7 - Town of Southampton

August 2016

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NY Prize Town of Southampton
Community Microgrid
Stage 1 Feasibility Study

Source: Google Maps

Prepared for: **The Town of Southampton**

Prepared by: **Global Common**

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D&B Engineers and Architects

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August 15, 2016

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Foreword

This report was prepared for the Town of Southampton by Global Common (GC), General Electric International, Inc. (“GEII”); acting through its Energy Consulting business (“GE Energy Consulting”) based in Schenectady, NY, D&B Engineers (D&B), and Burns Engineering (Burns) and submitted to the NYSERDA. Questions and any correspondence concerning this document should be referred to:

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EXECUTIVE SUMMARY

Background

The Town of Southampton is the oldest English settlement in the State of New York. It is one of 10 towns that comprise Suffolk County. Southampton occupies approximately two thirds of the geographic area known as the South Fork of Long Island (LI) and consists of approximately 140 square miles (land area). It is bounded by the Peconic Bays, Flanders Bay, Reeves Bay, Peconic River and the Town of Riverhead to the north, the Atlantic Ocean to the South, the Town of Brookhaven to the west, and the Town of East Hampton to the east.

The Town of Southampton is located on the south fork of Long Island, about 90 miles east of Manhattan, and about 25 miles west of Montauk Point, which is the eastern most point on the south fork of Long Island. The 2010 Census population for the Town of Southampton was about 56,000, which increases to over 115,000 during peak summer months. The year-round population for the incorporated Village of Southampton (which resides as a separate jurisdiction within the Town of Southampton) is about 3,100, which increase by tenfold during the summer.

The Village of Southampton (SHV) contains a vibrant commercial center and is a world-class resort destination. SHV is an important commercial center on the south fork of Long Island. In addition, the Village has a number of facilities that are critical to both the Village and the south fork in general, and these facilities are vulnerable to storm impacts. The most important regional facility is Southampton Hospital (SHH), which is the only hospital serving the entire South Fork, that stretches for over 40 miles from Riverhead to Montauk Point. In addition, government buildings, schools, fire and police department all reside in the Village of Southampton where the microgrid will be located.

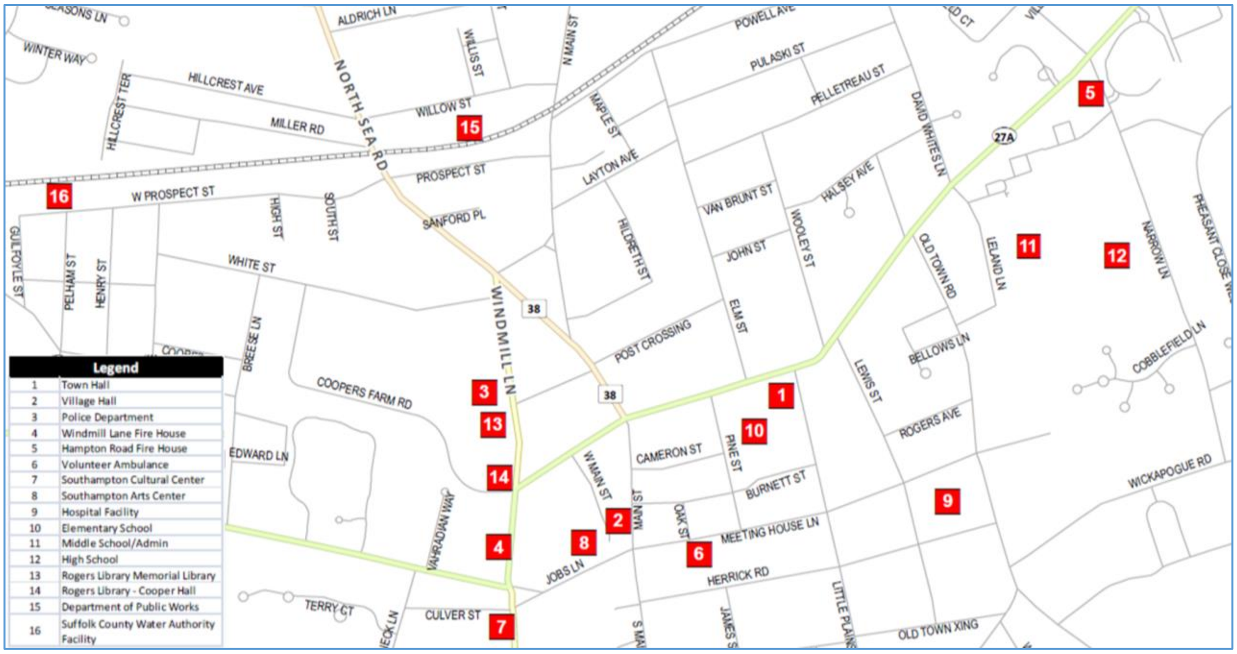
Task 5 Report Overview

This Executive Summary summarizes the information contained in the Task 1-4 reports, and addresses the questions presented in the Task 5 Statement of Work. The responses to the specific questions from the Task 5 Statement of Work are presented in the Conclusions and Recommendations sections below. The complete Task 1-4 reports are contained in the relevant report sections, and the complete Benefit Cost Analysis (BCA) report of Industrial Economics, Inc. (IEc) and the BCA questionnaires are contained in the Appendices.

Task 1-Description of Microgrid Capabilities

Critical Facilities and Loads

A map showing critical facilities in the SHV, and a listing of these facilities along with a summary of peak electrical demand and energy consumption are shown below.



Listing of Critical Facilities in Southampton

		Electrical Load	
Map #	**Facility**	**Energy (kWh)**	**Peak (kW)**
1	Town Hall	473,940	149
2	Village Hall	51,120	16
3	Police Department	365,800	137
4	Windmill Lane Fire House	211,584	127
5	Hampton Road Fire House	149,600	54
6	Volunteer Ambulance	37,650	19
7	Southampton Cultural Center	76,000	34
8	Southampton Arts Center	182,580	96
9	Hospital Facility	6,784,000	1,515
10	Elementary School	444,194	115
11	Middle School/Admin	903,900	232
12	High School	1,858,200	481
13	Rogers Memorial Library + Shed	470,045	171
14	Rogers Library - Cooper Hall	19,040	8
15	Department of Public Works (DPW)	75,870	49
16	Suffolk County Water Authority (SWCA)	448,880	144
Not Shown	Small commercial establishments and residences	10,884,694	2,634
	Total	**23,437,097**	**5,980***

* Sum of non-coincident peaks

In addition to the critical facilities, it is noted here that the schools within the microgrid are listed as the evacuation centers in the emergency management plan. The library was included as a critical facility for its potential to disseminate information and provide internet access and meeting rooms in the case of an extended outage. The cultural center and arts center are also traditional spaces for community gathering. Town Hall and Village Hall have building departments that could continue to function and issue permits and provide support in a post-storm event scenario.

In addition to the critical facilities, we estimate that the microgrid will serve approximately 150 small commercial establishments, as well as about 800 residences near the downtown area. These establishments include two pharmacies, a gas station, a bank, grocery store, and numerous restaurants, shops and stores with apartments above. Hence, the Southampton microgrid will enable continued normal life and economic activity in a large section of downtown SHV during outages to the main grid.

The non-coincident peak microgrid load is 5,980 kW, which includes the critical facilities, and about 2,634 kW from small commercial establishments and residences. The total microgrid uses about 23.4 million kWh per year, and the smaller facilities use a total of about 10.9 million kWh per year. In addition, Southampton Hospital uses about 38,000 MMBtu per year for heating.

In addition to these loads, SHV is considering installing a new wastewater treatment plant (WWTP) next to the police station. The WWTP would also be connected to the microgrid.

As shown, the critical facilities are all clustered around the central business district of SHV. These facilities provide critical services for the village, as well as the entire Town, and, as mentioned, the hospital serves the entire south fork.

Southampton Hospital has 125 beds and serves over 115,000 people dispersed over 50 miles, not including the surge in summer residents. The hospital admits more than 6,000 patients annually, and has about 25,000 emergency room visits each year (about 50% during the summer season). The Fire Department is responsible for fire, rescue and emergency services for the Village and the entire Town of Southampton. The fire department responds to over 700 calls per year.

The project will also provide electric and thermal energy to the hospital at all times, assuring that the hospital can maintain critical medical services for populations throughout the South Fork.

All of these facilities will be connected using portions of the existing PSEG Long Island (PSEG-LI) feeders that will be hardened in areas where there is risk of tree damage. The project will include a number of switches that will enable the microgrid to operate in island mode during outages to the main grid. These are shown in the electrical layout and one-line diagrams in the next section.

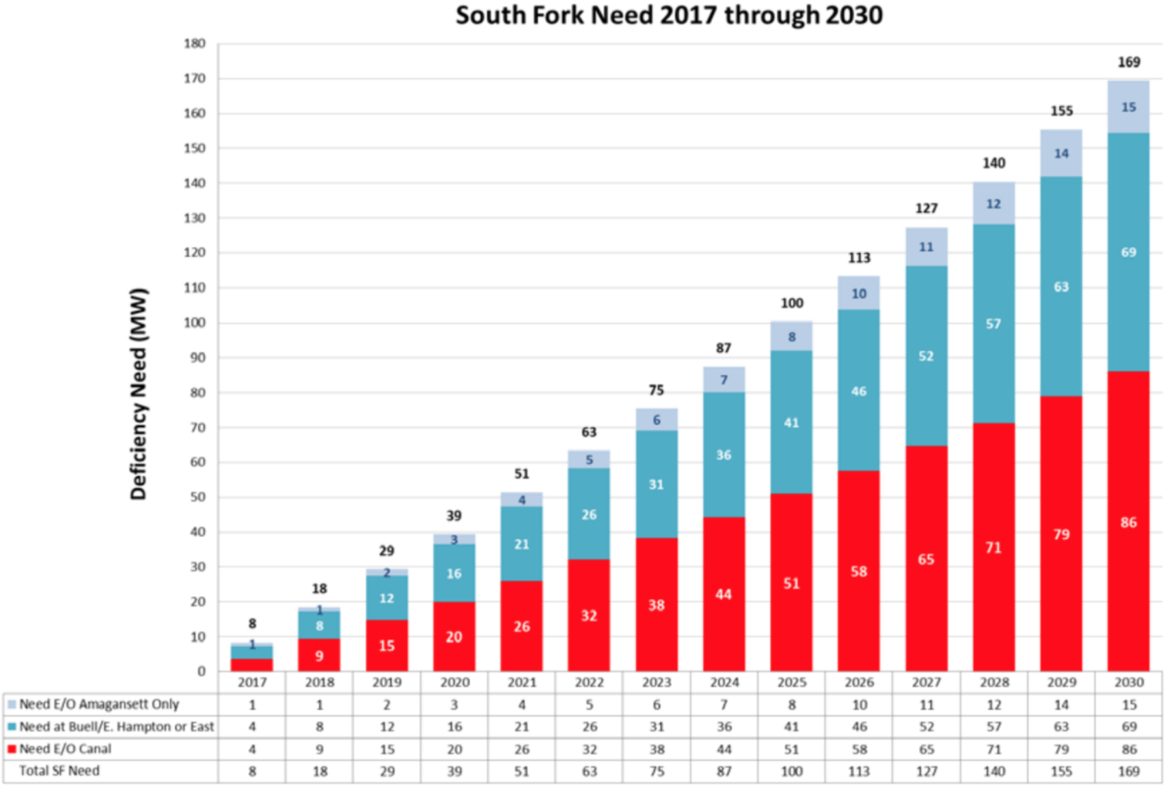
Need for the Project

The project is needed both to improve reliability and help address projected shortfalls in peak power supply. Southampton is geographically remote and isolated, and highly vulnerable to storm impacts. The village lost power following Hurricanes Sandy (seven days), Irene (two days) and the Northeast Blackout in 2003 (three days).

The Town of Southampton and the Village of Southampton are included as participating municipalities within Suffolk County’s multi-jurisdictional multi-hazard mitigation plan, most recently updated in 2014. The mission statement or guiding principle of the plan consistent with FEMA guidance is to “*Identify and reduce vulnerability to natural hazards in order to protect the health, safety, quality of life, environment and economy of the communities within Suffolk County*.” Hazard Risk/Vulnerability ranking was undertaken for the Town and Village of Southampton where the hazard types of flood, Hurricane, Nor’easter and Severe Winter Storm were all considered to have a “frequent” probability of occurrence with associated high risk ranking scores for probability & impact. The creation of a community microgrid is consistent with the intent of emergency preparedness as a mitigation strategy. In addition, the microgrid will support the intent of New York State's Reforming of Energy Vision (REV), which states that "the availability of reliable, resilient, and affordable electric service is critical to the welfare of citizenry and is essential to New York's economy."

The Village receives service via a 69 kV above ground transmission line that transmits power from western LI. If service on this line is disrupted, facilities in Southampton would be without power, except for limited local back up generation.

As shown below, PSEG-LI projects a 63 MW transmission deficit in the South Fork of Long Island by 2022, which includes a 32 MW deficit in the Southampton load area (the Southampton load area is shown in the red bars below). The South Fork deficit increases to 169 MW by 2030, which includes an 86 MW deficit in the Southampton load area. PSEG-LI estimates that the cost to upgrade the transmission system would be approximately $298 million.


South Fork Need 2017 through 2030

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
🟦 Need E/O Amagansett Only	1	1	2	3	4	5	6	7	8	10	11	12	14	15
🟦 Need at Buell/E. Hampton or East	4	8	12	16	21	26	31	36	41	46	52	57	63	69
🟥 Need E/O Canal	4	9	15	20	26	32	38	44	51	58	65	71	79	86
Total SF Need	8	18	29	39	51	63	75	87	100	113	127	140	155	169

PSEG-LI has indicated that it will be necessary to either install additional transmission or distributed generation to meet the peak needs in Southampton and the South Fork in general. However, residents on the south fork are strongly opposed to new above ground transmission lines that would be needed to supply power from western Long Island. In addition, there is not an adequate supply of pipeline gas on the South Fork to fuel new generating facilities to meet these loads, and residents are strongly opposed to new diesel fired power plants. However, in terms of emergency management and energy reliability, residents appear willing to support the components of the proposed microgrid concept with the addition of solar and battery backups that would provide greater reliability and resiliency and help meet local peak power needs.

Thus, in addition to assuring a more reliable and resilient energy supply, the project will reduce the need for new transmission or additional local generation.

Task 2-Develop Preliminary Technical Design Costs and Configuration

Distributed Energy Resources

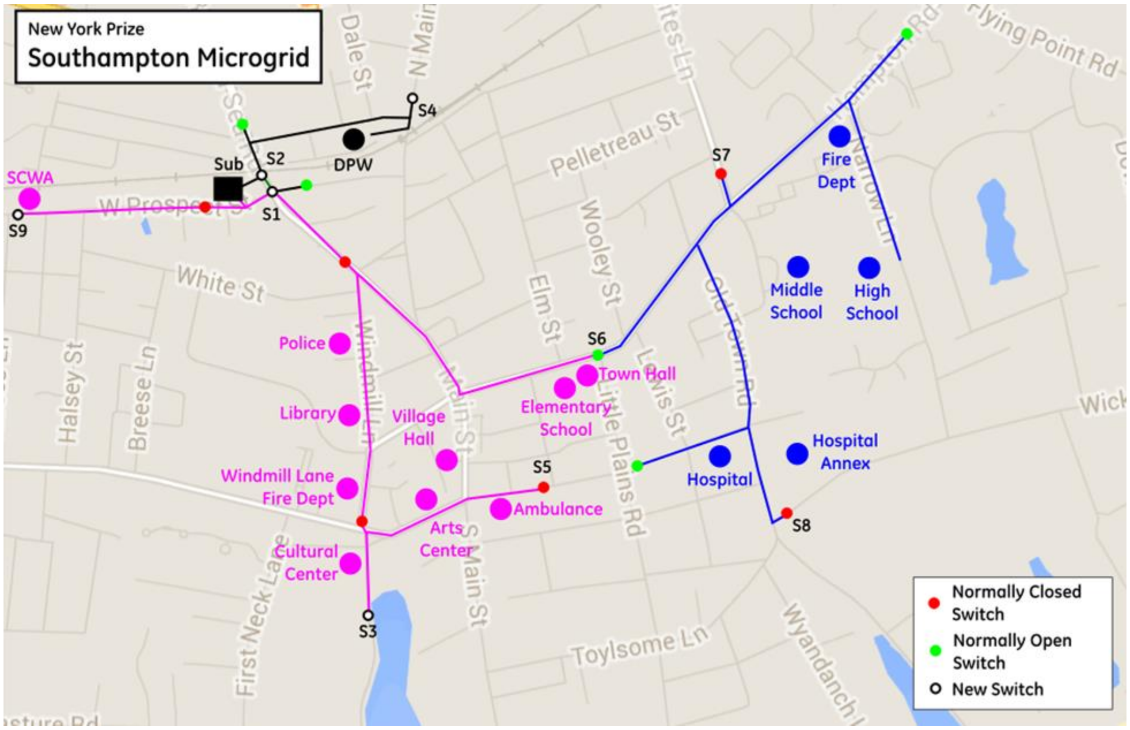
The project will include an optimized mix of Distributed Energy Resources (DERs) that will provide power for the microgrid and/or deliver power to the main grid, depending on operating conditions. Existing and proposed (bold font) DERs are listed below.

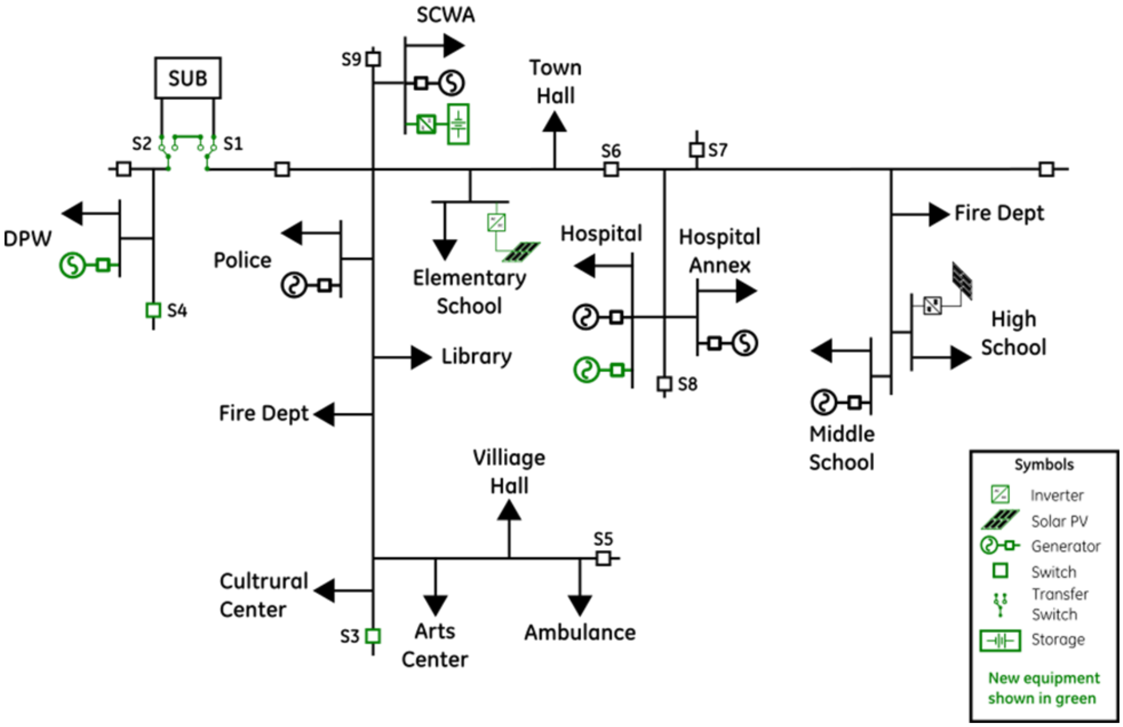
Microgrid Distributed Energy Resources	Facility Name	Energy Source	Nameplate Capacity (MW)
Existing Backup Generator 1	Hospital	*Natural Gas/Diesel*	0.800
Existing Backup Generator 2	Hospital	*Natural Gas/Diesel*	0.800
New CCHP	**Hospital**	***Natural Gas***	**1.500**
New Reciprocating Engine	**DPW**	***Natural Gas***	**2.000**
Existing Backup Generator	High School	*Natural Gas*	0.200
Existing PV 1	High School	*Solar*	0.100
Existing PV 2	High School	*Solar*	0.010
New PV	**Elementary School**	***Solar***	**0.300**
New Battery (200 kW, 800 kWh)	**SCWA**	***Electricity***	**0.200**
Existing Backup Generator	Police Department	*Natural Gas*	0.343

As shown, the capacity of total new and existing DERs will be 6.25 MW. This does not include 78 kW of smaller backup generators that will not be connected to the microgrid, but will be available to supply their hosts if needed. The project also assumes 126 kW of load curtailment, which represents 5% of the peak loads for the hospital and high school, and a new absorption chiller that will reduce the peak hospital load by approximately 289 kW.

The CCHP, battery and PV facilities will supply energy behind the meter, and the electric generation system will use the existing PSEG-LI distribution system. National Grid has indicated it can currently supply gas for the CCHP system on a Temperature Control (TC) rate basis, under which the gas supply would be curtailed at temperatures below 15 degrees F, which occurs very rarely. In this event, the hospital would use the PSEG-LI grid and its existing boilers. National Grid has indicated it could supply firm gas supply by 2021.

An electrical layout and a one-line diagram for the microgrid are shown below. As shown in the figures below, use of the existing PSEG-LI system will allow the DERs to connect with all the critical facilities and supply other customers served by PSEG-LI. The project will use the existing PSEG-LI above ground feeders, and install a number of switches that will enable the microgrid to operate in island mode during outages to the main grid. The existing feeders will be hardened in areas where there is significant exposure to vegetation.





Energy Dispatch Analysis

We utilized the Distributed Energy Resources Customer Adoption Model (DER-CAM) to evaluate and project the performance of the DERs. Results are presented below.

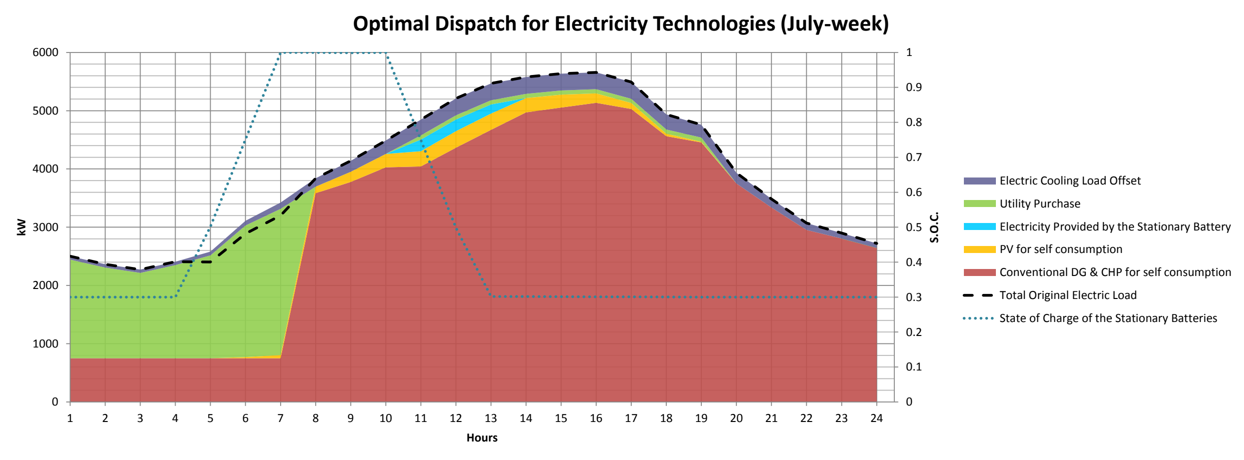
Electric Power Dispatch

The figure below shows the theoretical load and supply balance over a weekday of operation on a normal day in August. The DER-CAM model dispatches the generation resources based on the comparative economics of on-site generation versus purchase from the utility.

As can be seen, under the assumed prices, the DERs can produce all the needed energy onsite to meet the microgrid customers' load. The black dashed line is the microgrid electrical load. The burgundy colored area is the energy produced by the CCHP and the reciprocating engines. The light blue area is the battery storage discharge.

The dark blue area on the top is the electric cooling load offset due to the operation of the absorption chiller. The times where the colored areas go above the blue dotted line correspond to the times when the battery system gets charged.

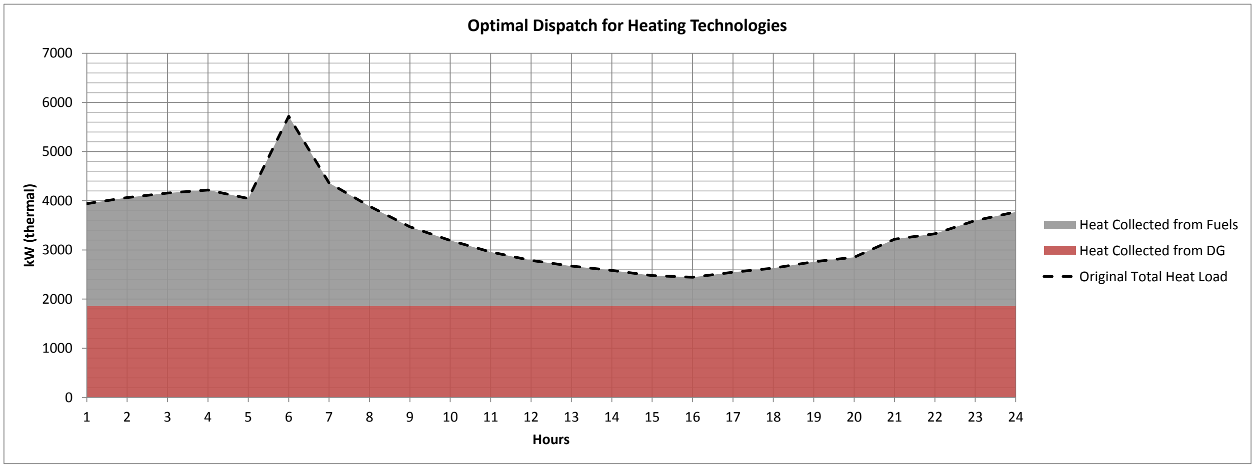
Under the current assumptions on the delivered prices of electricity and gas, it appears that the CCHP generators will operate during normal days, particularly during on-peak hours to minimize demand charges and avoid high on-peak prices. In practice, the CCHP system would have a capacity factor of 72%, and the electric only generators would have a capacity factor of about 50%.

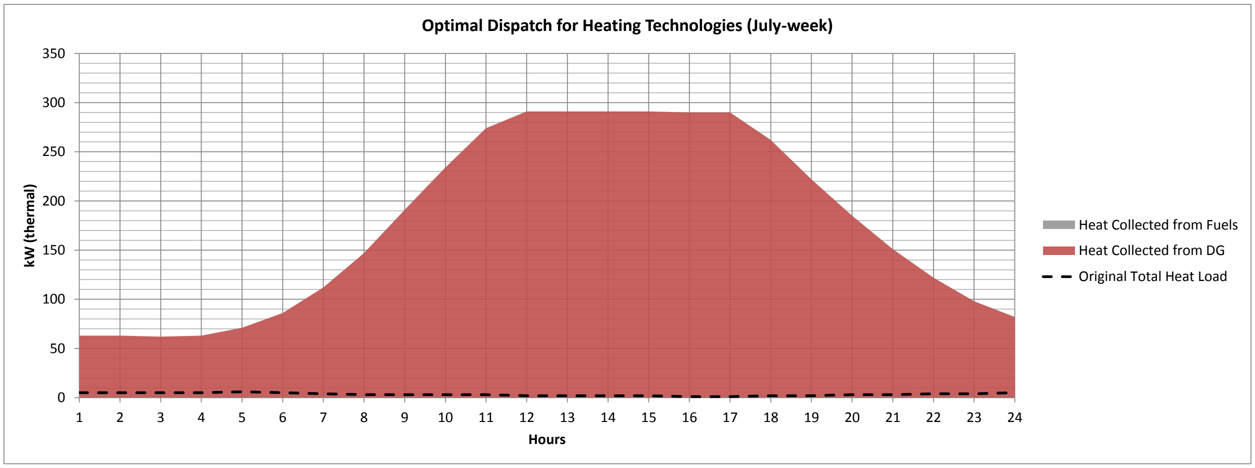


As shown, the CCHP systems would provide baseload power most of the time, eliminating most of the energy that Southampton Hospital would otherwise purchase from the grid throughout the day. The CCHP system will produce approximately 9.4 million kWh per year, or about 40% of the total annual microgrid energy usage. The solar, load curtailment and absorption chillers would significantly reduce peak demand. We estimate that these systems and measures would reduce the coincident peak demand by approximately 600 kW, or about 11% of total coincidental electrical load of 5,673 kW (5,332 kW of original coincidental electrical load plus 341 kW of central chiller load).

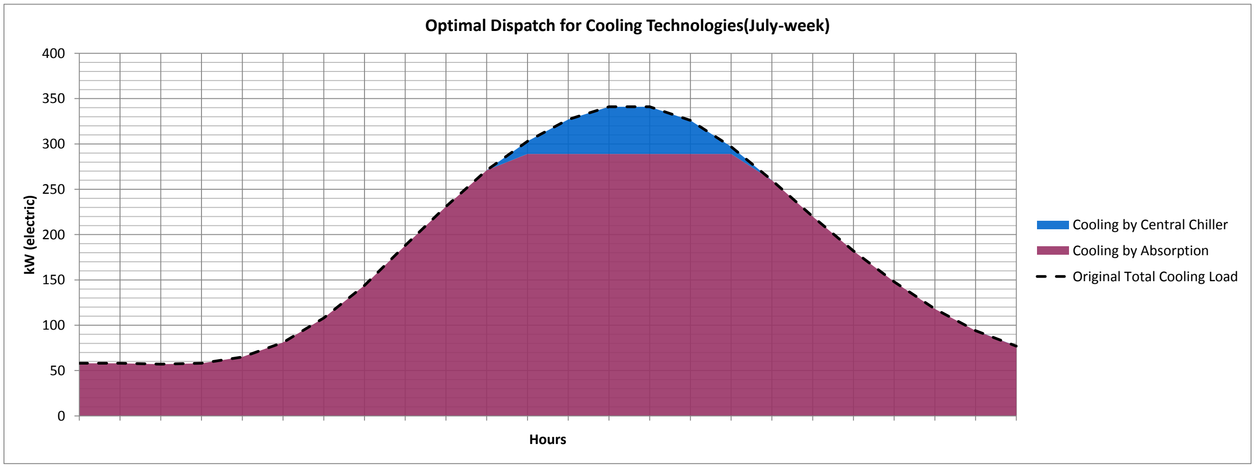
Thermal Dispatch

The two figures below show thermal dispatch for heating load during a normal weekday in January and during a normal weekday in July. The black dashed line in the top figure is the hospital's heating load. In January, a portion of the heating load is provided by the CCHP (burgundy shaded area) and the remainder by the conventional boilers (gray shaded area). As shown in the second figure, the heating load in July is almost zero, as shown by the dashed line touching the X-axis. Therefore, the amount of recovered heat above the dashed line (i.e., the solid area), is not being used to meet heating load, but instead, is used to power the absorption chiller.





The cooling dispatch in a July normal week is shown in the following figure. The burgundy shaded area is the cooling provided by the absorption chiller of CCHP. The blue shaded area is the remainder of the cooling load met by the central chiller.

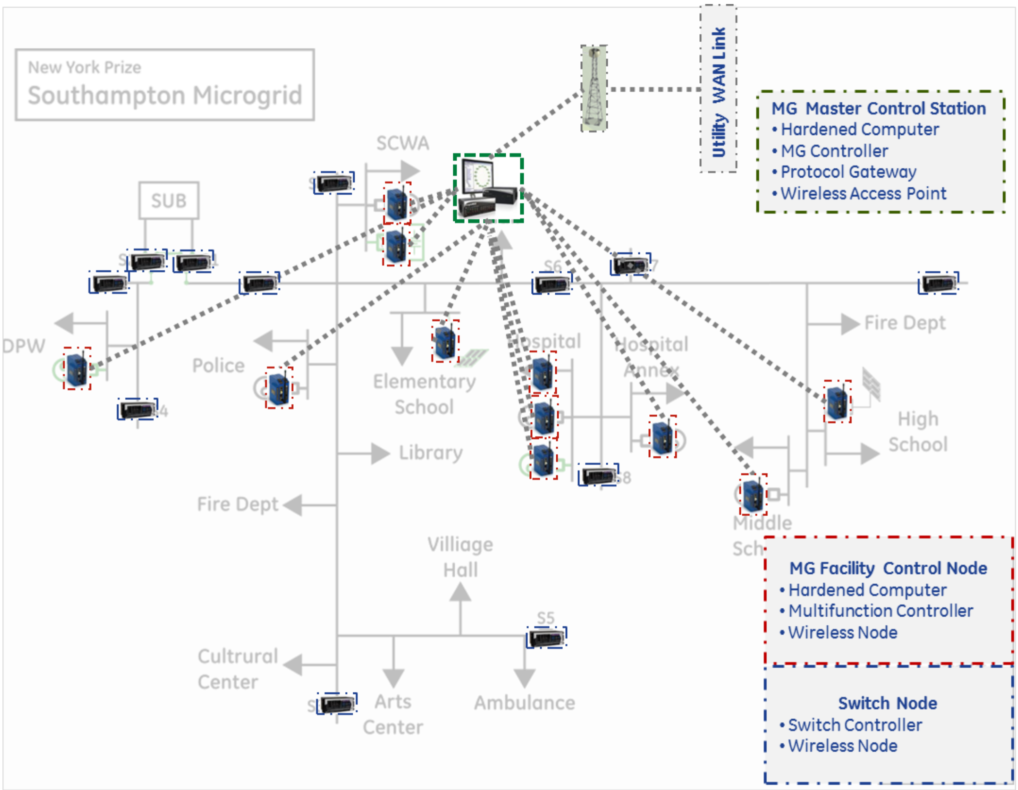


Microgrid Controls

The proposed microgrid control architecture consists of four control device types:

- Microgrid Energy Management System (MG EMS) (1 per microgrid)
- Microgrid Master Control Station (1 per microgrid)
- Microgrid Facility Control Node (1 per facility)
- Microgrid Edge Control Node (1 per facility)

The figure below shows control devices for the proposed Southampton microgrid as an overlay on the electrical one-line diagram.



Task 3-Assessment of Microgrid's Commercial and Financial Feasibility

Business Model and Contractual Relationships

We have devised an innovative business model called a Microgrid Energy Services Company ("MESCO") to supply energy for the microgrid customers. The MESCO is a modified version of an ESCO that will provide power during normal conditions and during grid outages. Business relationships between the MESCO and its customers are explained below.

Blue Sky Scenarios

- The MESCO will sell the electric and thermal energy from the CCHP system to SHH. The CCHP system will be located "behind the meter."
- The MESCO will dispatch energy from the battery to shave peak loads at the SCWA facility.

- The Elementary School will net meter the solar energy, and pay a fee to the MESCO based on savings received.
- The MESCO will sell energy and capacity from the 2.0 MW electric generator contractually to customers using an internal bilateral transaction structure.
- PSEG-LI will continue to own and operate the distribution system.

Grid Outages

- The MESCO will sell power produced by the electric and CCHP facilities, and the backup generators at the HS, police department, and SHH to PSEG-LI, which will then deliver energy to the microgrid customers using its existing but hardened distribution system.

The MESCO model could also be applied for other microgrid projects.

Project Benefits

A summary of project benefits for various stakeholders is presented below.

Stakeholder	Value Proposition
Southampton Hospital	• Reduce electric energy costs • Reduce or eliminate peak demand charges; currently at $22/kW from June-September • Reduce fuel costs by use of waste heat from the CCHP system • Provide more reliable energy supply • No capital investment
Other critical and non-critical facilities	• Reduce electric energy charges • Possibly reduce or eliminate demand charges • Continued power supply during outages to the main grid will assure these facilities can maintain services for customers and the community • Commercial establishments will continue to earn revenue from their business operations during power outages to the main grid
Village of Southampton	• Residents and customers will benefit from services provided by critical and non-critical facilities
PSEG-LI	• Project will help reduce need for peaking power and reduce congestion on the South Fork • Project will help assure power is maintained for PSEG-LI customers during outages to the main grid
National Grid	• CHP system will provide a significant new customer for National Grid, with a high load factor demand profile
Suffolk County Residents	• Residents will continue to benefit from services of Southampton Hospital and other critical facilities during outages to the main grid
Environment	• Project will reduce air emissions by using more efficient CCHP technology to supply both electric and thermal energy.
NY State	• Project would represent an innovative and financially viable microgrid and business model that could be replicated in other areas
Project investors, developers and lenders	• Will receive positive returns on investment, commensurate with project risk • Private investors and lenders will gain experience with an advanced microgrid that could enable similar future investments
Vendors and contractors	• Will generate new business by providing equipment and services • Will gain valuable experience in cutting edge project that could be applied to future microgrid projects

Project Financing Evaluation

The project can produce positive cash flow that should be able to attract private non-recourse financing assuming it receives adequate incentives from NYSERDA. The sources and uses of funds and projected simplified income statements are presented below. The analyses below assume that the MESCO will offer discounts of 10% and 15% for Southampton Hospital for electric and fuel cost, respectively, and a 10% electric discount for other customers. The analyses assume a delivered price of gas for the electric only generating plant of $4.00 per MMBTUs. However, the actual National Grid delivery charges could result in a higher price for natural gas. The discounts for the CCHP hosts will be greater than customers that use the PSEG-LI distribution system because the behind the meter customers would not have to pay demand and delivery charges, and because of the high efficiency of the CCHP plant.

Sources and Uses of Funds with NYSERDA Grants

Uses		Sources	
CCHP	$6,000,000	Equity	$2,397,832
Electric generation	$4,000,000	Debt	$2,351,298
Solar	$800,100	NY Prize	$7,000,000
Battery	$480,000	NYSERDA CHP PON	$0
Dist. and controls	$709,060	ITC	$240,030
Total	**$11,989,160**		**$11,989,160**

Sources and Uses of Funds without NYSERDA Grants

Uses		Sources	
CCHP	$6,000,000	Equity	$7,193,496
Electric generation	$4,000,000	Debt	$4,555,634
Solar	$800,100	NY Prize	$0
Battery	$480,000	NYSERDA CHP PON	$0
Dist. and controls	$709,060	ITC	$240,030
Total	**$11,989,160**		**$11,989,160**

Simplified Projected Income Statement with NYSERDA Funding

Revenue	**$2,536,630**
Cost of Goods Sold	
VOM	$225,140
Fuel	$490,871
Capacity/ancillary services/other	$269,960
Sub-total	**$985,972**
Gross Profit	$1,550,659
Gross margin	61.1%
FOM	**$378,370**
EBITDA	**$1,172,289**
Debt Service	$421,200
Cash flow and financial ratios	
Cash flow	$751,089
DSCR	2.78
Unlevered pre-tax IRR	7.5%
Levered pre-tax IRR	33.5%

Cash Flow and Financial Ratios without NYSERDA Funding

EBITDA	**$1,172,289**
Debt Service	$816,074
Cash flow and financial ratios	
Cash flow	$356,215
DSCR	1.44
Unlevered pre-tax IRR	7.5%
Levered pre-tax IRR	8.1%

Task 4-BCA Results

IEC performed the BCA analyses for two scenarios: Scenario 1A uses IEC's standard approach to valuing transmission capacity benefits; Scenario 1B considers benefits from avoidance of transmission capacity upgrades that would be necessary in the absence of the project. As shown, the project would provide substantial benefits for both scenarios.

ECONOMIC MEASURE	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES		
	SCENARIO 1A: 0 DAYS/YEAR	SCENARIO 1B: 0 DAYS/YEAR	SCENARIO 2
Net Benefits - Present Value	$3,870,000	$24,200,000	Not Evaluated
Benefit-Cost Ratio	1.1	1.6	Not Evaluated
Internal Rate of Return	9.3%	28.1%	Not Evaluated

The BCA calculates the emissions impacts from the microgrid. However, it does not account for the reduction of emissions from reducing dispatch of other liquid fired peaking plants on eastern LI. The project would significantly reduce emissions from the diesel-fueled plants in Southampton and East Hampton. These benefits are more significant for the Southampton project than most other locations in NYS because the new DERs reduce dispatch of diesel fueled plants, whereas in most other areas, the new microgrid DERs would reduce dispatch of gas-fueled plants.

Conclusions and Recommendations

We offer the following conclusions and recommendations for proceeding with the Southampton project and promoting other microgrid projects:

Conclusions

1. **A Southampton microgrid is technically feasible and would provide significant economic, environmental and societal benefits.** A microgrid project in Southampton would provide significant financial, environmental and societal benefits for the Village and Town of Southampton, Southampton Hospital (SHH), and Long Island's South Fork in general. The project would also help reduce the need for new peaking generation and/or transmission.
2. **Benefit Cost Ratio of 1.1 without major outage.** Results of IEc's analysis for a normal day scenario indicates that if no major power outages occur over the microgrid's assumed 20-year operating life, the project's benefits would exceed its costs with a Net Present Value (NPV) of $3,870,000, a Benefit-Cost Ratio of 1.1, and an Internal Rate of Return of 9.3%. IEc saw no need to do a scenario with a major power outage.
3. **Benefit Cost Ratio of 1.6, accounting for avoiding transmission upgrades.** A variant on the first scenario, with the assumption that the microgrid project would contribute to avoiding specific

transmission capacity upgrades on the South Fork of LI, indicated that if no major power outages occur over the microgrid's assumed 20-year operating life, the project's benefits would exceed its costs with an NPV of $24,200,000, a Benefit-Cost Ratio of 1.6, and an Internal Rate of Return of 28.1%.

4. **Energy storage and efficiency provides stability for microgrids and reduces peak demand charges.** A battery storage system can provide stability for the microgrid when operating in island mode, and can help reduce peak demand charges for facilities with "spikey" loads during blue-sky days, such as the water supply facility in Southampton.
5. **The Southampton microgrid will benefit utility partners.** The project will benefit PSEG-LI by reducing the need for peaking power or new transmission on the South Fork of LI, and by improving energy reliability and resiliency. The project will also provide a new customer (i.e. the CCHP system at SHH) for natural gas for gas supply, and the new pipeline infrastructure needed to serve the CCHP system may stimulate new demand from other customers.
6. **A MESCO is a viable business model for microgrids.** The MESCO, which is a type of ESCO that serves microgrids, would serve microgrid customers during blue-sky days and grid outages. The MESCO would establish Microgrid Energy Services Agreements (MESAs) with its customers that would define terms for sale of 100% of energy and capacity, and assure cash flow for the MESCO. This business model could be used for other microgrid projects.
7. **Some gas and electric utility policies create barriers to microgrids**
    a. PSEG-LI has indicated it may not allow hospitals to maintain supply from two feeders if they install CCHP systems. Since hospitals value the redundancy provided by dual feeds, this requirement effectively discourages CCHP at hospitals on Long Island. PSEG-LI has told the Team that they may be open to allowing SHH to use two-feeder service if the interconnect is designed to assure there will be no back-feed resulting from operation of the CCHP system.

    b. PSEG-LI has indicated it does not collect and archive load data at 15-minute intervals. Lack of this data precludes design of microgrid based on actual time-varying demand, and could limit the benefits of the DERs.

    c. The National Grid tariff for electric generation includes a Value Added Charge (VAC) that could result in prohibitive delivery charges for gas for the electric only generating plant. In addition, the VAC charge can impose a year-end True Up charge for generators that cannot be predicted or passed on to customers.

Recommendations

1. **The Southampton project should proceed with design, development and financing, subject to support from NYSERDA**.
2. **NYSERDA should continue to provide financial subsidies for microgrids in order to help recognize the value of greater reliability and resiliency**. NYSERDA should continue to provide financial incentives and technical support for development of microgrids. Incentives should include funding for feasibility studies, design and development, and construction funding.
    a. **The lack of a mechanism to assign a monetary value for reliability and resiliency limits microgrid development**. Although the project would provide substantial benefits during grid outages, the value of these benefits is not reflected in the actual price of energy, capacity or other attributes. This limits the potential opportunities for developing microgrid projects in the absence of some type of subsidies.
    b. **The Southampton community microgrid will require government subsidies and/or other incentives to attract private funding.** Incentives could include NYSERDA grants, favorable gas supply tariffs, and/or credits for DER generation or capacity. Some type of subsidy is generally needed for community microgrids on LI, since the zonal prices for energy and capacity alone are not sufficient to justify investment in DERs.
    c. **The NY Prize program provides highly valuable funding for early stage design. However, early stage funding is also needed for other microgrid projects in order to expand deployment of microgrids.** The costs to obtain, compile and analyze data from multiple facilities, and design the DERs and controls, and develop a microgrid project, are high in relation to the project size and risk. Government funding is critical for providing early stage capital to perform these tasks, and develop projects to the point where they can attract permanent private project financing.
3. **NYSERDA or local utilities should consider microgrid energy or capacity credits**. NYSERDA or local utilities should consider providing microgrid energy credits and/or capacity payments (“MECs” or “MCAPs”), similar to RECs for renewable energy sources, to provide financial incentives for DERs that support microgrids and are not eligible for RECs under the RPS. The MECs or MCAPs would be justified in light of the financial, societal and environmental benefits provided by microgrids.
    a. **Zonal capacity prices sometimes do not reflect the need for local peaking power.** The proposed electric generation facility would reduce the need for new transmission or peak generating capacity on the South Fork. However, the value of these benefits is not reflected in zonal capacity prices. As a result, the project would not be economically viable without a subsidy, or a power purchase agreement (PPA) with PSEG-LI with a fixed capacity payment that is more than the zonal capacity price.
4. **Utilities should eliminate obstacles and create incentives for microgrids**
    a. Gas and electric utilities should evaluate new incentives for microgrids to reflect their financial, societal and environmental benefits.

   b. Electric utilities should also expedite measures to harden local distribution infrastructure to support microgrids, and facilitate interconnection policies to streamline deployment of DERs.
   c. Gas utilities should offer favorable microgrid gas supply tariffs, and prioritize infrastructure improvements needed to serve microgrids.
   d. PSEG-LI should allow customers to maintain two feeders when using on-site generation if the interconnect is designed to protect the grid.
   e. PSEG-LI should retain and make available load data needed to properly design DERs.
   f. National Grid should eliminate the VAC that is currently charged to electric generating customers.

5. **Continue development of analytical tools.** Government entities should continue development of analytical tools for analyzing microgrids, such as DER-CAM.
6. **Develop appropriate DER pricing**. As part of REV development, the Transmission Service Charges (TSCs), stand-by charges, and demand charges need to be modified in the REV DER pricing. For instance, the “D” part of “LMP+D” should reflect the true impact and cost of the microgrid on the transmission and distribution systems.

1 DESCRIPTION OF MICROGRID CAPABILITIES

1.1 Minimum Required Capabilities

1.1.1 Critical Facilities

The main critical facilities in the study include the Southampton Hospital (SHH), the Southampton Schools (which serve as evacuation centers in FEMA all-hazard mitigation management plans), the Village Police Station and Fire Stations, the Suffolk County Water Authority (SCWA) water storage and treatment facility, the Department of Public Works facilities (DPW), and the Southampton Town Hall. Potential additions include properties within the Village planned for the construction of a new ambulance facility and a Sewage Treatment Plant that would treat all the waste from the Main Street business district. The Rogers Memorial Library, while not considered a critical facility per se, is also within the microgrid study area as it may serve as an alternate location for internet use, charging stations and as an important post-storm information resource. The project will also serve approximately 100 small commercial establishments and 400 residences in the downtown Southampton Village area. These commercial establishments include two pharmacies, a gas station, a bank, grocery store, and numerous restaurants, shops and stores with apartments above.

A listing of the critical facilities is shown on Figure 1-1 and in Table 1-1 below. The selection of critical facilities was based on the importance of the properties to the community, if they can assist the functionality of the microgrid and their distance from the main critical facilities. We also included SHH because its thermal load will help improve the energy efficiency and economics of the microgrid.

The total non-coincident peak electric demand for all critical facilities is about 5.98 MW, and the peak thermal load is about 5.72 MW, or 11.35 MMBtu per hour (see Section 2.2). The largest single facility load is the hospital, which has a peak electric and gas demand of about 1.5 MW. The hospital also has the following chillers: Two 235-ton absorption, two 100 ton reciprocators, one 50-ton air cooled, and one 40-ton air cooled chiller. Since SHH has the largest electric and thermal loads, it could serve as a host for a combined cooling, heat and power (CCHP) facility. There may also be opportunities for smaller CCHP at other facilities, such as the elementary school/Town Hall buildings, or the high school. Although the project does not currently include CCHP at the Town Hall, this will be evaluated further in Stage 2.

It should be noted that SHH is in the process of obtaining the required approvals from the NYS Attorney General and NYS Comptroller to complete a merger with Stony Brook University Hospital. The NYS Department of Health has conditionally approved Stony Brook's required Certificate of Need (CON) to accomplish the merger. As a result of this partnership, the building of a new hospital on the Stony Brook-Southampton (SB-SH) campus, located about 2.75 miles to the west of the existing hospital, is a very real possibility. Currently, there are no definite plans or timeline to move the hospital to the SB-SH campus, although the merger agreement that allows for such a move is expected in 2016. Once the merger agreement is finalized, it would be necessary to raise substantial financing to construct the new hospital before construction could begin. Assuming all these approvals and financing are completed, it is currently estimated that the move to a new location could be made in five to seven years. In the event that some or all of the hospital services move to this new location, it is also possible that the existing hospital building will be used for some hospital services, or for other medical arts purposes.

The microgrid distributed energy resources (DER) will be designed to provide flexibility to accommodate such possible future changes. For example, one possibility would be to create a new microgrid at the new hospital site that would serve the hospital and the SB-SH campus, while also using some or the entire original DER to continue serving the existing critical facilities in the Village area.

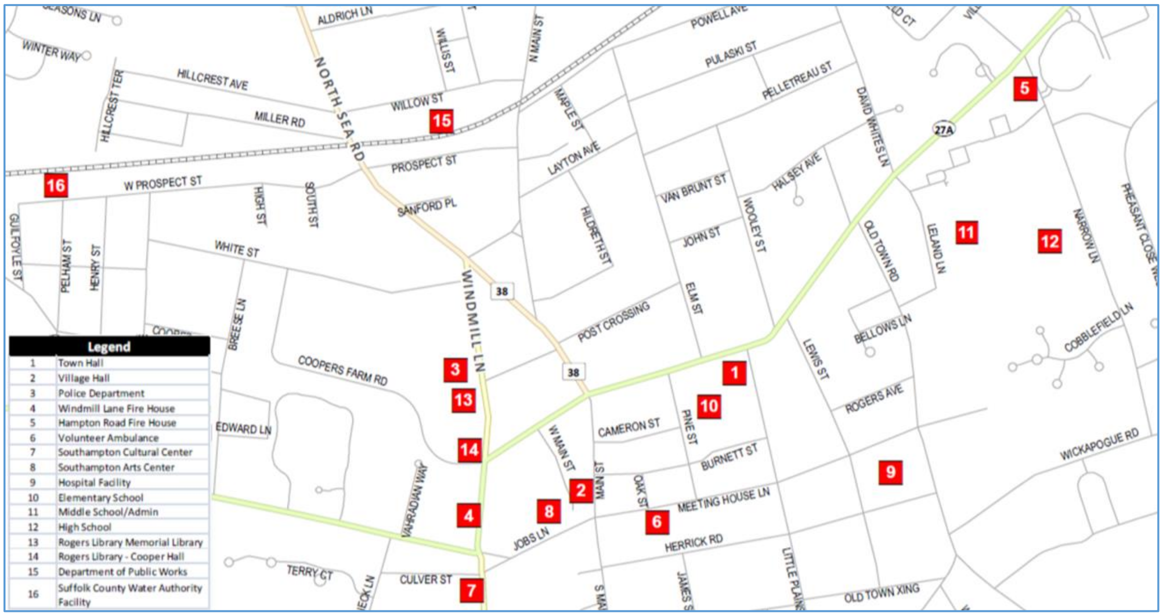


Figure 1-1: Map Showing Critical Facilities in Southampton

Table 1-1: Listing of Critical Facilities in Southampton

#	Facility
1	Town Hall
2	Village Hall
3	Police Department
4	Windmill Lane Fire House
5	Hampton Road Fire House
6	Volunteer Ambulance
7	Southampton Cultural Center
8	Southampton Arts Center
9	Hospital Facility
10	Elementary School
11	Middle School/Admin
12	High School
13	Rogers Library Memorial Library
14	Rogers Library Cooper Hall
15	Department of Public Works (DPW)
16	Suffolk County Water Authority (SCWA)
Not Shown	Small commercial establishments and residences

1.1.2 Primary Generation Source

The project is expected to utilize pipeline natural gas to supply a CCHP that would serve the SHH, and an electric only generating plant to be located at the DPW facility, or another viable location if there is not adequate space at the DPW facility. The project will also include renewable DER, such as solar panel arrays.

The SHH is served by a two-inch gas line with a pressure of 60 psi. National Grid has indicated that it can currently supply approximately 15 MMBtu per hour gas for the CCHP system on a Temperature Control (TC) Rate 331. Under this service, the customer must come off gas if temperature is less than 15 degrees F and can come back on at 20 degrees F. The customer is required to provide National Grid with specifications on how the automatic switch over will occur. SHH would use the grid and existing boilers to provide electric and thermal energy in the event of an interruption.

National Grid has also indicated that it could complete reinforcements needed to supply gas on a firm (i.e. uninterruptible) basis for the CCHP system by 2021, and could likely do the same for the electric generating facility. Therefore, the project would only operate on the TC rate for about two to three years.

The DPW site already has pipeline gas supply. National Grid has also indicated that it can likely supply gas needed for the electric generating plant on an interruptible basis using its existing infrastructure, or with relatively minor reinforcements.

Pipeline natural gas is less costly and is more reliable than diesel. Based on discussions with National Grid, we estimate that the delivered cost of natural gas would be approximately $2.06 per MMBtu plus the commodity charge (currently less than $2.00 per MMBtu), while the delivered cost of diesel is currently over $10 per MMBtu. In addition, pipeline supply of natural gas is highly reliable, even during severe weather events or outages to the electric grid. Newer natural gas engines can meet the 10-second startup requirements for backup systems, and hence, diesel engines no longer have an inherent startup/ramp-up capability advantage over the gas engines.

The microgrid may also include existing diesel power reciprocating engines that would provide backup energy in the event of an outage to the main grid. SHH has approximately five days of diesel storage under normal load, and some loads could be reduced if needed to assure seven days of fuel supply. In the absence of a formal emergency fuel delivery structure, for the purposes of this study (with the objective of replicability and scalability in mind), the Team will not assume continued and extended availability diesel fuel supply. The combination of gas supply for the CCHP and electric systems, and diesel storage at SHH hospital should assure adequate fuel supply under all reasonably foreseeable conditions.

1.1.3 Operation in Grid Connected and Islanded Mode

In Task 2 (described later), the Team evaluates the use of CCHP at SHH, as well as incorporation of solar and storage technologies. The new generation systems would supplement the existing 110 kW solar PV system at the high school.

Between the hospital, the high school and the police department, there is over 2.1 MW of backup natural gas and diesel engines available to the microgrid. To this mix, almost 4 MW of additional new

DER will be added to create a reliable and resilient microgrid for the village. This includes a new 1.5 MW CCHP system at the hospital, and 2.0 MW electric only gas engine at DPW.

In islanded mode, the generation sources are expected to be available to support the microgrid load. One of the new gas-fired engines is expected to provide a strong voltage reference that would allow inverter-based generation to function in islanded mode. To avoid a collapse of the island, some generators would switch from baseload to frequency control and excess (curtailable) load may be shed to maintain balance. This is further discussed in Section 2.3.6

The Team has considered both grid-connected and islanded mode in the microgrid design, including several possible solutions for the Microgrid Control System. Along with the advanced microgrid controller being developed in a Department of Energy (DOE) project by GE, National Renewable Energy Laboratory (NREL) and others, a set of commercial platforms are also available as candidate solutions. The available commercial microgrid control platforms vary in functionality. A complete control solution will typically be comprised of an integrated suite of both hardware and software components. Depending on the microgrid site use cases, the control solution will often require some level of custom code development or configuration scripting to support integration with electric distribution equipment, the building energy management systems (BEMS), controllable loads, and generation assets within the microgrid, the ISO control center, as well as the utility enterprise systems which include energy management systems (EMS), distribution management system (DMS), and outage management systems (OMS). More detail on the control and communications design for Southampton is provided in Section 2.5.

1.1.4 Intentional Islanding

Islanding is the situation where distributed generation or a microgrid continues energizing a feeder, or a portion of a feeder, when the normal utility source is disconnected. For a microgrid to sustain an islanded subsystem for any extended duration, the real and reactive power output of the generation must match the demand of that subsystem, at the time that the event occurs. Exact real and reactive power equilibrium on a subsystem is improbable without some means of control. If there is a mismatch, the subsystem voltage and frequency will go outside of the normal range, and cause the distributed generation (DG) to be tripped on over- or under-frequency or voltage protection. The amount of time required for voltage or frequency excursion to trip the DG is a function of the mismatch, parameters of the circuit, as well as the trip points used. Without active voltage and frequency regulation controls providing stabilization, an island is very unlikely to remain in continuous operation for long. The Team will consider switching technologies (described in the response above) that would allow the microgrid to seamlessly and quickly transition to islanded mode, and also incorporate the appropriate communications and controls technologies (also discussed above) that would allow the microgrid to remain electrically viable and persist for the duration of the emergency (subject to fuel availability).

The current concept includes several points of interconnection (POI) with the grid at various locations in the Southampton area. When these points are disconnected, an intentional island would be formed. To sustain the island, the microgrid logic controller would shed load (if necessary), and actively monitor and control voltage and frequency in the area. Some machines will operate as baseload generation, and others (perhaps some of the existing diesel engines at the hospital) will operate in load-following mode to maintain load-generation balance in "real time."

1.1.5 Automatic Separation from Grid

The design will include power and communication equipment necessary to separate from the grid in the microgrid design. Furthermore, strategies for re-connecting and the equipment necessary to accomplish these strategies are also considered. As discussed, the Southampton microgrid will be connected to the bulk power supply at the substation and several feeders are interconnected via normally-open switches. When the bulk power source is lost, the controller monitoring voltage at the POI would initiate the transition process from grid-connected to islanded mode. The specific nature of the transition is discussed later in Section 2.1 along with include power and communication equipment necessary to facilitate the transition. Furthermore, strategies for re-connecting and the equipment necessary to accomplish these strategies are also considered.

1.1.6 Requirements for Maintenance, Renewables and Energy Storage

The Team has explored the possibility of installing roof-top PV on the buildings. The amount of PV is significantly less than 10% of the microgrid peak demand and an even less percentage of the energy. However, steps will be taken to ensure that the microgrid generation has the range and flexibility to mitigate the expected variability of the PV generation. Nevertheless, it appears that energy storage may be cost-effective at the SCWA facility, since it could reduce short-term peaks due to pumping and reduce demand charges. To the extent that the microgrid includes intermittent renewable resources, the project will also include baseload or dispatchable resources to ensure that the system can provide reliable energy on a 24/7 basis. This is further discussed in Section 2.3, and will be studied in detail in Stage 2.

Most routine maintenance can be accomplished during off peak periods, eliminating the possibility of incurring peak demand penalties from system down-time. Lengthier maintenance can be scheduled for off peak hours.

The maintenance plan will adhere to and comply with manufacturer’s requirements for scheduled maintenance intervals for all generation. In addition, the Team will consider reliability-centered maintenance (RCM) strategies that focus more attention on critical pieces of equipment that could affect the microgrid operation (such as rotating machines, transfer switches, breakers) but will recommend periods during the day, week, and year when routine maintenance would be less likely to coincide with an outage event. This is a data driven task that is likely to become more effective given a longer operating history.

1.1.7 Load Following

The current generation portfolio in Southampton includes several large diesel units at the hospital, smaller diesel units at the Middle School and Village Hall, a 200 kW gas engine at the High School, and several tens of kW of distributed solar PV. Additional fossil-fueled generation and PV generation have been considered during the load and supply analysis subtask (see Task 2). Diesel engines are the best choice for load following applications for systems in this size range as they can ramp nearly instantaneously in response to sudden changes in demand. Gas engine may also be suitable for load-following, depending on its configuration. A microgrid can rely on slower-responding technologies such as lean gas engines, but employ diesel generators for load-following when islanded. Alternatively, some rich burn gas engines can easily follow changes in load without affecting frequency, and are therefore well suited for islanded systems.

In connected mode (parallel to the grid), microgrid generation resources would typically not be required to regulate frequency or voltage or follow load. These services are provided by generators under governor control. However, in islanded mode, microgrid resources must switch from baseload power control to frequency control and the bus voltage must be controlled either by a generator's voltage regulator or by some supervisory control (such as a microgrid controller). To avoid a collapse of the island, some generators would switch from baseload to frequency control; some voltage regulators would switch from power factor control to bus voltage regulation; and excess loads should be shed to maintain balance. With multiple DERs of various types, and controllable loads in an area, a microgrid control system may be preferable for successful islanded operation. The team will explore these operational issues in the analysis tasks.

When considering the load/generation mix, several classifications of load may be considered. Generally, these classifications fall into critical, discretionary, and deferrable. At a minimum, the generation and storage mix must be sufficient to meet critical load at all times, i.e. the microgrid will be sized to meet the critical load (constituting the baseload) at all times during normal and emergency periods. The microgrid will attempt to meet the discretionary load during the emergency period, provided there is sufficient supply from internal generation. However, in a variety of likely circumstances, available generation might exceed critical load. In such cases, additional load may be served, but sufficient controllability must be incorporated in the design to shed load if the need arises. In a contingency, the microgrid will incrementally shed discretionary loads until load and supply balance is achieved. Curtailable load is the load that will be immediately dropped at the onset of the interruption of power delivery from the larger grid. Additionally, some load has flexibility to be scheduled which adds an additional layer of control to the load/generation mix. If storage is feasible for the design, the load/generation mix will also consider charge/discharge needs for the storage system.

While the islanded operation of the microgrid was the primary driver for determining the generation and load mix, size and operating modes and import/export in grid-connected mode were also evaluated. The import/export of power to and from the microgrid was determined from the Load & Supply Analysis in Task 2 and comparison of variable costs of microgrid generation with the applicable hourly prices to buy from or sell to the larger grid.

Dispatch of internal generation was based on both economic (i.e., efficiency) and reliability considerations, with the least expensive generation resource running as baseload and incrementally more expensive resources running in cycling or peaking mode, and stacked on top of the baseload generation (i.e., microgrid’s merit order curve).

1.1.8 Two-Way Communication and Control

The Team considered design options for this task. Important information was requested from the utilities and facilities, which provided information on in-place networks and protocols that possibly could be leveraged in support of this requirement (e.g. leverage for cost saving and interoperability purposes).

The first step was to determine if the microgrid solution would leverage existing networks or if there was a need to design and deploy new communications systems. Once the network platform was identified the Team selected platform and protocol compatible monitoring services as well as security services to satisfy the cyber security protection functions.

The Team evaluated the use of existing communications systems in two important areas.

Cost Savings and Interoperability:

Reuse of existing communications systems can provide cost savings as the microgrid developer will not be required to deploy an entirely new communications fabric. Individual network segments or complete reuse of the communications system can be applied and significant cost savings can be achieved. Additionally, where reuse is leveraged, protocols and data models can be selected to achieve maximum interoperability and performance.

Security and Resilience:

There is a trade-off between cost savings acquired via reuse of existing communications systems and the reduced security and resilience attributes in older communications technology and design approaches. This will be analyzed, and cost and security considerations will be balanced to accommodate the site-specific functional requirements.

Maximum weather resilience and performance is achieved when underground fiber optic networks are deployed. Additional surety can be obtained by creating redundant fiber rings and including two-way communications. The use of fiber, redundant networks, and underground deployment makes this the most reliable and resilient method, but it is also the costliest option. The generation portfolio for the microgrid and potential use cases during connected and islanded modes would go a long way in determining the performance requirements for the communications infrastructure.

Cyber security addresses protection against hacking and malicious intent. The team will consider options such as: modern hardware platforms and network nodes that incorporate device level authentication and authorization; adding security services to the microgrid control nodes and control center to address encryption of data at rest and data in motion; and adding a security architecture that applies defense in depth design principles which includes segmenting of data and system components across different levels of security zones to offer a hierarchy of authorization constraints and system access barriers. Note that cyber security services can be added as a security layer on top of existing communications when reusing networks but cannot change the existing physical security, resilience or performance limitations of the existing networks or device nodes.

1.1.9 Power to Diverse Group of Customers

The proposed microgrid will serve the facilities identified in Table 1-1 based on the cost of providing service, importance of providing power to the critical facility, and alternatives to connection to the microgrid. The Team evaluated these considerations during subsequent tasks in the Feasibility Study. The potential facilities include the Southampton Hospital, which is the only hospital on the South Fork of Long Island, emergency responders (fire, police, and ambulance), South Hampton Town Hall, the library, public schools, the SCWA water storage facility, and a proposed waste water treatment plant. This presents a diversity of critical facilities and customers and thus the possible benefit of complimentary loads for maximum utilization and capacity factor.

The microgrid will benefit populations served by the critical facilities to be powered by the microgrid, which extends far beyond the resident population of the Village. The Town of Southampton provides essential services to a resident population of 56,790. In addition to the year-round population, Southampton Town's main economic engine is its second homeowners and seasonal residents, which swell the population during the summer months and on many weekends and holiday periods. During the peak summer period from Memorial Day to Labor Day, the Town's population swells by almost 3.5 times. Southampton Village serves a resident population of 3,149 and the seasonal population is estimated at ten times the resident figure. Both resident and seasonal populations will benefit from the project.

SHH serves a wide area of 115,536 residents (not including summer surge population) dispersed along a fifty mile stretch of Long Island's south fork. It also operates the area's only Emergency Department. The microgrid will support continuity of operations of the facility as well as communications infrastructure during periods of emergency.

Traffic control devices on roads within the microgrid service area, including roads leading to the hospital, will be powered, reducing strain on emergency responders and increasing public safety.

The microgrid service area is a major employment center. Southampton Town government supports 477 full time, 132 part-time, and 300 seasonal jobs. The Southampton School District serves over 1,600 students and supports 400+ full time equivalent (FTE) staff positions. Southampton Hospital employs over 1,000 staff. Southampton Village employs 120 full time staff. Dozens more are employed by the Rogers Memorial Library. The microgrid will reduce or eliminate the need to shut down facilities during regional power outages, eliminating the costs associated with lost productivity.

The Fire Department has 145 volunteer firefighters and responds to about 850 calls each year. Southampton Ambulance has a volunteer staff of 65 that responds to roughly 700 calls per year. First responder operations and public safety will benefit from microgrid power.

Information on the microgrid feasibility assessment as well as progress and outputs of Stage 2 and Stage 3 activities will be made available for public informational purposes. This public outreach aspect will raise awareness around the interrelated topics of resiliency planning, energy efficiency and renewable energy.

1.1.10 Uninterruptable Fuel Supply

The natural gas fired plants are supplied by pipeline, and the existing diesel plants are supplied by on-site storage and supplied by reliable regular delivery by truck. Renewable resources would be constrained by the extent of storage deployed in the microgrid and the intermittency of the renewable source.

The project would initially utilize at TC gas supply tariff, and have firm gas supply beginning in 2021. Under the TC tariff, gas would be interrupted if the temperature is less than 15 degrees F, which occurs very infrequently. If gas is interrupted and the main grid is operating, SHH would get electric energy and heat from the grid and existing boilers. If the main grid is out of service, and gas is interrupted (a very remote confluence of events), SHH would still be able to use its existing back up diesel generators. After 2021, the supply of firm pipeline gas for the CCHP and electric generating facilities would assure that the microgrid has fuel supply, as disruptions to pipeline gas supply are extremely rare. In addition, SHH and the schools could still utilize back up diesel fuel if for some reason pipeline gas is interrupted.

An additional measure to provide greater assurance of power supply is to designate some of the load as "super critical" and include backup diesel engines to supply only those supercritical loads during the low probability, high impact event where both electricity and natural gas supply fail.

1.1.11 Resiliency to Forces of Nature

Southampton is geographically remote and isolated compared to other Long Island communities. Located at the eastern end of Long Island's south fork, it is at the end of the PSEG power transmission line. Any damage to the substation tower at the Shinnecock Canal (7 miles to the west) will knock out power for the entire Southampton Village area. Major recent power outages are listed below:

Table 1-2 Recent Major Outages in Southampton

Event	Details	Duration of power loss
Hurricane Sandy	100-year storm Oct/Nov 2012 (DRW4085)	7 days
Hurricane Irene	August 26W29, 2011 (DR 4020)	2 days
Northeast Blackout	August 14W16, 2003 (EM 3186)	3 days

Storm impacts and mitigation plans are detailed in the Southampton Town Hazard Mitigation Plan Update adopted April 2014 and include power outages resulting from Super-storm Sandy (Oct/Nov 2012) and Hurricane Irene (Aug/Sep 2011) as documented above. In addition, the natural hazard event history for the Town demonstrates that Severe Snowstorms, Nor'easters, Severe Storms, Hurricanes and Severe Winter Storms are high risk hazards, all of which have the potential to cause short or long term power outages due to wind, water and snow related impacts on transmission lines. The microgrid will mitigate the impact of the power outage hazard by providing a redundant, resilient generation and distribution system. The system will also mitigate seasonal brownouts related to high utilization of air conditioning during peak hours in hot summer months, which in the past has caused businesses to close, sometimes at the direction of the Governor's office.

PSEG has confirmed that Southampton's location at the end of the transmission line is a significant factor in energy availability. Further, the area has a large load profile and is experiencing load growth due mainly to increasing construction of large houses that place a heavy demand on the grid. Further, PSEG has confirmed that a microgrid would be beneficial for this load pocket.

In Stage 2, the Team will develop a resilient design that incorporates hardening strategies commonly practiced by systems engineers in areas exposed to storms and outage events. One method to reduce outage frequency is to replace older style un-insulated open wire primary conductors with spacer cable. These conductors have the advantage of a compact design reducing exposure to tree related damage and are supported by a messenger wire further reducing the likelihood of conductor damage. Another alternative is to use tree wire, which has covering that can mitigate tree-contact faults.

Where appropriate, we may also utilize flood avoidance and flood control measures applied to generators, transformers, and switchgear. Flood avoidance and flood control measures include the use of submersible equipment, flood walls, pumping equipment, watertight enclosures, and elevated construction. The Team will also consider fault-tolerant and self-healing network designs, redundant supply or reconfigurable supply where it makes sense, remote monitoring and diagnostic equipment and other smart distribution design measures.

1.1.12 Black-Start Capability

The on-site power systems will have the ability to start and operate using battery power and UPS devices and controls to start from a state of zero power to a state of sustained power production as matched to the microgrid load. Based on criticality and necessity, certain critical loads will be given a priority during black-start operation. A number of facilities with existing backup generators are shown below.

Table 1-3 Facilities with Existing Back-up Generators

Facility	Fuel	Capacity (kW)
Hospital Facility	Diesel	800
Hospital Facility	Diesel	800
Middle School/Admin	Diesel	30
High School	Natural Gas	200
Village Hall	Diesel	20
Police Department	Natural Gas	343
Fire Department	Propane	20
Fire Department	Propane	9
Fire Department	Propane	9
Ambulance	Propane	10
Parks Department	Natural Gas	20
Highway Department	Propane	15
Central Garage	Propane	20
Total		**2,296**

The microgrid would likely include backup generators with capacities greater than 200 kW. The smaller generators would remain as standalone backups, since the benefit of connecting the small generators would not be worth the cost for system integration and automatic control interface needed to enable command-based dispatch.

The Team also considered CHP or fuel cells for use at the Southampton Hospital. One fuel cell design could involve a fuel cell that runs continuously, and idles in the event it is off-line. Thus, this system would always be able to provide start up power in the event of an outage to the main grid.

1.2 Preferable Microgrid Capabilities

1.2.1 Operational Capabilities

In Task 2, the Team explored the application of advanced automation and control technologies to enable enhanced visualization, monitoring, control and interaction. The ultimate goal of “advanced, innovative technologies” is to enable safe, reliable, economic operation of the microgrid, in both connected and islanded mode. Technologies considered during the analysis included: distributed energy resources, including demand response, energy efficiency measures and energy storage; smart grid and distribution automation technologies, such as transfer switches, and automatic fault location isolation and service restoration (FLISR) schemes to ensure reliability; smart relays, adaptive protection, special protection schemes.

Strategic placement of field devices can enhance the flexibility and innate reliability of the microgrid area, whether it is in connected or islanded mode. Reclosers, sectionalizers, and fuses are the mainstays of conventional utility overcurrent protection schemes. Digital sensors and measurement devices, such as transformer monitors, remote fault sensors, and Advanced Metering Infrastructure (AMI)/Smart Meters all help to provide additional situational awareness to the both the utility operations center and the microgrid control system. During storm operations and post-storm recovery, increased situational awareness provides faster detection of fault conditions to allow operators to respond more rapidly – both through automation and dispatch of field crews. Distribution Supervisory Control and Data Acquisition (D-SCADA) and Integrated DMS/OMS are emerging technologies that provide the operator interface for monitoring remote sensors, as well as the control fabric for communication with switching devices on the distribution system. When the microgrid is in islanded mode, it is possible for a mature microgrid controllers to take on features of a DMS/OMS, monitoring the system for fault events and automatically isolating faulted areas and reconfiguring the system so that as little of the load is affected as possible. In the Stage 2 design, the Team will assess the existing Smart Grid – Distribution Automation (SG-DA) investment and plans by the utility and determine, conceptually, how they impact the microgrid operations, and what additions may be feasible.

1.2.2 Active Network Control System

The Team is evaluating the current set of available commercial microgrid controllers. A best of breed selection will be made to obtain alignment with the microgrid site's requirements. From our recent microgrid studies we are aware that available commercial microgrid controllers primarily support various levels of the most fundamental operating functions such as; load shedding, optimal dispatch, integration of renewables or energy storage, forecast and scheduling, and basic situational awareness. Advanced functions like deep control integration with external SCADA or DMS systems or deep monitoring integration with AMI and other data collection and analysis systems is typically a custom developed adapter built to support a specific microgrid use case and system configuration. Section 2.5 provides a fuller characterization of the microgrid active network control system.

1.2.3 Clean Power Supply Sources

The Team has considered all opportunities to incorporate clean and renewable resources into the generation mix for the microgrid. The feasibility analysis evaluated a 1,500 kW CCHP plant at the hospital to supply the hospital's thermal loads and a portion of the electrical load with clean natural gas. In addition, a 2,000 kW natural gas reciprocating engine is planned at DPW.

The microgrid design also incorporates existing and new renewable resources, including a 110 kW solar system that currently exists at the high school. Although land is limited and very expensive, the project will include an additional 300 kW of solar at the elementary school and a 200 kW (800 kWh) Battery Energy Storage System at SCWA.

The project also incorporates 126 kW of demand response/load curtailment, roughly equal to 5% of peak loads of the two largest facilities.

1.2.4 Energy Efficiency and Other Demand Response

Based on the recommendations of an initial Town Hall audit done around 2012, the Town installed new windows at Town Hall as well as replaced all existing lighting with compact fluorescent lighting (CFL). The current protocol will replace the CFL's with light-emitting diode (LED) lighting as the CFL's deteriorate. At the present time, The Town of Southampton is conducting a Town Hall Assessment that will evaluate existing conditions and provide recommendations for various improvements that will enable the facility to better serve the Town's needs and to provide greater efficiency by reducing loads. The report is going to be structured in such a way so as to provide a hierarchy of recommendations based on the initial priorities of health and safety and then addressing infrastructure systems such as HVAC and conditioning, façade envelope improvements to include structural integrity, wastewater treatment, handicap accessibility, electrical infrastructure, spatial modifications that retrofit the former school auditorium into office space, fire alarm systems, lighting, telephone, IT, and utility services.

The microgrid includes other cost-effective energy efficiency measures that have not already been taken to minimize new generation requirements. The energy efficiency of the system will be based on the choice of new equipment and devices that will be included in the microgrid. The designed microgrid will include demand response functionalities for scheduling and control of the demand response resources included in the microgrid facilities.

This study considered the demand response options by working together with the facility owners/managers to identify potential demand response resources (curtailable and discretionary loads) and their size and location, and take them into consideration in the functional design of the control and communications infrastructure.

The microgrid has the ability to provide generation/load reduction to support the grid during critical periods as an alternative to distribution-system reinforcement and potentially receive; payments for islanding as a demand response ("DR") service, payments for exporting power as a generation service, and payments for maintaining critical loads during a larger system outage. A contract could call for immediate response in local crises, not just to reduce peak system demand. Short-term markets for local service could be local voltage/VAr support, short-term substation relief, and emergency services (e.g., agreements to make agreed-upon energy exports or to assume prescribed load shapes). Through distribution support services, the microgrid could provide grid restoration services that are more flexible than typical black-start capabilities and ultimately, ensure local reliability, circuit by circuit, across the larger grid. All of these different market constructs need to be discussed with PSEG, and an appropriate mix of services agreed to in order to support both PSEG and microgrid participant requirements.

This study will consider demand response options, both within the utility programs and also in NYISO markets, by working together with the facility owners/managers to identify potential demand response resources (curtailable and discretionary loads) and their size and location, and take them into consideration in the functional design of the control and communications infrastructure.

The Team met with NYISO representatives to discuss the potential for NYISO market participation by microgrids and behind the meter DG. NYISO is still working on the applicable market rules. The GE Team will maintain the relationship with NYISO and monitor on-going developments and impact on the Southampton Community Microgrid. Based on the latest information, as the project moves on, the team will explore ways for the proposed microgrid to actively participate in the NYISO's energy, capacity, and ancillary services markets.

1.2.5 Installation, Operations and Maintenance and Communications

The Team is coordinating with PSEG-LI and the Village to determine how to incorporate any new distribution infrastructure into the existing grid. In any case, above ground distribution lines will be hardened to assure reliability and resiliency of the microgrid. Given the options available for modern microgrid design, the existing infrastructure will often be the differentiating factor in design decisions. Considerations such as the interconnecting network construction and topology will govern many of the design decisions. When feasible, ease of maintenance and installation as well as operational synergy will be factored into design decisions. However, it should be noted that primary microgrid design criteria such as stability and resiliency will generally have priority over operations/maintenance concerns.

The Team worked with the utility to develop an understanding of the relevant features of the electric distribution system and identify the current distribution network challenges in terms of parsing out a microgrid out of the current grid and ensuring that the larger grid will not be adversely impacted.

The type and the configuration of the underlying electric network of the microgrid is highly dependent on the current distribution network, locations and distances of the microgrid facilities on the feeders, and the technical requirements that need to be considered in the functional design of the microgrid electrical infrastructure. A very important consideration is the overall cost of various grid type options. The Team developed a design that that interconnected sections of various feeders and isolated other sections so that primarily critical facilities could be served by the microgrid generation. This is detailed in Section 2.1.1.

1.2.6 Coordination with REV

The Team will take into account the latest REV developments in considering various business models and operational modes of the microgrid within the REV framework. In particular, the Team will describe the options for microgrid's operation during the blue sky days across the possible distribution system platform (DSP) and trading in the animated market, that most likely may involve dynamic trading (including buy and sell of power and demand resources) both at retail/distribution system level and also at NYISO/transmission system level. We understand that details of REV framework will keep evolving, which we will take into account in our development of the microgrid functionalities.

The Team has identified a number of key issues that need to be addressed that could impede development of the microgrid. A key potential obstacle involves utility franchise rules that prohibit on site generators from providing power to other loads located across public rights of way. This concern could be addressed by having the utility own and operate the microgrid distribution system.

Another issue involves devising mechanisms for sale of excess of energy from the microgrid to the market. Because of economies of scale, it may be economical to oversize new DER's to supply not only critical facilities, but also to generate revenue taking advantage of market opportunities for sale of energy, capacity and ancillary services. This approach could both improve the economics of the microgrid, and help address local peak supply shortages on the South Fork of LI.

A third issue involves PSEG-LI's policy regarding the number of feeders. In particular, PSEG-LI has stated that it would not allow hospitals to have two feeders if they install on-site generation. PSEG-LI is concerned that back feeding could occur from the hospital that could disrupt the main grid. However, since hospitals are concerned about the risk of losing grid power if they only have one feeder, this PSEG-LI policy effectively discourages on site generation at the hospitals. The team has discussed this issue with several technology providers and believes that monitoring and control technology (such as reverse power flow relays) could be applied to reduce the risk of back-feeding. However, further discussions with PSEG-LI are needed to understand the technical and philosophical hurdles. The team has sent an RFI to PSEG-LI and will engage the in discussions as a follow-up.

A final obstacle involves the business structure for owning and operating the microgrid. The DER's and distribution system will require resources and expertise that do not currently reside in the critical facilities or the Town to operate and maintain the facilities. If the facilities are owned by a public or non-profit entity, they would not benefit from significant tax credits for renewable energy resources. A possible solution to these issues would be to have the DER's owned and operated by a third party, and have PSEG-LI own and maintain any new distribution systems.

1.2.7 Comprehensive Cost/Benefit Analysis

In Task 4, the Team provided input needed for the NYSERDA cost/benefit analysis tool to evaluate both the net societal benefits and also the costs and benefits from the perspectives of the various stakeholders.

On the cost side, the Team identified (a) various costs elements, covering the design, development, and deployment of the microgrid, capital costs of various components, fuel, variable operations and maintenance (VOM), and fixed operations and maintenance (FOM) cost of generation and demand side resources, (b) costs of the electrical network infrastructure, (c) costs of the control and communications infrastructure.

On the benefit side, the Team identified various potential revenue sources such as utility demand side programs, and those from participating as a virtual plant in the NYISO wholesale market. Additional benefits include estimation of avoided costs of power interruptions for different facilities within the microgrid. See Chapter 4 for more detail on the cost/benefit analysis.

1.2.8 Leverage Private Capital

The Team designed the project and structured the financing to produce returns on investment and debt coverage that will attract private financing needed to complete the project. The team also evaluated different ownership models that will help attract third party funding. The full financial analysis will determine the amount of private funding needed to supplement any NYSERDA funding, and produce acceptable returns and risk for the private investors.

The Benefit Cost Analysis (BCA) includes potential benefits and costs from various perspectives, including the microgrid as a single entity, and also from the viewpoint of the facility owners and the utility.

In addition, the BCA includes the societal net benefits/costs. The Team's contributions reflect lessons from the original NYSERDA Five-Site study which included consideration of various financial benefit and cost streams, and was supplanted by accounting for other non-tangible benefits and costs, including environmental benefits and avoided interruption costs. The latter, which is more difficult to quantify, were estimated based on available benchmarks depending on the classification of the facility's type, critical loads impacted, number of persons impacted, and the duration of emergency period.

1.2.9 Tangible Community Benefits

The Project will benefit the community both by providing added reliability and resiliency for microgrid participants, and potentially reducing energy costs for the hospital. It is expected that the microgrid will serve up to 15 critical facilities, including the hospital, town hall, public schools, library, proposed waste water treatment plant, and other facilities. The specific facilities to be served will be determined in other tasks of the feasibility study. Providing reliable energy for these facilities during outages to the main grid will also benefit the entire community by assuring that the Town can continue to provide critical services, including effective emergency response and recovery, during outages to the main grid. The system will also mitigate seasonal brownouts related to high utilization of air conditioning during peak hours in hot summer months, which in the past has caused businesses to close, sometimes at the direction of the Governor's office.

1.2.10 Innovation That Strengthens the Power Grid

The Team will consider the options for interaction of the microgrid with the surrounding power grid, including both the distribution utility and the NYISO. The interaction with the surrounding grid across a Distribution System Platform (DSP) through market animation is a major aspect of the New York REV.

For instance, one possible innovation that may be considered within the REV framework is optimal economic operation of the resilient microgrid during blue sky days (i.e., during normal, non-emergency periods), by participation in the utility demand response programs and also NYISO's energy, ancillary services, and capacity markets.

An active and dynamic scheduling of microgrid operations that would maximize the economic efficiency and technical reliability of the microgrid and the surrounding system will require both technical innovations and also reform of regulatory and policy regime that would enable market participation. The Team will elaborate on needed innovations and requirements that would enable such market participation. These may include complementary hardware that would provide more flexibility, such as integrated energy storage, and the smart scheduling software.

The Team will describe the actionable information that would need to be made available to customers for economically efficient and technically reliable operation and scheduling of the microgrid generation. These include real-time load and supply status of the microgrid and the underlying variable costs of operations and the applicable seller and buyer prices on the DSP and/or NYISO. It should also be noted that such actionable information, although accessible to customers when requested or queried, would function and used mostly in the background in automated microgrid systems.

2 DEVELOP PRELIMINARY TECHNICAL DESIGN COSTS AND CONFIGURATION

2.1 Proposed Microgrid Infrastructure and Operations

2.1.1 Simplified **Equipment Layout Diagram and One-Line**

Figure 2-1 below shows a simplified layout of the Southampton microgrid. The microgrid is formed by connecting a number of facilities using portions of the existing utility infrastructure as shown in the figure. The microgrid is composed of a hospital, a county water authority, two fire stations, a police station, an ambulance station and a number of other critical and community support facilities. The majority of the power will come from natural gas generators located at the hospital and hospital annex facilities and the Department of Public Works (DPW).

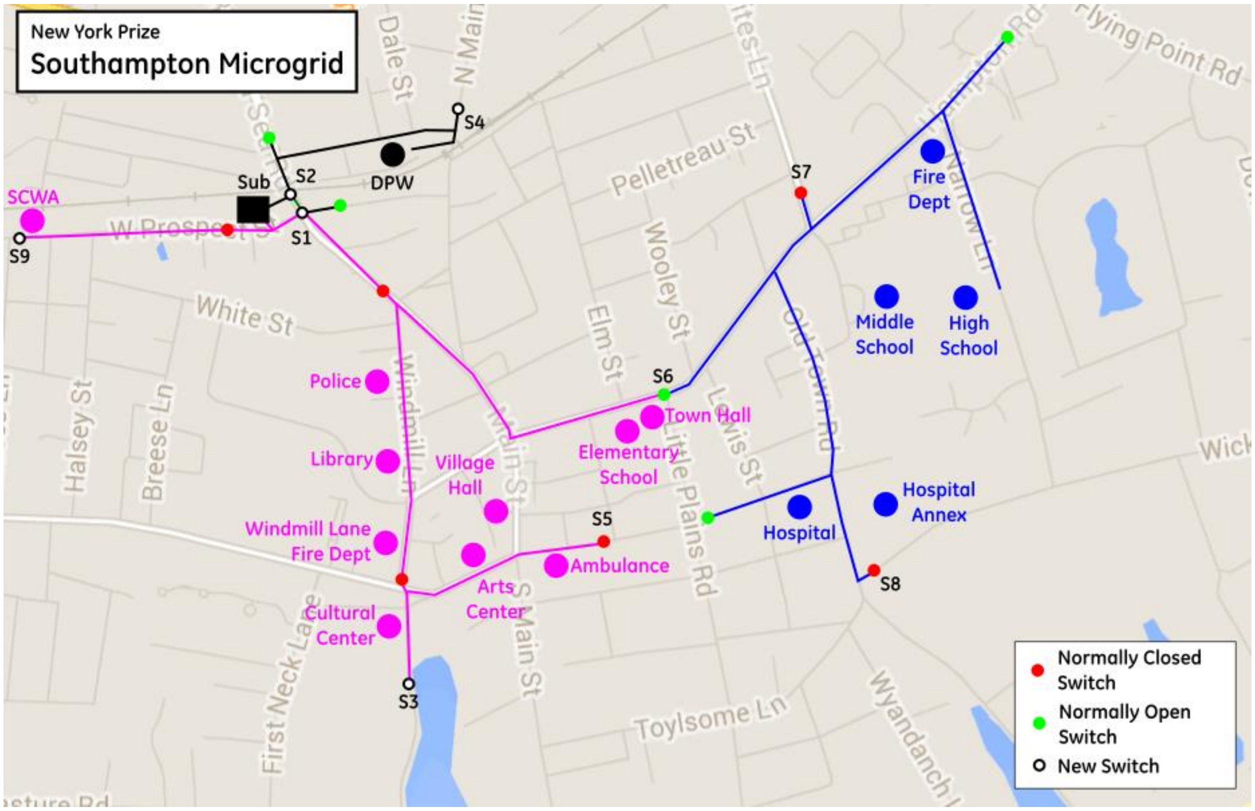


Figure 2-1: Simplified layout of Southampton Microgrid Showing Facilities and Routing of Electrical Connections

Figure 2-2 below shows a simplified one-line diagram with the location of the distributed energy resources (DER). Due to the distances between facilities, the microgrid design makes heavy use of existing utility infrastructure to interconnect microgrid loads and generation.

To facilitate formation of the microgrid, two new sectionalizing devices, two new transfer switches and a short line segment will be installed. The section of new line would be constructed between switches S1 and S2 just north of the intersection of W Prospect St and N Sea Rd. This will enable connection of DPW to the microgrid when the substation is bypassed. The team has assumed that the Town and Village Boards would approve construction of less than 300 feet of the new overhead line due to the local benefits of the project. However, if there is opposition to a new above-ground line, the short line segment can be placed underground (direct-buried) at relatively low cost.

Other additions include natural gas generation at the DPW, CCHP at the Hospital, battery storage at SCWA, and PV at the Elementary School. These are shown on the one-line diagram below.

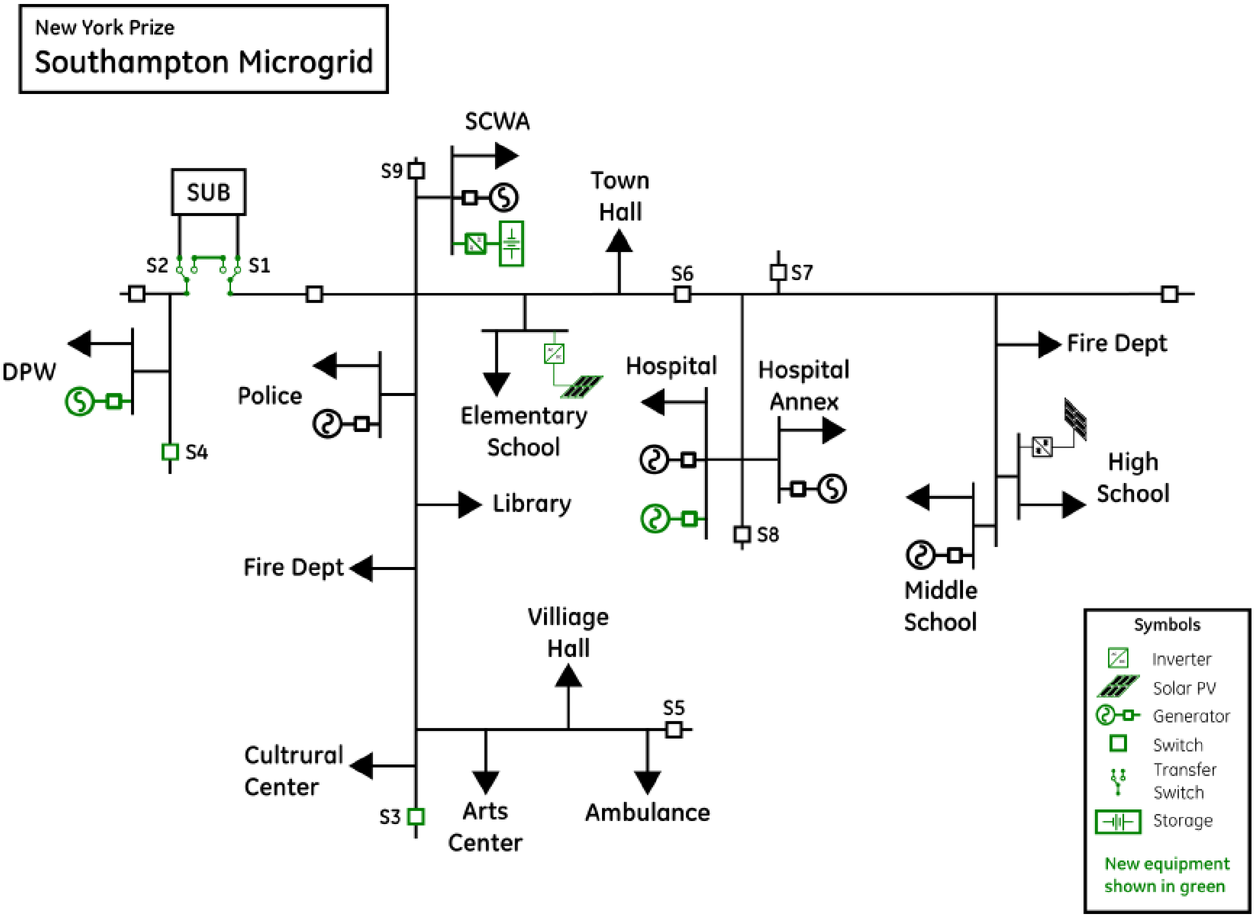


Figure 2-2: Southampton Microgrid One-Line Diagram Showing Generation Sources and Major Equipment

2.1.2 Operation under Normal and Emergency Conditions

Normal Conditions

Under normal conditions, the facilities that will be part of the microgrid are fed by the utility local distribution system. A proposed Microgrid Energy Service Company (MESCO), will own and operate the microgrid DERs, and have PPA/Bilateral agreements with the microgrid load customers and possibly with other customers in Southampton. During normal conditions, the MESCO will be obligated to serve the loads of its customers either by dispatching its generation resources or by purchase of power from the larger grid, depending on the comparative costs of on-site generation versus utility power purchase. The MESCO agreements with its customers, called Microgrid Energy Service Agreements (MESAs), will be based on financial transactions, but the power flows will be based on the larger grid operations. Hence, use of DERs will be determined by MESCO contracts and a combination of local usage needs (such as thermal load) and economic optimizations. The CCHP is expected to run as baseload throughout the year, due to its higher efficiency of combined electric and thermal energy output.

Emergency Conditions

Under emergency conditions, the facilities will be isolated from the local distribution system at switching S1, S2, S3, S4, S5, S7 and S8 as shown in Figure 2-1 and Figure 2-2. To tie adjacent circuits together, normally-open switch S6 will be closed, and a new section of the line will connect two adjacent circuits together via tie switches S1 and S2. The facilities in the above figures as well as all local load attached to the distribution infrastructure being used by the microgrid will be fed by microgrid sources.

During emergency periods, the microgrid electrical load will be met by the collective generation resources within the microgrid. In addition, the CCHP at the hospital will also serve a significant portion of the hospital's thermal heating and cooling loads. The microgrid's onsite supply and demand side resources will be more than adequate to meet the microgrid's electrical load during an extended emergency during the peak load month of the year.

2.2 Load Characterization

2.2.1 Description of **Electrical and Thermal Loads**

The main critical facilities in the study include the Southampton Hospital, the Southampton Schools (which serve as evacuation centers in FEMA all-hazard mitigation management plans), the Village Police Station, the Village Fire Stations, the Southampton Town Hall, the Department of Public Works (DPW), and Suffolk County Water Authority (SCWA). Other critical facilities include properties within the Village planned for the construction of a new ambulance facility and a Sewage Treatment Plant that would treat all the waste from the Main Street business district. The Rogers Memorial Library, while not considered a critical facility per se, is also within the microgrid study area as it may serve as an alternate location for use of the internet, charging stations and as an important information resource after a storm event. As stated, the business district is currently being evaluated for a municipal sewage treatment plant (STP). The trenching and excavation that is necessary to connect to the proposed STP would also allow for the installation of the electrical connections needed for the microgrid.

The proposed Southampton microgrid will include not only the critical loads described, but additional residential and commercial loads that are located on the same distribution feeders as the listed critical loads. Hence, the Southampton microgrid will enable continued normal life and economic activity in large section of the Southampton by providing electrical power to the whole microgrid and also thermal energy to the hospitals during emergency periods and prolonged larger grid power outage.

The table below summarizes monthly electrical load of the microgrid and thermal loads of the hospital. It should be noted that in DER-CAM, cooling load is based on the units of electric power input in kW needed to provide the equivalent cooling load based on the central chiller coefficient of performance (COP) - about 0.7 - and the absorption chiller COP – about 4.5. Hence, the actual cooling load output is the values shown times 4.5 and divided by 0.7.

Table 2-1: Monthly Microgrid Electrical, Heating, and Cooling Load

	Electrical Load			**Heating Load**			**Cooling Load**	
	Energy (kWh)	Peak (kW)		Energy (kWh)	Peak (kW)		Energy (kWh)	Peak (kW)
JAN	1,840,384	3,449		2,395,234	5,719		0	0
FEB	1,679,462	3,496		2,045,929	5,569		0	0
MAR	1,749,634	3,394		1,694,248	3,824		0	0
APR	1,596,534	3,245		931,480	2,335		1,991	6
MAY	1,873,274	3,777		323,166	796		17,923	49
JUN	1,966,327	4,108		38,020	99		69,367	194
JUL	2,639,322	5,332		2,376	6		125,127	341
AUG	2,598,848	5,264		2,376	6		111,519	304
SEP	2,309,111	4,850		95,049	233		46,798	131
OCT	1,801,644	3,560		591,680	1,480		5,642	17
NOV	1,551,791	3,002		1,245,141	3,013		332	1
DEC	1,830,766	3,408		1,986,523	4,801		0	0
YEAR	**23,437,097**	**5,332**		**11,351,221**	**5,719**		**378,699**	**341**

2.2.2 Hourly Profile of Loads

The main sources of electrical and thermal load data are the information collected from the utility billing statements of the critical facilities. However, since the project team decided to include in the microgrid other non-critical loads that happen to be on the same feeder(s) as the originally identified critical loads, the entire aggregated feeder load had to be modeled. Information provided by PSEG-LI was used to estimate the annual peak load of the microgrid and to estimate the annual energy demand on the microgrid. Consequently, a 12 x 24 (month x hour) load shape was developed, resulting in an annual peak load of entire microgrid.

The total annual heating and cooling load of the hospitals were also projected over 12 x 24 load shapes. The heating load daily profiles were based on the DER-CAM database's typical hospital load shape, and the cooling load daily profiles were based on seasonal load shapes developed by EPRI for each region of the USA by customer class and for different end uses.[1]

The microgrid's 12 x 24 electrical and thermal load profiles in tabular and graphical forms based on this information are provided in the following tables. We recognize that the actual peak loads for Southampton often occur during late afternoon on summer weekends, rather than during weekdays as shown below. However, since the capacity of the DERs is based on the peak load, the timing of the peak would not change the design capacity. Samples of daily load profiles for electrical, heating, and cooling loads are also provided in Figure 2-3 to Figure 2-8.

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[1] http://loadshape.epri.com/enduse

Table 2-2: Microgrid 12x24 Electrical Load (kW)

Day-type	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
weekday	JAN	1764	1759	1725	1753	1874	1953	2251	2880	3117	3217	3303	3396	3449	3435	3417	3396	3335	3243	2990	2872	2659	2175	1892	1833
weekday	FEB	1765	1760	1734	1753	1903	1967	2301	2958	3163	3263	3350	3441	3496	3477	3458	3433	3362	3255	2971	2901	2674	2161	1871	1814
weekday	MAR	1634	1606	1597	1680	1763	1989	2485	2916	3072	3164	3190	3332	3394	3383	3359	3334	3229	2953	2778	2582	2234	1907	1748	1675
weekday	APR	1477	1441	1426	1571	1588	1944	2513	2735	2855	2956	3063	3175	3245	3241	3234	3217	3104	2734	2652	2338	1886	1703	1619	1548
weekday	MAY	1622	1575	1547	1722	1728	2141	2721	2992	3149	3310	3463	3634	3748	3768	3777	3775	3651	3198	3094	2681	2159	1915	1817	1728
weekday	JUN	1776	1698	1654	1772	1765	2111	2633	2921	3115	3363	3603	3864	4034	4077	4103	4108	3992	3605	3474	3019	2432	2160	2057	1938
weekday	JUL	2443	2306	2215	2349	2337	2807	3093	3695	3951	4256	4576	4906	5141	5237	5295	5332	5196	4677	4538	3750	3337	2952	2805	2644
weekday	AUG	2412	2268	2178	2324	2306	2791	3080	3609	3849	4152	4481	4837	5080	5172	5231	5264	5159	4651	4495	3690	3314	2978	2805	2639
weekday	SEP	2072	2001	1960	2149	2154	2634	3330	3693	3862	4093	4326	4584	4764	4819	4849	4850	4691	4159	3983	3430	2807	2425	2279	2160
weekday	OCT	1620	1575	1557	1701	1708	2075	2679	2940	3050	3177	3312	3456	3548	3560	3558	3548	3428	3066	2969	2682	2141	1879	1794	1702
weekday	NOV	1488	1468	1436	1452	1551	1618	1901	2436	2610	2712	2806	2927	3002	3002	2991	2985	2926	2867	2644	2519	2332	1895	1646	1577
weekday	DEC	1726	1723	1673	1701	1829	1907	2235	2878	3074	3168	3253	3347	3408	3400	3391	3380	3335	3305	3021	2900	2667	2159	1869	1821
weekend	JAN	1795	1753	1720	1728	1767	1805	1892	2015	2108	2156	2214	2297	2366	2356	2287	2261	2215	2198	2157	2060	2003	1982	1851	1817
weekend	FEB	1789	1799	1723	1775	1777	1864	1910	2079	2115	2209	2232	2336	2376	2382	2291	2283	2212	2190	2122	2104	2008	2026	1862	1884
weekend	MAR	1647	1604	1578	1606	1633	1699	1778	1904	1993	2043	2122	2191	2256	2211	2160	2123	2051	1948	1882	1805	1845	1788	1735	1678
weekend	APR	1536	1478	1449	1484	1491	1578	1659	1763	1854	1919	1975	2060	2130	2101	2056	2038	1951	1825	1746	1616	1656	1622	1585	1516
weekend	MAY	1722	1637	1586	1630	1618	1724	1796	1944	2084	2232	2347	2480	2590	2572	2538	2534	2440	2290	2198	2015	1963	1905	1845	1769
weekend	JUN	1948	1817	1732	1739	1711	1786	1821	1974	2135	2339	2520	2757	2923	2947	2944	2950	2872	2743	2636	2409	2296	2182	2108	1994
weekend	JUL	2578	2391	2261	2255	2211	2302	2353	2554	2783	3094	3381	3704	3931	3966	3954	3967	3875	3679	3575	3302	3118	2938	2819	2660
weekend	AUG	2560	2375	2250	2248	2206	2288	2355	2507	2710	2990	3245	3532	3744	3794	3793	3813	3733	3569	3446	3184	3066	2935	2795	2638
weekend	SEP	2159	2047	1970	2008	1983	2101	2193	2379	2527	2744	2931	3160	3334	3342	3319	3331	3217	3041	2911	2647	2616	2446	2330	2213
weekend	OCT	1688	1618	1570	1609	1597	1687	1749	1890	1972	2063	2161	2276	2375	2355	2326	2314	2229	2109	2041	1956	1947	1844	1778	1699
weekend	NOV	1553	1495	1463	1471	1501	1558	1622	1751	1821	1895	1961	2069	2151	2138	2094	2068	2035	2012	1975	1866	1799	1757	1649	1603
weekend	DEC	1775	1742	1693	1685	1732	1776	1855	1995	2076	2142	2212	2315	2397	2402	2332	2310	2284	2300	2196	2101	2009	1993	1860	1824

Table 2-3: Microgrid 12x24 Heating Load (kW)

Day-type	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
weekday	JAN	3,942	4,064	4,158	4,220	4,047	5,719	4,363	3,889	3,469	3,194	2,958	2,787	2,671	2,583	2,479	2,444	2,546	2,629	2,758	2,850	3,218	3,330	3,597	3,772
weekday	FEB	3,800	3,872	3,966	4,071	3,864	5,569	4,205	3,552	3,195	2,989	2,787	2,635	2,554	2,469	2,366	2,322	2,311	2,456	2,627	2,741	3,097	3,239	3,505	3,638
weekday	MAR	2,873	2,936	3,008	2,925	3,824	3,558	2,895	2,558	2,365	2,203	2,091	1,992	1,916	1,832	1,759	1,734	1,735	1,872	2,026	2,239	2,386	2,549	2,686	2,762
weekday	APR	1,650	1,687	1,721	1,612	2,335	1,712	1,430	1,297	1,229	1,165	1,119	1,076	1,046	1,001	972	949	950	1,067	1,159	1,339	1,388	1,524	1,580	1,621
weekday	MAY	594	607	621	583	796	578	484	440	414	395	377	364	353	338	321	311	308	350	382	462	487	542	566	583
weekday	JUN	78	80	83	78	99	71	60	54	49	46	44	41	38	35	31	30	29	36	39	52	56	65	69	73
weekday	JUL	5	5	5	5	6	5	4	3	3	3	3	2	2	2	2	1	1	2	2	3	3	4	4	5
weekday	AUG	5	5	5	5	6	4	4	3	3	3	2	2	2	2	2	2	1	2	2	3	3	4	4	4
weekday	SEP	184	188	191	179	233	173	148	133	121	113	107	102	99	94	90	89	90	108	119	141	147	165	172	177
weekday	OCT	1,076	1,097	1,116	1,047	1,480	1,094	955	855	783	724	683	647	619	587	567	564	581	685	727	835	864	953	987	1,014
weekday	NOV	2,168	2,216	2,254	2,256	2,278	3,013	2,282	1,972	1,782	1,662	1,562	1,491	1,439	1,382	1,331	1,322	1,408	1,469	1,574	1,651	1,823	1,894	2,047	2,126
weekday	DEC	3,297	3,366	3,391	3,488	3,256	4,801	3,584	3,116	2,835	2,690	2,555	2,423	2,344	2,286	2,209	2,180	2,245	2,277	2,360	2,456	2,754	2,868	3,122	3,265
weekend	JAN	3,138	3,233	3,334	3,425	3,308	3,370	3,057	3,552	2,993	2,676	2,505	2,390	2,275	2,208	2,133	1,867	1,922	2,018	2,372	2,475	2,785	2,928	3,218	3,272
weekend	FEB	2,885	2,938	3,005	3,087	2,996	3,019	2,677	3,054	2,710	2,448	2,305	2,197	2,140	2,074	2,009	1,744	1,788	1,949	2,256	2,368	2,644	2,776	2,987	3,114
weekend	MAR	2,146	2,189	2,229	2,210	2,199	2,028	2,054	2,105	1,918	1,772	1,678	1,622	1,556	1,518	1,399	1,258	1,284	1,478	1,676	1,841	1,970	2,099	2,210	2,267
weekend	APR	1,321	1,343	1,363	1,303	1,301	1,096	1,303	1,198	1,096	1,036	998	969	949	921	791	764	778	929	1,001	1,137	1,173	1,270	1,314	1,349
weekend	MAY	452	462	468	447	449	361	407	368	327	305	291	277	266	253	223	221	225	279	302	359	375	413	427	437
weekend	JUN	61	63	64	62	62	49	50	45	41	39	37	35	33	32	27	26	26	32	35	44	47	54	57	59
weekend	JUL	4	4	4	4	4	3	3	3	3	2	2	2	2	2	2	2	2	2	2	3	3	3	4	4
weekend	AUG	4	4	5	4	4	3	4	3	3	3	3	3	2	2	2	2	2	2	3	4	4	4	4	5
weekend	SEP	135	138	140	134	133	108	122	114	102	97	92	89	86	82	71	70	72	92	101	117	121	133	137	141
weekend	OCT	783	797	811	779	779	646	725	665	595	554	534	518	508	488	432	427	455	573	611	694	720	786	815	836
weekend	NOV	1,609	1,666	1,732	1,705	1,665	1,610	1,463	1,637	1,446	1,317	1,242	1,185	1,142	1,101	1,053	959	1,022	1,112	1,251	1,330	1,458	1,519	1,632	1,677
weekend	DEC	2,419	2,470	2,532	2,577	2,566	2,545	2,263	2,653	2,358	2,094	1,958	1,866	1,800	1,754	1,724	1,504	1,583	1,662	1,892	1,972	2,213	2,301	2,435	2,505

Table 2-4: Microgrid 12x24 Cooling Load (kW)

Day-type	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
weekday	JAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
weekday	FEB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
weekday	MAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
weekday	APR	1	1	1	1	1	1	2	2	3	4	4	5	5	6	6	5	5	4	4	3	2	2	2	1
weekday	MAY	8	8	8	8	9	12	15	21	27	33	39	43	47	49	49	47	43	37	32	26	21	17	13	11
weekday	JUN	33	33	32	33	37	46	61	82	107	132	154	173	186	194	194	185	169	148	125	104	84	67	54	44
weekday	JUL	58	58	57	58	65	81	108	144	188	231	271	303	327	341	341	326	297	260	220	182	148	118	94	77
weekday	AUG	52	52	50	51	58	72	96	129	167	206	241	270	292	304	304	290	265	232	196	163	132	106	84	68
weekday	SEP	22	22	22	22	25	31	41	55	72	89	104	117	126	131	131	125	114	100	85	70	57	45	36	30
weekday	OCT	3	3	3	3	4	4	5	6	7	9	11	13	15	16	17	16	15	13	11	9	7	6	5	4
weekday	NOV	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
weekday	DEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
weekend	JAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
weekend	FEB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
weekend	MAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
weekend	APR	1	1	1	1	1	1	1	2	2	3	3	3	4	4	4	4	3	3	3	2	2	2	1	1
weekend	MAY	9	9	9	9	9	10	12	15	19	23	27	29	31	32	32	31	30	27	24	21	18	15	13	11
weekend	JUN	35	35	34	34	35	39	48	61	77	93	107	117	124	128	129	125	117	108	96	85	73	61	50	42
weekend	JUL	62	62	60	60	62	69	84	107	135	163	187	206	219	226	226	219	206	189	169	149	128	107	89	73
weekend	AUG	55	55	54	53	55	62	75	96	120	145	167	184	195	201	201	195	184	168	151	133	114	96	79	65
weekend	SEP	24	24	23	23	24	27	32	41	52	63	72	79	84	87	87	84	79	73	65	57	49	41	34	28
weekend	OCT	3	3	3	3	3	4	4	4	4	5	6	7	8	8	9	9	8	8	7	6	6	5	4	3
weekend	NOV	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
weekend	DEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

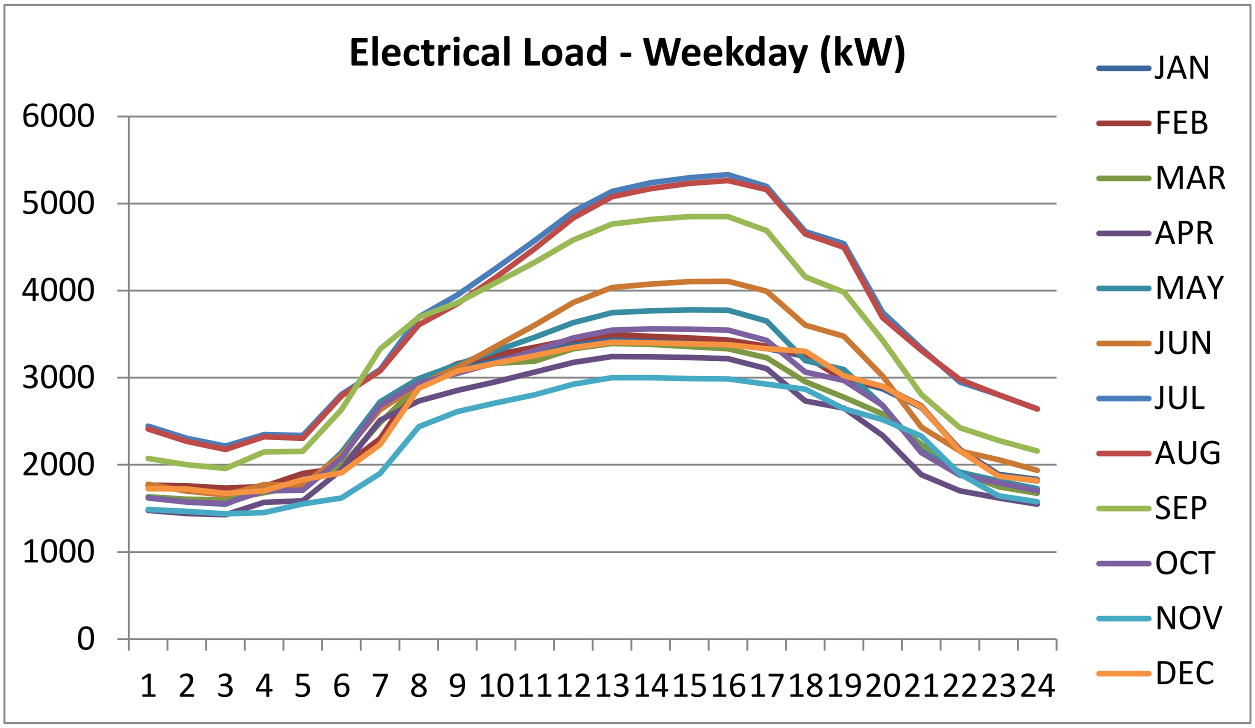

Figure 2-3: Microgrid Weekday Electrical Load Profile (kW)

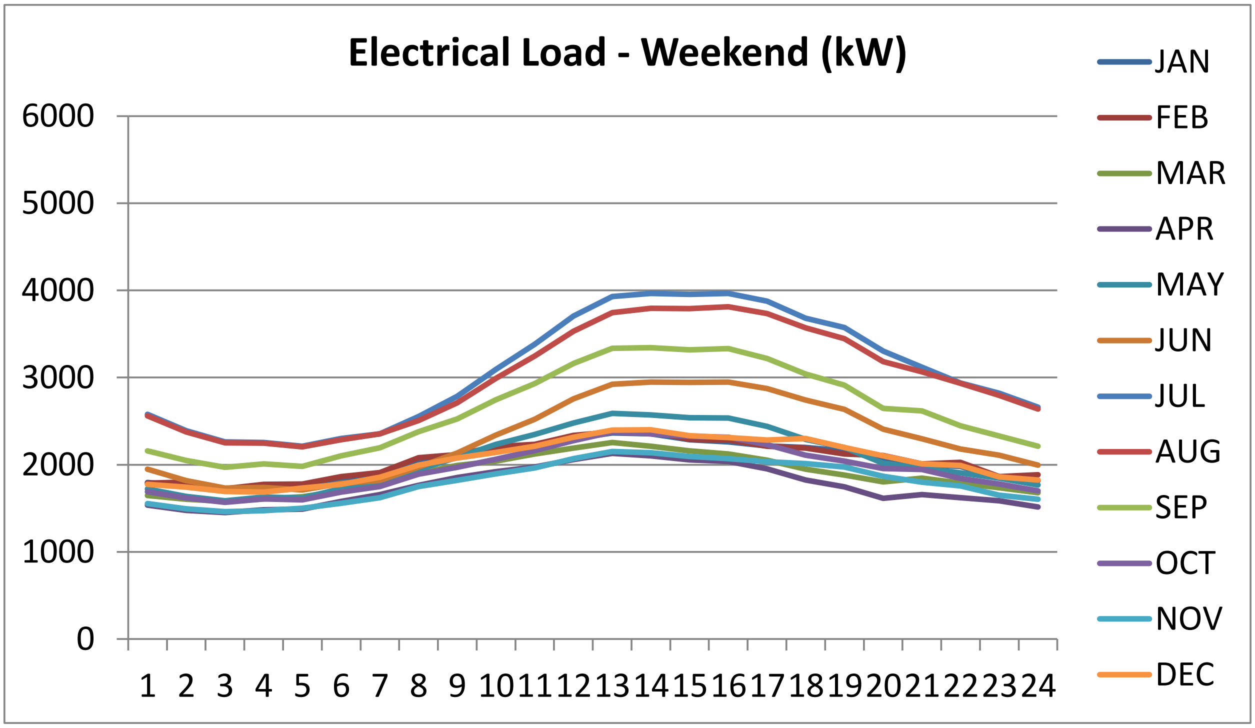

Figure 2-4: Microgrid Weekend Electrical Load Profile (kW)

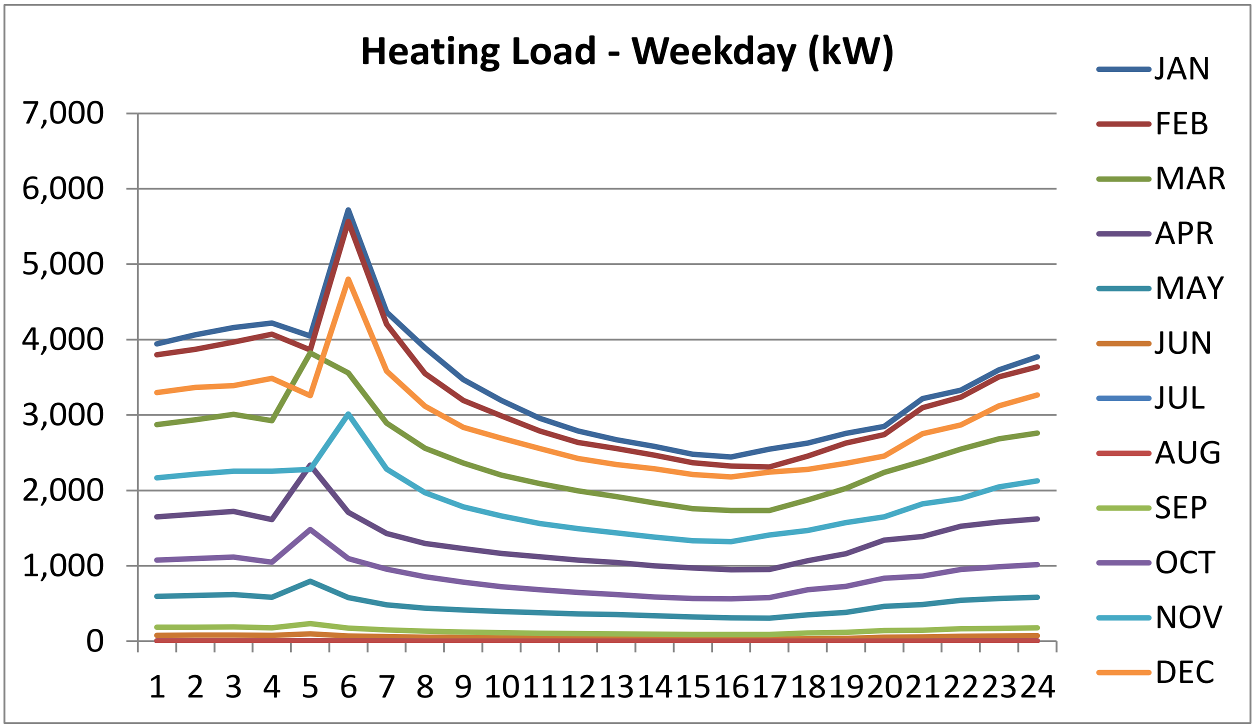

Figure 2-5: Microgrid Weekday Heating Load Profile (kW)

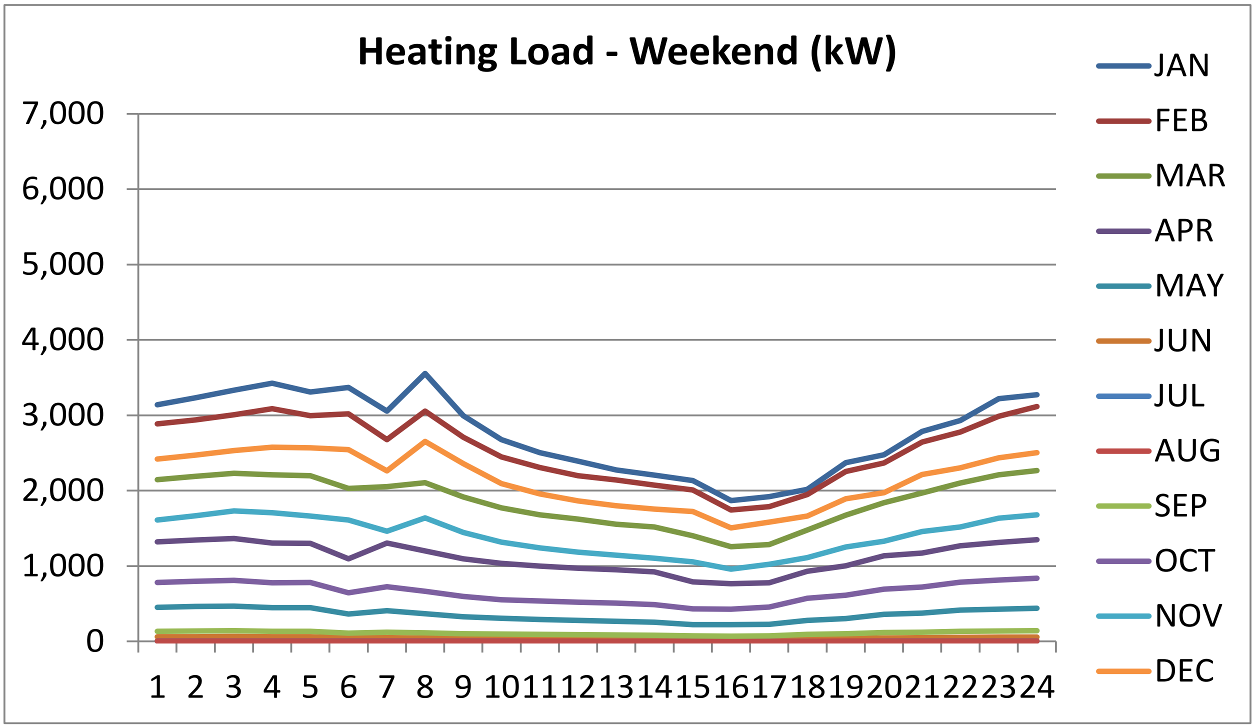

Figure 2-6: Microgrid Weekend Heating Load Profile (kW)

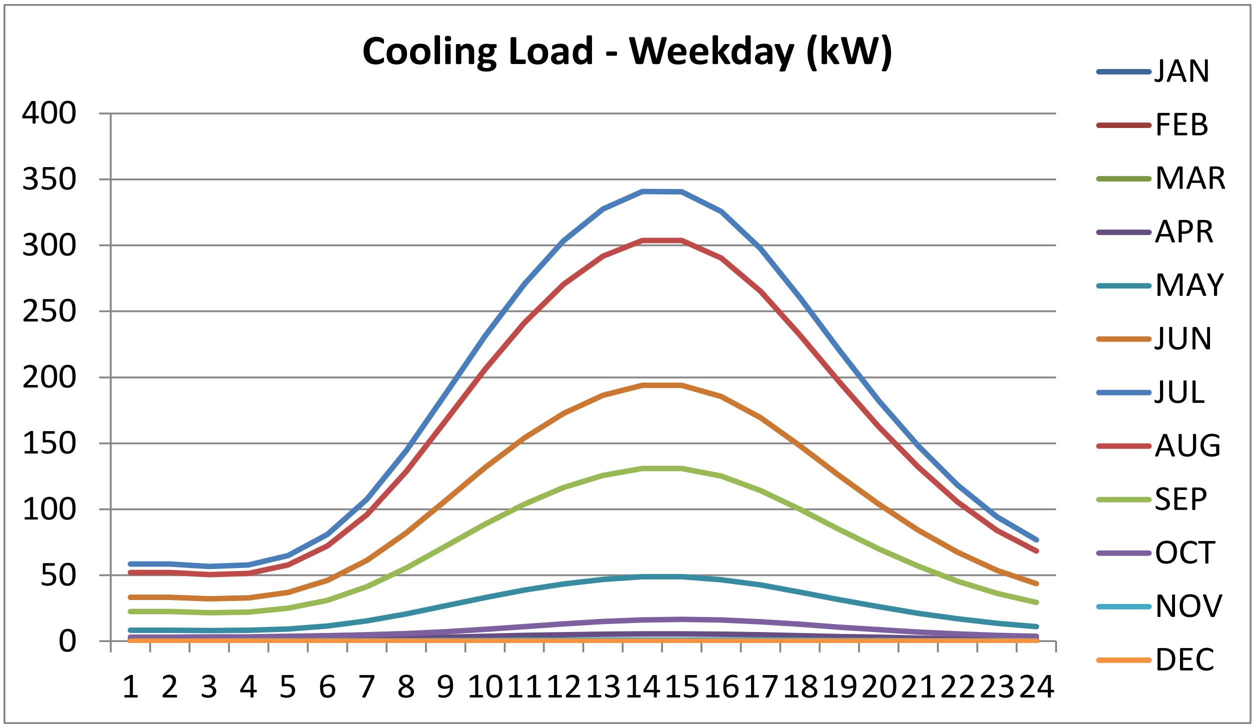

Figure 2-7: Microgrid Weekday Cooling Load Profile (kW)

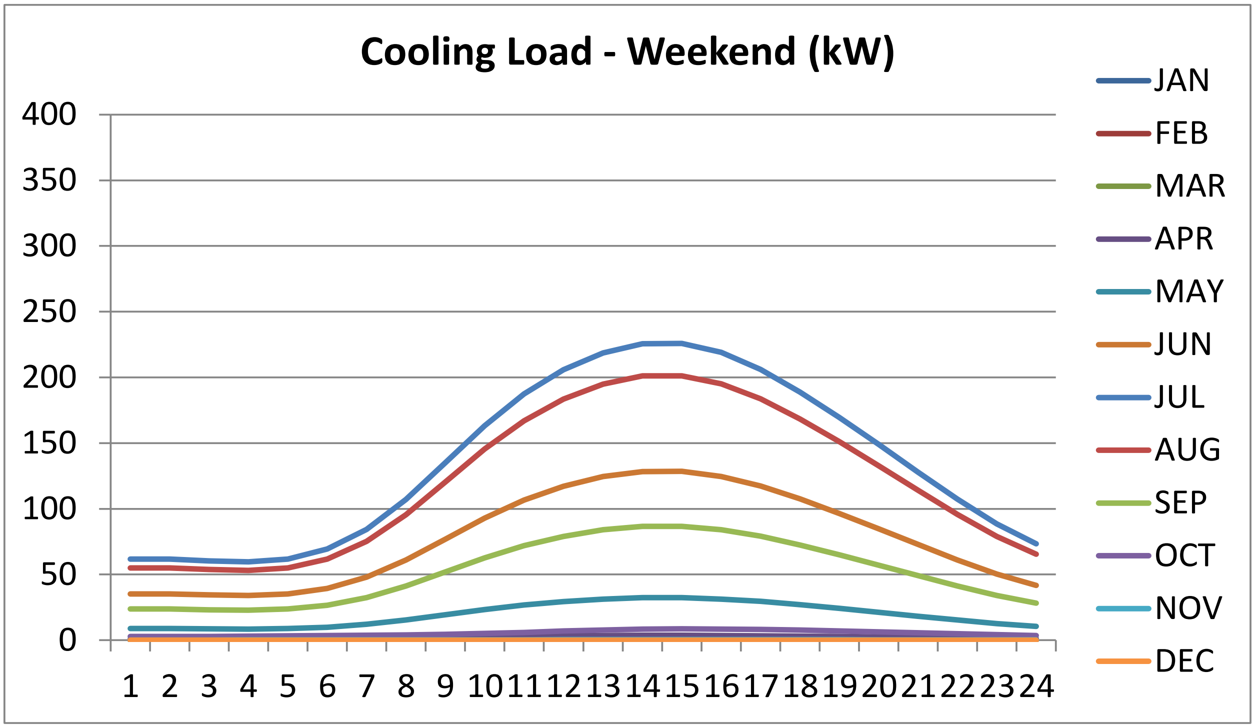

Figure 2-8: Microgrid Weekend Cooling Load Profile (kW)

2.2.3 Description of Sizing of Loads

The microgrid total electrical load is based on the sum of all the loads of individual critical facilities to be served by the microgrid, plus the additional non-critical loads connected to the microgrid feeders, as listed in Table 2-5 below.

The sum of the non-coincident peak loads in Table 2-5 is 5,980 kW, which is significantly higher than the estimated coincident peak load of 5,332 kW (which occurs in July as shown earlier in Table 2-1). The coincident peak load is used for planning the microgrid generation.

The thermal loads serviced by the microgrid are limited to the thermal heating and cooling loads of Southampton Hospital which are mostly met by the new CCHP unit located in the hospital.

Table 2-5: Summary of Electrical, Heating, and Cooling Load

		Electrical Load		**Heating Load**		**Cooling Load**	
	Facility	**Energy (kWh)**	**Peak (kW)**	**Energy (kWh)**	**Peak (kW)**	**Energy (kWh)**	**Peak (kW)**
1	Town Hall	473,940	149				
2	Village Hall	51,120	16				
3	Police Department	365,800	137				
4	Windmill Lane Fire House	211,584	127				
5	Hampton Road Fire House	149,600	54				
6	Volunteer Ambulance	37,650	19				
7	Southampton Cultural Center	76,000	34				
8	Southampton Arts Center	182,580	96				
9	Hospital Facility	6,784,000	1,515	11,351,221	5,719	378,699	341
10	Elementary School	444,194	115				
11	Middle School/Admin	903,900	232				
12	High School	1,858,200	481				
13	Rogers Library + Shed	470,045	171				
14	Rogers Library - Cooper Hall	19,040	8				
15	Department of Public Works (DPW)	75,870	49				
16	SCWA (Water Authority)	448,880	144				
17	Extra Feeder Load	10,884,694	2,634				
	Total	23,437,097	5,980*	11,351,221	5,835	378,699	341

* Sum of non-coincident peak loads

2.3 Distributed Energy Resources Characterization

2.3.1 DER and Thermal Generation Resources

Table 2-6 below lists the existing and proposed (in bold font) generation resources in the microgrid. It should be noted that there is a total of 78 kW of existing backup generators in the microgrid facilities which are not included in the above table. They will not be directly connected to the microgrid electrical network. They are not expected to be needed during emergency, and will not be required to run during normal microgrid operation, but may be available for peak load support. Other existing backup generators together with the new generation resources will be more than sufficient to meet the microgrid peak load during emergency.

Table 2-6: Microgrid Generation Resources

Microgrid Distributed Energy Resource	Facility Name	Energy Source	Nameplate Capacity (MW)
Existing Backup Generator 1	Hospital	*Natural Gas/Diesel*	0.800
Existing Backup Generator 2	Hospital	*Natural Gas/Diesel*	0.800
New CCHP	**Hospital**	***Natural Gas***	**1.500**
New Reciprocating Engine	**DPW**	***Natural Gas***	**2.000**
Existing Backup Generator	High School	*Natural Gas*	0.200
Existing PV 1	High School	*Solar*	0.100
Existing PV 2	High School	*Solar*	0.010
New PV	**Elementary School**	***Solar***	**0.300**
New Battery (200 kW, 800 kWh)	**SCWA**	***Electricity***	**0.200**
Existing Backup Generator	Police Department	*Natural Gas*	0.343

2.3.2 New DER and Thermal Generation

New generation resources and their locations are listed in bold font in Table 2-6. The equipment layout and one-line diagrams were provided in Figure 2-1 and Figure 2-2 (new generation resources are shaded in green). All the new generators are natural gas fueled. A 1,500 kW natural gas fueled CCHP will be located at the Southampton Hospital, as well as a 2,000 kW natural gas reciprocating engine generator at DPW, and a 200 kW (800 kWh) battery energy storage system to be located at the SCWA.

Southampton Hospital contains two existing 800 kW diesel fueled standby generators that are each limited to a maximum operating capacity of 640 kW (80%). These units will operate at most 3-4 hours during major power outages. Other major existing backup generators include a 200 kW natural gas unit at the High School, and a 343 kW natural gas unit at the Police Department. There are also a number of smaller than 100 kW units, but they are not expected to run for any significant amount of time - even during emergency periods - since they will not be needed to meet the microgrid load in islanded mode, and they will also be too costly to run during grid connected mode.

In addition to the dispatchable generation listed above, the microgrid already has two solar PV systems, with a total nameplate capacity of 110 kW. An additional 300 kW solar PV system is proposed for installation at the Elementary School. Additional resources include 126 kW of load curtailment (roughly equal to 5% of peak loads of the two largest facilities) available during emergency periods. The same 126 kW resource will be available as Demand Response resources during normal days. These measures would be implemented subject to approval of the hospital.

2.3.3 Adequacy of DERs and Thermal Generation Resources

The DER-CAM model takes into consideration the 12-month x 24-hour daily average electrical and thermal profiles of the aggregate loads of the facilities in the Southampton microgrid.

The solar energy (based on the solar irradiance profile in West Hampton Airport, NY) is available during on-peak hours.

Figure 2-9 provides a view of the "theoretical" load and supply balance over a weekday of operation on a normal day in the month of July. The DER-CAM model dispatches all the generation resources based on the comparative economics of on-site generation versus purchase from the utility. As can be seen, power is purchased from the utility during off-peak hours (there is a demand charge during on-peak hours from June-September).

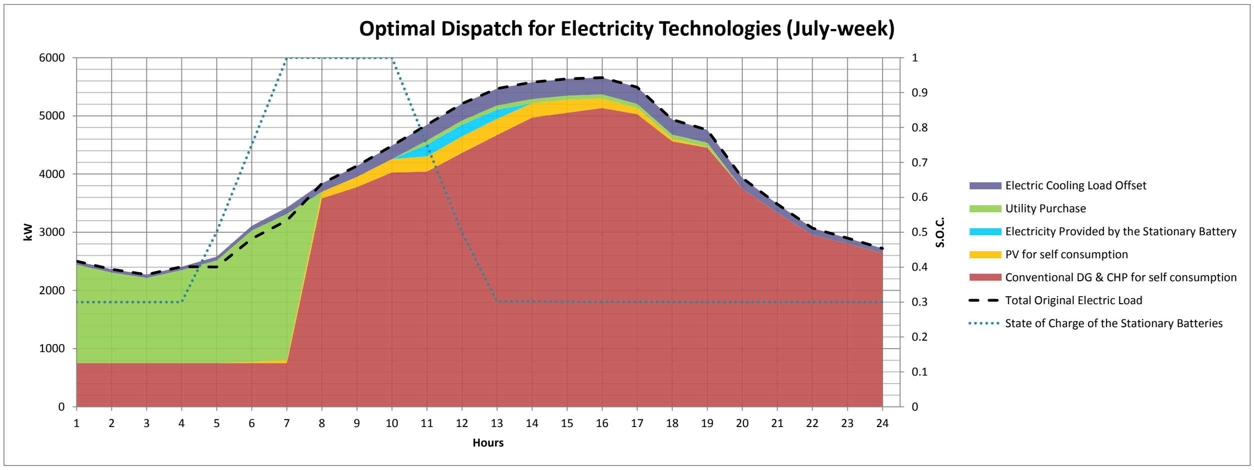

Figure 2-9: Optimal Electrical Dispatch to Meet Electrical Load – July Normal Weekday

In the above figure, the black dashed line represents the total original electrical load. The burgundy colored area represents the on-site generation by the microgrid (CCHP + Reciprocating Engine). The yellow colored area is the solar PV production. The green colored area is the additional electric energy purchased from the utility. The light blue colored area represents the battery storage discharge. The dark blue colored area is the reduction in the original electric load due to use of absorption chillers, which replaces the electric usage by central chillers. In DER-CAM, cooling loads are expressed in electricity needed to serve the cooling demand. The electric only generation will be dispatched when the LBMP price exceeds the strike price of the generator. The CCHP unit will operate as long as the total energy price, including the commodity, delivery and demand charges, exceed the strike price. Based on historic all in energy prices, it is expected that the CCHP unit will operate over 72% of the time. The State of Charge (SOC) of the battery storage is shown by the light blue dotted line and its value is indicated on the right-hand side Y-axis. The battery will help reduce peak loads at SCWA. This will reduce SCWA's demand for market priced peaking power.

When the main grid is out of service, the battery will help stabilize the microgrid by assuring a balance between supply and demand. However, since the current version of the DER-CAM model only considers the "aggregate" load, it does not link the SCWA's load to the battery storage, and hence it does not dispatch the battery storage due to the large size of the microgrid generation. Hence, dispatch of the battery storage is not properly handled by DER-CAM. In practice, it is expected that the storage battery will recharge at night when energy charges are low, and discharge during the day when energy and demand charges are high. The battery will have discharge duration of four hours.

Figure 2-10 shows the microgrid operation during an emergency weekday in July (the month with the highest microgrid load based on the assumed load shape. As can be observed, there is no utility purchase, and all microgrid load is met by on-site generation, including solar PV. The blank space below the black dashed line represents load curtailment applied during the emergency periods. Load curtailment level is about 5% of the peak load of the two largest facilities in the microgrid. It is believed that higher levels of load curtailment are achievable, but since the largest facility is a hospital, a conservative 5% level was selected.

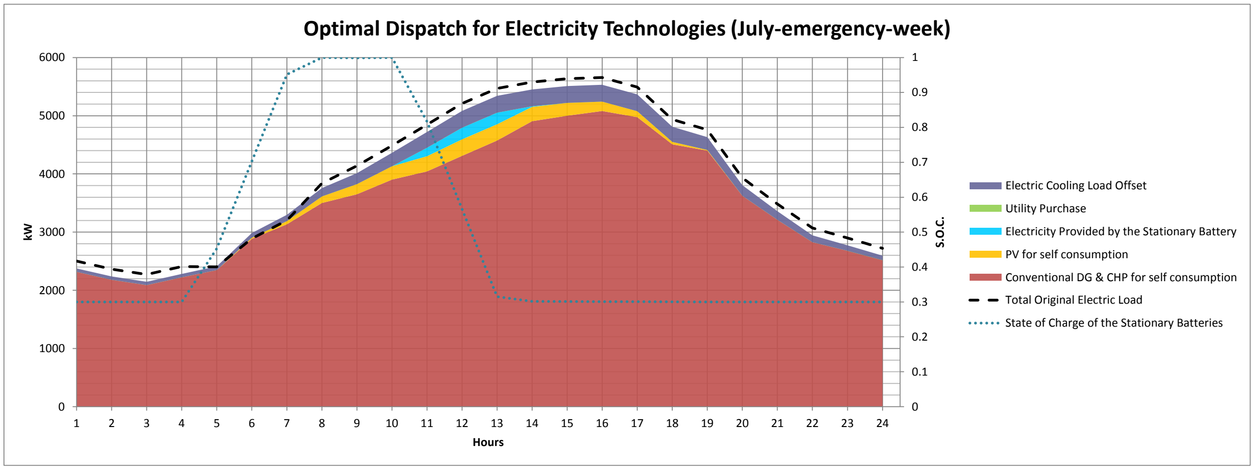

Figure 2-10: Optimal Electrical Dispatch to Meet Electrical Load – July Emergency Weekend

Figure 2-11 shows thermal dispatch for heating load during a normal weekday in January. The black dashed line is the microgrid original total heating load. The grey area represents additional thermal energy that is produced by boilers (i.e., “heat collected from fuels” in the figure below), above and beyond the recovered heat from CCHP, needed to meet the heating load.

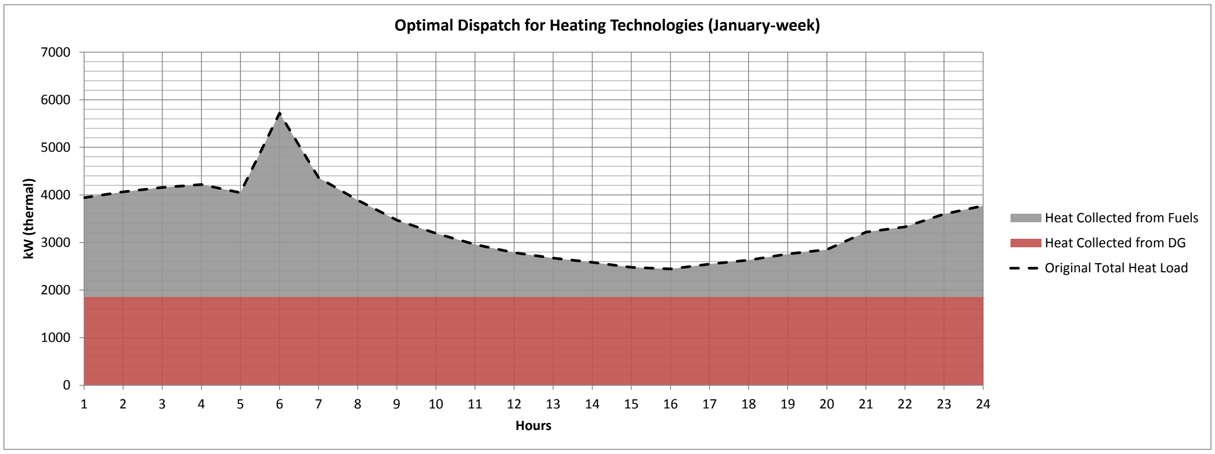

Figure 2-11: Microgrid Thermal Dispatch to Meet Heating Load – January Normal Weekday

Figure 2-12 shows thermal dispatch for heating load during a normal weekday in July. The black dashed line almost touching the X-axis is the microgrid original total heating load. It can be seen there is minimal heating load in the summer. The additional thermal generation going above and beyond the heat load is actually the portion of the thermal energy of the CCHP unit that is utilized to run the absorption chiller at the hospital. As shown, the grey areas represent additional thermal energy that is produced by boilers (i.e., "heat collected from fuels" in the figure below), which in turn is used to produce additional cooling energy by the absorption chiller. The flat top of the curve is the maximum needed recovered heat, which is reached when the absorption chiller operates at its maximum capacity.

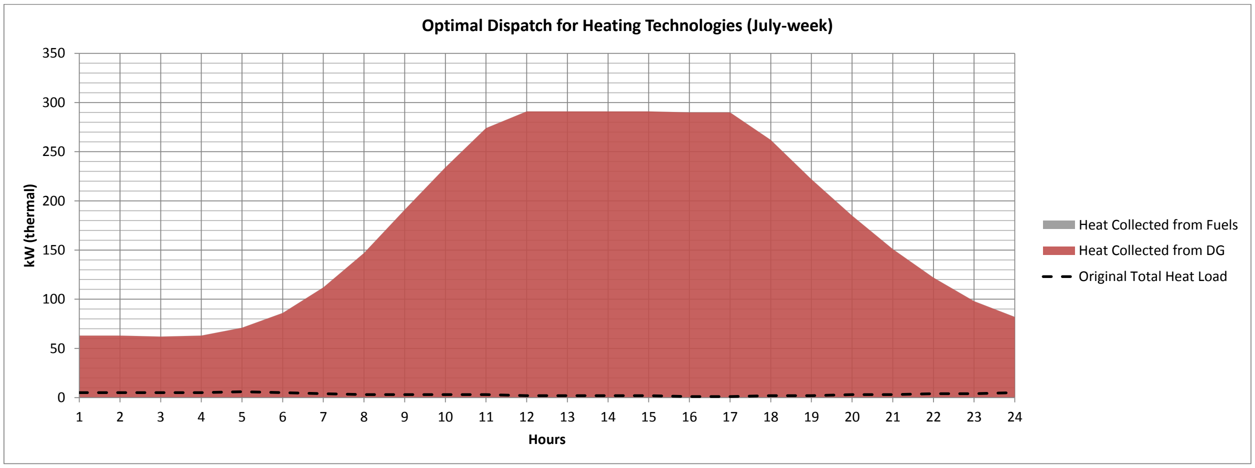

Figure 2-12: Microgrid Thermal Dispatch to Meet Heating Load – July Normal Weekday

Figure 2-13 shows thermal dispatch for cooling load during a normal weekday in July. The black dashed line is the microgrid original total cooling load. Note that in DER-CAM, the cooling load size is not based on the final cooling energy output. It is actually based on the equivalent electric input of central dispatch that will provide that amount of thermal energy, and hence reflects the assumed Coefficient of Performance (COP), which we have assumed to be 4.5.

The burgundy colored area is the cooling load that is provided by the absorption chiller. As shown, there is a need for additional supply to meet the total cooling load - provided by the central chiller (blue colored area).

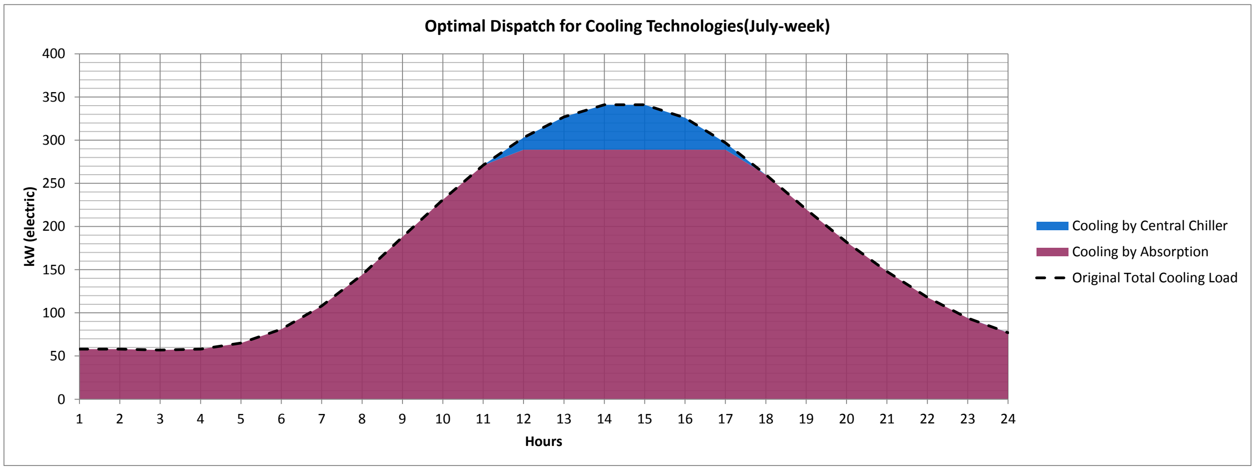

Figure 2-13: Microgrid Thermal Dispatch to Meeting Cooling Load – July Normal Weekday

2.3.4 Resiliency of Resources to the Forces of Nature

The new CCHP unit and the reciprocating engine will be installed above the flood plain at the hospitals and therefore will be protected from most severe weather incidents, and flooding. According to the EPA Catalog of CHP technologies[2], natural gas engine CHP units have an availability of about 1% for units sized 800-9000 kW, a forced outage rate of less than 1%, and a scheduled outage rate of about 2.5%. The CCHP unit and the reciprocating engine, along with the larger existing backup generation at the microgrid facilities constitute a collective power system with very high reliability that is insulated from the forces of nature. The expected forced-outage rate of the entire generation set of the microgrid will be analyzed in Stage 2.

According to the information from the facilities and the utility, natural gas supply has proven to be extremely resilient during past major events. Therefore, supply to the CCHP units is not expected to be interrupted during emergencies (barring seismic activity or sabotage).

The roof-top PV panels are at some risk of being partially or completely covered with snow cover during 4-5 months of the year. However, the contribution of these panels to the overall power profile is not substantial enough to warrant additional action besides an occasional cleaning during these months. The existing backup generation at both sites is more than enough to compensate for any energy lost due to snow cover on PV panels.

2.3.5 Description of Fuel Sources for DER

The primary source of energy for the Southampton microgrid is the roughly 1,500 kW of natural gas CCHP located at the Southampton Hospital, and a 2,000 kW reciprocating engine and a 200 kW (800 kWh) battery storage located at the SCWA. National Grid has confirmed that it can supply natural gas needed to operate the CCHP system by 2021.

National Grid already supplies natural gas to operate a 20 kW backup generator at the DPW complex. National Grid indicated that it will need to perform additional study, and that a fee deposit is required, to confirm additional gas supply for the electric only generation plants on the DPW. However, since gas is already supplied to this site, it is assumed that with the development of the microgrid and the prospects for providing normal economic activity to a significant portion of the town during emergencies and the larger grid outage, regulators and policy makers will act to ensure natural gas delivery needed to keep critical facilities in operation during emergencies.

In view of the timing of the gas infrastructure improvements for the CCHP system, the implementation of the DERs will be made in phases, with the initial DERs installed in 2018, and the CCHP system installed in as soon as National Grid completes the infrastructure improvements.

In the event it is determined that gas infrastructure improvements will be delayed beyond a reasonable time, the project team will consider installation of liquefied natural gas (LNG) storage for use by the CCHP at the hospital. The gas supply for the DPW generating facility is not expected to be an issue, since gas is already supplied to this site.

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[2] http://www.epa.gov/sites/production/files/2015-07/documents/catalog_of_chp_technologies.pdf

2.3.6 Description Operational Capabilities of DER

In connected mode (parallel to the grid), microgrid generation resources would not be required to regulate frequency, and would likely have a small role if any in voltage regulation. These services are provided by the bulk power system and the surrounding distribution system. However, in islanded mode, microgrid resources will need to provide for power balance/frequency control and reactive power balance/voltage control.

New York State and PSEG-LI interconnection requirements with respect to voltage and frequency response will apply to the microgrid generation when it is in grid-connected mode. Whenever voltage or frequency at the POI are outside the allowable bands, the microgrid controller should initiate a disconnect sequence. However, the microgrid generation and control system have the ability to ride-through grid events and regulate voltage and frequency at the POI to help in fault recovery. This action can be coordinated with the utility operations center if needed.

The new natural gas generator at the DPW and any of the existing standby generators located at the hospital are capable of operating without the presence of the distribution system. This ability makes them ideal candidates for black-start application. These generators will have the ability to maintain real and reactive power balance and can maintain frequency and voltage. Most have the capacity for partial load operation within a range (minimum/maximum capacity ratings). However, upgrades to control and protection equipment may be necessary to allow the generators to feed the larger grid.

Some types of generators are more capable of providing frequency control than others. For the Southampton microgrid, some assets will provide baseload power while other assets would switch to frequency control mode. The CCHP unit tends to be better suited to baseload operation than frequency control. For this reason, the majority of fast frequency regulation will come from the natural gas unit at the DPW and the backup generators at the Hospital. To augment this fast frequency regulation, load may need to be controlled. Additionally, it may be necessary for solar production to be curtailed. The specific demands for power matching/frequency regulation will be determined through study, and the microgrid controller will manage assets in response to changing conditions.

Unlike power matching/frequency regulation where some generators are better suited to respond quickly to changes in real power, most generators are capable providing VARs and reacting quickly to changes in voltage. Traditionally, a few types of generator controls are available: voltage control, VAr control and power factor control. For the Southampton microgrid, some combination of these modes will be employed depending on the asset type. For example, the natural gas generator will likely be in voltage control mode to provide fast voltage regulation/reactive power balance and to support voltage during a fault to allow the protection system to operate correctly. The CCHP unit may be used in VAr control mode to supply a reactive power base, and the PV inverters may be in power factor control to smooth voltage variations due to intermittent power output. As with the power balance/frequency control, the specific roles of the different generation assets will be determined through study, and the microgrid controller will manage these assets in response to changing conditions.

While the PV will likely have some advanced functionality such as Volt/VAR control, the dispatchable generation and storage will likely be used to perform the majority of frequency/voltage control. Further study will indicate if the PV will need to be curtailed to maintain stability in islanded operation.

2.4 Electrical and Thermal Infrastructure Characterization

2.4.1 High-Level Description of Electrical Infrastructure

Due to the distances between microgrid facilities and the difficulty in isolating critical and non-critical loads in an emergency, the Southampton microgrid will heavily leverage the existing utility infrastructure. Two new switches (S3 and S4) will be installed to isolate portions of the distribution circuit without any critical loads. The proposed new infrastructure (as well as the existing utility infrastructure) is shown in Figure 2-2, shaded in green.

As shown in Figure 2-1, the proposed microgrid will isolate from the grid in 7 locations labeled S1, S2, S3, S4, S5, S7 and S8. Two of these locations (S1 and S2) will be transfer switches which isolate the feeders from the substation while combining parts of adjacent feeders. Additionally, a normally open tie switch (S6) will be automatically closed during microgrid formation.

To detect abnormal conditions, and to detect when the grid has returned to normal, CTs/PTs will be installed at the isolations points. To achieve the appropriate selectivity/sensitivity and speed of operation, it is likely some combination of direct instrumentation of isolation points and transfer trip will be used. The appropriate configuration will be determined through further study.

Since the CCHP unit at the hospital will serve the heating and cooling requirements at the hospital only, relying on the current thermal networks and conduits, there is no need for additional development of thermal network in Southampton microgrid.

2.4.2 **Resiliency of Electrical and Thermal Infrastructure**

The proposed microgrid loads are currently served by overhead distribution lines. The largest risks to the electrical infrastructure are: 1) a widespread transmission outage, such as the 2003 Northeast blackout, 2) failure of the Southampton substation, such as during a catastrophic weather event or transformer failure, 3) storm surge and flooding leading to de-energization. The team has heard anecdotally that during past hurricane events, overhead lines in many Long island communities that were free of vegetation were not severely unaffected, but some substations were compromised. Due to the lack of vegetation (trees), the OH system near the coastline can actually be more resilient during flooding events than UG systems.

While the proposed microgrid infrastructure is relatively free of trees or other obstructions that typically cause distribution line outages, some susceptible portions of the circuit may need to be hardened to ensure reliability, particularly along some sections of Main Street, Hampton Road, Old Town Road, and North Sea Rd. This could include measures such as aggressive tree-trimming, removal of danger and hazard trees, use of upgraded poles and cross-arms, use of tree wire, compact construction, or selective use of space cable. Any efforts on behalf of the microgrid will have to be coordinated with ongoing hardening efforts by the PSEG-LI.

During a widespread emergency (such as a blackout, substation transformer failure, or system collapse), the microgrid infrastructure would likely not be affected and would be able to form an island. The gas supply line is also highly resilient, and will assure fuel supply at all times. The major risk to the microgrid infrastructure is a catastrophic weather event that might damage the sections of existing electric distribution system that microgrid intends to utilize. However, this risk will be limited because large trees in downtown Southampton are limited, and because the project will include measures to harden the existing distribution lines.

2.4.3 Description of **Microgrid Interconnection to the Grid**

Figure 2-2 shows the points of interconnection with the Southampton distribution system (as discussed in Section 2.4.1). When not in islanded mode, the microgrid will be fed normally through utility circuits. When entering islanded mode, the microgrid will isolate from the utility system via automatic switching operations as shown in Figure 2-2 and described in Section 2.4.1.

While the 2,000 kW natural gas generator and the existing backup generators will be rotating machines, the relatively high penetration of inverter based generation might complicate traditional protection systems based on high currents under faulted conditions. Additionally, since the microgrid infrastructure will be used in conjunction with utility infrastructure under normal conditions, the protection system elements will likely need multiple set-points/configurations.

In addition to overcurrent protection (Functions 50/51), the microgrid protection scheme will likely employ some combination of the following:

- Over/Under Voltage (Functions 27/59)
- Over/Under Frequency (Functions 81O/81U)
- Reverse Power (Function 32)
- Transfer Trip
- Anti-islanding

2.5 Microgrid and Building Controls Characterization

2.5.1 System Control Architecture Description

The proposed microgrid control architecture consists of four control device types:

- **Microgrid Energy Management System** (MG EMS) (1 per microgrid)

  The MG EMS orchestrates all control actions as well as provides the utility interface. It serves as a main microgrid configuration and dashboard station. For instance, a station operator is able to provide scheduling policies through its web interface. The data historian and possibly other data bases are stored at MG EMS which also provides analytics applications.

- **Microgrid Master Control Station** (1 per microgrid)

  Master Control Station is a hardened computer that hosts critical real-time monitoring and control services. It performs forecasting, optimization and dispatch functions.

- **Microgrid Facility Control Node** (1 per facility)

  Facility Control Node coordinates control across multiple buildings composing a specific facility. This controller abstraction is utilized also for any building in the microgrid with local control functions, i.e. a building that hosts a generation unit or building management system (BEMS). Most facility control nodes would also be hardened industrial computers.

- **Microgrid Edge Control Node** (1 per facility)

  Edge Control Node is an automation controller or a feeder management relay with a direct switching interface to loads in a building. This is typically a multifunction controller/IED providing automation and physical interface to switchgear and sensors.

Figure 2-14 shows control devices for the proposed Southampton microgrid as an overlay on the electrical one-line diagram.

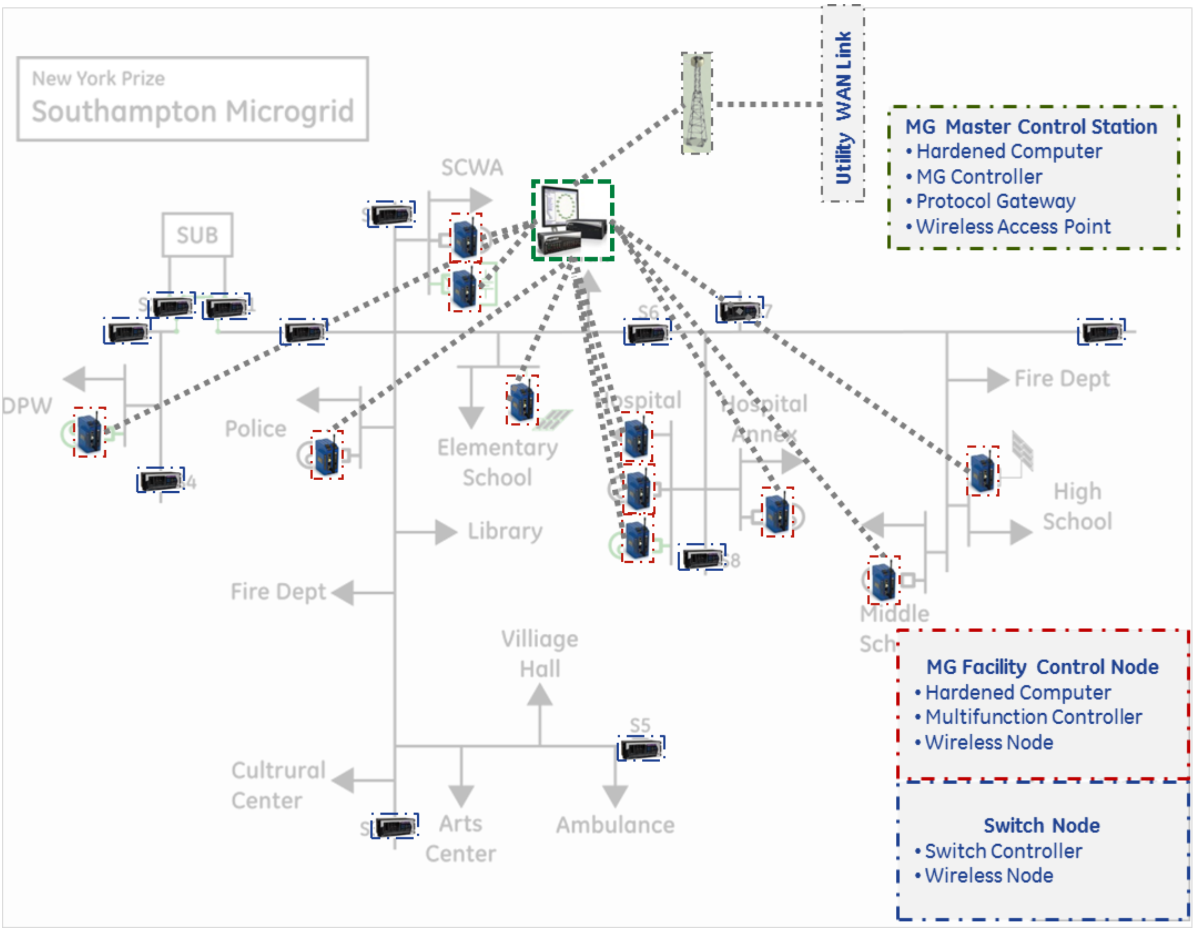

Figure 2-14 Southampton Microgrid Electrical One-Line Diagram with Control and Communications Overlay

The microgrid master control station performs economic optimization, i.e. it periodically determines a combination of generation units to bring on or keep on such that the total cost of operation is minimal. This includes the CCHP unit, the solar PV units, and even the backup generation, which will be tied into the control system with Edge Control Nodes. The start/stop commands as well as optimal set-points for real power, and sometimes even for reactive power, are sent to each generation unit. In addition to regulating the generation units a primary task of the Microgrid Master Control Station is to coordinate the switching devices at the boundary of the microgrid. To simplify Figure 2-14 these communication links are not shown.

Both existing larger backup generators and the new generation units are expected to be equipped with microprocessor-based controllers that can regulate either the natural-gas engines or the inverter-based power conditioning systems. During a typical operation, while a unit is in standby or parallel modes, the controller issues power set-points, while continuously adjusting the engine speed to optimize efficiency.

The local controller devices can interface with the hierarchical control system via Modbus communications. This interface would be used to communicate necessary information between a microgrid facility control node and the local controller of the generation unit located in that facility. The facility control node would act as Modbus master, and the local controller would act as the Modbus slave, sometimes called a remote transmitter unit. The master device initiates all communication, sending commands or requests for information. The local controller would relay all of the AC power related information back to the facility control node including the voltage, current, frequency, and power factor. Thus, this interface will allow the microgrid control system to individually start, stop, and change the set-point of any microgrid generation unit, as well as read all of its inputs and outputs.

The microgrid master controller will likely include load management in the economic optimization of microgrid assets. In such cases, it will communicate with building energy management systems to determine and set load set points. At this point it is not clear the energy management systems of which facilities will be included in microgrid optimization. In terms of peak demand, the primary candidate is the Hospital. We recommend that the microgrid control architecture be built on one of the open software control platforms such as Tridium JACE (Java Application Control Engine). Such a platform can be used to control a variety of BEMS systems, HVAC and DDC devices. This platform supports most of the open protocols for building automation systems sector such as LonWorks, BACnet, and Modbus.

2.5.2 **Services That Could Be Provided by the Microgrid**

Automatically connecting to and disconnecting from the grid

At all times in grid connected mode, the microgrid control scheme must maintain enough generation to supply the critical microgrid loads. When an event occurs, the microgrid control system would initiate a sequence of operations to transition from grid-connected to islanded mode. This was described earlier in Section 2.1.2. Seamless transition during an unplanned event is not foreseen due to current interconnection rules governing DER operation. However, it is conceivable that a planned seamless transition can be achieved.

The formation of a microgrid generally proceeds as follows:

- Detect abnormal conditions
- Isolate microgrid from utility system
- Isolate uninterruptable microgrid from rest of microgrid
- Stabilize generation and uninterruptable loads
- Add loads and generation to core microgrid

Note: some steps may be performed in parallel.

The steps listed above are a combination of predetermined operating procedures and automated control actions. For example, during the planning stages, the load and generation that make up the core or uninterruptable microgrid will be determined and the sectionalizing scheme that isolates the core microgrid will be established. When an abnormal condition is detected (or and isolation signal is given), relay operations will then automatically perform the topology reconfiguration. At the same time, generation controls must be sufficiently flexible to survive a disturbance that may be associated with the abnormal grid condition that requires the microgrid to go into islanded mode. Actions such as the addition of loads and generation to the core microgrid may be manual.

Automatic disconnection: At the points of interconnection, the microgrid will sense abnormal grid conditions such as loss of voltage (on all feeds) and automatically isolate from the larger utility system. Using the isolation switches (shown in Figure 2-2), the utility infrastructure will reconfigure to detach from the substation feed and to remove portions of the feeders that do not contain critical facilities. Further study will determine if the individual isolation points will determine the need to disconnect, or if a signal will be sent from the microgrid controller. To achieve the appropriate selectivity/sensitivity, a combination of direct detection of abnormal conditions and transfer trip will likely be used.

Automatic connection: The microgrid will also be capable of automatically reconnecting to the grid if desired. If automatic reconnection is desired, when the microgrid senses that the utility feed has returned to normal (generally for a period of time), the microgrid will sense the phase and magnitude of the voltage main utility interconnection point. Using either active or passive synchronization, the microgrid controller may close the breaker that ties the microgrid to the utility system. After the main microgrid core is reconnected to the utility system, the rest of the loads can be reconnected to the larger system.

At the time of reconnection, the net load to the system from the microgrid will be minimal. The microgrid can coordinate the return of the additional microgrid loads to normal status with the utility to avoid undue stress on the recovering grid. Depending on the final design of the microgrid, this return to normal may be a combination of automatic and manual operations.

Load shedding schemes

Load management is also integral in islanded mode and in the transition to islanded mode. During microgrid formation, load will likely be shed to allow seamless transition for the uninterruptable loads on the microgrid. Once the microgrid is established, controllable loads may be used in much the same was spinning reserve generation. The three largest facilities in the microgrid are slated to provide about 5% of their peak load as load curtailment resource during emergencies. The amount of load curtailment could be set at higher level (i.e., 10% of peak load for instance), but a conservative 5% level was selected since the largest facility is the Southampton Hospital and hence subject to stricter critical load requirements.

Black start and load addition

During an unplanned event, the microgrid must be capable of black-starting or energizing without an existing power system. Many grid-forming generators can be used for black-starting. Once the generator has been started and the core microgrid formed, the formation of the microgrid may proceed normally.

The existing backup generators located at Southampton Hospital are good candidates for black-start due to their close proximity to the 1,500 kW CCHP generation. As standby units, these generators are generally capable of operating without a grid connection (maintaining voltage and frequency); however, some upgrades to protection/control equipment may be necessary to allow connection to the larger grid.

Once black-start power is provided via the standby generators, the CCHP unit located at the Hospital can come online and provide power to the larger microgrid, along with the natural gas unit located at the

DPW. Finally, if the grid stability and generation margin is sufficient, the PV units located at the Elementary School and High School can connect to the grid.

Performing economic dispatch and load following

The Southampton microgrid will provide load following during emergency periods utilizing the new CCHP unit and reciprocating engine and existing backup generation if needed.

The economic dispatch of the microgrid plant during emergency periods will be performed by the microgrid controller and energy management system, based on the amount of generation needed to balance the time varying net load (i.e., load minus solar generation), and the microgrid generation unit efficiencies and constraints, fuel prices, and variable operations and maintenance (VOM) costs.

During normal/blue sky days, the CCHP units are expected to run as baseload, providing both electrical and thermal energy to the hospitals. The reciprocating engine will be dispatched based on the comparison if its marginal costs of operation and the price of electricity purchase from the larger grid. Other drivers include the structure of the electricity delivery charges (such as daily on-peak or monthly demand charges). It is plausible to assume that at some future point in time, a more complex decision process will determine the microgrid resource dispatch during normal days, more likely based on the relative economic costs of on-site generation versus purchase from the utility, or a future LMP+D pricing system being discussed by REV working groups, or even sales to the larger grid or NYISO, subject to applicable future REV framework. The trade-off between on-site generation and utility purchase is demonstrated in the DER-CAM modeling. Although simplified compared to actual operations, the DER-CAM model illustrates how utility purchases vary with time, and shows their dependency on relative energy costs of on-site generation versus utility purchases, and the influence of utility monthly and daily on-peak demand charges.

Demand response

The same load resources that are available for load curtailment are also available for demand response. The initial plan is to have at least 5% of the microgrid peak load be curtailable during a long-term emergency when the microgrid goes into islanded mode. However, the same load resources can be used as demand response during normal/blue sky days. The 5% of peak load of the combined facilities is about 126 kW, and should be available as demand response during normal days. The demand response resources can be utilized in various utility price-based or event-based demand response programs in the future, such as critical peak pricing (CPP) or critical peak rebates (CPR), or even as part of a portfolio of aggregated demand response resources under management of third party demand response providers who participate in the NYISO demand response and load management programs.

Storage optimization

The proposed Southampton microgrid includes a 200 kW – 800 kWh battery storage located at DPW. In grid connected mode the storage system will be scheduled based on applicable electricity rates and prices subject to its operational limitations. The main value of storage system will be to reduce the total cost of electricity consumption. This will be accomplished by storage charging during low price hours (usually during off-peak periods) and discharging during high price hours (usually during on-peak periods). Furthermore, more complex algorithms, such as those used in DER-CAM will be employed to schedule the discharge of the storage systems to minimize the applicable utility demand charges.

In fact, one of the earliest experiments in optimal scheduling of thermal cool[3] and heat[4] storage was managed and performed (under funding by NYSERDA, EPRI, ESEERCo, NYSEG, and Con Edison) by one of the lead technical consultants on this project. The experiment involved remote control of heat and cool storage using a complex but fast algorithm that used projected need of commercial facilities in the experiment, and next day's hourly real time prices (RTP) and weather forecast, to set the thermal storage schedule on a 4-hour ahead basis.

In islanded mode, the storage will generally be optimized for fast frequency control and to support dispatch of other generation assets. Storage can minimize the variability due to PV, help conventional generation maintain minimum loading requirements, provide power while units are coming online, reduce the need for baseload generation such as the CCHP unit to respond to changes in load, and provide a variety of service that will greatly increase the flexibility of the microgrid assets.

Maintaining frequency and voltage

For the Southampton microgrid, a large portion of the generation will be natural. This will provide a lot of base-load generation, but it will also be used to manage fluctuations in load as well as variation in power output caused by solar. The dual fuel generators will also help maintain frequency if necessary. If additional control is needed, curtailable load may be used to help maintain the microgrid frequency, and PV generation may be curtailed or taken offline. The microgrid controller will assign the load-generation mix based on what is needed to satisfy the primary control objectives. The CCHP will be used primarily as base load generation.

For reactive power/voltage control, all generators may be used. The microgrid controller will determine the appropriate control modes (voltage, pf control, VAR control, etc.) and set-points for the various microgrid assets.

PV observability and controllability; forecasting

PV production will be monitored by the microgrid controller and data will be communicated and stored so that it is available to microgrid operators and owners through a web interface. The controls and communications interface is shown in Figure 2-14. The total nameplate capacity of PV installations is 410 kW, less than 8% of microgrid coincident peak load.

Given the size of PV relative to firm generation, forecasting is probably unnecessary. The load-generation balance and stable operation of the microgrid is planned without dependency on solar PV. The microgrid controller will monitor PV production and will 1) balance PV variability with fast-acting generation resources, 2) use load resources to offset variability, 3) if necessary, curtail PV production when it goes beyond a percentage of online loads.

Coordination of protection settings

When the microgrid is in islanded mode, some key protection functions will be under the purview of the microgrid controller. Where fault current is insufficient to ensure that secure, safe, dependable, reliable

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[3] "Automatic Control of Thermal Electric Storage (Cool) under Real-Time Pricing", NYERDA, 1994, Lead Author: Bahman Daryanian: https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB96195151.xhtml

[4] "Automatic Control of Thermal Electric Storage (Heat) under Real-Time Pricing", NYERDA, 1995, Lead Author: Bahman Daryanian: https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/PB96198023.xhtml

operation of protection systems (such as fuses), the Team may consider another layer of protection that is predicated on transfer trip signals from the controller.

While the microgrid will contain some rotating machines, traditional protection schemes based on high fault currents may be inappropriate when in islanded mode due to the relatively high penetration of inverter based generation. While fuses are a low cost option for overcurrent protection, coordination the protection schemes between grid-connected and islanded mode may require relays capable of being switched between multiple modes or set-points.

In addition to Instantaneous/Timed Overcurrent protection (Functions 50P/50G/51P/51G), the microgrid protection scheme will employ some combination of the following:

- Over/Under Voltage (Functions 27/59)
- Over/Under Frequency (Functions 81O/81U)
- Reverse Power (Function 32)
- Transfer Trip
- Anti-islanding

Selling energy and ancillary services

Subject to evolving NY REV framework, the NYISO market rules applicable to microgrids and distributed generation, and enabling technology (to allow back-feeding in the network), it is expected that the distributed generation within the Southampton microgrid can sell energy into the larger grid though the Distribution System Platform (DSPP) model being developed within REV, but also participate in the NYISO energy, ancillary services, and capacity markets.

Based on the proposed business model described earlier, microgrid generators will be owned by a MESCO, which will have contracts with customers both within and outside of the microgrid to serve their load. The contracts will be purely financial transactions based on the metered electricity usage. During normal days, MESCO will choose between onsite generation and power purchase from the utility or the ISO based on the comparative economics of onsite generation and grid market prices. The complex scheduling software will also consider any applicable standby and demand charges.

The details of qualifications for selling energy to the utility, and the requirements for NYISO participation are to be determined within the REV process and NYISO market design development. From a theoretical perspective, the on-site generation would sell energy at times when applicable Locational Marginal Price + Distribution Component (LMP + D) are higher than the marginal cost of on-site generation.

The ancillary services, including regulation up and down and spinning and non-spinning reserve can also be provided by the on-site generation subject to future market rules.

And finally, subject to qualification, on-site generation can participate in NYISO capacity auctions, and if they clear the market, they can be paid the applicable NYISO capacity prices.

Data logging features

According to the control architecture presented above, data logging is both local (at microgrid facility control nodes) and global (at microgrid master control station). These controllers, typically industrial PCs, record system data at regular intervals of time. A Human Machine Interface client for accessing data through a web interface exists at least at the master control station.

The data is stored in a round robin database that overwrites oldest values. The standard storage solutions (e.g. 1TB) are sufficient to store data for at least a full year. Depending on the devices that a facility control node regulates, such a node may be equipped with an event recorder that captures asynchronous events with high time resolution. This allows for fast, sub-second, data collecting and

2.5.3 Resiliency of Microgrid and Building Controls

The standard industrial-grade control and communication devices can withstand extreme operational temperature range of -40^{o} C to +70^{o} C. In addition, they are often enclosed in rugged aluminum chassis tested for shock and vibration according to military standards. Control boxes will also be elevated for flood avoidance.

2.6 IT/Telecommunications Infrastructure Characterization

2.6.1 Information Technology

Due to the lack of existing dedicated communication infrastructure (e.g. fiber optic network), for the microgrid communications backbone we are proposing a wireless field network as shown in Figure 2-14.

The Microgrid Master Control Station is a hardened computer hosting monitoring, optimization and control services. It communicates to the utility wide area network through 3G/4G, WiMax, or 900 MHz communication links.

In addition, each microgrid facility is equipped with a Control Node, a hardened computer hosting local control applications with or without BEMS integration. At least the control node at the Hospital will integrate with the existing building management system. Communication with the master control station is achieved through 900 MHz or WiMax field network. The wireless communication links to the switchgear devices are not shown in the figure.

The communications network will provide at least 100 Mbit/s Ethernet which is expected to be sufficient for all monitoring and control applications and for the network of this size. The application-layer protocols will be selected among DNP3, Modbus TCP/IP, Modbus Serial, IEC61850, and Ethernet depending on MG deployed devices (e.g. IED’s, PLC, switchgear, relay, sensors, meters, etc.).

2.6.2 Communications

When the lack of communication signals from the utility is set as an abnormal condition, the microgrid can isolate from the utility and thus operate when there is a loss in communications with the utility. From that moment the local generation and load devices are under the control of the microgrid controller.

If the utility communications network is considered external to the microgrid communications network, an interposing server will be utilized to provide for controlled information flow. Firewalls will be utilized between the microgrid network and the interposing server and between the external link and the interposing server to provide enhanced cyber security for this link.

The suggested communication infrastructure design assumes industrial-grade, long range, point-to-multipoint wireless communication with MIMO (Multiple-In, Multiple-Out) antennas that provide robust communications.

3 ASSESSMENT OF MICROGRID'S COMMERCIAL AND FINANCIAL FEASIBILITY

3.1 Commercial Viability – Customers

3.1.1 Individuals Affected by/Associated with Critical Loads

The Town of Southampton has a population of 56,790 that roughly doubles to 115,000 in the summer. The area of the Town is about 295 square miles.

The Village of Southampton is an independent jurisdiction within the Town of Southampton. The village has a year-round population of 3,965 based on the 2,000 census, and an area of about 7.2 square miles. The village is the largest community on the South Fork, and is the main commercial center, with several region-wide businesses. Southampton Hospital (SHH), which is located in the village, is a 125-bed hospital that admits more than 6,000 patients annually and has about 25,000 emergency room visits each year (about 50% during the summer season). SHH is the only hospital on the south fork, which extends for over 40 miles from Riverhead to Montauk.

The microgrid will primarily serve the downtown area of the Village, but will benefit the entire South Fork by assuring that SHH and other commercial establishments can maintain service during outages to the PSEG-LI grid.

3.1.2 Direct/Paid Services Generated by Microgrid

The project will help meet predicted peak power shortages on the South Fork, and reduce the need for new transmission and/or generation to meet these needs. PSEG-LI predicts a 63 MW transmission deficit in the South Fork of Long Island by 2022, and estimates that the cost for transmission upgrades to meet this deficit will be $298 million.

The project assumes the electric generating plant will sell energy, capacity and ancillary services contractually to customers, and/or sell to the NYISO. However, we plan to explore PSEG-LI's interest in a power purchase agreement (PPA) for sale of energy, capacity and ancillary services produced by this facility.

The project will also improve reliability and resiliency of power supply in the Village of Southampton, by reinforcing the downtown distribution system, and providing DERs to serve a number of critical facilities and other local establishments in the event of an outage to the main grid.

3.1.3 Customers Expected to Purchase Services

The microgrid will serve the following critical facilities in the Village of Southampton:

- Southampton Hospital (SHH)
- Middle School
- High School
- Village Hall
- Town Hall
- Library Facilities
- Police Department

- Windmill Ln Fire Department
- Hampton Rd Fire Department
- Ambulance
- Southampton Arts Center
- Southampton Cultural Center
- Department of Water
- Suffolk County Water Authority

In addition, the project will serve approximately 100 small commercial and approximately 400 residences in downtown Southampton Village during outages to the PSEG-LI grid.

3.1.4 Other Microgrid Stakeholders

In addition to the more than 100,000 year-round and seasonal residents, local businesses and the thousands of travelers who visit Southampton daily during the summer will benefit by increased area power reliability and resilience in the event of a protracted grid failure. In addition, thousands of residents outside of Southampton will benefit from maintaining service of SHH during grid outages; as stated previously, SHH is the only hospital on the South Fork of LI, which extends for over 40 miles.

We do not anticipate that customers will experience any negative impacts as a result of the project.

3.1.5 Relationship between Microgrid Owner and Customers

Subject to approval of the stakeholders, the project will be owned by a Microgrid Energy Services Company (MESCO), which is a type of ESCO that serves microgrids. The MESCO will supply energy to the microgrid customers during normal operating conditions and during grid outages. PSEG-LI will continue to own and operate the distribution system. Specific relationships for the various DERs are expected to be as described below.

Normal Conditions

- The CCHP system will be “behind the meter” and deliver electric and thermal energy to SHH
- The elementary school will net meter energy from the new solar PV system, and pay a portion of the savings to the MESCO
- SCWA will draw energy from the batteries to reduce peak loads, and pay a fee to the MESCO
- The electric only plant will sell energy, capacity and ancillary services contractually to microgrid customers, and/or to the NYISO

Grid Outages

- The MESCO will sell power produced by the DERs to the microgrid customers at normal energy rates
- SHH will have priority on energy used by the microgrid

3.1.6 Customers during Normal Operation vs. Island Operation

Please see response to Question 3.1.5. The electric only plant will offer to sell energy to all microgrid customers (except SHH, which will be supplied by the CCHP facility) during normal conditions. This energy would be sold contractually, and delivered using the PSEG-LI distribution system. The customers would pay standard delivery and demand and other fees to PSEG-LI, and pay the MESCO for the energy. However, the customers would have the option to purchase energy from the MESCO or another ESCO, or continue purchasing from PSEG-LI. If the customers do not elect to purchase energy from the MESCO, the MESCO would sell energy to other customers, or to the NYISO.

During islanded operation, the MESCO will sell power produced by the DERs to the microgrid customers at normal energy rates.

3.1.7 Planned or Executed Contractual Agreements

Please see response to question 3.1.5. The following contracts or agreements are expected:

- It is anticipated that the MESCO will have a long-term agreement with SHH to sell electric and thermal energy from the CCHP system.
- The MESCO will have a Microgrid Energy Services Agreement (MESA) with the Southampton School district under which the elementary school will net meter solar energy, and pay the MESCO a fee for a portion of its savings
- The MESCO will have a contract with SCWA for sale of energy from the battery during peak periods
- The MESCO will obtain MESA's with microgrid customers to sell energy from the electric only plant to microgrid customers, or customers outside of SH village, using an Internal Bilateral Transaction structure. The MESCO will sell any excess energy, capacity or ancillary services to the NYISO.
- Alternatively, the MESCO will explore establishing a PPA to sell energy and capacity with PSEG-LI. PSEG-LI may have an interest in procuring energy and capacity from this plant to help meet its needs for peaking power on the South Fork, and because the cost of energy from this facility would be less than energy from its nearby 11.5 diesel fueled peaking plant located in SH. The PPA would contain provisions that would allow the plant to serve the microgrid in the event of an outage to the main grid.
- The MESCO will have a MESA with PSEG-LI to supply power to the microgrid customers during outages to the main grid. SHH will have priority on energy delivered to the microgrid during outages on the main grid.

3.1.8 Plan to Solicit and Register Customers

The Team has maintained an ongoing dialogue with Southampton Town and Village officials to obtain the input and concurrence on the key microgrid features. We expect to continue to obtain and incorporate this input into our design, as appropriate.

The Team will engage in direct negotiations with SHH to develop a mutually agreeable terms for sale of electric and thermal energy.

The MESCO plans to directly approach commercial customers within the microgrid service area that may have an interest in purchasing energy from the electric generating plant. We believe these customers may be interested in purchasing energy from the electric plant, because MESCO could reduce their energy costs. Alternatively, we may partner with an established ESCO to assist in marketing energy, or partner with an energy company, such as Con Ed Energy Services, that would help market energy from this facility.

As explained in Question 3.1.7, the MESCO will also approach PSEG-LI regarding the possibility of a long-term PPA for energy and capacity from the electric only plant. However, completion of the electric only generation is not dependent on securing a PPA with PSEG-LI, since this plant could generate adequate revenue from sale to the commercial customers if a PPA cannot be obtained with PSEG-LI.

3.1.9 Other Energy Commodities

Microgrid energy commodities will be predominantly electric but the CCHP system's thermal energy would also be sold to SHH.

3.2 Commercial Viability - Value Proposition

3.2.1 Benefits and Costs Realized by Community

Improved Reliability and Resiliency

Critical and Non-Critical Facilities

The project will improve the reliability and resiliency of power supply for critical facilities connected to the microgrid, as well as other commercial establishments and residences in downtown Southampton. A list of the critical facilities appears in the Task 1 section of the report. As shown in Figure 2-1 earlier, the microgrid will include the critical facilities listed in Task 1 (Table 1-1), as well as many commercial establishments and residences in downtown Southampton, including as a bank, grocery store, drug store, and restaurants, among others. Southampton has a population of approximately 56,000 that rely on many of these downtown commercial establishments. In addition, the entire South Fork relies on SHH.

The proposed DER's will assure that all of these facilities and establishments will have full power to meet coincident peak demand to operate at full capability during outages to the main grid.

Southampton Hospital (SHH)

SHH has 125 beds. Although the hospital has 1,600 kW of diesel powered backup power, fuel storage is limited to five days. The project will provide new gas supply for the CCHP system to assure that full power can be maintained in the event of an outage.

National Grid has indicated that it can currently supply approximately 15 MMBtu per hour gas for the CCHP system on a Temperature Control (TC) Rate 331, and could supply gas on a non-interruptible basis beginning in 2021. Under this service, the customer must come off gas if temperature is less than 15 degrees F and can come back on at 20 degrees F. The customer is required to provide National Grid with specifications on how the automatic switch over will occur. SHH would use the grid and existing boilers to provide electric and thermal energy in the event of an interruption.

Reduced Energy Costs

The project is expected to reduce energy costs for SHH and other facilities that purchase energy from the MESCO.

Use of the behind the meter CCHP system would allow SHH to reduce or eliminate PSEG-LI demand and delivery charges. The electric tariff demand charges are approximately $22 per kW from June through September, and delivery charges range from $0.0287 to $0.0428 per kWh, depending on the time of day. The average PSEG-LI energy price in 2015 was $81.19 per MWh. The plant would benefit from a "high load factor" gas delivery rate, which would reduce fuel cost for gas for the CHP system from approximately $8-9/MMBtu (the current gas cost) to $2.06 per MMBtu plus the commodity charge (currently less than $2.00 per MMBtu). The CCHP plant would operate when strike price of the CCHP plant is less than the all in delivered market price of electricity. The dispatch curves for the DERs are shown in Section 2.3. We estimate that the CHP system would reduce gas use for heating by approximately 44,000 MMBtu per year, or the equivalent of approximately 316,000 gallons of diesel fuel per year.

The project could also reduce energy costs for other critical facilities and commercial and residential establishments. Under the current PSEG-LI tariff structure, customers would still have to pay the same delivery and demand charges and other fixed charges, since the project will use the PSEG-LI distribution system.

Fuel Supply

As stated previously, National Grid can provide gas needed for the CCHP system on a TC rate basis, and can supply firm gas by 2021. This will assure long-term security of fuel supply.

Project Costs

It is expected that the DER and energy efficiency measures will be funded by a third party investor and NYSERDA grants. This structure will eliminate the need for investment by the owners of critical facilities or the local community.

3.2.2 Benefits to the Utility

PSEG-LI predicts a 63 MW transmission deficit in the South Fork of Long Island by 2022, and estimates that the cost for transmission upgrades to meet this deficit will be $298 million. Moreover, residents on the south fork are strongly opposed to installing new above ground transmission lines. One of the primary project benefits would be to help reduce these peak power deficits.

The project will also provide a more reliable and resilient microgrid that will help assure power for PSEG-LI's customers when the main grid is out of service.

The utility would not incur any costs as a result of this project.

3.2.3 Proposed Business Model

Subject to approval of project stakeholders, the Team anticipates that new DER will be financed, owned and operated by a third party "Microgrid Energy Services Company" (MESCO). This arrangement would allow the critical facilities to focus on their core businesses, while reducing their energy costs and providing a more reliable and resilient grid.

The MESCO would sell electric and thermal energy from the CCHP to SHH. The MESCO would net meter energy from the new solar PV systems at the elementary school.

The MESCO would supply other critical facilities and commercial and residential establishments with electric energy, either using excess energy from the electric only plant, or from energy purchased from the NYISO. PSEG-LI would continue to own and operate the transmission and distribution systems.

This structure would allow SHH and the elementary school to save money by reducing or eliminating energy, delivery charges, and demand charges. This arrangement would also allow customers who do not host DER's to reduce their energy charges, but they would continue to pay standard charges for delivery.

One issue that should be considered is whether the MESCO's customers who do not host DER should be obligated to continue paying demand charges to PSEG-LI. Since the MESCO would be financing the additional capacity for the microgrid, which would help PSEG-LI reduce or defer additional generating capacity and transmission infrastructure, it would appear that these customers should not be obligated to pay demand charges to PSEG-LI, or at least should pay a reduced demand charge.

- Strengths
    - The project will provide more reliable and lower cost energy for the hospital and other customers
    - MESCO has expertise and resources to finance and manage the project
    - The MESCO and/or investors can directly utilize Investment Tax Credits from the new solar PV system, whereas the schools are non-profits and could not directly utilize these incentives
    - More efficient gas fired CHP and electric generation would reduce emissions in comparison to more centralized and less efficient generation systems; in particular, PSEG-LI would be less reliant on generation from liquid fueled diesel plants in Southampton and East Hampton

- Weaknesses
    - The hospital (and other stakeholders) would be more reliant on a third party to supply its energy than in the past; (this concern could be mitigated since the facilities would continue to be connected to the PSEG-LI grid, which could serve as source of backup power if needed.)
    - SHH and possibly other customers would need to make a long-term commitment to purchase power in order to facilitate financing; (this concern would be mitigated by lower energy costs, and greater reliability)
    - Hospital may be required to guarantee a lease or other financing for the CCHP system, and may be reluctant to do so.
    - The MESCO may be subject to property taxes on the DER, which would increase energy costs

- Opportunities
    - Management personnel at SHH can continue to focus on their core businesses, while benefiting from the CCHP system
    - PSEG-LI could focus its resources on other areas of concern, and avoid the need to invest in new generation or transmission to serve the Southampton load pocket

- Threats
    - Project lenders and investors may be reluctant to finance the project due to concern over credit quality of the project participants, or concern over technical and operational

issues with the microgrid; (these concerns could be mitigated by NYSERDA grants, and innovative funding sources, such as the Green Bank, grants and tax incentives).

  - Existing PSEG-LI policy does not allow two feeders for facilities utilizing behind the meter CCHP; however, the hospitals require two feeders to assure redundancy. (Based on meeting with PSEG-LI, it appears we can address PSEG-LI's concern by designing the interconnection to assure that appropriate measures to prevent back-feeding.)
  - There is a possibility that SHH may relocate to an area outside the microgrid in five to seven years; in this case, the project would expand the electric generating plant to serve the microgrid, if needed; or CCHP may still be used for new operations at the existing SHH building.

3.2.4 Unique Characteristics of Site or Technology

Innovative Use of Emerging Technologies

The project is unique and innovative in several ways, including:

- Energy Storage
- Microgrid Controller

As explained further below, these technologies and strategies could also be used at other microgrid projects.

Energy Storage

The project will include a 200 kW battery near the SCWA water storage facility on West Prospect Street. It is expected that the batteries will recharge at night when energy demand and charges are low, and discharge during the day when energy and demand charges are high. The batteries will have discharge duration of four hours.

The batteries will help reduce peak loads due to pumping at the water supply facility. This will reduce peak energy demand, and reduce PSEG-LI's projected peak power deficit.

Microgrid Controls

The Team is evaluating the current set of available commercial microgrid controllers. A best of breed selection will be made to obtain alignment with the microgrid site requirements. The controller will include monitoring and control functions to monitor voltage, frequency and line flows at multiple POIs and quickly issue commands to load and generation in the microgrid to initiate islanded mode.

3.2.5 Replicability and Scalability

All elements of the proposed project could be utilized at other microgrids that have a similar design basis. Some specific features that should be replicable at many locations are described below:

- The ESCO contract structure could be used at other microgrids to fully utilize output from the DER to reduce energy costs at non-contiguous facilities.
- Sale of excess energy, capacity and ancillary services from DER to the NYISO could produce additional revenue sources that could make microgrids more economically viable.

- The proposed project financing business model involving third party ownership and non-recourse financing could be used for other microgrid projects. This structure would require that contracts and credit quality of all counterparties satisfy project lenders and investors.

3.2.6 Purpose and Need for Project

Southampton has experienced widespread and extended power outages as a result of extreme weather events, including hurricanes Sandy and Irene and other storms, and major bulk system outages such as the Northeastern Blackout in August 2003. These events resulted from disruptions to the main PSEG-LI grid, as well as from local distribution outages and resulted in significant economic loss, threats to life and safety, and disruptions to public and commercial services.

Southampton has a number of critical facilities, including Southampton hospital, which serves the entire south fork (i.e. Hamptons) area, a distance of nearly 40 miles; town hall, three schools, village hall, fire department, police department, as well as key parts of downtown Southampton.

During Hurricane Irene, Southampton Hospital lost power from PSEG-LI and was on emergency power for approximately 16 hours. Many complications occurred throughout the facility related to emergency power needs that were addressed by in-house staff during the following 36 hours.

During Hurricane Sandy Southampton Hospital lost power from PSEG-LI and was on Emergency power for approximately 6 hours. During this time, the fuel oil delivery system to the existing old generators failed causing the Hospital to go dark. Fortunately, the hospital had prepared for the worst case scenario by having a rental unit ready to go. The facilities and Engineering team worked feverishly and in 11 minutes the Hospital was on the Portable Emergency Generator.

The microgrid will utilize a mix of DER that will produce distributed energy, and reduce load.

The electric energy will be distributed using existing above ground feeders that will continue to be owned and operated by PSEG-LI. The feeders will be hardened in areas where there is a risk of tree damage to assure the functioning of the microgrid during and following storm events.

During outages to the main grid, the existing back up diesel and gas fueled generators would supply up to 85% of the hospitals peak load, and the new CCHP units would supply the remaining hospital load and the microgrid.

3.2.7 Overall Value Proposition to Customers and Stakeholders

Table 3-1 Project Value Proposition

Stakeholder	Value Proposition
Southampton Hospital	• Reduce electric energy costs • Reduce or eliminate peak demand charges; currently at $22/kW from June-Sep; • Reduce fuel costs by use of waste heat from the CCHP system • Provide more reliable energy supply • No capital investment
Other critical and non-critical facilities	• Reduce electric energy charges • Possibly reduce or eliminate demand charges • Continued power supply during outages to the main grid will assure these facilities can maintain services for customers and the community • Commercial establishments will continue to earn revenue from their business operations during power outages to the main grid
Village of Southampton	• Residents and customers will benefit from services provided by critical and non-critical facilities
PSEG-LI	• Project will help reduce need for peaking power and reduce congestion on the South Fork • Project will help assure power is maintained for PSEG-LI customers during outages to the main grid
National Grid	• CHP system will provide a significant new customer for National Grid, with a high load factor demand profile
Suffolk County Residents	• Residents will continue to benefit from services of Southampton Hospital and other critical facilities during outages to the main grid
Environment	• Project will reduce air emissions by using more efficient CCHP technology to supply both electric and thermal energy.
NY State	• Project would represent an innovative and financially viable microgrid and business model that could be replicated in other areas
Project investors, developers and lenders	• Will receive positive returns on investment, commensurate with project risk • Private investors and lenders will gain experience with an advanced microgrid that could enable similar future investments
Vendors and contractors	• Will generate new business by providing equipment and services • Will gain valuable experience in cutting edge project that could be applied to future microgrid projects

3.2.8 Added Revenue Streams, Savings, and/or Costs

Table 3-2 Revenue Streams, Savings, and/or Costs

Purchaser	Revenue/savings
Southampton Hospital	• Reduction in electric energy costs and fuel costs • Reduction or elimination of peak demand charges of about $22 per kW from June-September
Other microgrid customers	• Savings in electric energy costs • Possible reduction or elimination of demand charges

3.2.9 Project Promotion of State Policy Objectives

The project helps promote NY REV by providing distributed and renewable energy that will improve system reliability and resiliency and reduce costs and emissions. The project will also reduce peak energy demand by use of batteries at the SCWA water storage facility. A summary of benefits relating to the NY REV goals is presented below:

Table 3-3 Project Support of NY REV/RPS

Metric	Result Supporting NY REV/RPS
Distributed generation	Project will provide about 4,000 kW of new DER's, including 1,500 kW of new CCHP, 200 kW of batteries, 300 kW of solar, and 2,000 kW of new electric only generation
Renewable generation	410 kW of generation will come from existing or new solar PV, including 300 kW of new solar PV at Southampton Elementary School

3.2.10 Project Promotion of New Technology

The project involves use of several emerging technologies, including batteries and microgrid control systems. Successful implementation of these technologies will encourage their use at other locations.

The project will include innovative control systems to assure that DERs maintain a balance between supply and demand in the island, and that the transition between connected and islanded modes is stable and secure. The project will also include a protection scheme that employs some combination of the following:

- Over/Under Voltage (Functions 27/59)
- Over/Under Frequency (Functions 81O/81U)
- Reverse Power (Function 32)
- Transfer Trip
- Anti-islanding

The microgrid control system could also offer a suite of ancillary and distribution grid support services, as well as the ability to interact with the NYISO market.

Subject to evolving NY REV framework, the NYISO market rules applicable to microgrids and distributed generation, and enabling technology (to allow back-feeding in the network), it is expected that the distributed generation within the Southampton microgrid can sell energy into the larger grid though the Distribution System Platform (DSPP) model being developed within REV, but also participate in the NYISO energy, ancillary services, and capacity markets.

The details of qualifications for selling energy to the utility, and the requirements for NYISO participation are to be determined within the REV process and NYISO market design development. From a theoretical perspective, the on-site generation would sell energy at times when applicable Locational Marginal Price + Distribution Component (LMP + D) are higher than the marginal cost of on-site generation.

The ancillary services, including regulation up and down and spinning and non-spinning reserve can also be provided by the on-site generation subject to future market rules.

And finally, subject to qualification, on-site generation can participate in NYISO capacity auctions, and if they clear the market, they can be paid the applicable NYISO capacity prices.

The project would also promote use of LNG to power plants that do not have access to pipeline gas. In addition, the project would promote use of batteries to reduce peak loads.

3.3 Commercial Viability - Project Team

3.3.1 Securing Support from Local Partners

The project has received letters of support from the following groups:

- Mayor of the Village of Southampton
- Southampton Town Supervisor
- Southampton Hospital
- Southampton Fire Department
- PSEG-LI
- National Grid

We have continued to update key stakeholders on development activities, including Southampton Hospital, which we expect will host the CCHP system. We will need to obtain final formal approval from the hospital prior to finalizing the CCHP plans. We have met several times with representatives of the Town and Village to get their feedback on the project design and DER selection, and we also have an ongoing dialogue with the Town planning department to discuss the project. This will help assure that key representatives and community will support the project design.

3.3.2 Role of Each Team Member in Project Development

A summary of key roles and responsibilities is presented below:

Table 3-4 Summary of Key Team Member Roles

Team Member	Role
Southampton Hospital	Host of CCHP system, and customer for purchase of electric and thermal energy
PSEG-LI	Owner/operator of electric distribution system
National Grid	Supplier of pipeline gas for CHP system
Other critical facilities (e.g. Southampton High, Middle and Elementary Schools, Town and Village Halls	Hosts of DER's and participants in the microgrid
Vendors and contractors	To be determined; will provide DER equipment and construct the project
GE Energy Consulting, Burns Engineering, D&B Engineers	Project engineering and design services
Project investor and lender	To be determined; will provide project financing
Global Common, LLC (GC)	Project developer, principal of the Microgrid Energy Services Company (MESCO)

3.3.3 Public/Private Partnerships

We expect that the MESCO will have contracts with the Town and Village of Southampton relating to purchase and sale of energy from the DERs. In addition, the project will require NY Prize funding from NYSERDA.

3.3.4 Letter of Commitment from Utility

The project has letters of commitment from National Grid, the gas utility, and PSEG-LI. Also, National Grid has performed engineering analysis and provided written confirmation that it can currently supply 15 MMBtu per hour to SHH for the CCHP system on a TC rate basis, and can supply firm gas by 2021. The CCHP system will utilize about 13.5 MMBtu per hour. We have also met with PSEG-LI to explain the microgrid program and PSEG-LI's role

3.3.5 Applicant Financial Strength

The project will be owned by private investors who will provide non-recourse financing for a MESCO that will manage, own and operate the project. The investors will have adequate financial resources or the MESCO will provide acceptable financial security to satisfy NYSERDA and project lenders.

The project financing will be structured using traditional non-recourse project financing, with a capital structure that will include an appropriate level of equity, debt, and grant funding. We have extensive experience financing energy projects with similar structures. We have identified some potential investors, and will select the preferred investment partner during Stage 2. Subject to final approval from the Town of Southampton, it is expected that Global Common, LLC will be the applicant for Stage 2 and Stage 3 NYSERDA funding.

3.3.6 Project Team Qualifications and Performance

A summary of qualifications is presented below, and detailed qualifications and performance records are presented in the appendices. As shown, the current project team has the capability to design and develop the microgrid and DER's, and arrange project financing. We will add other team members, including an EPC contractor, project investors and lenders, during Stage 2 design.

Table 3-5 Summary of Project Team Qualifications and Performance

Team Member	Qualifications
GE Energy Consulting	Extensive experience in design of microgrids, including distribution and microgrid control systems, and design of DER; GE can also provide DER technologies, and advanced microgrid controllers.
Burns Engineering	Design and implementation of microgrids, including DER.
D&B Engineers and Architects	Environmental/civil and electrical engineering
Global Common, LLC	Project development and financing, including negotiation of power purchase agreements (PPA's), fuel supply contracts, EPC contracts, environmental permitting, and financial analyses and project structuring to satisfy lenders and investors.
PSEG-LI	Management and operations of electric distribution systems.
Vendors and contractors	To be determined during Stage 2.
Project investor and lender	To be determined during Stage 2.
DER Operator	To be determined during Stage 2.

3.3.7 Contractors and Suppliers

Please see response to prior question. The existing and future contractors are and will be subcontractors to the applicant. The contractors, equipment suppliers and other vendors will be selected during Stage 2 based on competitive procurement or other appropriate procedures, subject to approval of project lenders, investors, and NYSERDA. The MESCO will be formed prior to closing on project financing.

The MESCO will retain an experienced Engineering, Procurement and Construction (EPC) contractor experienced with significant energy projects, and the financial capacity to guarantee performance and satisfy the project lender, investor and NYDERDA. For example, we will consider firms such as Conti Construction, Burns & McDonnell, and Schneider Electric as possible EPC contractors.

3.3.8 Financiers or Investors

The project finance lenders and investors have not been identified and will be selected during Stage 2. We may engage an investment banker to assist in securing financing, or may select lenders/investors without outside advisors based on our prior relationships and evaluation of proposed financing terms. The investors will have adequate financial resources to complete the project and provide needed working capital for operations, and have experience investing in energy projects. For example, we will consider financing from GE Capital as a project investor, and we may engage Stern Brothers to provide investment banking services. We may also consider strategic investors, such as our selected EPC contractor, or GE Capital. The specific financing strategy will be developed during Stage 2.

We will consider cost of capital, and experience with energy projects, among other criteria. The current team members may contribute professional services, but it is not expected that the current team members will contribute cash.

3.3.9 Legal and Regulatory Advisors

There are no legal advisors on the current project team at the present time. We will retain an experienced project finance attorney during later stages of Stage 2 to assure that project documentation satisfies lenders and investors, and to assist in closing on project financing. The project attorney will have extensive experience with project financing of energy projects. Global Commons has worked extensively with Andrews Kurth on other energy projects, and may consider using their services on this project. Andrews Kurth is a nationally recognized firm in the energy project finance area. We will also engage Twomey Latham as local counsel to assist with local regulatory and environmental matters. Twomey Latham is based in Riverhead, and has extensive experience with energy and environmental issues on Long Island. It is expected that D&B Engineers will provide environmental consulting and permitting services. D&B is based in Melville, Long Island, and has extensive experience with environmental permitting on Long Island.

3.4 Commercial Viability - Creating and Delivering Value

3.4.1 Selection of Microgrid Technologies

The DERs were chosen based on a number of factors. We started overall system optimizations and initial asset selection, sizing, and configuration by using Lawrence Berkeley's Lab microgrid optimization tool, "DER-CAM." This tool takes a wide range of detailed inputs regarding DER assets, site loads, participant tariffs, site location weather, energy prices, and environmental parameters to optimize the selection and operation of DERs in the microgrid.

DER selections were further refined by considering the specific types of loads, available space, detailed asset performance characteristics and limitations given their intended function (e.g., base or peak generation) in the microgrid. Due to the significant electric and thermal base load of the hospital, cogeneration was an appropriate technology to deliver electricity and hot water. Converting existing diesel generation to dual fuel, where feasible, (diesel and natural gas) allows current assets to be incorporated into the microgrid to provide long term power with less concern for liquid fuel storage and availability.

We decided to use batteries because the water storage facility has a “spikey” load profile due to intermittent pumping operations. In addition, the batteries will help balance supply and demand when the microgrid operates in island mode.

We selected solar PV to contribute to clean energy goals, improve project economics, and reduce the peak demand. The amount of solar PV selected was constrained by available space, and operational considerations.

In this stage, the control design focused more on functionalities and architecture than equipment or vendor specifications. Controller functionalities were chosen based on the technologies and needs of the project, and features of commercially available products from a range of vendors, including GE. These include the ability to monitor multiple POIs, fast load-shedding, and economic optimization. The ability to integrate BEMS into the control architecture and communicate with external utility systems is also highly valued.

3.4.2 Assets Owned by Applicant and/or Microgrid Owner

The project will include 2,143 kW of existing diesel generators owned by the hospital, SCWA, the police department and High School that will be included in the microgrid and will provide emergency backup power to the individual facilities in the event of a feeder outage. In addition, the microgrid will include 110 kW of existing solar PV at the High School.

3.4.3 Generation/Load Balance

Once a utility outage is detected through voltage and frequency monitoring, the microgrid will island. The hospital’s site emergency generators will come online to comply with code mandated starting times, with the microgrid paralleling to the site emergency distribution system. Upon formation of the microgrid, the dual-fuel generators will ramp down and/or turn off based on demand.

The specific demands for power matching/frequency regulation will be determined through study during Stage 2. The microgrid controller will manage assets in response to changing conditions. In connected mode (parallel to the grid), microgrid generation resources would not be required to regulate frequency, and would likely have a small role if any in voltage regulation. These services are provided by the bulk power system. However, in islanded mode, microgrid resources will need to provide for power balance/frequency control and reactive power balance/voltage control.

Some assets will provide base load power while other assets would switch to frequency control mode. The diesel generators at SHH are excellent for black start and load-following applications, while the gas fired CCHP and reciprocating engines are better suited to base load operation than frequency control. This means the majority of fast frequency regulation would come from the diesel generator in isochronous mode, and the battery storage at the SCWA facility. To augment frequency regulation, load may need to be controlled, particularly at SHH (the largest load). Additionally, it may be necessary for solar production to be curtailed. This will also be managed by the controller.

3.4.4 Permits and/or Special Permissions

The project team expects to obtain typical construction permits as well as an air permit for the CCHP and electric only generation systems. It would also be necessary to obtain an interconnection agreement with PSEG-LI based on standard interconnection requirements. In addition, it will be necessary to get Site Plan approval from the Town and/or Village of Southampton to install the DERs.

3.4.5 Approach for Developing, Constructing and Operating

Global Commons will be the project developer, and will engage investors, contractors and suppliers needed to execute the project during Stage 2. GC will also establish a MESCO that will finance, build, own, operate and maintain the electric generating, batteries and solar PV facilities. PSEG-LI will continue to own and manage the distribution system. As explained in response to Question 3.3.7, we will retain a qualified EPC contractor to build the project and guarantee performance. The MESCO will secure service agreements with vendors who will operate and maintain DER, and the MESCO will provide the business management functions relative to their individual DER.

3.4.6 Benefits and Costs Passed to the Community

The benefits of the microgrid will redound to the community in a number of direct and indirect ways. Most directly, the new CCHP system will reduce energy costs for SHH. In addition, the long-term operational continuity of critical government, hospital, fire, and water facilities and services will be ensured. Also, the project will assure that all customers connected to the microgrid can maintain power during outages in the PSEG-LI grid. This reliability will benefit thousands of residents who rely on services in Southampton Village throughout the year. Potential revenues and savings from the microgrid operation will also help provide budget relief for the Town. The community would not incur any costs as a result of the project.

3.4.7 Requirements from Utility to Ensure Value

The existing PSEG-LI feeders will distribute energy from the DER to the customers. PSEG-LI will be responsible for hardening the feeder lines; however, the project Team will provide input to PSEG-LI to help focus on key areas of concern. The project financing will include funding needed to harden the feeders.

During an outage of the PSEG-LI grid, the circuit segments supporting the microgrid system will be disconnected from rest of the PSEG-LI distribution system by switches and form the microgrid. Selected switches on PSEG-LI’s system that define the boundaries of the microgrid will be automated to facilitate quick formation. This automation can only be accomplished in cooperation with PSEG-LI, and operation of the switches will be subject to hierarchical control from PSEG-LI’s control center.

3.4.8 Demonstration of Microgrid Technologies

All of the technologies incorporated in the proposed microgrid are commercialized and proven. Combined heat and power generators and solar PV are established technologies.

The Microgrid Control design may incorporate GE’s proven U90Plus Microgrid Cost Minimizer to dispatch the DERs, and the D400 RTU/Controller to implement various operational control strategies. GE is currently developing a DoE funded eMCS controller that expands upon the algorithms implemented in the U90Plus and incorporates many of the control functions that now reside in the D400. The eMCS will be tested at NREL in early 2016 and will be applied at a microgrid site on Potsdam, NY. The U90Plus algorithm is being incorporated into the D400 controller, and this solution will be deployed in mid-2016 on a Microgrid at the University of Ontario in Toronto.

Another proven solution that could be utilized is GE's proven C90Plus Fast Load Shed Controller. The C90Plus provides adaptive load shedding for loss of generation and/or a utility tie to trip non-critical load. The IEDs/relays communicate real-time load and generation values as well as status to the C90Plus via IEC 61850 GOOSE messaging. The C90Plus evaluates this information and will issue a fast trip GOOSE message to the IEDs/relays to trip non-critical loads to assure a generation-load balance. The tripping of the load breakers is initiated in less than 20ms from detection of the triggering event. This compares to 200ms to 400ms for conventional load shedding schemes. This solution was recently successfully deployed and demonstrated at the Portsmouth Naval Shipyard under a DoD Environmental Security Technology Certification Program (ESTCP) contract.

3.4.9 Operational Scheme

The operational scheme will be determined during Stage 2, based on input from the project team and project investor. It is currently expected to involve the following:

- Technical- During blue sky days, dispatchable DER's (including CCHP, electric only generation, and batteries) will deliver energy to the host and/or NYISO when market conditions are favorable; during grid outages, the microgrid will go into island mode, and the DER's will supply energy for the microgrid participants.
- Financial-The MESCO will arrange all project financing needed to close on the project, including construction costs, interest during construction, and soft costs. The MESCO will also secure an appropriate level of working capital needed to meet cash flow obligations, and performance security or letters of credit if required to meet counterparty requirements.
- Transactional-The project team will hire an experienced project finance attorney during Stage 2 to assure that all appropriate documentation needed to close on project financing is prepared to satisfy requirements of lenders and investors.
- Decision making- The decision making protocols will be documented in an Operating Agreement for the MESCO during Stage 2. It is expected that the Manager (to be determined) will be responsible for day-to-day operations of the MESCO, and that certain major decisions requiring investor approval will be defined in the Operating Agreement.

3.4.10 Plan to Charge Purchasers of Electricity Services

We expect that the MESCO would enter into a Microgrid Energy Service Agreements (MESAs) with various customers. The MESCO would sell energy from the DERs contractually to customers within or possibly outside the microgrid; however, GC will explore PSEG-LI's interest in establishing a PPA for sale of energy and capacity during normal conditions. The MESA for the CCHP system will include an appropriate fuel adjustment mechanism to maintain consistent cash flow to assure long-term financial viability of the project.

The MESCO will also establish a MESA with PSEG-LI that will define terms for providing energy in the event of an outage on the PSEG-LI grid.

Energy usage at individual sites would be recorded by revenue grade meters

3.4.11 Business/Commercialization and Replication Plans

As discussed previously, the DERs would be owned by a MESCO, and the distribution system would continue to be owned and operated by LIPA/PSEG-LI. The MESCO would have power purchase agreements (PPAs) with behind the meter customers, and contracts for differences with other customers. This structure could be used at other microgrid projects.

3.4.12 Barriers to Market Entry

There are a number of significant barriers to market entry, including but not limited to the following:

- Lack of mechanism to place a market value on reliability and resiliency limits financial viability of many projects
- Complexity of design of an integrated system of DERs, distribution and controls to meet varying microgrid loads during blue-sky days and during grid outages.
- Lack of funding for design and development activities
- Limited experience with microgrids may deter lenders and investors
- Relatively small capital requirements will deter most large energy investors
- Ability to identify an EPC contractor that will provide performance guarantees for a highly complex microgrid system
- Ability to identify project lenders and investors that will provide project financing at acceptable cost of capital
- Availability of a microgrid control system that can manage multiple DERs and varying load conditions

3.4.13 Steps Required to Overcome Barriers

We will use the following strategies for addressing these barriers:

- **Lack of mechanism to place a market value on reliability and resiliency limits financial viability of many projects**
  - NYSERDA grants can help subsidize projects to indirectly recognize the value of reliability and resiliency
  - Policy makers should consider other means to place a value on reliability and resiliency
- **Complexity of design of an integrated system of DERs, distribution and controls to meet varying microgrid loads during blue sky days and during grid outages.**
  - The Project Team members have extensive experience in a full range of energy development and financing, including design and development of microgrids. GE previously performed the technical work in the 5-Site NYSERDA "Microgrids for Critical Facility Resiliency in New York State," that formed the basis for the NY Prize program. GE is also working on several other NY Prize projects.
  - Burns Engineering has a comprehensive understanding of the use of P3 for energy projects and has participated in several as both owner's engineer and engineer of record. In particular, Burns has led the multi-year planning and implementation of a microgrid at the Philadelphia Navy Yard and developed a number of P3 project structures to fund the construction and facilitate the operation and ownership of distributed generation resources central to the microgrid.

  - Global Common has developed and arranged financing for a variety of conventional and renewable energy projects in NY and throughout the US, including an anaerobic digester/CHP project in Auburn, NY, that was partially funded by NYSERDA, and a 54 MW peaking plant in Southampton, NY. Global Common is also managing two other NY Prize projects.
- **Lack of funding for design and development activities**
  - Design and development will be partially funded by a NY Prize Stage 2 grant, supplemented by in-kind services from the Project Team and the Village of Southampton.
- **Limited experience with microgrids may deter lenders and investors**
  - The team's credibility and experience, project design, EPC performance guarantees, capital structure (including significant grant funding), credible revenue and cost model, and adequate financial returns should be sufficient to attract financing
- **Relatively small capital requirements will exclude most large energy investors**
  - Medium sized financial investors and/or strategic investors are likely to have interest in the project because they believe microgrids are a potentially significant growth opportunity
- **Ability to identify an EPC contractor that will provide performance guarantees for a highly complex microgrid system**
  - Medium sized EPC firms will have an interest in microgrid construction projects because of potential growth opportunities
- **Ability to identify project lenders and investors that will provide project financing at acceptable cost of capital**
  - Lenders and investors have an interest in participating in microgrids because of its potential for future growth, and because returns with other opportunities are relatively low
- **Availability of a microgrid control system that can manage multiple DERs and varying load conditions**
  - GE and others are developing sophisticated microgrid control systems, with funding assistance from US DOE.

The Project Team members have extensive experience in a full range of energy development and financing, including design and development of microgrids. GE previously performed the technical work in the 5-Site NYSERDA "Microgrids for Critical Facility Resiliency in New York State," that formed the basis for the NY Prize program. GE is also working on several other NY Prize projects.

Burns Engineering has a comprehensive understanding of the use of P3 for energy projects and has participated in several as both owner's engineer and engineer of record. In particular, Burns has led the multi-year planning and implementation of a microgrid at the Philadelphia Navy Yard and developed a number of P3 project structures to fund the construction and facilitate the operation and ownership of distributed generation resources central to the microgrid. Global Common has developed and arranged financing for a variety of conventional and renewable energy projects in NY and throughout the US, including an anaerobic digester/CHP project in Auburn, NY, that was partially funded by NYSERDA, and a 54 MW peaking plant in Southampton, NY. Global Common is also managing two other NY Prize projects

3.4.14 Market Identification and Characterization

The potential market for sale of electric and thermal energy would include all of the facilities included in the microgrid. In addition, it is possible that the MESCO may sell energy to some customers outside of the microgrid, if microgrid customers do not contract to purchase of the DER output. Also, the MESCO will explore if PSEG-LI would be interested in a PPA to purchase energy and capacity from the electric plant.

The project customers within the microgrid will include SHH, the Town and Village of Southampton, and other commercial and residential customers in and around the Village. SHH would purchase electric and thermal energy produced by the CCHP system from the MESCO, and the electric only plant will sell energy to commercial and residential customers during normal conditions.

We expect that SHH, the Town, Village and SCWA and other smaller users will all have interest in purchasing from the MESCO because the project would reduce costs and improve reliability.

Our review of PSEG-LI and NYISO prices indicates that revenue from sale of energy and capacity would produce returns that are adequate to attract private financing, assuming the project receives NY Prize Stage 3 funding. This new electric plant would be dispatched ahead of other less efficient, diesel and kerosene fueled peaking power plants on eastern LI located in Southampton and East Hampton, since the strike price with the proposed plant would be less than these other plants due to higher efficiency and lower fuel and VOM costs.

The market value of the energy produced by the DERs, and fuel and VOM costs, are reflected in the financial analyses in Section 3.5.

3.5 Financial Viability

3.5.1 Categories of Revenue Streams

A breakdown of annual revenue and income for different DERs is shown below.

Table 3-6 Revenue and EBITDA Breakdown

DER	Revenue	EBITDA
CCHP	$1,372,862	$636,868
Electric generation	$1,033,683	$449,148
Battery	$75,580	$59,060
Solar	$54,505	$27,212
Total	**$2,536,630**	**$1,172,289**

3.5.2 Other Incentives Required or Preferred

Sources and uses of funds are shown below. As shown, the project will require incentives from NYSERDA, as well as ITC credits.

Table 3-7 Sources and Uses of Funds with NYSERDA Grants

Uses		Sources	
CCHP	$6,000,000	Equity	$2,397,832
Electric generation	$4,000,000	Debt	$2,351,298
Solar	$800,100	NY Prize	$7,000,000
Battery	$480,000	NYSERDA CHP PON	$0
Dist. and controls	$709,060	ITC	$240,030
Total	**$11,989,160**		**$11,989,160**

Table 3-8 Sources and Uses of Funds without NYSERDA Grants

Uses		Sources	
CCHP	$6,000,000	Equity	$7,193,496
Electric generation	$4,000,000	Debt	$4,555,634
Solar	$800,100	NY Prize	$0
Battery	$480,000	NYSERDA CHP PON	$0
Dist. and controls	$709,060	ITC	$240,030
Total	**$11,989,160**		**$11,989,160**

3.5.3 Categories of Capital and Operating Costs

Preliminary income statements showing revenues and operating costs and financial ratios with and without NYSERDA grants are shown below. Capital costs for the individual DER's are shown in the table above. The capital costs for the distribution and control system is estimated to be $220,000 and $489,060, respectively.

As shown in Table 3-9, the project would have acceptable financial performance assuming NYSERDA grant funding is provided. However, as shown on Table 3-10, the project would not produce adequate internal rates of return to attract equity without NYSERDA grants. For example, the levered pre-tax IRR would only be 2.5% without NYSERDA grants.

Table 3-9 Consolidated MESCO Income Statement with NYSERDA Grants

Revenue	Amount ($/year)
Energy sale to CCHP host	$1,150,584
Demand payment from battery host	$15,021
NYISO energy sales	$446,792
Energy sale to microgrid customers	$493,772
CCHP Host thermal revenue	$304,382
Capacity payments from NYISO	$102,720
Frequency response	$98,285
Sub Total	**$2,536,630**
Cost of Goods Sold	
Natural gas fuel	$490,871
VOM	$225,140
Energy purchases from NYISO	$113,231
Ancillary service purchases from NYISO	$34,689
NTAC, RS1	$28,061
TSC	$93,979
Sub-total	**$985,972**
Gross Profit	$1,550,659
Gross margin	61.1%
FOM	
Maintenance fee	$756
Site Lease	$10,337
Insurance	$26,667
Management Fee	$126,832
Utilities	$35,337
Outside services	$45,337
Property Taxes	$133,105
Sub-total	**$378,370**
EBITDA	**$1,172,289**
Debt Service	$421,200
Cash flow	**$751,089**
Financial ratios	
DSCR	2.78
Unlevered pre-tax IRR	7.5%
Levered pre-tax IRR	33.5%

Table 3-10 Consolidated MESCO Financial Ratios without NYSERDA Grants

EBITDA (same as Table 3-9)	$1,172,289
Debt Service	$816,074
Cash flow	**$356,215**
Financial ratios	
DSCR	1.44
Unlevered pre-tax IRR	7.5%
Levered pre-tax IRR	8.1%

3.5.4 Business Model Profitability

The project risk will be mitigated using the following strategies:

- Capital structure will include adequate equity and grants to assure adequate cash flow and debt coverage. Please see tables above.
- The project company will have definitive energy and fuel supply contracts with key counterparties. The contracts will include traditional project finance terms satisfactory to project lenders, investors and NYSERDA.

3.5.5 Description of Financing Structure

A preliminary capital structure is presented below:

Table 3-11 Preliminary Capital Structure With NYSERDA Grants

Equity	$2,397,832
Debt	$2,351,298
NYSEDA grants	$7,000,000
ITC	$240,030
Total Capital	**$11,989,160**

Table 3-12 Preliminary Capital Structure without NYSERDA Grants

Equity	$7,193,496
Debt	$4,555,634
NYSEDA grants	$0
ITC	$240,030
Total Capital	**$11,989,160**

Development funding would be provided primarily by the NYSERDA Stage 2 grant. The project investor will provide funding to cover the ITC, and the ITC will be recognized by the investor. The lenders and investors/owners will receive project cash flows to recover their loans, and provide a return of and on investment

3.6 Legal Viability

3.6.1 Proposed Project Ownership

Subject to approval of the Town of Southampton and project stakeholders, the MESCO will own all of the new DERs, and GC and other qualified investors will own the MESCO. The specific ownership structure and participants will be determined during Stage 2. GC has relationships with a number of potential investors who may have an interest in investing in the project, assuming the project structure and returns meet their requirements. It is expected that GC will continue to manage the project and have an ownership stake in the electric generation and solar PV facilities.

3.6.2 Project Owner

The project owner/investor has not yet been identified. The project team has relationships with a number of qualified investors, one of which will be selected during Stage 2. For example, GC will explore the possibility of GE Capital providing part of the project financing. GC will arrange project financing and likely maintain an ownership interest in the project.

3.6.3 Site Ownership

The Southampton Microgrid will likely utilize land owned by project participants to accommodate the DER equipment. The participant off-takers would likely benefit from reduced energy costs in lieu of lease payments. The owner of the microgrid would be a private third party. GC will identify and secure space required for the DER’s, and negotiate a long-term power purchase and/or energy services agreement during Stage 2.

3.6.4 Protecting of Customer Privacy Rights

All terms involving customers would be protected with standard confidentiality agreements.

3.6.5 Regulatory Hurdles

We would need to confirm that NYISO requirements will allow certain the behind the meter DERs to sell energy to the grid when market conditions are favorable. We also need to confirm the ability of microgrid ownership entity to act as DR aggregator for wholesale markets.

4 DEVELOP INFORMATION FOR BENEFIT COST ANALYSIS

The project Team prepared detailed questionnaires to obtain data needed for the IEC BCA analyses, and met with or called major energy users to obtain relevant data. The Team then compiled and analyzed the data, and completed the IEC questionnaires to provide all of the data requested in Task 4. The IEC report is presented later in this section, and the completed questionnaires are shown in the Appendices.

The sections below describe the procedures and key assumptions regarding the data for the BCA analyses. In addition, this section discusses the how exclusion of reductions in air emissions in the BCA model understates the project benefits.

Air Emissions Benefits

The BCA calculates the emissions impacts from the DERs. However, it does not account for the reduction of emissions from reducing dispatch of other liquid fired peaking plants on Eastern LI.

There is existing diesel and kerosene fired peaking plants in Southampton, East Hampton and Southampton. These plants are older and inefficient units, but they are dispatched frequently during hot summer days to meet peak summer loads on the South Fork. For example, the Southampton kerosene fueled peaking plant has been dispatched between 500 and 1,000 hours per year for the past five years. (The Southampton plant is connected to East Hampton by underground cable.)

Since the new gas fueled electric and CCHP plants, as well as other DERs, would have lower variable operating costs than the existing diesel and kerosene fueled facilities, the project would reduce the need to dispatch these plants, thus significantly reducing air emissions. However, the BCA analysis does not recognize the benefits from these reductions in emissions at the existing facilities. This omission is more significant on the east end of LI than in most other areas of NYS, since the microgrid DERs in other

4.1 Facility and Customer Description

The Team consulted with Southampton Town and Village officials to identify the critical facilities and other establishments that should be included in the microgrid. We then worked closely with Town officials to obtain load data for these facilities. We obtained individual electric and fuel bills for large commercial and government establishments. PSEG-LI provided data on individual feeders that was used to estimate loads for smaller residential and commercial establishments. National Grid provided information on existing gas supply, and potential supply for new DERs. Based on a review of this information, the Team decided that the microgrid should include the selected critical facilities as well as numerous commercial establishments and residences in the downtown area of the Village of Southampton.

4.2 Characterization of Distributed Energy Resources

The Team designed the DERs to meet peak microgrid loads during grid outages, and ensure an economically viable business model during normal conditions.

The CCHP system would reduce or possibly eliminate use of fuel oil at SHH and reduce the cost of electricity.

The 2.0 MW electric generating plant would assure that most of downtown Southampton Village has service has power during grid outages. During normal conditions, this plant would sell energy and capacity contractually to customers within and outside the microgrid service area. Since this plant would have lower fuel and operating costs than the diesel and kerosene fueled plants in Southampton and elsewhere on eastern LI, would be dispatched ahead of these plants, thus reducing their operating hours and significantly reduce air emissions.

The battery facility would shave peak loads due to pumping at the SWCA water supply facility, and help stabilize the microgrid during main grid outages. The new solar PV would further help reduce peak loads.

Tables showing the requested microgrid data are provided in Appendix BA.

4.3 Capacity Impacts and Ancillary Services

The project will provide peak load support and significantly reduce the need for new transmission or peak generation needed to meet projected transmission deficits on the South Fork. PSEG-LI estimates there will be a 63MW transmission deficit on the South Fork by 2022. PSEG-LI estimates that new transmission to meet these needs would cost approximately $298 million.

The project will provide 5.8 MW of peak load support, reducing the need for new peaking generation or transmission on the South Fork.

The project will also provide ancillary services and capacity. Finally, the project will significantly reduce emissions by reducing the need to dispatch existing diesel and kerosene fueled peaking plants, as discussed previously.

4.4 Project Costs

A breakdown of project costs is shown below:

Table 4-1 project Costs

Capital Component	Installed Cost ($)
CCHP	6,000,000
Generator	3,800,000
Switchgear/distribution	220,000
Solar	800,100
Battery	480,000
Control & Communication	489,060

As shown, total project cost, including DERs, distribution improvements and microgrid controls, is estimated to be approximately $11.8 million, or about $2,000 per kW.

4.5 Costs to Maintain Service during a Power Outage

Information addressing the points responding in this section is contained in Appendix B.

4.6 Services Supported by the Microgrid

The project will be able to meet peak loads for most of the downtown area of Southampton Village during outages to the main grid. Specific responses to the points in this section are in Appendix B.

4.7 Summary of BCA Results

To assist with the completion of the project's NY Prize Stage 1 feasibility study, Industrial Economics, Inc. (IEc) conducted a screening-level analysis of its potential costs and benefits. IEc typically considers two scenarios for the benefit cost analysis. The first scenario assumes a 20-year operation periods with no major power outages (i.e., normal operating conditions only). The second scenario calculates the average annual duration of major power outages required for project benefits to equal costs, if benefits do not exceed costs under the first scenario. In this case, a second scenario was not needed, but two variants of the first scenario were considered.

Results of IEc's analysis for Scenario 1A (included in Appendix A) suggest that if no major power outages occur over the microgrid's assumed 20-year operating life, the project's benefits would exceed its costs. A variant on the first scenario, Scenario 1B, was also ran with the assumption that the microgrid project would contribute to avoiding specific transmission capacity upgrades on the South Fork of LI.

The results are summarized in the table below. Figure 4-1 and Figure 4-2 show a breakdown of the benefits and costs for Scenario 1A and 1B.

Table 4-2 BCA Results (Assuming 7 Percent Discount Rate)

ECONOMIC MEASURE	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES		
	SCENARIO 1A: 0 DAYS/YEAR	SCENARIO 1B: 0 DAYS/YEAR	SCENARIO 2
Net Benefits - Present Value	$3,870,000	$24,200,000	Not Evaluated
Benefit-Cost Ratio	1.1	1.6	Not Evaluated
Internal Rate of Return	9.3%	28.1%	Not Evaluated

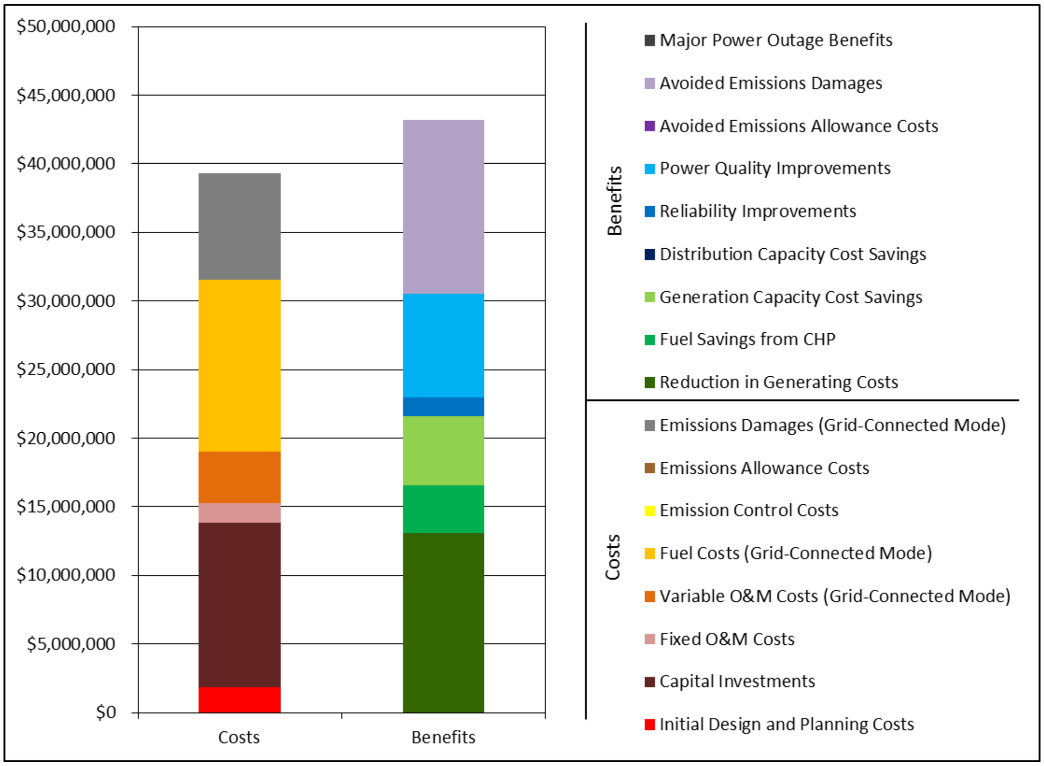

Figure 4-1 Present Value Results, Scenario 1A (No Major Power Outages; Default Transmission Capacity Benefits; 7 % Discount Rate)

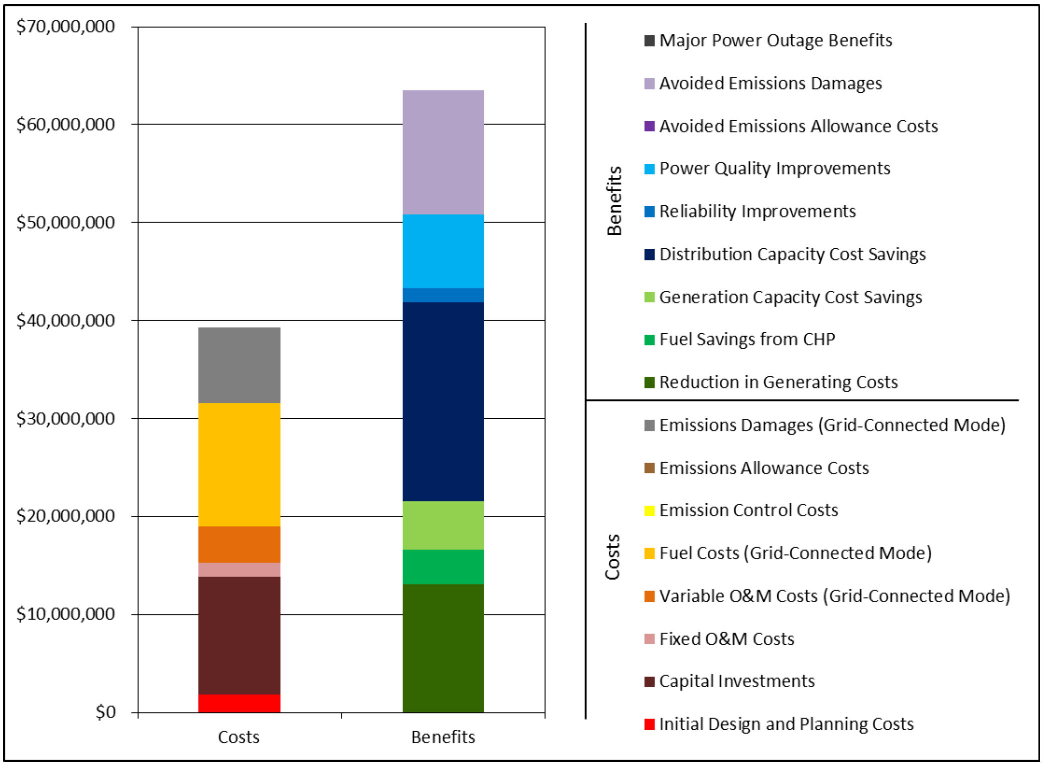

Figure 4-2 Present Value Results, Scenario 1B (No Major Power Outages; Avoided Transmission Capacity Upgrade Project; 7 % Discount Rate)

For Scenarios 1A and 1B, the major cost components are the DER fuel and the capital investment in the microgrid, particularly the CCHP units. The CCHP machines provide a return on investment during normal grid operations by providing thermal services to microgrid customers. This return is not included in IEc's societal-based evaluation. Emission Damages and Variable O&M costs of the microgrid generation resources during grid connected operations (due to the fuel consumption by the CCHP running during normal days) are also substantial cost components.

For Scenario 1A the major benefit components are the reduction in generating costs, attributable to the microgrid generation that displaces other conventional generation in the grid; and the avoided emission damages, attributable to clean natural gas and solar PV. The other significant benefit stream is the power quality improvements, particularly for the hospital.

For Scenario 1B the most significant benefit stream is derived from Transmission/Distribution Capacity Cost Savings category, due to the project providing peak load support and significantly reducing the need for new transmission or peak generation to meet projected transmission deficits on the South Fork. Other significant benefit streams are due to are the reduction in generating costs and avoided emission damages.

The full IEc results including tables that detail the cost and benefits for both scenarios are included in Appendix A.

APPENDIX A - BENEFIT-COST ANALYSIS SUMMARY REPORT

Site 7 – Town of Southampton

Project Overview

As part of NYSERDA's NY Prize community microgrid competition, the Town of Southampton has proposed development of a microgrid that would serve 400 residential customers and 114 commercial customers in this Suffolk County community.[1]

The critical service providers that would be served by the microgrid include a police station, two firehouses, one hospital, one water pumping station, and one volunteer ambulance. In addition, the microgrid would serve several municipal or community-focused facilities, including three local public schools, the department of public works, both the town and village hall, and two local culture and arts centers.

Southampton's microgrid would be powered by a new 2MW natural gas generator, a 1.5MW natural gas-fired combined cooling, heat, and power (CCHP) system, a new 300kW solar photovoltaic array, and 200kW of battery storage. In addition, the microgrid would connect two existing solar photovoltaic arrays (total capacity: 110 kW) and four existing natural gas-fired backup generators (total capacity: 2.1 MW). The solar arrays, cogeneration plant, and new natural gas generator would produce electricity for the grid during periods of normal operation. All resources would be available for peak load support and to support islanded operation during power outages. The system as designed would have sufficient generating capacity to meet average demand for electricity from all facilities on the microgrid during a major outage. The project's consultants also indicate that the system would be capable of providing frequency regulation, reactive power support, and black start support to the grid.

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

Methodology and Assumptions

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

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

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[1] The microgrid will be connected to a PSEG Long Island feeder line with approximately 400 residential and 100 commercial customers. Since the project team is unable to provide detailed electricity usage information for each load group, this analysis applies PSEG Long Island's estimate of average annual residential electricity usage to the 400 residential customers and assumes that the remaining load is split evenly among the 100 commercial customers.

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

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

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

The BCA considers costs and benefits for the following scenarios:

- Scenario 1A: No major power outages over the assumed 20-year operating period (i.e., normal operating conditions only). For this scenario, the analysis employs the model's standard approach to valuing transmission capacity benefits.

- Scenario 1B: No major power outages over the assumed 20-year operating period (i.e., normal operating conditions only). For this scenario, the analysis values the impact of the project on transmission capacity requirements on the basis of specific transmission capacity upgrades that would be necessary in the absence of the microgrid.

- Scenario 2: The average annual duration of major power outages required for project benefits to equal costs, if benefits do not exceed costs under Scenario 1.[3]

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

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

Results

Table 1 summarizes the estimated net benefits, benefit-cost ratios, and internal rates of return for the scenarios described above. The results indicate that although the value assigned to the project's transmission capacity benefits greatly influences the magnitude of benefits, the benefits outweigh the costs in both Scenario 1A and Scenario 1B. When the model's default estimate of the value of transmission capacity is applied and no major power outages are assumed to occur (Scenario 1A), the project's benefits exceed its costs by approximately 10 percent. If the analysis uses alternate estimates of the project's transmission capacity benefits (based on the avoided costs of specific transmission capacity augmentation projects planned for the South Fork of Long Island), the project's benefits increase by an additional $20.3 million (Scenario 1B).

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

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

	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES		
ECONOMIC MEASURE	SCENARIO 1A: 0 DAYS/YEAR	SCENARIO 1B: 0 DAYS/YEAR	SCENARIO 2
Net Benefits - Present Value	$3,870,000	$24,200,000	Not Evaluated
Benefit-Cost Ratio	1.1	1.6	Not Evaluated
Internal Rate of Return	9.3%	28.1%	Not Evaluated

Scenarios 1A and 1B

Figure 1 and Table 2 present the detailed results of the Scenario 1A analysis, while Figure 2 and Table 3 present the detailed results of the Scenario 1B analysis.

Figure 1. Present Value Results, Scenario 1A (No Major Power Outages; Default Transmission Capacity Benefits; 7 Percent Discount Rate)

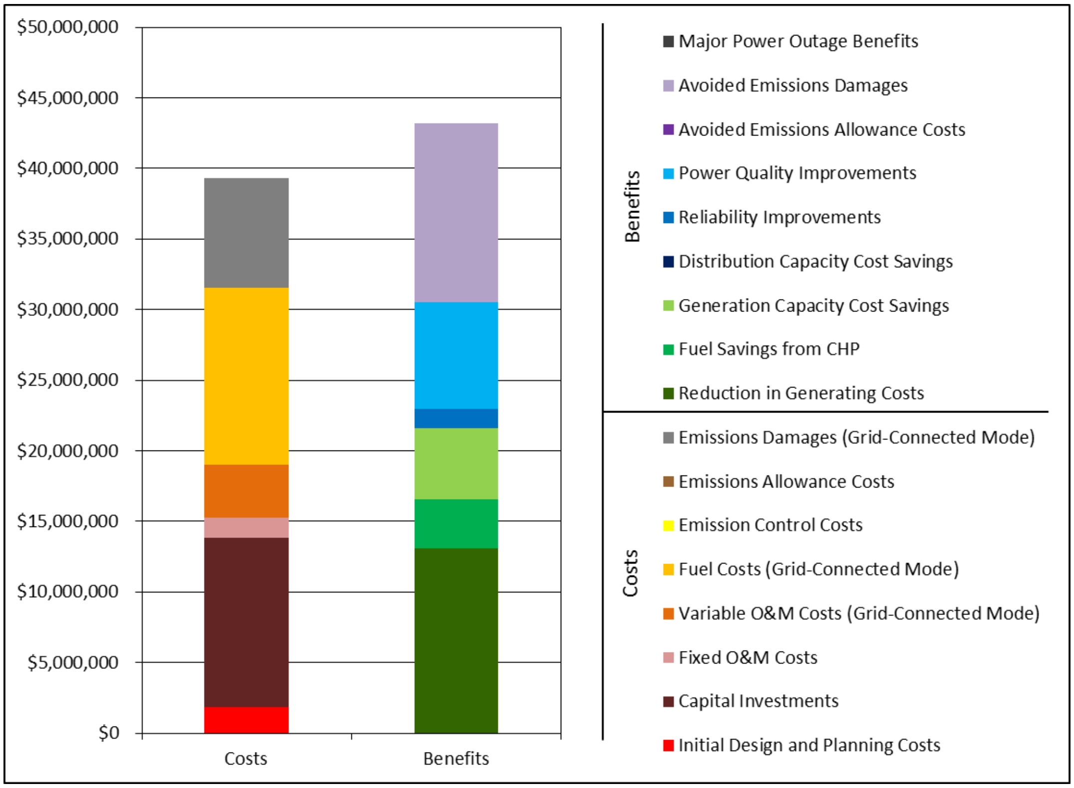

Table 2. Detailed BCA Results, Scenario 1A (No Major Power Outages; Default Transmission Capacity Benefits; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$1,840,000	$162,000
Capital Investments	$12,000,000	$1,040,000
Fixed O&M	$1,370,000	$121,000
Variable O&M (Grid-Connected Mode)	$3,780,000	$333,000
Fuel (Grid-Connected Mode)	$12,600,000	$1,110,000
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$7,760,000	$506,000
Total Costs	**$39,300,000**	
Benefits		
Reduction in Generating Costs	$13,100,000	$1,160,000
Fuel Savings from CCHP	$3,470,000	$306,000
Generation Capacity Cost Savings	$5,030,000	$443,000
Transmission/Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,400,000	$123,000
Power Quality Improvements	$7,510,000	$663,000
Avoided Emissions Allowance Costs	$6,580	$580
Avoided Emissions Damages	$12,700,000	$828,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$43,200,000**	
Net Benefits	**$3,870,000**	
Benefit/Cost Ratio	**1.1**	
Internal Rate of Return	**9.3%**	

Figure 2. Present Value Results, Scenario 1B (No Major Power Outages; Avoided Transmission Capacity Upgrade Project; 7 Percent Discount Rate)

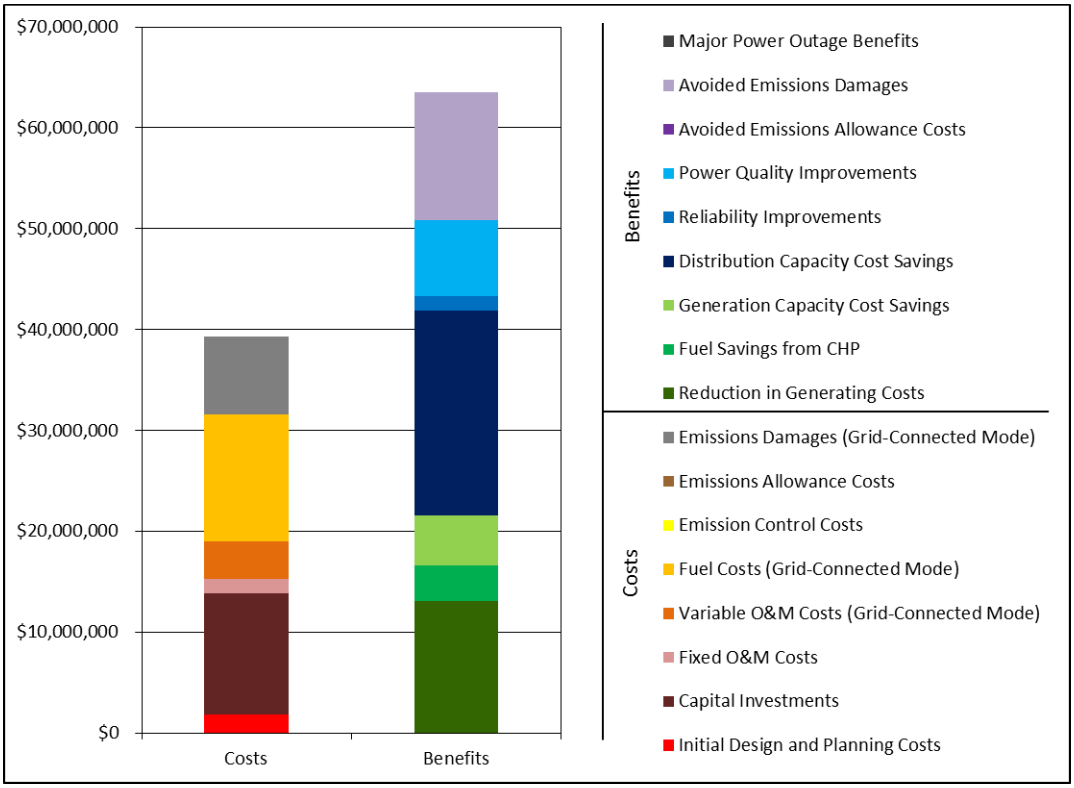

Table3. Detailed BCA Results, Scenario 1B (No Major Power Outages; Avoided Transmission Capacity Upgrade Project; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$1,840,000	$162,000
Capital Investments	$12,000,000	$1,040,000
Fixed O&M	$1,370,000	$121,000
Variable O&M (Grid-Connected Mode)	$3,780,000	$333,000
Fuel (Grid-Connected Mode)	$12,600,000	$1,110,000
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$7,760,000	$506,000
Total Costs	**$39,300,000**	
Benefits		
Reduction in Generating Costs	$13,100,000	$1,160,000
Fuel Savings from CCHP	$3,470,000	$306,000
Generation Capacity Cost Savings	$5,030,000	$443,000
Transmission/Distribution Capacity Cost Savings	$20,300,000	$1,790,000
Reliability Improvements	$1,400,000	$123,000
Power Quality Improvements	$7,510,000	$663,000
Avoided Emissions Allowance Costs	$6,580	$580
Avoided Emissions Damages	$12,700,000	$828,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$63,500,000**	
Net Benefits	**$24,200,000**	
Benefit/Cost Ratio	**1.6**	
Internal Rate of Return	**28.1%**	

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 $1.84 million. The present value of the project's capital costs is estimated at approximately $12 million, including the costs of the new natural gas generator ($3.8 million), new CCHP plant ($6 million), new solar arrays ($800,100), new battery storage ($480,000), and $709,160 for microgrid switches and control equipment.

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 $1.37 million (approximately $121,000 annually). These costs include parts, preventative maintenance, and monitoring for all energy resources, as well as software licenses, site leases, and management fees.

Variable Costs

The most significant variable cost associated with the proposed project is the cost of natural gas to fuel operation of the system's new generator and CCHP plant. To characterize these costs, the BCA relies on estimates of fuel consumption provided by the project team and projections of fuel costs from New York's 2015 State Energy Plan (SEP), adjusted to reflect recent market prices.[4] The present value of the project's fuel costs over a 20-year operating period is estimated to be approximately $12.6 million.

The BCA also considers the project team's best estimate of the microgrid's variable O&M costs (i.e., O&M costs that vary with the amount of energy produced). These costs cover general operations and maintenance; their 20-year present value is estimated to be $3.78 million, or approximately $17.52 per MWh.

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 $506,000 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 $7.76 million.

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. In Southampton's case, these cost savings would stem both from the production of electricity by distributed energy resources and by a reduction in annual electricity use associated with development of the new CCHP plant.[5] The BCA estimates the present value of these savings over a 20-year operating period to be approximately $13.1 million; this estimate assumes the microgrid provides base load power. In the case of the Town of Southampton's proposed microgrid, this assumption is consistent with the project's team operating profiles for the proposed photovoltaic arrays, new natural gas generator, and the new natural gas-fired CCHP plant; the existing natural gas generators, however, are expected to operate for between one and six percent of the year, and could therefore offset more expensive production during system peak periods, resulting in even greater cost savings. The heightened fuel efficiency of the new CCHP system would provide additional cost savings; the BCA estimates the present value of these savings over the 20-year operating period to be approximately $3.47 million. The reductions in demand for electricity from bulk energy suppliers would also reduce emissions of CO_2, SO_2, NO_x, and particulate matter, yielding emissions allowance cost savings with a present value of approximately $6,580 and avoided emissions damages with a present value of approximately $12.7 million.[6]

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

[5] The project team estimates that installation of the CCHP plant at Southampton Hospital would enable the facility to reduce its annual electricity use by 373 MWh.

[6] 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

In addition to the savings noted above, development of a microgrid could yield cost savings by avoiding or deferring the need to invest in expansion of the conventional grid's energy generation or distribution capacity. Based on standard capacity factors for solar resources (20 percent of total generating capacity for photovoltaic solar), the project team estimates the capacity available for the provision of peak load support to be approximately 5.8 MW per year. In addition, the project team expects development of the microgrid to reduce the conventional grid's demand for generating capacity by 127 kW as a result of new demand response capabilities. Based on these figures, the BCA estimates the present value of the project's generating capacity benefits to be approximately $5.03 million over a 20-year operating period.

Based on the information provided by the Southampton team, the analysis assumes that development of the microgrid would have no impact on distribution capacity requirements; however, the team indicates that the microgrid would reduce demand for transmission capacity by approximately 4.3 MW per year. As a default, the BCA model does not estimate avoided transmission capacity costs separately from other avoided costs.[7] In this case, however, the project team estimates that the project would contribute to avoiding a specific transmission capacity augmentation project, which would have an estimated cost of approximately $417,000 per MW-year.[8] The analysis therefore presents estimates of the project's transmission capacity benefits using both the model's default values (as presented in Scenario 1A) and using the alternate values associated with the transmission capacity augmentation project that would be avoided by the microgrid (as presented in Scenario 1B). Using the alternate values, the present value of the project's potential transmission capacity benefits is estimated to be approximately $20.3 million.[9]

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

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 $123,000 per year, with a present value of $1.4 million over a 20-year operating period. This estimate is calculated

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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.

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

[8] The regional electricity provider, PSEG Long Island, projects a 63 MW transmission deficit in the South Fork of Long Island by 2022. To cover this deficit, they estimate that $298 million in transmission reinforcement projects will need to be built by 2022.Therefore, this analysis assumes that each MW of additional transmission capacity avoids approximately $4.73 million in expenditures by PSEG Long Island. [See: https://www.psegliny.com/files.cfm/SFRFP1.pdf and https://www.psegliny.com/files.cfm/Utility20-Document-100614.pdf].

[9] This estimate likely overestimates the true value of the project's transmission capacity benefits because a portion of these benefits is already accounted for in the analysis's estimates of other avoided costs.

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:[10]

- System Average Interruption Frequency Index (SAIFI) – 0.72 events per year.
- Customer Average Interruption Duration Index (CAIDI) – 81.6 minutes.[11]

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[12]. 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. 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 each year. In the case of the Town of Southampton's proposed microgrid, the project team has indicated that approximately three power quality events would be avoided each year. Assuming that each customer in the proposed microgrid would experience these improvements in power quality, the model estimates the present value of this benefit to be approximately $7.51 million over a 20-year operating period.[13] In reality, some customers for whom power quality is important (e.g., medical facilities) may already have systems in place to protect against voltage sags, swells, and momentary outages. If this is the case in Southampton, the BCA may overstate the power quality benefits the project would provide.

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[10] www.icecalculator.com.

[11] The analysis is based on DPS's reported 2014 SAIFI and CAIDI values for the regional electricity service provider, PSEG Long Island.

[12] Where data was not provided by the project team, this analysis used the ICE calculator's default values for NY State.

[13] Importantly, the model relies on average costs per power quality event for customers across the United States, based on meta-analysis of data collected through 28 studies of electric utility customers between 1989 and 2005. These costs therefore incorporate assumptions about the distribution of customers across economic sectors and other key characteristics, such as the prevalence of backup generation and power conditioning that may not reflect the characteristics of the proposed microgrid. This is likely to be the case for the Town of Southampton. Based on information provided by the site team, Southampton's proposed microgrid will serve few, if any, customers in the construction, manufacturing, and mining sectors, which typically have the highest costs per power quality event. Instead, the proposed microgrid's customers are more likely to fall into the retail and public administration sectors, which typically have substantially lower costs of power quality events. [See: Sullivan, Michael J. *et al*. Estimated Value of Service Reliability for Electric Utility Customers in the United States. LBNL-2132E: June 2009.]

Summary

The analysis of Scenarios 1A and 1B yields a benefit/cost ratio of 1.1 and 1.6 respectively; i.e., the estimate of project benefits is in both cases greater than that of project costs. Accordingly, the analysis does not consider the potential of the microgrid to mitigate the impact of major power outages in Scenario 2. Consideration of such benefits would further increase the net benefits of the project's development.

APPENDIX B - FACILITY QUESTIONNAIRE

Facility Questionnaire

This questionnaire requests information needed to estimate the impact that a microgrid might have in protecting the facilities it serves from the effects of a major power outage (i.e., an outage lasting at least 24 hours). For each facility, we are interested in information on:

I. Current backup generation capabilities.

II. The costs that would be incurred to maintain service during a power outage, both when operating on its backup power system (if any) and when backup power is down or not available.

III. The types of services the facility provides.

I. Backup Generation Capabilities

1. Do any of the facilities that would be served by the microgrid currently have backup generation capabilities?
   a. ☐ No - proceed to Question 4
   b. ■ Yes - proceed to Question 2

2. For each facility that is equipped with a backup generator, please complete the table below, following the example provided. Please include the following information:
   a. **Facility name:** For example, "Main Street Apartments."
   b. **Identity of backup generator:** For example, "Unit 1."
   c. **Energy source:** Select the fuel/energy source used by each backup generator from the dropdown list. If you select "other," please type in the energy source used.
   d. **Nameplate capacity:** Specify the nameplate capacity (in MW) of each backup generator.
   e. **Standard operating capacity:** Specify the percentage of nameplate capacity at which the backup generator is likely to operate during an extended power outage.
   f. **Average electricity production per day in the event of a major power outage**: Estimate the average daily electricity production (MWh per day) for the generator in the event of a major power outage. In developing the estimate, please consider the unit's capacity, the daily demand at the facility it serves, and the hours of service the facility requires.
   g. **Fuel consumption per day:** Estimate the amount of fuel required per day (e.g., MMBtu per day) to generate the amount of electricity specified above. This question does not apply to renewable energy resources, such as wind and solar.

h. **One-time operating costs:** Please identify any one-time costs (e.g., labor or contract service costs) associated with connecting and starting the backup generator.

i. **Ongoing operating costs:** Estimate the costs ($/day) (e.g., maintenance costs) associated with operating the backup generator, excluding fuel costs.

Note that backup generators may also serve as distributed energy resources in the microgrid. Therefore, there may be some overlap between the information provided in the table below and the information provided for the distributed energy resource table (Question 2) in the general Microgrid Data Collection Questionnaire.

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		
Hospital Facility	*Unit 1*	*Diesel*	*0.800*	*80*	15.36	187.18	*MMBtu/Day*	*200*	322.6
Hospital Facility	*Unit 2*	*Diesel*	*0.800*	*80*	15.36	187.18	*MMBtu/Day*	*200*	322.6
Middle School	*Unit 1*	*Diesel*	*0.030*	*100*	0.72	9.83	*MMBtu/Day*	*100*	15.1
High School	*Unit 1*	*Natural Gas*	*0.200*	*100*	4.8	58.49	*MMBtu/Day*	*200*	100.8
Village Hall	*Unit 1*	*Diesel*	*0.020*	*100*	0.48	6.55	*MMBtu/Day*	*100*	10.1
Police Department	*Unit 1*	*Natural Gas*	*0.343*	*50*	4.116	50.16	*MMBtu/Day*	*200*	86.4
Fire Department	*Unit 2*	*Propane*	*0.009*	*100*	0.216	2.95	*MMBtu/Day*	*100*	4.5
Fire Department	*Unit 3*	*Propane*	*0.009*	*100*	0.216	2.95	*MMBtu/Day*	*100*	4.5
Ambulance	*Unit 1*	*Propane*	*0.010*	*100*	0.24	3.28	*MMBtu/Day*	*100*	5.04
DPW - Park Dept.	Unit 1	Natural Gas	0.02	100	0.48	6.55	MMBtu/Day	200	8.16
DPW - Highway Dept.	Unit 2	Propane	0.015	100	0.36	4.91	MMBtu/Day	200	7.56
DPW - Central Garage	Unit 3	Propane	0.02	100	0.48	6.55	MMBtu/Day	200	10.08
SCWA	*Unit 1*	*Diesel*	*0.180*	*100*	*4.32*	52.7	MMBtu/day	200	99.36

Note: The values for Daily Production, Fuel Consumption, and Operating Costs are based on the number of hours per 24-hour day the plants will be dispatched during outages.

II. Costs of Emergency Measures Necessary to Maintain Service

We understand that facilities may have to take emergency measures during a power outage in order to maintain operations, preserve property, and/or protect the health and safety of workers, residents, or the general public. These measures may impose extraordinary costs, including both one-time expenditures (e.g., the cost of evacuating and relocating residents) and ongoing costs (e.g., the daily expense of renting a portable generator). The questions below address these costs. We begin by requesting information on the costs facilities would be likely to incur when operating on backup power. We then request information on the costs facilities would be likely to incur when backup power is not available.

A. *Cost of Maintaining Service while Operating on Backup Power*

3. Please provide information in the table below for each facility the microgrid would serve which is currently equipped with some form of backup power (e.g., an emergency generator). For each facility, please describe the costs of any emergency measures that would be necessary in the event of a widespread power outage (i.e., a total loss of power in the area surrounding the facility lasting at least 24 hours). In completing the table, please assume that the facility's backup power system is fully operational. In your response, please describe and estimate the costs for:
   a. One-time emergency measures (total costs)
   b. Ongoing emergency measures (costs per day)

Note that these measures do not include the costs associated with running the facility's existing backup power system, as estimated in the previous question.

In addition, for each emergency measure, please provide additional information related to when the measure would be required. For example, measures undertaken for heating purposes may only be required during winter months. As another example, some commercial facilities may undertake emergency measures during the work week only.

As a guide, see the examples the table provides.

Facility Name	**Type of Measure (One-Time or Ongoing)**	**Description**	**Costs**	**Units**	**When would these measures be required?**
	One-Time Measures				
Hospital Facility	*One-Time Measures*	Even though there is back power, some emergency measures need to be taken. Turn on and check backup power. Keep critical safety and security functions in operation. Notify personnel. Send non-essential staff home	10,000.	$	In the event of loss of power
Middle School	*One-Time Measures*	Middle School backup power is not enough to meet all the load, and only good for certain building maintenance needs. Emergency measures need to be taken. Turn on and check backup power. Keep critical safety and security functions in operation. Notify personnel. Send all students and most staff home.	5,000	$	In the event of loss of power
High School	*One-Time Measures*	High School backup power is not enough to meet all the load, and only good for certain building maintenance needs. Emergency measures need to be taken. Turn on and check backup power. Keep critical safety and security functions in operation. Notify personnel. Send all students and most staff home.	5,000	$	In the event of loss of power

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
Village Hall	*One-Time Measures*	Village Hall backup power is not enough to meet all the load, and only good for certain building maintenance needs. Emergency measures need to be taken. Turn on and check backup power. Keep critical safety and security functions in operation. Notify personnel. Move staff.	1,000	$	In the event of loss of power
Village Hall	*One-Time Measures*	To continue daily operations, since backup generation is not enough > Hook up additional backup generation.	22,100	$	In the event of loss of power
Village Hall	*Ongoing Measures*	To continue daily operations, since backup generation is not enough > Hook up additional backup generation.	9,00	$/day	In the event of loss of power
Police Department	*One-Time Measures*	Check and turn on backup generation – take emergency measures for safety and security – send non-essential staff home.	1,000	$	In the event of loss of power
Fire Department	*One-Time Measures*	Check and turn on backup generation – take emergency measures for safety and security – send non-essential staff home.	1,000	$	In the event of loss of power
Fire Department	*One-Time Measures*	Check and turn on backup generation – take emergency measures for safety and security – send non-essential staff home.	1,000	$	In the event of loss of power
Ambulance	*One-Time Measures*	Check and turn on backup generation – take emergency measures for safety and security – send non-essential staff home.	1,000	$	In the event of loss of power
DPW – Park Dept.	*One-Time Measures*	Check and turn on backup generation – take emergency measures for safety and security – send non-essential staff home.	1,000	$	In the event of loss of power
DPW – Highway Dept.	*One-Time Measures*	Check and turn on backup generation – take emergency measures for safety and security – send non-essential staff home.	1,000	$	In the event of loss of power
DPW – Central Garage	*One-Time Measures*	Check and turn on backup generation – take emergency measures for safety and security – send non-essential staff home.	1,000	$	In the event of loss of power
Suffolk County Water Authority Supply Well	*One-Time Measures*	Backup power will enable partial operations. Emergency measures need to be taken. Turn on and check backup power. Keep critical safety and security functions in operation. Notify personnel. Send non-essential staff home	2,000.	$	In the event of loss of power

Note: In the above cases, except in the case of the hospital, the backup generation is not sufficient to meet the facilities' load. Hence, additional emergency measures will be needed. In the case of Village Hall, the backup generation will have to be checked and tuned on. Then arrangements have to be made to hook up and operate additional portable backup generation on a daily basis in order to enable critical village hall services. Hence, the costs associated with portable generation are the same as the case in the following table.

B. *Cost of Maintaining Service while Backup Power is Not Available*

4. Please provide information in the table below for each facility the microgrid would serve. For each facility, please describe the costs of any emergency measures that would be necessary in the event of a widespread power outage (i.e., a total loss of power in the area surrounding the facility lasting at least 24 hours). In completing the table, please assume that service from any backup generators currently on-site is not available. In your response, please describe and estimate the costs for:
    a. One-time emergency measures (total costs)
    b. Ongoing emergency measures (costs per day)

In addition, for each emergency measure, please provide additional information related to when the measure would be required. For example, measures undertaken for heating purposes may only be required during winter months. As another example, some commercial facilities may undertake emergency measures during the work week only.

As a guide, see the examples the table provides.

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
Hospital	*One-Time Measures*	*Hooking up additional portable generator*	13000	$	Year-round
Hospital	*Ongoing Measures*	*Renting additional portable generator*	17000	$/day	Year-round
Middle School	*One-Time Measures*	*Hooking up additional portable generator*	4000	$	5 days a week September – June
Middle School	*Ongoing Measures*	*Renting additional portable generator*	32000	$/day	5 days a week September – June
High School	*One-Time Measures*	*Hooking up additional portable generator*	4500	$	5 days a week September – June
High School	*Ongoing Measures*	*Renting additional portable generator*	5400	$/day	5 days a week September – June
Elementary School	*One-Time Measures*	*Hooking up additional portable generator*	4000	$	5 days a week September – June
Elementary School	*Ongoing Measures*	*Renting additional portable generator*	32000	$	5 days a week September-June
Village Hall	*One-Time Measures*	*Hooking up additional portable generator*	22100	$	5 days a week, year-round
Village Hall	*Ongoing Measures*	*Renting additional portable generator*	900	$/day	5 days a week, year-round
Town Hall	*One-Time Measures*	*Hooking up additional portable generator*	2100	$	5 days a week, year-round
Town Hall	*Ongoing Measures*	*Renting additional portable generator*	900	$/day	5 days a week, year-round
Library	*One-Time Measures*	*Hooking up additional portable generator*	3200	$	5 days a week, year-round
Library	*Ongoing Measures*	*Renting additional portable generator*	2500	$/day	5 days a week, year-round
Police Department	*One-Time Measures*	*Hooking up additional portable generator*	3600	$	Year-round
Police Department	*Ongoing Measures*	*Renting additional portable generator*	2000	$/day	Year-round
Windmill Ln Fire Department	*One-Time Measures*	*Hooking up additional portable generator*	3600	$	Year-round
Windmill Ln Fire Department	*Ongoing Measures*	*Renting additional portable generator*	2000	$/day	Year-round

Facility Name	**Type of Measure (One-Time or Ongoing)**	**Description**	**Costs**	**Units**	**When would these measures be required?**
Hampton Rd Fire Department	*One-Time Measures*	*Hooking up additional portable generator*	2400	$	Year-round
Hampton Rd Fire Department	*Ongoing Measures*	*Renting additional portable generator*	1300	$/day	Year-round
Ambulance	*One-Time Measures*	*Hooking up additional portable generator*	2100	$	Year-round
Ambulance	*Ongoing Measures*	*Renting additional portable generator*	900	$/day	Year-round
Southampton Arts Center	*One-Time Measures*	*Hooking up additional portable generator*	2600	$	5 days a week, year-round
Southampton Arts Center	*Ongoing Measures*	*Renting additional portable generator*	1700	$/day	5 days a week, year-round
Southampton Cultural Center	*One-Time Measures*	*Hooking up additional portable generator*	2100	$	5 days a week, year-round
Southampton Cultural Center	*Ongoing Measures*	*Renting additional portable generator*	900	$/day	5 days a week, year-round
DPW	*One-Time Measures*	*Hooking up additional portable generator*	2100	$	Year-round
DPW	*Ongoing Measures*	*Renting additional portable generator*	900	$/day	Year-round
Suffolk County Water Authority	*One-Time Measures*	*Hooking up additional portable generator*	4500	$	Year-round
Suffolk County Water Authority	*Ongoing Measures*	*Renting additional portable generator*	5400	$/day	Year-round
Non-Critical Load (400 Residences + 100 Commercial establishments: Costs apply to Commercial establishments)	*One-Time Measures*	*Hooking up additional portable generator*	210,000	$	Year-round
Non-Critical Load (400 Residences + 100 Commercial establishments: Costs apply to Commercial establishments)	*Ongoing Measures*	*Renting additional portable generator*	90,000	$/day	Year-round

III. Services Provided

We are interested in the types of services provided by the facilities the microgrid would serve, as well as the potential impact of a major power outage on these services. As specified below, the information of interest includes some general information on all facilities, as well as more detailed information on residential facilities and critical service providers (i.e., facilities that provide fire, police, hospital, water, wastewater treatment, or emergency medical services (EMS)).

*A. Questions for: **All Facilities***

5. During a power outage, is each facility able to provide the same level of service when using backup generation as under normal operations? If not, please estimate the percent loss in the services for each facility (e.g., 20% loss in services provided during outage while on backup power). As a guide, see the example the table provides.

Facility Name	Percent Loss in Services When Using Backup Gen.
Middle School (not enough backup)	0%
Hospital	20%
Windmill Ln Fire Department	0%
Hampton Rd Fire Department	0%
Ambulance	0%
Police Department	0%
Village Hall (not enough backup)	0%
High School (not enough backup)	0%
Department of Public Works	0%
SCWA	0%

6. During a power outage, if backup generation is not available, is each facility able to provide the same level of service as under normal operations? If not, please estimate the percent loss in the services for each facility (e.g., 40% loss in services provided during outage when backup power is not available). As a guide, see the example the table provides.

Facility Name	Percent Loss in Services When Backup Gen. is Not Available
Town Hall	100%
Village Hall	100%
Police Department	100%
Windmill Lane Fire House	40%
Hampton Road Fire House	40%
Volunteer Ambulance	100%
Southampton Cultural Center	100%
Southampton Arts Center	100%
Hospital	100%
Elementary School	100%
Middle School	100%
High School	100%
Library	100%
Non-Critical Load	100%
DPW	100%
SCWA	100%

*B. Questions for facilities that provide**: Fire Services***

7. What is the total population served by the facility?

56,790

8. Please estimate the percent increase in average response time for this facility during a power outage:

100%

9. What is the distance (in miles) to the nearest backup fire station or alternative fire service provider?

1.7 Miles

*C. Questions for facilities that provide: **Emergency Medical Services (EMS)***

10. What is the total population served by the facility?

78,247

11. Is the area served by the facility primarily:

☐ Urban

■ Suburban

☐ Rural

☐ Wilderness

12. Please estimate the percent increase in average response time for this facility during a power outage:

100%

13. What is the distance (in miles) to the next nearest alternative EMS provider?

3

*D. Questions for facilities that provide: **Hospital Services***

14. What is the total population served by the facility?

78,247

15. What is the distance (in miles) to the nearest alternative hospital?

18

16. What is the population served by the nearest alternative hospital?

200,000

E. Questions for facilities that provide: Police Services

17. What is the total population served by the facility?

60,000

18. Is the facility located in a:

☐ Metropolitan Statistical Area

■ Non-Metropolitan City

☐ Non-Metropolitan County

19. Please estimate:

   a. The number of police officers working at the station under normal operations.

   10

   b. The number of police officers working at the station during a power outage.

   10

   c. The percent reduction in service effectiveness during an outage.

   50%

F. Questions for facilities that provide: Wastewater Services

20. What is the total population served by the facility?

Click here to enter text.

21. Does the facility support:

☐ Residential customers

☐ Businesses

☐ Both

G. *Questions for facilities that provide:* ***Water Services***

22. What is the total population served by the facility?

8,164

23. Does the facility support:

☐ Residential customers

☐ Businesses

■ Both

H. *Questions for:* ***Residential Facilities***

24. What types of housing does the facility provide (e.g., group housing, apartments, nursing homes, assisted living facilities, etc.)?

Single family homes

25. Please estimate the number of residents that would be left without power during a complete loss of power (i.e., when backup generators fail or are otherwise not available).

400

APPENDIX C - MICROGRID QUESTIONNAIRE

Microgrid Questionnaire

This questionnaire solicits information on the community microgrid you are proposing for the NY Prize competition. The information in this questionnaire will be used to develop a preliminary benefit-cost analysis of the proposed microgrid. Please provide as much detail as possible. The questionnaire is organized into the following sections:

A. Project Overview, Energy Production, and Fuel Use

B. Capacity Impacts

C. Project Costs

D. Environmental Impacts

E. Ancillary Services

F. Power Quality and Reliability

G. Other Information

If you have any questions regarding the information requested, please contact Industrial Economics, Incorporated, either by email (NYPrize@indecon.com) or phone (929-445-7641).

Microgrid site: 7. Town of Southampton

Point of contact for this questionnaire:

Name: Bob Foxen

Address: 95 Brook Street
Garden City, New York 11530

Telephone: 516-528-8396

Email: bob_foxen@globalcommon.com

A. Project Overview, Energy Production, and Fuel Use

1. The table below is designed to gather background information on the facilities your microgrid would serve. It includes two examples: one for Main Street Apartments, a residential facility with multiple utility customers; and another for Main Street Grocery, a commercial facility. Please follow these examples in providing the information specified for each facility. Additional guidance is provided below.

    - **Facility name:** Please enter the name of each facility the microgrid would serve. Note that a single **facility** may include multiple **customers** (e.g., individually-metered apartments within a multi-family apartment building). When this is the case, you do not need to list each customer individually;

simply identify the facility as a whole (see Table 1, “Main Street Apartments,” for an example).

- **Rate class:** Select the appropriate rate class for the facility from the dropdown list. Rate class options are residential, small commercial/industrial (defined as a facility using less than 50 MWh of electricity per year), or large commercial/industrial (defined as a facility using 50 or more MWh of electricity per year).
- **Facility/customer description:** Provide a brief description of the facility, including the number of individual customers at the facility if it includes more than one (e.g., individually-metered apartments within a multi-family apartment building). For commercial and industrial facilities, please describe the type of commercial/industrial activity conducted at the facility.
- **Economic sector:** Select the appropriate economic sector for the facility from the dropdown list.
- **Average annual usage:** Specify the average annual electricity usage (in MWh) **per customer**. Note that in the case of facilities with multiple, similar customers, such as multi-family apartment buildings, this value will be different from average annual usage for the facility as a whole.
- **Peak demand:** Specify the peak electricity demand (in MW) **per customer**. Note that in the case of facilities with multiple, similar customers, such as multi-family apartment buildings, this value will be different from peak demand for the facility as a whole.
- **Percent of average usage the microgrid could support in the event of a major power outage:** Specify the percent of each facility’s typical usage that the microgrid would be designed to support in the event of a major power outage (i.e., an outage lasting at least 24 hours that necessitates that the microgrid operate in islanded mode). In many cases, this will be 100%. In some cases, however, the microgrid may be designed to provide only enough energy to support critical services (e.g., elevators but not lighting). In these cases, the value you report should be less than 100%.
- **Hours of electricity supply required per day in the event of a major power outage:** Please indicate the number of hours per day that service to each facility would be maintained by the microgrid in the event of a major outage. Note that this value may be less than 24 hours for some facilities; for example, some commercial facilities may only require electricity during business hours.

Facility Name	Rate Class	Facility/Customer Description (Specify Number of Customers if More Than One)	Economic Sector Code	Average Annual Electricity Usage Per Customer (MWh)	Peak Electricity Demand Per Customer (MW)	Percent of Average Usage Microgrid Could Support During Major Power Outage	Hours of Electricity Supply Required Per Day During Major Power Outage
Town Hall	Large Commercial/Industrial (>50 annual MWh)	Town Building	*All other industries*	474	0.149	100%	8
Village Hall	Large Commercial/Industrial (>50 annual MWh)	Town Building	*All other industries*	51	0.016	100%	8
Department of Public Works	Large Commercial/Industrial (>50MWH/year)	Town owned buildings	All other industries	76	0.049	100%	8
Suffolk County Water Authority (SCWA)	Large Commercial/Industrial	Water Supply	*All other industries*	448.9	0.144	100%	24
Police Department	Large Commercial/Industrial (>50 annual MWh)	Police	*All other industries*	366	0.137	100%	24
Windmill Lane Fire House	Large Commercial/Industrial (>50 annual MWh)	Fire Department	*All other industries*	212	0.127	100%	24
Hampton Road Fire House	Large Commercial/Industrial (>50 annual MWh)	Fire Department	*All other industries*	150	0.054	100%	24
Volunteer Ambulance	Small Commercial/Industrial (<50 annual MWh)	EMS	*All other industries*	38	0.019	100%	24
Southampton Cultural Center	Large Commercial/Industrial (>50 annual MWh)	Town Building	*All other industries*	76	0.034	100%	8
Southampton Arts Center	Large Commercial/Industrial (>50 annual MWh)	Town Building	*All other industries*	183	0.096	100%	8
Hospital	Large Commercial/Industrial (>50 annual MWh)	Hospital	*All other industries*	6,784	1.515	100%	24
Southampton Elementary School	Large Commercial/Industrial (>50 annual MWh)	School	*All other industries*	444	0.115	100%	8

Facility Name	Rate Class	Facility/Customer Description (Specify Number of Customers if More Than One)	Economic Sector Code	Average Annual Electricity Usage Per Customer (MWh)	Peak Electricity Demand Per Customer (MW)	Percent of Average Usage Microgrid Could Support During Major Power Outage	Hours of Electricity Supply Required Per Day During Major Power Outage
Southampton Middle School	Large Commercial/Industrial (>50 annual MWh)	School	*All other industries*	904	0.232	100%	8
High School	Large Commercial/Industrial (>50 annual MWh)	School	*All other industries*	1,858	0.481	100%	8
Library Facilities	Large Commercial/Industrial (>50 annual MWh)	Library	*All other industries*	489	0.179	100%	8
Non-Critical Load	Residential	Mix of commercial and residential loads(1)	*Residential*	10,885	2,634	100%	24

(Note 1: Non-Critical Load (i.e., Extra Feeder Load) is estimated to be approximately 400 residences, and approximately 100 small commercial establishments.

2. In the table below, please provide information on the distributed energy resources the microgrid will incorporate. Use the two examples included in the table as a guide.

    - **Distributed energy resource name:** Please identify each distributed energy resource with a brief description. In the event that a single facility has multiple distributed energy resources of the same type (e.g., two diesel generators), please use numbers to uniquely identify each (e.g., "Diesel generator 1" and "Diesel generator 2").
    - **Facility name:** Please specify the facility at which each distributed energy resource is or would be based.
    - **Energy source:** Select the fuel/energy source used by each distributed energy resource from the dropdown list. If you select "other," please type in the energy source used.
    - **Nameplate capacity:** Specify the total nameplate capacity (in MW) of each distributed energy resource included in the microgrid.
    - **Average annual production:** Please estimate the amount of electricity (in MWh) that each distributed energy resource is likely to produce each year, on average, **under normal operating conditions.** The benefit-cost analysis will separately estimate production in islanded mode in the event of an extended power outage. **If the distributed energy resource will operate only in the event of an outage, please enter zero.**
    - **Average daily production in the event of a major power outage:** Please estimate the amount of electricity (in MWh per day) that each distributed energy resource is likely to produce, on average, **in the event of a major power outage.** In developing your estimate for each distributed energy resource, you should consider the electricity requirements of the facilities the microgrid would serve, as specified in your response to Question 1.
    - **Fuel consumption per MWh:** For each distributed energy resource, please estimate the amount of fuel required to generate one MWh of energy. This question does not apply to renewable energy resources, such as wind and solar.

Distributed Energy Resource Name	Facility Name	Energy Source	Nameplate Capacity (MW)	Average Annual Production Under Normal Conditions (MWh)	Average Daily Production During Major Power Outage (MWh)	Fuel Consumption per MWh	
						Quantity	Unit
Backup Generator 1-existing	Hospital	*Other – Natural Gas/Diesel*	0.800	148.60	2.43	12.186	MMBtu/MWh
Backup Generator 2-existing	Hospital	*Other – Natural Gas/Diesel*	0.800	122.85	2.70	12.186	MMBtu/MWh
CHP -new	Hospital	*Natural Gas*	1.500	9,444.21	28.41	8.979	MMBtu/MWh
Generator-new	DPW	*Natural Gas*	2.000	8,743.30	45.12	8.530	MMBtu/MWh
Backup generator-existing	SCWA	*Diesel*	0.180	0.00	4.32	12.200	MMBtu/MWH
Backup Generator-existing	High School	*Natural Gas*	0.200	144.29	2.00	12.186	MMBtu/MWh
PV 1-existing	High School	*Solar*	0.100	167.53	0.54	N/A	N/A
PV 2-existing	High School	*Solar*	0.010	16.75	0.05	N/A	N/A
PV-new	Elementary School	*Solar*	0.300	502.58	1.61	N/A	N/A
Backup Generator-existing	Police Department	*Natural Gas*	0.343	275.60	3.59	12.186	MMBtu/MWh
Backup Generator - existing	Middle School	*Diesel*	0.030	0.00	0.00	12.200	MMBtu/MWh
Backup Generator-existing	Village Hall	*Diesel*	0.020	0.00	0.00	12.200	MMBtu/MWh
Backup Generator-existing	Fire Department – Windmill Ln	*Propane*	0.009	0.00	0.00	12.200	MMBtu/MWh
Backup Generator-existing	Fire Department – Hampton Rd	*Propane*	0.009	0.00	0.00	12.200	MMBtu/MWh
Backup Generator-existing	Ambulance	*Propane*	0.010	0.00	0.00	12.200	MMBtu/MWh
Backup Generator 1-existing	DPW - Park Dept.	*Natural Gas*	0.020	0.00	0.00	12.200	MMBtu/MWh
Backup Generator 2-existing	DPW - Highway Dept.	*Propane*	0.015	0.00	0.00	12.200	MMBtu/MWh
Backup Generator 3-existing	DPW - Central Garage	*Propane*	0.020	0.00	0.00	12.200	MMBtu/MWh

(Notes:

The existing backup generation is not needed during microgrid islanded operation, due to the sufficiency of additional new generation and load curtailment).

Load Curtailment during emergency is will be based on 76 kW from Southampton Hospital, 48 kW from High School, and 3 kW from Southampton Cultural Center. Same resources will also provide demand response during normal days (please see Table 5).

The Combined Cool & Heat & Power (CCHP) unit is equipped with a 289 kW equivalent absorption chiller.

The proposed Absorption Chiller (not shown in the table) saves 373.34 MWh per year of electricity; if same cooling load was provided by a central chiller, i.e., the 373.34 MWh is the Electric Cooling Load Offset by absorption chiller which is powered by the recovered heat from CCHP.

B. Capacity Impacts

3. Is development of the microgrid expected to reduce the need for bulk energy suppliers to expand generating capacity, either by directly providing peak load support or by enabling the microgrid's customers to participate in a demand response program?

☐ No – proceed to Question 6

☒ Yes, both by providing peak load support and by enabling participation in a demand response program – proceed to Question 4

☐ Yes, by providing peak load support only – proceed to Question 4

☐ Yes, by enabling participation in a demand response program only – proceed to Question 5

Provision of Peak Load Support

4. Please provide the following information for all distributed energy resources that would be available to provide peak load support:

- **Available capacity:** Please indicate the capacity of each distributed energy resource that would be available to provide peak load support (in MW/year).
- **Current provision of peak load support, if any:** Please indicate whether the distributed energy resource currently provides peak load support.

Please use the same distributed energy resource and facility names from Question 2.

Distributed Energy Resource Name	Facility Name	Available Capacity (MW/year)	Does distributed energy resource currently provide peak load support?
Backup Generator 1	Hospital	0.640	☐ Yes
Backup Generator 2	Hospital	0.640	☐ Yes
CCHP	Hospital	1.500	☐ Yes
Generator	DPW	2.000	☐ Yes
Generator	SCWA	0.180	
Battery	SCWA	0.200	

Solar	High School	0.044	☐ Yes
Solar	Elementary School	0.120	☐ Yes
Backup Generator	High School	0.200	☐ Yes
Backup Generator	Police Department	0.343	☐ Yes

Note: Solar peak load support is 40% of peak solar output.

If development of the microgrid is also expected to enable the microgrid's customers to participate in a demand response program, please proceed to Question 5. Otherwise, please proceed to Question 6.

Participation in a Demand Response Program

5. Please provide the following information for each facility that is likely to participate in a demand response program following development of the microgrid:
   - **Available capacity:** Please estimate the capacity that would be available to participate in a demand response program (in MW/year) following development of the microgrid.
   - **Capacity currently participating in a demand response program, if any:** Please indicate the capacity (in MW/year), if any, that currently participates in a demand response program.

Facility Name	**Capacity Participating in Demand Response Program (MW/year)**	
	Following Development of Microgrid	**Currently**
Hospital (5% of Peak Load)	0.758	0
High School (10% of Peak Load)	0.048	0
Southampton Cultural Center (10% of Peak Load	0.003	

6. Is development of the microgrid expected to enable utilities to avoid or defer expansion of their transmission or distribution networks?

☐ Yes – proceed to Question 7

☒ No – proceed to Section C

7. Please estimate the impact of the microgrid on utilities' **transmission** capacity requirements. The following question will ask about the impact on distribution capacity.

Impact of Microgrid on Utility Transmission Capacity	**Unit**
4.295	MW

Note: Based on PSEG=LI RFP "2015 SF RFP" – includes the following new capacities: 1,500 kW Hospital CCHP + 2,000 kW DPW + 180kW SCWA generator (existing)+200KW SCWA battery (new) + 164 kW average peak of solar PV + 126 kW Load Curtailment + 289 kW Absorption Chiller Cooling Load Offset.

8. Please estimate the impact of the microgrid on utilities' **distribution** capacity requirements.

Impact of Microgrid on Utility Distribution Capacity	Unit
0	MW/year

(No distribution capacity impact)

C. Project Costs

We are interested in developing a year-by-year profile of project costs over a 20-year operating period. The following questions ask for information on specific categories of costs.

Capital Costs

9. In the table below, please estimate the fully installed cost and lifespan of all equipment associated with the microgrid, including equipment or infrastructure associated with power generation (including combined heat and power systems), energy storage, energy distribution, and interconnection with the local utility.

Capital Component	Installed Cost ($)	Component Lifespan (round to nearest year)	Description of Component
CHP	6,000,000	20	Hospital Facility CHP
Generator	3,800,000	20	DPW Natural Gas Generator
Battery	480,000	20	200kW battery at SCWA facility
Switchgear/distribution	220,000	30	Microgrid switchgear, distribution improvements, transformer
Solar	800,100	18	Elementary School Solar
Control & Communication	489,060	20	Microgrid control and communication installation

Initial Planning and Design Costs

10. Please estimate initial planning and design costs. These costs should include costs associated with project design, building and development permits, efforts to secure financing, marketing the project, and negotiating contracts. Include only upfront costs. Do not include costs associated with operation of the microgrid.

Initial Planning and Design Costs ($)	What cost components are included in this figure?
1,840,374	Planning and design, development, financing fees

Fixed O&M Costs

11. Fixed O&M costs are costs associated with operating and maintaining the microgrid that are unlikely to vary with the amount of energy the system produces each year (e.g., software licenses, technical support). Will there be any year-to-year variation in these costs for other reasons (e.g., due to maintenance cycles)?

☒ No – proceed to Question 12

☐ Yes – proceed to Question 13

12. Please estimate any costs associated with operating and maintaining the microgrid that are unlikely to vary with the amount of energy the system produces each year.

Fixed O&M Costs ($/year)	What cost components are included in this figure?
121,060	Generator FOM, including Insurance, outside services, software license upgrades and annual testing, site lease, management fee; does not include property taxes

Please proceed to Question 14.

13. For each year over an assumed 20-year operating life, please estimate any costs associated with operating and maintaining the microgrid that are unlikely to vary with the amount of energy the system produces.

Year	Fixed O&M Cost ($)	What cost components are included in this figure?
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

Year	Fixed O&M Cost ($)	What cost components are included in this figure?
20		

Variable O&M Costs (Excluding Fuel Costs)

14. Please estimate any costs associated with operating and maintaining the microgrid (excluding fuel costs) that are likely to vary with the amount of energy the system produces each year. Please estimate these costs per unit of energy produced (e.g., $/MWh).

Variable O&M Costs ($/Unit of Energy Produced)	Unit	What cost components are included in this figure?
0	$/MWh	Solar installations at elementary school and high school and storage system
19	$/MWh	CHP installation at Southampton Hospital
17	$/MWh	Natural Gas Generation at DPW
21	$/MWh	Natural Gas/Diesel generation at Southampton Hospital
21	$/MWh	Natural Gas Generation at High School and Police Station

Fuel Costs

15. In the table below, please provide information on the fuel use for each distributed energy resource the microgrid will incorporate. Please use the same distributed energy resource and facility names from Question 2.

- **Duration of design event:** For each distributed energy resource, please indicate the maximum period of time in days that the distributed energy resource would be able to operate in islanded mode without replenishing its fuel supply (i.e., the duration of the maximum power outage event for which the system is designed). **For renewable energy resources, your answer may be "indefinitely."**
- **Fuel consumption:** For each distributed energy resource that requires fuel, please specify the quantity of fuel the resource would consume if operated in islanded mode for the assumed duration of the design event.

Distributed Energy Resource Name	Facility Name	Duration of Design Event (Days)	Quantity of Fuel Needed to Operate in Islanded Mode for Duration of Design Event	Unit
Backup Generator 1 – Diesel	Hospital	7	207	MMBtu

Backup Generator 2 – Diesel	Hospital	7	230	MMBtu
CHP	Hospital	7	1,786	MMBtu
2000 kW Unit	DPW	7	2,694	MMBtu
Backup Generator	High School	7	171	MMBtu
Backup Generator	Police Dep.	7	306	MMBtu
PV 1	High School	Indefinite	N/A	N/A
PV 2	High School	Indefinite	N/A	N/A
PV	Elementary School	Indefinite	N/A	N/A

16. Will the project include development of a combined heat and power (CHP) system?

☒ Yes – proceed to Question 17

☐ No – proceed to Question 18

17. If the microgrid will include development of a CHP system, please indicate the type of fuel that will be offset by use of the new CHP system and the annual energy savings (relative to the current heating system) that the new system is expected to provide.

Type of Fuel Offset by New CHP System	Annual Energy Savings Relative to Current Heating System	Unit
Natural gas	44,762	MMBtu
Electricity (by CCHP Absorption Chiller)	373.34	MWh

Note:

The Combined Cool & Heat & Power (CCHP) unit is equipped with a 289 kW equivalent absorption chiller.

Absorption Chiller saves 373.34 MWh of electricity, if same cooling load was provided by a central chiller, i.e., the 373.34 MWh is the Electric Cooling Load Offset by absorption chiller which is powered by the recovered heat from CCHP.

Emissions Control Costs

18. We anticipate that the costs of installing and operating emissions control equipment will be incorporated into the capital and O&M cost estimates you provided in response to the

questions above. If this is not the case, please estimate these costs, noting what cost components are included in these estimates. For capital costs, please also estimate the engineering lifespan of each component.

Cost Category	Costs ($)	Description of Component(s)	Component Lifespan(s) (round to nearest year)
Capital Costs ($)	0		
Annual O&M Costs ($/MWh)	0		▨
Other Annual Costs ($/Year)	0		▨

19. Will environmental regulations mandate the purchase of emissions allowances for the microgrid (for example, due to system size thresholds)?

☐ Yes

☒ No

D. Environmental Impacts

20. For each pollutant listed below, what is the estimated emissions rate (e.g., tons/MWh) for the microgrid?

Emissions Type	Emissions per MWh	Unit
CO_2	0.46	Short tons per MWH
SO_2	0.0000063	Short tons per MWH
NO_x	0.	Short tons per MWH
PM	0	Short tons per MWH
Note: NOX emissions controls provided		

E. Ancillary Services

21. Will the microgrid be designed to provide any of the following ancillary services? If so, we may contact you for additional information.

Ancillary Service	Yes	No
Frequency or Real Power Support	☒	☐
Voltage or Reactive Power Support	☒	☐

Black Start or System Restoration Support	☒	☐

F. Power Quality and Reliability

22. Will the microgrid improve power quality for the facilities it serves? YES

☒ Yes – proceed to Question 23

☐ No – proceed to Question 24

23. If the microgrid will result in power quality improvements, how many power quality events (e.g., voltage sags, swells, momentary outages) will the microgrid avoid each year, on average? Please also indicate which facilities will experience these improvements.

Number of Power Quality Events Avoided Each Year	**Which facilities will experience these improvements?**
3	All facilities in the microgrid

24. The benefit-cost analysis model will characterize the potential reliability benefits of a microgrid based, in part, on standard estimates of the frequency and duration of power outages for the local utility. In the table below, please estimate your local utility's average **outage frequency per customer** (system average interruption frequency index, or SAIFI, in events per customer per year) and average **outage duration per customer** (customer average interruption duration index, or CAIDI, in hours per event per customer).

For reference, the values cited in the Department of Public Service's 2014 Electric Reliability Performance Report are provided on the following page. If your project would be located in an area served by one of the utilities listed, please use the values given for that utility. If your project would be located in an area served by a utility that is not listed, please provide your best estimate of SAIFI and CAIDI values for the utility that serves your area. In developing your estimate, please *exclude* outages caused by major storms (a major storm is defined as any storm which causes service interruptions of at least 10 percent of customers in an operating area, and/or interruptions with duration of 24 hours or more). This will ensure that your estimates are consistent with those provided for the utilities listed on the following page.[1]

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[1] The DPS service interruption reporting system specifies 10 cause categories: major storms; tree contacts; overloads; operating errors; equipment failures; accidents; prearranged interruptions; customers equipment; lightning; and unknown (there are an additional seven cause codes used exclusively for Con Edison's underground network system). SAIFI and CAIDI 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. The BCA model treats the benefits of averting lengthy outages caused by major storms as a separate category; therefore, the analysis of reliability benefits focuses on the effect of a microgrid on SAIFI and CAIDI values that exclude outages caused by major storms.

Estimated SAIFI	Estimated CAIDI
0.76	1.42

SAIFI and CAIDI Values for 2014, as reported by DPS

Utility	SAIFI (events per year per customer)	CAIDI (hours per event per customer)
Central Hudson Gas & Electric	1.62	3.74
Consolidated Edison	0.11	3.09
PSEG Long Island	0.76	1.42
National Grid	1.17	2.87
New York State Electric & Gas	1.34	2.97
Orange & Rockland	1.19	2.40
Rochester Gas & Electric	0.85	2.32
Statewide	*0.68*	*2.70*
Source: New York State Department of Public Service, Electric Distribution Systems Office of Electric, Gas, and Water. June 2015. 2014 Electric Reliability Performance Report, accessed at: http://www3.dps.ny.gov/W/PSCWeb.nsf/All/D82A200687D96D3985257687006F39CA?OpenDocument.		

G. Other Information

25. If you would like to include any other information on the proposed microgrid, please provide it here.