11 - Village of East Rockaway (Bay Park)

Notice

Village of East Rockaway Bay Park Community Microgrid Feasibility Study

Deliverable 5: Final Written Document

Agreement Number: 67588

August 1, 2016

Submitted By:

Nassau County

TABLE OF CONTENTS

Executive Summary

The purpose of this study is to determine the feasibility of implementing a microgrid (MG) system to serve the East Rockaway community, Bay Park Sewage Treatment Plant (STP) and its surrounding critical facilities. Most self-generating wastewater treatment plants are normally ideal for this type of system since they have probably existed for years in the same general area of a community and are a known entity, meaning no additional siting or permit issues. Additionally, power generation and backup power supplies are necessary functions at a treatment plant and can be augmented to supply power to neighboring infrastructure.

To accomplish these objectives, the following tasks were completed and are summarized within this report:

- Task 1 Description of MG Capabilities
- Task 2 Develop Preliminary Technical Design Costs and Configuration
- Task 3 Assessment of MG's Commercial and Financial Feasibility
- Task 4 Develop Information for Benefit Cost Analysis

Task 1 Description of MG Capabilities

The East Rockaway Bay Park Community MG site consists of ten facilities within the East Rockaway community, along the south shore of Long Island. These facilities include, a wastewater treatment plant, three schools, a public works department, two fire department locations, a post office, a public library and a village hall. These facilities serve over 530,000 people and can provide important shelter and staging areas for the community during an emergency. The proposed MG would serve as backup power to these facilities during emergencies, such as a major storm event.

The MG could be powered by the following primary power sources:

- Advanced Sludge Digestion with Combined Heat and Power (CHP)
- Wind Power
- Solar Power
- Fuel Cell/High Efficiency Power Systems

These power sources would be housed at Bay Park STP and could produce an estimated 6 Megawatts (MW) of energy, which more than exceeds the amount necessary to power the facilities outside the fence line and reduce the amount of power consumed from the PSEG grid. After the completion of the Bay Park Phase E3 Main Substation and Electrical Distribution Project, there will be two direct feeders from PSEG into Bay Park STP to power the plant. Therefore, all power produced by the MG is available to power the other referenced facilities.

Task 2 Develop Preliminary Technical Design Costs and Configuration

The proposed MG may utilize a variety of Distributed Energy Resources (DER) and Thermal Generation Resources. Nassau County plans on utilizing Advanced Sludge Digestion and CHP to produce additional energy to be distributed throughout Bay Park STP and to be utilized in the MG, when necessary. The tri-fuel engines are already existing on-site and are connected to many of the major on-site distribution systems which will allow for power generation at a very

low capital cost. It is anticipated that the County will assess the need for more efficient CHP systems, as the existing engines are over 30 years old and are not efficient enough to maximize the amount of power produced by the digester gas. Fuel cells or similar high efficiency generation systems, which can run off digester gas are likely candidates to replace the older tri-fuel engines. The tri-fuel engines will only be used to power the MG outside the fence line during emergency conditions. Similarly, Wind Power and Solar Power are being evaluated as potential sources of energy that can supplement the MG system and ultimately be available to reduce power consumption from the grid.

Once the power is created and leaves Bay Park STP, it will pass through a series of transformers and switches prior to entering the overhead lines. These feeders will connect to a series of medium voltage and low voltage switches that will be located adjacent to each critical facility. The MG will be operated by a controls center located within Bay Park STP. The controls for the MG outside the fence line are anticipated to have minimal architecture, since it is planned only to be used during emergencies.

Task 3 Assessment of MG's Commercial and Financial Feasibility

In the event of an emergency and a local power grid failure, the Village of East Rockaway will be the main customer purchasing the services from the County's MG. Currently, it is anticipated that no residential customers will be connected to the MG. Power will only be generated and purchased during emergencies, when the main PSEG grid is down.

The County will benefit from the proposed MG, as it will allow critical facilities within the County to operate during a mass power outage and create important shelters and staging areas for emergency response. Furthermore the MG would help reduce the load purchased from the PSEG grid at the Bay Park STP annually, which over the long term will save the county millions of dollars in energy fees.

The community will experience crucial benefits with the construction and operation of the proposed MG project. These benefits include but are not limited to, allowing access to powered facilities during a major power outage, as the facilities can be used as shelters or staging areas. If the County is purchasing less power from the PSEG grid, this could result in reduced taxes for the residents of Nassau County. All MG energy generation will be created by renewable sources, resulting in environmental benefits and reduces the need to purchase natural gas or power from the grid. Lastly, the community will incur no costs associated with the construction and operation of the MG.

The local electrical utility, PSEG will also experience benefits of the MG. During a major power outage, it would be less pertinent that PSEG get its services up and running as the critical facilities in the area will have backup power and the utility will incur little to no capital costs associated with the construction of the MG.

The MG also poses a different value proposition to New York State. The proposed project promotes New York State's energy policies, such as the Renewable Portfolio Standard and NY

REV. The MG will be an efficient power generator and it would generate energy using renewable fuel.

Initially, there will be no revenue streams associated with the proposed MG. The financial savings and benefits will be achieved by decreasing the amount of power purchased from the grid for the Bay Park STP and the realization that certain facilities in the area are able to provide comfort for local citizens.

Task 4 Develop Information for Benefit Cost Analysis

As part of NYSERDA's NY Prize Community MG Competition, Nassau County was asked to provide preliminary design and configuration costs for the MG system, as well as a breakdown of the necessary load conditions for the facilities.

The total installed capital costs of the MG is estimated to be $6,976,910.00. This amount includes the installed costs of the electrical and controls infrastructure.

Other costs associated with the MG include:

- The initial planning and design costs are estimated to be about $600,000.00.
- The fixed operation and maintenance costs are projected to be $150,000.00.
- There are no variable O&M costs, excluding fuel costs, associated with the MG.

The MG would be able to power one hundred percent of the critical facilities, outside the fence line, during an emergency. The DERs would be able to operate indefinitely in islanded mode without replenishing fuel supply, as the DERs operate on renewable energies. This is contingent on the processing of wastewater and generation of enough digester gas to be keep the CHP functioning at Bay Park STP.

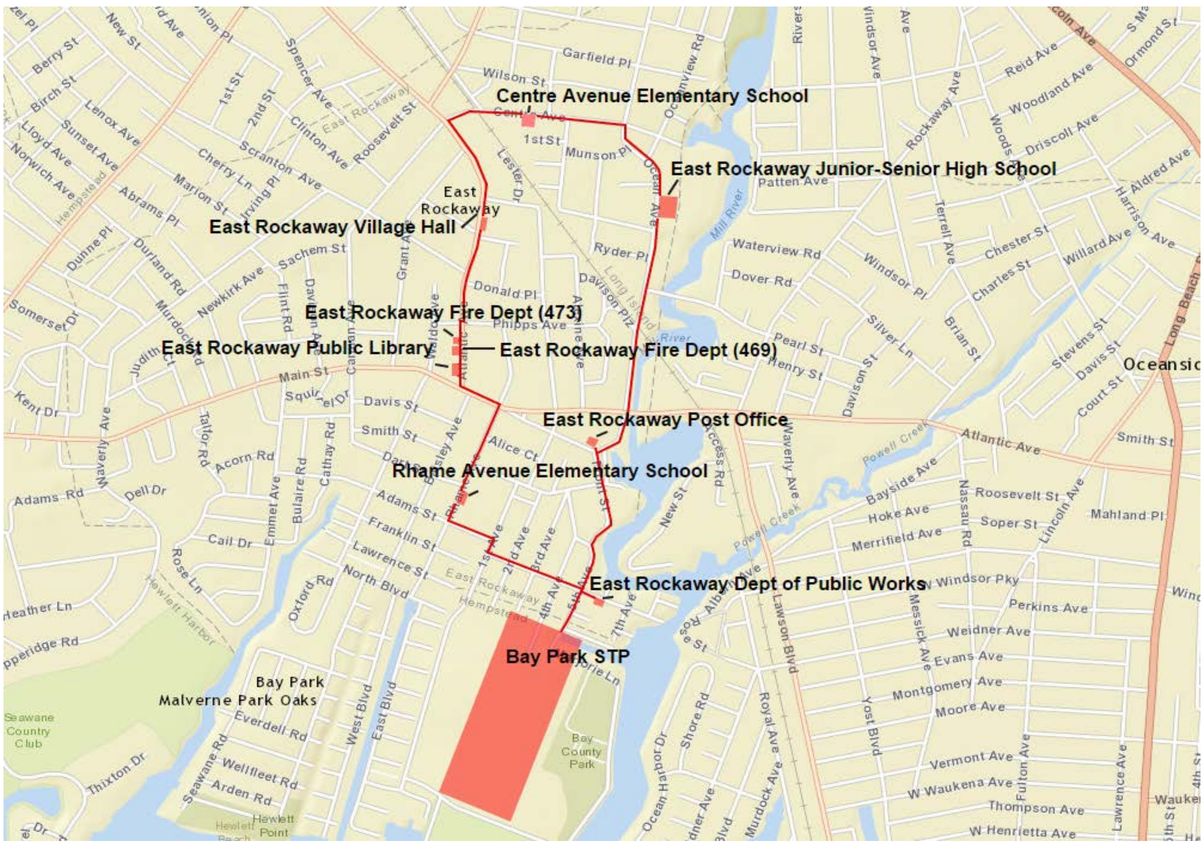
Using the information provided in this task, a cost benefit analysis was conducted by a third party economics firm. It was determined that the proposed MG yields a benefit cost ratio of 2.2. Therefore, the project benefits exceed the project costs by a multiple of two. This calculation is represented in the attached Benefit Cost Analysis created by IEc, attached here as **Appendix A**.

Task 1 Description of MG Capabilities

Sub Task 1.1 Minimum Required Capabilities for Proposed Bay Park STP MG

The Bay Park STP (STP) MG site consists of 10 facilities within the East Rockaway community, along the south shore of Long Island. See **Figure 1.1** for the proposed site location map showing all of the MG facilities.

Figure 1.1: Potential MG Connections



This area was heavily flooded by Superstorm Sandy. East Rockaway and its neighboring communities experienced tidal surges as high as 11 feet. As a result, the area's infrastructure and housing was decimated. **Figure 1.2** illustrates the flood inundation in the vicinity of Bay Park STP and **Figure 1.3** depicts the Future Flood Inundation Risk in the same area. The facilities consist of a variety of public buildings that vary from Public Works Departments, Schools, Post Offices, Libraries and Town Halls. It is most likely that these facilities would provide evacuation shelters or emergency responder staging areas in the event of another disaster.

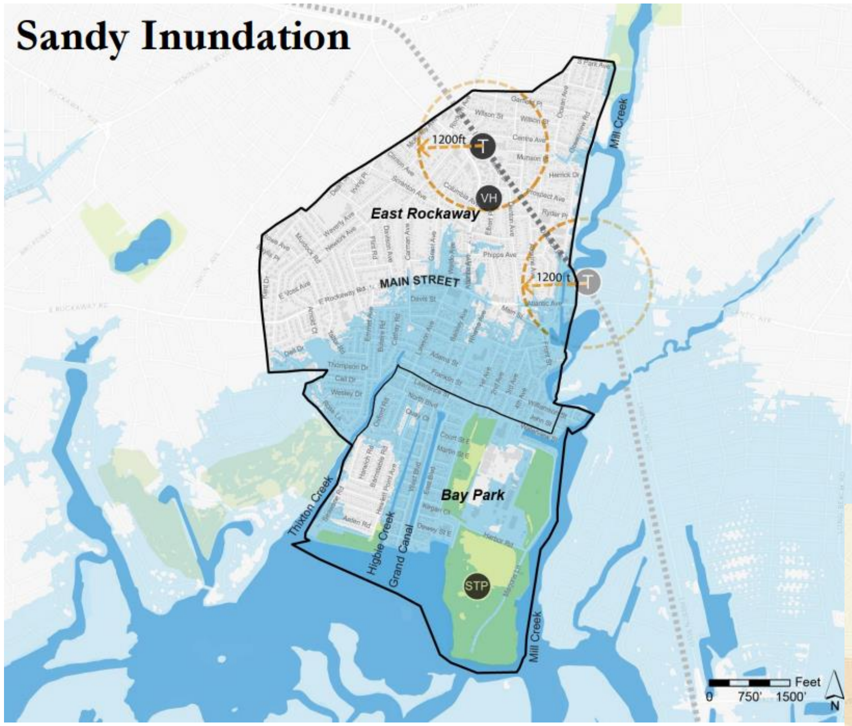


Figure 1.2: East Rockaway Sandy Flood Inundation
East Rockaway Village Planning Committee

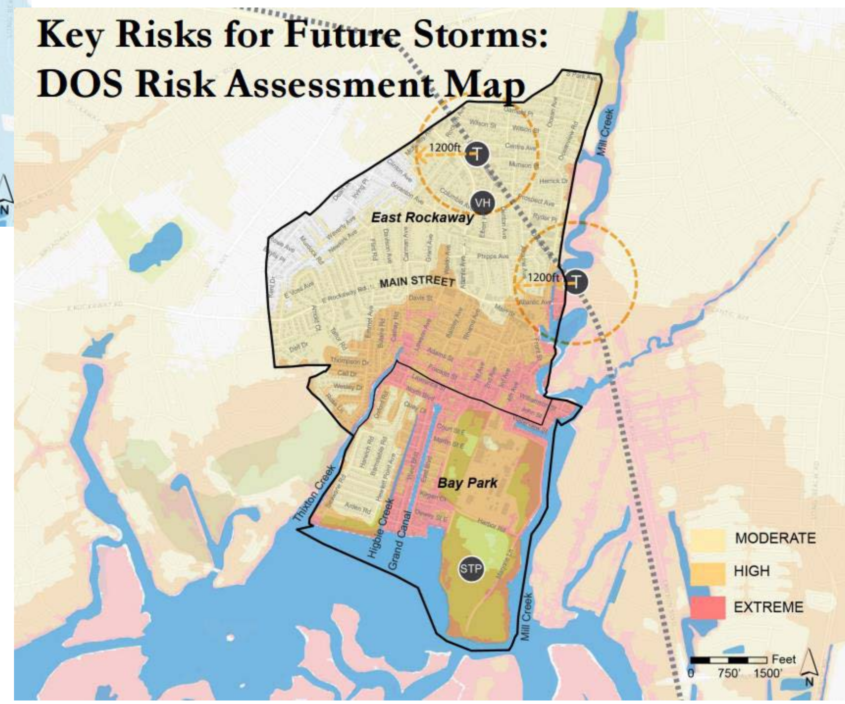


Figure 1.3: East Rockaway Future Flood Inundation Risk
East Rockaway Village Planning Committee

The 10 facilities located in the MG site are as follows:

Bay Park STP

Bay Park STP is one of two wastewater treatment plants on the south shore of Long Island owned by Nassau County and operated by SUEZ. Bay Park STP serves over 530,000 people on Long Island. The facility is designed to treat 70 million gallons per day (MGD) and currently treats an average of 50 MGD. The Bay Park STP facility is located at 2 Marjorie Lane in East Rockaway, adjacent to the Bay Park Golf Course. The plant covers approximately 55 acres and consists of over 50 structures connected by a series of underground tunnels.

Currently, Bay Park STP is a self-powered facility during normal operation. There are nine on-site rented Aggreko 1200 Kilowatts (KW) generators that run on natural gas and serve as the power for the facility. The 1200 KW generators were installed after the storm to provide continuous power and will be in service for the next several years.

The original four 3600 KW tri-fuel engines were damaged during the storm but have been rebuilt and include new control systems. These engines are capable of running on diesel, natural gas or digester gas. A vast majority of the time the engines run on natural gas or a blend of natural gas and digester gas. Diesel is rarely, if ever, used to fuel the engines. Daily peak operation is approximately 5.5 Megawatts (MW) with a 6.2 MW generator capacity, as there is only sufficient ancillary systems to operate two generators at one time. However, at the end of 2017, the load at the plant is expected to be 6.0 MW on average, with a peak of 7.0 MW. Therefore, for purposes of this study 7.0 MW will be the average load. The Aggreko generators are capable of powering the entire plant. Once the Bay Park Phase E3 Main Substation and Electrical Distribution Project is completed in 2018, the plant will have 7.2 MW of backup power. According to the local electrical utility, PSEG, twin feeders will be installed by the end of 2017 which will enable the facility to run completed off the grid.

Bay Park STP was severely damaged from the tidal conditions of Superstorm Sandy. The majority of the facility was inundated with saltwater causing power outages. The plant is currently under construction to increase its resiliency during similar storm events. One of the resiliency measures is to build a perimeter berm and storm water pump station to prevent the effects of tidal conditions and to increase the plant's resilience to electrical outages. The berm project is scheduled to be completed in early 2016, and the pump station in 2017.

The site manages its own electric distribution and control systems. Transfer switches configure service to each building and treatment process. All switches are automated. There are uninterruptible power supplies (UPS) on seven units with battery cells to provide enough power for one hour of plant controls. The plant has been down twice in the last four years. In these instances, the plant is connected to the local energy provider, PSEG for service. The utility service is currently inoperable; it is being rebuilt and restored under a current construction project.

In terms of potential to house emergency services, the site has favorable attributes:

- There is available conditioned building space, including unoccupied space that could accommodate emergency workers.
- The facility is currently being designed to provide additional resiliency during similar events like Superstorm Sandy via a perimeter berm and storm water pump station.

East Rockaway Village Hall

The East Rockaway Village Hall, located at 376 Atlantic Avenue in East Rockaway, is a central operation point for the Village of East Rockaway and it services approximately 9,800 residents. The Village Hall is a vital operation center for staging and resident call response during emergency events and houses one on-site emergency generator. The Village Hall is owned and operated by Village of East Rockaway.

Centre Avenue & Rhame Avenue Elementary Schools (both locations)

Centre Avenue Elementary School, located at 55 Centre Avenue in East Rockaway, is part of the East Rockaway School District and hosts over 300 students ranging from kindergarten to sixth grade. Rhame Avenue Elementary School is located at 100 Rhame Avenue in East Rockaway and hosts a similar number of students. These facilities currently do not have on-site powergeneration however they have space to accommodate on-site distributed energy. These schools can provide evacuation shelter and an emergency responder staging area. In addition, a back-up energy source would lower the number of disruptions during normal facility operations. Both facilities are owned and operated by the East Rockaway School District.

East Rockaway Junior-Senior High School

The high school is part of the East Rockaway School District and hosts over 500 students ranging from seventh grade to twelfth grade. This facility is located at 443 Ocean Avenue in East Rockaway. These facilities currently do not have on-site power generation however, they have space to accommodate on-site distributed energy. This school can provide evacuation shelter and an emergency responder staging area. In addition, a back-up energy source would lower the number of disruptions during normal facility operations.

East Rockaway Fire Departments (both locations)

There is an East Rockaway Fire Department located at 473 Atlantic Avenue in East Rockaway, and one located at 469 Atlantic Avenue in East Rockaway. These facilities do not currently have on-site power generation. Fire departments are critical facilities that need to be operational, particularly during emergency events when they receive an above average call volume. In addition, these facilities can be used as a staging area for emergency responders. These are owned and operated by the Village of East Rockaway.

East Rockaway Public Library

The East Rockaway Public Library, located at 477 Atlantic Avenue in East Rockaway, does not currently have on-site energy generation. This facility can provide critical shelter and can serve as a meeting place during emergency events and the facility is owned and operated by the Village of East Rockaway.

East Rockaway Public Works

The East Rockaway Public Works, located at 85 Williamson Street in East Rockaway, does not currently have on-site energy generation. The Public Works Department is a key responder during emergency events. The Village of East Rockaway owns and operates the Public Works facility.

East Rockaway Post Office

The East Rockaway Post Office, located at 10 Main Street in East Rockaway, does not currently have on-site energy generation. The Post Office is owned and operated by the U.S. Postal Service.

The MG serves an extremely diverse group of customers. Bay Park STP itself services; residential, small and large commercial, industrial and institutional sites throughout Nassau County. In addition, the remainder of the facilities included in the MG are all public facilities allowing the MG to serve the local population during emergency conditions and provide safe facilities during mass power outages.

Potential Primary Power Sources

The MG primary generation source capacity includes multiple sources. The following combination of generation resources were evaluated to provide on-site power to feed the MG in both grid connected and islanded mode.

Advanced Sludge Digestion Advanced sludge digestion via Thermal Hydrolysis or a similar system, would increase the quality and quantity of digester gas and reduce the quantity of sludge. The digested sludge would be an Environmental Protection Agency (EPA) Class A material and would be used as a fertilizer or soil amendment for landscaping businesses on Long Island. Thermal Hydrolysis is a high pressure steam post-treatment for anaerobically digested municipal sludge. These systems are typically married with Combined Heat and Power (CHP), which can provide green electricity and steam. It is anticipated that the production of biogas would be more than double the pre-Sandy rates. In addition, the possibility of anaerobic digestion of municipal food waste may be analyzed in the future.

Currently, Bay Park STP is operating digesters and gas collection systems that are piped to the existing 3600 KW tri-fuel engines. The current thinking is to utilize the existing systems to produce the needed power for the MG system outside the fence line of Bay Park STP. This will help reduce capital expenditures and provide a better cost benefit ratio. Long term more efficient generation systems will be employed at the site instead of the 30 year old engines.

The County and SUEZ have evaluated various options for a new 2.5 MW CHP system including reciprocating engines and microturbines. Based on a triple bottom line analysis, reciprocating engines were found to have the best payback and would provide long term renewable energy production from biogas. The new CHP units would replace the existing tri-fuel engines which are reaching the end of their useful lives. These new CHP units are proposed to be built at the Bay Park STP site and because biogas is infinitely available at the plant, the new CHP system can operate 24/7 and continuously meet the demand of the MG.

Wind Power As part of harnessing the wind along the Long Island coast, wind power could be considered as a viable alternative power supply for Bay Park STP and the MG. Noticeably, the system must be structurally designed to withstand hurricane force winds. As an example, the Town of Hempstead recently constructed a wind turbine along the coast near Lido Beach. Wind power is an alternative to fossil fuels, is plentiful, renewable, produces no greenhouse gas emissions and can be sited on a small piece of property. Wind has significant variation over shorter periods of time and must be used in conjunction with other power generating sources that are more consistent. As illustrated in **Figure 1.4** and **Figure 1.5**, the potential to site a turbine near Bay Park STP appears to be favorable relative to available wind speeds. Permitting and siting such a turbine tends to be somewhat controversial to some public interests.

Figure 1.4: Average Wind Speed at East Rockaway (July 2014- July 2015)

Wunderground.com

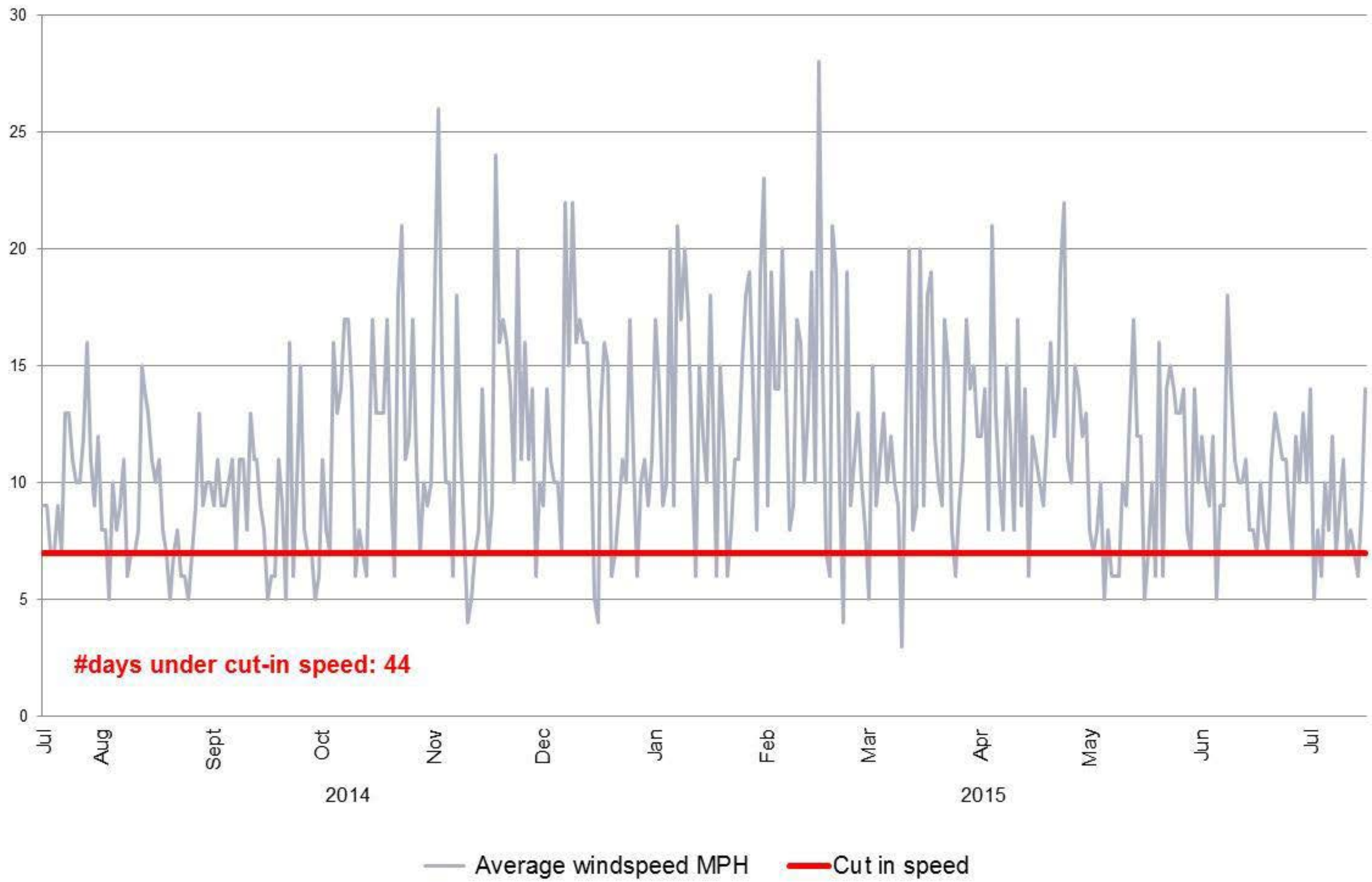
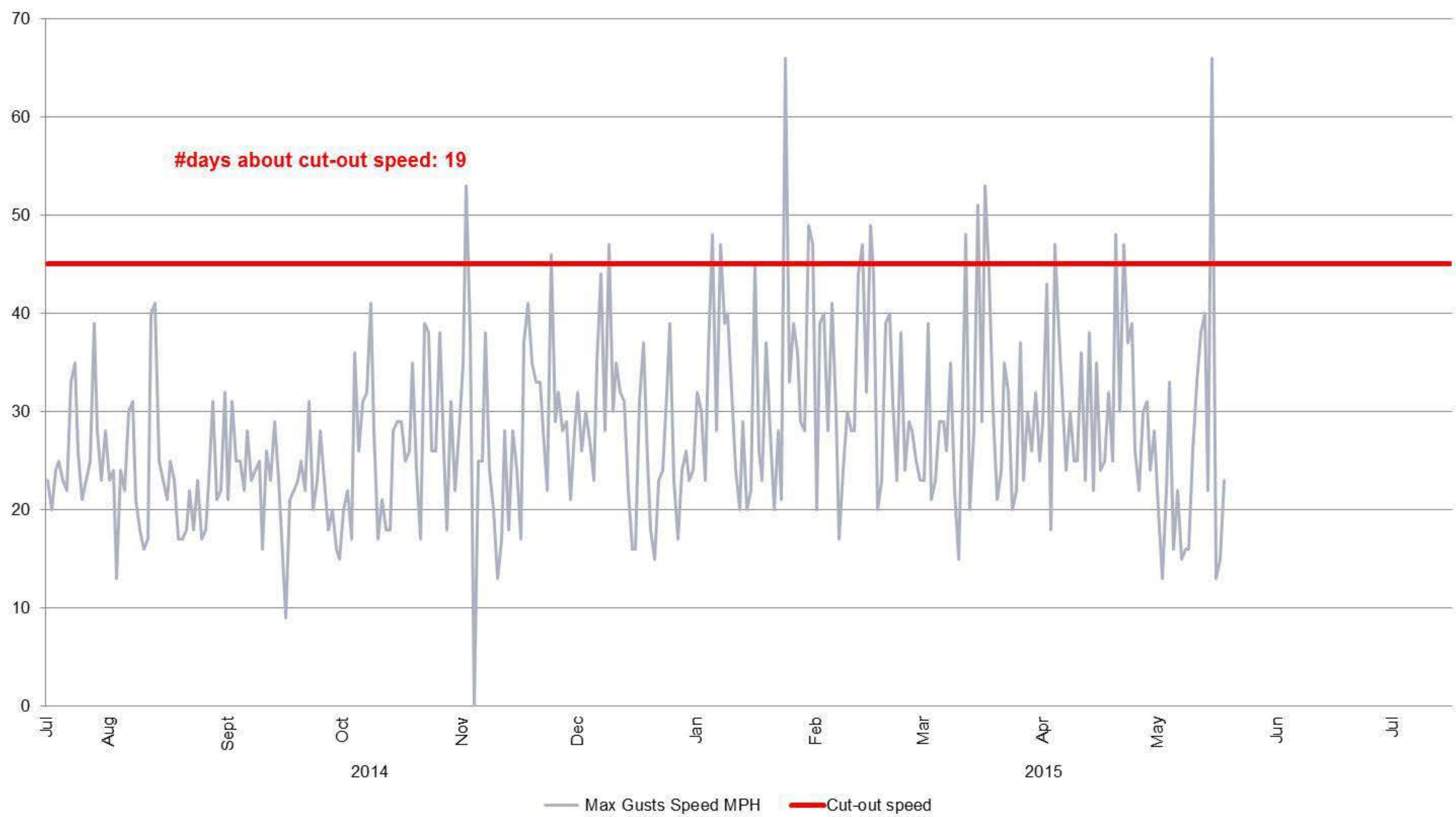


Figure 1.5: Max Gusts Speed at East Rockaway (July 2014- July 2015)

Wunderground.com



Solar Power Solar power will be analyzed relative to its ability to be sited at the Bay Park STP facility. Recently, the cost of both manufacturing and installation of this technology has decreased drastically, making solar power more attractive. By locating the solar panels on the roofs (represented in yellow in **Figure 1.6**) of several existing buildings, it is estimated that 20,000 m^2 of panels could be installed, shown here in **Figure 1.6**, which should be able to produce an average of 1.5MW of power.

Total Potential Area at Bay Park STP: 200,000ft^2 (about 20,000m^2)

Average Solar Radiation in East Rockaway: 4.72 KWh/m^2 /day
NREL data

Figure 1.6: Potential Solar Panel Locations at Bay Park STP

Backup Power Backup power (being implemented with the Phase E3 project at Bay Park STP) will consist of 7.2 MW of generating capacity (six units at 1.2 MW each) will be placed on top of a building ensuring mitigation from another hurricane and flood. The backup generators will be fueled by natural gas and/or digester gas. The backup generators will not be utilized for the MG outside the fence line.

Fuel Cell A fuel cell is a device that converts chemical energy from a fuel into electricity though a chemical reaction. Unlike batteries, fuel cells need a continuous source of fuel and oxygen to sustain the chemical reaction. Whereas in a battery the chemicals are already present and react with each other. Therefore, fuel cells will continuously produce electricity as long as oxygen and hydrogen are present. As part of this study, several private fuel cell manufacturers have contacted the County to provide proposals to build, operate and maintain fuel cells at Bay Park STP. The fuel cell has the ability to use high quality methane gas from the digesters, providing the gas is refined to above 90% methane. This fuel cell technology is being evaluated as a possibility in the long term as a CHP alternative to the 30 year old engines.

PSEG Feeder As stated earlier, at the end of 2017 the primary source of power will be a dedicated electric supply to Bay Park STP. The new feeder is being paid for by FEMA as part of the Bay Park Post Sandy Rehabilitation Program and will provide the plant with a direct feed from a PSEG substation. In the event of a localized power outage the MG could still be fed by the direct feeder line, providing it is still operational; or by a portion of the backup generator system; or operated by the existing tri-fuel backup generators. The operation scenarios will be at the sole authority of the County.

Below find **Table 1.1** comparing these technologies and their current power production and their potential future power production at Bay Park STP:

Table 1.1: Current Power Production vs. Potential Future Power Production at Bay Park STP

Technologies	Current Power Production	Future Power Production-1	Future Power Production-2	MG Power Production
Advanced Sludge Digestion	-	2.5MW	2.5 MW	2.5MW
Wind Power	-	1 MW	1.0 MW	1.0 MW
Solar Power	-	1.5 MW	1.5 MW	1.5 MW
Backup Power	-	7.2 MW	7.2 MW	-
Fuel Cell	-	1 MW	1.0 MW	1.0 MW
Tri-Fuel Engines*	6 MW	6 MW	-	-
PSEG Feeder	-	-	11 MW	-
Total	**6 MW**	**12 MW****	**17 MW****	**6 MW**

**6MW with one engine in maintenance mode and one engine in standby mode.*

***Does not include 7.2 MW of backup power.*

With the potential of having a total power supply of approximately 12 MW of energy and eventually 17 MW, the additional capacity of the MG could be as much as 6 MW on an average day. The renewable resources portion of the total capacity could be as much as 3.5 MW with Wind, Solar and Fuel Cell, and the additional capacity within the Advanced Sludge Digestion process via the existing tri-fuel engines. This capacity would allow for a substantial power island. This total generation will include an uninterruptible fuel supply for a minimum of one week of fuel supply onsite.

While capacity is increasing, power demand at Bay Park STP will also increase. Once these upgrades are complete, Bay Park STP's power demand will increase from its current 6 MW peak demand to 9 MW peak demand by 2018 under maximum design conditions. This will require possible load shedding in the future when peak demand coincides with a time period when the plant is operated on backup power.

All technologies proposed will comply with manufacturer's requirements for scheduled maintenance intervals for all generation and could potentially be built, operated and maintained by private entities. All generation will be able to follow the load while maintaining the voltage and frequency when running parallel connected to the grid.

The MG site will manage its own electrical distribution. This management includes transfer switches to configure services to each building or process. All of these switches will be automated. The MG will include a means for two way communication and control between the community MG owner, Nassau County, and the local distribution utility, PSEG, through automated, seamless integration. The Master Control Station will be located inside the fence line, on site at Bay Park STP. Additional control stations will be located within the MG, all required feeder automation will come directly from the Master Control Station at Bay Park STP.

The MG at Bay Park STP will be able to disconnect from the rest of the grid and enter an intentional islanded mode in a case of loss of utility source. The intentional island will be created by physically disconnecting the group of electrical circuits from the utility system and operating those circuits independently. In addition, all generation will follow system load and maintain system voltage within American National Standards Institute (ANSI) c84-1 standards when in island mode.

The MG has an UPS to maintain continuous electricity service for specific systems or circuits. The UPS system relies on storage batteries, with backup generators to ensure power supply for a longer duration.

The Bay Park STP is surrounded by a concrete wall and plans are to construct a storm water pump station inside the site to protect the site from flooding. The backup generators will be positioned on the roofs of several of the buildings to provide further resiliency. There will be several small diesel generators which will provide a black start to the backup generators for the MG. The critical facilities will be sandbagged by the County and waterproofed over the next several years. These measures will ensure the MG site and host infrastructure will be more resilient during the next storm.

Sub Task 1.2 Preferable MG Capabilities

Since Bay Park STP will soon be connected to the grid with enough capacity to run the entire facility, it is assumed that the existing tri-fuel engines will initially be utilized in conjunction with digester gas as the fuel to provide energy to the MG outside the fence line. The new system will utilize new aboveground feeders and interconnect hardware between Bay Park STP and the facilities selected in this feasibility study.

The Control and Communication System envisioned could eventually include technologies that enable customer and operation interaction via MG Logic Controllers, Smart Grid technologies, Smart Meters, distribution automation and storage capacity. The system may be designed to have an active network control functionality in order to be able to optimize demand, supply and network operations. The design and construction of the system should be coordinated and optimized with the Reforming the Energy Vision (REV) work to ensure the MG provides the most innovative services to customers. The ultimate benefit cost analysis will include not only the benefits to the community, Nassau County and potential developers, but to the environment and the quality of life of the surrounding population. Since currently the MG outside the fence line is only contemplated to provide power during emergency conditions, the systems can be designed to include space and functionality for future enhancements necessary to connect residential and commercial facilities.

Nassau County and SUEZ have taken the approach to assess as many clean, green power alternatives that appear to be practical and innovative. The advanced sludge digestion process that will be evaluated will not only produce more and higher quality digester gas, but also produce a material that can be used as a fertilizer. Truck traffic leaving the facility will also be reduced, helping to decrease greenhouse gases emissions and air pollution generated by transportation, as well as noise and traffic nuisances. Wind and Solar Power are two more power sources that are clean energy and can add to the benefits provided by the MG.

There are many private companies interested in investing funds in the pursuit of new technologies at Bay Park STP, specifically, in Advanced Sludge Digestion technology. Similarly, there are potential private developers in the solar, wind and fuel cell arenas that have expressed interest in the MG project. All of these clean and green energy producers can and will produce tangible community benefits such as jobs, environmental health, better electrical infrastructure to essential facilities, and better energy efficiency. Finally, the MG system will provide a platform for customers to be able to interact with the grid in ways that maximize its value, and hopefully change the way people view the grid. Fuel cells and other more efficient power generating systems will ultimately be the long term CHP system utilized at Bay Park STO and their costs have been included in the Benefit Cost Analysis, attached as **Appendix A**.

Task 2: Develop Preliminary Technical Design Costs and Configuration

Subtask 2.1: Proposed MG Infrastructure and Operations

The MG (represented in **Figure 2.1**), outside the fence line, will be installed and used only in the event of an emergency, such as a hurricane or other type of major power outage that leads to mass power losses in the Bay Park area. However, during normal operations the MG system can be used to reduce the amount of power used at Bay Park STP from the electrical utility, PSEG grid. During an emergency, any treatment process train at Bay Park STP will receive the necessary power to operate prior to energy being switched to the infrastructure outside the fence line. The MG will be exercised on a quarterly basis to ensure its operability.

The MG will be housed at Bay Park STP. As discussed on page 1.3, Bay Park STP is one of two wastewater treatment plants on the south shore of Long Island owned by Nassau County and operated by SUEZ. The facility is designed to treat 70 million gallons per day (MGD) and currently treats an average of 50 MGD. Post Superstorm Sandy (Sandy), a flood wall has been constructed around the perimeter of the facility to protect it from future floods and tidal surges. This will ensure the operability of the backup generators and the process units at Bay Park STP.

Currently, Bay Park STP is a self-powered facility during normal operation. There are nine on-site, rented Aggreko 1200 Kilowatts (KW) generators that run on natural gas and serve as back-up or stand-by power. The original four 30 year old 3600 KW tri-fuel engines have new control systems and were recently rebuilt and overhauled post Sandy. These engines are capable of running on diesel, natural gas or digester gas. A vast majority of the time the engines run on natural gas or a blend of natural gas and digester gas. Diesel is rarely, if ever, used to fuel the engines. Daily peak operation is approximately 5.5 Megawatts (MW) with a 6.2 MW generator capacity, as there is only sufficient ancillary systems to operate two generators at one time. However, at the end of 2017, the load at the plant is expected to be 6.0 MW on average, with a peak of 7.0 MW. Therefore, for purposes of this study 7.0 MW will be the average load. The Aggreko generators are capable of supplying power to the entire plant. Once the Bay Park Phase E3 Main Substation and Electrical Distribution Project is completed in 2018, the plant will have 7.2 MW of backup power. Shortly thereafter, the electric utility provider (PSEG) will install two large feeders for providing all of the Plant's needed electricity.

The site manages its own electric distribution throughout the series of process units. Transfer switches configure service to each building and treatment process. All switches are automated. There are UPS on seven units with battery cells to provide enough power for one hour of plant controls. The plant has been down twice in the last four years. In these instances, the plant is connected to the local energy provider, PSEG for limited service. The utility service is currently inoperable; it is being restored under a current construction project.

Figure 2.1: Simplified Facility Connection Layout

The MG will generate energy at Bay Park STP and then power the following facilities, described on page 1.4 during a major power outage:

- **The East Rockaway Village Hall**
- **Centre Avenue Elementary School**
- **Rhame Avenue Elementary School**
- **East Rockaway Junior-Senior High School**
- two **East Rockaway Fire Department** locations
- **The East Rockaway Public Library**
- **The East Rockaway Public Works**
- **The East Rockaway Post Office**

Subtask 2.2: Load Characterization

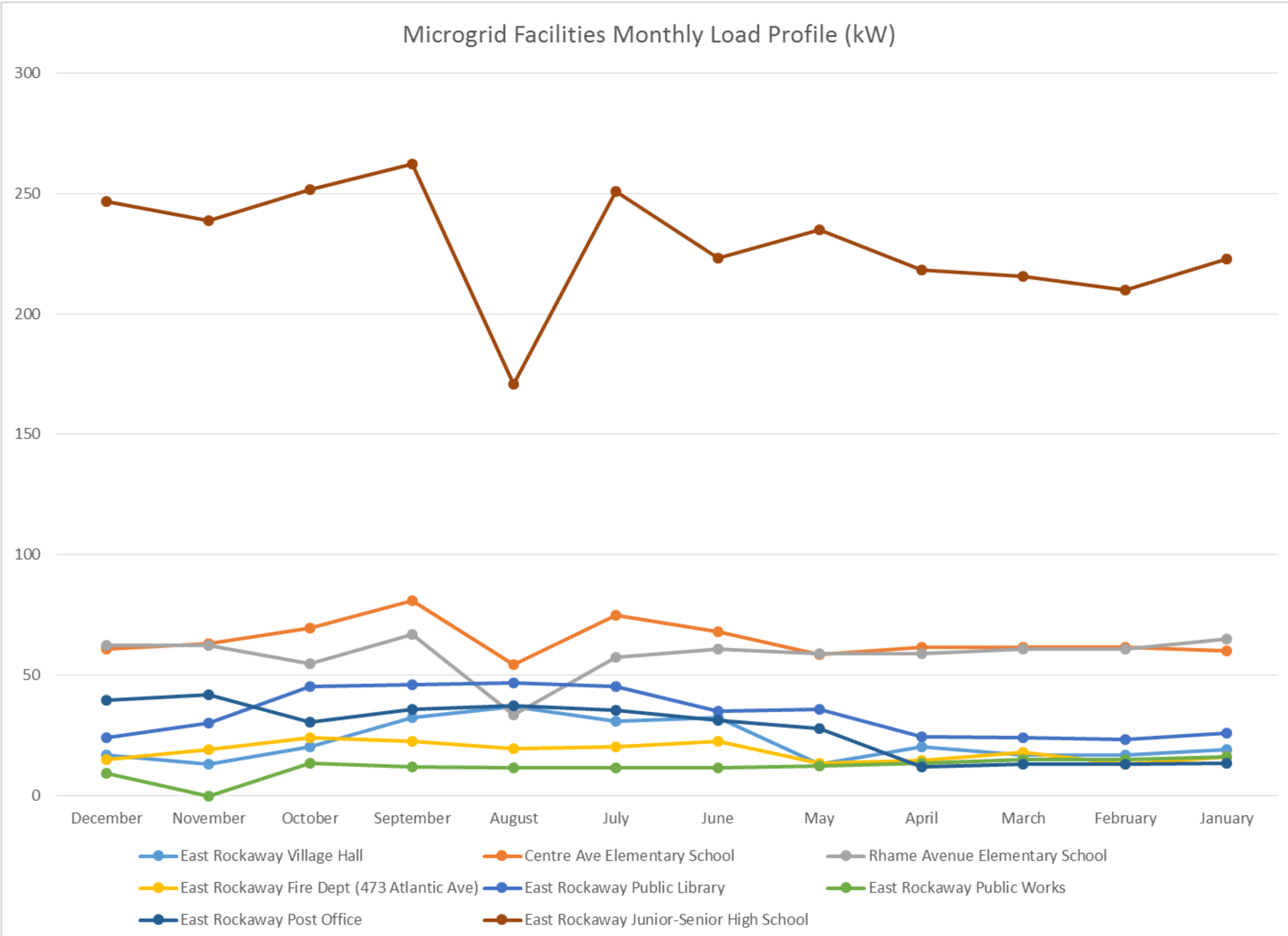
The electrical loads for the MG infrastructure are included below in **Table 2.1** and in **Figure 2.2.** The facilities' load information was provided by the located electrical utility, PSEG.

Table 2.1: Load Characterization

Infrastructure	Peak KW	Average KW	Average Annual KWh	Average Monthly KWh	Average Weekly KWh
Bay Park STP	7500	7500	65,700,000	5,475,000	1,263,462
East Rockaway Village Hall	42	23	67,840	5,653	1,413
Centre Avenue Elementary School	87	63	224,980	18,748	4,687
Rhame Avenue Elementary School	73	52	248,397	20,700	5,175
East Rockaway Fire Department (473 Atlantic Ave)	34	20	57,600	4,800	1,200
East Rockaway Fire Department (469 Atlantic Ave)	*Not recorded*	*Not recorded*	10,546	879	220
East Rockaway Public Library	81	43	145,820	12,152	3,038
East Rockaway Public Works	16	10	27,705	2,309	577
East Rockaway Post Office	42	25	82,513	6,876	1,719
East Rockaway Junior-Senior High School	262	219	729,000	60,750	15,188

Information from PSEG, 2015-2016

Figure 2.2: Monthly Load Profile



**kW are not recorded for the East Rockaway Fire Department located at 469 Atlantic Avenue.*
***Bay Park STP's load profile remains steady at an average of 7,500 kW*
Load information from 2014, PSEG.

The MG outside the fence line will not be powered unless during an emergency condition. However, inside Bay Park STP, the system will be used to reduce the amount of power that is purchased from the grid. Therefore, the MG will be functioning in islanded mode outside of the facility when the local power supply is not operable. The MG islanded mode and parallel mode operations are shown in **Figure 2.3** and **Figure 2.4** respectively. It is the intent of the system to provide power to the identified facilities at their peak load via a CHP system and using the new backup generators when necessary. This assumes the new PSEG feeders are not in service. The backup generators will provide up to 7.2 MW in the islanded mode to Bay Park STP. It is not anticipated that the backup generators or the CHP would normally operate in the parallel mode during a large scale power outage.

During normal conditions (no power outage), the CHP would operate in the parallel mode with the duel feed from PSEG. It is anticipated that the CHP would produce power for a set of processes within the treatment plant.

Figure 2.3: Islanded Mode Diagram

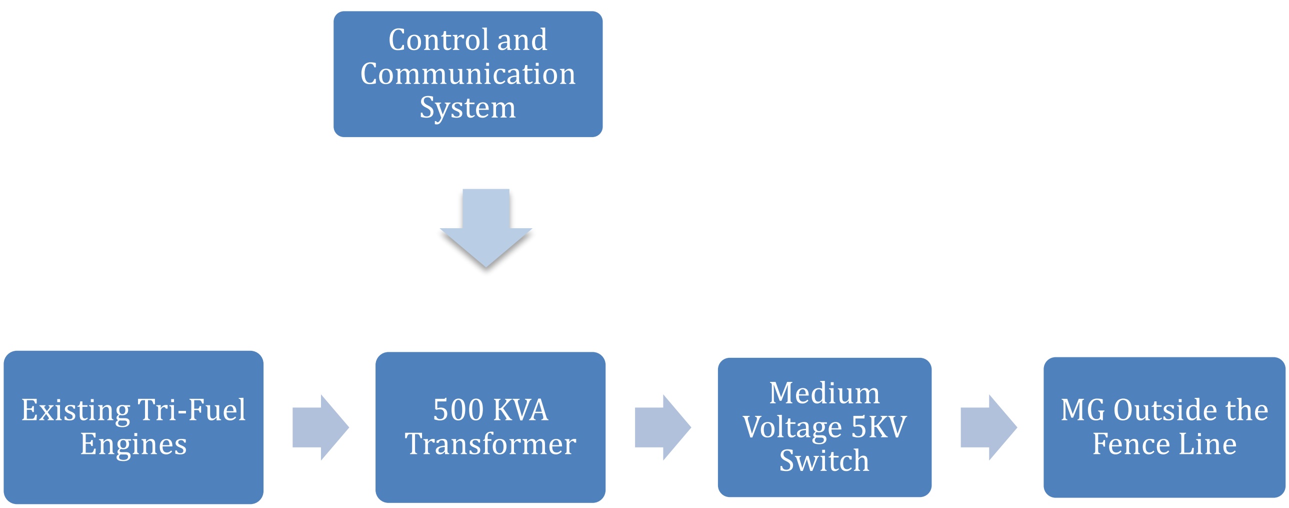
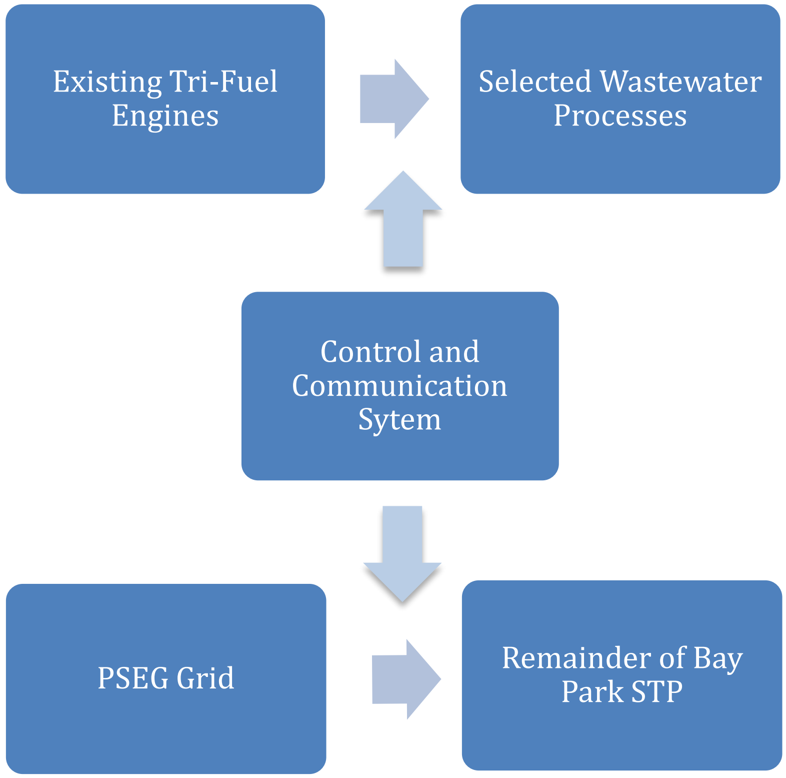


Figure 2.4: Parallel Mode Diagram



Subtask 2.3: Distributed Energy Resources Characterization

For this feasibility study, the County will look at the ability to implement a variety of supplemental Distributed Energy Resources (DERs) that could be implemented at the site over a period of time. The sites of the possible new and existing DERs are represented in **Figure 2.5**. The paramount issue is to utilize existing infrastructure to limit the amount of capital dollars and to plan to use the most efficient energy generating systems for the long term.

The East Rockaway Bay Park Community MG may utilize a variety of DERs and Thermal Generation Resources. As stated in Task 1, Nassau County plans on utilizing Advanced Sludge Digestion and Combined Heat and Power (CHP) to produce additional energy to be distributed throughout Bay Park STP and to be utilized in the MG, when necessary. The tri-fuel engines already exist on-site and are connected to many of the major on-site distribution system which will allow for power generation at a very low capital cost. This system with the old engines will only power up the MG outside the fence line and only during emergencies conditions. Similarly, Wind Power and Solar Power are being evaluated as potential sources of energy that can supplement the MG system. Finally, a fuel cell or other more efficient systems, which will run off natural gas or digester gas are currently being evaluated to provide an additional future source of constant power into the Bay Park STP and the MG, and is much more efficient than the existing 30 year old 3600 KW tri-fuel engines.

Figure 2.5: New and Existing DER Sites

The described power sources are shown below in **Table 2.2.**

Table 2.2: Potential MG Power Production Technologies

Technologies	Potential MG Power Production	Fuel
Advanced Sludge Digestion/CHP *(partially existing)*	2.5MW	Digester Gas
Wind Power *(new)*	1.0 MW	Wind
Solar Power *(new)*	1.5 MW	Solar
Fuel Cell *(new)*	1.0 MW	Natural Gas/Digester Gas
*Tri-Fuel Engines *(existing)*	5.5 MW	Natural/Digester Gas
Total	**6 MW**	

**Tri-fuel Engine power production will be limited to the amount of digester gas production; 2.5MW*

Advanced Sludge Digestion

The Advanced Sludge Digestion DER system would be located inside the fence line of Bay Park STP. The digesters, gas collection, advanced sludge digestion process and CHP will be located behind a flood wall to protect the facility from storm surge, thus providing a resilient energy source. The digesters and gas collection system already exist at the facility and are, or will be, in good working order. Additional equipment associated with the thermal hydrolysis facility will be sited in the existing Sludge Dewatering Building and the adjacent property. Initial estimates show that the combination of the new technology and cleaning out of the existing digesters should increase the production of gas significantly.

The advanced sludge digestion system and CHP can operate 24/7 and are not dependent on another resource to produce power. Therefore, its adequacy to continuously meet the demand of the MG is high. This form of energy generation is renewable therefore, it can run indefinitely, providing the facility is processing wastewater.

As discussed on page 1.6, the County and SUEZ have evaluated various options for a new 2.5 MW CHP system including reciprocating engines and microturbines. Based on a triple bottom line analysis, reciprocating engines were found to have the best payback and would provide long term renewable energy production from biogas. The new CHP units would replace the existing tri-fuel engines which are reaching the end of their useful lives. These new CHP units are proposed to be built at the Bay Park Sewage Treatment Plant site and because biogas is infinitely available at the plant, the new CHP system can operate 24/7 and continuously meet the demand of the MG.

Combined Heat and Power (CHP)
The tri-fuel engines are existing at the facility and have been rebuilt after Sandy, and will be used initially as the CHP for the MG. The CHP system can operate 24/7 and is not dependent on another resource to produce power. Therefore, its adequacy to continuously meet the demand of the MG is high. Additionally, since this form of energy generation is renewable, it can run indefinitely. The CHP system is located inside of the Bay Park STP Main Building, sheltering it from all weather conditions.

Wind Power
A wind turbine will be evaluated to consider being constructed on the southern part of Bay Park to harness Wind Power. The turbine would require minimal dedicated surface area within the park. The wind turbine is dependent on the current wind speed, therefore, its ability to meet the demand of the MG will vary. Since this form of energy generation is renewable, it can produce power as long as the weather allows it to. The wind turbine is tall enough to be resistant to possible flooding and is structurally designed to withstand the high winds of a weather event such as a hurricane. As with most wind turbine installations, there is a need to permit a facility which may be controversial in the Bay Park area. For purposes of this study, the technology is proven, but the ability to implement it is unknown and beyond the scope of this study.

Solar Power
Solar panels will be evaluated to be installed on the rooftops of the buildings located on the Bay Park STP campus. There is approximately 200,000ft^2 of available surface area on top of the administration building and other buildings within Bay Park STP where these solar panels can be implemented.

The solar panels are dependent on the current sun position and cloud cover. Therefore, its ability to meet the demand of the MG will vary. This form of energy generation is renewable, meaning it can produce power as long as the weather conditions are favorable. Much like wind power, solar may be controversial and must be further evaluated with the local civic groups and is beyond the scope of this study.

Fuel Cell
The Fuel Cell is a more modern and efficient generator of energy, which may be the long term solution to CHP at the Bay Park Plant for all, or a portion of the digester gas that can be converted to energy to reduce the load from the grid or to power the MG. The units are small and can be placed in a variety of locations that allow them to be connected to the existing, or new electrical infrastructure. It is the intent of the County to utilize the existing tri-fuel engines initially, during emergencies in order to reduce the capital costs of the project. However, the County plans to explore potentially utilizing fuel cells or a new CHP system as a long term solution.

Subtask 2.4: Electrical and Thermal Infrastructure Characterization

All energy will initially be generated at Bay Park STP by the existing tri-fuel engines. The site of the existing engines at Bay Park STP can be seen in **Figure 2.6** and **Figure 2.7**. The existing electrical infrastructure will provide the means to distribute the energy throughout the various process trains and equipment necessary to operate the portions of the plant. Since the plant will be mainly operating off the grid, only a portion of the facility will be powered by the CHP/Tri-fuel engines. SUEZ and Nassau County will decide and implement the necessary configuration of distributed energy in parallel with the energy from the PSEG grid. The waste heat from the engines is used in concert with heat exchangers to warm the sludge loop for the anaerobic digesters.

Outside the fence line, the MG will be connected using overhead feeders between Bay Park STP and the critical facilities. Once the power is created and leaves the tri-fuel engines, it will pass through a series of transformers and switches prior to entering the overhead lines. These feeders will connect to a series of medium voltage and low voltage switches that will be located adjacent to of each critical facility, represented in **Figure 2.8.**

All electrical infrastructure included in the MG will be new or is already existing within Bay Park STP.

There are several projects underway at Bay Park STP to make the entire facility more resilient to flooding and other damage that occurred during the last major storm event. Therefore, during a widespread power outage due to a weather event, energy will still be able to be generated at Bay Park STP to power the MG. Considering the energy that will be generated at Bay Park STP for the MG is renewable energy, it will be able to power the MG indefinitely, due to the fact that there are 7.5 MW of backup power being installed at the plant.

The proposed overhead feeders will be resilient to flooding and wind occurrences, which was the largest problem, during Superstorm Sandy. Additionally, the equipment located at the critical facilities will be elevated and properly sheltered to protect it from flooding.

The MG will not be interconnected with the grid and will be dedicated to the identified facilities in **Table 2.1**. The MG will use completely new electrical infrastructure.

Figure 2.6: Bay Park STP Site Plan

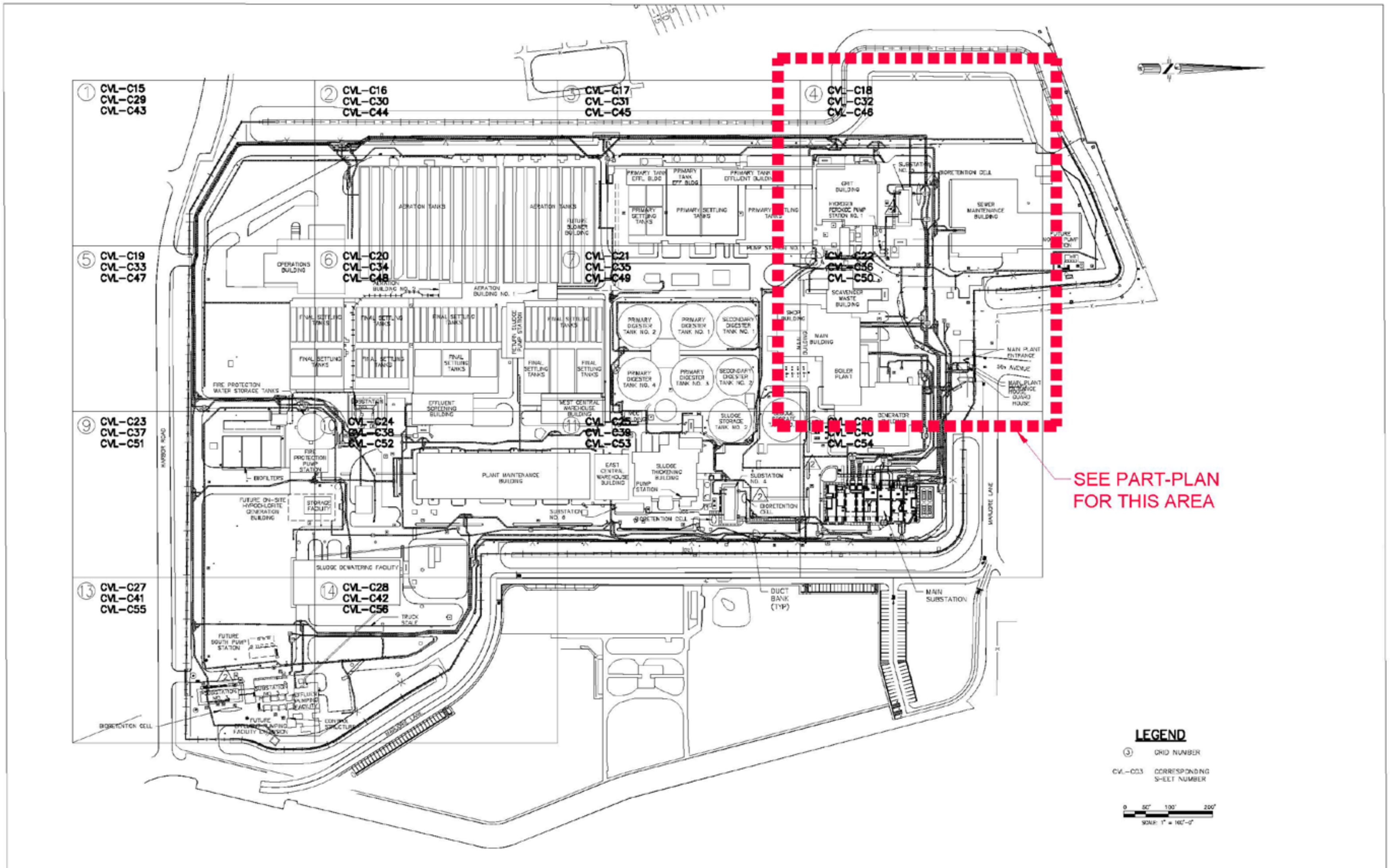
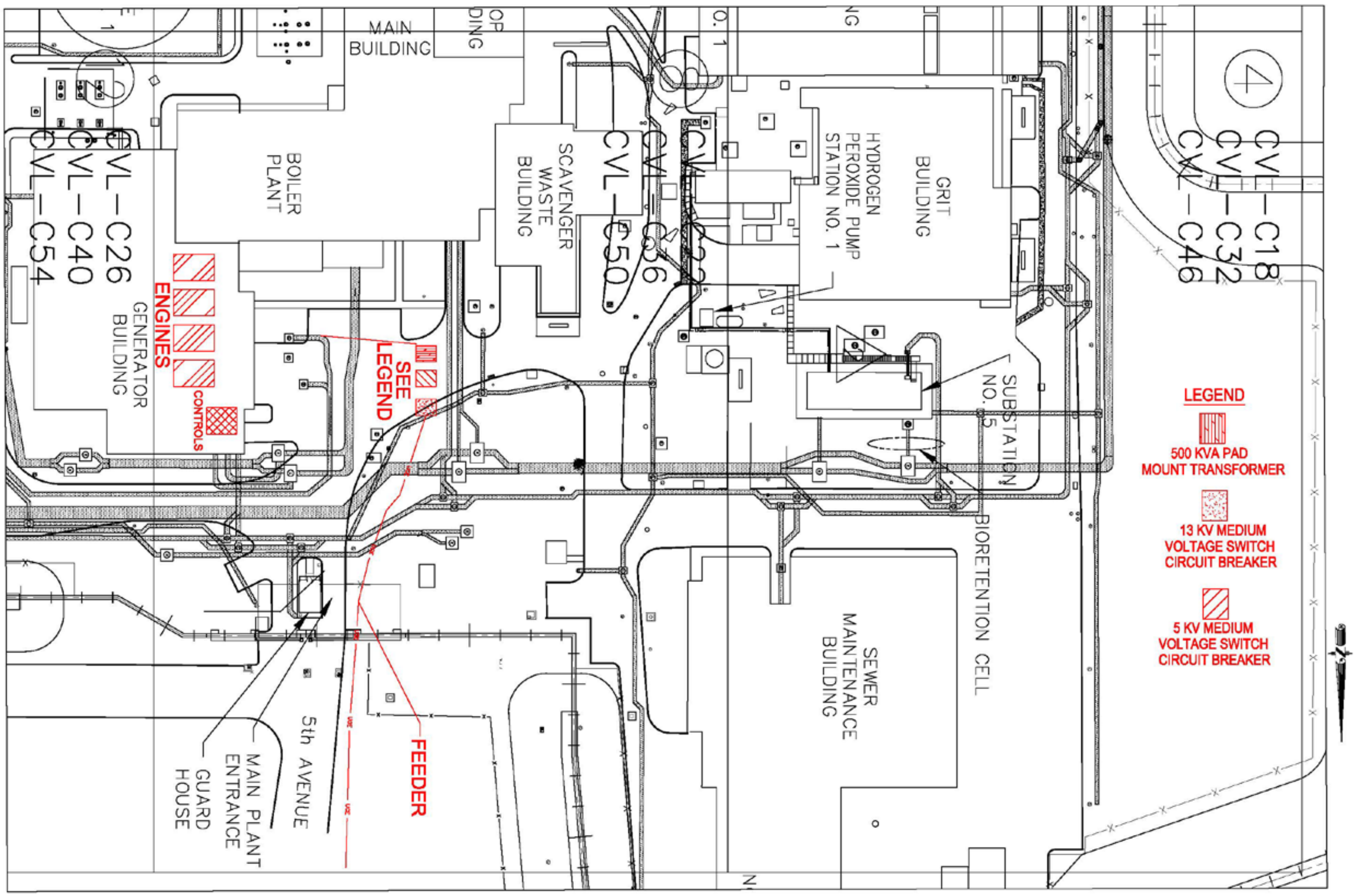
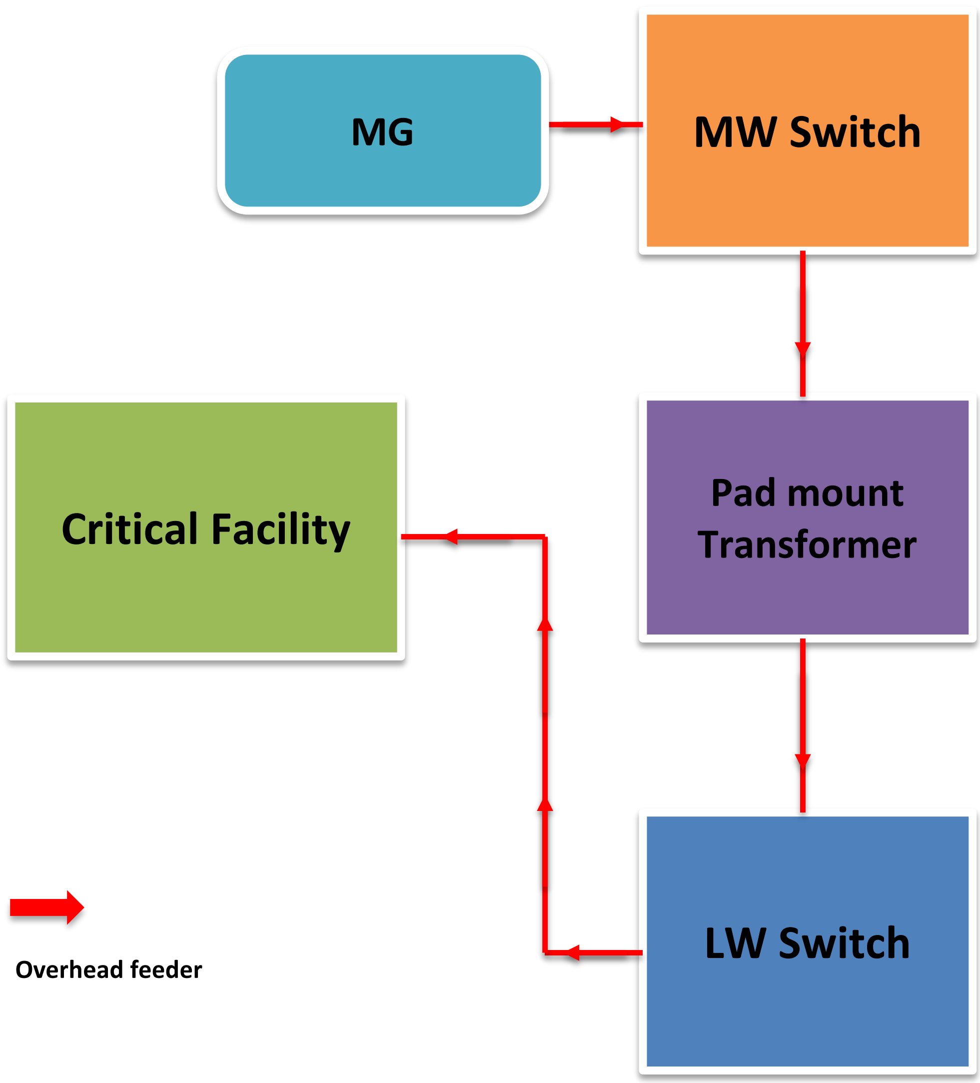


Figure 2.7: Bay Park STP Electrical Infrastructure- MG Part Plan



PART-PLAN

Figure 2.8: Simplified Equipment Layout Diagram



Subtask 2.5: MG and Building Controls Characterization

The MG controls will be housed and operated at Bay Park STP, the site of the controls is shown in **Figure 2.7**. The MG Control Characterization will include the design elements:

Master Control Station at Bay Park STP

- Located within the fence line of Bay Park STP
- Able to serve both Bay Park STP and the other selected infrastructure in **Table 2.1**
- Communication link to MG automation/switching
- Communication link to selected infrastructure and local utility
- No local controls at the selected infrastructure; all managed from master controller
- All feeder automation is sent directly from Master Control Station
- Field Area Network (FAN) will be basic wireless mesh network with optional microwave or 3G/4G backup
- Assumes the switching controllers that configure the feeders which serve the designated facilities can be reached wirelessly from Master Control Station.

Software Assumptions

- Only providing basic MG control functions; only DG control, feeder switching and automation and protection control logic
- No automation at the buildings (outside the fence line only)
- Assumes load is well defined across a specific range
- No custom code or integration software necessary to perform dynamic supply/demand balancing or automated demand response functions
- There will be no utility integration.

The controls for the MG outside the fence line are anticipated to have a minimal architecture, since it is planned only to be used during emergencies. The hardware and software located in the Master Control Station generally include the following:

The portion of the MG used within Bay Park STP will be potentially operated in parallel with the PSEG grid. As, previously stated, the CHP will be utilized to reduce the amount energy purchased from the grid or load shedding. The MG will not be used to sell power back to the grid.

The MG controls will include a black start capability.

The MG can operate when there is a loss of communications from the utility, as there is no connection between the MG and the utility.

The IT and telecommunications infrastructure will be extremely resilient, as they will be housed within Bay Park STP.

Task 3 Assessment of MG's Commercial and Financial Feasibility

Per **Task 3**, an assessment of the commercial and financial feasibility of the proposed MG project was conducted.

Sub Task 3.1 Commercial Viability- Customers

In the event of an emergency and a local power grid failure, the Village of East Rockaway will be the main customer purchasing the services from the County's MG. Additionally, the Village of East Rockaway will also be the major stakeholder. Currently, it is anticipated that no residential customers will be connected to the MG. Power will only be generated and purchased during emergencies when the main PSEG grid is down. During non-emergency situations, the Combined Heat and Power (CHP) process which produces the energy for the MG will be used to offset the amount of energy purchased from the PSEG grid on a daily basis.

It is anticipated that there will be a contractual agreement with Nassau County and the Village of East Rockaway, once the project is approved. An additional agreement will need to be signed between Nassau County and the United States Postal Service, so that the East Rockaway Post Office can also be connected.

See **Table 3.1**: Summary of MG Customers for a breakdown of the MG's customers and the populations that they serve.

Table 3.1: Summary of MG Customers

Facility	Population Served
*Bay Park STP	530,000
East Rockaway Junior-Senior High School	561
Rhame Avenue Elementary School	300
Centre Avenue Elementary School	300
East Rockaway Public Library	9,818
East Rockaway Post Office	9,818
East Rockaway Village Hall	9,818
East Rockaway Public Works	9,818
East Rockaway Fire Department (473 Atlantic Ave)	9,818
East Rockaway Fire Department (469 Atlantic Ave)	9,818

**Bay Park STP will run off the PSEG grid and the CHP will be run in Parallel Mode*

Sub Task 3.2 Commercial Viability- Value Proposition

The community will experience crucial benefits with the construction and operation of the proposed MG project. First, critical facilities will be powered during emergencies and disastrous weather events. These facilities can be used for shelter, meeting areas and staging areas for emergency personnel. Additionally, the CHP will create energy to be used within Bay Park STP, which will reduce the amount of energy purchased from PSEG. This will save the County money and keep the taxes lower for the citizens of the County. All of the MG energy generation is created by renewable digester gas, which reduces the need for purchasing additional natural gas or power from the grid.

Installation of the MG would also benefit the utility, PSEG. During a major power outage, it would be less pertinent that PSEG get its services up and running quickly, as the surrounding critical facilities would be powered by the MG. The community or the electrical utility would not incur any costs associated by the construction and operation of the proposed MG.

The main weakness associated with this project is that it will not produce a constant revenue stream, as it will only function during emergencies. However, the CHP will produce enough energy to offset a significant amount of energy purchased from the PSEG grid.

There is the opportunity to expand the MG to include other critical facilities and to increase the amount of energy produced by increasing the generation sources at Bay Park STP.

The major threat to the MG would be a major storm event that damages the overhead distribution system or a much larger storm than Superstorm Sandy (Sandy) that inundates Bay Park STP. Many measures have been taken to prevent this, including construction projects to make the plant more resilient to storm events.

The MG's technology is unique whereas, the fuel source for the CHP is renewable digester gas, which gas generation is increased by a system that creates more gas and an additional renewable Class A biosolids.

This project is replicable, due to the fact that most urban and suburban areas of New York State have wastewater treatment facilities that produce digester gas and may have additional energy schemes that would allow for a MG to be beneficial.

The purpose of this project is to ensure that during a major storm event or other mass power outage, the included critical facilities can still be operational. Bay Park STP was severely damaged from the tidal conditions of Sandy. The majority of the facility was inundated with saltwater causing power outages. The critical facilities included in the MG also incurred flooding and power outages. The propose of the proposed MG is to prevent these customers' needs going unserved due to another storm or other outage. Bay Park STP is currently under construction to increase its resiliency during similar storm events. One of the resiliency measures is to build a berm to prevent the effects of tidal conditions that increases its resilience to electrical outages. With the MG power sources located at Bay Park STP, they should remain functional during a similar storm event.

The overall value proposition for all customers of the proposed MG is that they will be provided with clean, renewable and resilient power during an emergency or mass power outage. With this power they will be able to continue to serve their customers and their community during times of crises.

The MG also poses a different value proposition to New York State. The proposed project promotes New York State's energy policies, such as the Renewable Portfolio Standard and NY REV. The MG will emit small amounts of greenhouse gases and it only generates energy using renewable energy processes.

There will be savings generated by the MG. Since all MG energy will be generated using renewable resources, thereby reducing the cost of buying additional energy. These savings include the cost of buying and replacing backup generators during emergencies. Additional savings include the costs of purchasing the fuel to power these backup generators.

Sub Task 3.3 Commercial Viability- Project Team

Currently, the MG project has the support of the local municipality, the Village of East Rockaway, Nassau County and Suez. Additionally, the electrical utility, PSEG has pledged its support. The Project Team plans to continue to work with the community groups to gain their recommendation to design and build the system. It is anticipated, when the MG is constructed Suez will operate the MG in concert with the CHP and the rest of the Bay Park STP.

As part of the feasibility study, the project team has had multiple meetings and conversations with private suppliers of energy sources and private energy providers looking for access into new markets. All the different vendors have portfolios that include potential public/private partnerships (P3) or lease back agreements that would need to be further developed with Nassau County. The County is currently implementing billions of dollars of capital improvements across the county and is entertaining billions more of P3 opportunities associated with concessions for a power plant and the entire wastewater system. Nassau County is one of the most progressive governments in New York State and has the financial strength and professional knowledge to implement any number of P3 projects including a MG.

Sub Task 3.4 Commercial Viability- Creating and Delivering Value

The specific MG system was chosen based on utilizing existing infrastructure to reduce the amount of necessary capital costs and to utilize renewable fuel already existing at the facility. Also, to implement unique technology that increases digester gas and its quality, while at the same time creating a useable end product which further enhances the value added by the proposed system.

Since the operations of the system are within the confines of a County owned facility, which has been just retrofitted to ensure its resiliency during a major disaster, the additional long term attractiveness of this site and system could be repeated in a variety of locations throughout Long Island and New York State. The County is uniquely qualified to implement this type of infrastructure, as it has implemented projects of a similar size.

As for the operation of the MG, the system will balance loads easily during emergency conditions since it will only distribute power when the PSEG grid is down. During non-emergency conditions, the power will be distributed within the Bay Park STP facility, thus reducing the amount of energy purchased.

As in most of the County's public works projects, the County normally solicits qualifications or proposals from the engineering or consultant community and selects the most qualified firm or entity to perform the planning and design of the project. Then the design is put out to public bid and the lowest most responsible bidder is awarded the job. During the planning phase public meetings are held and special permits are acquired on an as needed basis prior to final design and bidding. However, the County could choose to entertain proposals from private entities for a P3 providing the proposals were structured in a format that was lawful in the State of New York.

Sub Task 3.5 Financial Viability

Initially, there will be no revenue streams associated with the MG (outside the fence line), as it will only be utilized during emergencies. The real financial savings will be in reducing the amount of power purchased off the grid and utilizing renewable fuel and existing CHP infrastructure.

The capital costs incurred to the MG owner will be fixed. These costs include the planning, design and construction of the MG. The operating costs incurred to the MG owner will be variable. Both of these costs are included in **Task 4: Develop Information for Benefit Cost Analysis**.

Sub Task 3.6 Legal Viability

The project's owner and applicant, is Nassau County. The only additional stakeholder is the Village of East Rockaway.

Nassau County owns Bay Park STP. The Village of East Rockaway, which is located in Nassau County owns the remaining facilities with the exception of the East Rockaway Post Office which is owned by the United States Postal Service. Nassau County and the Village of East Rockaway work closely on a regular basis and the Village of East Rockaway has already expressed interest in the project. Therefore, we do not foresee any issues with installing equipment at these locations.

Protecting the privacy rights of the customers is not anticipated to be an issue, as the owners and customers are municipalities and the federal government.

Task 4 Develop Information for Benefit Cost Analysis

As part of NYSERDA's NY Prize Community MG Competition, Nassau County was to provide to preliminary design and configuration costs for the MG system as well as a breakdown of the necessary load conditions for the facilities. Once that was completed, the data was provided to IEc to conduct a screening level analysis of the projects potential costs and benefits. The Benefit Cost Analysis Summary report and a print out of the spread sheet is included in **Appendix A**.

Per **Task 4: Develop Information for Cost Benefit Cost Analysis**, information required for the Benefit Cost Analysis has been developed and provided below.

Sub Task 4.1 Facility and Customer Description

The proposed MG consists of ten connected critical facilities located in East Rockaway. The majority of the critical facilities connected to the MG are considered large commercial/industrial rate class facilities, shown below in **Table 4.1.** Also shown below, all of the represented facilities are considered part of the "All other industries" economic sector code. Lastly, no multiple rate payers are present at any of the connected facilities.

Table 4.1: Facilities- Rate Class and Economic Sector

Facility Name	Rate Class	Economic Sector Code
Bay Park Sewage Treatment Plant	Large Commercial/Industrial	All other industries
East Rockaway Village Hall	Large Commercial/Industrial	All other industries
East Rockaway Junior-Senior High School	Large Commercial/Industrial	All other industries
Centre Avenue Elementary School	Large Commercial/Industrial	All other industries
Rhame Avenue Elementary School	Large Commercial/Industrial	All other industries
East Rockaway Dept. of Public Works	Large Commercial/Industrial	All other industries
East Rockaway Public Library	Large Commercial/Industrial	All other industries
East Rockaway Fire Dept. (473 Atlantic Ave)	Large Commercial/Industrial	All other industries
East Rockaway Fire Dept. (469 Atlantic Ave)	Small Commercial/Industrial	All other industries
East Rockaway Post Office	Large Commercial/Industrial	All other industries

Below in **Table 4.2** each facility's average annual electricity usage (MWh) and its peak electricity demand per customer (MW) are represented. Each facility consist of one customer. For Bay Park STP, the customer is Nassau County. For the Post Office, the customer is the U.S. Postal Services. For all other facilities the customer is the Village of East Rockaway. Since there is only one customer per facility, there is only one figure per facility.

Table 4.2: Facility Load Characterization

Facility Name	Average Annual Electricity Usage Per Customer (MWh)	Peak Electricity Demand Per Customer (MW)
Bay Park Sewage Treatment Plant	65700	7.5
East Rockaway Village Hall	68	0.04
East Rockaway Junior-Senior High School	729	0.26
Centre Avenue Elementary School	225	0.09
Rhame Avenue Elementary School	248	0.07
East Rockaway Dept. of Public Works	28	0.02
East Rockaway Public Library	146	0.08
East Rockaway Fire Dept. 473 Atlantic Ave)	58	0.03
East Rockaway Fire Dept. (469 Atlantic Ave)	11	*Not recorded*
East Rockaway Post Office	83	0.04

**Information provided by PSEG, 2015-2016*

The MG would be able to support one hundred percent of the demand from all of the connected facilities, shown below in **Table 4.3**. The MG will not power Bay Park STP as the facility with have a direct feed from PSEG. The MG would be able to meet the demand of these facilities indefinitely, as the energy is generated using mostly renewable energy processes.

Table 4.3: Percentage of Facility Average Demand Supported by the MG

Facility	Average Demand Supported by MG	Number of Hours Per Day Electricity Required from MG
Bay Park Sewage Treatment Plant	100%	24
East Rockaway Village Hall	100%	24
East Rockaway Junior-Senior High School	100%	24
Centre Avenue Elementary School	100%	24
Rhame Avenue Elementary School	100%	24
East Rockaway Dept. of Public Works	100%	24
East Rockaway Public Library	100%	24
East Rockaway Fire Dept. (473 Atlantic Ave)	100%	24
East Rockaway Fire Dept. (469 Atlantic Ave)	100%	24
East Rockaway Post Office	100%	24

Subtask 4.2: Characterization of Distributed Energy Resources

The proposed MG would potentially utilize the following Distributed Energy Resources (DERs).

Advanced Sludge Digestion

The Advanced Sludge Digestion process will use existing digester gas that is currently being generated at Bay Park STP and flared. Since the digester gas being utilized is excess, there will be no additional fuel consumption within this process. The Advanced Sludge Digestion will create a nameplate capacity of 2.5 megawatts (MW). During normal operating conditions the average annual power production is estimated to be 21,900 megawatt hours (MWh). During a major power outage, the average daily power production is projected to be about 60 MWh.

The advanced sludge digestion system and CHP can operate 24/7 and is not dependent on another resource to produce power. Therefore, its adequacy to continuously meet the demand of the MG is high. Additionally, this form of energy generation is renewable therefore, it can run indefinitely, providing the facility is processing wastewater.

As described on page 1.6, the County and SUEZ have evaluated various options for a new 2.5 MW CHP system including reciprocating engines and microturbines. Based on a triple bottom line analysis, reciprocating engines were found to have the best payback and would provide long term renewable energy production from biogas. The new CHP units would replace the existing tri-fuel engines which are reaching the end of their useful lives. These new CHP units are proposed to be built at the Bay Park Sewage Treatment Plant site and because biogas is infinitely available at the plant, the new CHP system can operate 24/7 and continuously meet the demand of the MG.

Combined Heat and Power (CHP)

Initially, the CHP system will utilize the tri-fuel engines are existing at the facility. The CHP system can operate 24/7 and is not dependent on another resource to produce power. Therefore, its adequacy to continuously meet the demand of the MG is high. Additionally, since this form of energy generation is renewable, it can run indefinitely. The CHP system is located inside of the Bay Park STP Main Building, sheltering it from all weather conditions.

Wind Power

The possibility of a wind turbine constructed on the southern part of Bay Park to harness Wind Power would be evaluated. The turbine would require minimal dedicated surface area within the park. The wind turbine is dependent on the current wind speed, therefore, its ability to meet the demand of the MG will vary. The nameplate capacity is 1 MW for the wind turbine. It is projected that this process will produce an average of 6,570 MWh annually under normal operating conditions. During, a major power outage, it is estimated that the turbine would produce an average of 18 MWh daily.

Since this form of energy generation is renewable, it can produce power as long as the weather allows it to and requires no fuel consumption. The wind turbine is tall enough to be resistant to possible flooding and is structurally designed to withstand the high winds of a weather event such as a hurricane. As with most wind turbine installations, there is a need to permit a facility which may be controversial in the Bay Park area. For purposes of this study, the technology is proven, but the ability to implement it is unknown and beyond the scope of this study.

Solar Power
Solar panels will be assessed to be installed on the rooftops of the buildings located on the Bay Park STP campus. There is approximately 200,000ft^2 of available surface area on top of the administration building and other buildings within Bay Park STP where these solar panels can be implemented. The solar panels are dependent on the current sun position and cloud cover. Therefore, its ability to meet the demand of the MG will vary. The nameplate capacity of the solar panels is 1.5 MW. It is estimated that this method would produce an average of 10,950 MWh annually, during normal operating conditions. In the case of a major power outage, it is estimated that the solar panels would produce an average of 30 MWh daily.

This form of energy generation is renewable, meaning it can produce power as long as the weather conditions are favorable and requires no fuel consumption. Much like wind power, solar may be controversial and must be further evaluated with the local civic groups and is beyond the scope of this study.

The proposed MG could have a nameplate capacity of 6 MW when combining all of the above DERs, shown below in **Table 4.4.** However, as stated earlier only the existing CHP (tri-fuel engines) and the digester gas produced by Advanced Sludge Digestion will be included in the final analysis of this current study. This system is rated at 2.5 MW.

Table 4.4: Characterization of Potential Distributed Energy Resources

Distributed Energy Resource	**Facility**	**Energy Source**	**Nameplate Capacity (MW)**	**Average Annual Production Under Normal Conditions (MWh)**	**Average Daily Production During Major Power Outage (MWh)**	**Fuel Consumption per MWh**	
						Quantity	**Unit**
Advanced Sludge Digestion	Bay Park STP	Digester Gas	2.5	21900	60	0	MMBtu/MWh
Wind Turbine *Future Potential*	Bay Park STP	Wind	1	6570	18	0	MMBtu/MWh
Solar Power *Future Potential*	Bay Park STP	Solar	1.5	10950	30	0	MMBtu/MWh
Fuel Cell *Future Potential*	Bay Park STP	Digester Gas	1	8760	24	0	MMBtu/MWh
Totals	**-**	**-**	**6***	**48180**	**132**	**0**	**-**

**Long-term potential DER*

Subtask 4.3: Capacity Impacts and Ancillary Services

For purposes of analyzing Benefit Cost rations, the total capacity of the CHP process was split between Available Peak Load Support and Available Demand Response Capacity. These capacities are represented below in **Table 5.**

Table 4.5: Description of Distributed Energy Resources Available Peak Load Support Capacity and Demand Response Capacity

Distributed Energy Resource	Available Peak Load Support Capacity (MW/year)	Available Demand Response Capacity (MW/year)
Advanced Sludge Digestion	1.25	1.25

Since the MG will only power facilities during an emergency, the power produced during normal operations would be unused. Therefore, the entirety of the capacity of the MG would be available to use for peak load support and for demand response.

The MG will have a black start capability. Therefore, the MG will restore power to the connect facilities without relying on the external transmission network. It is no anticipated that here will be any associated impacts on the transmission or distribution capacity of the MG.

The CHP system will be powered by excess digester gas, therefore there will be no savings due to less fuel consumption. However, in the future, the County and SUEZ will look for more efficient CHP systems.

The emissions from the proposed energy sources will not be high enough to warrant the purchase of emissions allowances. The emissions per MWh are represented below in **Table 4.6**.

Table 4.6: Description of Emissions from Distributed Energy Resources

Emissions Type	Emissions per MWh	Unit
CO_2	0.272155746	Metric tons/MWh
SO_x	4.53593^{e-08}	Metric tons/MWh
NO_x	4.53593^{e-06}	Metric tons/MWh
PM	9.07186^{e-09}	Metric tons/MWh

Subtask 4.4 Project Costs

The estimated installed costs and engineering lifespan of the MG's capital equipment is described below in **Table 4.7**. Some capital costs may change, as the design of the MG is incorporated into the variety of projects that are being designed and construction at Bay Park STP.

Table 4.7: Description of Capital Components and Costs

Capital Component	Installed Cost ($)	Component Lifespan	Description of Component
Ph Line	$1,625,990.00	20	OH conductor to connect Bay Park STP to facilities
Ph Cable	$616,720.00	20	LV cable to connect Bay Park STP to facilities
MV Switch/Circuit Breaker	$270,000.00	10	Switches at all facilities
MV Switch/Circuit Breaker	$30,000.00	10	Switch at Bay Park STP
LV Circuit Breaker	$180,000.00	10	Circuit breakers at facilities
Pad mount Transformer	$180,000.00	10	Pad mount Transformer at facilities
Pad mount Transformer	$20,000.00	10	Pad mount Transformer at Bay Park STP
Transition Compartment	$20,000.00	10	Transition Compartment at Bay Park STP and facilities
Protection System Evaluation	$40,000.00	10	Model the existing system with new infrastructure and evaluate the protection system
Master Control Station Computer	$20,000.00	10	System Computer
Integrator	$1,500.00	10	MG Devise Integration
HMI/SCADA Development	$150,000.00	10	MG Command and Control SCADA
System Integration & I/F Modules	$250,000.00	10	Integration and Control Software
Control Station Computer	$5,000.00	10	Application Host Computer
Smart Meter	$1,000.00	10	Load Metering
Multifunction Controller	$10,000.00	10	DER Control Monitoring and Sensing
BEMS Integration	$50,000.00	10	Configuration/Integration
MDS orbit-MCR-4G access point	$2,200.00	10	MG Control Station network access point
MDS orbit- remote mxnx-u91-s1n	$1,500.00	10	MG remote control access point
MLS2400 Ethernet Switch	$3,000.00	10	Network switch panel for MG substation
Fuel Cell/More Efficient CHP System	$3,500,000.00	15	
Total Capital Costs	**$6,976,910.00**		

All above referenced equipment will be new.

Additional DERs, including solar and wind technology were also evaluated with this study as solutions for the long term. Therefore, these costs may need to be revised to include the costs of these technologies.

Other costs associated with the MG include:

- The initial planning and design costs are estimated to be about $600,000.00.
- The fixed operation and maintenance costs are projected to be $150,000.00.

- There are no variable O&M costs, excluding fuel costs, associated with the MG.

The DERs would be able to operate indefinitely in islanded mode without replenishing fuel supply, as the DERs operate on renewable energies. This is represented below in **Table 4.8.** This of course is contingent on the processing of wastewater and weather conditions at Bay Park STP.

Table 4.8: Maximum Amount of Time Energy Sources Can Operate Without Replenishing Fuel

Distributed Energy Resource	Facility Name	Duration of Design Event (Days)	Quantity of Fuel Needed to Operate in Islanded Mode for Duration of Design Event	Unit
Advanced Sludge Digestion with (CHP)	Bay Park Sewage Treatment Plant	Indefinitely	0	Gallons

Subtask 4.5 Costs to Maintain Service During a Power Outage

There is only one facility within the MG with an existing backup generator with any significant capacity, Bay Park STP itself, shown below in **Table 4.9**. The nameplate capacity of this generator is 7.2 MW. The generator's standard operating capacity during an extended power outage is one hundred percent. Therefore, 7.2 MW of power could be available during a major outage. The backup generator's average daily productions during a major power outage is 172.8 MWh per day. The fuel consumption associated with this average is 589.5 million British thermal units (MMBtu) per day at an ongoing operating cost estimated at $2,500 per day. The ongoing operating costs include maintenance costs and labor costs. Since the backup generator is already existing, there are no one-time operating costs.

Table 4.9: Description of Existing Backup Generation/Cost of Operating on Backup Power

Facility Name	Generator ID	Energy Source	Nameplate Capacity (MW)	Standard Operating Capacity (%)	Avg. Daily Production During Power Outage (MWh/Day)	Fuel Consumption per Day		One-Time Operating Costs ($)	Ongoing Operating Costs ($/Day)
						Quantity	Unit		
Bay Park Sewage Treatment Plant	Backup	Natural Gas	7.2	100	172.8	589.5	MMBtu/Day	0	$2,500.00

During a wide spread power outage and no available backup power, there would be additional costs in order to continue operations at all facilities. It would cost about $150,000 to rent the six needed 1.5 MW (5 working generators and 1 standby generator) generators per month for Bay Park STP. It would then cost $150,000 each to purchase generators to be installed at the other facilities. The generators at these facilities would be purchased rather than rented due to the cost of renting them for $10,000 per month. The cost would be offset within 15 months. Additionally, rented generators would be difficult to get onsite as quickly as they are needed during an emergency. The ongoing costs would include a rate of

$230 per MWh, this accounts for the fuel costs to operate the generators. These costs are broken down by facility below in **Table 4.10.**

Table 4.10: Cost of Powering Facilities if No Existing Backup Generation is Available

Facility Name	Type of Measure	Description	Costs	Units	When would these measures be required?
Bay Park Sewage Treatment Plant	One-Time Measures	Rent (6) 1.5 MW generators	$150,000.00	$/month	While backup power is not available
Bay Park Sewage Treatment Plant	Ongoing Measures	Fuel costs to operate generator	$41,400.00	$/day	While backup power is not available
East Rockaway Junior-Senior High School	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
East Rockaway Junior-Senior High School	Ongoing Measures	Fuel costs to operate generator	$459.37	$/day	While backup power is not available
Centre Ave Elementary School	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
Centre Ave Elementary School	Ongoing Measures	Fuel costs to operate generator	$141.77	$/day	While backup power is not available
Rhame Ave Elementary School	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
Rhame Ave Elementary School	Ongoing Measures	Fuel costs to operate generator	$156.52	$/day	While backup power is not available
East Rockaway Public Library	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
East Rockaway Public Library	Ongoing Measures	Fuel costs to operate generator	$91.89	$/day	While backup power is not available
East Rockaway Fire Department (473 Atlantic Ave)	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
East Rockaway Fire Department (473 Atlantic Ave)	Ongoing Measures	Fuel costs to operate generator	$36.30	$/day	While backup power is not available
East Rockaway Fire Department (469 Atlantic Ave)	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
East Rockaway Fire Department (469 Atlantic Ave)	Ongoing Measures	Fuel costs to operate generator	$6.65	$/day	While backup power is not available

East Rockaway Village Hall	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
East Rockaway Village Hall	Ongoing Measures	Fuel costs to operate generator	$42.75	$/day	While backup power is not available
East Rockaway Public Works	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
East Rockaway Public Works	Ongoing Measures	Fuel costs to operate generator	$17.46	$/day	While backup power is not available
East Rockaway Post Office	One-Time Measures	Purchase of generator	$150,000.00	$	While backup power is not available
East Rockaway Post Office	Ongoing Measures	Fuel costs to operate generator	$51.99	$/day	While backup power is not available

Subtask 4.6 Services Supported by the MG

Bay Park STP serves over half of the population of Nassau County, 530,000 people according to SUEZ. The East Rockaway Fire Departments and Public Works Department serve the entire population of East Rockaway, 9,818 people, according to the 2010 Census.

During an emergency event and major power outage these facilities are extremely critical. These facilities will have a 100% loss in services without available backup generation, shown in **Table 4.11**.

Table 4.11: Impact of Major Power Outage to Each Facilities' Ability to Provide Service

Facility Name	Percent Loss in Services When Using Backup Generation (%)	Percent Loss in Services When Backup Gen. is Not Available (%)
Bay Park STP	0	100
East Rockaway Fire Department (473 Atlantic Ave)	0	100
East Rockaway Fire Department (469 Atlantic Ave)	0	100
East Rockaway Public Works	0	100

Based off the information provided above, a cost benefit analysis was conducted by a third party economics firm. It was determined that the proposed MG yields a benefit cost ratio of 2.2. Therefore, the project benefits exceed the project costs by a multiple of two. This calculation is represented in the attached **Appendix A**.

Conclusions and Recommendations

In conclusion, the Village of East Rockaway Bay Park Community MG would benefit significantly from the addition of a MG system that has the ability to provide valuable power to a variety of facilities in the area during emergency conditions. Therefore, a decision to invest resources in this project, would be cost effective and provide a great benefit.

The MG yields a benefit cost ratio of 2.2 in an analysis conducted by IEc. This benefit cost ratio was calculated by IEc using a model developed specifically for NYSERDA to analyze the benefits and the costs of implementing MGs in New York State. IEc developed this model to evaluate the economic viability based on the information provided by the Project Team.

- The information provided to IEc for analysis includes, project costs, design and operating characteristics and connected facilities. Appendix A includes the analysis as well as the electronic spreadsheet that was used to produce the benefit cost ratio.

This scenario of the model assumes a 20 year operating period where no major power outages occur, only normal operating conditions. Considering that this scenario resulted in a benefit cost ratio greater than one (2.2), IEc did not provide a detailed analysis of the impact of major power outages under a second scenario. The second scenario would further increase the project's already positive benefit cost ratio. The model determined Net Benefits to be $34,000,000.00, in present value, with an internal rate of return of 61%. Clearly, constructing the MG for use during emergency conditions and as a separate power generation system run in parallel with the PSEG feeders to Bay Park STP has a huge benefit for the community and Nassau County.

The Village of East Rockaway and its neighboring communities were heavily flooded by Superstorm Sandy. The area experienced tidal surges as high as 11 feet. As a result, the area's infrastructure and housing was decimated. If the proposed MG were to be implemented, it could help mitigate the effects of a future storm event and provide much needed electricity to a variety of different facilities in the community.

Lessons Learned

Having a third party firm complete the benefit cost analysis for all of the feasibility studies was extremely beneficial to the project. It allowed the entirety of the results to be determined using the same assumptions and scenarios.

Benefit-Cost Analysis Summary Report

Site 11 – Village of East Rockaway (Bay Park)

PROJECT OVERVIEW

As part of NYSERDA's NY Prize community microgrid competition, the Village of East Rockaway (Bay Park) has proposed a microgrid that will use wind and solar power combined with fuel cell and combustion generators fueled by digester gas. 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.

East Rockaway is a community of approximately 9,900 residents located on the south shore of Long Island's Nassau County. The proposed microgrid resources would be concentrated at the Bay Park Sewage Treatment Plant (STP). Since incurring significant damage in Superstorm Sandy, the STP has been powered by rented natural gas generators. Under the proposed project, the STP would adopt advanced sludge digestion to enhance the recovery of digester gas. The digester gas would be used in a newly installed fuel cell with a nameplate capacity of 1.0 MW. The digester gas would also serve several reconditioned tri-fuel generators with a collective nameplate capacity of 2.5 MW. These generators were damaged in Sandy, but have been repaired and are currently mothballed in anticipation of the microgrid resources being brought online. Additional power would come from a 1.0 MW wind turbine and solar power resources with a combined capacity of 1.5 MW. In parallel with the rehabilitation of the STP, FEMA is financing the installation of two 11 MW feeders that would provide bulk power to the STP. The longer-term plan is to use the distributed energy resources described above to minimize reliance on bulk power.

In addition to the Bay Park STP, the proposed microgrid would serve the following facilities:

- East Rockaway Village Hall;
- Three public schools, including East Rockaway Junior-Senior High School, Centre Avenue Elementary School, and Rhame Avenue Elementary School;
- The East Rockaway Department of Public Works;
- The East Rockaway Public Library;
- Two firehouses; and
- The East Rockaway Post Office.

As planned, the microgrid would be capable of supplying all of the power required at the facilities during regional power outages.

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. Of note, 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:

- 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]

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[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.]

[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

RESULTS

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

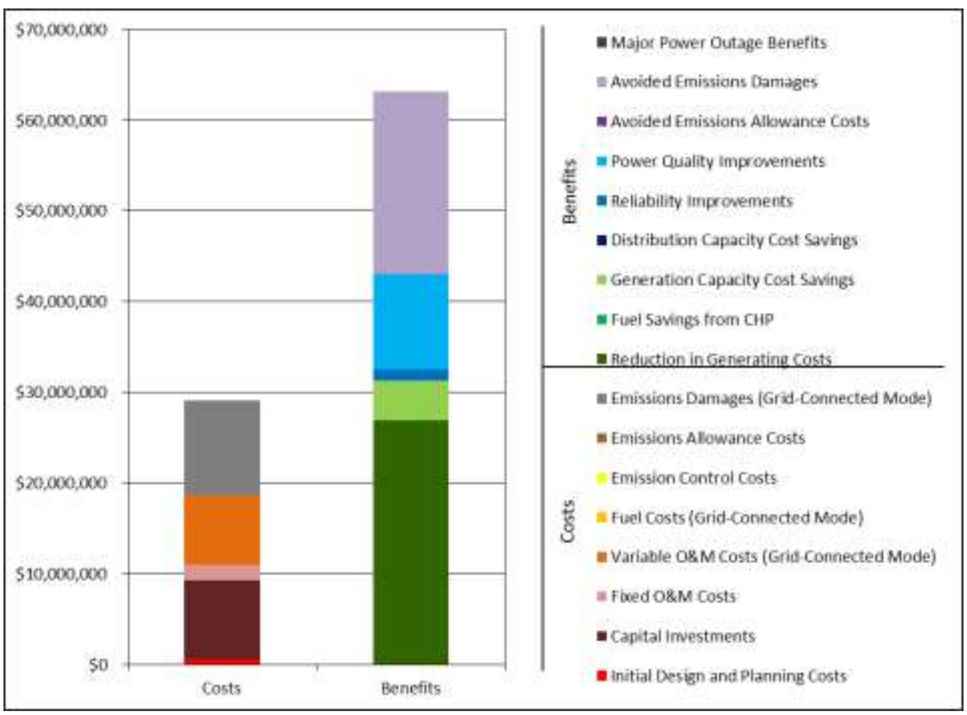
Since the Scenario 1 results suggest a benefit-cost ratio greater than one, this report does not provide a detailed analysis of the impact of major power outages under Scenario 2. Consideration of Scenario 2 would further increase the project's already positive benefit-cost ratio.

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
Net Benefits - Present Value	$34,000,000	Not Evaluated
Benefit-Cost Ratio	2.2	Not Evaluated
Internal Rate of Return	61.0%	Not Evaluated

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

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



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.

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	$600,000	$52,900
Capital Investments	$8,640,000	$701,000
Fixed O&M	$1,700,000	$150,000
Variable O&M (Grid-Connected Mode)	$7,680,000	$678,000
Fuel (Grid-Connected Mode)	$0	$0
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$10,500,000	$686,000
Total Costs	**$29,100,000**	
Benefits		
Reduction in Generating Costs	$26,900,000	$2,380,000
Fuel Savings from CHP	$0	$0
Generation Capacity Cost Savings	$4,330,000	$382,000
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,240,000	$109,000
Power Quality Improvements	$10,500,000	$928,000
Avoided Emissions Allowance Costs	$13,500	$1,190
Avoided Emissions Damages	$20,100,000	$1,310,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$63,100,000**	
Net Benefits	**$34,000,000**	
Benefit/Cost Ratio	**2.2**	
Internal Rate of Return	**61.0%**	

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 $600,000. The present value of the project's capital costs is estimated at approximately $8.6 million. The major contributors to capital costs are the 200,000-square foot solar array (costing roughly $1.95 million); the wind turbine; the fuel cell unit; and the overhead lines to connect the generating equipment at the Bay Park STP to the other facilities in the microgrid. The present value of the microgrid's fixed operations and maintenance (O&M) costs (i.e., O&M costs that do not vary with the amount of energy produced) is estimated at approximately $1.7 million, or $150,000 annually.

Variable Costs

One significant variable cost associated with the proposed project is the cost of maintaining and operating the microgrid systems. The project team estimates a cost of $17 per MWh, yielding a total annual cost of $678,000. Over the life of the project, this cost translates to a present value of roughly $7.7 million. The use of digester gas to supply the fuel cell and the tri-fuel generators greatly influences the variable costs of the microgrid. Existing digester gas is currently flared, and proposed investment in advanced sludge digestion would enhance the gas supply. Likewise, other proposed energy sources – wind and solar – are renewable. Therefore, annual fuel costs are effectively zero.

In addition, the analysis of variable costs 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 none of the system's generators would be subject to emissions allowance requirements. In this case, the damages attributable to emissions from the microgrid's fuel-based generators are estimated at approximately $686,000 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 $10.5 million.[3]

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 $26.9 million. The reduction in demand for electricity from bulk energy suppliers would also avoid emissions of CO_2, SO_2, NO_x, and particulate matter, yielding emissions allowance cost savings with a present value of approximately $13,500 and avoided emissions damages with a present value of approximately $20.1 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] The project team estimates the capacity available for the provision of peak load support to be approximately 2.4 MW per year, based on estimates of output from the new fuel cell, photovoltaic array, and generators burning digester gas.[6] Based on these figures, the BCA estimates the present value of the project's generating capacity benefits to be approximately $4.3 million over a 20-year operating period.

The project team has indicated that the proposed microgrid would be designed to provide ancillary services in the form of black start support to the New York Independent System Operator (NYISO). Whether NYISO would select the project to provide such 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 such services.

[3] As noted, the microgrid would use a substantial quantity of digester gas that is currently flared, a process which itself creates emissions in the baseline. This analysis does not account for those baseline emissions, and as such, likely overstates the net emissions damages associated with operation of the microgrid.

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

[6] The project team originally assumed a capacity factor of 37.5 percent for the solar resources providing peak load support. The analysis replaces this assumption with a standard capacity factor of 20 percent. This change has a negligible effect on the estimated benefit-cost ratio.

Reliability Benefits

An additional benefit of the proposed microgrid would be to reduce customers' susceptibility to power outages by enabling a seamless transition from grid-connected mode to islanded mode. The analysis estimates that development of a microgrid would yield reliability benefits of approximately $109,000 per year, with a present value of $1.2 million over a 20-year operating period. This estimate is calculated using the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator, and is based on the following indicators of the likelihood and average duration of outages in the service area:[7]

- System Average Interruption Frequency Index (SAIFI) – 0.72 events per year.
- Customer Average Interruption Duration Index (CAIDI) – 81.6 minutes.[8]

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

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

Power Quality Benefits

The power quality benefits of a microgrid may include reductions in the frequency of voltage sags and swells or reductions in the frequency of momentary outages (i.e., outages of less than five minutes, which are not captured in the reliability indices described above). The analysis of power quality benefits relies on the project team's best estimate of the number of power quality events that development of the microgrid would avoid: an average of 7.6 per year. The model estimates the present value of this benefit to be approximately $10.5 million over a 20-year operating period.

Summary

The analysis of Scenario 1 yields a benefit/cost ratio of 2.2; i.e., the estimate of project benefits exceeds costs by about a factor of two. Accordingly, the analysis does not consider the potential for the microgrid to mitigate the impact of major power outages in Scenario 2. Consideration of such benefits would further increase the net benefits of the project's development.

[7] www.icecalculator.com.

[8] SAIFI and CAIDI values were provided by the project team for PSEG Long Island.

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