
2. Investigate additional funding sources and mechanisms.
3. Verify economic assumptions to better refine cost estimates.
4. Gain approval from, and prepare Agreements with/between facilities within the microgrids and with potential generation sources/host locations.
5. Proceed with Stakeholder Engagement, Design, Permitting, etc.
6. Proceed with Bidding and Construction.
7. Look at the opportunity to develop other microgrids within the Village, or expand these microgrids to support additional critical facilities.

6.0 Reference Documents

The following reference documents have been reviewed to collect and present information during the preparation of this Report. Refer to **Appendix G and Appendix I** for the reference documents.

1. General Electric – Technical Description Genset JGS 320 GS-N.L, dated September 23, 2015 (as included in AB Technical Description document).
2. General Electric – Technical Description Genset JGS 312 GS-N.L, dated March 29, 2016 (as included in AB Technical Description document).
3. General Electric Energy – Technical Instruction Manual for Isolated Operation of Spark Ignition Gas Engines with DIA.NE (Type 4 Engines), TA 2108-0029, dated May 26, 2010.
4. General Electric Power & Water – Technical Instruction Manual for General Isolated Operation of Plants and Engines, TA 2108-0031, dated December 19, 2014.
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