38 - Village of Wappingers Falls

Notice

NY PRIZE MICROGRID FEASIBILITY EVALUATION – FINAL AMENDED REPORT

PREPARED BY

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MODIFIED TO INCLUDE NYSERDA COMMMENTS AND BCA

DISCLAIMER PER NYSERDA FORMAT

This report follows the format and task scope items as defined in NYSERDA PON 3044.

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We thank and recognize the following Strategic Allies, Service providers:

Village of Wappingers Falls, CHG&E, Solar City, Eos Energy Storage, Elite Energy, Wappinger Falls Hydroelectric, KC Engineering and Land Surveying P.C., Genesys Engineering P.C..

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Arkados Energy Solutions

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EXECUTIVE SUMMARY

This report presents the detail for, and our findings regarding, the NY Prize Microgrid Feasibility Evaluation. The work was performed in accordance with the NYSERDA Scope Items presented in PON 3044, and includes the Benefit Cost Analysis Questionnaire with Results.

Our evaluation presents detail as regards the microgrid configuration. The system one-line is presented in the Appendix, and illustrates the equipment ratings, location on the microgrid circuit, the eight critical customers and their loads. Electric generation and circuit load simultaneous hour by hour profiles were developed for this evaluation.

This configuration meets the intent of the basic and preferred microgrid capabilities as defined by NYSERDA.

The distributed energy supply resources are integrated and comprised of existing and new intermittent and renewable energy supply, battery storage and stored hydroelectric water reserves with existing and new engine generation. This allows all customers of the entire microgrid, comprised of critical and non-critical load, to be served, and controlled, with capacity in a reliable and grid resilient manner. The annual electrical energy consumed by *all* customers on the microgrid circuit is 17,708,298 kWH, and the peak demand is 3,407 kW. The critical loads consume 2,730,328 kWH and their peak demand is 638 kW.

Renewable resources account for more than half of the annual energy supply. A summary of supply resources is per Table 5. See Table 7 for load summary.

A method to pay for resiliency and reliability measures by applying some of the revenues from Community Net Metering (CNM) energy sales that originate from the renewable power plants is presented as a novel means of capitalizing the microgrid, in part. There are an estimated 9,518,665 kWH of renewable generation from the existing hydro plant, the existing PV plant at the water treatment plant, and the proposed new Mt. Alvernia PV project. CNM revenues are based on 14.59 cents per kWH tariff as applied to CHG&E residential customers.

Estimated capital cost for the microgrid development is $17.2 million, with a $3.0 million allowance for utility (CHG&E) scope included. Valuation of existing generation assets such as the existing diesel engines, PV project at the water treatment plant, and the hydroelectric plant is excluded from the $17.2 million capital cost estimate. There are $1.9 million of Investment Tax Credit subsidies that reduce the capital outlay, as well as an assumed $8.0 million NYSERDA NY Prize Phase 2 and Phase 3 potential co-funding. In the event that less NYSERDA co-funding is available, the project is still viable although there are serious ramifications as follows: (1) the microgrid can be reduced in scope to include a reduced microgrid service area, or (2) can be built in phases, or (3) attract additional financing with a formula to include rate recovery, or (4) CNM revenue that is allocated to utility Market Based Earnings could be applied to fund critical elements of the microgrid.

Utility scope requires gas system reinforcement as well as all electric interconnection costs and electric grid modifications, as well as deployment of any smart grid technology and control system upgrades.

The business case is primarily driven by the CNM opportunity. Area development of the Industrial Park including managing load growth and providing ultra-reliable clean power to this microgrid subsection is another key business case driver.

Battery systems are an important component of this microgrid. They provide the ride-through capability, black start motive power, ancillary services, load shifting, and on-site emergency supply.

PV modules to be located at Mt. Alvernia and the battery system to be located at the Water Supply plant are manufactured in New York State.

The model presented herein is replicable across New York State.

Battery system manufacturers have expressed interest in assembly operations within the Industrial Park. There is job creation and business development opportunity.

Coordination and consistency with NY REV is described herein, as requested by NYSERDA. Most importantly, this microgrid furnishes:

- Added resiliency and reliability that are useful attributes in emergency events including storms, and Homeland Security episodes
- Grid support, grid capital deferment, grid ancillary benefits
- Cost savings to low income residents of the Village
- Revenue stream to the Village for work performed to in-part promote and administer the microgrid efforts via the "microgrid entity"
- Investment opportunity using a unique and customized business model based on Community Distributive Generation (or Community Net Metering)
- Job creation and growth
- Development and deployment of innovative New York and American technology
- Public – private partnership with strategic allies and service providers including the Village of Wappingers Falls, CHG&E, Solar City, Eos, Energy Storage, Elite Energy, Wappinger Falls Hydroelectric, KC Engineering and Land Surveying P.C., and Genesys Engineering P.C..
- Economic and operational benefits to all customers connected to the microgrid circuit as well as the service providers:

  1. All utility accounts on the microgrid circuit receive the benefits of enhanced grid resiliency
  2. Residential accounts, with preference to low income household, receive a discount
  3. The utility can enjoy market based earnings as per NYREV
  4. The older existing assets (hydro plant) can be rebuilt to serve load for 40 more years.
  5. New Technologies are encouraged, that is, control systems, and battery storage
  6. New Renewable supply by PV solar energy is added
  7. Load growth is accomplished, in which jobs are created
  8. Participation by microgrid generators in other markets, including ancillary services, ICAP / UCAP, and demand response adds revenue to the bottom line of the owners of generation
  9. The Village is afforded opportunity to earn revenue through microgrid services as a participant in the "microgrid entity"

1.0 TASK 1 DESCRIPTION OF MICROGRID CAPABILITIES

1.1 SUB TASK Minimum Required Capabilities

1.1.1 Critical Loads and Customers

The VWF's microgrid program includes electric service to 8 critical loads that are physically separated. The critical load customers are:

A. Tri-Municipal Sewer Commission Wastewater Treatment Plant
B. Mt. Alvernia Retreat Center (Potential Emergency Shelter)
C. Monastery of St. Clare (Potential Emergency Shelter)
D. Village Water Supply Facility
E. SW Johnson Fire House
K. New Hamburg Fire Department
P. St. Mary's School
WCSD. Sheafe Road Elementary School

Figure 1, below, identifies each critical load facility that will be served and will benefit from the proposed community microgrid. Each critical load is on a separate property, is a distribution system customer of Central Hudson Gas & Electric (CHG&E), and is served (or will be served after CHG&E makes minor modifications by connection of a section of the 8024 circuit to the 8023 circuit) via the upgraded 8023 Circuit as operated by CHG&E.

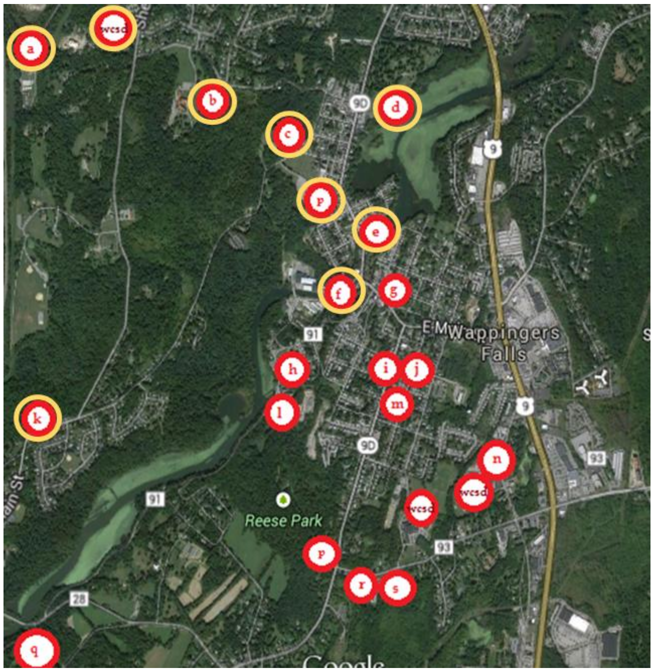


FIGURE 1 – MICROGRID CRITICAL LOADS

1.1.2 Electric Generation and Supply, Microgrid Resource Operating Modes

The VWF Microgrid Program includes six existing sources of electric generation, and will include three new sources of power supply. Additionally, electric battery storage will be added to serve several critical functions as further described in the body of the report. The primary generation source capacity has some renewable supply, diesel, and natural gas, and meets the NYSERDA requirement for generation to be not totally dependent upon diesel fuel. The controls, governing systems, and power conversion equipment allow both grid connected and electrically isolated modes of operation. The system can function in:

- Normal operating mode, in which the regional and area transmission system is operational,
- Demand Response / Ancillary Service mode, in which the regional and area transmission system is operational and the assets and resources of the microgrid are providing technical benefit and exporting economic value to this system.
- Microgrid "Islanded" mode, in which the distribution system is sound and functional, but there is an outage at the substation or transmission system. The microgrid has the capability to form an intentional island, as required by NYSERDA.
- Back-up mode, in which the distribution system is partly or completely out-of-service, and the electric generators must operate to serve their host sites only, or part of the upgraded 8023 microgrid circuit. NOTE – ALL REFERENCES TO 8023 CIRCUIT IN THIS DOCUMENT REFER TO AN UPGRADED 8023 CIRCUIT THAT INCLUDES A SECTION OF THE EXISTING 8024 CIRCUIT THAT WILL BE CONNECTED TO THE EXISTING 8023 CIRCUIT.

Table 1 below itemizes the generation capability of the proposed microgrid. There are two existing renewable energy supply resources that anchor the microgrid intermittent resources. The new gas engine and existing diesels allow this system to be totally grid resilient.

These sources of electric power supply will:

- Comply with manufacturer's requirements for scheduled maintenance intervals for all generation;
- Consists of intermittent renewable resources that are utilized toward overall generation capacity because these resources are paired with conventional generation and energy storage. Twenty-four (24) hrs per day and seven (7) days per week utilization of the power produced by these resources results.
- Generation and system controls will allow load following of the critical, as well as non-critical, customers that are served by the upgraded 8023 microgrid circuit while maintaining the voltage and frequency when running in parallel and connected to the grid in normal, microgrid, or back-up operating modes. The microgrid functions in accordance with ANSI c84-1 standards when islanded as specified by NYSERDA. In certain instances of near zero intermittent (renewable)

resource power supply and near peak demand of all critical and non-critical loads, some load shedding made possible by CHG&E Smart grid technology will be necessary.

CRITICAL LOAD / Property Name	Existing Emergency or Baseload Generation, kW	New Gas Engine, kW	Existing PV Generation	New PV or Hydro Turbine, kW	New Energy Storage
a - Tri-Municipal Sewer Commission, Tri-Muni Wastewater Treatment Facility Facility	300	-	-	-	-
b - Mt. Alvernia Retreat Center	-	-	-	1,000	1000 kW / 500 kWH
c - Monastery of St. Clare	80	-	-	-	-
d - Village Water Supply Facility	350	-	200	-	250 KW / 1000 KWH
e - SW Johnson Firehouse	25	-	-	-	-
f - Wappingers Falls Hydroelectic Generation Station and Industrial Park Locations	2,450	2,000	-	250	-
k - New Hamburg Fire Dept	-	-	-	-	-
wcsd - Sheafe Road Elementary School	-	-	-	-	-
p - St. Mary's School	-	-	-	-	-
Total Supply Capacity at Critical Load + Wappingers Falls Hydro	3,205	2,000	200	1,250	1,250

	Renewable Only	Renewable + Gas Engine	Renewable + Gas Engine + Diesels	TOTAL CAPACITY
Existing Capacity	2,650 kW	-	755 kW	3,405 kW
New Capacity	1,250 kW	2,000 kW	-	3,250 kW
TOTAL CAPACITY	3,900 kW	2,000 kW	755 kW	**6,655 kW**
Energy Storage				1,250 kW

TABLE 1 – GENERATION CAPACITY OF VWF MICROGRID ON 8023 CIRCUIT

As further discussed in the Load Characterization section below, power is supplied to both critical commercial facilities as well as a diverse group of customers connected directly to the microgrid. The customer base includes not only the critical loads, but the residential non-critical customers and small commercial facilities as well. The following Table presents Operation Modes of the Microgrid and status of Microgrid Major Systems. The Table illustrates compliance with NYSERDA Minimum Capabilities.

	GRID STATUS		GENERATION SUPPLY STATUS								LOAD STATUS	
OPERATING MODES	*Transmission*	*8023 Circuit*	*PV Water Tmnt*	*PV Mt. Alvernia*	*Energy Storage Systems*	*Gas Engine*	*Hydro Plant*	*Existing Diesels*	*Wholesale Import of Electric Energy*	*Notes*	*Critical*	*Non-Critical*
			200 kW	*1,000 kW*	*1,250 kW / 1,500 kWH*	*2,000 kW*	*2,700 kW*	*755 kW*		*6,655 kW Capacity*		
NORMAL												
Renewable Supply > 8023 Ckt Load	On	On	On	On	Charging	Off	On	Off	No	1,931 Hrs / yr	ON	ON
Renewable + Gas Engine Supply > 8023 Ckt Load	On	On	On	On	Charging	Economic Dispatch	On	Off	Economic Dispatch	7,592 Hrs / yr	ON	ON
Renewable + Gas Engine + Diesel Supply > 8023 Ckt Load	On	On	On	On	Partial Discharge	Economic Dispatch	On	Off	Economic Dispatch	8,609 Hrs / yr	ON	ON
Renewable + Gas Engine + Diesel Supply < 8023 Ckt Load	On	On	On	On	Partial Discharge	Economic Dispatch	On	Off	Yes	151 Hrs / yr	ON	ON
DEMAND RESPONSE / ANCILLARY SERVICES	On	On	On	On	Partial Discharge	On	On	Off	No	CHG&E Initiates	ON	ON
MICROGRID / ISLANDED - AREA / REGIONAL / SUBSTATION DISRUPTION										CHG&E Data	ON	ON
Renewable Supply > 8023 Ckt Load	Off	On	On	On	Charging	Standby On	On	Off	No	Up To 1931 Hrs/yr	ON	ON
Renewable + Gas Engine Supply > 8023 Ckt Load	Off	On	On	On	Charging	On	On	Off	No	Up To 7592 Hrs/yr	ON	ON
Renewable + Gas Engine + Diesel Supply > 8023 Ckt Load	Off	On	On	On	Partial Discharge	On	On	On	No	Up To 8609 Hrs/yr	ON	ON
Renewable + Gas Engine + Diesel Supply < 8023 Ckt Load	Off	On	On	On	Full Discharge and Charge	On	On	On	No	Up To 151 Hrs/yr	ON	Partial Disruption
MICROGRID / ISLANDED - AREA / REGIONAL / SUBSTATION DISRUPTION and PARTIAL OUTAGES OF 8023 CIRCUIT												
Renewable + Gas Engine + Diesel Supply > 8023 Ckt Load	Off	Off	On	On	Charging	On	On	On	No	All Critical Loads Supplied; Non Critical Loads Partially Disrupted	ON	Partial Disruption
Renewable + Gas Engine + Diesel Supply < 8023 Ckt Load	Off	Off	On	On	Discharging	On - Supplies Industrial Park		On	No	All Critical Loads Supplied; Non Critical Loads Partially Disrupted	ON	Partial Disruption

TABLE 2 – OPERATING MODES AND STATUS OF MICROGRID MAJOR SYSTEMS

1.1.3 Customer Overview

The following presents highlights of the customer load base served by the microgrid:

- The microgrid will supply low income and other customer accounts through a Community Net Metering arrangement.
- Existing and new commercial, industrial, and residential load in the Development adjacent to the hydroelectric facility which comprises the VWF's Industrial Park will be served by extra-reliable green power. The Industrial Park is an economic development initiative that is further described in "Preferable Microgrid Capabilities", below.
- A varied fuel mix inclusive of:
    - natural gas for a 2 MW engine generation system,
    - diesel fuel including new storage tankage sized for 7 day supply capability,
    - renewable resources (PV and hydro),
    - appropriately sized battery storage,
- The varied fuel mix provides an uninterruptible fuel supply that will meet critical load projections. The following exists or will exist at each critical load: (1) a minimum of one week of diesel fuel supply on-site, (2) a method to assure 7 days continuous run via interconnection to the microgrid, and in the event of microgrid distribution system partial or complete outage, a method for pairing renewable supply with storage. This method includes operating a large battery system designed to inject power for ride-through in a "trickle discharge" mode, and (3) firm supply of natural gas via an underground piping system.Although there are extremely infrequent instances of gas supply interruption, the inherent reliability of an underground piping system is considered firm supply. CHG&E will need to reinforce the gas distribution system to meet load projections
- Critical facilities and the generation that supplies them are resilient to the forces of nature which are typical to and pose the highest risk to the location/facilities in the community grid, because:
    - Natural gas is distributed to a new 2 MW gas engine generator in an underground piping network,
    - Batteries are sized to provide high power injection for ride-through, but then run-back to the host sites's critical load and discharge in "trickle" mode,
    - Diesels including 7 day fuel storage can supply three critical loads,
    - 1 MWac PV is sized as a community resource, but can fuel the energy storage system to meet critical load of the Mt. Alvernia host location for at least 12 hours if this location were to become totally isolated. Even in Winter, PV will also satisfy the host site load,
    - It is possible that extreme weather can disrupt distribution utility service. All critical loads will then be served with their own emergency generation capability, or storage,

- Black start can be accomplished via the battery storage systems,
- The VWF Microgrid Response Team is evaluating the viability of a small fleet of portable diesel generation and additional on-site fuel oil storage, or portable battery systems that can be charged by the hydro plant,
- The lake is an energy storage reservoir that even in dry times has sufficient water storage reserve to run the 3 MW hydro-electric generation plant and charge batteries. The likely cause of distribution system outage is rain-related storm events. The hydro plant will therefore have plenty of "fuel",
- High priority restoration service by CHG&E will be accomplished should the distribution system be a cause of microgrid service interruption,
- Black start capability is provided by the batteries, which then allows the gas engine and other supply resources to start. There will be sectioning of the distribution system, to restore the microgrid, and then the area or regional grid, if necessary,
- There are numerous ancillary benefits, demand response values, and capital avoidance that provides source of revenue for the microgrid system investors, as further presented herein,
- In the event of a substation or transmission system outage caused by events such as a Homeland Security disruption, the microgrid and all customers on the 8023 circuit will be served through the new and existing privately owned generation and CHG&E distribution system.

1.2 SUB TASK Preferable Microgrid Capabilities

1.2.1 Active Network Control System

The microgrid supply and distribution resources will be centrally managed and controlled via an active network control system that optimizes demand, supply, and other network operation functions. Communication to local distributed controllers will be accomplished. However, should the communications system be disabled for any reason including sabotage, the distributed resource can be operated using low-tech manual controls. Each distributed resource will have island-to-host load capability, and parallel operation to microgrid capability without the central control functionality. However, normal mode operations will have the active central SCADA system in operation.

The Operating modes that are indicated in Table 2 will each be managed by the central controller that integrates the technical, as well as the economic, functionality. Details will be further refined during Phase 2 of this effort, as the control functions must optimize both the technical and economic values in a partnership arrangement that embraces the priorities of the Municipality, Private Investors, the Utility, and the Customers.

The hardware, software, and communications capability exists and can be procured as part of the project. For example, Solar City offers their Grid Logic Microgrid Control system. The following is adapted from Solar City's descriptions of their Grid Logic system; the Appendix presents attributes of their system which includes the:

- Control Capabilities (GridLogic is deployed with dynamic control capabilities that monitor real-time grid conditions and make continual adjustments to keep the community microgrid stable while delivering economically optimized energy at all times of day and night).
- Energy Management capabilities in which a combination of distributed intelligence and centralized control, Distributed Energy Resources (DER) dispatch and load consumption is continually optimized to maximize the community's energy savings. Production from microgrid DER assets is balanced against utility grid availability based on prioritization by least cost.
- Frequency control is provided by generation assets using either isochronous operation or enabling generator droop control in response to varying load conditions. GridLogic can configure any of the power generating resource types that comprise the VWF microgrid to provide frequency control:
- Voltage and Reactive Power Management control is provided to ensure power quality through dynamic voltage and reactive power management, both autonomously and via centralized control signals. By utilizing the embedded four-quadrant volt/VAR smart inverter capabilities within the microgrid, voltage and reactive power management can reliably ensure power quality is delivered to within ANSI technical standards or better.
- Monitoring and Control functionality is provided to assure continuous and automatic operation of the VWF microgrid. Seamless behind-the-scenes control and optimization is provided. SolarCity's proprietary PowerGuide system utilizes revenue-grade metering and monitoring equipment to collect a real-time and granular snapshot of all DERs and consumption. The GridLogic Control System uses this data to make real-time adjustments, day-ahead forecast and monitor overall system performance.
- Island Mode functionality occurs in the event of a grid failure. The 8023 circuit microgrid will automatically enter microgrid-island mode. By coordinating protection schemes and islanding switchgear, the microgrid will continue to supply locally generated electricity while these generators are collectively in parallel but isolated from the area or regional grid. In addition, non-critical loads could be automatically shed if necessary. GridLogic can be configured to permanently operate islanded from the grid, or only during times of utility grid failure. GridLogic islanding mode enables the highest level of resiliency for critical facilities when power is needed most.
- Dynamic Forecasting functionality will fully optimize economic energy delivery, DER generation and load consumption on a day-of, and day-ahead basis. To ensure DER availability and

economic dispatch, the system continuously adjusts its projections based on real-time monitoring data and historical performance to improve forecasts.

- Black Start Capability is included in the event that the 8023 circuit temporarily malfunctions. Circuit sections will be brought back and commence operation via the energy storage capacity.

Other suppliers, such as EnSync, have experience and technology to provide a functioning system. CHG&E offers their SmartGrid technology.

1.2.2 Energy Efficiency

The Village of Wappingers Falls has been actively embracing energy efficiency by ordering energy audits of its public buildings, installing a 240 kW solar array at its water treatment facility, conducting energy audits on public buildings, and hosting energy efficiency forums for home owners. A comprehensive energy audit of the Tri-Muni Wastewater Treatment Facility was conducted. The Village could save energy by converting the street lighting to LED.

As part of the NY Prize effort, a brief survey of the Scheafe Rd. School, the St. Mary's School, and the VWF street lighting was conducted by Arkados Energy Solutions in order to gain an understanding of energy efficiency measures that could be deployed. Both schools have older T-8 lighting fixtures, and could save energy and demand by converting to LED lighting. Both schools could also support PV projects on their roofs and / or as a carport.

Implementing the findings of the energy audits previously conducted, upgrading to LED lighting at the schools, and conducting a street lighting upgrade will be elements of the NY Prize Phase 2 and 3 efforts; this will assure that the microgrid does not consume more energy than today's technology would anticipate.

In addition, the VWF will continue to support energy reduction measures for their residential and commercial customers. Some of the proceeds from the Community Net Metering program will be used to offset capital costs for energy conservation measures.

A target reduction of 10% electric power demand, or about 300 kW, is deemed achievable.

1.2.3 Electric System Installations, O & M, and Communications – CHG&E

All interconnection will be accomplished to CHG&E Standard Interconnect Specifications.

A section of CHG&E circuit 8024 that serves the Water Treatment Facility, St. Mary's School, and the SW Johnson Firehouse will be removed from this circuit, and connected to the 8023 circuit.

1.2.4 Coordination with Reforming the Energy Vision (REV)

The Department of Public Service website presents summary detail about New York's REV initiatives. The following presents select extracts from REV, and explains how the VWF microgrid addresses the initiatives.

REV EXTRACT: The electric industry is in transition. Technological innovation and increasing competitiveness of renewable energy resources, combined with aging infrastructure, extreme weather events, and system security and resiliency needs, are all leading to significant changes in how electricity is generated, distributed, managed and consumed. New York State must lead the way to ensure these trends benefit consumers, whose lives are so directly affected by how they procure energy.

VWF MICROGRID: The proposed microgrid utilizes existing and new renewable generation, supplemented by new conventional gas fueled electric power system that assure the peak-day capacity requirements of the microgrid customers are fulfilled. Energy storage provides the "mortar" for the distributed generators, as they will provide ride-through capacity, black-start capability, and ancillary services both in normal, demand response, microgrid-island, and isolated emergency modes.

- The new PV project located at Mt. Alvernia shelter will utilize New York manufactured photovoltaic modules as supplied by Solar City.
- The new battery storage system will utilize zinc-air technology that is manufactured in New York State by Eos Energy Storage.
- The gas engine generator set is a NYSERDA approved package furnished by Elite Energy, using American CAT prime mover.
- Other suppliers have expressed an interest in considering assembly or manufacturing operation in the Industrial Park. This depends on market growth of battery storage systems, LED lighting. Discussions with manufacturers are underway to attract them in assembly of packaged battery-storage solutions to be used in the congested New York City load pocket.

REV EXTRACT: Achieve 40% Reduction in GHG, 50% generation by renewable resources, and 23% reduction in year 2012 building energy use by 2030.

VWF MICROGRID: The microgrid customer loads will be supplied from existing and new renewable resources. More than half the current annual electric usage will be supplied from zero emission energy supplies generated from the VWF microgrid. See further explanations within the body of this report.

REV EXTRACT: The availability of reliable, resilient, and affordable electric service is critical to the welfare of citizenry and is essential to New York's economy.

VWF MICROGRID: The VWF microgrid spans an area that is depressed economically, in which there exists a poverty rate of 25% for families with children 5 years old and younger, and a poverty rate of 18% for families with children 18 years or younger. The Industrial Park, once a vital resource that offered job opportunities for the local citizenry, could possibly be restored as a mixed use commercial – residential complex, in a joint area development effort including CHG&E, the VWF, and the strategic allies that will invest in the energy resources necessary.

During Hurricane Irene this community experienced 49 incidents of flooding, which were resolved through the use of electrical pumps. In the event of power loss there would be little chance of remedying the flooding before substantial property damage and potential structural failure occurred. This very densely populated region holds critical assets including emergency shelters, response centers, and water treatment infrastructure that provides services to a vast area of Dutchess County.

REV EXTRACT: To ensure continuing economic growth and prosperity for New York, Governor Andrew M. Cuomo laid out an ambitious energy agenda for the State in 2015, with the Public Service Commission (PSC) playing an important role in crafting the significant regulatory changes needed to make the Governor's agenda a reality.

VWF MICROGRID: Community Net Metering will be the economic engine for stimulating the investment in microgrid assets. The Revenue Decoupling mechanism embedded in this regulation will result in economies for all microgrid stakeholders that are part of the VWF microgrid program. A result of Revenue Decoupling is that there are other CHG&E ratepayers in other areas that initially must subsidize the premium that the generators receive and the discounts offered to the VWF customer base. It is envisioned that a longer term benefit to all CHG&E ratepayers and customers will result due to load growth in this economically distressed load pocket.

REV EXTRACT: Under Governor Cuomo's "Reforming the Energy Vision" (REV) strategy, New York is actively spurring clean energy innovation, bringing new investments into the State and improving consumer choice and affordability. In its role, the PSC is aligning markets and the regulatory landscape with the overarching state policy objectives of giving all customers new opportunities for energy savings, local power generation, and enhanced reliability to provide safe, clean, and affordable electric service.

VWF MICROGRID: Innovative technology will be deployed in the VWF microgrid. It is anticipated that manufacturers will be attracted to the Industrial Park in the VWF, low-income customers will receive a discount as a result of community net metering, the Industrial Park will be supplied by locally generated ultra-reliable green energy.

REV Extract “STAFF WHITE PAPER ON RATEMAKING AND UTILITY BUSINESS MODELS”

(Market-Based Earnings (MBE) in a Fully Developed Market, p.29 as regards Platform Service Revenues, Customer Enhancements, and Synergy Opportunities)

The makeup, mixture, and pricing of MBEs will be driven more by market forces and innovation than by regulatory requirements.

MBEs should be an important part of the utility business model in a fully developed REV environment. Along with performance incentives and traditional cost recovery, MBEs will be a part of a utility’s total revenue stream and will be particularly important as an opportunity to increase earnings without adding to base rates.

VWF MICROGRID:

The VWF microgrid serves the growing load of the Industrial Park. The Industrial Park will be designed to attract (in part) a base of customers that will provide innovative energy products, such as assembly of battery systems for deployment in New York State. It is the intent of the VWF microgrid to include CHG&E as a partner in the revenue potential.

The business proposition is significantly enhanced by Community Net Metering, and the revenue decoupling mechanism which allows the broad base of ratepayers to subsidize the renewable energy supply can be converting to revenue opportunity through a managed energy load growth.

REV EXTRACT and VWF MICROGRID: The REV initiative will lead to regulatory changes that promote more efficient use of energy, deeper penetration of renewable energy resources such as wind, *HYDRO*, and solar, wider deployment of “distributed” energy resources, such as micro grids, roof-top solar and other on-site power supplies, and storage. It will also promote markets to achieve greater use of advanced energy management products to enhance demand elasticity and efficiencies. These changes, in turn, will empower customers by allowing them more choice in how they manage and consume electric energy.

2.0 DEVELOP PRELIMINARY TECHNICAL DESIGN COSTS AND CONFIGURATION

2.1 SUB TASK Proposed Microgrid Infrastructure and Operations

2.1.1 Electric One-Line

A simplified electric one-line diagram is presented in Appendix 1. Tabular data is presented in a second sheet that further defines key particulars and presents detail regarding the critical loads that are represented in the one-line diagram. A portion of the 8024 circuit will be relocated and connected by CHG&E to the current existing 8023 circuit. The “8023 microgrid” circuit (hereafter referred to as the 8023 circuit) will then supply 8 critical loads as well as the non-critical customers that are not indicated on this one-line.

2.1.2 Equipment Layouts and Diagram

The new electric power generation equipment and systems will be furnished and installed by each strategic ally. The physical arrangement and layout drawings are presented in Appendix 2 for the PV project at Mt. Alvernia. Representative physical sizes and other key physical parameters for the energy storage systems, and new gas engine.. It is premature to prepare site layouts at this time for the gas engine system and energy storage systems – sufficient space is available for implementing each project.

“Table 1 – generation capacity of vwf microgrid on 8023 circuit” (refer to Section 1.1.2) presents an inventory of generation assets that will comprise the microgrid.

2.1.3 Microgrid operations under normal, and emergency conditions

“Table 2 – operating modes and status of microgrid major systems” in Section 1.1.2 above presents the operating modes for normal operation, demand response mode, emergency mode with the 8023 circuit entirely operational, and emergency mode with the 8023 circuit partially or completely out of service. The status of the grid (including transmission as well as CHG&E’s local distribution 8023 circuit), the status of each generation supply plant, and the customer status (service or no service) for critical as well as non-critical loads is indicated. The following provides additional explanation:

	GRID STATUS		
OPERATING MODES	***Transmission***	***8023 Circuit***	***EXPLANTIONS***
1. NORMAL			**The critical and non-critical loads will take distribution service from CHG&E. Customers, with the exception of those electing to enroll in a Community Net Metering (CNP) program, can take Supply service from CHG&E, or opt to receive energy supply via an ESCO. CNP customers (residential load per S.C. No. 1) will receive service at CNP terms and rates. Supply resource owners sell capacity, energy, and ancillary services per their own contracts. CHG&E retains the Obligation to Serve.**
Renewable Supply > 8023 Ckt Load	On	On	
Renewable + Gas Engine Supply > 8023 Ckt Load	On	On	
Renewable + Gas Engine + Diesel Supply > 8023 Ckt Load	On	On	
Renewable + Gas Engine + Diesel Supply < 8023 Ckt Load	On	On	
2. DEMAND RESPONSE / ANCILLARY SERVICES	On	On	**Customers receive service as per "Normal" mode. Additional revenues accrue to the power system owners.**
3. MICROGRID / ISLANDED - AREA / REGIONAL / SUBSTATION DISRUPTION			**A substation or transmission system outage invokes this emergency mode. Customers receive distribution service from CHG&E and pay for the supply and delivery service as per the Normal operating mode. Non-renewable supply (gas engine, battery storage plant) resource owners are compensated by a special tariff provision that allows cost recovery from maintaining same in a readiness state, and operation of these microgrid resources when necessary. There is an obligation to serve.**
Renewable Supply > 8023 Ckt Load	Off	On	
Renewable + Gas Engine Supply > 8023 Ckt Load	Off	On	
Renewable + Gas Engine + Diesel Supply > 8023 Ckt Load	Off	On	
Renewable + Gas Engine + Diesel Supply < 8023 Ckt Load	Off	On	
4. MICROGRID / ISLANDED - AREA / REGIONAL / SUBSTATION DISRUPTION and PARTIAL OUTAGES OF 8023 CIRCUIT			**Distribution system 8023 circuit outages, either partial or complete, trigger this emergency mode. Customers being served by an operating section of circuit receive service as per 3. above; non-critical customers that are not being served with distribution service and do not have a generator experience an outage. Critical customers are served by their supply resource.**
Renewable + Gas Engine + Diesel Supply > 8023 Ckt Load	Off	Off	
Renewable + Gas Engine + Diesel Supply < 8023 Ckt Load	Off	Off	

TABLE 3 – OPERATING MODES – EXPLANATIONS AND DETAILS

2.2 SUB TASK Load Characterization

2.2.1 Electrical Loads, Circuit 8023 Measured Data

The 8023 microgrid circuit (including the relocated 8024 circuit section) consists of 8 critical facilities (see Table 1 – generation capacity of VWF microgrid on 8023 circuit), and a mix of noncritical loads including residential, commercial, industrial, and municipal facilities. CHG&E provided actual measured data for the 8024 circuit section that will be relocated and connected to the 8023 circuit. The measurement interval spanned approximately one month. The initial x-axis point "1" refers to July 16, 2015 at 1 am.

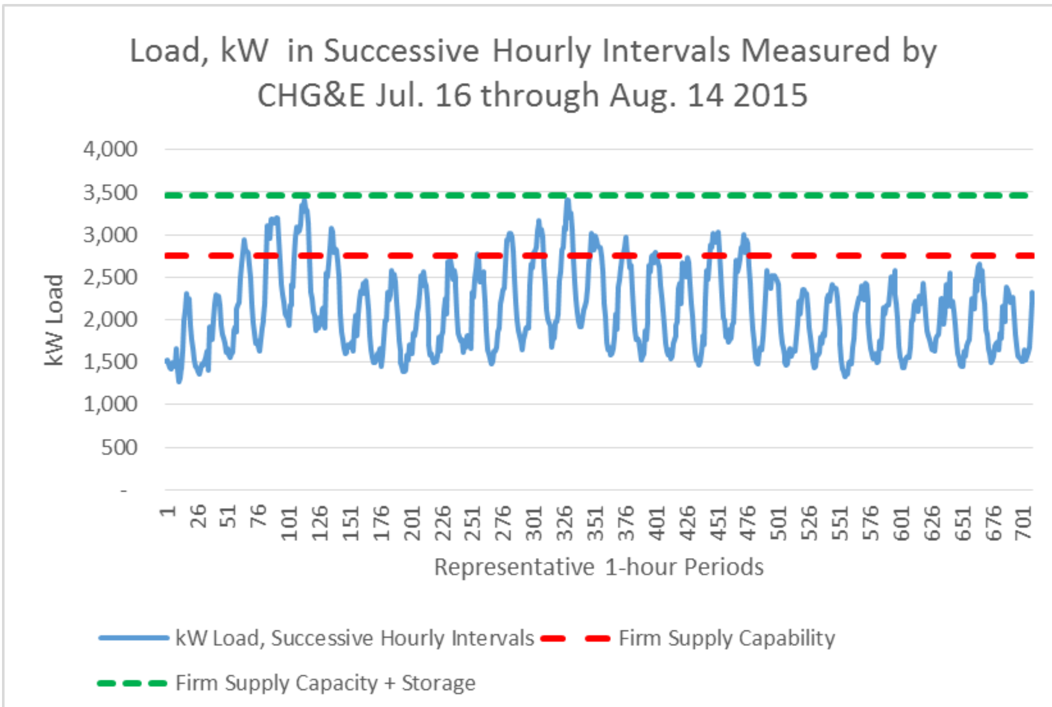


FIGURE 2 - MEASURED LOADS ON 8023 CIRCUIT

"Figure 2 - Measured loads on 8023 circuit" includes the firm supply of electric generation resources, and the additional power capacity that is provided by the electric storage systems. There is sufficient power capability to supply all load on the upgraded 8023 microgrid circuit.

	MEASURED DATA	SCALED DATA	MEASURED + SCALED DATA
709 Hrs	8024 CIRCUIT	8023 CIRCUIT (MAX per CHG&E est.)	
MAX kW Load	1,055	2,400	3,455
MIN kW Load	384	886	1,276
AVG kW Load	641	1,465	2,108

TABLE 4 - SUMMARY OF MEASURED AND SCALED DATA FOR THE MODIFIED 8023 CIRCUIT

Table 4 - Summary of Measured and Scaled Data for the Modified 8023 Circuit presents the peak of the peak demand as 3,455 kW based on 15 minute data supplied by CHG&E for the 8024 circuit, and an estimate of the currently configured 8023 data.

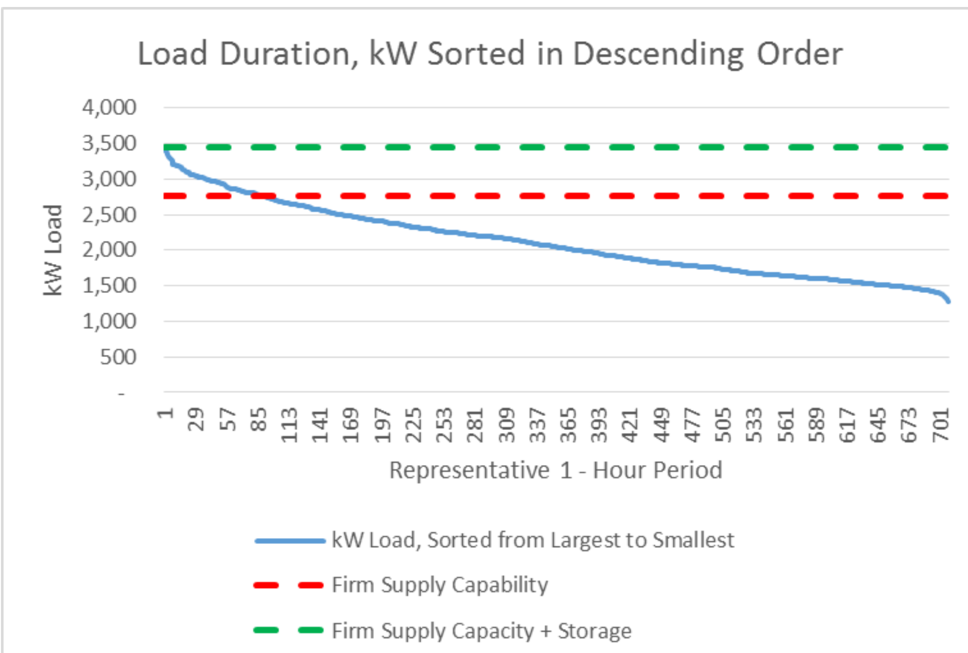


FIGURE 3 - LOAD DURATION CURVE - MEASURED DATA

The load duration curve is used to determine the number of hours that a given power demand occurs.

2.2.2 Electric Loads 8023 Circuit – Annual hourly demand

This data was extrapolated to produce an “8760” (1 year) of hourly loads for the microgrid. In absence of actual microgrid circuit data, the extrapolations to a full year comprised of 8,760 hours will be verified by CHG&E through continued measurement. It should be noted that efficiency measures will serve to reduce the peak demand and energy use, and load growth would add to the load projections. The microgrid will accommodate these changes by adding resources.

The microgrid circuit's "8760" load profile is provided in Figure 4. Also indicated for reference are the firm and intermittent generation resources.

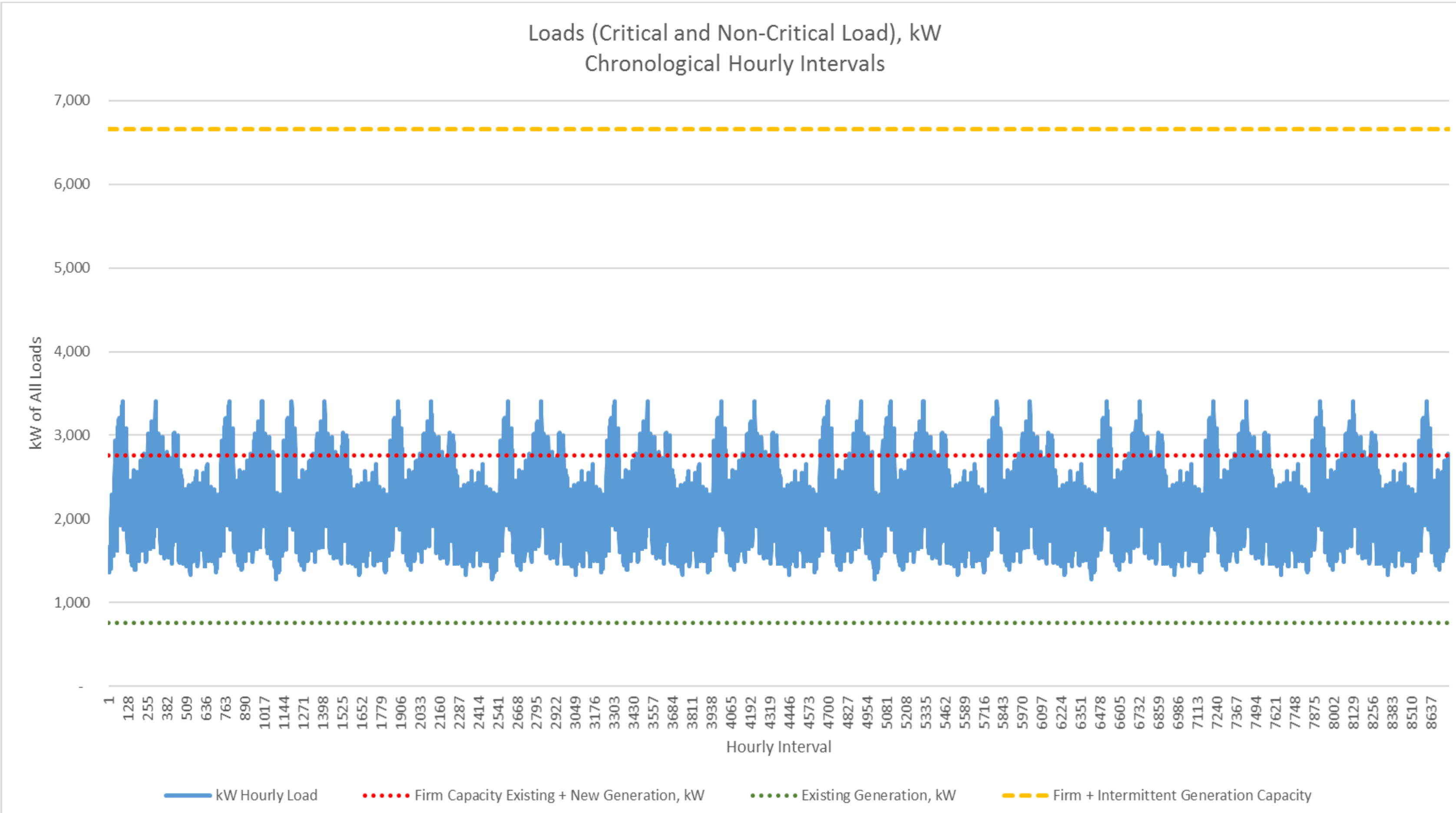


FIGURE 4 - HOURLY LOAD PROFILE OF MICROGRID CIRCUIT

2.2.3 Load Characterization and Sizing the 8023 Circuit microgrid generation supply capacity

The annual 8760 data was used to produce simultaneous load and supply profiles that allow the microgrid resources to be characterized and the capacity of the generators and batteries to be determined. Firm supply resources with storage can supply the load and meet baseline peak demand at all times. Depending on the capability of the intermittent resources, the gas engine may or may not be required.

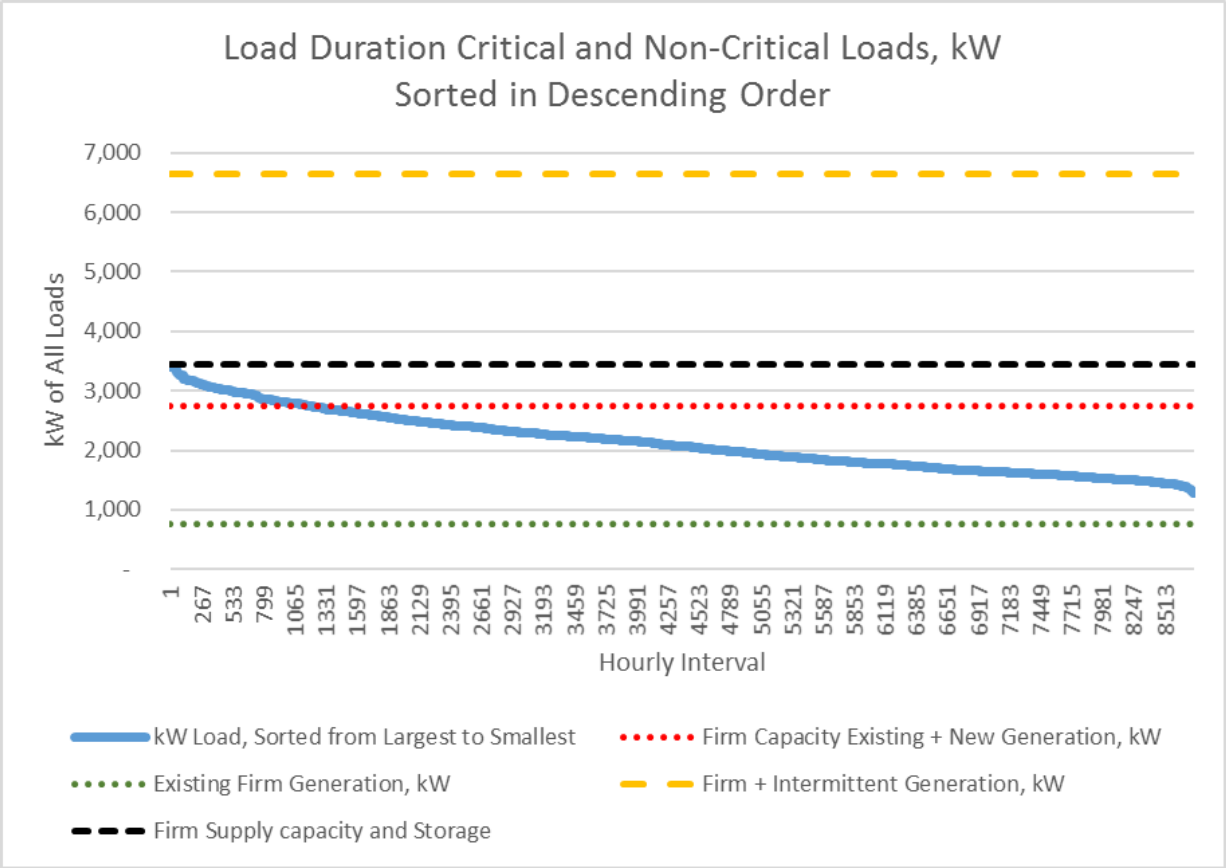
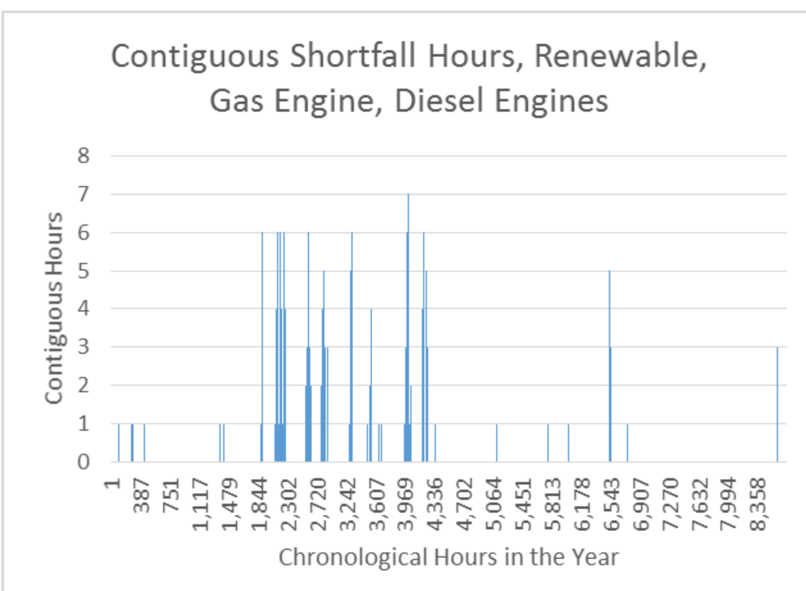


FIGURE 5 - ANNUAL LOAD DURATION CURVE, 8760 MICROGRID CIRCUIT

The Load Duration Curve and hourly demand data indicates a maximum microgrid circuit peak-of-the-peak demand of 3,407 kW (note, the peak 15 minute demand was indicated as 3,455 kW). The following table provides information from the load profiling and characterization analysis that indicates there are only 151 hours in which supply cannot meet load of the entire upgraded 8023 microgrid circuit. The energy storage system would compensate for the shortfall. There is only one instance of a contiguous 7-hour duration period in which supply would be inadequate to meet the load.

	Renewable Only	Gas Engine	Diesels	TOTAL CAPACITY
Existing Capacity	2,650 kW	-	755 kW	3,405 kW
New Capacity	1,250 kW	2,000 kW	-	3,250 kW
TOTAL CAPACITY	3,900 kW	2,000 kW	755 kW	**6,655 kW**
Energy Storage				1,250 kW
	Renewable Only	Renewable + Gas Engine	Renewable + Gas Engine + Diesels	
Hours Unable to Meet Load	6,829 Hrs / yr	1,168 Hrs / yr	151 Hrs / yr	
Max Duration in which Supply cannot meet Load	1,176 Hrs / yr	15 Hrs / yr	7 Hrs / yr	
			With Battery Storage, Integrity of Supply is Maintained	

TABLE 5 - GENERATION CAPACITY AND ABILITY TO SUPPLY ALL LOADS



2.2.4 Sizing of the Loads to be served by the microgrid

The electric bills for the past year were reviewed and the data summarized in “Table 6 - Summary of Critical Load Electric Bill Data, Including Demand”. The standard rate class profiles provided by CHG&E were used to develop the 8760.

There is sufficient redundancy to supply the critical loads. The total installed capacity of all resources is 7,905 kW, of which 3,900 kW is intermittent renewable power, 1,250 kW is provided by energy storage, and 2,755 kW is gas engine plus existing 755 kW diesel. If in the unlikely event the natural gas engine is out of service, the existing diesels at critical load a., c., d., and e. will serve the site loads of their host facilities. See “Table 1 – generation capacity of vwf microgrid on 8023 circuit” for a listing of generation resources and the location in the microgrid.

Further detail is provided in “2.3 SUB TASK Distributed Energy Resource (DER) Characterization”.

CRITICAL LOAD / Property Name	Peak Demand, kW most recent 12 month period	Annual Usage, kWH most recent 12 month period	Transformers Total rating, kVA from CHG&E
a - Tri-Municipal Sewer Commission, Tri-Muni Wastewater Treatment Facility Facility	246.30	1,582,558	500
b - Mt. Alvernia Retreat Center	82.25	348,560	150
	5.36	20,369	25
c - Monastery of St. Clare	24.40	102,000	225
d - Village Water Supply Facility	76.80	239,880	500
e - SW Johnson Firehouse	19.30	30,396	38
f - Wappingers Falls Hydroelectic Generation Station and Industrial Park Locations			3,000
k - New Hamburg Fire Dept	2.54	6,514	25
	28.90	81,811	38
wcsd - Sheafe Road Elementary School	105.60	241,320	150
p - St. Mary's School	46.80	76,920	75
TOTALS at Critical Loads	638.25	2,730,328	1,725

TABLE 6 - SUMMARY OF CRITICAL LOAD ELECTRIC BILL DATA, INCLUDING DEMAND

The annual electrical energy consumed by all customers on the microgrid circuit is 17,708,298 kWH. Other relevant parameters are as indicated in the Table below.

The critical load customers consume 15.4% of the microgrid's annual energy, and account for 18.7% of the demand. These parametrics will be refined with additional metering and verification upon Phase 2 award.

TOTAL LOAD ON MICROGRID CKT
3,407 MAX KW
17,708,298 kWH
2,127 AVG. KW
62.42% Load Fctr

TABLE 7 - TOTAL LOAD ON MICROCIRCUIT

2.3 SUB TASK Distributed Energy Resource (DER) Characterization

2.3.1 DER Type, Rating, Fuel, Simultaneous Supply and Load Profiles

The existing and new distributed energy resources are as follows:

CRITICAL LOAD / Property Name	Existing Emergency or Baseload Generation, kW	New Gas Engine, kW	Existing PV Generation	New PV or Hydro Turbine, kW	New Energy Storage	Notes
a - Tri-Municipal Sewer Commission, Tri-Muni Wastewater Treatment Facility Facility	300	-	-	-	-	Diesel with 2,000 gal oil tank; Enrolled in DR; convert to grid parallel operation; add second 2,000 gal oil tank to meet 7-day supply; consider PV with Storage
b - Mt. Alvernia Retreat Center	-	-	-	1,000	1000 kW / 500 kWH	**Add 1,000 kW PV and 1,000kVA transformer with**
c - Monastery of St. Clare	80	-	-	-	-	Tie into Mt. Alvernia PV and Storage Plant
d - Village Water Supply Facility	350	-	200	-	250 KW / 1000 KWH	Add Energy Store system: Can supply 500 kW for 15 -
e - SW Johnson Firehouse	25	-	-	-	-	Consider Energy Storage as an Alternative
f - Wappingers Falls Hydroelectic Generation Station and Industrial Park Locations	2,450	2,000	-	250	-	Add 2000 kW Gas Engine and new 250 kW hydro
k - New Hamburg Fire Dept	-	-	-	-	-	-
wcsd - Sheafe Road Elementary School	-	-	-	-	-	Consider PV with Battery Storage as an Alternative
p - St. Mary's School	-	-	-	-	-	Consider PV with Battery Storage as an Alternative
TOTAL AT Critical Loads						
Total Supply Capacity at Critical Loads	755	-	200	1,000	1,250	
Total Supply Capacity at Critical Load + Wappingers Falls Hydro	3,205	2,000	200	1,250	1,250	

TABLE 8 - DER TYPE, RATING, AND FUEL

Hourly Generation and Simultaneous Supply and Load profiles were developed from actual data for existing resources and performance projections using commercial software for new generation assets. The customized software developed by Genesys Engineering compiled the simultaneous profiles. The software allows any 24 hour period to be examined by inputting the period, reviewing the output of each generation resource and the simultaneous load on the circuit. The entire "8760" is illustrated in the analysis software, and select extracts are presented in the following illustrations, tables, and figures.

Renewable, intermittent resources supply more than 50% of the annual energy requirements of the microgrid, as indicated in the following table.

TOTAL RENEWABLE INTERMITTENT SUPPLY	TOTAL LOAD ON MICROGRID CKT	Renewable Supply less Load
3,901 MAX KW	3,407 MAX KW	2,233 MAX KW
9,518,665 kWH	17,708,298 kWH	-8,189,633 kWH
1,143 AVG. KW	2,127 AVG. KW	-984 Avg. kW
29.31% Load Fctr	62.42% Load Fctr	-

TABLE 9 - PORTION OF ANNUAL ENERGY ON MICROGRID CIRCUIT SERVED BY RENEWABLE SUPPLY

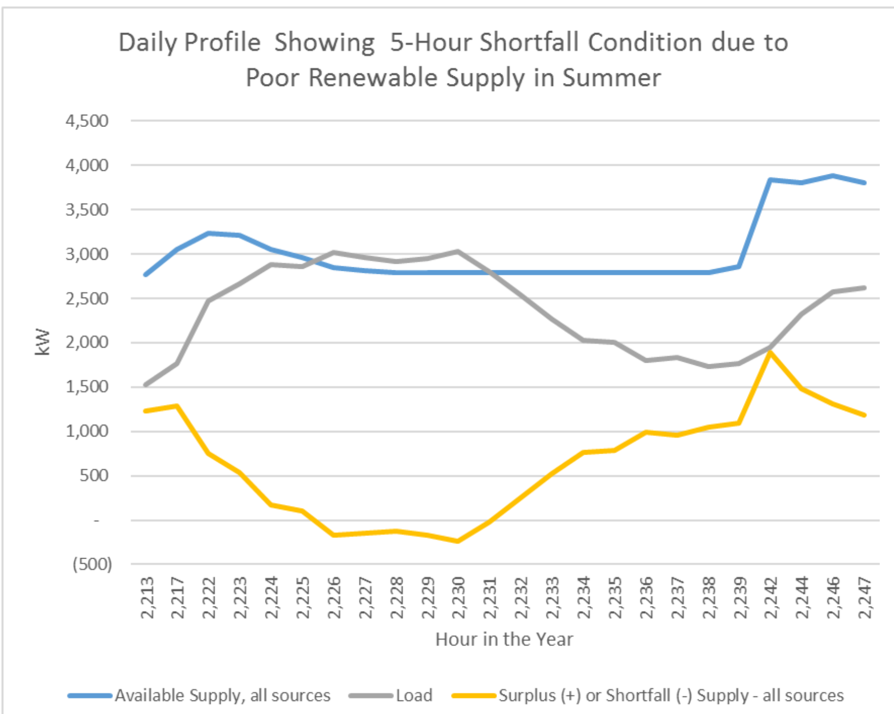


FIGURE 6 - DAILY PROFILE SHOWING SMALL SHORTFALL OF CAPACITY DUE TO POOR RENEWABLE RESOURCE

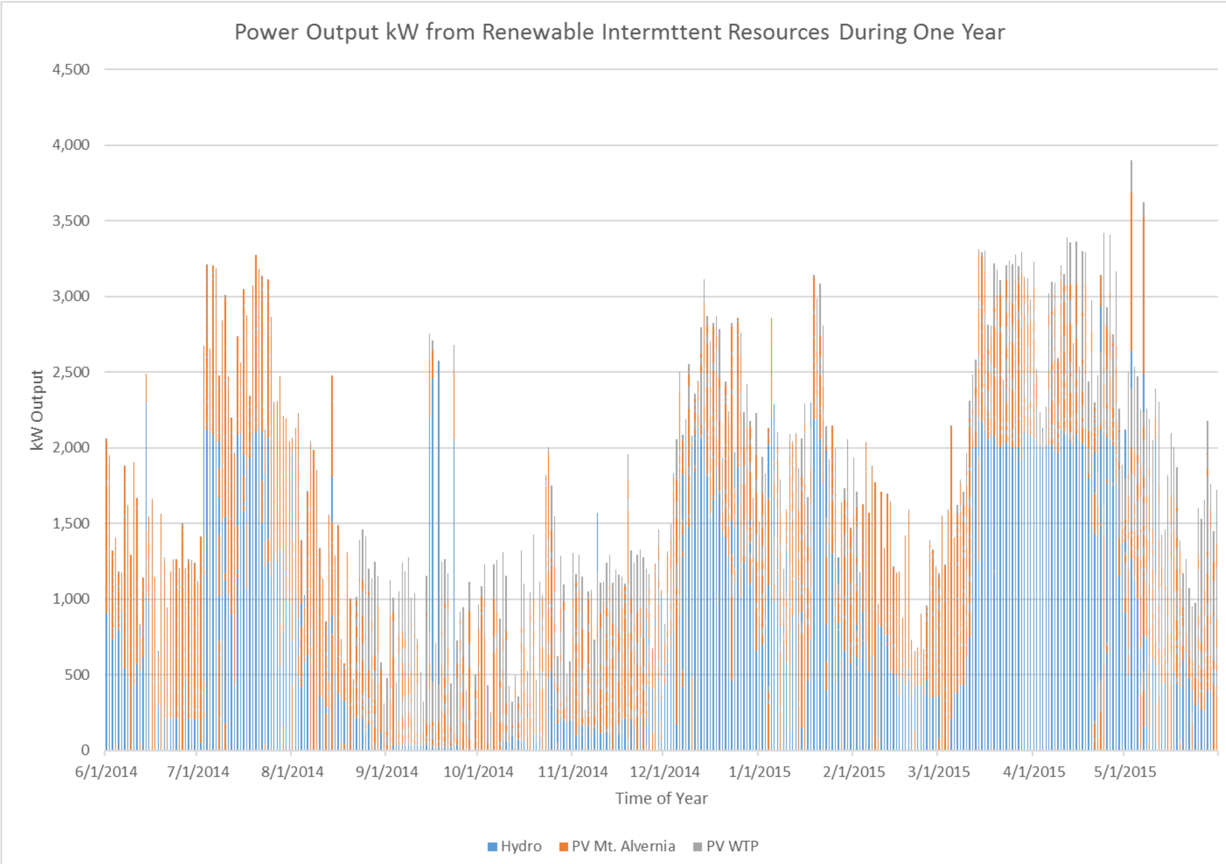


FIGURE 7 - SIMULTANEOUS PROFILE FOR RENEWABLE RESOURCES

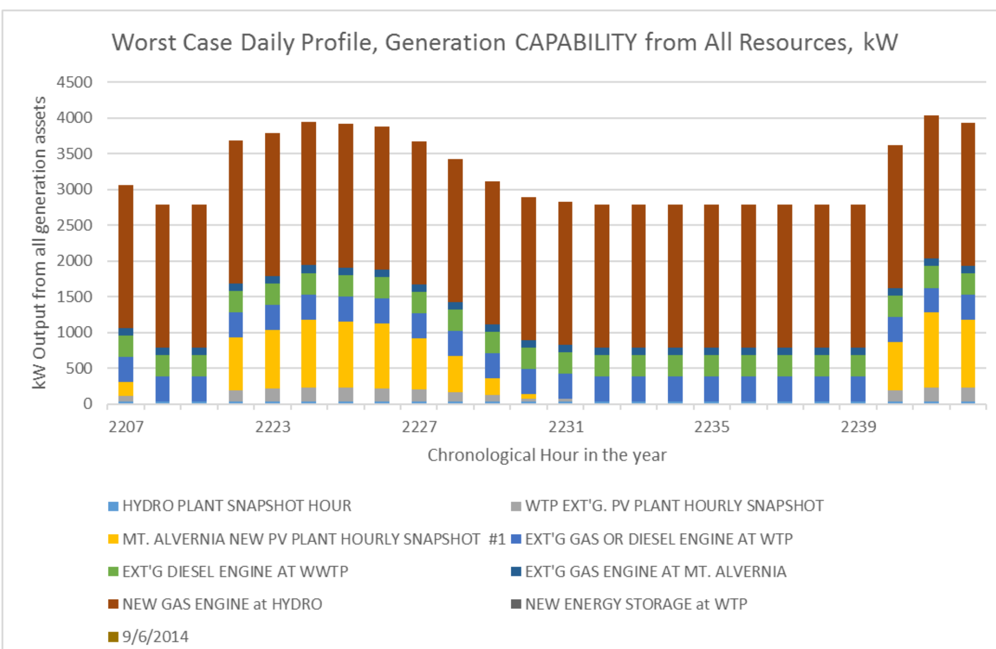


FIGURE 8 - GENERATION CAPACITY WORST CASE

The Energy Storage system power ratings are based on the kW difference between Points 1 and 2 in the following graph.

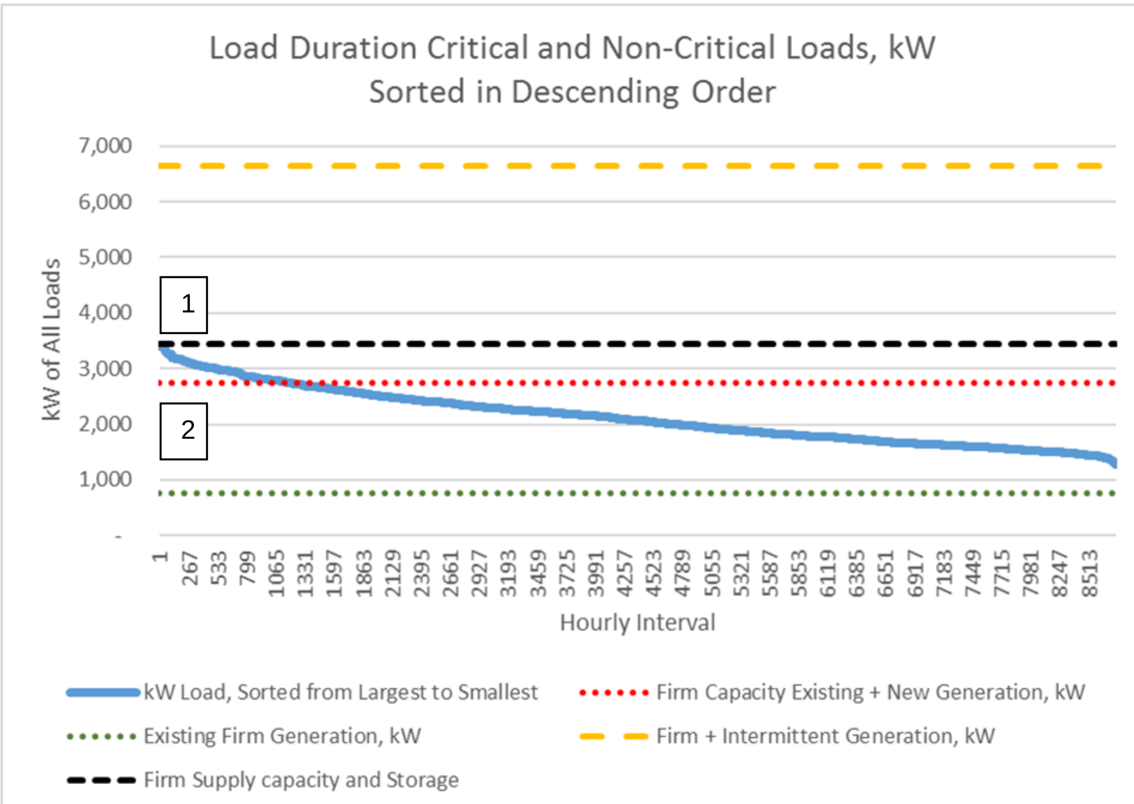


FIGURE 9 - BASIS OF SIZING ENERGY STORAGE SYSTEMS

2.3.2 Tri-Muni Wastewater Treatment Plant, 300 kW Diesel, One-Line Site A

This critical load customer is located at 345 Sheafe Rd. in VWF, and the account number is 7120-0180-00. Electric distribution service is provided by CHG&E, and the customer is a Demand Response account. Refer to Customer / Load A on the Electric One-Line. There is an existing 300 kW Caterpillar diesel, which is more than sufficient to serve the host site peak demand of 246.3 kW. Annual electric energy usage is 1,582,558 Kwh. The load factor is 73.3%. A 500 KVA transformer offers capability to serve the microgrid if added generation or storage becomes necessary. On-site diesel fuel is stored in a 2,000 gallon tank.

PHOTO 1 – WASTEWATER TREATMENT PLANT 300 KW DIESEL **PHOTO 2 - 500 KVA TRANSFORMER**

To equip this site to serve the microgrid, the following enhancements are required:

- A second new 2,000 gallon tank will allow 7-day generation capability
- Paralleling switchgear and direct interconnect to the utility's 8023 distribution circuit will be accomplished

The project team evaluated conversion to a new natural gas system, and adding a second prime mover (200 kW natural gas engine). The length of run to supply natural gas was determined to be too great and not cost effective.

The diesel will run in emergency mode when renewable resources are insufficient to carry the load of the microgrid, or if the microgrid is out-of-service. The diesel can also operate in demand response mode as a supplement to the renewable resources and gas engine that will run as a preferred demand response resource.

Further optimization is required to determine if equipping this site for an additional 54 Kw (rating of diesel less the peak demand) export to the grid is economically viable. This site could be an alternate location for a battery storage system and PV project.

2.3.3 Mt. Alvernia Retreat Center and 1 MWac PV Plant – One Line Site B

This critical load customer is located at 158 Delavergne Ave in the Village of Wappingers Falls, and the account numbers are 7139-0565-00, and 7643-1395-00. Refer to Customer / Load B on the Electric One-Line. There is a small existing 25 kW gas engine used for select loads. There is a single phase feeder, and a larger three phase feeder that service the two (2) customer accounts. A 150 KVA transformer on the 3 phase feeder offers capability to serve the load, but not the microgrid. The peak demand of the facility is 82.25 Kw, and annual usage is 348,650 Kwh. The load factor is 48.4%.

A new 1,000 kWac PV plant will be added to provide interconnection to the utility grid. The plant will also require a new 1,000 KVA transformer to allow direct connection to the 8023 distribution system circuit. The entire energy yield of the PV plant will be input into the 8023 circuit, and used as a source of supply for Community Net Metering.

PHOTO 3 - MT. ALVERNIA SITE FOR 1 MWAC PV

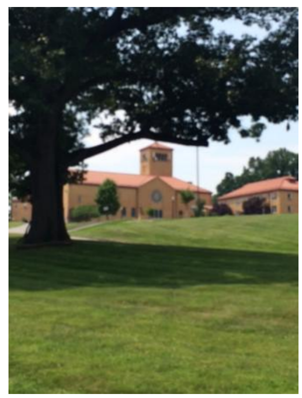


PHOTO 4 - MT. ALVERNIA CRITICAL SHELTER

The PV Plant will be developed by Solar City, and will use their modules that are manufactured near Buffalo, NY. Refer to the Silevo 340W module in the following Table for a summary of plant performance. The PV system will be a fixed tilt ground mount PV system, and will have inverters that are capable of grid parallel or isolated operation. The plant will have the ability to operate at various power factors.

Module	Silevo 340W	Trina 310W
	60 cell	72 cell
Tilt	30º	30º
Azimuth	180º	180º
kW AC nameplate	984	984
kW DC	1,376	1,278
kWh/yr1	1,642,917	1,519,684
kWh/kW	1,194	1,189

TABLE 10 - MT. ALVERNIA PV SYSTEM - PERFORMANCE SUMMARY

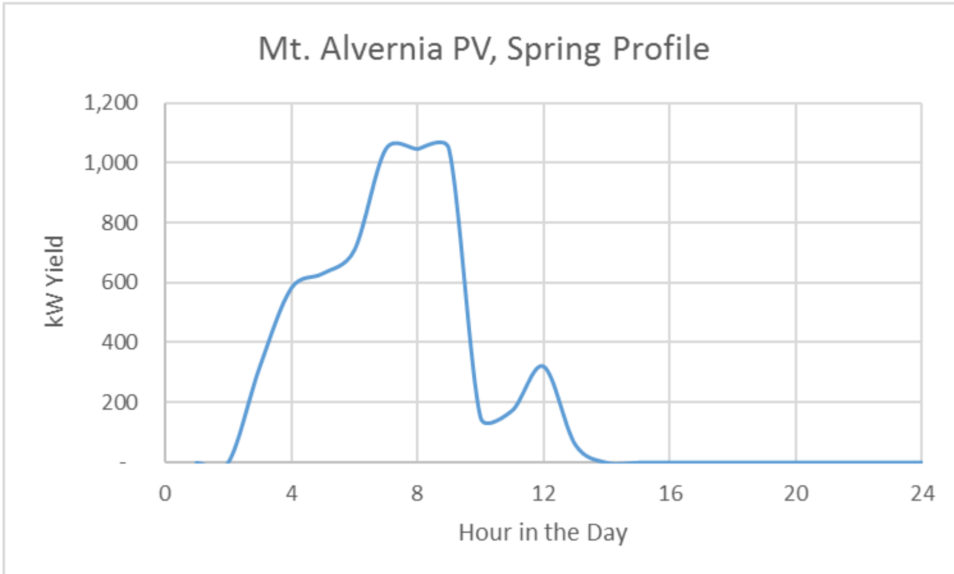


Figure 10 - Typical Daily Profile of Mt. Alvernia PV

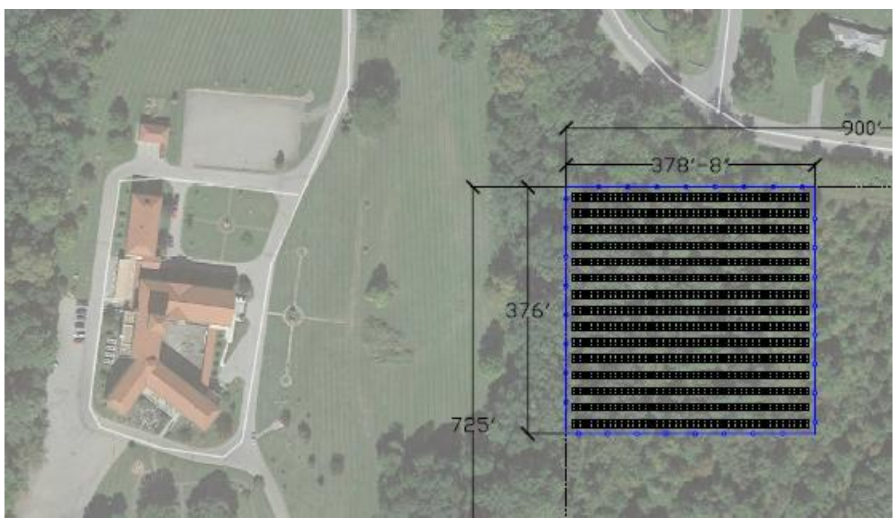


Figure 11 – 1 MW PV System Layout at Mt. Alvernia ~ 3.5 acres

The exact location of the 1 MWac array is to be determined. This layout reflects a DC:AC ratio of 1.0. The solar array is displayed without a buffer zone, and occupies 3.27 acres. However, optimized DC:AC ratios could increase the number of modules, increase the row spacing to reduce shading during winter months and morning and late afternoon hours. Performance is based on a DC:AC ratio of 1.35. There is also discussion concerning a 2 MWac system. The acreage required for a fully buffered 2 MWac plant with 2.7 MWdc could require 15 acres.

The 1,000 Kw / 500 Kwh energy storage system will be located adjacent to the PV plant, and will have black start capability. The battery management system will control charge and discharge cycles. The 2C battery system provides ride through capability. It can also be operated in trickle charge / discharge mode when isolated from the grid, and provide about 8 hours energy supply to the host site loads.

See the Appendix, “Solar City”, for additional descriptive detail.

2.3.4 Wappinger Falls 3 MW Hydro, the Industrial Complex as per One-Line Site F, and 2 MW Natural Gas or Diesel Engine

The hydroelectric plant is located 62 McKinley Street, Building 100. Refer to Location F on the One-Line. The plant has three operating hydroelectric turbines, whose combined rating is 2,450 kW. A fourth 250 kW turbine-generator will be added as part of the microgrid project.

Data from the plant was compiled and an annual generation profile prepared. The plant produces 7,736 MWH per year, and has produced power at a maximum of 3 MW.

The plant output is sometimes subject to low water flow and reduced yield. Data from 2014 demonstrates a late Summer period of low output. However, the hydroelectric plant can be considered a modified capacity resource. NYSERDA provided guidance to use 36% of rated nameplate capacity, which equates to 972 kW.

The plant operates in parallel with the grid. The generators are induction systems, however, one generator will be converted to a synchronous machine in order to achieve capability of the hydro plant to operate in island mode.

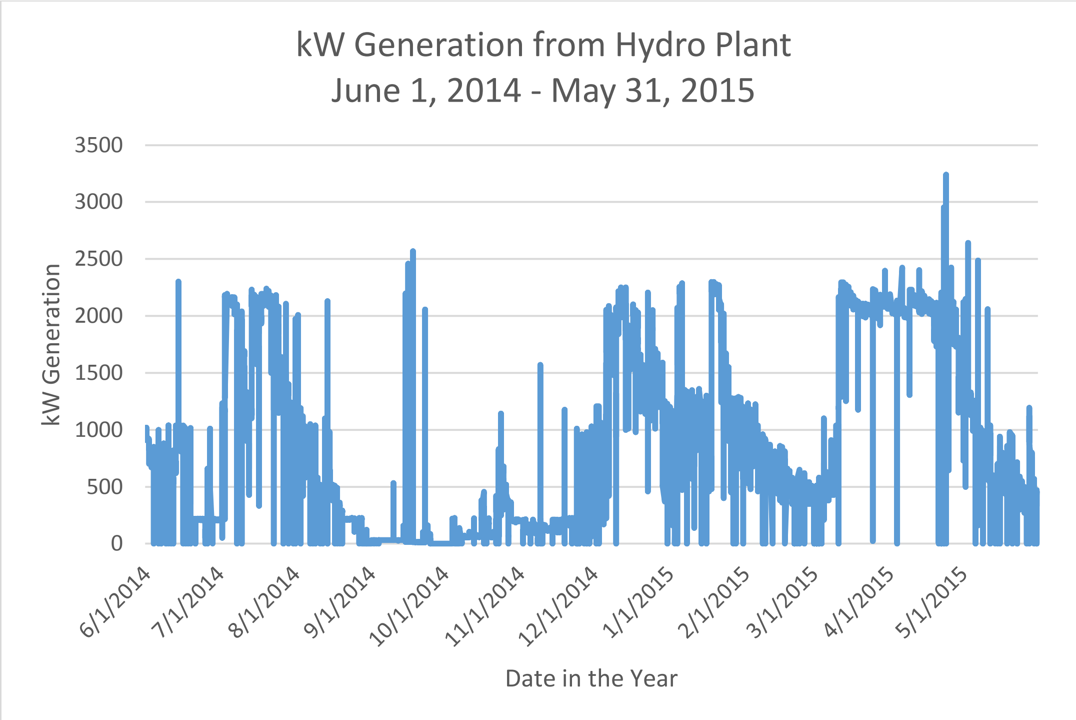


FIGURE 12 - HYDROELECTRIC PLANT HOURLY GENERATION PROFILE

The addition of a fourth 250 kW generator will add standby capacity. The existing three turbines will continue to operate as an energy resource, but the fourth unit will be operated in the event of loss of the area-wide grid and initiation microgrid operations. The plant controls are set up to maintain lake level. However, upon initiation of a microgrid event, the controls have the capability to support ride-through which if necessary, and could result in lake level reduction. This requires a review of contracts and is a legal issue to address.

PHOTO 5 – RESERVOIR

The plant is connected to two transformers that step up the generation voltage to 13.2 kV, the utility's distribution voltage. The distribution lines are overhead.

PHOTO 6 - HYDROELECTRIC TURBINE GENERATOR

Upgrades to the plant will include the following: New 250 Kw hydro turbine and genset, retrofit new 250 Kw / 300 KVA synchronous generator including exciter, new 1,250 Kw / 1,500 KVA synchronous generator for retrofit, water pipe lining and bridge repair.

The Industrial Park is a section of the 8023 microgrid that could attract new customers and load growth.

A 2 MW gas engine, or 2 MW diesel if gas cannot be provided, will be added as part of this project. The engine requires approximately 20 mmBTU / hr of gas. The final location and interconnect point has not been determined; there are still alternative spots for placing this resource.

PHOTO 7 - INDUSTRIAL PARK

Elite Energy, a NYSERDA approved supplier of packaged gas engine systems including combined heat and power, has provided performance data including fuel consumption and emissions, as well as a cost estimate proposal. The system could be converted to combined heat and power as thermal load emerges within the Industrial Park. See Appendix for cost estimate break-out.

The natural gas supply can be supplied by CHG&E, although there are currently constraints that are being evaluated. In the event that it is not economically viable or feasible to reinforce the natural gas system to accommodate the engine, a diesel with 7 day storage can be considered.

2.3.4a Cost Estimates for Hydro Plant and Gas Engine Plant

WAPPINGERS FALLS HYDRO, COST ESTIMATES	
Installed Cost for Eqp't	
New 250 kW Hydro Turbine-Genset	$ 200,000
New 250 kW / 300 kVA Synchronous Generator for Retrofit (includes exciter, ~ $50k)	$ 100,000
New 1,250 kW / 1,500 kVA Synchronous Generator for Retrofit	$ 250,000
Installed Cost for Repairs	
Water Pipe Lining	$ 600,000
Bridge repair	$ 500,000
Contingency @ 10%	$ 165,000
Total Est. Cost for Upgrades	$ 1,815,000
OPEX	
Ruotine O&M / yr	$ 200,000
Major Overhauls	tbd

GAS ENGINE PLANT COST ESTIMATES

	2,000 kW					
		Unit	Unit Price incl Mat'l, Labor, OH&P	Location factor	Total	Unit Cost, $ / kW
	TOTAL (01 INCLUDED)				***$ 3,208,825***	***$ 1,604.41***
	HARD COSTS				$ 1,980,756	$ 990.38
	SOFT COSTS				$ 693,265	$ 346.63
	CONTINGENCY @ 20%				$ 534,804	$ 267.40
			SOFT COSTS			
01	***General Requirements***				***$ 693,265***	***$ 346.63***
	ENGINEERING				$ 198,076	$ 99.04
	INSURANCES, BONDING				$ 99,038	$ 49.52
	DEVELOPMENT COSTS				$ 198,076	$ 99.04
	CONSTRUCTION MANAGEMENT				$ 198,076	$ 99.04
			HARD COSTS			
02	Existing Conditions					
03	***Concrete***				***$ 2,586***	***$ 1.29***
	Slab on Grade, 6 in. thick	11 yd3.	$ 204.00	117%	$ 2,586	$ 1.29
21	***Fire Suppression***				***$ 8,000***	***$ 4.00***
21.21 16.50	Based on CO2 system				$ 8,000	$ 4.00
22	Plumbing - For Natural Gas, see Utilities					
23	HVAC					
26	***Electrical***				***$ 266,021***	***$ 133.01***
26.13 16.10	Switchgear, Load Interruption	1	$ 31,200	117%	$ 36,504	$ 18.25
26.13 16.10	Transformers, 1,000 kVA ea	2	$ 67,500	117%	$ 157,950	$ 78.98
	Cabling, 4,160 V; 500 kcMIL	400 ft.	$ 65.00	117%	$ 30,420	$ 15.21
	Conduit, 3in dia.	400 ft.	$ 24.50	117%	$ 11,466	$ 5.73
	Excavation and Backfill	400 ft.	$ 30.92	117%	$ 14,471	$ 7.24
	Cabling, 13,200 V; 500 kcMIL	200 ft.	$ 65.00	117%	$ 15,210	$ 7.61
33	***Utilities***				***$ 28,350***	***$ 14.18***
33.51 13.20	Nat. Gas Distribution, 3 in. steel up to 10 psig	200 ft.	$ 24.50	117%	$ 5,733	$ 2.87
31.23 16.14	Trenching for Gas Piping, 36 in deep x 8 in wide	200 ft.	$ 2.31	117%	$ 541	$ 0.27
31.23 16.14	Backfill for Gas Piping, 36 in deep x 8 in wide	200 ft.	$ 4.11	117%	$ 962	$ 0.48
CHG&E	Natural Gas Service					
31.23 16.14	Connection to Engine Skid, Trench and Backfill	50 ft.	$ 30.92	117%	$ 1,809	$ 0.90
	Rock Drilling, Rock and Debris Removal, Allowance	100 yd3.	$ 165.00	117%	$ 19,306	$ 9.65
48	***Electric Power Generation***				***$ 1,675,800***	$ 837.90
	Elite Engine Genset, Nominal 2 MW: Vendor Quote	1			$ 1,675,800	$ 837.90

2.3.5 Village Water Supply Facility

The Municipal water treatment plant is located at 2784 West Main Street. Refer to Location D on the One-Line in the Appendix. The plant has a back-up diesel, whose rating is 350 kW. The peak demand of the facility is 76.8 kW, with an annual usage of 239,800 kWH. An existing PV plant is nominally rated at 200 kWac. This PV plant currently net meters the account. The utility transformer that serves the load is rated at 500 KVA; hence, there is sufficient transformer capacity to accommodate export.

The new equipment that will be added includes paralleling switchgear to allow the diesel to operate in parallel with the microgrid. Additionally, a 250 kW / 1,000 kWH battery storage system will be installed by Eos Energy Storage as part of a separate NYSERDA award. This battery system will provide ride-through capability, voltage support, black start, and other ancillary services such as frequency regulation.

PHOTO 8 - EXISTING 200 KWAC PV SYSTEM AT WTP

PHOTO 9 - 350 KW DIESEL AND 500 KVA TRANSFORMER AT WATER SUPPLY PLANT

3.0 COMMERCIAL AND FINANCIAL FEASIBILITY

3.1 Customers

The proposed microgrid will affect several different service groups due to the variety of critical facilities located at this location. The Tri-Municipal Waste Water Treatment Facility services 14,300 residents spanning across the Towns of Poughkeepsie, Wappinger, and the Village of Wappingers Falls. The Village's Water Treatment Facility serves the entire 5,600 population of Wappingers Falls. Fire Stations in the service area include the Village of Wappingers Falls' SW Johnson Firehouse and the Town of Poughkeepsie's New Hamburg Firehouse. Johnson Firehouse serves 5,600 Village residents and New Hamburg serves approximately 900 residents. Mt. Alvernia and the Sisters of St. Clare provide sheltering capability. The Hydroelectric Plant is a critical supply resource located adjacent to the Industrial Park and its operating businesses. We anticipate mixed use growth within the Industrial Park.

Our plan to serve all critical customers with grid resilient power has been presented in previous sections of this report. Most importantly, we emphasize that these critical customers are also instrumental to the enhanced reliability of the microgrid. In effect, these customers, as host sites for generation and / or energy storage, are key suppliers of grid related services. That is, the grid, as operated and owned by CHG&E, is a customer as well as a service provider! The utility, and the modern 2-way grid as both a customer and service provider is articulated in NYREV; this concept is presented in our feasibility level microgrid design presented herein, which we believe meets the highest goals of New York State.

Most importantly, we emphasize that our concept provides for the electric power demand of all critical and non-critical customers that are served by CHG&E that are provided by the 8023 circuit. These customers could be offered energy at discounted prices via a net metering arrangement that is anchored by new contracts with energy supply from the existing and functioning hydroelectric plant, and a new PV plant. We cannot stress enough that reliability in an emergency, not only related to weather but other Homeland Security events such as sabotage or computer hacking, is enhanced by a secure and functioning power supply.

We anticipate also that secure power will be one of many factors that encourage more businesses to locate in our Industrial Park, including battery storage corporations. We believe that the Industrial Park is also a good staging location for disaster recovery efforts. For example, electric vehicle charging could be accomplished at this location and supplied from the hydro plant. In effect, electric vehicles could be mobile sources of power supply.

We also look forward to working with CHG&E in encouraging the necessary gas utility distribution system upgrades that will allow a thriving mixed use residential / commercial / industrial community to grow. It should be noted, that environmental betterment efforts are also underway in this area of the Village. We believe that CHG&E can be a true partner within the spirit of NYREV in which there is revenue sharing potential.

The following provides further treatment in accordance with NYSERDA's bulleted Scope items that were detailed in the RFP.

3.1.1 Number of affected individuals

The entire population will be affected because if the water and the waste treatment plant (two of the critical loads) loses power, water cannot be provided and wastewater cannot be processed. Wastewater services affect 14,300 people, and water services affect 5,600 people.

The other critical loads include:

> Sheafe Rd. Elementary School and St. Mary's School: There are approximately ____________ students at these facilities.
>
> Mt. Alvernia and Monastery of St. Clare: There are approximately __________________ affected individuals at if these critical shelters were not able to function due to lack of electric power.

3.1.2 Services (direct / paid) affected by microgrid operation

3.1.2.1 Ancillary Services and Capacity in all operating modes:

- Voltage Support – Strategic locations at dispersed microgrid sites. Optimized load flow analysis to be developed for Phase 2.
- Frequency Regulation (FR) and Real Power Support – 1.25 MW of Battery Storage can supply FR services at 4 second intervals
- 10-minute and 30-minute spinning reserve: In an emergency, the hydro plant can utilize the reservoir water storage capacity. Gas engine can be synchronized within a minute. All resources except for the PV plants totaling 6.71 MW can be utilized at their rated capacity subject to further load flow analysis and time duration limits

- Black Start and System Restoration Support: 1.25 MW of Battery Storage
- Generation Capacity (Net Available Addition to Capacity is 5.05 MW / yr (Solar PV coincident summer peak at 37% factor, hydro summer peak coincidence at 36% factor per IEC guidance)
- Distribution Capacity Impact is 3.5 MW: Distributed resources from within the microgrid can generate to meet the peak circuit load of 3.5 MW. The substation can continue to import 3.5 MW to serve a growing load. (Example: If the Industrial Park experiences 1 MW load growth, the distributed resources could supply the load without burdening the distribution system to meet the load growth).
- Transmission Capacity Impact is 4.17 MW: The distributed resources can generate sufficient power, including some export into the transmission system, to avoid import at the substation.
- Demand Response Capability
- Economic Dispatch of Generation
- Battery Storage Price Arbitrage

3.1.3 Microgrid customer's purchasing services

It is not envisioned that customers will pay more for their electric supply and distribution service. More detailed explanations as to the financial business model is presented in Section 3.5.

The financial model is based on Community Net Metering (CNM - also called Community Distributive Generation). In a CNM model, a "Microgrid Entity" (legal structure to be determined during Phase 2 in conjunction with the Strategic Allies) will market CNM commodity as per the CHG&E tariff. The microgrid entity will also take responsibility for the obligation to serve load in an emergency, that is, when islanded operations occur.

The CNM commodity originates from authorized renewable electric energy supply resources (the existing hydro plant, new and existing PV plant). The increased revenue made available due to the price arbitrage (difference between wholesale electric supply prices at approximately 6 cents per kWH and residential tariff rate per CHG&E SC1 at approximately 14.585 cents per kWH) is estimated to be 8.585 cents per kWH. This arbitrage in part supports the costs and profitability of the microgrid. The allocation of the arbitrage is detailed in Section 3.5.

- Critical Load Customers include the following, and as host sites for generation resources, could possibly receive revenue via land-lease arrangements or other transactions with project developers. These customers will be the beneficiaries of a more resilient microgrid, will pay for normal distribution service at utility tariff rates, can enroll with a third party Energy Service Company (ESCO) for supply or take bundled service from CHG&E, or could participate in revenue producing transactions such as demand response.

- TriMuni Wastewater Treatment Facility
- Monastery of St. Clare
- Village Water Supply
- Mt. Alvernia
- New Hamburg Fire Department
- Sheafe Rd. Elementary
- St. Mary's School
- SW Johnson Firehouse

- Non-critical Residential Customers will be provided the opportunity to purchase Community Net Metered (CNM) product at a discount. Verifiable operating costs during a grid outage in which the microgrid operates in an islanded mode would be deducted from the discount.
- Non-critical municipal, commercial, and industrial customers will be the beneficiaries of a more resilient microgrid, will pay for normal distribution service at utility tariff rates, can enroll with a third party ESCO for supply or take bundled service from CHG&E,

3.1.4 Other microgrid stakeholders

- The "microgrid entity" will be established to perform functions that are not currently provided:
    - Enter into Energy Sale Agreements with CNM Satellite Accounts
    - Operate the microgrid in an emergency with Obligation to Serve, that is, when isolated islanded mode occurs
- The microgrid entity would include CHG&E, and could include the participants as indicated in Section 3.3 ("Project Team") below.
- During normal operating modes, that is, whenever the area grid is present and Circuit 8023 is not operating in islanded mode, the stakeholders operate independently, that is, operations will be based upon the economic needs of each supply resource owner. Each supply resources controls the dispatch and operations of their power generation system.

3.1.5 Relationships with Microgrid Owner and Purchaser of Power

There is not one single owner of this microgrid. A "microgrid entity" will be established to perform functions that are not currently provided (see 3.1.4).

- The "microgrid entity" will represent the interests of the various renewable generating assets that comprise the supply resources of the microgrid. It is envisioned that CHG&E, as the owner of the distribution assets, will also be a member of the "microgrid entity".
- The "microgrid entity" will be given authority by the members to enter into energy sale agreements for CNM product, that is, excess generated renewable energy. Settlement will be conducted by the microgrid entity; CHG&E meter readings will be utilized to tabulate net metering credits.
- The "microgrid entity" will have limited oversight of the distribution assets comprising Circuit 8023 that is currently owned by CHG&E, and this will be only with regards to emergency islanded mode of operation. That is, the "microgrid entity" will administer a contract for assuring priority restoration services of distribution lines that are affected by a grid emergency while in isolated mode of operation. These priority restoration services as well as the generation assets that can supply the microgrid assure ultra-high reliability of electric service to all customers on the 8023 circuit.

3.1.6 Normal Operation Purchases and Islanded Operation Purchases of Power

Purchasers of power and energy are described in Section 3.1.3.

3.1.6.1 Normal Grid Operation Purchases of power

If customers are not subscribed to purchase CNM energy, they are free to buy bundled service from CHG&E, or third party supply as allowed in New York State. If they are subscribed as CNM customers, energy sales will originate from the renewable resource asset owner, custody of the energy will be transferred to the "microgrid entity", and the customer will receive the commodity.

Distribution, or delivery service, will be purchased under tariff from CHG&E.

3.1.6.2 Emergency Islanded Mode Operation

All customers on the 8023 microgrid circuit will receive supply and distribution service during a grid emergency if the microgrid distribution lines are functional. There is no additional charge for emergency islanded-mode service, although there will be an allocation of verifiable costs to CNM customers that reduces the discount. If some or all the microgrid distribution lines are compromised, all critical load sites will receive power as hosts of generation resources, and some non-critical loads could receive power depending on the isolation capabilities of the microgrid subsections.

The two modes of operation (normal parallel operations with the area grid, and islanded operations in an emergency) are different in order to maintain continuity with existing methods and regulations during normal grid operations, and to establish a framework to supply load during area or regional grid outage events.

3.1.7 Contractual Agreements with critical and non-critical load purchasers

An energy sale agreement between the “microgrid entity” for CNM energy, and critical as well as non-critical customers. Other provisions include:

- Supply originates from renewable resource asset owners who transfer custody to the “microgrid entity”.
- The “microgrid entity” earns a fee to cover costs
- Agreements as per CHG&E Tariff “Community Distributive Generation” Section 46, Leaf 163.7
- Deduction from the CNM discount when emergency events occur. In no case will the deduction cause a net loss to the customer.

3.1.8 Customer Registration

The “microgrid entity” will register customers. Other stakeholders as part of the “microgrid entity”, will participate in supporting enrollment of new customers.

3.1.9 Other Commodities

There will be no other commodities.

3.2 Value Proposition

3.2.1 Benefits and Costs to the Community

The Village of Wappingers Falls values the ability of this microgrid to maintain operations in the event of conventional grid failure. The Village also values the potential for revenue streams available through community net metering (CNM) which will allow it to stimulate investment in microgrid assets and allocate more funding toward resiliency improvements. Resiliency is of paramount importance as extreme weather events as well as potential Homeland Security threats are becoming increasingly more common.

The Village has been attempting to usher in an economic revitalization in recent years. Resiliency is critical to attracting certain industries and retaining existing enterprises throughout years of looming weather related hardships. This proposed microgrid is essential in cultivating a business climate that suits the demanding needs of a turbulent 21st Century. This microgrid program also allows reconstruction of the hydroelectric plant dam and upgrades to the hydroelectric plant, which may not be possible otherwise. If the dam and the hydro plant are not rebuilt, the generation asset will likely go out of business, and the dam could possibly fail with catastrophic consequences.

The Village has invested heavily in renewable energy and energy efficiency measures; in an effort to bring about a more livable and viable community. These investments are evident in the Village's building stock which is equipped exclusively with LED lighting. Also, the Village's 239 kW municipal solar array is a testament to these long-term investments. The proposed microgrid would serve to further advance the Village's goal of providing reliable and efficient services to residents with little or no environmental impact. As regards costs to the Village, there will be costs associated with enrolling CNM customers.

3.2.2 Microgrid Benefits / Costs to the Utility

This microgrid benefits the utility by supporting load growth in the Village of Wappingers Falls, resulting in increased revenue base for CHG&E.

There are 3.5 MW of distribution capacity that can be deferred.

The regional transmission system also is the beneficiary of 5.05 MW

The following is extracted from the NYSERDA BCA report:

> *"The development and operation of a microgrid may avoid or reduce a number of costs that otherwise would be incurred. These include generating cost savings resulting from a reduction in demand for electricity from bulk energy suppliers. The BCA estimates the present value of these savings over a 20-year operating period to be approximately $6.60 million. The reduction in demand for electricity from bulk energy suppliers would also reduce the emissions of air pollutants from such facilities, yielding emissions allowance cost savings with a present value of approximately $3,500 and avoided emissions damages with a present value of approximately $5.2 million.*
>
> *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. Based on the capacity of the DERs, the capacity of the energy storage system, and the availability factors the project team applied to the renewable DERs to*

characterize annual production, the analysis estimates the incremental impact of the project on generating capacity requirements to be approximately 5.05 MW. Over a 20-year operating period, the present value of these benefits is estimated at approximately $5.8 million. Similarly, the project team estimates that the investment in utility upgrades will reduce the need for future improvements in local distribution capacity. Over a 20-year period, the present value of this benefit is estimated to be approximately $1.5 million."

"The project team has also indicated that the proposed microgrid would be designed to provide ancillary services (real power support, 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 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 this service."

As regards costs to the utility, there will be upgrades required to the 8023 circuit in order to connect portions of the current 8024 circuit. Load shedding, and circuit breakers that allow electric isolation of microgrid subsections will also result in equipment and installation costs. There will also be costs associated with deploying smart grid technology. Additionally, gas system supply will need to be reinforced at some point in time to accommodate added load of the new gas engine (20,000 scf / hr). However, the gas system upgrade would need to be accomplished to accommodate gas requirements due to projected load growth in the industrial park.

3.2.3 Proposed Business Model

This section outlines the proposed business model, which is based on Community Net Metering (CNM). CNM integrates various value revenue and cost streams into a value proposition that is consistent with NYREV. For purposes of this feasibility study, CNM is synonymous with Community Distributive Generation (CDG) as used in the CHG&E Tariff Book. CNM is potentially viable because of the existing hydroelectric plant, existing PV plant, and proposed new PV plant.

A "Microgrid Entity" (legal structure to be determined during Phase 2 in conjunction with the Strategic Allies) will market CNM commodity as permitted by the CHG&E tariff. The CNM commodity originates from authorized renewable electric energy supply resources (the existing hydro plant, new and existing PV plant). The increased revenue made available due to the price arbitrage (difference between wholesale electric supply prices at approximately 6 cents per kWH and residential tariff rate per CHG&E

SC1 at approximately 14.585 cents per kWH) is estimated to be 8.585 cents per kWH. This arbitrage in part supports the costs and profitability of the microgrid. Further description of the model, and the allocation of the arbitrage, is detailed in Section 3.5

Summary of SWOT assessment:

- ***Strength*** of the model is based on the existing tariff that gives legal ability to develop CNM energy sale agreements, as well as the significant price signal based on the difference between residential retail rates and the wholesale market. The VWF microgrid project also allows all customers / ratepayers on the 8023 circuit to be served with electric service in an area wide grid outage.
- ***Weakness*** of model is the dependency on many independent parties entering into an agreement. A second weakness is the dependence on incentives (NYSERDA NY Prize, Federal Investment Tax Credits). However, if incentives are reduced, the project could either be reduced in scope (that is, limited to the Industrial Park area), or constructed in phases.
- ***Opportunities*** include a novel means of financing part of the necessary upgrades. The novel means includes using some of the CNM revenue to pay for microgrid upgrades. A second opportunity includes the scalability and repeatability of the business model, to include potential microgrids with hydroelectric plants or older facilities that could be rebuilt, in the State.
- ***Threats*** include possible failure to secure CNM commitments.

3.2.4 Unique Site and Technology Characteristics

This project includes an existing functional hydroelectric plant and operational PV plant that will be integrated with new generation and energy storage.

Upgrade costs are significantly less than constructing new renewable plant of the same capacity. If the funds for microgrid development are not made available for upgrade, the hydroelectric plant could go out of business.

The microgrid includes an Industrial Park site that currently has over thirty (30) tenants, and a large opportunity for rebuilding and adding new industrial and commercial customers. The Industrial Park (34.395 acres of Industrial Zoned property) is also the recipient of a Brownfield Opportunities Area Nomination study.

One energy storage project has been awarded a NYSERDA grant under a separate PON, and is awaiting contract.

3.2.5 Replicability and Scalability

This microgrid program is replicable and scalable in New York State, as well as nationally.

The FERC database of active hydroelectric plant licenses was searched as part of this effort. Expiration dates were included. There are 108 licenses in New York State. Although detailed research has not yet been prepared, many hydro plants have expiring licenses, and could have older PURPA era energy sale agreement contracts that offer insufficient revenue to continue operations. The model presented herein can be deployed to stimulate renovation of some of these hydro resources, as well as other older assets in the State. Renovated assets can serve as the anchor for a microgrid and associated area development.

3.2.6 Purpose and Need for Project

- Added resiliency and reliability that are useful attributes in emergency events including storms, and Homeland Security episodes.

  Of particular import, the added reliability will allow attraction of new technology driven businesses within the Industrial Park zone of the microgrid. This could include energy storage manufacturing companies.

  The microgrid will be designed for disruptive weather events, as well as Homeland Security events including cyber-attack, and terrorist attack.

  The microgrid remains resilient by having sufficient distributed resources to accommodate the peak load of the circuit. The controls allow islanded operation upon an event triggered at the substation or on the transmission system. If weather forces an outage of overhead lines, sections of the microgrid remain functional, and are fed from different injection points. Priority distribution line restoration services by CHG&E will occur. The critical loads have sufficient on-site resources to allow isolated operation of each critical load for up to seven (7) days.

- Demonstration of a “two-way” grid

  Integration of distributed energy resources that include grid support (voltage, power factor, ancillary services), grid capital deferment (new load can be met in-part by new capacity originating from within the load pocket), grid ancillary benefits.

- Cost savings to low income residents and other residential customers

  The CNM business model allows for a discount to be applied to residential tariff rates.

- Revenue stream to the Village

  For work performed to promote and administer the microgrid efforts as part of the “microgrid entity”, there will be a revenue to cover costs.

- Repair of hydroelectric plant and dam

  CNM revenues will cover this work.

- Promotion of new technology (Eos battery storage system, PV modules manufactured in NYS), and Development and deployment of innovative New York and American technology

  Eos' zinc-air technology will be manufactured in New York State; PV modules are manufactured in New York State.

- Investment opportunity using a unique and customized business model

  The business proposition is economically viable and should attract private equity investment for new plant.

- Job creation and growth

  The Industrial Park, with its secure and resilient power supply, will attract new manufacturing and commercial works as well as associated jobs.

- Public – private partnership business model

  Includes the strategic allies and service providers: the Village of Wappingers Falls, CHG&E, Solar City, Eos Energy Storage, Elite Energy, Wappinger Falls Hydroelectric, KC Engineering and Land Surveying P.C., and Genesys Engineering P.C.

- Economic and operational benefits to all customers connected to the microgrid circuit

  During disruptive events, the added resiliency will allow customers on the microgrid to have a better chance for being able to go to their jobs, and remain functional.

3.2.7 Value Proposition

The value proposition includes:

- enhanced reliability and resiliency for all customers (critical and non-critical loads) on the microgrid,
- reduced or same electricity cost for all microgrid customers,
- suitable returns for investors,
- market based earnings for the utility.
- integration of renewable generation from existing but upgraded supply, and new systems
- corollary benefit regarding the microgrid's catalyzing effect in stimulating commercial development of the Industrial Park area within the Village, resulting in energy load growth and jobs.

3.2.8 Added revenue streams, savings, costs created for the purchaser of power

The following value add streams apply to the VWF microgrid:

- Discount for customers that enter into an energy sale agreement with the "microgrid entity".

- During outages, all customers on the 8023 microgrid circuit will benefit from supply of power and priority restoration services. The operating costs of this enhanced reliability during outage events will be debited to the discount provided to CNM customers. However, CNM customers would never pay more than they otherwise would have paid for conventional bundled-tariff services.
- Critical loads that host generation can receive revenues from demand response, capacity as a NYISO Special Case Resource, ancillary services.
- The net revenue after all operating costs are considered amortizes the net capital cost after incentives are applied and yields a reasonable internal rate of return. See Section 3.5.5.

3.2.9 Promotion of State Policy Objectives, NYREV, RPS

The NYREV Framework Order articulated a vision for the future of the electric industry in New York that is (1) customer-centric, (2) focused on reducing the total energy bill to New York customers, and (3) fully integrated to ensure optimal resource choices are made. Among other components, the Framework Order requires New York's electric utilities to provide distributed system platform (DSP) services to enable third-party providers of distributed energy resources (DER) to create value for both customers and the system.

The Village of Wappingers Falls Micorgrid Design facilitates the goals and objectives of the Distributed System Platform (DSP) market design by:

- Involving all Customers on the 8023 microgrid circuit by providing enhanced level of resiliency
- Providing discounts to low income customers, and other customers, that partake of a CNM offer
- Integrating renewable, zero emission resources into the microgrid, as well as energy storage
- Involving the utility (CHG&E) as a DSP provider

Please refer to SubSection 1.2.4 for a more detailed account. The descriptions provided within Section 1.2.4 are identical to that required in this section, and is too lengthy to reproduce.

3.2.10 New Technology

The following new technologies will be deployed:

- Energy Storage: Eos zinc air battery systems as manufactured in New York State
- Solar City PV modules will be manufactured in New York State
- CHG&E Smart Grid Technology
- Control Systems as applied to the microgrid

Existing but modernized technology will be deployed for upgrading the hydroelectric plant, new gas engine system.

3.3 Commercial Viability - Project Team

3.3.1 Support from local partners

The Village of Wappingers Falls is committed to the project and values the proposed microgrid. Critical load customers are fully supportive and are aware of the NY Prize feasibility study. Community Groups and Residents will be contacted in Phase 2 – it is too premature to contact Community Groups during a feasibility study.

3.3.2 Team members and roles

The Project Team, and their roles, for the Phase 1 of the NY Prize effort consists of the following organizations:

- Village of Wappingers Falls (VWF): VWF is project sponsor and potential member of the "microgrid entity"
- KC Engineering and Land Surveying, P.C. is the Village's Engineer
- Genesys Engineering P.C. is the Subject Matter expert, and NY Prize NYSERDA microgrid resource
- New York State Energy Research and Development Authority:

Strategic Allies for this Project include the following:

- Central Hudson Gas & Electric: Electric Utility
- EOS Energy Storage: Supplier of 250 kW / 1,000 kWH battery storage system also responsible for system maintenance
- Elite Energy Engineering: Supplier of 2,000 kW natural gas engine; also considered for maintenance, as well as development (financing) of the system
- Solar City: Supplier for 1,000 kWac PV system, developer of project, and responsible for operations and maintenance
- Wappingers Falls Hydroelectric, LLC: Owner / operator of existing 2.4 MW hydroelectric plant

Contributors include:

- Arkados Energy Solutions: Energy efficiency evaluations

- Storage Power Solutions: Energy storage systems equipment supply at locations other than Mt. Alvernia and the water treatment plant

The Engineering Team and the Village have reviewed the technical submittals and qualifications / experience of the firms identified.

Other Enterprises include:

- “Microgrid Entity”; This will be established to purchase renewable energy and develop energy sale agreements for CNM product; this entity will also have oversight responsibility to assure compliance with high reliability standards for the CHG&E distribution system in an emergency, that is, priority restoration services.
- NY Green Bank: Consider for financing
- NuEnergen: Demand response services
- Contractors have not been selected at this time. Construction services will be competitively bid.

Financing institutions, equity investors / developers: These will be disclosed as part of Phase 2.

3.3.3. Public / Private Partnerships

Public / Private partnerships will be considered as part of the business structure for this project.

The “microgrid entity” could be composed of CHG&E and the Village, as well as other limited partners. The entity will buy CNM product from eligible resources, and contract with eligible CNM satellite accounts. The “microgrid entity” will earn a fee from the CNM allocated revenues.

All supply resources will be privately owned, or in the case of existing diesels and the existing PV plant, owned by the Municipality.

The utility distribution lines and associated equipment are owned by CHG&E’s regulated business.

3.3.4 Letter of Commitment from the Utility

The utility has endorsed Phase 1 of the project. CHG&E will be requested to renew their endorsement at key project milestones.

3.3.5 Financial Strength of Applicant

The Village of Wappingers Falls is the Applicant, and is not delinquent on any debt.

3.3.6 Project Members' Qualifications and Performance records

The Appendix presents qualifications and performance records of the Project team members (Strategic Allies). The following presents a brief summary of each strategic partner:

- Village of Wappingers Falls: The Village of Wappingers Falls is a small, historic mill community situated around its name sake waterfall. Despite its size it has made substantial investments in renewable energy, strengthening its green infrastructure, and exploring potential resiliency and efficiency measures.The Village has invested heavily in renewable energy, including a 239 kW PV system, and energy efficiency measures, in an effort to bring about a more livable and viable community. The Village remains committed to NYREV.

- Central Hudson Gas and Electric (CHG&E) CHG&E serves the Village of Wappingers Falls with electric delivery services and supply if requested. Central Hudson's mission is to deliver electricity and natural gas to an expanding customer base in a safe, reliable, courteous and affordable manner; to produce growing financial returns for shareholders; to foster a culture that encourages employees to reach their full potential; and to be a good corporate citizen.

- KC Engineering and Land Surveying (KC): KC provides both public and private sector clients with comprehensive engineering and surveying services which include civil engineering, structural engineering, traffic and highway engineering, land development, site inspection, construction management, water supply and distribution, wastewater collection and treatment, building code compliance, GIS, land surveying and mapping. The firm specializes in master planning infrastructure projects and implementing improvements in a phased approach from funding strategy through construction.

  KC (formerly Paggi Martin Delbene) has served as the Village Engineer for Wappingers Falls from 1979 to current. KC has provided engineering services for many years of infrastructure replacement projects including new water main, sanitary sewer, stormwater management, sidewalk and roadway facilities, in addition to the design and construction of a new water supply facility and ground-mount solar PV at the water supply facility.

  For this project, KC provided project management, assisted with communication among the participants, evaluated alternatives, and coordinated completion of project deliverables.

- Genesys Engineering, P.C.: Genesys Engineering, P.C. (Genesys), with a staff of more than fifty professionals, is a multi-discipline engineering firm that provides planning, design, construction, and commissioning services for new and existing utility infrastructure projects, assisting our clients in implementing their most challenging projects in a cost effective manner. Genesys Engineering P.C. is a NYSERDA FlexTech contractor and is listed on the NY Prize website as a NYSERDA approved Microgrid Resource. Genesys is experienced with CHP, DER, central plant, and electric distribution system feasibility evaluations, design / engineering, utility master planning, and construction management. As part of the Village of Wappingers Falls implementation team, Genesys Engineering has defined microgrid requirements, developed microgrid system concepts, refined alternatives, taken lead responsibility for optimizing the technical solution in conjunction with the project team, and developed sufficient details that support the Project Objectives as defined by NYSERDA RFP 3044 in the Statement of Work Sample.

- Elite Energy Engineering: Elite Energy Engineering offers the market CHP and simple cycle gas engine packaging, with unequalled product support capabilities. The engineering team at Elite includes individuals with significant experience in the areas of general mechanical design, CHP module design, CHP system design, natural gas engine design, emissions control (gas and diesel), engine/generator controls, electronic systems design, utility paralleling electronic design and general packaging. Elite Energy equipment is listed with NYSERDA for CHP application.

- Solar City: As a recognized leader in the design, construction, and financing of solar power and microgrid systems, SolarCity is uniquely qualified as a partner in the development and implementation of the proposed Wappinger Falls microgrid. SolarCity is a public corporation and has deployed 1.212 GW of photovoltaic systems across the country as of March 31, 2015. In addition to this broader corporate experience, SolarCity has been developing distributed energy storage solutions for 5+ years. SolarCity is committed to both manufacturing and deploying solar in the state of New York. Beginning local service in 2011, SolarCity has become one of the few solar companies in New York that has experience in municipal and residential markets, with locations in Albany, Amsterdam, New Windsor, Westchester (Elmsford), and Long Island (Hauppauge). Solar City has deployed over 5,500 residential, governmental and commercial projects in New York as of March 31, 2015.

- Eos Energy Storage: Eos' mission is to develop cost effective energy storage solutions that are not only less expensive than other battery technologies, but less expensive than the most economical alternative used today to provide the same services – a gas turbine for peak power generation and transmission and distribution assets for delivery capacity. Eos views energy storage as a solution to real business problems, and is developing a battery technology that responds directly to the requirements of the business case at hand. The result is Eos' novel, proprietary Znyth™ technology—the first low-cost, long-life, inherently safe, energy dense, and highly efficient aqueous battery. Founded in 2008 after the issuance of the patent for its core technology, Eos has grown to become a leader in the nascent and rapidly growing energy storage industry. Eos' elite research and development team is led by management with decades of experience in battery technology and building successful energy companies.

The Eos Aurora product is a containerized DC battery system designed specifically to meet the requirements of the grid-scale energy storage market. With 4 hours of discharge capability, immediate response time, surge capability, and modular construction, the Aurora system can be scaled and configured to reduce cost and maximize profitability in utility, commercial, and industrial markets.

Eos will be building the energy storage project at the Village's water treatment plant, which has received a separate NYSERDA award.

3.3.7 Contractors and Suppliers

Contractors will be selected from an approved bidder's list of pre-qualified enterprises. Suppliers, other than those indicated in the preceding section, have not been selected for this feasibility evaluation.

3.3.8 Financiers

The project team will consider NY Green Bank Financing as a debt vehicle.

Equity can be provided by the Strategic Allies for each of their generation supply projects. Equity investment will supplement capital cost incentives and investment tax credits, and debt obligations.

3.3.9 Legal and regulatory advisors

Professional and fee paid legal and regulatory advise was beyond the scope of this feasibility assessment. The Project team did consult unofficially with several legal and regulatory firms. In-house capability also exisits. CHG&E provided guidance to the team.

These services will be procured during Phase 2.

3.4 Creating and Delivering Value

This microgrid project will create and deliver the following values:

- Added resiliency and reliability that are useful attributes in emergency events including storms, and Homeland Security episodes
- Grid support, grid capital deferment, grid ancillary benefits
- Cost savings to low income residents of the Village
- Revenue stream to the Village for work performed to in-part promote and administer the microgrid efforts via the "microgrid entity"
- Investment opportunity using a unique and customized business model based on Community Distributive Generation (or Community Net Metering)
- Job creation and growth
- Development and deployment of innovative New York and American technology
- Public – private partnership with strategic allies and service providers including the Village of Wappingers Falls, CHG&E, Solar City, Eos, Energy Storage, Elite Energy, Wappinger Falls Hydroelectric, KC Engineering and Land Surveying P.C., and Genesys Engineering P.C..
- Economic and operational benefits to all customers connected to the microgrid circuit

3.4.1 Chosen Technologies

- Hydroelectric Power Generation (Renewable): This nominal 2,450 kWac generation plant is existing, operational, and in need of upgrade and requiring incentive support. One new 250 kWac hydro-electric turbine will be added. It can operate as a resource for the microgrid. Benefits include the proven track record of this resource, and economies of utilizing the hydro station if upgrades can be financed. This is a less expensive alternative than a new station. Challenges include making the necessary repairs, and expiration of the PURPA era contract. A CNM contract with a "microgrid entity" would anchor the entire microgrid business proposition.
- Photovoltaic (PV) Power Generation (Renewable): There is an existing, functional, and proven 200 kWac PV power plant, and there will be a new 1,000 kWac PV system that will be constructed. The technology is commercially available, and the new system will use NY manufactured modules, if available. Challenges could include the lease of the property for the new ground-mounted system.
- Battery Storage: Relatively new technology including control systems could prove technically challenging. The Eos system, manufactured in New York State, will be a beta test

unit. The 1,000 kW / 500 kWH Li-Ion system (or equal) also has limited operational experience.

- Gas Engine: The equipment is tried and proven, and commercially available with suitable warrantees and guarantees. Emission control is proven. Demand response revenues present a challenge, as programs can change. There is risk associated with price uncertainty. This risk can be mitigated by involving the utility as a Platform Service Provider.

3.4.2 Existing Assets

The hydroelectric plant is an existing asset.

The 200 kWac PV plant is an existing asset.

3.4.3 Load Balancing

The batteries provide frequency regulation service during grid outages in the islanded, emergency mode. The system is controlled with one unit operating in droop control.

In normal operating mode, the grid temporarily absorbs small deviations from dispatched electric power setpoints. In normal mode, the generation systems operate in accordance with their own unique contracts as outlined in previous sections. Import power from, or export power to, the transmission system can be deployed based on pricing signals.

3.4.4 Permits and Special Permissions

The microgrid works described in this evaluation will require the typical permits including environmental, construction, electrical interconnection,

Special permissions to establish a microgrid entity could be necessary, or may not be necessary. Legal opinion is required during Phase 2. The business structure detailed in this evaluation is unique as far as this team understands; however, the tariff may be interpreted to allow for this structure. CNM limitation of 2 MW needs to be addressed.

3.4.5 Proposed approach for developing, constructing, operating the project

The project will be developed upon award of a Phase 2 contract by NYSERDA. The $1 mm NYSERDA incentive is a necessary component in preparing the numerous technical design documents, legal framework documents such as Memoranda of Understandings (MOU) or Letters of Intent (LOI), and other documentation and supporting materials.

Each strategic ally will be provided with a share of the incentive funds to advance their piece of the design, and business proposition. The microgrid entity will be established. The engineering that is necessary will be prepared by KC Engineering and Genesys Engineering. The Village will interact with the community as necessary, and will receive fees from the NY Prize award. It will need to be determined how CHG&E will finance their piece of the effort, as it is unclear how NYREV treats the costs and cost recovery mechanisms of the regulated enterprise. However, some allocation of funds has been reserved for CHG&E.

During Phase 3, the balance of funds will be appropriated from equity of the Strategic Allies, debt assumed by the Strategic Allies, or Incentives via NY Prize or other rate recovery mechanism.

3.4.6 Community Benefits

The benefits are passed to the community via a discount on electric bills resulting from CNM.
Other benefits include job creation and growth, grid resiliency.

3.4.7 Requirements of the Utility

- The utility must set up a plan for Priority Restoration Services that applies to Circuit 8023, during islanded mode operation only.
- CNM accounting must be accomplished by CHG&E per tariff. CHG&E will be welcome as a platform service provider as part of the "microgrid entity".
- The utility must reinforce their natural gas system for supply of fuel to the new 2 MW gas engine.
- The utility needs to modify circuit 8024 to connect part of the wiring to circuit 8023.
- The utility needs to accomplish micrgrid circuit subdivision by using appropriate breakers in sectionalizing the microgrid in order to isolate faults in subsections.
- Application of the utility's Smart Grid technology will be necessary for the load shedding of select customers on the 8023 circuit, in particular, as load grows.
- Utility involvement in area development activities.

3.4.8 Microgrid technologies experience

Energy Storage has been demonstrated in beta tests.

Controls include battery management systems and microgrid control. These have been demonstrated, are commercially available, and require adaptation. Campus microgrids, and islanded operations, have been implemented for 125 years. Equipment suppliers have experience, but the application presented herein is new and requires adaptation.

All other generation has a long track record.

3.4.9 Operational Scheme

The microgrid exists to add a level of resiliency during emergencies that include storms, and Homeland Security events. The "microgrid entity" is established to assure that this mission is accomplished.

<u>The following apply to operational schemes during emergencies as defined by isolated islanded operational mode:</u>

Technical: The microgrid functions as an islanded system in emergency mode. The control system assures that frequency regulation, power factor, load balancing, voltages, dispatch of supply resources, and all technical parameters operate within specification as prepared during Phase 2.

Financial: In emergency mode, the costs (such as fuel, priority restoration, maintenance during the grid outage) will be allocated to the CNM satellite accounts and will reduce the discount, although never above tariff costs. Some costs (normal distribution system restoration costs as an example) will be allocated via the traditional utility rate base.

Transactional: The "microgrid entity" has transactional accounting responsibility for emergency islanded mode operations.

Decision making: The operations manager for the "microgrid entity" has decision making final authority.

During normal operations, the role of the "microgrid entity" is to administer the CNM program defined in the CHG&E tariff, and to enter into energy sale agreements on behalf of the renewable supply resources. The "microgrid entity" also has oversite responsibility as regards potential emergency events.

<u>The following apply to operational schemes during normal operations as defined by area grid parallel operational mode:</u>

Technical: Each generation supply resource functions as a distributed generator in parallel with the grid.

Financial: Renewable supply assets sell their energy to the "microgrid entity". The "microgrid entity" enters into CNM energy sale agreements with Satellite Accounts.

Transactional: CHG&E meets their obligations regarding meter services and accounting, and provides their report to the "microgrid entity".

Decision Making: Each generation supply resource maintains authority to dispatch as per their interconnect agreements, demand response agreements, CNM agreements, ancillary services agreements, NYISO Special Case Resource Agreements, and / or as entered into as part of this program.

3.4.10 Purchasers of Energy:

The utility meters will be deployed to ascertain electric energy usage, and demand, of microgrid customers.

For normal operations:

- Charges will be based upon utility meter reads, and customers are billed by the utility for bundled services, or for distribution only services if a customer accepts third party supply services from an ESCO. The ESCO then provides a separate bill in this case.
- CHG&E provides meter reading services and accounting, and for CNM customer satellite accounts, provides their report to the "microgrid entity". This service is defined in the CHG&E tariffs.

For emergency events,

- Direct Meter reads or inferred energy usage will be tabulated by CHG&E and provided to the "microgrid entity".
- Generation supply costs will be tabulated by the "microgrid entity",
- Allocation for costs applied to reducing the CNM discount will be applied by the "microgrid entity"

3.4.11 Business Commercialization / Replication Plans

There are business plans developed by Genesys Engineering that are replicable as applied to community microgrids. The plans also involve and integrate existing older assets that have PURPA contracts, or aging plant and infrastructure, throughout NYS, in which new supply resources including renewable supply and energy storage are added.

3.4.12 Market Entry Barriers

The success of this microgrid program depends upon CNM being applied as indicated, receipt of NYSERDA incentives, and Federal Investment Tax Credit for new PV plant. If load in New York State grows due to increased industrial and commercial activity, CNM will be sustainable, the load factor of the transmission system will improve, and capital deferment on behalf of utilities will result. Thus, there are limited market barriers unless CNM cannot be applied for the lifetime of the project.

3.4.13 Understanding of Market Barriers

Barriers include an acceptance of CNM as a viable mechanism for financing, in-part, the microgrid. The barriers are overcome by establishing a working relationship with the Utility as a Platform Service Provider that agrees to support implementation of CNM for the VWF microgrid on Circuit 8023.

3.4.14 Market Characterization

The VWF microgrid project serves a broader market in which older hydroelectric plants as well as other conventional electric generation assets can be renovated at much less cost than building new plant. These renovated assets then provide the anchor electric generation resources for the microgrid. Some new energy storage and renewable generation, as well as conventional gas-engine demand response distributed generation capacity, can also be included. The net cost is less than new generation with distribution and transmission additions.

Details of this characterization have been provided as part of this effort and are described in this report. In summary, the market addresses the following needs:

1. All utility accounts on the microgrid circuit receive the benefits of enhanced grid resiliency
2. Residential accounts, with preference to low income household, receive a discount
3. The utility can enjoy market based earnings as per NYREV
4. The older existing assets (hydro plant) can be rebuilt to serve load for 40 more years.
5. New Technologies are encouraged, that is, control systems, and battery storage
6. New Renewable supply by PV solar energy is added
7. Load growth is accomplished, in which jobs are created
8. Participation by microgrid generators in other markets, including ancillary services, ICAP / UCAP, and demand response adds revenue to the bottom line of the owners of generation
9. The Village is afforded opportunity to earn revenue through microgrid services as a participant in the “microgrid entity”

3.5 Financial – Operating Costs and Revenue Requirements, The Case For Financial Viability

This section develops the business case for financial viability, which is based on ***Community Net Metering (CNM).*** CNM integrates various revenue and cost streams into a value proposition that is consistent with NYREV. For purposes of this feasibility study, CNM is synonymous with Community Distributive Generation (CDG) as used in the CHG&E Tariff Book. The cash flow model with explanatory detail is presented later in this Section, as well as answers to the five (5) bullets as itemized in the NYSERDA scope SubTask 3.5. The discounted cashflow supports the economic and financial viability, and yields a projected IRR that meets commercial hurdle return rates.

The value proposition includes:

- enhanced reliability and resiliency for all customers (critical and non-critical loads) on the microgrid,
- reduced or same electricity cost for all microgrid customers,
- suitable returns for investors,
- market based earnings for the utility.
- integration of renewable generation from existing but upgraded supply, and new systems
- corollary benefit regarding the microgrid's catalyzing effect in stimulating commercial development of the Industrial Park area within the Village, resulting in energy load growth and jobs.

Because revenue decoupling is necessary to support CNM, it can be argued that a large population of ratepayers "subsidize" the benefits of a smaller population of "satellite customers" (that is, the residential utility accounts that enroll into the CNM program via the excess energy credits made available by the CNM Host). This subsidization could be a source of concern regarding the CNM program, because it renders the program a temporary and limited stimulus measure. However, our team envisions that, for the Village of Wappingers Falls microgrid program, this subsidy will be counterbalanced in proportion to local load growth that in part results from job creation. Load growth coupled with distributed generation from within the load pocket, a feature of our VWF microgrid, will likely also result in a greater load factor on the regional grid. This model is also replicable throughout New York State.

The NYSERDA Benefit Cost Analysis (BCA) supports the economic case from a societal perspective. The BCA inputs are presented in the Appendix, Section 4 provides descriptive detail, and the BCA report is reproduced in Section 4.

The model referred to in this section is presented from the cashflow perspective of a "microgrid entity". Inputs are consistent with the BCA model.

Each revenue and cost component is described in SubSections below. The discounted cashflow model is first presented, and quantifies the projected revenues and costs. The resulting Internal Rate of Return (IRR) Index is determined to be 7.5% and yields a business case that is economically viable. This model establishes viability of at least one scenario, but does not attempt to optimize financial metrics that could include Return on Equity enhancing mechanisms such as leveraged financing via the NY Green Bank.

CNM (aka CDG) is allowed by CHG&E as per their tariffs (Section 46, Rate Leaf 163.7). CNM was discussed at a meeting in October 2015 between CHG&E and the Project Team (the meeting's agenda is published in the Appendix). CHG&E presented guidance at this meeting as well as favorable support indicating an interest in reviewing a business model that combined developing the VWF's microgrid and deploying CNM.

CNM Customers (CDG Satellite Accounts) may be located outside the 8023 Circuit area, but within the CHG&E Load Zone. Accordingly, a "Microgrid Entity" (legal structure to be determined during Phase 2 in conjunction with the Strategic Allies) will market CNM commodity as per the CHG&E tariff. The CNM commodity originates from authorized renewable electric energy supply resources (the existing hydro plant, new and existing PV plant). The increased revenue made available due to the price arbitrage (difference between wholesale electric supply prices at approximately 6 cents per kWH and residential tariff rate per CHG&E SC1 at approximately 14.585 cents per kWH) is estimated to be 8.585 cents per kWH. This arbitrage in part supports the necessary capital and operating costs and profitability of the microgrid, and the individual assets that support the microgrid. The allocation of the arbitrage is detailed below for the key existing hydroelectric plant.

One unique element of the model includes "Market Based Earnings" (MBE) for CHG&E in exchange for their participation as a business partner. While legal structures are beyond the scope of this feasibility effort, the microgrid Team believes that the role of CHG&E as a Platform Service Provided, and active participant is essential and an opportunity for profitable utility enterprise. The distribution of energy to all customers receiving CNM energy, and microgrid services, remains in CHG&E's domain, as a public tariff based service. However, MBE can be utilized as an additional economic driver for CHG&E.

The legal structure of the "Microgrid Entity" is yet to be defined. Supply resource owners must include Wappingers Falls Hydroelectric or an entity that operates the hydroelectric generating plant, the Village of Wappingers Falls as owner of the dam, and could include an independent owner of the 2 MW gas engine, Eos Energy Storage (a separate project in-part funded by NYSERDA is awaiting contract completion), and Solar City. Other participants could be invited during the Phase 2 effort. It is possible that a Master Limited Partnership (MLP) could be crafted to structure the business. In such a structure, managing partners responsible for the day to day operations, as well as other stakeholders, could own up to 20% of the MLP. Investors would own 80%.

It is envisioned that there will be centralized control and dispatch of resources in the emergency mode, The emergency islanded operation occurs to meet resiliency objectives for all customers on the micrigrid. The microgrid entity does not earn additional revenue or offer for sale services associated with reliability improvement and / or islanded emergency operation. The ability of the microgrid and all customers on the CHG&E 8023 circuit to retain power supply in a grid emergency is the primary mission of this enterprise. Only verifiable costs during emergency operation mode will be recovered – no excess profit occurs due to emergency mode operations of the microgrid, The microgrid entity retains the Obligation to Serve in an emergency.

The control and dispatch of resources when there are normal grid operations will be based upon the economic needs of each supply resource owner. Each supply resources controls the dispatch and operations of their power generation system. For example, the hydro plant operates as an energy supply resource that continues to control lake level, and PV generates energy as a function of the solar radiation supply. Batteries must maintain a charge level as required to meet the ancillary service requirements in an emergency, and the owners of the battery systems will purchase power from the grid, or from other microgrid generation resources, as each deems necessary in accordance with the best value. The supply resources need to meet their individual obligations under the contractual terms and conditions of their legal contracts. For example, a resource that enrolls as a demand response (DR) generation system must adhere to the rules and obligations of the CHG&E DR program. Under any of the normal modes of operation in which the regional grid is functional and the microgrid is not operating in islanded mode, CHG&E maintains the Obligation to Serve load with distribution services,

The renewable energy will be sold to those customers (aka ratepayers) that enroll as Satellite Accounts per tariff rules and regulations. It is envisioned that the Village will support enrollment marketing efforts, and that the Village will earn revenue as a result. The actual administration of the CNM credits will be per Section 46 of the CHG&E tariff, in which CHG&E applies the credit to Satellite Accounts (mostly residential customers) bills, The microgrid entity must enter into a separate energy sale agreement with each Satellite Account, and bears the risk of collection. CHG&E could earn market based revenue. The rebate (or credit, or discount) will be paid by the microgrid entity.

A projection of allocated costs and revenues from CNM, capacity, and ancillary services sales for the key Hydroelectric Plant is presented as follows, and further explained below.

	Annual HYDROELECTRIC PLANT COST ALLOCATIONS			
1	Market Based Earnings Payment to Utility for Microgrid Services from CNM revenues	$ 225,657	7,735,921 kWH	$0.0292 /kWH
2	Rebate to Low Income Residential Customers per CNM program	$ 77,359	7,735,921 kWH	$0.0100 /kWH
3	Village Enrollment and Administration of CNM	$ 154,718	7,735,921 kWH	$0.0200 /kWH
4	O&M Hydro Plant	$ 200,000	7,735,921 kWH	$0.0259 /kWH
5 = 1+2+3+4	***NET COST FROM ALL SOURCES***	***$ 657,734***	***7,735,921 kWH***	***$0.0850 /kWH***
	Annual HYDROELECTRIC PLANT REVENUE ALLOCATIONS			
	CNM ENERGY SALES			
6	***Hydro Plant projected revenues from CNM energy sales, prelim estimate***	***$ 1,128,284***	***7,735,921 kWH***	***$0.1459 /kWH***
	Annual HYDROELECTRIC PLANT NET EARNINGS FROM CNM ENERGY SALES			
7=6-5	**Net hydro projected earnings (REVS - COSTS) from energy sales, prelim estimate**	**$ 470,550**	**7,735,921 kWH**	**$0.0608 /kWH**
	Annual CAPACITY AND ANCILLARY SERVICES SALES			
8	Projected Capacity sales, 1,135 kW incl reserve margin @ $83888 / MW per yr	$ 95,213	7,735,921 kWH	$0.0123 /kWH
9	Prelim estimate of ancillary services	$ 37,639	7,735,921 kWH	$0.0049 /kWH
	Annual NET HYDRO PLANT EARNINGS BASED ON CNM Energy, Capacity, and Ancillary Services Sales,			
10=7+8+9	*Net hydro projected earnings (REVS - COSTS) from ENERGY, CAPACITY, AND ANCILLARY sales, prelim estimate*	*$ 603,402*	*7,735,921 kWH*	*$0.0780 /kWH*
	CAPEX COST	**$ 7,096,011**		
	Upgrades Repairs	$ 1,815,000		
	Hydro Valuation	$ 5,281,011		
	PAYBACK PERIOD, YRS	11.76		
	IRR, 20 YRS	6.00%		

TABLE 11 - HYDRO PLANT COSTS, REVENUES

The net projected earnings by the Hydroelectric Plant is 7.8 cents per kWH, and represents a 30% premium to the current PURPA contract. The net earnings will yield a 6.00% 20 year return on investment if the Hydroelectric plant is valued at $5.28 mm and repair and upgrade cost valued at $1.82 million. Alternatively, 7.8 cents per kWH represents the price a "Microgrid Entity" would pay for the projected 7,735,921 kWH generated in a year.

To develop the preliminary estimate of valuation of the hydroelectric plant, the 10 year revenue stream of $603,402 per year is used to determine a 10 year net present value (NPV) of $5,281,011 at a 2% discount rate. This NPV is also used as a Valuation in the event a "Microgrid Entity" were to purchase the plant assets from an enterprise that might utilize T-bills as an index. ***NO REPRESENTATION IS MADE THAT THE CURRENT OWNERS OF THE HYDROELECTRIC PLANT ACCEPT OR DENY THIS CLAIM. THIS VALUATION IS DEVELOPED FOR PURPOSES OF THIS FEASIBILITY EVALUATION ONLY AND SUPPORT THE ECONOMIC POTENTIAL OF THE CNM MODEL DEFINED HEREIN!***

A similar analysis for a new 1 MW PV plant at Mt. Alvernia illustrates the economics from the perspective of a PV plant developer:

ONE SCENARIO NEW PV PLANT ECONOMICS	Yield, kWH	Unit Prices, $ / kWH		CAPEX AFTER ITC and NY PRIZE	1 Year	10 Year
Mt. Alvernia PV COST				$ (3,200,000)		
ITC				$ 960,000		
NY Prize				$ 1,000,000		
Solar City Equity, Revs from sale of CNM Energy	1,555,089 kWH	$0.1459 /kWH		$ (1,240,000)	$ 226,810	$ 226,810
CNM Admin Cost + O&M + 1 cent / kWH rebate for CNM customers	1,555,089 kWH	($0.0300 /kWH)			$ (46,653)	$ (46,653)
IRR, 10 yr	7.44%			$ (1,240,000)	$ 180,157	$ 180,157

TABLE 12 - NEW PV PLANT COST AND REVENUES

3.5.1 Categories and Relative Magnitudes of Revenue Streams – THE CASHFLOW MODEL

The categories of the elements that comprise the cashflow are as indicated in the spreadsheet. Refer to the second columns on the following pages entitled “Revenues x 1,000”. Magnitudes are as shown in these Tables on the following page. All values are variable except as stated in the spreadsheet. The following also presents detailed explanatory materials regarding the revenues.

3.5.2 Incentives

Important to the economic viability are the NY Prize incentives, Investment Tax Credits, Community Net Metering (including Revenue Decoupling). These must be available and timed with the project’s development as well as during the lifespan of the project – that is, CNM cannot disappear prior to the projected life of the project.

3.5.3 Categories and Relative Magnitudes of Cost Streams – THE CASHFLOW MODEL

The categories of the elements that comprise the cashflow are as indicated in the spreadsheet. Refer to the second columns on the following pages entitled “Costs x 1,000”. Magnitudes are as shown in these Tables on the following page. All values are variable except as stated in the spreadsheet. The following also presents detailed explanatory materials regarding the revenues.

Engineers Estimates of Likely Costs were developed and based upon supporting information and detail provided by the Strategic Allies.

CAPEX SUMMARY					
		Unit Cost	Gross Cost	Incentives 1 (ITC, or Other)	Incentives 2 (NY Prize)
AVAILABLE FUNDS					*$ 8,000,000*
Resources					
Mt. Alvernia PV	1,000 kW	$3,200 /kW	$ 3,200,000	$ (960,000)	$ (1,000,000)
WTP PV Upgrades to accommodate storage	200 kW	$300 /kW	$ 60,000		
Gas Engine	2,000 kW	$1,604 /kW	$ 3,208,825		$ (1,000,000)
Hydro Plant Upgrade and Repairs	250 kW	$7,260 /kW	$ 1,815,000		
Hydro Valuation	2,450 kW	$2,156 /kW	$ 5,281,011		
Existing Engines, Parallel Op; Additional Oil Tanks	755 kW	$500 /kW	$ 377,500		
Energy Storage at WTP	1,000 kWH at 250 kW	$1,900 /kWH	$ 1,900,000	$ (1,000,000)	$ (500,000)
Energy Storage at Mt. Alvernia or Other Locations, ridethrough provisions	1,000 kW at 500 kWH	$1,200 /kW	$ 1,200,000		
			$ -		
Engrg, Development, Soft Costs			$ 2,500,000		$ (2,500,000)
SUB-TOTALS, NON-UTILITY INVESTMENT			*$ 19,542,337*	*$ (1,960,000)*	*$ (5,000,000)*
UTILITY COSTS, ASSUMED, INPUT RQD			*$ 3,000,000*		*$ (3,000,000)*

TABLE 13 - CAPITAL COST ESTIMATE SUMMARY BY RESOURCE FOR MICROGRID PROGRAM

CAPEX INVESTED SUMMARY - Refer to Table 12	$ X 1,000	
Capital Investment by Non-Utility Sources	$	(19,542)
Investment Tax Credit on Eligible resources	$	1,960
Incentives and Subsidies per NY Prize	$	5,000
Capital Investment by Utility Sources	$	(3,000)
Incentives and Subsidies per NY Prize	$	3,000
Capital Investment by Village	$	-
NET INVESTMENT FROM PRIVATE RESOURCES	**$**	**(12,582)**

TABLE 14 - SOURCE OF FUNDS

3.5.4 Profitability

Revenues are assured if CHG&E Community Distributive Generation tariff is applicable for the project's lifespan. There cannot be a significant deterioration in the tariff pricing. Accordingly, contractual structure that locks in tariff rates effective as of a date certain for a period of 20 years should be considered. Other risks (construction, performance, etc.) of the project are common to all projects, and can be protected with proper and appropriate insurance packages.

The cashflow model presented in the following table provides a pre-tax projection of profitability in which a satisfactory return on investment for all new and upgraded assets that comprise the VWF microgrid is provided after incentives. A projected net pre-tax 1st year cashflow of \$1.07 mm (with subsequent cashflows as shown) yields a 7.5% IRR return on an after-incentive investment for all resources. There is a \$12.58 mm net investment required.

Line #	*REVENUES x 1,000*	*Units*	*Unit Prices*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*	*2026*
1	Renewable Energy, Community Net Metered	9,519,655 kWH	$ 0.14585	$ -	$ 1,388	$ 1,416	$ 1,445	$ 1,473	$ 1,503	$ 1,533	$ 1,564	$ 1,595	$ 1,627
2	Energy Supply from Purchases of Market Available Energy as per CHG&E tariff	8,188,643 kWH	$ 0.07999	$ -	$ 655	$ 668	$ 681	$ 695	$ 709	$ 723	$ 738	$ 752	$ 767
3	Energy Delivery Charge per CHG&E Residential Tariff	8,188,643 kWH	$ 0.06586	$ -	$ 539	$ 550	$ 561	$ 572	$ 584	$ 595	$ 607	$ 619	$ 632
4	Generation Capacity (NYISO ICAP / UCAP) from IEC Tables Incl. Reserve Margin	5,909 kW	See IEC Table of Gen Capacity	$ -	$ 453	$ 480	$ 496	$ 496	$ 496	$ 496	$ 496	$ 496	$ 496
5	Distribution Capacity (per IEC)	3,500 kW	$ 33.48	$ -	$ 117	$ 120	$ 122	$ 124	$ 127	$ 129	$ 132	$ 135	$ 137
6	Utility Demand Response Program	5,909 kW	TBD	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7	Ancillary Benefits	TBD	TBD	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8													
9	**NET REVENUE FROM ALL SOURCES**			$ -	**$ 3,153**	**$ 3,233**	**$ 3,305**	**$ 3,361**	**$ 3,418**	**$ 3,477**	**$ 3,536**	**$ 3,597**	**$ 3,659**

11	***COSTS x 1,000***												
12	Energy Supply from Purchases of Market Available Energy as per CHG&E tariff	7,988,643 kWH	$ 0.07999	$ -	$ 639	$ 652	$ 665	$ 678	$ 692	$ 706	$ 720	$ 734	$ 749
13	Energy Delivery Charge per CHG&E Residential Tariff	8,188,643 kWH	$ 0.06586	$ -	$ 539	$ 550	$ 561	$ 572	$ 584	$ 595	$ 607	$ 619	$ 632
14	Market Based Earnings Payment to Utility for Microgrid Services from CNM revenues	9,519,655 kWH	$ 0.02917	$ -	$ 278	$ 283	$ 289	$ 295	$ 301	$ 307	$ 313	$ 319	$ 325
15	Rebate to Low Income Residential Customers per CNM program	9,519,655 kWH	$ 0.01000	$ -	$ 95	$ 97	$ 99	$ 101	$ 103	$ 105	$ 107	$ 109	$ 112
16	Village Enrollment and Administration of CNM	9,519,655 kWH	$ 0.02000	$ -	$ 190	$ 194	$ 198	$ 202	$ 206	$ 210	$ 214	$ 219	$ 223
17	O&M Hydro Plant	Annual Fixed Cost	$ 200,000	$ -	$ 200	$ 204	$ 208	$ 212	$ 216	$ 221	$ 225	$ 230	$ 234
18	O&M Gas Engines @ 100 hrs / yr	200,000 kWH	$ 0.02000	$ -	$ 4	$ 4	$ 4	$ 4	$ 4	$ 4	$ 5	$ 5	$ 5
19	Fuel Gas Engines @ 100 hrs / yr	1,800 mmBTU	$ 9.00000	$ -	$ 16	$ 17	$ 17	$ 17	$ 18	$ 18	$ 18	$ 19	$ 19
20	O&M Diesel Engines	By Municipality		$ -	0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
21	O&M Storage	Annual Fixed Cost	$ 30,000	$ -	$ 30	$ 31	$ 31	$ 32	$ 32	$ 33	$ 34	$ 34	$ 35
22	Inefficiency Storage, 90% RTE, 365 cycles	36,500 kWH	$ 0.07999	$ -	$ 3	$ 3	$ 3	$ 3	$ 3	$ 3	$ 3	$ 3	$ 3
23	O&M PV	1,555,089 kWH	$ 0.01000	$ -	$ 16	$ 16	$ 16	$ 17	$ 17	$ 17	$ 18	$ 18	$ 18
24	O&M Power Lines	Included in Market based Earnings		$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
25	Lease of Power Lines - Not Applicable	17,708,298 kWH	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
26	Lease of Land for PV at Mt. Alvernia	Annual Fixed Cost	$ 73,000	$ -	$ 73	$ 74	$ 76	$ 77	$ 79	$ 81	$ 82	$ 84	$ 86
27	**NET CAPITAL OUTLAY**			$ 12,582									
28	**NET COST FROM ALL SOURCES**			**$ 12,582**	**$ 2,083**	**$ 2,125**	**$ 2,167**	**$ 2,211**	**$ 2,255**	**$ 2,300**	**$ 2,346**	**$ 2,393**	**$ 2,441**
29													
30													
31	***20 YR IRR, REVENUE LESS COST***		*7.52%*	*$ (12,582)*	*$ 1,069*	*$ 1,109*	*$ 1,137*	*$ 1,150*	*$ 1,163*	*$ 1,177*	*$ 1,190*	*$ 1,204*	*$ 1,218*

TABLE 15 - MICROGRID CASH FLOW

3.5.5 Financing Structure

The net investment required after all incentives are applied could utilize a mix of NY Green Bank financing, other sources of debt, and equity raised. The cashflow presented with return of 7.5% illustrates an acceptable IRR of 7.5%.

3.5.6 Further Explanations Regarding the Cash Flow Model

3.5.6.1 The Tariff for Residential Customers

The primary revenue driver will be community net metering from existing and new renewable energy assets. It is anticipated that a large increase in revenue margin results from the difference between wholesale energy prices (estimated to be $0.0600 per kWH), and residential tariff rates (estimated to be $0.1459 per kWH) including supply and distribution charges (estimated at $0.07999 + $0.06586)

Electric Supply Charge Stated in Dollars per kWh				
Effective Date	Commercial Monthly		Residential Bi-Monthly	
Average Past 12 Months	$	0.0795	$	0.0800
11-Sep-15	$	0.0791	$	0.0759
12-Aug-15	$	0.0726	$	0.0666
14-Jul-15	$	0.0605	$	0.0558
12-Jun-15	$	0.0515	$	0.0408
13-May-15	$	0.0301	$	0.0576
14-Apr-15	$	0.0850	$	0.1069
13-Mar-15	$	0.1288	$	0.1169
12-Feb-15	$	0.1050	$	0.0977
14-Jan-15	$	0.0905	$	0.0824
11-Dec-14	$	0.0743	$	0.0798
10-Nov-14	$	0.0854	$	0.0882

TABLE 16 - CHG&E TARIFFS

Central Hudson Gas & Electric Corporation
Cases 14-E-0318 & 14-G-0319
Summary of Proposed Monthly Electric Base Delivery Rates
(Excludes S.C. Nos. 5 & 8, Unbilled & Interdepartmental)

			Current Rates		Rate Year 1 July 1, 2015		Rate Year 2 July 1, 2016		Rate Year 3 July 1, 2017
S.C. No. 1									
	Customer Charge	$	24.00	$	24.00	$	24.00	$	24.00
	kWh Delivery	$	0.04963	$	0.05484	$	0.06070	$	0.06586

This revenue margin will provide, in-part, return on investment for upgrades and new systems and equipment, coverage of existing contractual sales (that is the continuation in principal of PURPA contracts) plus a reasonable increase, a discount to low income residential customers that elect Community Net Metering tariff provisions, fee to the Municipality for services provided by the Village regarding CNM enrollment, market based earnings to CHG&E for participation and support, and other costs.

3.5.6.2 Line by Line Explanation of the Financial model

Lines 1,2,3,12, and 13 utilize tariff electric prices.

> Line 1 is the revenue associated with CNM and the "microgrid entity" would receive this revenue stream. This revenue would be received from each satellite customer account (less the "rebate" shown in Line 15, with low income customers being offered the CNM supply first).
>
> Lines 2,3, reflect revenues that CHG&E would receive directly for bundled service of electric supply and distribution. These are accounted for as customers of the "microgrid entity" will still continue to receive supply and distribution service per SC No. 1 of the CHG&E tariff.
>
> The costs indicated in Lines 12 and 13 for conventional electric supply and distribution are viewed from the perspective of the "microgrid entity"- that is the "microgrid entity" makes nothing nor does it cost anything for conventional supply and distribution of electric energy – it is a pass-through, except for when the gas engine is called to run in an emergency or demand response mode. Therefore, these costs approximately equal the revenues in Lines 2 and 3.
>
> Lines 18 and 19 reflect gas engine costs, and gas engine generation is assumed to normally occur 100 hrs per year, although could be called for 500 hours per year. Line 12 is debited by Line 18 generation. The "microgrid entity" absorbs the risk of costs being greater than tariff electric cost.

Lines 4 and 5 utilize the capacity values in the BCA analysis. These are revenues that support the microgrid generation assets.

Lines 6 and 7 are not used for this scenario.

Line 14 reflects the Market Based Earnings (MBE) earned by CHG&E for their support and involvement with CNM and microgrid distribution services. MBE is consistent with NYREV.

Line 16 reflects the Villages revenue by enrolling CNM customers.

Lines 17- 25 reflect operating and maintenance costs of the various generating resources and other elements of the microgrid.

Line 26 reflects the lease cost of property for the Mt. Alvernia PV project.

3.5.6.3 Capacity

The generation capacity and distribution capacity prices were provided in the NYSERDA BCA model.

3.5.6.4 Ancillary Benefits

Ancillary Benefits prices will be developed in conjunction with CHG&E, and then factored into the economics. These include 10 minute spinning reserve, 30 minute spinning reserve, black start capability, voltage support, frequency regulation, black start capability. These ancillary benefits could possibly be sold as part of the NYISO special case resources program for distributed generation. However, this feasibility evaluation treats these ancillary benefits as necessary elements of the microgrid's function in emergency islanded mode.

3.5.6.5 Potential Financial Structures based on Community Net Metering and Microgrids

The potential business model presented is based on Community Net Metering. Possibly, all the owners of generation assets could form a special purpose "microgrid entity" that would develop an energy sale agreement with Community Net Metered customers. This CNM company would manage all billing, receivables, and payables, as well as guarantee the price of energy. Alternatively, an existing ESCO could handle these functions. The role of CHG&E as a platform service provider, strategic ally, and recipient of market based earnings remains to be developed.

It needs to be noted that the scenario presented in the preceding pages demonstrates one of several business models that demonstrate economic feasibility of the microgrid concept detailed herein. Further discussions and consensus of the stakeholders is necessary.

3.6 Legal Viability

Legal issues require resolution by specialized firms; legal issues are beyond the scope and budget of the current Phase 1 effort.

The following represents a summary list, by no means complete, of issues that would need to be considered:

- Obligations to serve load
- Contractual structure of Community Net Metering (CNM)
- Issues regarding public utility law and allowing a regulated enterprise to participate in joint ownership with private investors
- Issues properly belonging in Rate Cases – that is, targeted demand response
- Compensation related issues, such as the Village's efforts to market CNM product.
- Non-Disclosure, Confidentiality related matters within a public process

4.0 DEVELOP INFORMATION FOR COST BENEFIT ANALYSIS

4.1 Facility and Customer Description

4.1.1 Rate Class

The Microgrid includes 8 critical facilities. These facilities are listed in the table below and their rate classes can be seen second column. Aside from two religious structures which serve as extreme weather shelters, the majority of these facilities are in the "large commercial" rate class. In addition to these critical facilities, there are over 6,000 residents served by the critical facilities in this service area. This equates to an estimated 2,000 residential units.

4.1.2. Economic Sector

Listed in the table below, the economic sector for many of the critical loads is listed as "All Other Industries." The vast majority of the remaining structures are residential.

4.1.3. Multiple Ratepayers at Facilities

The Village of Wappingers Falls has many residential structures with multiple rate payers. The Village has the smallest dwelling units (on average) in Dutchess County due to its large number of single family homes retrofitted into apartment housing. Additionally, many of the residential structures in the Village were built as workforce housing in the early 20th Century for employees at the now derelict Dutchess Bleachery which sits across the street from what is now Market Street Industrial Park. In regards to the critical facilities, each structure has a single rate paying entity.

4.1.4. Average Annual Electricity Demand (MWh) and Peak Electricity Demand (MW)

The average annual demand and peak demand of the critical facilities are each listed in the table below. Their combined annual electric demand is 2,730 MWh while their combined peak electrical demand is listed at 1.438 megawatts (*Please note that these combined statistics only include critical load customers listed above, and DOES NOT INCLUDE RESIDENTIAL CUSTOMERS)*.

4.1.5. Percentage of the Facilities' Average Demand the Microgrid would be designed to Support in a Major Power Outage.

As depicted in the table below, the microgrid would be designed to supply 100% of each facility's average usage during the duration of a major outage.

4.1.6. Hours per Day – During Multiday Outage – Facilities would Require Electricity from Microgrid

Each critical facility would require 24 hours per day, on average, of microgrid support in the event of a multiday outage.

TABLE 17

Facility Name	Rate Class	Facility/Customer Description (Specify Number of Customers if More Than One)	Economic Sector Code	Average Annual Electricity Usage Per Customer (MWh)	Peak Electricity Demand Per Customer (MW)	Percent of Average Usage Microgrid Could Support During Major Power Outage	Hours of Electricity Supply Required Per Day During Major Power Outage
TriMuni Wastewater Tmn. Facility	*Large Commercial/Industrial (>50 annual MWh)*	*Wastewater Treatment Plant*	*All other industries*	*1,583*	*0.246*	*100%*	*24*
Mt. Alvernia Retreat Center	*Residential*	*Critical Shelter*	*Residential*	*369*	*0.088*	*100%*	*24*
Monastery of St. Clare	*Residential*	*Critical Shelter*	*Residential*	*102*	*0.024*	*100%*	*24*
Village Water Supply Facility	*Large Commercial/Industrial (>50 annual MWh)*	*Water treatment Plant*	*All other industries*	*240*	*0.077*	*100%*	*24*
SW Johnson Firehouse	*Small Commercial/Industrial (<50 annual MWh)*	*Fire Station*	*All other industries*	*31*	*0.019*	*100%*	*24*
New Hamburg Fire Dep't.	*Large Commercial/Industrial (>50 annual MWh)*	*Fire Department*	*All other industries*	*87*	*0.031*	*100%*	*24*
Sheafe Rd. Elementary School	*Large Commercial/Industrial (>50 annual MWh)*	*School*	*All other industries*	*241*	*0.106*	*100%*	*24*
St. Mary's School	*Large Commercial/Industrial (>50 annual MWh)*	*School*	*All other industries*	*77*	*0.047*	*100%*	*24*

4.2 Characterization of Distributed Energy Resources

Please Reference Table 18 below

The Microgrid contains 10 distributed energy resources listed below. Corresponding to each resource is a listing of energy source , nameplate capacity(MW), average annual production (MWh) under normal operating conditions, average daily production (MWh/day) in the event of major power outage, and fuel consumption per MMBtu/MWh for each non-renewable resource.

TABLE 18

Distributed Energy Resource Name	Facility Name	Energy Source	Nameplate Capacity (MW)	Average Annual Production Under Normal Conditions (MWh)	Average Daily Production During Major Power Outage (MWh) – See Note 1	Fuel Consumption per MWh	
						Quantity	Unit
Backup Generator Unit A	*TriMuni Wastewater Waste Water Treatment Facility*	*Diesel*	*0.3*	*0*	*7.20*	*10.0*	*MMBtu/MWh*
PV Plant Unit B	*Mt. Alvernia Retreat Center*	*Solar*	*1.0*	*1,643*	*4.50*	*0*	*Other - Renewable*
Backup Generator Unit C	*Monastery of St. Clare*	*Diesel*	*0.08*	*0*	*1.92*	*10.0*	*MMBtu/MWh*
Backup Generator Unit D	*Village Water Supply Facility*	*Diesel*	*0.35*	*0*	*8.40*	*10.0*	*MMBtu/MWh*
PV Plant Unit D	*Village Water Supply Facility*	*Solar*	*0.20*	*229*	*0.63*	*0*	*Other - Renewable*
Hydro Plant Unit F	*Wappingers Falls Generating Station*	*Hydro*	*2.7*	*7,736*	*21.19*	*0*	*Other - Renewable*
Gas Engine Unit F	*Wappingers Falls Industrial Park*	*Natural Gas*	*2.0*	*1,000*	*48.0*	*8.8*	*MMBtu/MWh*
Backup Generator Unit E	*SW Johnson Firehouse*	*Diesel*	*0.03*	*0*	*0.6*	*11.0*	*MMBtu/MWh*
Battery Storage Unit D	*Village Water Supply Facility*	*Other - please specify: Battery Storage*	*0.25*	*0*	*1.0*	*0*	*Other - Storage*
Battery Storage Unit B	*Mt. Alvernia Retreat Center*	*Other - please specify: Battery Storage*	*1.00*	*0*	*0.50*	*0*	*Other - Storage*

NOTE 1 – ALL DIESELS RUN AT THEIR RATED CAPACITY IN MICROGRID EMERGENCY MODE and EXPORT SURPLUS POWER INTO THE MICROGRID; GAS ENGINE ASSUMED TO OPERATE 500 HRS PER YEAR FOR NORMAL OPERATING MODE OF DEMAND RESPONSE, AND ALSO OPERATES IN AN EMERGENCY. UNIT D BATTERY CAN OPERATE AT FULL POWER FOR 4 HOURS; UNIT B BATTERY CAN OPERATE AT FULL POWER FOR ½ HOUR.

4.3 Capacity Impacts and Ancillary Services

4.3.1. Expected Provision of Peak Load Support on Generating Capacity

Per Table 19, the provision of peak load support includes a combined available capacity of 4.17 MW/Year. The distributed energy resources which compile this capacity include:

Table 19

Distributed Energy Resource Name	Facility Name	Available Capacity (MW/year):	Does distributed energy resource currently provide peak load support?
Backup Generator Unit A	*TriMuni Wastewater Tmn. Facility*	*0.30*	☒ Yes
PV Plant Unit B	*Mt. Alvernia Retreat Center*	*0.37*	☐ Yes
Backup Generator Unit C	*Monastery of St. Clare*	*0.08*	☐ Yes
Backup Generator Unit D	*Village Water Supply Facility*	*0.35*	☐ Yes
PV Plant Unit D	*Village Water Supply Facility*	*0.07*	☐ Yes
Hydro Plant Unit F	*Wappingers Falls Generating Station*	*0.97*	☐ Yes
Gas Engine Unit F	*Wappingers Falls Industrial Park*	*2.00*	☐ Yes
Backup Generator Unit E	*SW Johnson Firehouse*	*0.03*	☐ Yes
Battery Storage Unit D	*Village Water Supply Facility*	*0.00*	☐ Yes
Battery Storage Unit B	*Mt. Alvernia Retreat Center*	*0.00*	☐ Yes

(*Note: Per guidance from Clair Santoro/Indecon in email to Stephen Eber/Genesys Engineering dated December 9.2015 11:45am: Solar PV, Summer peak coincidence 37%; Hydro, summer peak coincidence: 36%)*

4.3.2 Capacity (MW/year) of Demand Response per Facility

Table 20 below shows the Capacity Participating in Demand Response Program.

TABLE 20

Facility Name	Capacity Participating in Demand Response Program (MW/year)	
	Following Development of Microgrid	Currently
TriMuni Wastewater Tmn. Facility	0.30	0.30
Mt. Alvernia Retreat Center	*1.00*	0.00
Monastery of St. Clare	*0.08*	0.00
Village Water Supply Facility	*0.35*	0.00
Village Water Supply Facility	*0.20*	0.00

Wappingers Falls Generating Station	*2.70*	0.00
Wappingers Falls Industrial Park	*2.00*	0.00
SW Johnson Firehouse	*0.03*	0.00
Village Water Supply Facility - Storage	*0.25*	0.00
Mt. Alvernia Retreat Center - Storage	*1.00*	0.00

4.3.3. Impact of Microgrid on Utility Transmission Capacity Requirements

Impact of Microgrid on Utility Transmission Capacity	Unit
4.17	MW/year
Note: (Sum of Capacity values for All Generating Sources per Question 4)	

4.3.4. Impact on Distribution Capacity Requirements

Impact of Microgrid on Utility Distribution Capacity	Unit
3.5	MW/year
Note: Gas Engine + Diesel Engines + 800 kW of intermittent resources can serve the peak capacity of all loads on the microgrid circuit. With storage, all ridethrough and ancillary services are provided to serve the distribution system needs.	

4.3.5. Ancillary Services to the Local Utility

Ancillary Service	Yes	No
Frequency or Real Power Support	☒	☐
Voltage or Reactive Power Support	☒	☐
Black Start or System Restoration Support	☒	☐

4.3.6. Estimated Projected Annual Energy Savings from Development of New CHP

N/A – No new CHP.

4.3.7. Environmental Regulations Mandating the Purchase of Emissions Allowance for the Microgrid

This Microgrid will receive 9,518 MWh from renewable resources that emit 0 pollutants. Additionally, 8,189 MWh are supplied by: (1) Conventional procurement of energy from the grid, (2) Dispatch of a natural gas fueled demand response generator limited to 500 hours (equal to 1,000 MWh), (3) and in an emergency, operation of gas engine and renewable generators with diesels placed into operation as a last resource. A net decrease in regional emissions should result.

Table 21

Emissions Type	Emissions per MWh	Unit
CO_2	0 renewable;0.5987 gas engine	Short tons/MWh
SO_2	0 renewable; 0.0000 gas engine	Short tons/MWh
NO_x	0 renewable; 0.0014 gas engine	Short tons/MWh
PM	0 renewable; 0.0000 gas engine	Short tons/MWh

4.4 Project Cost

4.4.1. Installed Costs and Engineering Life Span of all Capital Equipment

The grand total of all capital costs is $14,761,325. This calculation includes:

Table 22

Capital Component	Installed Cost ($)	Life Span (Round to nearest year)
Mt. Alvernia PV	$3,200,000	30
Water Treatment Plant Upgrades	$60,000	50
Gas Engine	$3,208,825	40
Hydro Plant Upgrade and Repairs	$1,815,000	40
Diesel Plants – Upgrade	$377,500	40
Energy Storage – WTP	$1,900,000	25
Energy Storage – Mt. Alvernia	$1,200,000	25
Assumed Utility System Upgrade and Reinforcement	$3,000,000	N/A

4.4.2. Initial Planning and Design Costs

Planning and design costs are estimated at $2,500,000. This amount includes: building and development permits, efforts to secure financing, marketing the project, negotiating contracts, and developer expenses. This amount does *not* include financing.

4.4.3. Fixed Operations and Maintenance Costs

The project will be operating with several fixed operations and maintenance costs. These costs include an estimated $73,000 annually for lease payments and fixed Village expenses. Additionally, the routine maintenance required to the hydro-electric facility would cost an estimated $200,000 per year. Several expected O&M expenses will remain variable throughout the life span of the microgrid. These costs include $72,500 per year for replacement of battery cells and inverters at the PV Plant.

4.4.4. Variable O&M Costs (Excluding Fuel)

The following Table shows estimated costs associated with operations and maintenance that are likely to vary with the amount of energy the system produces each year.

Table 23

Variable O&M Costs ($/Unit of Energy Produced)	Unit	What cost components are included in this figure?
20	$/MWh	Gas Engine oil changes, plugs, accruals for minor and major overhauls: Assumed hours of operation per year = 500!
20	$/MWh	Diesel Engine oil changes, accruals for minor and major overhauls: Assumed hours of operation per year = 100!
10	$/MWh	PV Plant maintenance
$ 42,500 per year	Other - please specify: 2.5% CAPEX per year	Replacement of battery cells; inverter and Balance of Plant
$ 30,000 per year	Other - please specify: 2.5% CAPEX per year	Replacement of battery cells; inverter and balance of Plant

4.4.5. Ability to Operate in Islanded Mode without Replenishing Fuel Supply

Please see Table 24, below, for information regarding operation in islanded mode.

Table 24

Distributed Energy Resource Name	Facility Name	Duration of Design Event (Days)	Quantity of Fuel Needed to Operate in Islanded Mode for Duration of Design Event	Unit
Backup Generator Unit A	*TriMuni Wastewater Tmn. Facility*	7	3,500	Gallons
PV Plant Unit B	*Mt. Alvernia Retreat Center*	Indefinitely		Other - please specify: Renewable
Backup Generator Unit C	*Monastery of St. Clare*	7	933	Gallons
Backup Generator Unit D	*Village Water Supply Facility*	7	4,083	Gallons
PV Plant Unit D	*Village Water Supply Facility*	Indefinitely		Other - please specify: Renewable
Hydro Plant Unit F	*Wappingers Falls Generating Station*	Indefinitely		Gallons
Gas Engine Unit F	*Wappingers Falls Industrial Park*	7	2,956,800	Cubic Feet
Backup Generator Unit E	*SW Johnson Firehouse*	7	292	Gallons
Battery Storage Unit D	*Village Water Supply Facility*	1/6 day		
Battery Storage Unit B	*Mt. Alvernia Retreat Center*	1/12 day		

4.5 Costs to Maintain Service during a Power Outage

4.5.1. Fuel/Energy Source of Each Existing Backup Generator

Backup Generator Location	Fuel Source
Tri Municipal Wastewater Treatment Facility	**Diesel**
Monastery of St. Clare	**Diesel**
Village of Wappingers Falls Water Supply	**Diesel**
SW Johnson Firehouse	**Diesel**

4.5.2. Nameplate Capacity of Each Existing Backup Generator

Backup Generator Location	Nameplate Capacity
Tri Municipal Wastewater Treatment Facility	**.30**
Monastery of St. Clare	**.08**
Village of Wappingers Falls Water Supply	**.35**
SW Johnson Firehouse	**.03**

4.5.3. The Percentage of Nameplate Capacity at which Each Backup Generator is Likely to Operate during Extended Power Outage

Backup Generator Location	Percentage of Nameplate Capacity Each Backup is Likely to Operate
Tri Municipal Wastewater Treatment Facility	100%
Monastery of St. Clare	100%
Village of Wappingers Falls Water Supply	100%
SW Johnson Firehouse	100%

4.5.4. Average Daily Electricity Production For Each Generator In the Vent of A Major Power Outage

Backup Generator Location	Average Daily Electricity Production (MWh/day)
Tri Municipal Wastewater Treatment Facility	4.336
Monastery of St. Clare	.0279
Village of Wappingers Falls Water Supply	.0657
SW Johnson Firehouse	.083

4.5.5. Any One-Time Costs

Table 25

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
Mt. Alvernia	One-Time Measures	Renting and Hooking up additional 100 kW portable generator	3,000	$	2 week rental
New Hamburg Fire Department	One-Time Measures	Renting and Hooking up additional 50 kW portable generator	2,000	$	2-Week rental
Scheafe Rd. Elemantary	One-Time Measures	Renting and Hooking up additional 100 kW portable generator	3,000	$	2-Week rental
St. Mary's School	One-Time Measures	Renting and Hooking up additional 50 kW portable generator	2,000	$	2-Week rental

4.6 Services Supported by the Microgrid

4.6.1. Population of Service Area

Below is a list of facilities with a population figure corresponding to their service area.

Facility Name	**Service Area Population**
Tri-Municipal Wastewater Treatment Facility	14,300
Village Water Supply	5,600
New Hamburg Fire Department	2,500
S.W. Johnson Firehouse	5,600

4.6.2. Percentage of Service Loss During Power Outage

All facilities listed below are currently using existing backup generators. It is important to note that these four facilities are capable of providing for their entire peak demand at all times. Therefore, it is calculated that they would each experience 0% loss in service when using backup generation. These facilities include:

Tri-Municipal Wastewater Treatment Facility
Monastery of St. Clare
Village of Wappingers Falls Water Supply
SW Johnson Firehouse

4.6.3. Residential

The total residential population affected would be 14,300 residents of the Town of Poughkeepsie, Village of Wappingers Falls, and Town of Wappinger.

Benefit-Cost Analysis Summary Report

Site 38 – Village of Wappingers Falls

PROJECT OVERVIEW

As part of NYSERDA's NY Prize community microgrid competition, the Village of Wappingers Falls has proposed development of a microgrid that would enhance the resiliency of electric service for a variety of critical facilities located within the village or in neighboring areas of the towns of Wappinger and Poughkeepsie. These include:

- The S.W. Johnson Fire House and the New Hamburg Fire Department;
- The Tri-Municipal Sewer Commission Wastewater Treatment Plant;
- The Village of Wappingers Falls Water Treatment Facility;
- The Mt. Alvernia Retreat Center and the Monastery of St. Claire, both of which can serve as emergency shelters; and
- Two local schools, St. Mary's and Sheafe Road Elementary.

The microgrid would also provide service to an estimated 1,500 residential customers in the area, and to an unspecified number of non-critical commercial and industrial customers. The project team estimates that the customers on the microgrid circuit consume approximately 17,708 MWh of electricity annually; the eight critical loads account for approximately 15 percent of this total.

The Wappingers Falls microgrid would be powered by a mix of distributed energy resources (DERs), including a currently operating 2.45 MW hydroelectric facility that would be upgraded and expanded to a total capacity of 2.7 MW; a new 1.0 MW photovoltaic array at Mt. Alvernia Retreat Center; an existing 0.2 MW solar array at the water treatment plant; and a new 2.0 MW natural gas generator, which would operate in demand response mode for an estimated 500 hours per year. The operating scenario submitted by the project's consultants anticipates that these sources would generate 10,608 MWh of electricity annually. In the event of an outage, the production of these sources would be supplemented by the output of diesel generators at several of the critical facilities; these four units, which are already in place, have a combined capacity of 0.93 MW. New battery systems with a total capacity of 1.25 MW would provide additional resilience. The project's consultants indicate that in islanded mode, the system in most cases would have sufficient capacity to maintain service to all customers. In some instances, however (e.g., peak demand from all loads coupled with a lack of availability of power from the renewable DERs), shedding of non-critical loads could prove necessary.

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.

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.[1] 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:

[1] 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.]

- 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.[2]

In analyzing the costs and benefits of the Wappingers Falls project, a key consideration is the treatment of the DERs that are currently producing power. There is no indication that continued production of power by the 0.2 MW PV array at the water treatment plant is contingent upon development of the microgrid. Accordingly, the assessment of the microgrid's impact nets out the energy this unit produces and the capacity it provides. In contrast, the project team has indicated that the hydroelectric facility may not be relicensed if the microgrid is not developed and investments in upgrading the hydroelectric facility are not made. In light of this possibility, the analysis treats the continued operation of the hydroelectric facility and the generating capacity it provides as benefits of the microgrid's development. As noted in the discussion that follows, this has substantial implications for the results of the analysis.

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 if there were no major power outages over the 20-year period analyzed (Scenario 1), the project's costs would exceed its benefits. In order for the project's benefits to outweigh its costs, the average duration of major outages would need to equal or exceed 0.1 days per year (Scenario 2). The discussion that follows provides additional detail on these findings.

TABLE 1. BCA RESULTS (ASSUMING 7 PERCENT DISCOUNT RATE)

ECONOMIC MEASURE	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES	
	SCENARIO 1: 0 DAYS/YEAR	SCENARIO 2: 0.1 DAYS/YEAR
Net Benefits - Present Value	-$1,670,000	$519,000
Benefit-Cost Ratio	0.9	1.0
Internal Rate of Return	4.7%	6.4%

Scenario 1

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

[2] 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.

FIGURE 1. PRESENT VALUE RESULTS, SCENARIO 1 (NO MAJOR POWER OUTAGES; 7 PERCENT DISCOUNT RATE)

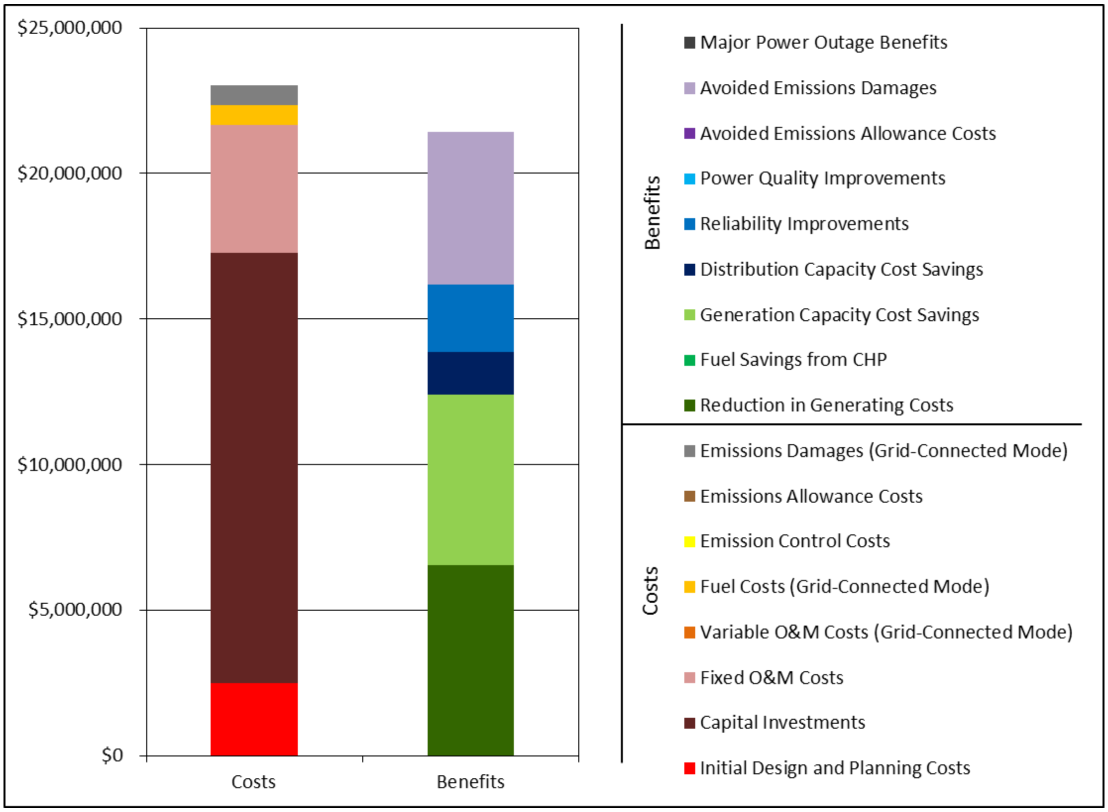


TABLE 2. DETAILED BCA RESULTS, SCENARIO 1 (NO MAJOR POWER OUTAGES; 7 PERCENT DISCOUNT RATE)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$2,500,000	$221,000
Capital Investments	$14,800,000	$1,080,000
Fixed O&M	$4,410,000	$389,000
Variable O&M (Grid-Connected Mode)	$0	$0
Fuel (Grid-Connected Mode)	$682,000	$60,100
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$671,000	$43,800
Total Costs	**$23,000,000**	
Benefits		
Reduction in Generating Costs	$6,550,000	$578,000
Fuel Savings from CHP	$0	$0
Generation Capacity Cost Savings	$5,770,000	$509,000
Distribution Capacity Cost Savings	$1,450,000	$128,000
Reliability Improvements	$2,340,000	$207,000
Power Quality Improvements	$0	$0
Avoided Emissions Allowance Costs	$3,520	$311
Avoided Emissions Damages	$5,230,000	$341,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$21,300,000**	
Net Benefits	**-$1,670,000**	
Benefit/Cost Ratio	**0.9**	
Internal Rate of Return	**4.7%**	

Fixed Costs

The BCA relies on information provided by the project team to estimate the fixed costs of developing the microgrid. The project team's best estimate of initial design and planning costs is approximately $2.5 million. The present value of the project's capital costs is estimated at approximately $14.8 million, including costs associated with acquiring and installing the new PV array, the natural gas generator, and the energy storage systems; an investment in upgrading the diesel plants; and an anticipated investment in upgrading/reinforcing the utility system. The project's capital costs also include approximately $1.8 million to upgrade and repair the hydroelectric facility.

The present value of the microgrid' s fixed operation and maintenance (O&M) costs (i.e., O&M costs that do not vary with the amount of energy produced) is estimated at $4.4 million, based on an annual cost of $389,000. This figure includes costs that the project team initially identified as variable O&M costs, which have been converted to fixed O&M costs based on the operating scenario the team specified.

Variable Costs

The most significant variable cost associated with the proposed project is the cost of fuel for the system's natural gas generator. 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.[3] The present value of the project's fuel costs over a 20-year operating period is estimated to be approximately $682,000.

The analysis of variable costs also considers the environmental damages associated with pollutant emissions from the distributed energy resources that serve the microgrid, based on the operating scenario and emissions rates provided by the project team and the understanding that the natural gas generator would not be subject to emissions allowance requirements. In this case, the damages attributable to emissions from the new natural gas generator are estimated at approximately $43,800 annually. The majority of these damages are attributable to the emission of CO_2. Over a 20-year operating period, the present value of emissions damages is estimated at approximately $671,000.

Avoided Costs

The development and operation of a microgrid may avoid or reduce a number of costs that otherwise would be incurred. These include generating cost savings resulting from a reduction in demand for electricity from bulk energy suppliers. The BCA estimates the present value of these savings over a 20-year operating period to be approximately $6.60 million. The reduction in demand for electricity from bulk energy suppliers would also reduce the emissions of air pollutants from such facilities, yielding emissions allowance cost savings with a present value of approximately $3,500 and avoided emissions damages with a present value of approximately $5.2 million.[4]

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.[5] Based on the capacity of the DERs, the capacity of the energy storage system, and the availability factors the project team applied to the renewable DERs to characterize annual production, the analysis estimates the incremental impact of the project on generating capacity requirements to be approximately 5.05 MW. Over a 20-year operating period, the present value of these benefits is estimated at approximately $5.8 million. Similarly, the project team estimates that the investment in utility upgrades will reduce the need for future improvements in local distribution capacity. Over a 20-year period, the present value of this benefit is estimated to be approximately $1.5 million.

The project team has also indicated that the proposed microgrid would be designed to provide ancillary services (real power support, 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

[3] The model adjusts the State Energy Plan's natural gas and diesel price projections using fuel-specific multipliers that are 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.

[4] 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.

[5] Impacts to 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.

markets for ancillary services are highly competitive, and that projects of this type would have a relatively 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 this service.

Reliability Benefits

An additional benefit of the proposed microgrid would be to reduce facilities' 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 $207,000 per year, with a present value of $2.3 million over a 20-year operating period. This estimate was developed 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:[6]

- System Average Interruption Frequency Index (SAIFI) – 1.24 events per year.
- Customer Average Interruption Duration Index (CAIDI) – 136.2 minutes.[7]

The estimate takes into account the number of residential and small or large commercial or industrial customers the project would serve; the distribution of commercial or industrial 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.[8] 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 0.9; i.e., the estimate of project benefits is approximately 90 percent that of project costs.[9] Accordingly, the analysis moves to Scenario 2, taking into account the potential benefits of a microgrid in mitigating the impact of major power outages.

Scenario 2

Benefits in the Event of a Major Power Outage

As previously noted, the estimate of reliability benefits presented in Scenario 1 does not include the benefits of maintaining service during outages caused by major storm events or other factors generally considered beyond the control of the local utility. These types of outages can affect a broad area and may require an extended period of time to rectify. To estimate the benefits of a microgrid in the event of such outages, the BCA methodology is designed to assess the impact of a total loss of power – including plausible assumptions about the failure of backup generation – on the facilities the microgrid would serve. It calculates the economic damages that development of a microgrid would avoid based on (1) the

[6] www.icecalculator.com.

[7] The analysis is based on DPS's reported 2014 SAIFI and CAIDI values for Central Hudson Gas & Electric.

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

[9] We examined the sensitivity of these findings to our treatment of the costs and benefits associated with upgrading and expanding the hydroelectric facility. We found that excluding these costs and benefits would reduce the net benefits of the microgrid project by approximately $8.1 million. As a result, the project's benefit/cost ratio would fall to approximately 0.5.

incremental cost of potential emergency measures that would be required in the event of a prolonged outage, and (2) the value of the services that would be lost.[10,11]

The Village of Wappingers Falls' proposed microgrid project would serve eight critical facilities, four of which – the S.W. Johnson Fire House, the water and wastewater treatment plants, and the Monastery of St. Claire – are currently equipped with backup generators. In the event of an extended outage, the project team indicates that the other four critical facilities would rent backup generators. Table 3 summarizes the estimated daily cost of providing backup generation at each facility. Table 3 also indicates the loss in service capabilities that would occur while relying on these units, as well as the loss in service capabilities that would occur should these generators fail.

Table 3. Daily Cost and Level of Service Maintained by Backup Generators at Critical Facilities

FACILITY	OPERATING COSTS ($/DAY)	PERCENT LOSS IN SERVICE CAPABILITIES DURING AN OUTAGE	
		WITH BACKUP GENERATOR	WITHOUT BACKUP GENERATOR
S.W. Johnson Fire House[1]	$11	0%	100%
New Hamburg Fire Department[2]	$143	0%	100%
Tri-Municipal Sewer Commission Wastewater Treatment Plant[1]	$604	0%	100%
Village of Wappingers Falls Water Treatment Facility[1]	$91	0%	100%
Mt. Alvernia Retreat Center[2]	$214	0%	100%
Monastery of St. Claire[1]	$39	0%	75%
St. Mary's School[2]	$143	0%	100%
Sheafe Road Elementary[2]	$214	0%	100%

Notes:

[1]Operating costs for existing backup generator, including fuel and other ongoing costs.
[2]Estimate based on pro-rated cost of renting an emergency generator for two weeks.

The information provided above contributes to the specification of a baseline for evaluating the benefits of developing a microgrid. Specifically, the assessment of Scenario 2 makes the following assumptions to characterize the impacts of a major power outage in the absence of a microgrid:

- All critical facilities currently equipped with backup generators would rely on them, while those not equipped with backup generators would rent them, experiencing no loss in service capabilities while the generators operate. If their backup generators fail, these facilities would experience the loss in service capabilities specified for them in Table 3.

- The supply of fuel necessary to operate backup generators at all critical facilities would be maintained indefinitely.

- In all cases, there is a 15 percent chance that the backup generator would fail.

---

[10] The methodology used to estimate the value of lost services was developed by the Federal Emergency Management Agency (FEMA) for use in administering its Hazard Mitigation Grant Program. See: FEMA Benefit-Cost Analysis Re-Engineering (BCAR): Development of Standard Economic Values, Version 4.0. May 2011.

[11] As with the analysis of reliability benefits, the analysis of major power outage benefits assumes that development of a microgrid would insulate the facilities the project would serve from all outages. The distribution network within the microgrid is unlikely to be wholly invulnerable to service interruptions. All else equal, this will lead the BCA to overstate the benefits the project would provide.

The consequences of a major power outage also depend on the economic costs of a sustained interruption of service at the facilities the microgrid would serve. The analysis calculates the impact of a loss in fire, sewage, and water supply services using standard FEMA methodologies. The impact of a loss in service at other facilities is based on the value of service estimates shown in Table 4. These figures were estimated using the Department of Energy's ICE Calculator.[12] The values are based on the following factors:

- For critical facilities – the nature of the facility, its estimated annual use of electricity, and the presence or absence of a backup generator at the site;
- For residential customers – an estimated 1,500 customers consuming an average of 6.7 MWh of electricity per year.[13]
- For non-critical large/medium commercial and industrial customers – an estimated three customers consuming an average of approximately 821.4 MWh of electricity per year.
- For non-critical small commercial and industrial customers – an estimated 82 customers consuming an average of approximately 30.1 MWh of electricity per year.[14]
- For all non-critical commercial and industrial customers – use of the ICE Calculator's state-specific default values for the distribution of customers by industry and the percentage of customers equipped with backup generators.

Table 4. Value of Maintaining Service, Scenario 2

FACILITY	VALUE PER DAY
Mt. Alvernia Retreat Center	$61,000
Monastery of St. Claire	$39,200
St. Mary's School	$31,200
Sheafe Road Elementary	$50,800
Residential Customers	$63,800
Other Large/Medium Commercial & Industrial Customers (Non-Critical)	$288,000
Other Small Commercial & Industrial Customers (Non-Critical)	$1,380,000

Based on these values and the other assumptions outlined above, the analysis estimates that in the absence of a microgrid, the average cost of an outage for the facilities the project would serve is approximately $1.9 million per day.

[12] http://icecalculator.com/

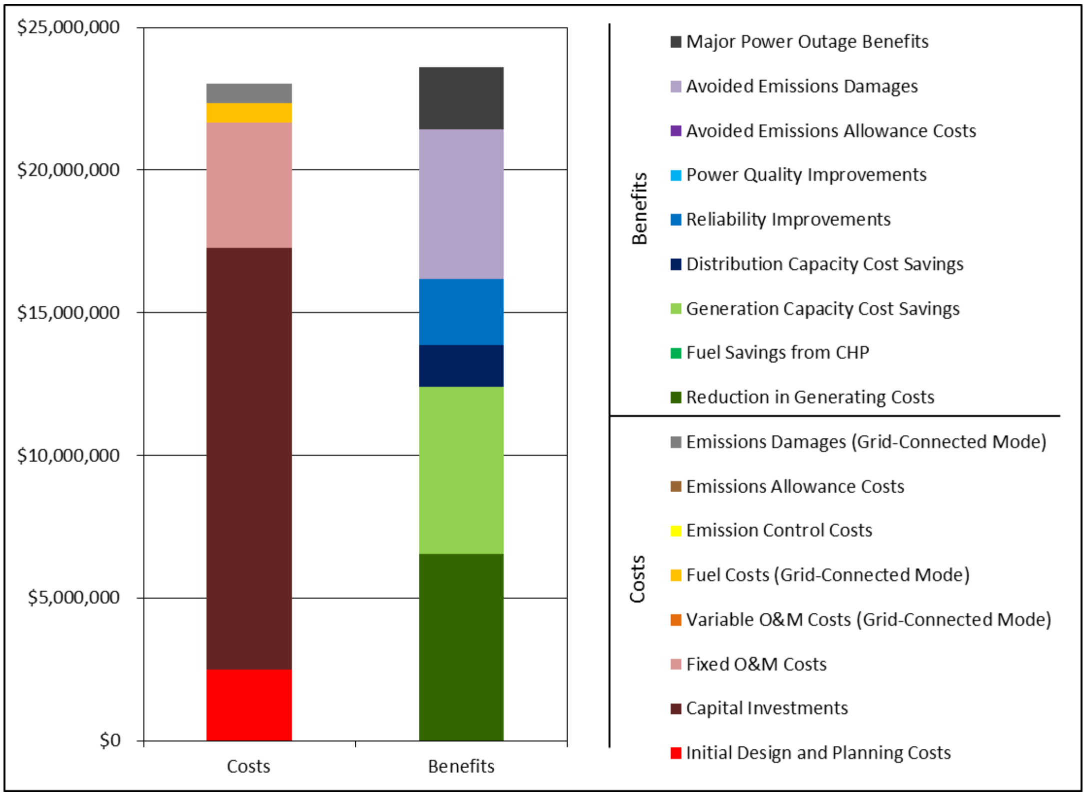
[13] These figures are based on the project team's estimate that the microgrid circuit would serve approximately 1,500 residential customers consuming a total of 10,050 MWh of electricity annually.

[14] The project team estimates that non-critical customers on the microgrid circuit consume approximately 14,978 MWh of electricity annually. The team indicates that residential customers account for approximately 10,050 MWh of this total; for purposes of the BCA, they estimate that the remaining consumption is evenly split between Small and Large/Medium customers in the Commercial and Industrial category. The analysis employs the ICE Calculator's state-specific default values for average annual electricity consumption by class to estimate the number of customers in the Small and Large/Medium categories.

Summary

Figure 2 and Table 5 present the results of the BCA for Scenario 2. The results indicate that the benefits of the proposed project would equal or exceed its costs if the project enabled the facilities it would serve to avoid an average of 0.1 days per year without power. If the average annual duration of the outages the microgrid prevents is less than this figure, its costs are projected to exceed its benefits.[15]

FIGURE 2. PRESENT VALUE RESULTS, SCENARIO 2 (MAJOR POWER OUTAGES AVERAGING 0.1 DAYS/YEAR; 7 PERCENT DISCOUNT RATE)



[15] We again examined the sensitivity of these findings to our treatment of the costs and benefits associated with upgrading and expanding the hydroelectric facility. As previously noted, excluding these costs and benefits would reduce the net benefits of the microgrid project by approximately $8.1 million. As a result, the breakeven point identified under Scenario 2 would increase; the benefits of the project would equal or exceed its costs only if it enabled the facilities it would serve to avoid an average of 0.5 days per year without power.

TABLE 5. DETAILED BCA RESULTS, SCENARIO 2 (MAJOR POWER OUTAGES AVERAGING 0.1 DAYS/YEAR; 7 PERCENT DISCOUNT RATE)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$2,500,000	$221,000
Capital Investments	$14,800,000	$1,080,000
Fixed O&M	$4,410,000	$389,000
Variable O&M (Grid-Connected Mode)	$0	$0
Fuel (Grid-Connected Mode)	$682,000	$60,100
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$671,000	$43,800
Total Costs	**$23,000,000**	
Benefits		
Reduction in Generating Costs	$6,550,000	$578,000
Fuel Savings from CHP	$0	$0
Generation Capacity Cost Savings	$5,770,000	$509,000
Distribution Capacity Cost Savings	$1,450,000	$128,000
Reliability Improvements	$2,340,000	$207,000
Power Quality Improvements	$0	$0
Avoided Emissions Allowance Costs	$3,520	$311
Avoided Emissions Damages	$5,230,000	$341,000
Major Power Outage Benefits	$2,190,000	$193,000
Total Benefits	**$23,500,000**	
Net Benefits	**$519,000**	
Benefit/Cost Ratio	**1.0**	
Internal Rate of Return	**6.4%**	

5.0 Final Written Documentation and Summary

This report presents the detail for, and our findings regarding, the NY Prize Microgrid Feasibility Evaluation. The work was performed in accordance with the NYSERDA Scope Items presented in PON 3044, and includes the Benefit Cost Analysis Questionnaire with Results.

Our evaluation presents detail as regards the microgrid configuration. The system one-line is presented in the Appendix, and illustrates the equipment ratings, location on the microgrid circuit, the eight critical customers and their loads. Electric generation and circuit load simultaneous hour by hour profiles were developed for this evaluation.

This configuration meets the intent of the basic and preferred microgrid capabilities as defined by NYSERDA.

The distributed energy supply resources are integrated and comprised of existing and new intermittent and renewable energy supply, battery storage and stored hydroelectric water reserves with existing and new engine generation. This allows all customers of the entire microgrid, comprised of critical and non-critical load, to be served, and controlled, with capacity in a reliable and grid resilient manner. The annual electrical energy consumed by *all* customers on the microgrid circuit is 17,708,298 kWH, and the peak demand is 3,407 kW. The critical loads consume 2,730,328 kWH and their peak demand is 638 kW.

Renewable resources account for more than half of the annual energy supply. A summary of supply resources is per Table 5. See Table 7 for load summary.

A method to pay for resiliency and reliability measures by applying some of the revenues from Community Net Metering (CNM) energy sales that originate from the renewable power plants is presented as a novel means of capitalizing the microgrid, in part. There are an estimated 9,518,665 kWH of renewable generation from the existing hydro plant, the existing PV plant at the water treatment plant, and the proposed new Mt. Alvernia PV project. CNM revenues are based on 14.59 cents per kWH tariff as applied to CHG&E residential customers.

Estimated capital cost for the microgrid development is $17.2 million, with a $3.0 million allowance for utility (CHG&E) scope included. Valuation of existing generation assets such as the existing diesel engines, PV project at the water treatment plant, and the hydroelectric plant is excluded from the $17.2 million capital cost estimate. There are $1.9 million of Investment Tax Credit subsidies that reduce the capital outlay, as well as an assumed $8.0 million NYSERDA NY Prize Phase 2 and Phase 3 potential co-funding. In the event that less NYSERDA co-funding is available, the project is still viable although there are serious ramifications as follows: (1) the microgrid can be reduced in scope to include a reduced microgrid service area, or (2) can be built in phases, or (3) attract additional financing with a formula to include rate recovery, or (4) CNM revenue that is allocated to utility Market Based Earnings could be applied to fund critical elements of the microgrid.

Utility scope requires gas system reinforcement as well as all electric interconnection costs and electric grid modifications, as well as deployment of any smart grid technology and control system upgrades.

The business case is primarily driven by the CNM opportunity. Area development of the Industrial Park including managing load growth and providing ultra-reliable clean power to this microgrid subsection is another key business case driver.

Battery systems are an important component of this microgrid. They provide the ride-through capability, black start motive power, ancillary services, load shifting, and on-site emergency supply.

PV modules to be located at Mt. Alvernia and the battery system to be located at the Water Supply plant are manufactured in New York State.

The model presented herein is replicable across New York State.

Battery system manufacturers have expressed interest in assembly operations within the Industrial Park. There is job creation and business development opportunity.

Coordination and consistency with NY REV is described herein, as requested by NYSERDA. Most importantly, this microgrid furnishes:

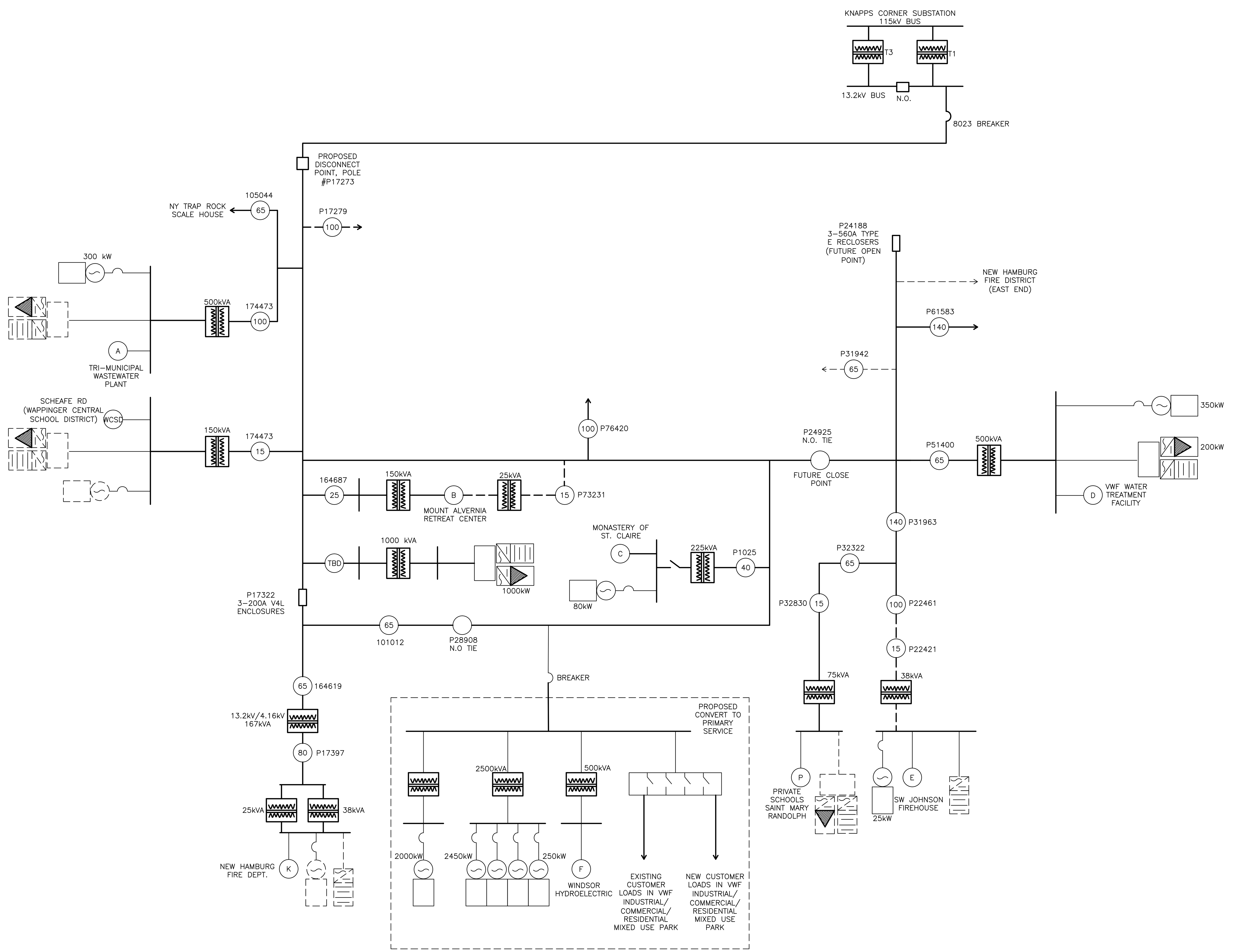
- Added resiliency and reliability that are useful attributes in emergency events including storms, and Homeland Security episodes
- Grid support, grid capital deferment, grid ancillary benefits
- Cost savings to low income residents of the Village
- Revenue stream to the Village for work performed to in-part promote and administer the microgrid efforts via the “microgrid entity”
- Investment opportunity using a unique and customized business model based on Community Distributive Generation (or Community Net Metering)
- Job creation and growth
- Development and deployment of innovative New York and American technology
- Public – private partnership with strategic allies and service providers including the Village of Wappingers Falls, CHG&E, Solar City, Eos, Energy Storage, Elite Energy, Wappinger Falls Hydroelectric, KC Engineering and Land Surveying P.C., and Genesys Engineering P.C..
- Economic and operational benefits to all customers connected to the microgrid circuit as well as the service providers:

    1. All utility accounts on the microgrid circuit receive the benefits of enhanced grid resiliency
    2. Residential accounts, with preference to low income household, receive a discount
    3. The utility can enjoy market based earnings as per NYREV
    4. The older existing assets (hydro plant) can be rebuilt to serve load for 40 more years.
    5. New Technologies are encouraged, that is, control systems, and battery storage
    6. New Renewable supply by PV solar energy is added
    7. Load growth is accomplished, in which jobs are created
    8. Participation by microgrid generators in other markets, including ancillary services, ICAP / UCAP, and demand response adds revenue to the bottom line of the owners of generation

9. The Village is afforded opportunity to earn revenue through microgrid services as a participant in the “microgrid entity”

APPENDIX 1

ELECTRIC ONE-LINE



KEY:

Symbol	Description
	PV AND INVERTER
	BATTERY STORAGE AND INVERTER
	ENGINE IN PARALLEL
	ALTERNATIVE PV AND INVERTER
	ALTERNATIVE BATTERY STORAGE AND INVERTER
	ALTERNATIVE ENGINE IN PARALLEL
	SWITCHGEAR
	AC GENERATOR
(100)	FUSE LINK WITH 100A RAITING
(A)	CRITICAL LOAD
	TRANSFORMER
– – – – – –	1–PHASE
—— – – —	2–PHASE
————	3–PHASE

VILLAGE OF WAPPINGERS FALLS MICROGRID ONE LINE DIAGRAM

NOT FOR CONSTRUCTION

OWNER

CLIENT

KC ENGINEERING & LAND SURVEYING

PROJECT NAME

VILLAGE OF WAPPINGERS FALLS– NY PRIZE MICROGRID

KEY PLAN

No.	DATE	REVISION

MEP ENGINEER

Genesys Engineering P.C.
629 Fifth Avenue Bldg 3, Suite 111, Pelham, New York 10803
TEL (914) 633-6490 FAX (914) 633-6951

ARCHITECT

STRUCTURAL

DRAWING TITLE:

ELECTRICAL ONE–LINE SCHEMATIC

DRAWN BY: | CHECKED BY:

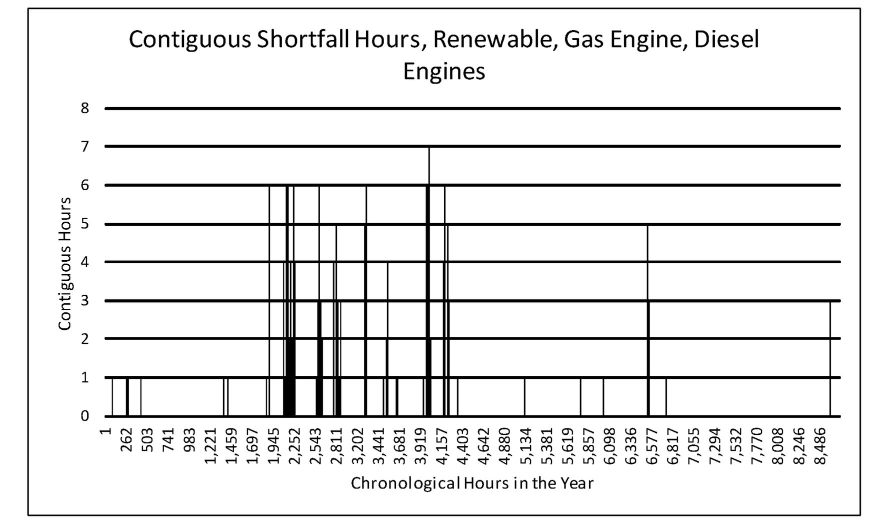
DATE:

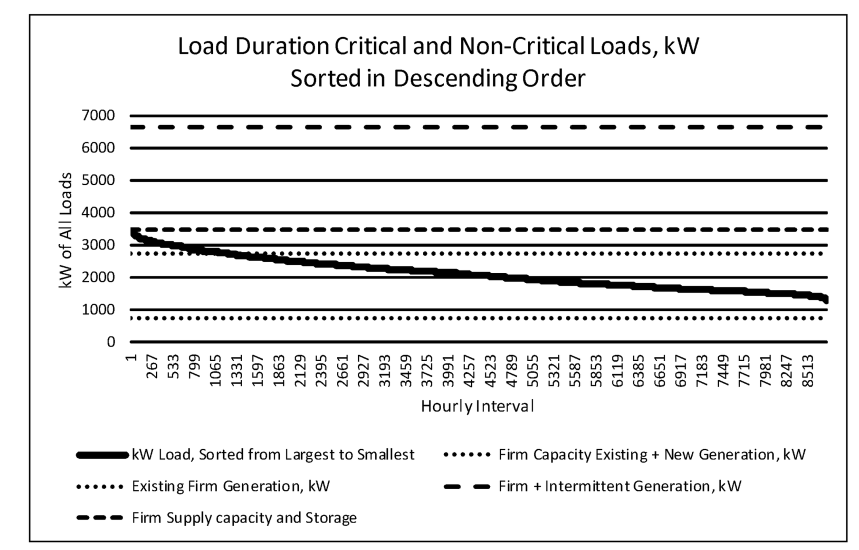
JOB NUMBER: 0927.00–000

CAD/FILE NO.

DWG NUMBER: E–600.00

CRITICAL LOAD / Property Name (2)	Peak Demand, kW most recent 12 month period	Annual Usage, kWH most recent 12 month period	Transformers Total rating, kVA from CHG&E	Existing Emergency or Baseload Generation, kW	New Gas Engine, kW	Existing PV Generation	New PV or Hydro Turbine, kW	*New Transformers, kVA*	New Energy Storage	Notes
a - Tri-Municipal Sewer Commission, Tri-Muni Wastewater Treatment Facility Facility	246.30	1,582,558	500	300	-	-	-	-	-	Diesel with 2,000 gal oil tank; Enrolled in DR; convert to grid parallel operation; add second 2,000 gal oil tank to meet 7-day supply; consider PV with Storage
b - Mt. Alvernia Retreat Center (2 Services)	82.25	348,560	150	-	-	-	1,000	*1,000*	1000 kW / 500 kWH	Add 1,000 kW PV and 1,000kVA transformer with storage; Consider Community Net Metering; batter for microgrid ridethrough or 12 hour shelter load; SOLAR CITY
	5.36	20,369	25	-	-	-	-	-	-	
c- Monastery of St. Clare	24.40	102,000	225	80	-	-	-	-	-	Tie into Mt. Alvernia PV and Storage Plant
d- Village Water Supply Facility	76.80	239,880	500	350	-	200	-	-	250 KW / 1000 KWH	Add Energy Store system: Can supply 500 kW for 15 - minutes; EOS
e- SW Johnson Firehouse	19.30	30,396	38	25	-	-	-	-	-	Consider Energy Storage as an Alternative
f- Wappingers Falls Hydroelectic Generation Station and Industrial Park Locations	-	0	3,000	2,450	2,000	-	250	-	-	Add 2000 kW Gas Engine and new 250 kW hydro generator
k - New hamburg Fire Dept (2 Services)	2.54	6,514	25	-	-	-	-	-	-	-
	28.90	81,811	38	-	-	-	-	-	-	Consider Energy Storage as an Alternative
Sheafe Road Elementary School	105.60	241,320	150	-	-	-	-	-	-	Consider PV with Battery Storage as an Alternative
St. Mary's School	46.80	76,920	75	-	-	-	-	-	-	Consider PV with Battery Storage as an Alternative
Total at Critical Loads	638.25	2,730,328	1,725	755	-	200	1,000	*1,000*	1,250	
Total at Critical Load + Wappingers Falls Hydro	638.25	2,730,328	4,725	3,205	2,000	200	1,250	*1,000*	1,250	





TOTAL RENEWABLE INTERMITTENT SUPPLY	TOTAL LOAD ON MICROGRID CKT	Renewable Supply less Load
3,901 MAX KW	3,407 MAX KW	2,233 MAX KW
9,518,665 kWH	17,708,298 kWH	-8,189,633 kWH
1,143 AVG. KW	2,127 AVG. KW	-984 Avg. kW
29.31% Load Fctr	62.42% Load Fctr	-

	Renewable Only	Renewable + Gas Engine	Renewable + Gas Engine + Diesels	TOTAL CAPACITY
Existing Capacity	2,650 kW	-	755 kW	3,405 kW
New Capacity	1,250 kW	2,000 kW	-	3,250 kW
TOTAL CAPACITY	3,900 kW	2,000 kW	755 kW	**6,655 kW**
Hours Unable to Meet Load	6,829 Hrs / yr	1,168 Hrs / yr	151 Hrs / yr	
Max Duration of Supply < Load	1,176 Hrs / yr	15 Hrs / yr	7 Hrs / yr	
			With Battery Storage, Integrity of Supply is Maintained	

1,250 KW	STORAGE
755 KW	LOAD THAT CAN BE SUPPLIED WITH EXISTING FIRM CAPACITY (DIESEL)
2,000 KW	LOAD THAT CAN BE SUPPLIED BY NEW FIRM CAPACITY (NEW GAS ENGINE)
2,650 KW	EXISTING RENEWABLE INTERMITTENT RESOURCES
1,250 KW	NEW RENEWABLE INTERMITTENT RESOURCES
6,655 KW	TOTAL GENERATION

VILLAGE OF WAPPINGERS FALLS MICROGRID TABLES AND CHARTS

NOT FOR CONSTRUCTION

OWNER

CLIENT

KC ENGINEERING & LAND SURVEYING

PROJECT NAME

VILLAGE OF WAPPINGERS FALLS- NY PRIZE MICROGRID

KEY PLAN

No.	DATE	REVISION

MEP ENGINEER

Genesys Engineering P.C.
629 Fifth Avenue Bldg 3, Suite 111, Pelham, New York 10803
TEL (914) 633-6490 FAX (914) 633-6951

ARCHITECT

STRUCTURAL

DRAWING TITLE:

ELECTRICAL TABBLES AND CHARTS

DRAWN BY: CHECKED BY

DATE:

JOB NUMBER: 0927.00-000

CAD/FILE NO.

DWG NUMBER: E-700.00

APPENDIX 2

SIMPLIFIED PV PLANT LAYOUT

MT. ALVERNIA RETREAT CENTER

SYSTEM SIZE:	1.00 MW AC
SITE ADDRESS:	158 DELAVERGNE AVENUE WAPPINGERS FALLS, NY 12590
DATE:	10/22/15
MODULE:	SILEVO
INVERTER:	FRONIUS

DESCRIPTION:

PV ARRAY

RBI RACKING SYSTEM

STRINGS OF 18 MODULES

PRELIMINARY DRAWING – NOT FOR CONSTRUCTION

ARRAY INFORMATION

MOUNTING METHOD	MODULE COUNT	TILT	AZIMUTH	KW DC
GROUND MOUNT	3240	25	180	1,069.20

GENERAL NOTES

1. THIS SYSTEM IS GRID–INTERTIED VIA A UL–LISTED POWER–CONDITIONING INVERTER.
2. THIS SYSTEM HAS NO BATTERIES, NO UPS.
3. ALL INVERTERS AND ARRAYS ARE NEGATIVELY GROUNDED.
4. SOLAR MOUNTING FRAMES ARE TO BE GROUNDED.
5. ALL WORK TO BE DONE TO 2010 UBC
6. ALL ELECTRICAL WORK SHALL COMPLY WITH THE 2008 NATIONAL ELECTRIC CODE.

SHEET NOTES

1. INVERTER.
2. DEDICATED PV SYSTEM METER.
3. AC DISCONNECT.
4. UTILITY METER.
5. DC DISCONNECT.

LEGEND

- (M) (E) UTILITY METER
- (Inv) INVERTER W/ INTEGRATED DC DISCO & WARNING LABELS.
- DC DC DISCONNECT
- AC AC DISCONNECT
- (J) JUNCTION BOX
- (C) DC COMBINER BOX
- (D) DISTRIBUTION PANEL
- (LC) LOAD CENTER
- (M) DEDICATED PV SYSTEM METER
- CONDUIT RUN ON EXTERIOR
- CONDUIT RUN ON INTERIOR
- GATE
- INTERIOR EQUIPMENT

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SolarCity