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Notice

SourceOne
Energy Solutions

Ithaca Microgrid
NY Prize Stage I
Feasibility Assessment

PREPARED FOR:

PREPARED BY:

SourceOne, Inc.
A Veolia Energy Company

53 State Street
Boston, MA 02109
Phone: (617) 399-6100
www.sourceone-energy.com

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1. Executive Summary

The New York State Energy Research and Development Authority (NYSERDA) awarded the City of Ithaca (the "City") funding for the first of the three-staged NY Prize program, and the City has retained SourceOne as its lead contractor for the project. The NY Prize is a first-in-the nation $40 million competition to help communities create microgrids—standalone energy systems that can operate independently in the event of a power outage. NY Prize offers support for feasibility studies (Stage 1), audit-grade engineering design and business planning (Stage 2), and project build-out and post-operational monitoring (Stage 3). Applications will be judged against program requirements at each stage of the competition for which funding is being requested. Cost sharing will be required for Stage 2 and Stage 3 of the competition.

In its request for proposal for the Stage 1 NY Prize, the City identified high-level concepts for a microgrid that involve two separate energy districts within the city: the North Energy District (NED) and the South Energy District (SED). These energy districts, according to the NY Prize definition, would qualify as microgrids because they contain a minimum of one critical facility and have both supply and demand resources capable of connecting and disconnecting from the electric utility (otherwise referred to as the macrogrid). Based on NYSEG's response to the feasibility of a microgrid concept in the South Energy District and per direction of NYSERDA, this report focuses only on the North Energy District.

The proposed microgrid in the NED will be located at the Ithaca Area Waste Water Treatment Facility (IAWWTF). Utilizing standard industry-proven equipment and existing utility operating procedures, the proposed project modifies New York State Electric and Gas (NYSEG) infrastructure with new load-break switches to isolate certain sections of the distribution system while supplying 100% of the power requirements to all critical and non-critical facilities in the microgrid. The microgrid will combine traditional emergency generator power systems with several unique low-carbon generating assets including microturbines and reciprocating engines powered by anaerobic digester gas (ADG) in a combined heat and power (CHP) arrangement. Solar photovoltaic (PV) arrays will also be used during normal operation but would not be used during an isolated microgrid event as they do not provide firm power. Recovered thermal energy from the CHP plant will be delivered to end users through a district energy system where it is used to offset NYSEG natural gas from the Marcellus shale. The proposed system is scalable and can be developed in phases to serve existing loads as well as new loads which are developing in and around the Cayuga Lake waterfront.

The combination of the unique expansion of the existing low-carbon ADG (produced with sewage and food waste), renewable energy, and efficient combined heat and power district energy system allows the IAWWTF to be the microgrid hub during electric utility emergencies while simultaneously becoming a net exporter of energy during normal grid operations.

The proposed Ithaca microgrid represents a unique opportunity that would be a model for other communities within New York State, throughout the northeast, and potentially nationwide. As this feasibility study came to completion, numerous benefits became apparent making this site unique in its potential as a model site for a community microgrid. The exceptional benefits which could be realized with this project are summarized as follows:

- The proposed distributed generation assets for this site are either low carbon, no carbon or carbon neutral. No fossil fuel based generation is proposed. Further carbon reductions are realized by utilizing energy recovery from the combustion of ADG. This will set the stage for the development of the waterfront area (in the current Ithaca master plan) based on a carbon neutral platform that does not require procurement of offsets (credits).
- Ithaca is an intellectual hub and an environmentally progressive community which has the energy and academic resources to fully optimize this project and to optimize the information transfer necessary for replication in other communities. After speaking with several professors and program leaders, they stated that this community microgrid would be integrated into the sustainable energy academic programs at Cornell University and Ithaca College.
- Ithaca has significant interest for a community based solar farm whereby local residents, who do not have space for PV arrays, can support renewable energy through their utility bills. The concept of a community solar farm would allow participants to better realize the benefit of the renewable energy resource they are supporting and own a tangible asset.
- More broadly, if this project moves forward, there is significant local support for creating a "community carbon cycle" whereby food-scraps from locally grown produce would be collected to provide the raw material for production of additional ADG fuel. Recovered heat would be utilized to operate the drying process for residual solids from the digester which would then be returned to the growers as a soil amendment. The result would be locally sourced renewable fuel that reduces landfill waste and handling impacts. A microgrid project in Ithaca could easily become the catalyst for a national model demonstrating community level sustainable practices.
- Ithaca is the selected community for the NYSEG Community Energy Coordination (CEC) demonstration project in compliance with PSC Track One Order for Case 14-M-0101, Reforming the Energy Vision. This project is a natural fit for garnering the full support of NYSEG to further develop a community microgrid and to showcase a successful demonstration project.

This report accomplishes three main tasks:

1. Evaluation of the technical and financial feasibility of conceptual microgrid deployments in the North Energy District.
2. Fulfillment of the NY PRIZE Stage 1 feasibility study requirements.
3. Establishment of the project's basis of design for subsequent development efforts or NY Prize program participation.

In support of the goals of the NY Prize program, this study focuses on city facilities that offer resources deemed as critical during an electric utility emergency/outage, including wastewater treatment, public works, public transportation, and places of refuge. However, other private facilities were considered for inclusion in the proposed microgrid. These private facilities were included because of locational advantages, existing electrical distribution configurations, the community value of a large-scale fully-powered place of refuge, the ability to efficiently serve future planned development, and the ability to maximize the effective use of low-carbon ADG power and recovered thermal energy products.

The City initially provided a list of over eighteen facilities to evaluate for inclusion in the microgrid. After receiving information from NYSEG and developing infrastructure survey maps, some facilities were dropped and additional facilities were added. The table below lists the final facilities that are included in the microgrid along with a summary of the existing loads and proposed generation for each facility.

Facility	Peak Load kW	Existing Generation kW	Proposed Generation kW
Ithaca Area Wastewater Treatment Facility	778	1,018	985
High School and Admin Complex	575	300	-
Tompkins Consolidated Area Transit (TCAT)	174	-	-
Department of Public Works (Streets & Facilities)	78	150	-
Balance of Feeder 783 Boatyard & Boat Center* Hydroponics Shop* Golf course* Church* 40 Residential Units*	200	-	-
Individual totals	**1,805**	**1,468**	**985**
The coincident peak load	**1,453**	Total Generation	**2,453**
**These are not critical facilities and were not part of the City's initial list. However, they are included by virtue of existing NYSEG distribution configuration.*			

Table 1: Microgrid Load and Generation Summary

The project's technical and financial feasibility constraints were mainly driven by how the facilities are connected through NYSEG's existing distribution infrastructure and the existing prices of electric and natural gas service. Based on the premise that new generation should be cost effective during normal macrogrid operation, current biogas production constraints at the IAWWTF and the lack of nearby thermal and electric loads limited the total installed electrical capacity of the project. The peak load of the microgrid is therefore limited by the amount of cost effective generation that can be installed. The proposed project uses existing NYSEG regulations, interconnect requirements, and tariff structures to govern the value of the power generated by the microgrid during normal electric utility operation and can be expanded with future increases in biogas production.

SourceOne evaluated several deployment configurations to determine the optimum scenario for the City and have selected five options to include in this study, with the top option presented as the most feasible. The evaluation process included energy load profile applicability, critical operational needs, existing electrical distribution infrastructure, electric distribution system constraints, geographical constraints for district heating, and overall compliance with the goals and objectives of the New York's Prize and Reforming the Energy Vision (REV).

The following illustration provides an overall context of the major energy flows and how they connect in the proposed microgrid.

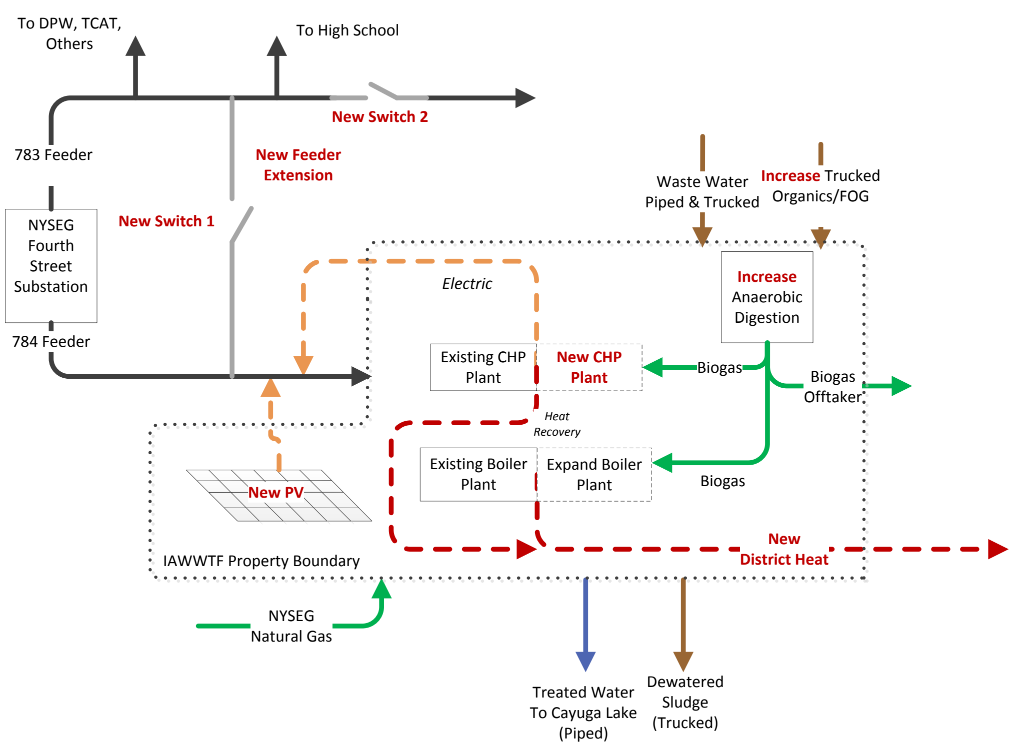

Figure 1: NED Microgrid Conceptual Energy Flows

SourceOne has constructed indicative project proformas for each of the five scenarios evaluated. These scenarios have configurations ranging from electric-only generation to an integrated combined heat and power with district energy deployment. Additional details on the scenarios evaluated can be found in Section 4.2.

In addition to SourceOne's project level benefit cost and proforma analysis, a benefit cost analysis was conducted by NYSERDA. More information on this analysis can be found in Section 6: Benefit

Cost Analysis (NYSERDA Task 4) and through the New York State Public Service Commission (NYPSC) order establishing the benefit cost analysis framework[1]. This benefit cost analysis utilizes inputs and assumptions that may differ from those that would be used by project investors or developers or others involved in making investment decisions relative to the concepts presented. As for SourceOne's technical and financial analysis, Appendix C: Technical, Financial & Operational Summary contains a summary of the key inputs and assumptions used to develop the preliminary technical and financial feasibility of the concepts presented in this study.

The following table provides a summary of deployment scenarios evaluated in this study.

Scenario Parameter	Units	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Prime Mover		Duel Fueled Natural Gas/Biogas Reciprocating Engine				
Prime Mover Location		IAWWTF	IAWWTF	High School	IAWWTF	IAWWTF
Electric Revenue Source		Net Meter w/ Export at Wholesale Rate				Net Meter w/ Export at Retail Rate
Heat Recovery / Distribution		None	IAWWTF & High School	High School	IAWWTF & Waterfront	IAWWTF & Waterfront
PV Location		IAWWTF				
Project Life	Yrs.	20				
WACC	%	5%				
New ADG Expansion	MMBTU/Yr	41,230				
New ADG Generation Capacity	KW	550				
ADG CHP System Cost	$	$1,709,500	$1,839,500	$2,567,500	$1,839,500	$1,839,500
Available Heat Recovery	MMBTU/Yr	0	12,509			
District Energy System Cost	$	$0	$2,470,000	$260,000	$910,000	$910,000
PV System Capacity	KW	435				
PV System Cost	$	$1,400,000				
Microgrid System Infrastructure Cost	$	$1,222,650				
Total Project Cost	$	$4,250,331	$6,850,331	$5,368,331	$5,290,331	$5,290,331
Year 1 Value of Electricity Generated	$	$429,886	$429,886	$452,204	$429,886	$487,931
Year 1 Value of Heat Recovered	$	$0	$106,474	$110,882	$66,803	$154,962

[1] NYS PSC CASE 14-M-0101 - Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision. Order Establishing the Benefit Cost Analysis Framework.

Scenario Parameter	Units	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Year 1 Operating Costs	$	$342,242	$355,369	$350,369	$355,369	$355,369
Year 1 Cash Flow	$	$87,644	$180,991	$212,717	$141,320	$287,524
Net Present Value	$	-$2,358,690	-$3,162,414	-$629,133	-$1,617,765	-$149,874
Required Incentive for Zero NPV	$	$2,470,514	$3,314,544	$654,599	$1,692,662	$151,377

Table 2: Summary of Microgrid Scenarios

1.1. Preferred Microgrid Solution

Final deployment configuration selection was based on project level financial metrics including net present value (NPV), internal rate of return (IRR), and return on investment (ROI), as well as overall constructability and anticipated developments occurring on the waterfront. Siting the proposed CHP plant at the IAWWTF and recovering the available heat for immediate use at the IAWWTF with thermal loads developing at the nearby waterfront in Year Six of the project proved to be the most attractive combination of these criteria. The proposed project is scalable and project financial performance will improve should the new development loads materialize sooner than Year Six.

This scenario (referenced as “Scenario 4” throughout the rest of this report) is expected to cost $5.2 million and yields a negative NPV of $1.6 million without financial incentive through the NY Prize or other funding mechanisms. The table below illustrates the project’s financial performance with and without the incentive to get the project to a zero net present value.

Scenario #4	Capital Cost	Simple Payback Yr	ROI	IRR	NPV
Without Incentive	$5,290,331	19	17%	1%	-$1,617,765
With Zero NPV Incentive	$3,597,699	15	90%	5%	$0

Table 3: Financial Analysis of Preferred Microgrid – Minimum Incentive

Although Stage 2 and 3 funding could theoretically cover the entire project cost, there is a 25% cost share requirement. Taking the cost share into account and assuming the project receives the full funding amounts for Stage 2 and 3 of the NY Prize, for a total award of $3,967,748, the project’s financial performance would be as follows:

Scenario #4	Capital Cost	Simple Payback Yr	ROI	IRR	NPV
With Maximum Incentive	$1,322,583	8	428%	18%	$2,020,335

Table 4: Financial Analysis of Preferred Microgrid – Maximum Incentive

1.2. Findings and Recommendations

1. The NED has direct and immediate opportunity for continued involvement in the NY Prize program. SourceOne recommends a thorough review of all applicable federal, state and local incentive and grant programs to determine the most cost effective approach for the City to further develop the NED microgrid and continue with the NY Prize program.

2. The City should hold a meeting with project stakeholders to determine a strategy for applying for subsequent stages of the NY Prize. In particular, SourceOne recommends developing a single strategy for project delivery and implementation so that NYSERDA has a clear understanding of how this project will be implemented. SourceOne has provided additional context in Section 5.4: Commercial Viability - Project Team (NYSERDA Task 3.3).

3. The IAWWTF has already demonstrated the successful operation of anaerobic digester to electricity technology using a microturbine-based CHP system. IAWWTF is planning on additional anaerobic gas production by way of expanding existing digester capacity, modifying its sludge handling process, and increasing the amount of trucked in digester feedstock. SourceOne has assumed that an increase in digester capacity is feasible based on the results of a separate study commissioned by the IAWWTF. As such the results of this study are predicated on the IAWWTF providing gas in the quality and quantity indicated in this report.

4. All scenarios presented under the NY Prize program will require a strong partnership with NYSEG to co-develop and implement the microgrid solutions presented. This is imperative because the design involves reconfiguring NYSEG distribution feeders during macrogrid outages. SourceOne recommends conducting a review meeting with NYSEG to inform the application process for Stage 2 and 3.

5. All scenarios are cash flow positive within the first year of operation. However, due to large infrastructure investment requirements, incentive money is required to yield a positive net present value. If the project advances through the next stage of the NY Prize program, available funding will provide the project with a positive net present value.

6. Expanding biogas production and scaling existing combined heat and power operations is cost effective and should be pursued regardless of continued NY Prize or microgrid project status.

7. Future developments within the proposed microgrid territory, namely the development adjacent to the IAWWTF known as the Cayuga Lake Inlet could feasibly be added to the microgrid. SourceOne recommends this development be served with

a new cost effective natural gas CHP plant coupled with district energy from the biogas CHP plant proposed as part of this study. It is recommended that consideration be given to including these new development loads in subsequent project development efforts.

8. All of the proposed changes to NYSEG's distribution system will be managed, owned, and operated through NYSEG's existing standard operating procedures. Project stakeholders should work with NYSEG staff to develop detailed operating requirements of the microgrid under both normal and emergency conditions.

9. Project benefits would increase if the biogas based generation could qualify as a net metered facility under NY PSL § 66-j. This would effectively value all generation at the retail rate as opposed to exporting a fraction of the generation through NYSEG's wholesale buy back tariff (refer to Scenario #5). Project stakeholders should further evaluate the most applicable NYSEG tariffs for the microgrid, such as the recently announced Community DG tariff that has been developed under REV.

10. All facilities in the microgrid should request access to NYSEG's "Energy Profiler Online" so that more detailed consumption data can be captured. Using this existing energy management system to aggregate microgrid consumption data and provide utility and consumer access will help establish buy in from the various facilities within the microgrid as well as advance the design and development of the project.

11. The project should leverage the fact that NYSEG has already proposed to the New York State Public Service Commission (NYPSC) that Tompkins County serve as a demonstration project under the REV proceedings. The proposed microgrid project has direct synergies with the concepts put forth by NYSEG in their January 4, 2016 report titled "Reforming the Energy Vision Demonstration Project Assessment Report Iberdrola, USA: Community Energy Coordination".

12. The facilities included in the study have a variety of energy procurement strategies in place, ranging from NYSEG-supplied electricity and natural gas to various third party supplier agreements. For purposes of this study actual costs incurred at the IAWWTF in 2015 were used to establish a reference year with retail delivered electricity and natural gas costs of $91/MWh and $6.61/MMBTU, respectively. For purposes of valuing excess generation delivered from the project to NYSEG's system, a wholesale buyback rate of $62/MWh was used for the baseline year. Both SourceOne commodity forecasts and NYSERDA's benefit cost forecasts can be found in Appendix E.

13. SourceOne recommends further evaluation of additional heat loads through sludge drying during subsequent phases of development. Finding thermal loads located closer to the proposed heat recovery system will increase financial benefits to the project.

1.3. Report Structure and Organization

As stated previously, this report has been organized to accomplish three main tasks:

1. Evaluate the technical and financial feasibility of conceptual microgrid deployments in the North Energy District.
2. Fulfill the NY PRIZE Stage 1 feasibility study requirements
3. Establish of the project's basis of design for subsequent development efforts or NY Prize program participation.

Some of the content may be repeated and may be addressed in multiple sections of the report due to the organizational structure, contents and requirements of NYSERDA's NY Prize requirements document.

2. INTRODUCTION TO PROPOSED MICROGRID AND EXISTING INFRASTRUCTURE

As defined in the NY Prize Grid Competition RFP 3044, Attachment C, microgrids rely on a combination of Demand-side Resources (DR) (i.e. resources such as energy efficiency or curtailable load that impact how energy is consumed) and Distributed Generation resources (DG) (i.e. resources that produce energy). For the purposes of the NY Prize competition, these collectively are considered Distributed Energy Resources or DER as defined below[2]:

2.1. Distributed Energy Resources (DER) Definitions

2.1.1. *Demand-side resources*

Demand-side resources are those that affect how and when energy is consumed within the microgrid. Most commonly, these will include intelligent energy management systems and energy efficiency investments. Intelligent energy management technologies are systems that monitor and control electricity consumption in real time. These technologies allow the operator of the microgrid to reduce demand for either practical reasons (such as the microgrid islanding and needing to curtail consumption to match local generation) or in response to economic incentives (such as the microgrid's participation in a demand response program).

2.1.2. *Supply-side resources*

Supply-side resources affect energy production within a microgrid. The most common are distributed generators (DG). DG encompasses a wide range of generation technologies, including gas turbines, solar electric (photovoltaic or PV), wind turbines, fuel cells, biomass, and small hydroelectric generators.

DG units that use conventional fuel-burning engines may be designed to operate as combined heat and power (CHP) systems that are capable of providing heat for buildings or industrial processes using the "waste" energy from electricity generation. Some of the key attributes for microgrid developers to consider when choosing between types of DG to install in a microgrid include the intermittency of the generator's output (e.g. solar panels produce power only "intermittently," when the sun is shining), whether it is renewable or non-renewable, its location, its size, its relationship with the conventional electric grid, and its operating regime.

A microgrid is defined by the U.S. Department of Energy as a group of interconnected loads and distributed energy resources (DER) with clearly defined electrical boundaries that acts as a single,

[2] NY Prize Grid Competition RFP 3044, Attachment C

controllable entity with respect to the grid and can connect and disconnect from the grid to enable it to operate in both grid-connected or island mode.

The proposed microgrid for Ithaca is referred to as a partial feeder microgrid as further illustrated in the following figure from the US Department of Energy.

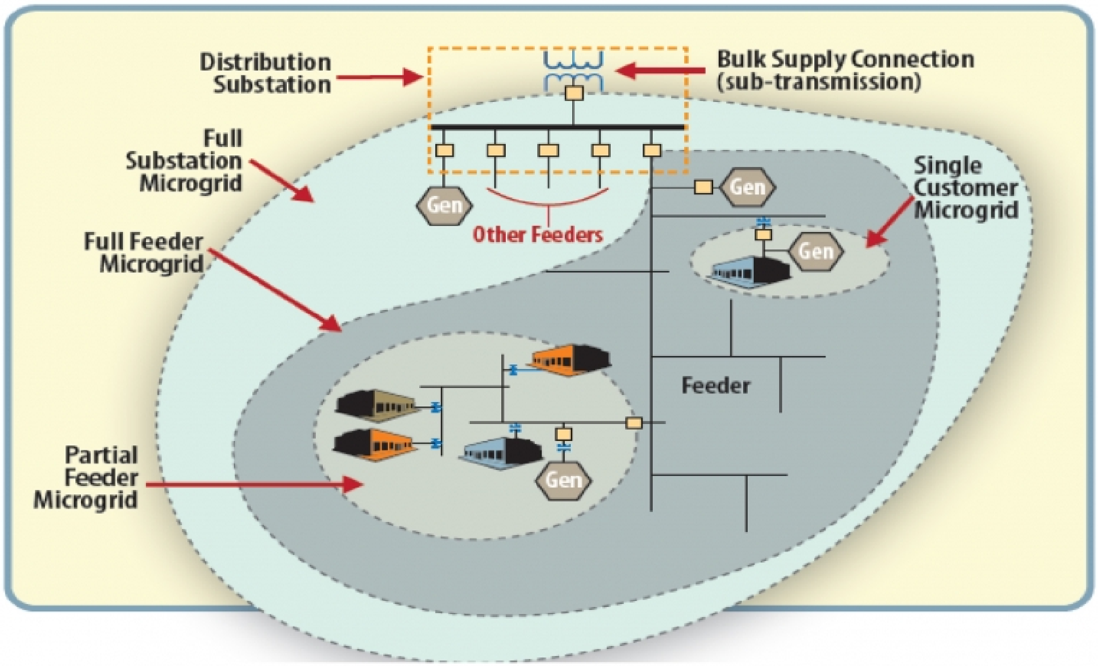

Figure 2: Types of Microgrids[3]

2.2. Existing Infrastructure Summary

2.2.1. *Electric*

Electricity is delivered to Ithaca through multiple 115-kV transmission lines which are fed by a 345-kV transmission network east of Ithaca, both of which are owned and operated by Iberdrola, SA. NYSEG, a subsidiary of Iberdrola, delivers power from the 115-kV transmission system throughout the city through its underground and overhead distribution system which ranges from 5 kV to 34.5 kV.

NYSEG owns and operates four substations which serve the City. The facilities evaluated in this study are served from the Fourth Street substation.

[3] US Department of Energy: Office of Electricity Delivery and Energy Reliability

2.2.2. *Natural Gas*

Natural gas is delivered to Ithaca through the high pressure interstate gas transmission system owned by Dominion Resources, Inc. This pipeline transports gas to what is referred to as the city gate station, whereby NYSEG takes delivery of the gas and distributes it throughout the city. The city gate station is located east of Route 96 B, north of Ithaca College, and next to the former Emerson Plant.

2.3. Critical Facilities and Places of Refuge in Proposed Microgrid

According to the NY Prize program requirements, community microgrids eligible to receive NY Prize awards must involve at least one facility that provides a critical service to the public (i.e. critical facility). The proposed microgrid has four critical facilities, the IAWWTF, Ithaca High School, the Tompkins Consolidated Area Transit (TCAT) garage (public transportation), and the City of Ithaca Department of Public Works Streets and Facilities (DPW). In times of emergency the microgrid will provide full load power requirements for all of these critical facilities as well as several commercial establishments which could potentially serve as places of refuge during an emergency. Further investigation is required to determine the feasibility of and logistics involved with allowing the general public to use privately owned facilities during times of emergencies and electric utility outages.

3. Summary of Microgrid Capabilities (NYSERDA Task 1)

3.1. Introduction

The IAWWTF will be the anchor load and host for the NED microgrid. The IAWWTF is designed to treat thirteen million gallons of wastewater per day and discharges its effluent into Cayuga Lake. It treats wastewater from the City of Ithaca, the Town of Ithaca, and the Town of Dryden. It also accepts trucked waste from a number of other sources, including a growing tonnage of local food and agricultural waste. Going forward the increase in trucked waste will enable additional biogas production.

The microgrid for the NED will combine the existing four 65-kW ADG-powered microturbine CHP systems, 7.5-kW solar PV array, and 750-kW diesel emergency generator with additional generation capacity. Additional new capacity will include the installation of an additional 435 kW of solar PV and 550 kW of dual fuel (ADG and natural gas) reciprocating engine CHP. Heat recovery through a small and scalable district energy system will immediately offset the IAWWTF's natural gas purchases and may serve a neighboring new development during later phases of the project. The total generation proposed to be active in the microgrid is 2,003 kW, which excludes emergency generation at the high school and the DPW. The proposed microgrid operation does not require the existing non-parallel emergency generators at the high school or DPW because the coincident load for all facilities within the microgrid is only 1,453 kW. New generation as part of this project totals 985 kW, of which 550 kW is dispatchable and the remaining 435 kW is subject to solar radiation. The new generation, plus the existing microturbines and emergency generator at the IAWWTF provide 1,560 KW of dispatchable generation to serve the microgrid loads.

The control and protection system will allow for flexible dispatch to accommodate economic operation during grid normal conditions and to comply with all applicable NYSEG interconnect requirements. NYSEG's existing distribution system will be utilized to export power during times when generation exceeds loads. It is anticipated that approximately 50% (2,500 MWh) of the total new generation capacity will be exported into NYSEG's system on an annual basis under normal grid conditions. Under emergency grid conditions, the electrical distribution system will be reconfigured by NYSEG under standard operating procedures to provide power to the loads on circuits 783 and 784 as listed in Table 1 above.

There are notable critical facilities in the microgrid which provide crucial services to the community. The IAWWTF provides water treatment for 40,000 residents; Ithaca High School will serve as a large scale place of refuge; the TCAT provides mass transportation services; the DPW provides critical infrastructure services to the city. The proposed microgrid will provide 100% power to these facilities during electric utility outages.

3.2. NED Future Loads

The area between the IAWWTF and the waterfront is expected to be redeveloped into a variety of mixed use facilities. Due to the unknown nature of the development cycle and ultimate end use typology, this study makes two assumptions relative to the deployment scenarios for the NED microgrid. The firsts assumption is that additional electrical and thermal load will be added to the area, above what is already being supplied by NYSEG to the existing facilities. The next assumption is that the heating loads of the new facilities could be served by thermal energy from the microgrid and are assumed to materialize in the out years of the initial operation of the microgrid. Based on a cursory review of publicly available information pertaining to the waterfront redevelopment, SourceOne has determined that a range of 6,000 to 14,000 square feet of commercial space with up to 130 residential units and the potential for a new 124 room hotel are slated to be developed right next to the IAWWTF.

It is recommended that additional evaluation be conducted as soon as details on end use typology and square footage become available. SourceOne recommends that new developments tie into the microgrid electrical or thermal distribution network. This will allow the energy requirements of the development to be cost effectively served through a scaled approach to CHP and district energy while allowing the microgrid project to move forward.

The following figure illustrates some proposed concepts for the new development. Note the grey building in the top right corner of each figure is the IAWWTF.

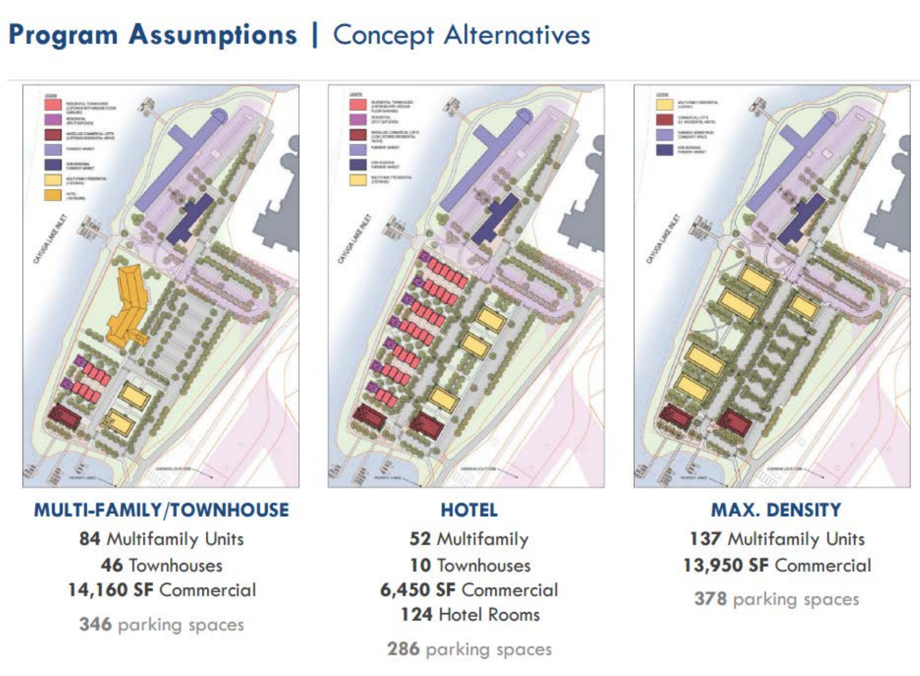

Figure 3: Proposed New Development Concepts

3.3. Residential Engagement in Microgrid

The proposed concept of utilizing NYSEG's existing distribution system as part of the microgrid presents both opportunities and challenges with respect to the residential loads that are fed from feeder 784. In the event this project moves forward, NYSEG could potentially reach out to these customers and engage them with smart grid initiatives under the current REV construct in a way that links their participation in the microgrid. Although the details of this are beyond the scope of this project, SourceOne recognizes the importance of garnering the support of the City residents that will be impacted by the proposed microgrid and how that support ties into other NYSEG initiatives such as their Community Energy Coordination project. Based on a public property records, a preliminarily list of property owners whose facilities/homes may be fed off the 784 feeder and associated microgrid can be found in Appendix G: Property Owners Included in Microgrid. The list of property owners was compiled from publically available information made available through Tompkins County GIS Division.

3.4. Minimum Required Capabilities (NYSERDA Task 1.1)

The microgrid will incorporate the minimum required capabilities, as called for under Task 1.1 of NYSERDA's NY Prize requirements document Attachment C: Scope of Work.

3.4.1. *Microgrid Fuel*

The proposed prime movers will be primarily fueled by anaerobic digester gas with natural gas as a backup in the event of a process interruption. The production of biogas will remain operational during an electric utility grid emergency as the existing 750-kW emergency diesel generator and the existing microturbine-based CHP system are configured to provide power and heat to support the anaerobic digestion process. Although trucked in fats, oils, grease (FOG) and other organic matter may be disrupted in the event of a natural disaster, the gravity fed influent portion of the waste water treatment facility will provide adequate supply to the digesters to sustain the methane production process. Specific quantities of methane production during a natural disaster will need to be determined during the design development phase of the project and incorporated into operational and contingency planning protocols.

In addition to anaerobic digester methane production, a significant fuel supply depot is located only 1,500 feet from the IAWWTF and could serve as a primary supply source for the diesel generators in the event of a prolonged digester fuel interruption.

3.4.2. *Microgrid Generation Technology*

Proposed generation includes microturbine CHP, reciprocating engine CHP, power only emergency generators, and solar PV. All generating assets will be capable of providing power in both grid-connected and island modes of operation. The proposed reciprocating engines will be black start capable. The existing 750-kW diesel emergency generator is currently operated via an automatic transfer switch (ATS). The microturbine system has an induction generator and requires utility voltage to operate as is not a synchronous machine. The proposed system will reconfigure the microturbine system to allow for black start capability, adding to the reliability of the treatment plant and the facilities served by the microgrid. NYSEG's distribution will be modified to include switching on certain feeders during a macrogrid outage. All switching equipment on NYSEG's system would be specified, installed, owned, operated, and maintained by NYSEG in accordance with their standard operating procedures.

3.4.3. *Islanding Capabilities*

The new generation will be capable of forming an intentional island (i.e. the microgrid) in the event of an electric utility outage and at a minimum be capable of self-supplying 100% of its energy requirements. Switching between the microgrid and the normal utility supply will be a manual, coordinated effort between NYSEG and IAWWTF staff.

3.4.4. *Maintenance and Reliability*

All of the equipment proposed as part of the microgrid will comply with manufacturers' requirements for scheduled maintenance intervals so as to maintain reliability and to uphold the financial performance of the project. The proposed system includes 435 kW of solar PV. However, this capacity is not required to meet the peak load of the microgrid, making the system that much more reliable because all generation is dispatchable. Under normal conditions, the PV system will be paired with the dispatchable generation resources to allow 24/7 use of the power produced by these resources.

3.4.5. *Generator Control and Protection*

All rotating machines and any PV arrays will be capable of maintaining voltage and frequency while connected to the grid and maintain all standards in accordance with ANSI c84-1 while operating in island mode.

Pending additional information and collaboration with NYSEG, the most applicable communication system will be adopted for the control and protection of the microgrid, especially the portions that will be owned and operated by NYSEG. It is anticipated that NYSEG will have full view and control of the generating assets on the microgrid. Refer to Section 4.2 Microgrid for further details on the operations, control, and protection.

3.5. Preferred Capabilities (NYSERDA Task 1.2)

3.5.1. *Control Systems*

The control system will include an active network control system that optimizes demand, supply, and other network operation functions within the microgrid. Sufficient metering and or other SCADA will be part of the system such that load and generation can be monitored and/or controlled to allow for the most effective dispatch of supply and demand during both grid normal and grid emergency operations. The project will utilize an existing microgrid controller solution offered by Schweitzer, ABB, GE, or other manufacturer that is able to meet the project requirements.

3.5.2. *Energy Efficiency*

Energy efficiency options to minimize new microgrid generation requirements will be reviewed during design development of the project. IAWWTF has recently implemented a wide range of demand side projects to reduce their electrical load. As part of the next phase of development, all facilities proposed to be connected to the microgrid should take necessary action to fully qualify and quantify all cost effective demand side projects. This will simultaneously improve the microgrid's financial position while supporting the right-sizing of the generating assets within microgrid. The facilities should utilize all applicable NYSERDA programs and resources in their efforts to identify and optimize demand side solutions.

3.5.3. *Coordination with REV*

The project will coordinate with the Reforming the Energy Vision (REV) work to provide a platform for the delivery of innovative services to end use customers. This project can benefit from the fact that NYSEG is dedicating resources to Tompkins Country through its existing Community Energy Demonstration project.

SourceOne intends to coordinate this project with NYSEG's Ithaca region Energy Smart Community (ESC) project. The City may benefit from the various program elements planned by NYSEG, including a phased deployment of advanced Metering Infrastructure (AMI) and increased Distribution Automation (DA). According to NYSEG's May 20, 2015 testimony on the Reforming the Energy Vision, the program elements, whose budget is estimated at $15.5 million involve Integrated System Planning, Grid Automation and Communications, Volt/VAR Optimization, Customer Research and Engagement, Customer Communications Platform, Customer Web Portal, and Joint Partnership Development. The ESC Project is described in more detail in NYSEG's May 20, 2015 testimony on the Reforming the Energy Vision Panel.

In addition to coordinating with the ongoing REV work that NYESG is performing, the project could benefit from a change in the net metering definition for waste water biogas generation. This would allow the new biogas generators to qualify as part of the recent REV work whereby the utilities are now offering a Community Distributed Operating Agreement. According to NYSEG's Community Distributed Generation Operating Agreement, a CDG Host is a non-residential customer who owns or operates electric generating equipment eligible for net metering under New York Public Service

Law § 66-j or 66-l and whose net energy produced by its generating equipment is applied to accounts of other electric customers ("CDG Satellites") with which it has a contractual arrangement related to the disposition of net metering credits.

It is recommended to closely monitor net metering legislation to determine how the proposed digester gas CHP and PV generation (i.e. Microgrid Host Plant) might qualify as a net metered facility. In the event the Microgrid Host Plant is unable to qualify as a net metered facility through the Community Distributed Generation Operating Agreement and underlying Community Distributed Generation Tariff, the net output of the plant will then be sold through NYSEG's existing Buy Back Tariff Rate, which is represented as the wholesale power cost for NYISO Zone C.

3.5.4. *Comprehensive Benefit Cost Analysis*

SourceOne has developed a comprehensive benefit cost analysis that includes, but is not limited to, the community, utility and developer's perspective. Section 5: Assessment of Commercial and Financial Feasibility (NYSERDA Task 3), Appendix C, and Appendix D provide the results of project financial analysis using commodity forecasts developed by SourceOne and as well as those provided by NYSERDA a part of their benefit cost test.

3.5.5. *Clean Power*

To minimize its environmental impact the microgrid will utilize both solar PV as well as anaerobic digester gas generated from waste created by the community. The combination of these generating sources provides a unique opportunity to provide a resilient and reliable microgrid with low carbon sources and potentially create a one of a kind carbon neutral microgrid.

3.5.6. *Community Benefits*

Tangible community benefits, including redirecting a significant amount of food waste from local landfills and the associated delivery/hauling jobs which will be created as part of this project. Ithaca will also become one of the few net zero waste water treatment facilities in the country and stands the chance of being a role model for other facilities looking to create a clean powered microgrid.

Additional community benefits could be created by integrating microgrid participants with NYSEG programs such as peak load relief and system load reduction programs that are being evaluated as part of REV. Additional PV could also be installed on microgrid participant rooftops.

Ithaca is an intellectual hub and an environmentally progressive community. This community will have the energy and academic resources to fully optimize this installation and to optimize the information transfer necessary for replication in other communities. After speaking with several professor and program leaders, they stated that this community microgrid would be integrated into the sustainable energy academic programs at Cornell University and Ithaca College. Ithaca has significant interest for a community based solar farm whereby local residents, who do not have space for Solar PV arrays, can support renewable energy through their utility bills. The concept of a community solar farm would allow participants to better realize the benefit of the renewable energy resource they are supporting and own a tangible asset.

4. Preliminary Technical Design Costs and Configuration (NYSERDA Task 2)

4.1. *Project Siting Considerations*

The map below shows possible locations for the new biogas CHP plant and PV array as well as the new tie line (green) which connects the existing NYSEG distribution circuits to enable the microgrid during a macrogrid outage. Due to the preliminary nature of the project, these areas are shown for scale and concept only. Project stakeholders have identified other available parcels around the IAWWTF that could be used for the new biogas CHP plant, all of which will be identified during subsequent phases of development.

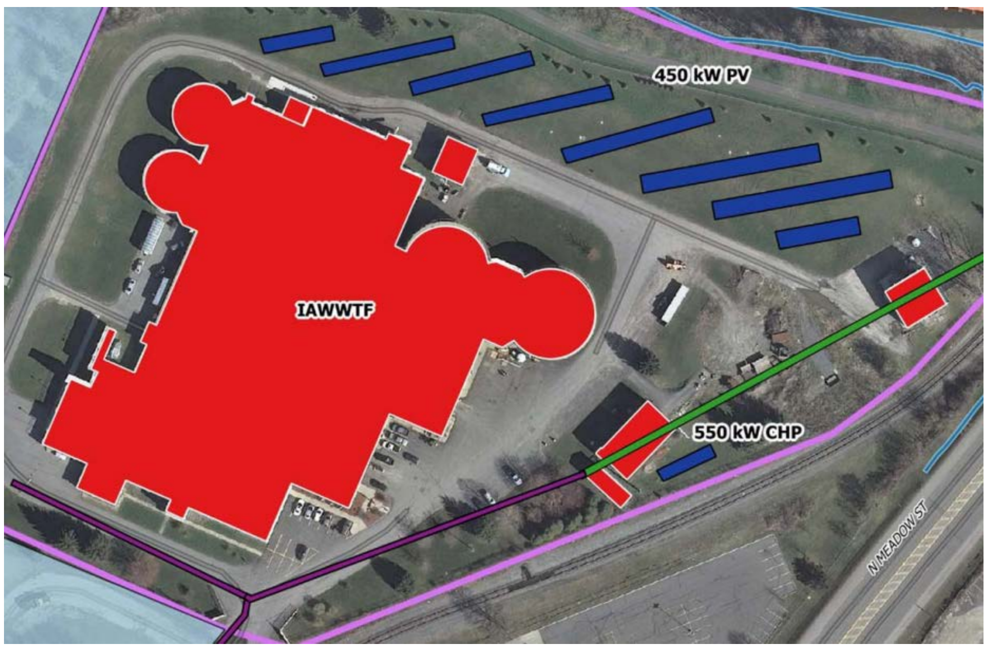

Figure 4: Project Site General Arrangement

4.2. *Microgrid Infrastructure and Operations (NYSERDA Task 2.1)*

4.2.1. *Existing NYSEG Distribution System Description*

The IAWWTF is supplied electricity via the 784 distribution feeder which originates at NYSEG's Fourth Street Substation and operates at a nominal voltage of 8.3 kV. With the exception of several non-critical commercial facilities near the IAWWTF, the 784 feeder serves mostly residential customers within the eastern portion of Fall Creek neighborhood.

In addition to the 784 feeder, NYSEG's 783 feeder also clips the northeast corner of the property occupied by the IAWWTF. Also originating from the Fourth Street Substation to the south, the 783 feeder follows the western bank of the Cascadilla Creek, crossing over N. Meadow Street (NY-13) and the Norfolk Southern Railroad before entering the property near the Cayuga Waterfront Trail. The parcel is city-owned, providing easy access to a potential extension of the 783 feeder. An overview of the locations of the 783 and 784 feeders relative to the IAWWTF are shown in Figure 5. A broader area overview can be found in Appendix A: Project Development Maps and Appendix B: Project Conceptual Design Drawings.

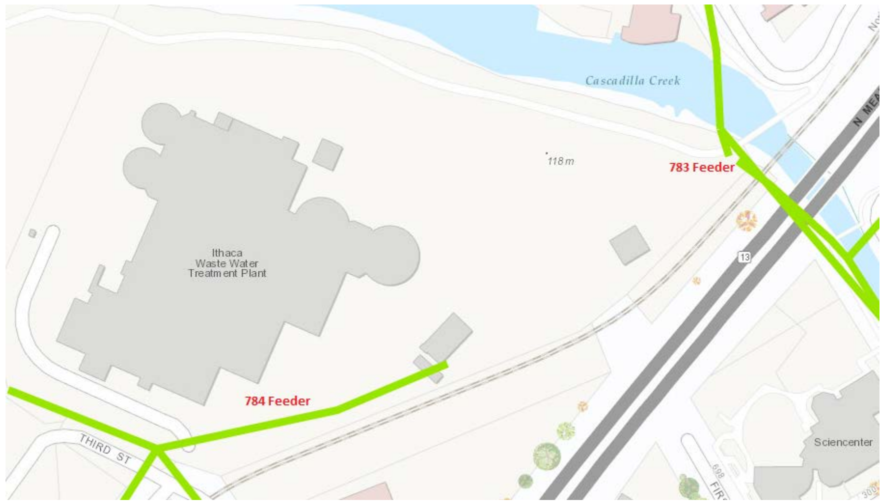

Figure 5: IAWWTF Area Feeder Locations (Existing)

The 783 feeder continues north and east of the Cascadilla Creek and serves the key facilities that are shown in Appendix A: Project Development Maps. Of key interest is Ithaca High School to the proposed microgrid as it will be capable of operating with full power during an emergency or disaster event. The other facilities were specifically selected because they are along the route between the IAWTTF and include critical public services. The total coincident peak load of these facilities is estimated to be less than 1,500 kW.

Facility	Classification	Critical	Peak Load (kW)
Ithaca Area Waste Water Treatment Facility	Public	Yes	778
Ithaca High School and Administration	Public	Yes	575
Tompkins Consolidated Area Transit	Public	Yes	174
the City Department of Public Works	Public	Yes	78
Johnson Boatyard	Commercial	No	
Newman Municipal Golf Course Clubhouse	Public	No	
Finger Lakes Boating Center	Commercial	No	
Hydroponic Shops of America	Commercial	No	
Municipal Pumping Stations	Industrial	Yes	
Church of Christ	Religious	No	
Residential (40 homes estimated)	Residential	No	200 (Est.)
Coincident Peak Load: 1,453 kW	**Sum of Peak Loads: 1,805 kW**		

Table 5: Key Facilities Served by NYSEG 783 Feeder

4.2.2. *Ithaca Area Wastewater Treatment Facility Electrical Systems*

Electricity from NYSEG's 784 feeder is stepped down from 8.3 kV to 480/277 V by one 2,500 KVA transformer at the plant's outdoor unit substation. The main bus distributes power to the plant at 480/277 V. A single line diagram of this arrangement can be found in Appendix B: Project Conceptual Design Drawings. The IAWWTF has multiple types of existing generation. Note that as currently configured, the emergency generator at the IAWWTF is never connected in parallel with the utility. A summary of both existing and proposed generation is shown below.

Facility	Type	Capacity
IAWWTF	Proposed ADG Recip CHP	550 kW
IAWWTF	Proposed Solar PV	435 kW
IAWWTF	Existing Diesel E-Gen	750 kW
IAWWTF	Existing ADG Microturbine CHP	260 kW
IAWWTF	Existing Solar PV	7.5 kW
Public Works Facility	Existing Diesel E-Gen	150 kW
Ithaca High School	Existing Diesel E-Gen	300 kW
Total Generating Capacity		2,453 kW

Table 6: Existing and Proposed Generation within Microgrid

4.2.3. *Required NYSEG Distribution System Modifications*

Based on the critical loads served by the 783 feeder and its close proximity to the IAWWTF, there is an opportunity to extend the 783 feeder to the IAWWTF and use a portion of the feeder as a microgrid in the event of an extended utility interruption. By extending the feeder and installing new load-break switches in key locations, the most critical portion of the feeder could be isolated and repurposed for the microgrid.

Figure 6 depicts (in red) this proposed line extension. The feeder would be extended for approximately 500 feet on an overhead pole line on the IAWWTF property to the existing outdoor unit substation.

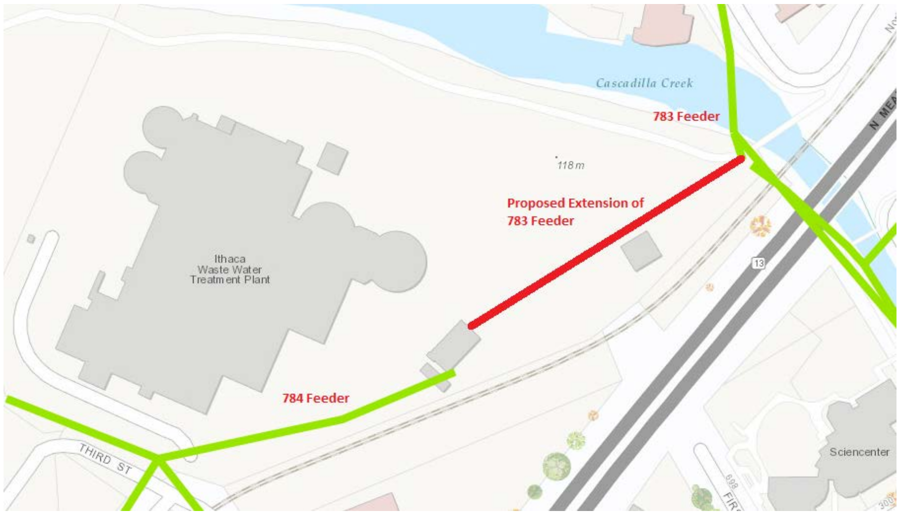

Figure 6: Proposed Extension of NYSEG 783 Feeder

Two new load-break switches would need to be installed on the 783 distribution feeder at the following locations:

- North Cayuga Street at a location just north of the tap to Ithaca High School
- N. Meadow Street (NY-13) at Cascadilla Creek crossing

The locations can be seen graphically in the map in Appendix A: Project Development Maps and the feeder main line diagram in Appendix B: Project Conceptual Design Drawings. Due to standard operating procedures and in an effort to reduce cost, SourceOne recommends that the new switches be manual, non-SCADA-controlled devices. More information on this rationale can be found in Section 4.3.2. Additionally, for ease of operation, SourceOne recommends the installation of fault indicators at each load-break location.

When the load-break switches are open and the microgrid is isolated, the IAWWTF could be transferred to the 783 feeder and distribute electricity on the isolated section of the feeder. This would serve the loads noted in Table 4 along Willow Avenue, Pier Road, W. York Street, and N. Cayuga Street. It is estimated that the total peak load for this area would be 1,453 kW including the IAWWTF.

Because the upgrades needed to facilitate a microgrid are limited in scope, the capital cost is expected to be minimal. However, because the IAWWTF will likely export power on its normal feeder on a regular basis, SourceOne has also added costs that will likely be associated with such an interconnection. Table 7 summarizes the estimated capital costs for NYSEG distribution system upgrades.

Item	Cost
500-ft Line Extension (336 Bare AL)	$23,000
(2) 15-kV Load-break Switches (Replace poles)	$25,000
Feeder 784 Interconnection with Direct Transfer Trip	$200,000
Engineering and Overhead	$50,000
Total	**$298,000**

Table 7: Estimated Capital Cost of NYSEG Distribution System Upgrades

4.2.4. *Required IAWWTF Electric System Modifications*

Most of the required electrical work needed to establish the microgrid will be at the existing service to the IAWWTF. The existing 8.3-kV service line will need to be tapped before the existing transformer and fed to a new 15-kV switchgear line up. The new switchgear will act as a collector bus for all new generation and will allow for back-feeding on to the 783 feeder during microgrid operation. To interconnect to the 783 feeder, a new transformer is also required. Refer to Appendix B: Project Conceptual Design Drawings for the proposed single line diagram.

To facilitate the transition to microgrid mode, when required, SourceOne recommends that the switchgear is designed and constructed to NYSEG standards for customer-owned substations. NYSEG will have exclusive control of the two breakers on the incoming 783 and 784 feeders and will also need to install primary metering within the switchgear. This will allow NYSEG personnel to activate the microgrid with the support of IAWWTF staff.

An estimate for the required equipment (including labor) is shown in Table 8.

Item	Cost
15-kV Switchgear with 6 Breakers	$300,000
3000 KVA Transformer	$70,000
15-kV Cabling and Terminations	$7,500
Microgrid Controller	$10,000
Metering	$10,000
Engineering and Overhead	$79,500
Total	**$477,000**

Table 8: Estimated Capital Cost of IAWWTF Distribution System Upgrades

4.3. Microgrid Operations

4.3.1. *Normal Operation*

Under normal conditions, there will be no microgrid in operation, that is to say the CHP and PV systems will operate in parallel with the grid. NYSEG will continue to supply the

IAWTTF on the 784 feeder and all of the aforementioned critical loads on the 783 feeder. NYSEG has indicated a peak load of 1.44 MW on the 783 and 1.77 MW on the 784 feeder. The IAWTTF will operate approximately 443 kW of photovoltaic, 260 kW of microturbine, and 550 kW of biogas-powered engines to offset their electrical use. During periods where generation exceeds the facility's load, power will be exported on to the 784 feeder. At no time during normal operation will the existing emergency generation be placed in parallel with the 784 feeder. The existing 750-kW emergency generator will be modified to provide black start and synchronizing support for the microgrid. It will also be modified so it can be placed in parallel with the microgrid to contribute, along with the other generators to serve the load of the microgrid during a macrogrid outage.

4.3.2. *Emergency Operation*

For purposes of this microgrid, an "emergency" can be defined as an event that interrupts the NYSEG 783 feeder for an extended period of time without local feeder damage (e.g. substation issue or loss of transmission supply). In this situation, after evaluating the outage, the NYSEG control center and the IAWWTF would need to mutually agree to activate the microgrid.

Upon agreement, the following steps would be taken to bring the microgrid online:

1) NYSEG will dispatch a trouble man, line crew, or supervisor to survey the 783 feeder to ensure that no damage or faults exist on the feeder. This process may be accelerated by observing fault indicators on the line.
2) After determining that the feeder is clear to energize, NYSEG crews will commence switching on the feeder to isolate the microgrid. This will require crews to open and tag the load-break switches at the following locations:
    - N. Cayuga Street at a location just north of Ithaca High School (new switch)
    - N. Meadow Street (NY-13) at Cascadilla Creek crossing (new switch)
    - N. Cayuga Street at W. York Street (existing 785 tie point)
3) At the new switchgear at the IAWWTF, NYSEG will:
    - Check open the 783 feeder breaker.
    - Open, check open, and lock open the 784 feeder breaker.
4) This will de-energize the IAWWTF. All existing PV, biogas, and microturbine generation will be automatically tripped. The on-site emergency generator will start, and the facility will automatically be transferred to the back-up generator.
5) IAWWTF staff will activate microgrid operation at the switchgear using the proposed microgrid controller. The controller will start the biogas reciprocating

engines and sync them to the main bus that will already be energized by the back-up generator.

6) When the IAWWTF is ready to accept load, the plant staff will notify NYSEG that they are ready to energize the microgrid.
7) At the IAWWTF switchgear, NYSEG will close the 783 feeder breaker. For protection purposes, the 783 feeder breaker will be interlocked with the 784 feeder breaker to ensure that both breakers cannot be closed simultaneously. In addition, when microgrid mode is activated, the 783 feeder breaker will be unable to close if the upstream 783 feeder is energized.
8) At this point, the microgrid will be energized and the generation at the IAWWTF will control voltage and frequency within parameters to be determined by NYSEG. This will ensure that no customers on NYSEG's system within the microgrid will experience power quality problems.
9) The existing emergency generators at Ithaca High School and DPW will not require modification and will continue to operate according to their existing configuration. Furthermore, the existing ATS systems should not be able to discriminate between microgrid and utility supplied power and therefore will remain in service as currently configured.

When returning back to normal operation, these steps will essentially be taken in reverse. The IAWWTF will stop generating and return to its normal feed through a break-before-make switching operation. Likewise, NYSEG will restore the 783 feeder to its normal configuration.

4.3.3. *Control and Protection Considerations*

With additional generation at the IAWWTF, a short-circuit and protection coordination study will need to be performed to ensure that the available fault current will not exceed the fault duty rating of NYSEG's distribution equipment. NYSEG will also need to specify the protection settings for the 783 breaker at the IAWWTF because it is the exclusive protection of their equipment during a microgrid event.

Considerations will also need to be made for distribution line control protection. Within the microgrid area, there is limited existing feeder control and protection. There are no capacitor banks, voltage regulators, reclosers, fused taps, or other downstream protection for the distribution line. Individual transformers are fused with cutouts. The size of these fuses should be evaluated to ensure compatibility with both normal operation and microgrid operation. If available fault current during microgrid operation is calculated to be extraordinarily high, current-limiting fuses may be considered as a mitigating solution.

4.4. Load Characterization (NYSERDA Task 2.2)

SourceOne obtained energy consumption data from a variety of sources for each of the facilities contemplated as part of the microgrid. Data resolution ranges from hourly to monthly and has been provided from either the facility itself or through NYSEG by way of a letter of authorization executed between SourceOne and the end customer.

Curve fit techniques were applied to monthly data to combine with metered hourly data to create an 8,760 hourly model for the electrical and thermal consumption of facilities in the microgrid. The figure below shows the hourly electric and thermal load profiles for the combined hourly interval data for each facility within the microgrid.

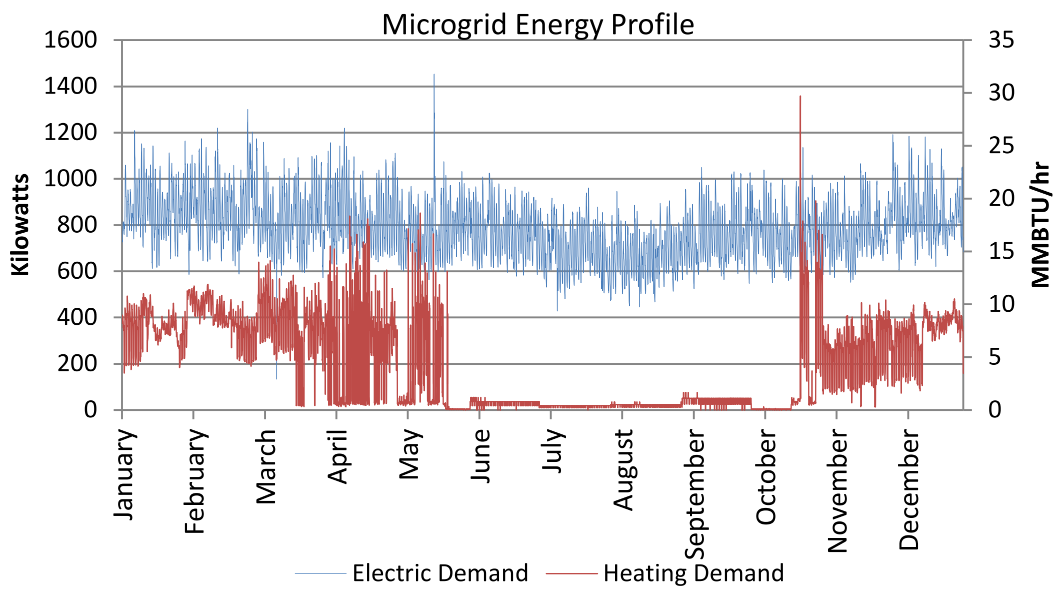

Figure 7: Microgrid Energy Profile

Appendix F: Facility Energy Profiles presents load profile summaries for the microgrid facilities. Unlike the plot above, these profile summaries are for each facility and include monthly, annual hourly and load duration curves for both electric and thermal loads. Summary statistics such as load factors and peak values are provided, utility account meters and account numbers where available and the reference source for the consumption data.

4.5. Distributed Energy Resources Characterization (NYSERDA Task 2.3)

4.5.1. *Anaerobic Digester Gas Combined Heat and Power Deployments*

A cursory review of the historical monthly performance data for the existing microturbine CHP system reveals the average heat rate of the system in 2014 was 14,168 BTU/kWh. A reciprocating engine in the size range for this application has an average heat rate of 8,200 BTU/kWh, a 42 % improvement over the microturbine. The existing electric and thermal loads, natural gas and electricity prices, physical location of the interconnects, and dual fuel capability proved that the reciprocating engine presents a higher value to this project and as such is the prime mover technology of choice. Further information pertaining to the value of electric generation versus recoverable heat is presented in Section 5: Assessment of Commercial and Financial Feasibility (NYSERDA Task 3).

To identify the most economically feasible deployment configuration, SourceOne investigated the impact that different site locations, recovered heat utilization, and tariff changes have on the net present value of the project. The following are brief descriptions of the five different deployment scenarios that were evaluated. The table in Appendix C: Technical, Financial & Operational Summary provides a summary of key performance and cost metrics for each of these scenarios. Note that each scenario includes the utilization of the existing PV array as well as the existing four 65-kW microturbines currently in operation at the IAWWTF. It is also important to note that all ADG, associated feedstock handling, tank and process expansion as well as required gas conditioning will be the responsibility of IAWWTF. The IAWWTF will provide ADG at the quality and pressure required by the reciprocating engines. It is also assumed that all available ADG will be used for generating electricity for the microgrid.

Scenario 1 – This option calls for the deployment of a single 550-kW dual fuel, natural gas and ADG-powered reciprocating engine at the IAWWTF without heat recovery. The biogas will be generated by the anaerobic digesters at the IAWWTF. The generation will be used to offset existing NYSEG-supplied power at the retail rate. The balance of generation, if any, will be exported at the wholesale rate through NYSEG Service Classification 10, buy back agreement. No waste heat will be recovered in this electric-only configuration.

Appendix C: Technical, Financial & Operational Summary summarizes the key metrics for this scenario and the indicative proforma for this scenario is located in Appendix D: Indicative Project Proformas

Scenario 2 – This option calls for the deployment of a single 550-kW dual fuel, natural gas and ADG-powered reciprocating engine at the IAWWTF. The biogas will be generated by the anaerobic digesters at the IAWWTF. The generation will be used to offset existing NYSEG-supplied power at the retail rate. The balance of generation, if any, will be exported at the wholesale rate through NYSEG Service Classification 10, buy back agreement. The available recoverable heat will be used to generate hot water to serve loads at the IAWWTF as well as at Ithaca High School. To serve the loads at the high school, a new two-pipe low-enthalpy hot water district energy system will be installed. The estimated distance between the IAWWTF and the High School is 1,700 feet.

Appendix C: Technical, Financial & Operational Summary summarizes the key metrics for this scenario and the indicative proforma for this scenario is located in Appendix D: Indicative Project Proformas.

Scenario 3 – This option calls for the deployment of a single 550-kW dual fuel, natural gas and ADG-powered reciprocating engine at the Ithaca High School and Administration building complex. The biogas will be generated by the anaerobic digesters at the IAWWTF and supplied to the high school via polyethylene SDR-10 piping routed from the IAWWTF to the high school (1,700 feet). The generation will be used to offset existing NYSEG-supplied power at the retail rate. The balance of generation, if any, will be exported at the wholesale rate through NYSEG Service Classification 10, buy back agreement. The recoverable heat will be captured to generate hot water which will serve the thermal loads at the High School.

Appendix C: Technical, Financial & Operational Summary summarizes the key metrics for this scenario and the indicative proforma for this scenario is located in Appendix D: Indicative Project Proformas.

Scenario 4 – This option is the preferred microgrid configuration and consists of the deployment of a single 550-kW dual fuel, natural gas and ADG-powered reciprocating engine at the IAWWTF. The biogas will be generated by the anaerobic digesters at the IAWWTF. The generation will be used to offset existing NYSEG-supplied power at the retail rate. The balance of generation, if any, will be exported at the wholesale rate through NYSEG Service Classification 10, buy back agreement. The available recoverable heat will be captured to generate hot water which will be used to serve thermal loads at both the IAWWTF and any development at the nearby waterfront properties. Although heat loads are expected to develop in Year Six of the project, heat recovery can be immediately used at the IAWWTF. To serve the thermal load at the nearby waterfront properties, a new two-pipe low-enthalpy hot water district energy system will be installed in Year Five of the project, from the IAWWTF to the development (500 feet).

Appendix C: Technical, Financial & Operational Summary summarizes the key metrics for this scenario and the indicative proforma for this scenario is located in Appendix D: Indicative Project Proformas.

Scenario 5 – This option calls for the deployment of a single 550-kW dual fuel, natural gas and ADG-powered reciprocating engine at the IAWWTF. The biogas will be supplied by the anaerobic digesters at the IAWWTF. The generation will be used to offset existing NYSEG-supplied power at the retail rate. The balance of generation, if any, is assumed to qualify as net metered generation and will therefore be exported at the retail rate through the community DG tariff or other, as agreed to by NYSEG. The available recoverable heat will be captured to generate hot water which will be used to serve thermal loads at both the IAWWTF and any development at the nearby waterfront properties. To serve the thermal load at the nearby waterfront properties, a new two-pipe low-enthalpy hot water district energy system will be installed from the IAWWTF to the development (500 feet).

Appendix C: Technical, Financial & Operational Summary summarizes the key metrics for this scenario and the indicative proforma for this scenario is located in Appendix D: Indicative Project Proformas.

4.5.2. *Photovoltaic Array*

The proposed PV array will be a ground mounted array with a total nominal capacity of 435 kW. Sited on the grounds at the IAWWTF, preliminary estimates indicate that the proposed system will cost $1.4 million and generate an estimated 565 MWh/yr. This proposed installation of PV capacity will be in addition to the existing 7.5 kW rooftop mounted PV array already in operation at the IAWWTF. The proposed array will operate on either a solar net metered tariff, the community DG tariff or other as agreed to by NYSEG and thus will export power at a retail rate.

To serve as a compliment to the PV array, energy storage in the form of batteries was also investigated. Both an 800 kWh (100 kW peak) lithium ion (LiO) and 1600 kWh (200 kW peak) LiO battery options were considered with prices being estimated at $644/kWh and $597/kWh, respectively. At these prices, SourceOne was unable to find a revenue stream that would make the addition of energy storage to the microgrid a financially viable option. It is forecasted that prices for these installations will continue to drop, and REV models currently being evaluated may provide a compensation mechanism for ancillary services and storage capacity in the near future. As such consideration for installation in the future is recommended.

Generation	Size	Location
Proposed Photovoltaic Array, ground mount	430 kW	IAWWTF Grounds
Existing Photovoltaic Array, roof mount	7.5 kW	IAWWTF Roof
Total	437.5 kW	IAWWTF

Table 9 - Photovoltaic Array Summary

4.5.3. *Existing and Proposed Emergency Generators*

Three of the facilities intended to be included in the microgrid currently have emergency generators. As currently configured, these generators are standby generators which utilize an automatic transfer switch to select between emergency generator power and utility supplied power. Although these existing backup generators play a critical role in safeguarding against utility outages, the proposed microgrid will provide all facilities with 100% power during macrogrid outages without utilizing any of the existing emergency generators in the microgrid, with the exception of the 750 KW unit at the IAWWTF. This unit will serve as the black-start generator which will allow the synchronization of all other generators to the microgrid during a macrogrid outage.

Location	Size	Fuel
High School	300 kW	Diesel
IAWWTF	750 kW	Diesel
Department Public Works	150 kW	Nat. Gas

Table 10: Existing Emergency Generation Summary

It should be noted that if additional capacity is required, the generators at the High School and DPW could be converted into paralleling generators and controlled via the Microgrid controller. As mentioned above, this is not necessary as the peak load in the microgrid can be met without them.

4.5.4. *Microgrid Thermal Energy Operations*

The proposed microgrid incorporates a straightforward combined heat and power system with recoverable heat distributed to IAWWTF and the neighboring new development. SourceOne evaluated local thermal loads in an attempt to find a steady and reliable thermal host for the recovered heat. The heat recovered from the generation proposed at the IAWWTF is greater than the current thermal load at the IAWWTF. Therefore an offsite thermal host is needed. The IAWWTF can use approximately 60% of the recovered heat, with the balance either being dumped to the atmosphere or delivered to an end user. As presented in Scenario 3, low temperature hot water could be delivered to the high school. However, given the relatively low cost of natural gas and the considerable investment required, SourceOne determined this to be cost prohibitive. The most feasible approach is to use recovered heat to offset natural gas loads at the IAWWTF while planning to deliver the remaining 40% of useful heat to future neighboring loads as presented in Scenario 4.

4.5.5. *Microgrid Fuel Supply*

The existing anaerobic digester has approximately one day of biogas storage based on the current energy loads of the process, inclusive of heating and microturbine operation. The proposed anaerobic digester expansion will increase onsite biogas storage to approximately two days. In addition to this short term biogas storage, there is an existing 2,000 gallon diesel storage tank that is dedicated to the existing 750-kW emergency generator. Assuming a sustained plant load at 90% of the rated capacity of the generator, or 675 kW, the existing diesel storage can support approximately 37 hours of operation. This is an adequate amount of time based on the fact that there is a significant fuel depot within walking distance of the IAWWTF and the proposed reciprocating engines as well as the existing microturbines can be run on natural gas.

4.6. *Electrical and Thermal Infrastructure Characterization (NYSERDA Task 2.4)*

The proposed system will be capable of full operation during grid outages that are either caused by natural phenomenon (e.g. storm, animal activity, etc.) or human related interruptions (e.g. operator error, terrorism, vandalism, general equipment/infrastructure failures, etc.). One must also consider the level of redundancy incorporated into the project design and the level of confidence in the operator of the generating assets. Leaving generator outages aside, any of the aforementioned events could occur on the NYSEG owned distribution system that is part of the microgrid, specifically the 784 or 783 feeders. However, based on past reliability, it is less likely that any of the facilities proposed to be connected to microgrid experience a power interruption.

The NYPSC evaluates electric reliability using two metrics, the System Average Interruption Frequency Index (SAIFI) and the Customer Average Interruption Duration Index (CAIDI). SAIFI is a measurement of the number of customers interrupted over the total customer base, and CAIDI is a measurement of the average duration of each interruption that customers experienced. Based on the data reported by NYSEG in their Annual Reliability Report filed with the NYPSC, the Fourth Street 783 and 784 feeders have had substantially fewer customer interruptions than the rest of the Ithaca area and the rest of the NYSEG system (Table 11).

SAIFI	2010	2011	2012	2013	2014	5-Yr Average
Fourth St. 783	2.03	0.10	1.02	0.05	0.01	**0.64**
Fourth St. 784	1.01	0.34	0.07	0.00	0.05	**0.29**
Ithaca Area	1.07	0.89	1.11	0.76	1.04	**0.97**
NYSEG System	1.14	1.20	0.98	1.09	1.03	**1.09**

Table 11: NYSEG Reliability Statistics (SAIFI) [4]

Likewise, when customers did an experience an interruption, power was restored more quickly than average on the NYSEG system. On average, under non-major storm conditions, power has been restored in less than two hours. However, during major storms, the 783 feeder has seen partial interruptions that have been over 24 hours in duration. However, these long interruptions only affected fused side-taps with a limited number of customers (<150 customers). Considering the proposed microgrid on the 783 does not include any fused side-taps, these interruptions should have no effect on the ability to activate the microgrid.

[4] Excludes PSC Major Storms.

CAIDI	2010	2011	2012	2013	2014	5-Yr Average
Fourth St. 783	0.53	3.41	2.03	0.74	2.29	**1.80**
Fourth St. 784	0.22	0.88	0.58	0.00	0.69	**0.47**
Ithaca Area	1.60	2.17	1.79	1.76	1.66	**1.80**
NYSEG System	1.98	2.07	2.00	1.93	1.97	**1.99**

Table 12: NYSEG Reliability Statistics (CAIDI)[5]

Thermal loads within the microgrid can be categorized as those associated with the heat recovery from new ADG CHP and those at each of the facilities that will be served by microgrid power in the event of an electric utility outage. The thermal loads associated with the anaerobic digester process are critical as proper temperature is required to produce biogas. Future loads at the waterfront, although important to maintain, will most likely be comfort heating based. All thermal loads, whether served directly or indirectly from recovered heat, will have natural gas as a redundant fuel.

4.7. Microgrid and Building Controls Characterization (NYSERDA Task 2.5)

The following excerpt taken from a recent report on NYSEG's interconnection of distributed generation characterizes the anticipated protection, control, and communications systems for the proposed microgrid:

> Systems larger than 250 kW automatically go through the Preliminary Technical Review and CESIR study process. The number of applications requiring a CESIR has also been increasing recently and, depending on volume, the 60 business-day time window to do a CESIR study can be challenging. The typical cost of a CESIR study is $3,000 to $5,000. NYSEG requires the installation of a reclosing device for all non-net-metered systems 250 kW and above. This device is capable of connection to the system's supervisory control and data acquisition (SCADA) control system, enables revenue metering and can help with monitoring and control of multiple DG on the same distribution circuit. The specific purposes of the recloser device are:
>
> • System Protection – the recloser will be programmed to operate in a traditional protection mode to isolate the utility system for faults beyond the recloser. Fuses in each phase cannot be used for protection as blown fuse(s) would allow for the solar electric system to be interconnected in a single phase causing overvoltage conditions.

[5] Excludes PSC Major Storms.

• Safety – the recloser will be SCADA-equipped to provide the local switching authority and the ability to isolate the generation from the utility system when needed either remotely or locally in the event of an emergency

• Operational Efficiency – the recloser will be SCADA equipped to provide the local switching authority the ability to switch the generator offline for non-normal circuit contingencies when needed either remotely or locally in the event of routine switching and operation of the utility system.

• Telemetry – various data measurements will be collected and transmitted via the SCADA system to track the generator individual system's performance and its contribution to the overall performance of the distribution system. NYSEG uses a number of software tools to internally process and study interconnection applications, and human interaction with these tools is key to proper use. When CESIR studies are required, data needs to be pulled from several different databases to perform the evaluation, including GIS, SAP (for customer peak load), and an Access database (moving to Sequel database) where customer and application information and equipment ratings are stored. In addition, different tools are used for feeder analysis and load flow (CYME) and protection (Aspen One Liner). The NYSEG distribution system is documented except for the Rochester and Binghamton downtown networks. Even so, there are several human interfaces required to conduct the studies.[6]

4.7.1. *Demand Response Opportunities*

Water treatment facilities involve processes that are capable of being operated on a variable and or reduced basis while still remaining in compliance with applicable laws and regulations. Such processes may include dewatering operations, pumping, and aeration blowers. The ability to vary the electric loads of these processes may provide a host of benefits for the microgrid and the interconnecting utility. Participation in either formal NYSEG-sponsored demand response programs or a self-sponsored economic dispatch strategy may be beneficial in times where the locational and/or temporal market price signals suggest that a reduction and subsequent increase in onsite generation are cost effective. Additional evaluation of this strategy, along with a review

[6] "*Interconnection of Distributed Generation in New York State: A Utility Readiness Assessment Final Report*", prepared for New York State Energy Research and Development Authority (NYSERDA) and New York State Department of Public Service (NYS DPS), prepared by: Electric Power Research Institute (EPRI). September 2015

of potential storage integration and ancillary service (frequency and voltage support) is recommended as part of the next phase of development.

4.8. Information Technology (IT)/Telecommunications Infrastructure Characterization (NYSERDA Task 2.6)

The microgrid will be equipped with adequate IT/Telecommunications Infrastructure (wide area networks, access point, Ethernet switch, cables etc.) and protocols necessary to support the safe and economical operation of all equipment in the microgrid. Specific IT and SCADA design criteria will be determined during the next phase of project development and design however for purposes of informing the project's basis of design, the following criteria will be included:

1. All communications and control systems necessary for the safe operation of equipment connected to NYSEG's distribution system will be able to operate in both grid normal and grid emergency modes. Battery backup or otherwise will be included for seamless transfer.

2. In the event of a complete power failure, last know state or otherwise will be programmed into all control logic as to hold equipment in a safe operating condition.

3. Communication equipment protocol will be in accordance with NYSEG approved design requirements and specifications.

5. Assessment of Commercial and Financial Feasibility (NYSERDA Task 3)

This section defines the project value proposition, microgrid customers, project team, commercial structures, development and delivery models, and a summary of the financial performance of the project.

A discussion surrounding commercial viability must begin by understanding the status quo. In this case, the status quo represents the existing commercial terms and conditions for electric and gas service from NYSEG as compared to the additional value that will be brought by the proposed microgrid.

5.1. Energy Pricing and Forecasts

5.1.1. *Existing Rate and Tariff Structure*

Table 13 shows a summary of the average 2015 electric and natural gas rates at the IAWWTF. The IAWWTF is currently on a NYSEG Time of Use rate for delivery and purchases power from a third party supplier. Natural gas is delivered by NYSEG through a non-residential aggregation rate and is also purchased through a third party supplier.

Energy Product	Electricity	Natural Gas
NYSEG Delivery	$0.03/kWh	$2.60/MMBTU
Third Party Supply	$0.06/kWh	$4.00/MMBTU
Total	$0.09/kWh	$6.60/MMBTU

Table 13: Baseline Year Electric and Natural Gas Pricing

Through utility bill observation, it appears the IAWWTF is penalized for low power factor. SourceOne recommends further investigation during subsequent design efforts so that this power quality problem is not exacerbated with the expansion of on-site generation.

5.1.2. *Proposed Rate and Tariff Structure*

SourceOne has assumed the ADG CHP generation will be subject to a different tariff than the solar PV. Although this assumption is subject to final project agreements with NYSEG, as proposed, the generation at the IAWWTF will exceed the facility's electricity needs on an annual basis. Based on the fact ADG CHP does not currently qualify as a net metered facility, any excess generation exported to NYSEG's distribution system will fall under SC-10 – Non-Residential Distributed Generation Firm Sales Service. This is effectively the wholesale rate and is valued at NYISO's Zone C day ahead and real time prices. SourceOne has forecasted $0.06/kWh as a representative value for the wholesale rate during the first year of the project.

New solar PV power may fall under NYSEG's Solar Non-Residential Electric Service Option or the Community Distributed Generation tariff, whichever provides greater value to the project. Final determination will be made when the project requests an interconnection agreement from NYSEG. SourceOne has reviewed the recent Community DG tariff and understands that 60% of the generator (i.e. PV) output needs to be allocated to loads that are less than 25 kW. Therefore the project may need to enter into contractual agreements with satellite loads and could be the foundation for a community based PV farm. These loads do not necessarily need to be within the microgrid but do need to be within NYSEG's distribution territory.

Should the microgrid be approved to distribute power using NYSEG's infrastructure the generator(s) should not be subject to standby rates. A similar clause is currently included in NYSEG's Service Classification #11 (SC11) wherein it is stated that Standby Service is not applicable to emergency generators. Although the microgrid is not a dedicated emergency generator, by design, it will functionally operate as one during an electric utility outage.

5.1.3. *Electric and Natural Gas Price Forecasts*

To support comparisons between the two benefit costs tests presented in the study and to document the values driving the economic analysis of the project, two separate commodity forecasts are provided. The reason for the two forecasts is based on NYSERDA's Task 1.2, which requests that the contractor take account of a comprehensive cost/benefit analysis that includes, but is not limited to, the community, utility, and developer's perspective. The forecasts provided by NYSERDA do not represent the actual market conditions in Ithaca. As such, to represent the perspectives of the community, utility, and developer, SourceOne has developed a separate forecast.

For reference purposes these forecasts are presented below and in Appendix E: Commodity Forecasts.

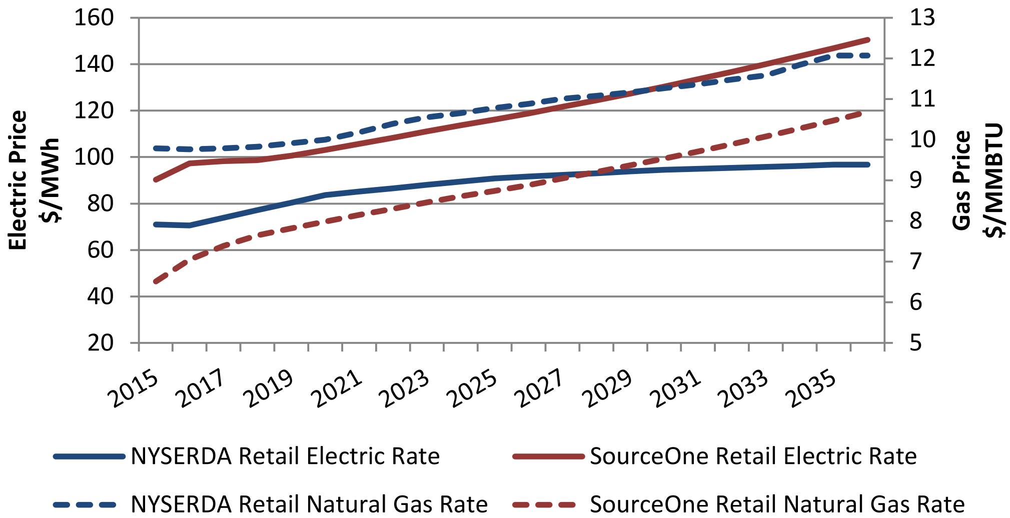

Figure 8: Electricity and Natural Gas Price Forecasts

5.2. Commercial Viability – Customers (NYSERDA Task 3.1)

5.2.1. *Facility and Customer Impact*

As presented in Table 1: Microgrid Load and Generation Summary, the customers in the microgrid are those located on the portion of NYSEG's 783 and 784 feeders that will become energized during a macrogrid outage. During normal operations the energy from the new generating assets in the microgrid will serve the IAWWTF, aggregated solar net metered customers, and eventually thermal off-takers at the new waterfront development. The number of individuals affected by/associated with critical loads within the microgrid number in the tens of thousands as the IAWWTF, TCAT, and DPW provide services for the entire City and beyond. Specifically, Ithaca High School could serve upwards of two thousand community members when configured as a fully powered emergency shelter.

It should also be noted that the proposed microgrid may require an interruption of service to customers served by the microgrid during testing and commissioning. Close coordination with NYSEG is paramount for a successful implementation. Construction will primarily be contained to grounds on the IAWWTF and therefore will have minimum impact on the surrounding community.

5.2.2. *Energy Sales and Contracts – Grid Normal*

It is anticipated that the owner of the new generation and thermal distribution system will establish energy service agreements with thermal off-takers under normal operating conditions. In the event IAWWTF is the owner, they will account for the value of the project through NYSEG's tariff structures as previously discussed. As proposed, the owner of the generating asset, if other than IAWWTF could establish a back to back energy service agreement that mimics the IAWWTF's existing NYSEG rate and third party supply costs. Additional electrical energy would be compensated at the NYSEG wholesale rate from the ADG CHP system and through a net metering agreement or community distributed generation tariff for the solar PV. These concepts and how they relate to the underlying NSYEG rates and tariffs are more fully presented in the commercial block diagram located in Appendix B: Project Conceptual Design Drawings. Proper revenue grade metering will be installed at each generator and as required at the points of interconnection with IAWWTF or NSYEG's system to be used for billing and performance evaluation purposes.

5.2.3. *Energy Sales and Contracts – Grid Emergency*

It is anticipated that the owner of the new generation and thermal distribution system will establish energy service agreements that clearly define the availability of thermal energy during emergency (i.e. macrogrid outage) conditions. It is assumed that the project will have backup natural gas boiler capacity or the end users will have separate heating systems they can rely on should the proposed system be incapable of providing thermal energy during a macrogrid outage.

The energy service agreements could consider a cost sharing clause to cover the operational costs of the microgrid during a macrogrid outage. As further defined in Section 6: Benefit Cost Analysis (NYSERDA Task 4), there are costs associated with a macrogrid outage which need to be covered through rate design or by a per event assessment by the City or its designated authority. Proper revenue grade metering, along with system integration with existing NYSEG supplied meters, will be installed at each generator and as required at the points of interconnection with IAWWTF or NYSEG's system to be used for billing and performance evaluation purposes.

5.3. Commercial Viability - Value Proposition (NYSERDA Task 3.2)

The value proposition of this microgrid is based on the unique combination of dispatchable low-carbon electric generation fueled by what would otherwise be considered waste, in an expanded bio-digestion process. Expanding existing bio-digestion, adding new PV, and recovering heat through a new district energy system creates a unique value to the community at large and, in particular, the microgrid customers. By introducing standard equipment and using industry-accepted operating procedures, the existing NYSEG-owned distribution system can be modified to increase reliability and provide 100% power to critical facilities in the event of a macrogrid outage. In particular, having Ithaca High School serve as a place of community refuge and providing 100% power to the transportation center and Department of Public Works enhances the emergency preparedness of the City.

Due to the nature of the ADG-based generation coupled with solar PV, this microgrid will be by far one of the cleanest emergency backup systems in the area. Dispatchable and controllable reciprocating engines enhance the reliability and operability of the microgrid.

Aside from the benefits associated with converting food and other organic matter into useable fuel, the value of the converted energy products need be compared to existing or status quo supplied energy. The following analysis compares the value of converting the biogas produced through increased anaerobic digestion to either electricity or heat. Based on 2015 NYSEG electric and gas rates, the value of each delivered energy product, on a $/MMBTU basis is as follows.

Item	Electricity	Natural Gas
Current Delivered Price (Traditional Units)	$ 0.09 / kWh	$ 6.61 / MMBTU
Current Delivered Price (Comparative Units)	$ 26.38 / MMBTU	$ 6.61 / MMBTU
Anaerobic Digester Gas Price	$ 4.04 / MMBTU	
Conversion Efficiency: Separate Heat and Power	41%	85%
Resulting Finished Product Value	$ 11.59 / MMBTU	$ 5.59 / MMBTU

Table 14 - Biogas Conversion Value

Admittedly, this high level analysis does not take into account the required conversation and distribution costs to get the energy products to end users. However, it does provide a framework to determine the highest and best use of the ADG. Based on the table above, ADG converted into electricity is of higher value than if it were converted into heat.

When evaluating the feasibility of on-site electrical generation, the implied heat rate based on existing market prices can be compared to the proposed prime mover technology. Using the values presented in Table 13, the table below compares the market implied heat rate to the prime mover of the proposed ADG CHP system.

<table>
<tr><th>Energy Product Price</th><th>Market Implied Heat Rate</th><th>Proposed Generator Heat Rate</th></tr>
<tr><td>Total Electric Price</td><td>$0.09/kWh</td><td rowspan="3">8,248 BTU/kWh</td></tr>
<tr><td>Total Natural Gas Price</td><td>$6.61/MMBTU</td></tr>
<tr><td>Market Implied Heat Rate ($/kWh / $/MMBTU)</td><td>13,615 BTU/kWh</td></tr>
<tr><td colspan="2">Cost of Electric Generation (Fuel Only, ADG @ $4.04/MMBTU)</td><td>$0.03/kWh</td></tr>
</table>

Table 15: Market Implied Heat Rate vs. Proposed Generation

Not only does the proposed generator have a heat rate 40% better than the market implied heat rate, the fuel being supplied to the generator costs less than the market price of natural gas. Lower cost gas, via anaerobic digestion coupled with thermal heat recovery sales allows the project to be cost effective when compared to macrogrid power and utility supplied natural gas.

5.3.1. *Commercial Block Diagram*

The following commercial block diagram presents an overview of the energy streams and how they are valued throughout the project. The energy flow and tariffs are shown under normal operating conditions. It is assumed that no special tariffs will be required during emergency operation; however the project may wish to establish agreements with the facilities in the microgrid to establish a clear understanding of expectations during emergency mode of operations.

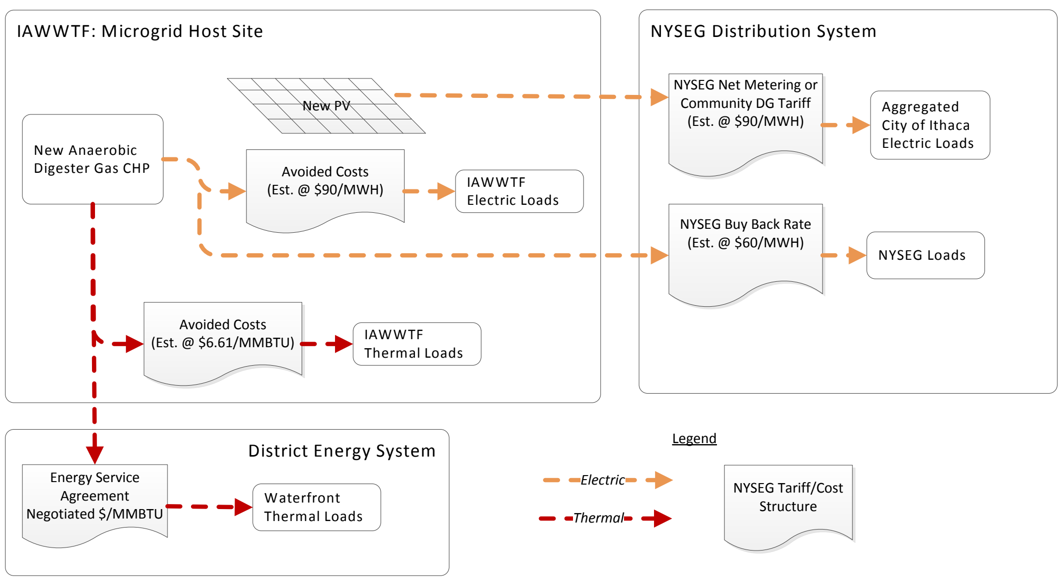

Figure 9: Commercial Block Diagram

As discussed above in Section 4.5, the IAWWTF will be providing ADG to the project at the required pressure and quality for use in the proposed reciprocating engines. The project has assumed an ADG price of $4.04/MMBTU for the first year and then escalated at 2% per year thereafter.

5.3.2. *Promoting State Policy Objectives*

In an order issued February 26, 2015, the New York State Public Service Commission (NYPSC) directed the six large investor owned electric utilities, which includes NYSEG, to develop and file initial demonstration projects, consistent with the guidelines adopted by the Order, on or before July 1, 2015. These projects are intended to demonstrate the potential of various aspects of the Reforming the Energy Vision (REV), the regulatory initiative launched by the NYPSC as part of Governor Cuomo's comprehensive energy strategy for New York[7].

Of relevance to this project, Iberdrola, NYSEG's parent company, has selected Tompkins County as the host for its demonstration project. As such, SourceOne recommends coordinating the project concepts presented in this feasibility study with NYSEG's proposed Ithaca region Energy Smart Community (ESC) project. There are particular components of the proposed microgrid, namely the modification of NYSEG's distribution system, which may benefit from NYSEG's current project plans for the ESC. Specifically, NYSEG has stated a phased deployment of advanced Metering Infrastructure (AMI) and increased Distribution Automation (DA). The estimated of $15.5 million involves Integrated System Planning, Grid Automation and Communications, Volt/VAR Optimization, Customer Research and Engagement, Customer Communications Platform, Customer Web Portal and Joint Partnership Development[8].

In addition to coordinating with the ESC initiatives the proposed project may also be a suitable candidate for NYSEG's Community Energy Coordination (CEC) efforts where it has stated that it will utilize its customer and system data to identify optimal candidates for product offerings at locations with specific system features (i.e., distribution system constraints, etc.). Participating service providers will receive leads identified during the customer solicitation phase. The service providers will pursue sales with customers that have already expressed interest, thus reducing acquisition costs. Service providers will then pay the Company a lead generation fee for this service. As such, this aspect of the demonstration will help inform decisions related to developing DSP (Distributed System Platform) functionalities.

NYSEG has indicated that the goals of the CEC project will the coincide with the existing energy and sustainability goals in Tompkins County and Ithaca, such as reducing greenhouse gas emissions by 40% by 2025[7].

5.4. Commercial Viability - Project Team (NYSERDA Task 3.3)

The project has the support from the City, various community leaders, and community based energy groups. Through its proposal for the NY Prize, the City has also secured a letter of commitment from NYSEG. Of particular interest, this project involves community stakeholders involved in the supply chain for the feedstock for the production of biogas. This makes this

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[7] Reforming the Energy Vision Demonstration Project Assessment Report Iberdrola, USA: Community Energy Coordination January 4, 2016.

[8] Before the NYS PSC - Direct Testimony of Reforming the Energy Vision, May 20, 2015

project unique in its ability to bring together a wide range of community members who are either involved in or impacted by, water, waste, energy, and the local food supply. Therefore, by design, the project team and the resulting project is truly a community microgrid.

Because the IAWWTF is jointly owned by the City of Ithaca, Town of Ithaca, and Town of Dryden, various project team structures have been contemplated. In subsequent phases of the project additional assessment and evaluation will determine the most advantageous project development and delivery model.

The simplified block diagram below shows the major project assets and the various development, design, construction, ownership, operation, and maintenance possibilities.

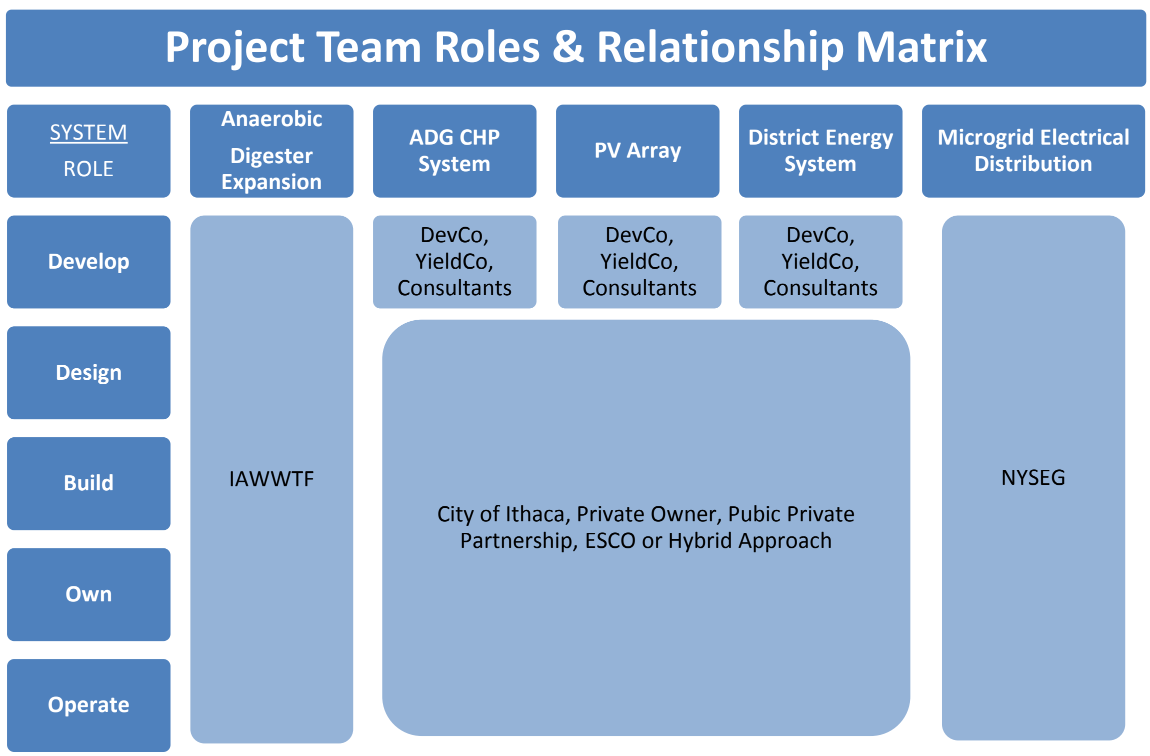


Figure 10: Project Team Roles & Relationship Matrix

5.4.1. *Project Delivery Models*

It is understood that the project may be executed through a variety of development models. At this point in the development the following project delivery models are contemplated:

5.4.1.1. Public Private Partnership

A public private partnership (PPP) is a government service or private business venture, which is funded and operated through a partnership of government and one or more private sector companies.

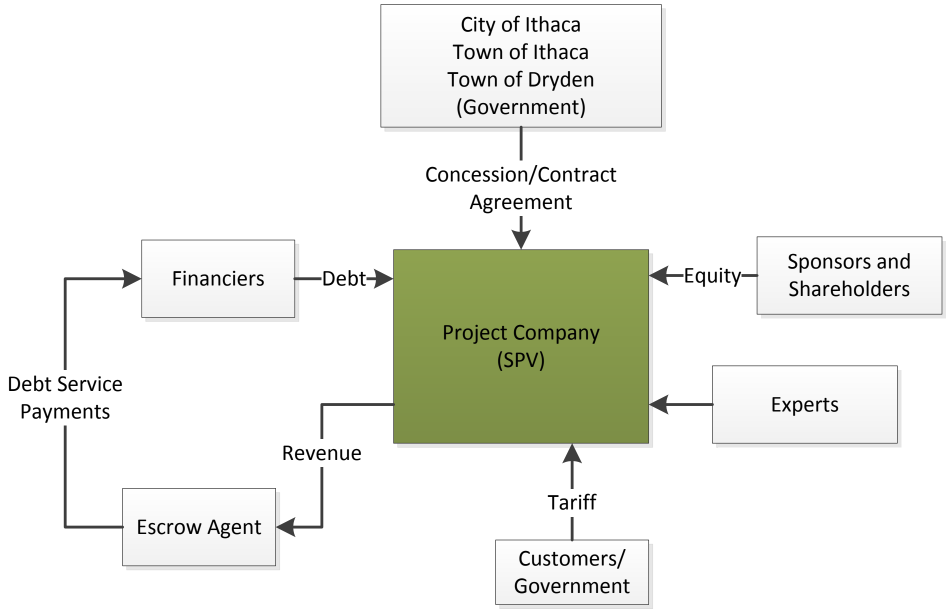


Figure 11: Simplified Public Private Partnership Model

PPP involves a contract between a public sector authority and a private party, in which the private party provides a public service or project and assumes substantial financial, technical and operational risk in the project.

PPPs are claimed to enable the public sector to harness the expertise and efficiencies that the private sector can bring to the delivery of certain facilities and services traditionally procured and delivered by the public sector. A PPP is structured so that the public sector body seeking to make a capital investment does not incur any borrowing.

5.4.1.2. Utility Ownership

Pursuant to the New York State Public Service Commission's "Order Adopting Regulatory Policy Framework and Implementation Plan" there may be the possibility that Iberdrola, or a subsidiary may be interested in owning and or operating the project.

Regardless of final ownership structures, it is assumed that NYSEG will own and operate all distribution system equipment necessary and related to the line switching and isolation of feeders 783 and 784 to create the microgrid circuit.

5.4.1.3. City of Ithaca Ownership

The City may choose to own all or a portion of the assets proposed as part of the microgrid or choose to purchase them once they are developed and or operational.

5.4.2. *General Development & Delivery Methods*

Once the final ownership and commercial structure of the project is determined, the development and delivery model must be selected. Below is a summary of methods which outline the possible ways the City could implement the project. Each method has inherent pros and cons as well as risks and rewards.

5.4.2.1. Internally Develop

This method is similar to the traditional design-bid-build approach where the customer/owner/end user facility hires a consultant, manages the design and construction scope and maintains control of the project from concept to commercial operation. Although this method maximizes the owner's financial return, it also comes with the greatest amount of project risk and requires a high level of oversight, project management and staff resources.

It is possible for the City to internally develop some or all of the project systems or sub systems. For example, the City may wish to develop and install the PV portion of the project while another firm or approach is used for the CHP system.

5.4.2.2. Purchase Turnkey Project

With this method the owner selects a project developer to design and build the project on a "turnkey" basis whereby the developer turns over the project to the owner after startup and commissioning. Although this method relieves some of the project risk from the owner it comes at a price and can sometimes limit customized solutions or specific technologies. Multiple developers may be required to meet the needs of the project should it involve one or more base technologies that cannot be served by a single entity. The project developer could also retain ownership and or operational responsibility of the project after construction.

It is possible for the City to utilize a turnkey approach for some or all of the project systems or sub systems. For example, the City may wish to approach the CHP system as a turnkey project while implementing another approach for the microgrid/electrical distribution component of the project.

5.4.2.3. Team with Partner(s)

This method involves teaming with one or more of the following entities: equipment vendor, engineer, procurement, and construction firm (EPC) or joint venture partnership to develop the project. This approach assumes that both the risk and financial reward are shared amongst the parties involved.

The City could choose which portion of the project components it wishes to partner on.

5.4.2.4. Design through Design Build Own Operate Maintain (DBOOM)

The Design Build Own Operate Maintain delivery method is based on an underlying energy purchase or energy service agreement with a turnkey system provider or joint venture/consortium of system providers. The system provider agrees to take on the responsibility similar to that of a turnkey project provider however also owns or partially owns, operates and maintains the energy system(s). The provider is usually compensated through power purchased agreement contacts and or an operations and maintenance contract with the host facility.

The City could choose to Design the project first, then go to market for the BOOM portion of the development or choose to select a complete DBOOM provider. The City could choose to split the DBOOM by major equipment/plant/system boundaries or wrap the entire project with a DBOOM contract.

5.5. Commercial Viability - Creating and Delivering Value (NYSERDA Task 3.4)

The technologies selected for this microgrid have a strong track record of proven performance. In addition, the anaerobic digester gas to electricity concept is currently operational at the IAWWTF and has been successfully deployed throughout the world. It is anticipated that existing systems and operating procedures at the IAWWTF will be used in support of this project.

One challenge that has been identified is the reliance on biogas production to power the microgrid. This challenge can be overcome by ensuring all processes are backed up with emergency power. As is currently the case, in the event of a macrogrid outage; this emergency power will also serve as the main synchronizing source for all other microgrid generators. Synchronizing operations can easily be accomplished with standard commercially available systems.

Once operational, the rotating machines (i.e. microturbines and reciprocating engines) can be dispatched to meet the loads of the microgrid during a macrogrid outage. Providing the community with an increased level of resiliency for utilities serving critical facilities helping the City meet its emergency preparedness goals. The solar PV will be incorporated through the use of a load and microgrid controller. During normal operations, generation will be distributed through NYSEG's system.

Standard construction and operating permits will be required for the majority of the project with the exception of the permits and permissions from NYSEG to modify their distribution system with the proposed load-break switches. Working with NYSEG to develop, design, and agree to operational requirements for the project will be critical to success.

Section 5.2 of this report describes how the project owner plans to charge the purchasers of electricity services and how will the purchasers' use be metered.

With respect to business/commercialization and replication plans appropriate for this type of project, there are several systems in the country that incorporate the generating assets similar to those proposed in this project. What is unique is the application in the context of a microgrid to serve certain facilities in the event of a macrogrid outage. Recent efforts at other waste water treatment facilities to become net energy exporter or at least net zero energy users should be reviewed so that lessons learned can be applied to this project.

With the exception of obtaining NYSEG approval there are no barriers to market entry that have been identified for the microgrid participants. The market has been identified as the operational and functional services provided by the facilities in the microgrid and the energy requirements necessary to conduct such operations.

5.6. Financial Viability (NYSERDA Task 3.5)

The overall financial viability of this project stems from the operational and economic efficiencies of converting otherwise wasted organic matter into biogas and then converting that biogas to electricity and recovered heat. If this project were a straightforward behind the meter campus style CHP project the required incentives to allow for a positive net present value would be lower. However, based on the goal of creating a microgrid, additional infrastructure to the tune of $1.2 million is necessary to enable the system to provide power to the critical facilities within the microgrid.

Detailed feasibility level cost estimates are located in Appendix C: Technical, Financial & Operational Summary and are broken out by the major systems that constitute the microgrid project as a whole. It should be noted that the digester expansion project is not part of the microgrid project as it is being developed separately by the IAWWTF, whose intention is to supply ADG to the project.

As described in Section 5.1.3: Electric and Natural Gas Price Forecasts, two forecasts were used in a comprehensive cost benefit analysis, one from the customer or developer perspective and one from NYSERDA's perspective. Each forecast yields a separate financial result as the revenue streams are based on these forecasts. The recommended option referred to as Scenario 4 and as further detailed in Section 4.5.1 Anaerobic Digester Gas Combined Heat and Power Deployments has a negative net present value. Depending on the forecast, an incentive ranging from $1.6 to $3.1 million is required to bring the project to a zero net present value. Additional details of this conclusion can be seen in Appendix D: Indicative Project Proformas.

The project's revenue streams and/or savings that will flow to the microgrid owner are comprised of electricity and natural gas avoided costs at the IAWWTF, electricity sales to other facilities within NYSEG's distribution territory, and thermal hot water sales to neighboring facilities. These revenue streams are further described in the table below and in the project proformas located in Appendix D: Indicative Project Proformas. It should be noted that revenues vary in accordance with the forecasts presented in Appendix E: Commodity Forecasts.

Project Revenue	Description
Avoided Costs: Electric PV Generation	This revenue stream stems from the value of the electricity produced from the PV array in accordance with NYSEG's non-residential net metering tariff or NYSEG's Community Distributed Generation tariff, whichever is greater. The project has assumed the value of the electric generation is at the avoided retail rate, which is described above in Section 5.1: Energy Pricing and Forecasts.
Avoided Costs: Electric CHP Generation	The project has assumed the value of this electric generation is at IAWWTF's avoided retail rate, which is described above in Section 5.1: Energy Pricing and Forecasts. The proposed CHP generation capacity will exceed the load at the IAWWTF therefore this revenue stream only applies to the balance of the IAWWTF load as currently supplied by NYSEG. The remaining generation is valued as export revenue, described later in this table.
Avoided Costs: Thermal NG	This revenue stream stems from the value of the heat recovered from the ADG CHP system. This value is based on the cost of hot water produced by natural gas in an 85% efficient boiler system. The proposed heat recovery will exceed the load at the IAWWTF therefore this revenue stream only applies to the balance of the IAWWTF load as currently supplied by NYSEG. The remaining recovered heat is valued as export revenue, described later in this table.
Export Revenue: Electric CHP Generation	This revenue stream applies to the balance of the generation from the CHP system and the value of the electricity is in accordance with NYSEG's Buy Back tariff or as otherwise agreed to with NYSEG. This is not the full retail value, rather the wholesale value or what NYSEG purchased power for, which for this project is represented by NYISO Zone C pricing.
Export Revenue: Thermal Export – Hot Water	This revenue stream applies to the heat recovered from the ADG CHP system that is in excess of that needed by IAWWTF. This value is based on the cost of hot water produced by natural gas in an 85% efficient boiler system. To be conservative, the project does not take into account the avoided capital and operating costs for a separate heat and power system at the end users facility.

Table 16: Project Revenue Descriptions

The project's expenses and operating costs are comprised of the fixed and variable operating costs associated with the ADG CHP system, district energy system, PV array, and microgrid components. Appendix C: Technical, Financial & Operational Summary provides a table of the assumptions and corresponding costs for all operating and maintenance activities for the project.

The financing structure for this project during development, construction, and operation will be determined in subsequent phases and may include a variety of private and public funding mechanisms.

5.7. Legal Viability (NYSERDA Task 3.6)

The ownership definition and structure for this project is still being developed at this time, with the concepts presented in Section 5.4: Commercial Viability - Project Team (NYSERDA Task 3.3) still being evaluated. It is anticipated that once this report is reviewed by the City they will be able to assess the project ownership structure with more certainty.

Access to the site will require coordinating with the City as they own the property that is being proposed as the site of the new systems.

In order to protect the privacy rights of the microgrids' customers, the project anticipates relying on NYSEG's standard operating procedures and codes of conduct. This includes privacy rights of microgrid customers including establishing proper protocols in the event a privacy concern is identified during subsequent project development, design, or operation of the microgrid.

With respect to regulatory hurdles and their implications, the proposed project includes the modification and use of NYSEG's existing distribution system, namely the Fourth Street 783 and 784 feeders, and as such the project will need to work closely with NYSEG to obtain approval to do so. Additional regulatory hurdles include the need to further evaluate the best tariff options for the various forms of generation. As of this report, the current applicable tariffs include NYSEG's net metering tariff, distributed generation buyback tariff, and the standard interconnection agreement for behind the meter generators. The project may further benefit should the anaerobic digester generation qualify as electric generating equipment eligible for net metering under New York Public Service Law § 66-j.

6. Benefit Cost Analysis (NYSERDA Task 4)

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

For IEc's full report, refer to Appendix H: NYSERDA COST BENEFIT REPORT, for the inputs and assumptions used to develop the results of the cost benefit test refer to Appendix I: NYSERDA COST BENEFIT QUESTIONNAIRES.

6.1. Methodology and Assumptions

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

- *Costs* represent the value of resources consumed (or benefits forgone) in the production of a good or service.
- *Benefits* are impacts that have value to a firm, a household, or society in general.
- *Net benefits* are the difference between a project's benefits and costs.

Both costs and benefits must be measured relative to a common *baseline* - for a microgrid, the "without project" scenario - that describes the conditions that would prevail absent a project's development. The BCA considers only those costs and benefits that are *incremental* to the baseline.

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

The BCA model is structured to analyze a project's costs and benefits over a 20-year operating period. The model applies conventional discounting techniques to calculate the present value of costs and benefits, employing an annual discount rate that the user specifies – in this case, seven percent.[9] It also calculates an annualized estimate of costs and benefits based on the anticipated

[9] 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

engineering lifespan of the system's equipment. Once a project's cumulative benefits and costs have been adjusted to present values, the model calculates both the project's net benefits and the ratio of project benefits to project costs. The model also calculates the project's internal rate of return, which indicates the discount rate at which the project's costs and benefits would be equal. All monetized results are adjusted for inflation and expressed in 2014 dollars.

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

The BCA considers costs and benefits for two scenarios:

Scenario 1: No major power outages over the assumed 20-year operating period (i.e., normal operating conditions only).

Scenario 2: The average annual duration of major power outages required for project benefits to equal costs, if benefits do not exceed costs under Scenario 1.[10]

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.]

[10] 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.

6.2. Developing Cost Benefit Test Inputs and Assumptions

To facilitate IEc's cost benefit test, SourceOne compiled information necessary to complete the questionnaires as provided by NYSERDA. The areas of information requested are summarized as follows:

- Facility and Customer Description
- Characterization of Distributed Energy Resources
- Capacity Impacts and Ancillary Services
- Project Costs
- Costs to Maintain Service during a Power Outage
- Services Supported by the Microgrid

Additional information pertaining to the above topics can be found in Appendix I: NYSERDA COST BENEFIT QUESTIONNAIRES.

6.3. Cost Benefit Test Results

As summary of the results of IEc's Cost Benefit Test are provided below.

ECONOMIC MEASURE	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES	
	SCENARIO 1: 0 DAYS/YEAR	SCENARIO 2: 0.2 DAYS/YEAR
Net Benefits - Present Value	**-$534,000**	**$467,000**
Benefit-Cost Ratio	**0.96**	**1.0**
Internal Rate of Return	**6.2%**	**8.2%**

Table 17: Cost Benefit Test Results

Details for each scenario are provided in the tables below.

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	**$1,380,000**	**$122,000**
Capital Investments	**$5,280,000**	**$465,000**
Fixed O&M	**$1,380,000**	**$121,000**
Variable O&M (Grid-Connected Mode)	**$839,000**	**$74,000**

Fuel (Grid-Connected Mode)	**$0**	**$0**
Emission Control	**$0**	**$0**
Emissions Allowances	**$0**	**$0**
Emissions Damages (Grid-Connected Mode)	**$4,200,000**	**$274,000**
Total Costs	**$13,100,000**	
Benefits		
Reduction in Generating Costs	**$3,510,000**	**$310,000**
Fuel Savings from CHP	**$969,000**	**$85,500**
Generation Capacity Cost Savings	**$1,960,000**	**$173,000**
Distribution Capacity Cost Savings	**$315,000**	**$27,800**
Reliability Improvements	**$434,000**	**$38,300**
Power Quality Improvements	**$1,680,000**	**$148,000**
Avoided Emissions Allowance Costs	**$1,930**	**$170**
Avoided Emissions Damages	**$3,680,000**	**$240,000**
Major Power Outage Benefits	**$0**	**$0**
Total Benefits	**$12,500,000**	
Net Benefits	**-$534,000**	
Benefit/Cost Ratio	**0.96**	
Internal Rate of Return	**6.2%**	

Table 18: Scenario 1 Cost Benefit Test Details

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$1,380,000	$122,000
Capital Investments	$5,280,000	$465,000
Fixed O&M	$1,380,000	$121,000
Variable O&M (Grid-Connected Mode)	$839,000	$74,000
Fuel (Grid-Connected Mode)	$0	$0
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$4,200,000	$274,000
Total Costs	$13,100,000	
Benefits		
Reduction in Generating Costs	$3,510,000	$310,000
Fuel Savings from CHP	$969,000	$85,500
Generation Capacity Cost Savings	$1,960,000	$173,000
Distribution Capacity Cost Savings	$315,000	$27,800
Reliability Improvements	$434,000	$38,300
Power Quality Improvements	$1,680,000	$148,000
Avoided Emissions Allowance Costs	$1,930	$170
Avoided Emissions Damages	$3,680,000	$240,000
Major Power Outage Benefits	$1,000,000	$88,400
Total Benefits	$13,500,000	
Net Benefits	$467,000	
Benefit/Cost Ratio	1.0	
Internal Rate of Return	8.2%	

Table 19: Scenario 2 Cost Benefit Test Details

7. Additional Project Concepts

This section provides a summary of concepts that have been contemplated during the evaluation of the microgrid and which warrant fatal flaw screening and evaluation in subsequent phases of development.

7.1. Biogas Upgrading and Effluent Heat Recovery

The ability to produce and combust pipeline quality natural gas has several benefits over the combustion of raw biogas ; increased flexibility for conversion to electricity, vehicle fuel, standard boiler fuel to name a few. From a marketing perspective the pipeline natural gas could be viewed as a source of non-frack gas. The following two diagrams are provided to show a simplified schematic of the existing process as compared to a modified process which includes a biogas upgrading unit and effluent heat pump system.

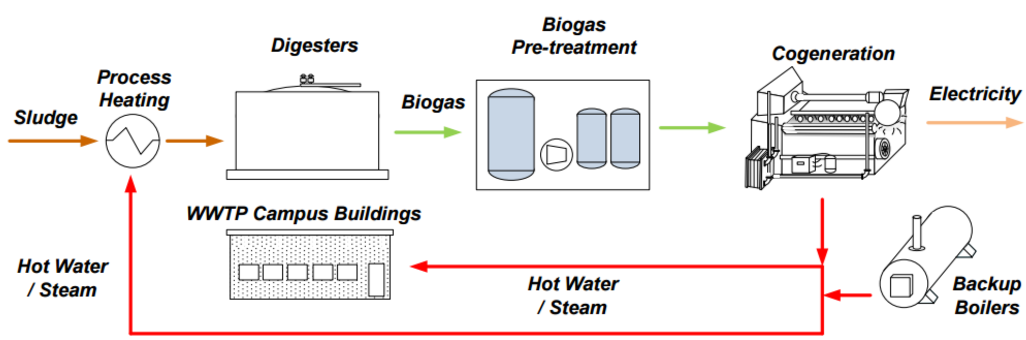


Figure 12: Existing IAWWTF - Simplified Process[11]

[11] Process diagrams from "Heat Extraction from Plant Effluent: "Pumped up Heat Pumps", Brown and Caldwell

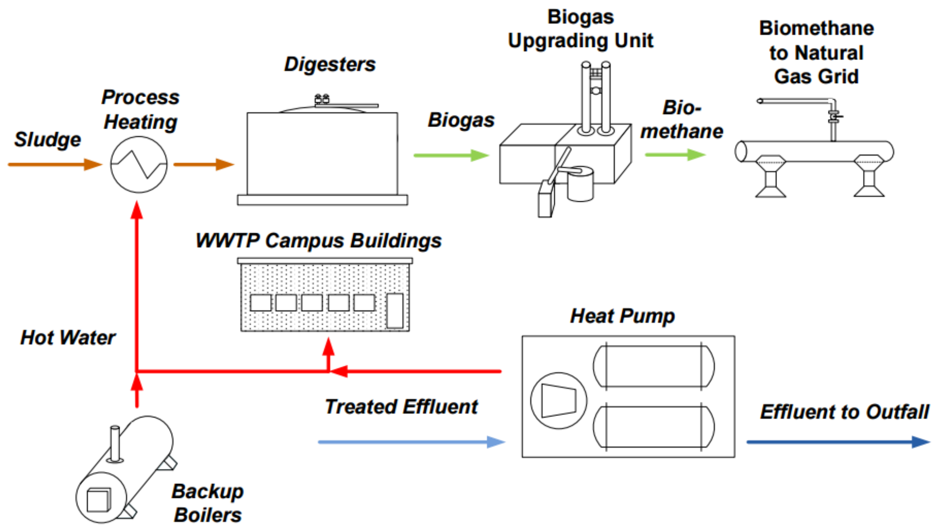


Figure 13: Conceptual Process w/ Biogas upgrading and Heat Pump System

7.2. Sludge Drying w/ Biogas or Heat Recovery

The following diagram depicts concept options for additional sludge drying (i.e. increased use of biogas or heat recovery from onsite biogas electrical generation). The IAWWTF currently produces approximately 4500 tons of sludge per year and utilizes a belt filter press for dewatering. There is currently no active heating system used to further remove moisture. The belt filter press process produced sludge at 23% T.S which is hauled from the plant at a cost of approximately $55/Wet Ton.

SourceOne recommended further evaluation of additional heat loads through sludge drying during subsequent phases of development. Thermal loads closer to the proposed new biogas and heat recovery system have greater financial benefit over distant thermal loads.

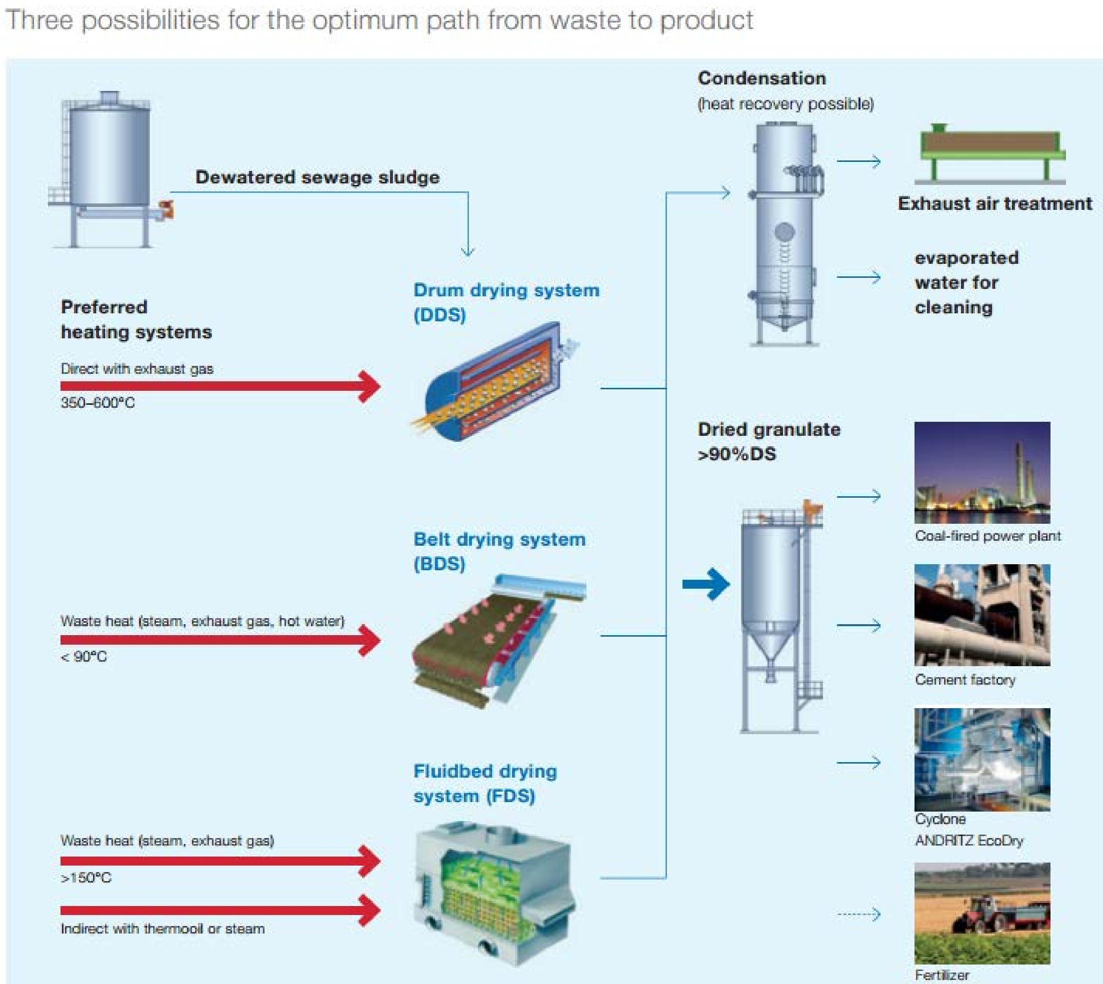


Figure 14: Sludge Drying Concepts[12]

7.3. Hydro w/ and w/o Pumped Storage

Six Mile creek, Fall Creek and Cascadilla creek along with two local reservoirs may offer the opportunity for small scale hydroelectric power and or pumped storage. As the City continues to evaluate options to meet its energy requirements, these concepts should be vetted through an initial fatal flaw analysis to determine their applicability. The area has a rich history of hydroelectric generation and a small (1MW) run of the river facility is currently in operation on the Cornell University Campus (Fall Creek).

[12] Andritz Separation, drying technologies for sewage sludge

7.4. Other Potential District Energy Systems[13]

Through research conducted as part of this feasibility study SourceOne revealed a summary document of other potential microgrid/district energy concepts that have been noted in and around the City. The intention of listing these potential projects is to provide context for the City as it evaluates the concepts presented in this study relative to other energy project developments.

- The Commons: Potential 12 MW grid to serve 3.5 million square feet of building space in downtown Ithaca
- Cornell Business and Technology Park: 300 acres (200 commercial, 100 residential), 26 buildings, approximately 700,000 square feet of space, large concentration of wet labs and clean rooms
- Healthcare Facilities: Cayuga Medical Center (CMC) has a thermal energy plant and future expansion of this system could convert it to CHP. The peak electricity load for Cayuga Medical Center is ~2.2 MW. CMC completed the first phase of a CHP feasibility study in fall 2012 and conducted a technical study on assessing whether district heating for structures near the medical center could be incorporated into the system.
- Retirement Communities: Kendal at Ithaca, a senior living community in Ithaca, owns 212 cottages of different sizes ranging from a studio to a two bedroom with den, a 36-room Enhanced Assisted Living Residence, and a 35-room Skilled Nursing Facility. Constant heat and electricity are also required for Kendal to provide reliable medical care and nursing services.
- Hotels: Hotels have a number of characteristics that make them good targets for installing CHP systems.
- Ithaca Chainworks District: This active project will redevelop upwards of 1 million square feet of a former industrial site. A recent CHP and renewable energy study has been performed and concluded that a 2MW CHP system would be viable.

[13] http://tompkinscountyny.gov/files/planning/energyclimate/documents/District%20Energy%20Systems%2010-15-15.pdf

8. Lessons Learned

This section provides a brief summary of some of the key lessons that the project team has learned throughout the process of evaluating of the proposed microgrid.

1. Understanding key drivers for the development of the microgrid is critical for the entire project team to understand from the onset of the project. For example, will the generating equipment be expected to only operate when there is an emergency event or for the entirety of the year.

2. It is difficult to identify a clear revenue stream associated with the equipment upgrades on the host utility's distribution system. Including these costs into a potential combined heat and power plant increases the difficulty in developing a financially feasible project without financial incentives. As such, it is likely necessary to separate control and association of these assets from the generating equipment to encourage private development of the generating equipment.

3. Stakeholder management is complex and difficult as there are a large number of varying interests and levels of support. Stakeholders range from the end use facilities, host utility, various city and town agencies as well as the feedstock supply chain for anaerobic digester gas production.

4. There still exists an extensive amount of policy work to be done regarding the responsibility and liability for the equipment served by the microgrid during an event. It is still not clear who will be held responsible in the event that equipment served by the microgrid is damaged.

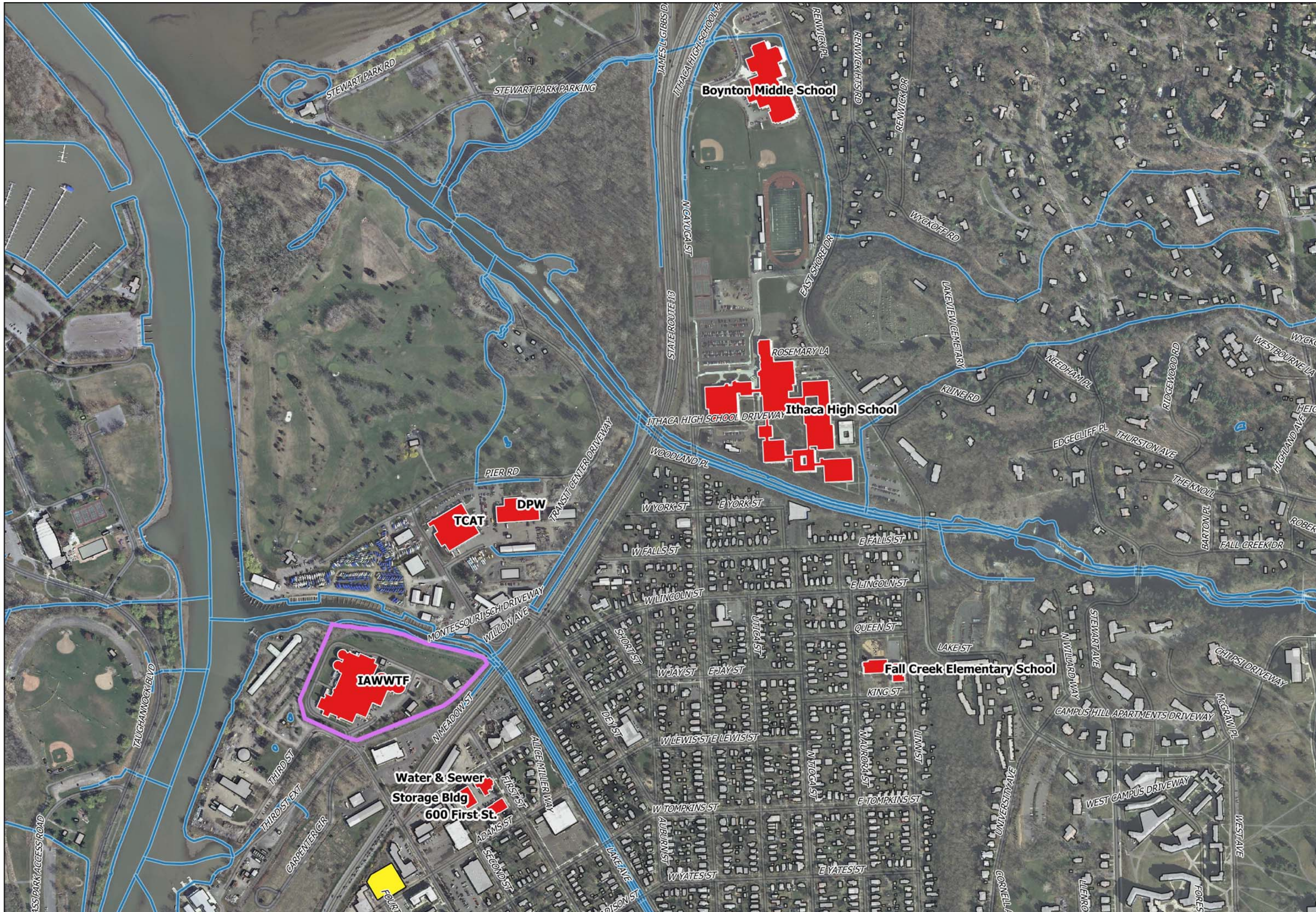
5. Difficulty in obtaining information from both the participating utility and potential load sites resulted in delays in developing the study. Feeder maps and feeder load information became critical path early on in the development process and the project needed to be put on hold until the information was made available.

APPENDIX A. PROJECT DEVELOPMENT MAPS

NED1

Legend

- Points of Interest
- Buildings
- Substations
- IAWWTF Tax Parcel
- Roads
- Waterways



0	500	1000 ft

N

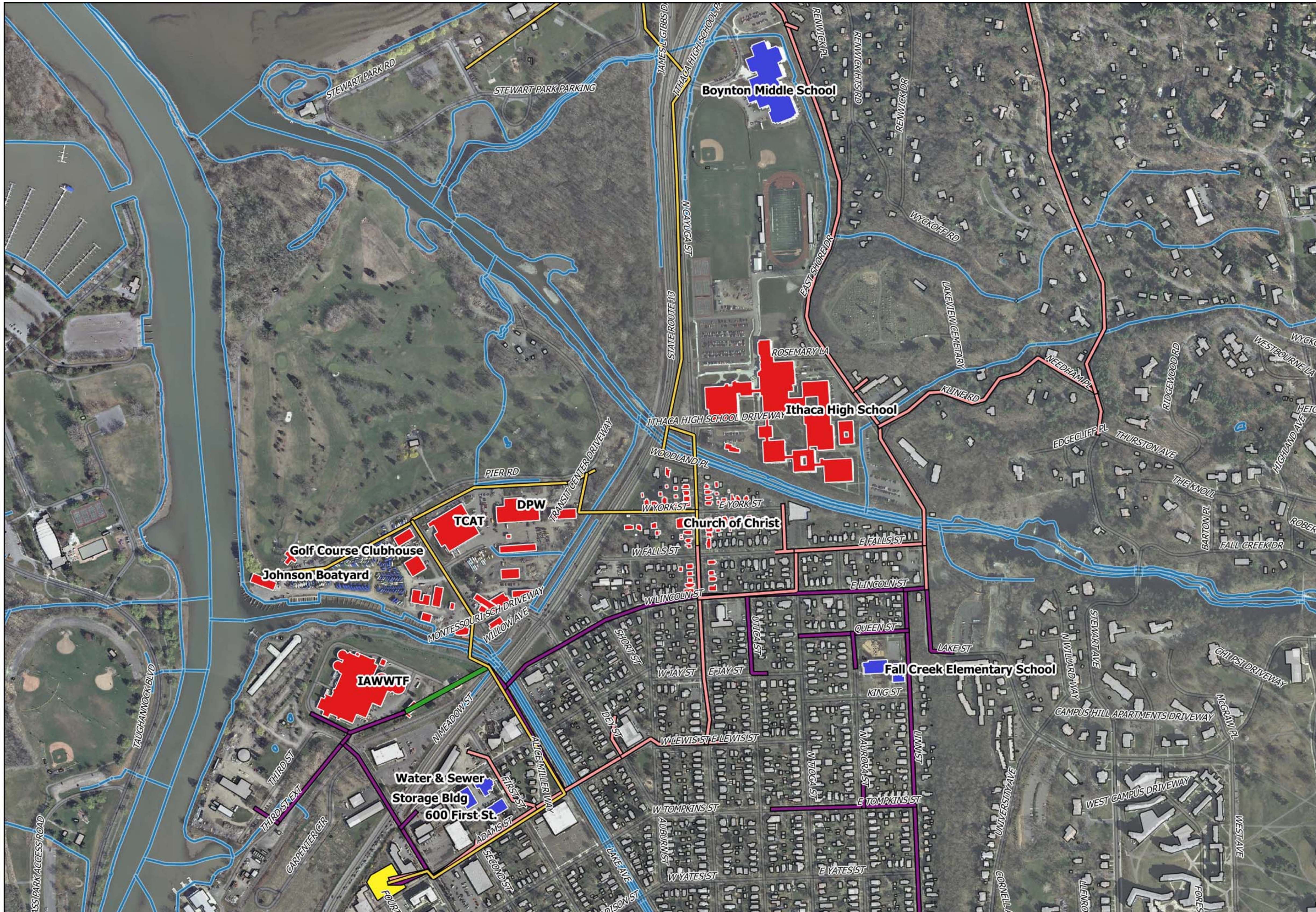
For discussion purposes only.
Not for construction.

Ithaca Community Microgrid
North Energy District—Overview

REV	1
SIZE	B
REVISED	02/04/2016
ISSUED	02/04/2016
DRAWN BY	C.C.L.
SCALE	

SourceOne
A Veolia Energy Company

NED2



Legend

Points of Interest

- Microgrid Buildings
- Excluded Buildings
- Buildings
- Substations
- Roads
- Waterways

NYSEG Distribution Lines

- 783
- 784
- 785
- Proposed Changes

Peak Energy Loads

Building Name	Electric (kW)
Boynton Middle School	311.52
TCAT	173.91
DPW	77.73
IAWWTF	778.32
Ithaca High School	574.56

0 500 1000 ft

N

For discussion purposes only.
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Ithaca Community Microgrid
North Energy District—Feeders and Microgrid Buildings

REV	1
SIZE	B
Drawn by	C.C.L.
SCALE	
REVISED	02/04/2016
ISSUED	02/04/2016

SourceOne
A Veolia Energy Company

NED3

Legend

Points of Interest
- Microgrid Buildings
- Buildings
- Substations
- Roads
- Waterways

NYSEG Distribution Lines
- 783
- 784
- 785
- Proposed Changes

Peak Energy Loads

Building Name	Electric (kW)
TCAT	173.91
DPW	77.73
IAWWTF	778.32
Ithaca High School	574.56

0 250 500 750 ft

For discussion purposes only.
Not for construction.

Ithaca Community Microgrid North Energy District—Feeders, Microgrid Buildings, and Existing Emergency Generators	REV 1	SIZE B	SourceOne A Veolia Energy Company
Drawn by G.J.	Scale		Revised 02/04/2016 Issued 02/04/2016

NED4

Legend

- Microgrid Buildings
- Proposed Generation
- Possible Development
- Buildings
- IAWWTF Tax Parcel
- Roads
- Waterways

NYSEG Distribution Lines

- 783
- 784
- 785
- Proposed Changes

0 125 250 ft

N

For discussion purposes only.
Not for construction.

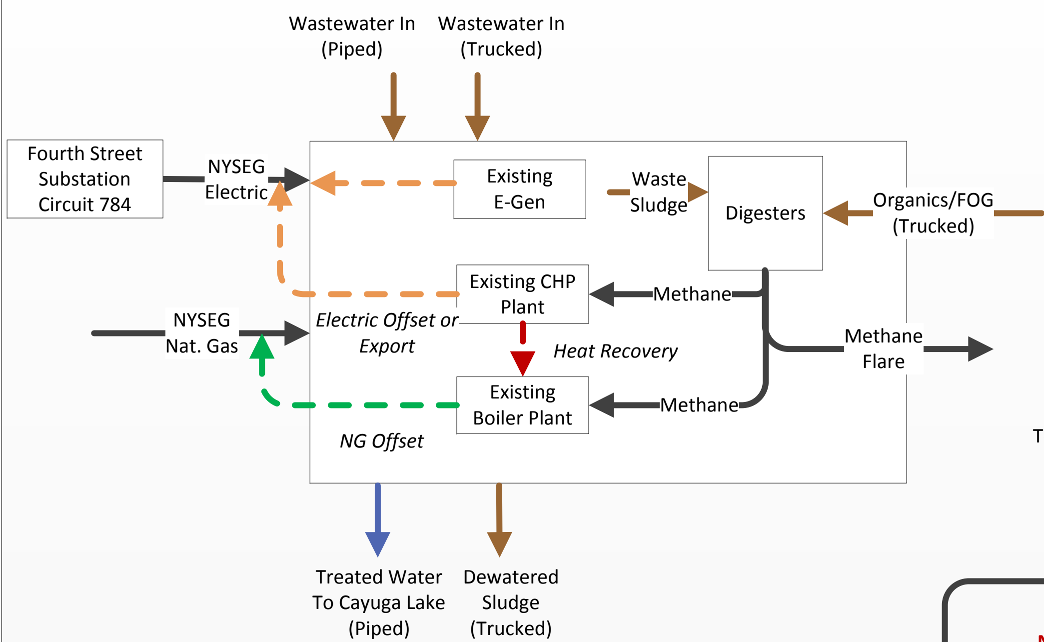
Ithaca Community Microgrid
North Energy District—Proposed PV and CHP Generation Systems

REV 2	SIZE B	REVISED	02/05/2016
Drawn by	A.R.C.	ISSUED	02/05/2016
SCALE			

SourceOne
A Veolia Energy Company

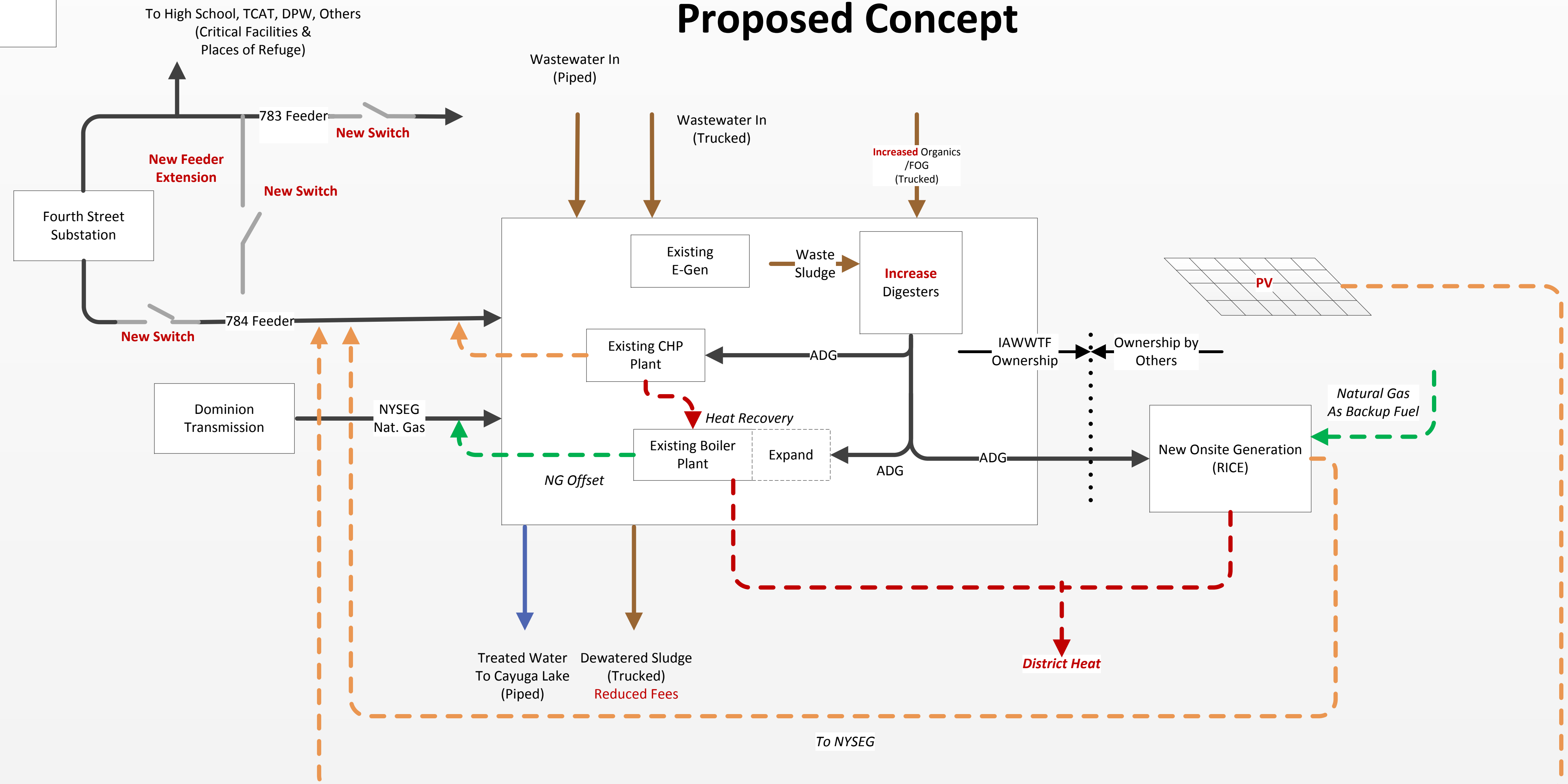
APPENDIX B. PROJECT CONCEPTUAL DESIGN DRAWINGS

Existing System



CONCEPT 1

Proposed Concept

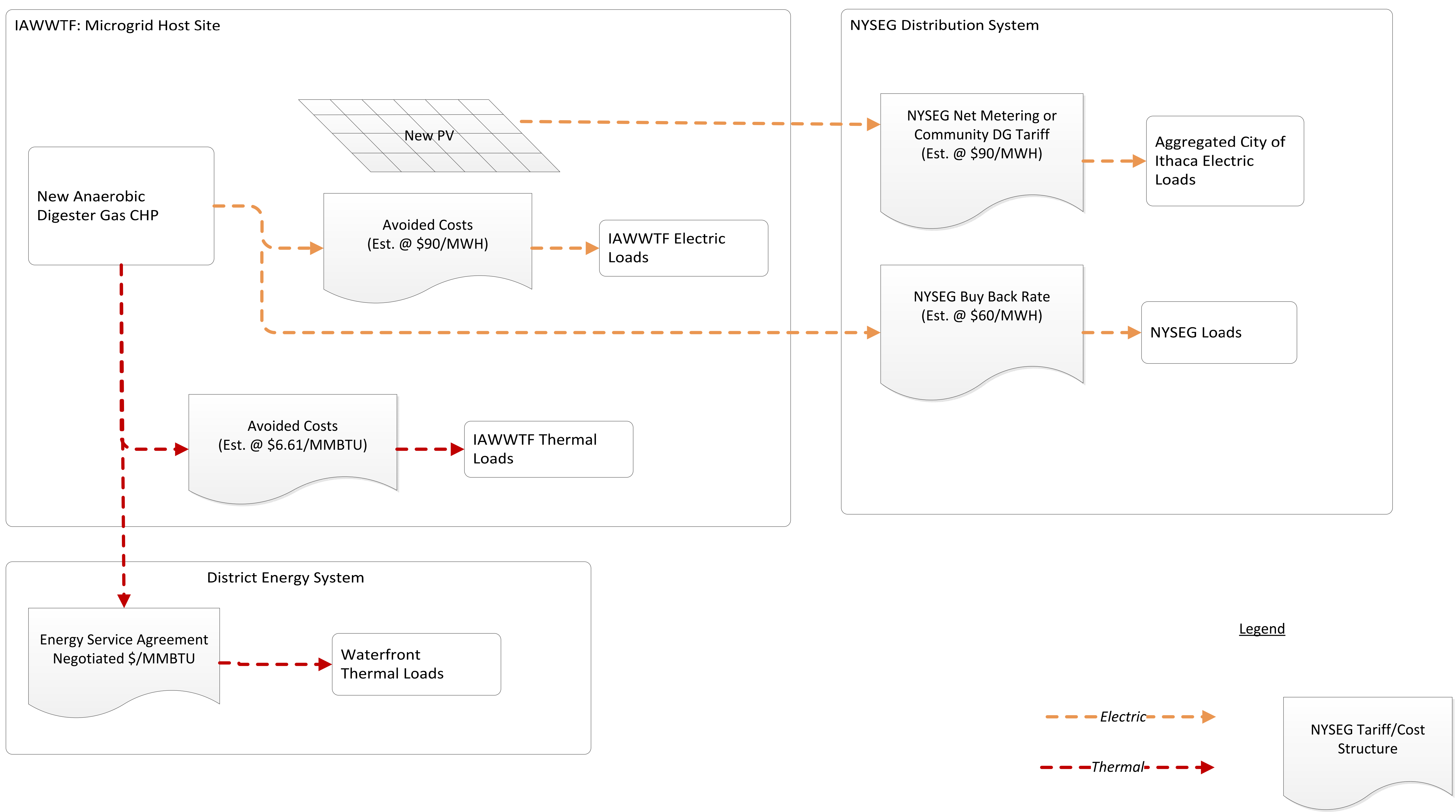


For discussion purposes only.
Not for construction.

Ithaca Community Microgrid Energy Systems & Energy Flows	REV 1	REVISED 02/08/2016
	SIZE B	ISSUED 02/08/2016
Drawn by G.J.	SCALE: NTS	

SourceOne
A Veolia Energy Company

Commercial 1



For discussion purposes only.
Not for construction.

Ithaca Community Microgrid Commercial Block Diagram	REV 1	SourceOne — A Veolia Energy Company
	SIZE B	REVISED 02/08/2016
Drawn by G.J.	SCALE: NTS	ISSUED 02/08/2016

MG1

General Notes

- Symbols shown in green indicate proposed microgrid equipment.

Legend

- Microgrid Buildings
- Substations
- Roads
- Waterways

NYSEG Distribution Lines

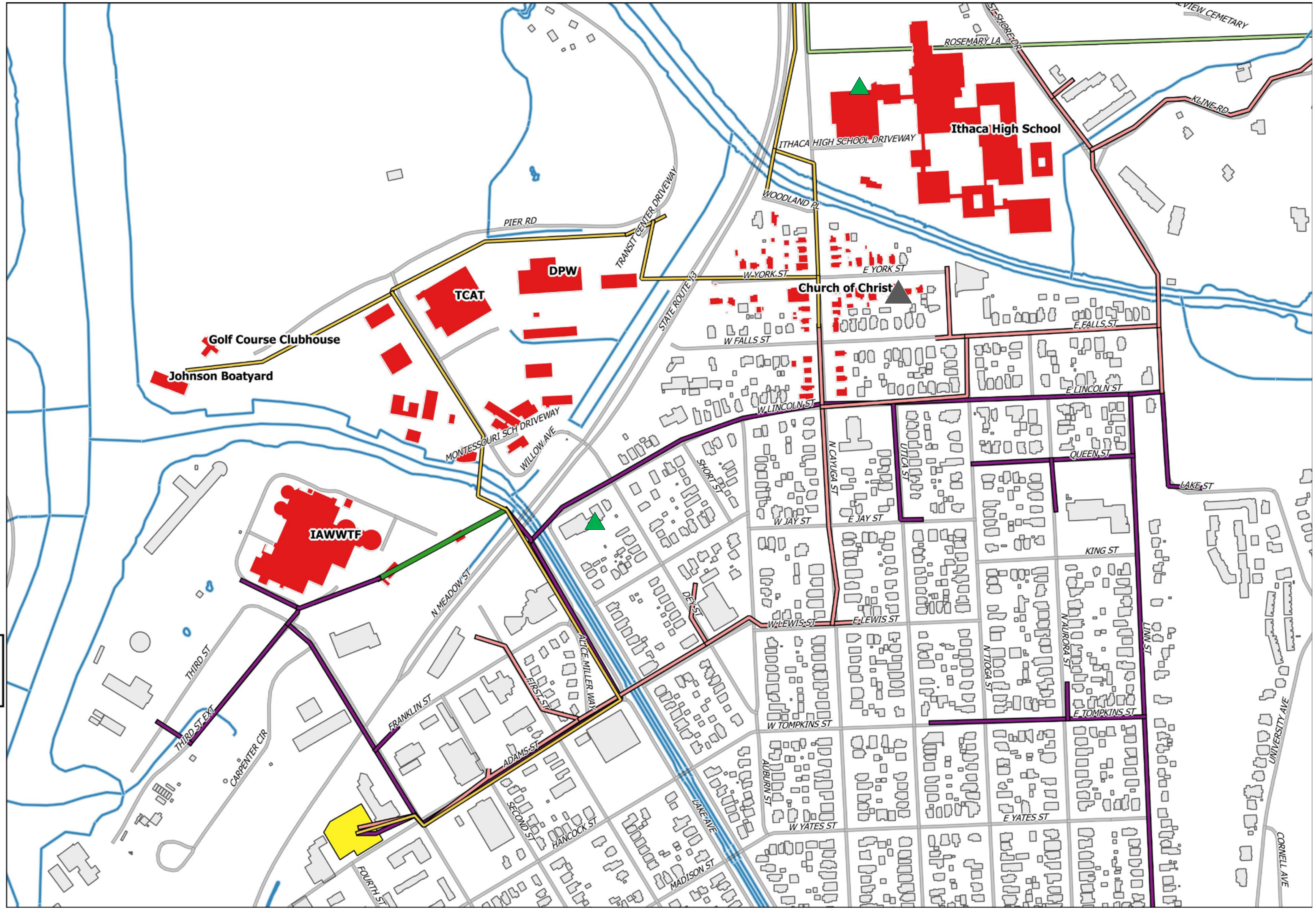
- 783
- 784
- 785
- Proposed Changes

Symbol Guide

- Load Break Switch-Proposed
- Load Break Switch-Existing

0 250 500 750 ft

N



For discussion purposes only.
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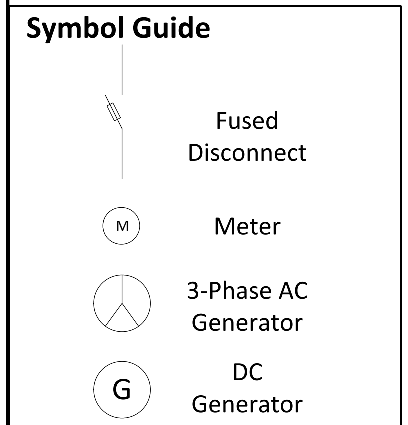
Ithaca Community Microgrid
North Energy District—Proposed Changes

REV	1	SIZE	B
Drawn by	G.J.	Scale	
REVISED	02/08/2016	ISSUED	02/08/2016

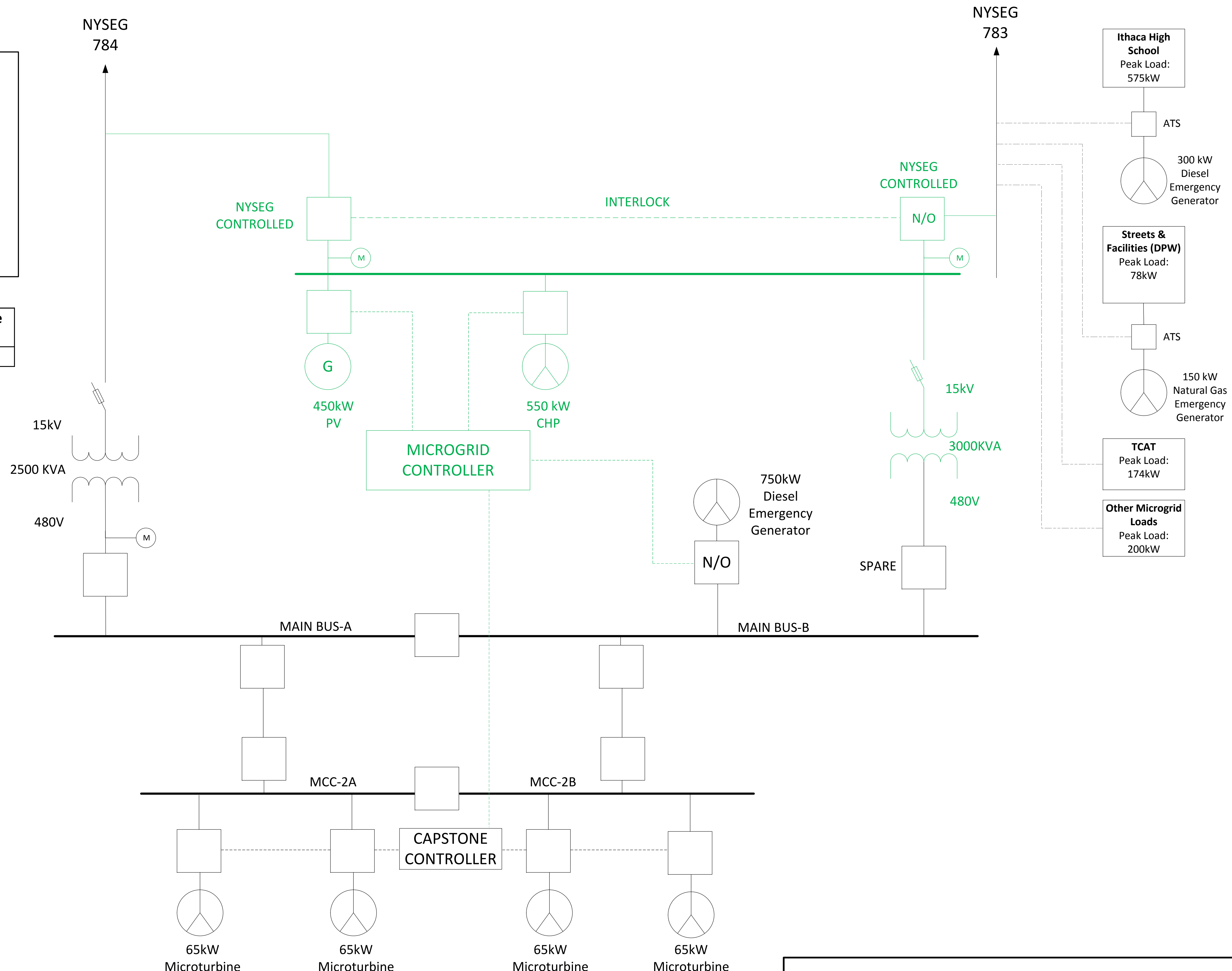
SourceOne
A Veolia Energy Company

MG2

General Notes
- Black color indicates existing infrastructure and equipment.
- Green color indicates future/ proposed infrastructure and equipment.
- All breakers normally closed unless otherwise indicated.



Coincident Peak Load	Dispatchable Generation
1440 kW	1560 kW



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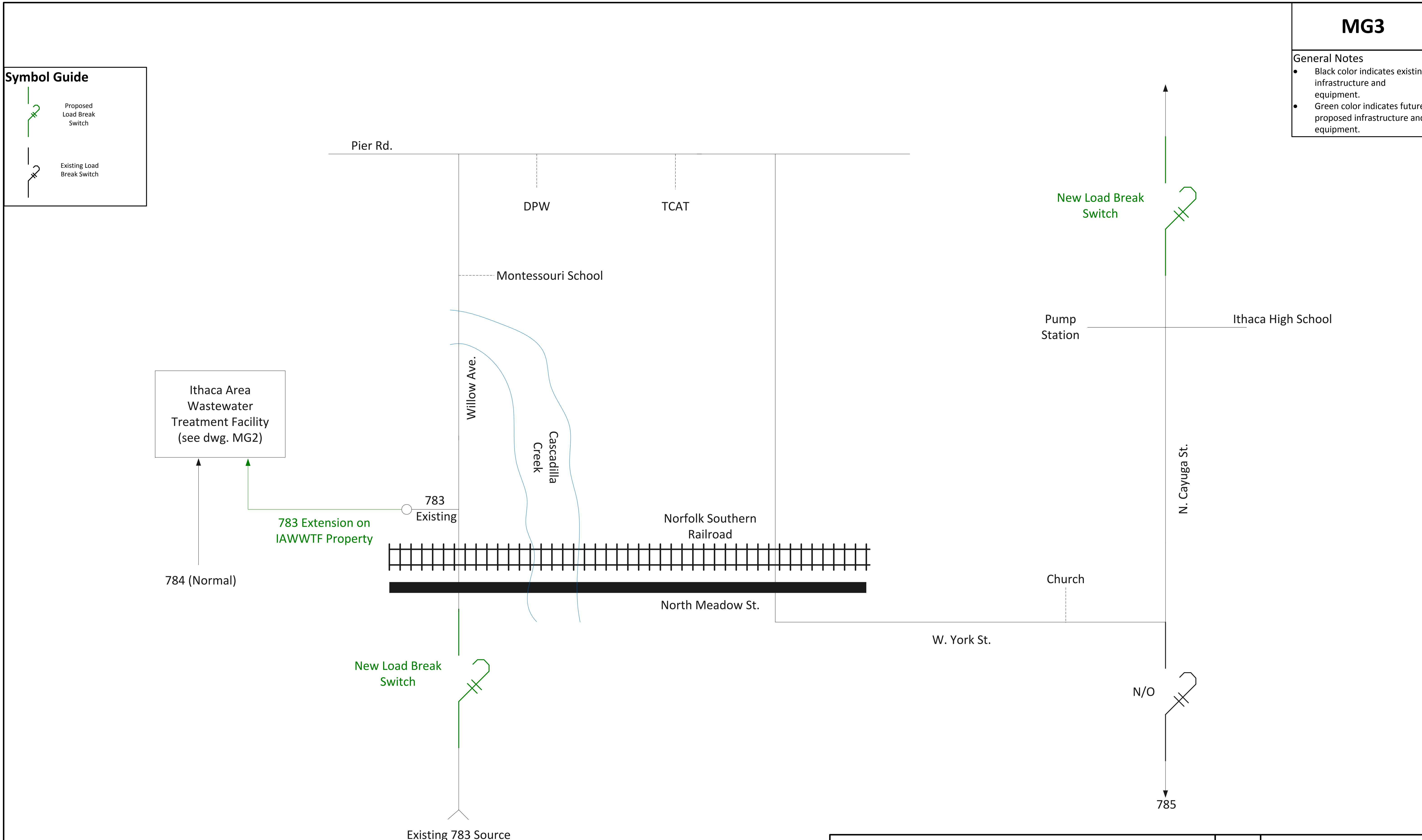
ITHACA COMMUNITY MICROGRID IAWWTF CONNECTION ONE-LINE—PROPOSED	REV 1	SourceOne A Veolia Energy Company
	SIZE B	REVISED 02/04/2016
DRAWN BY G.J. / NOT TO SCALE		ISSUED 02/04/2016



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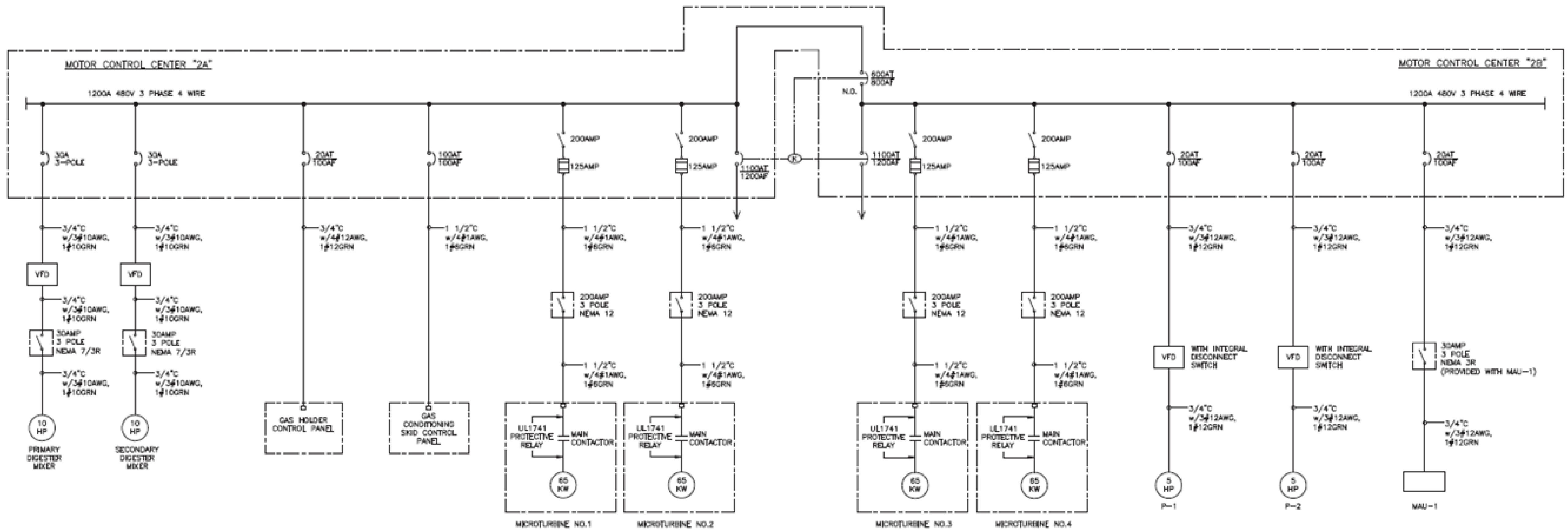
Not for construction.

Ithaca Community Microgrid Feeder Main Line Diagram	REV 1	SIZE B	SourceOne A Veolia Energy Company
Drawn by G.J.	Not to scale	Revised 02/04/2016	Issued 02/04/2016

MG4



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THIS DRAWING DERIVED FROM: STEARNS & WHEELER - ITHACA AREA WASTEWATER TREATMENT PLANT, CONTRACT NO. 3A, DRAWING S-1 OF RECORD DRAWING SET, DATED 12/05/88.

IN CHARGE OF CASE H. SMEENK
DESIGNED BY BTN CHECKED BY BTN
DRAWN BY BTN

NOT TO SCALE

NO.	DATE	REVISION	INIT.
0	09/14/2012	ISSUED FOR CONSTRUCTION	CHS

Johnson Controls

O'BRIEN & GERE

JCI ENERGY PERFORMANCE CONTRACT
ITHACA AREA WASTEWATER TREATMENT FACILITY (IAWWTF)

ELECTRICAL
FIM NOS. 1, 3, & 4
ONE-LINE DIAGRAM

FILE NO. 10747.44774-501
DATE SEPTEMBER 2012

E-2

FOR DISCUSSION PURPOSES ONLY.
NOT FOR CONSTRUCTION.

REFERENCE ONELINE DWG #1

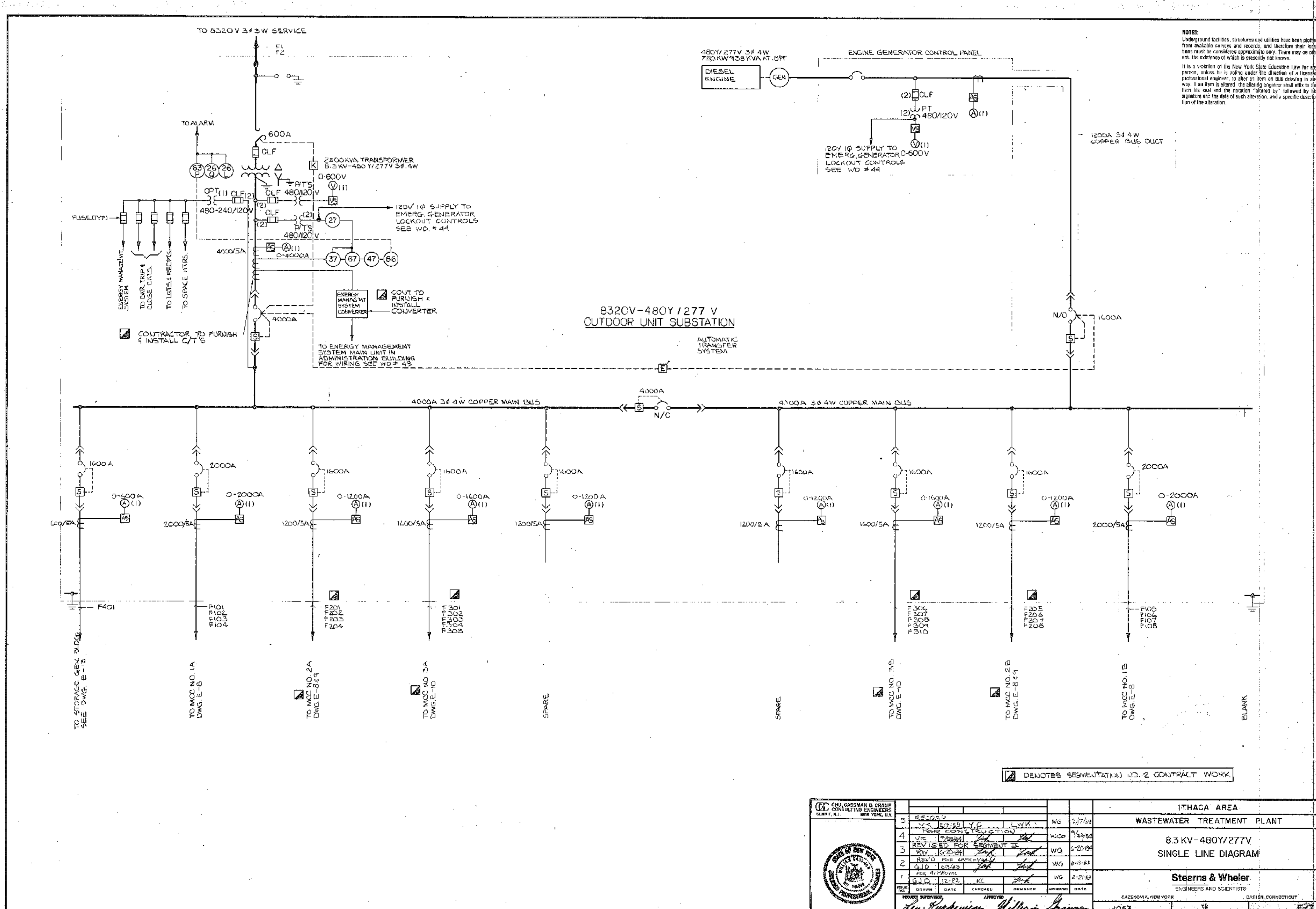
REV 1
SIZE B

SourceOne
A Veolia Energy Company

DRAWN BY G.J.

REVISED 01/20/2016
ISSUED 01/20/2016

MG5



For discussion purposes only.
Not for construction.

Reference One Line Dwg #2

REV	1
SIZE	B

SourceOne
A Veolia Energy Company

REVISED	01/20/2016
ISSUED	01/20/2016

Drawn by G.J.

APPENDIX C. TECHNICAL, FINANCIAL & OPERATIONAL SUMMARY

Conceptual Microgrid Deployment Scenarios

Technical and Financial Summary

Scenario		1	2	3	4	5
Prime Mover		Duel Fueled Natural Gas/Biogas Reciprocating Engine				
Prime Mover Location		IAWWTF	IAWWTF	High School	IAWWTF	IAWWTF
Electric Revenue Source		Net Meter at Retail Rate w/ Export at Wholesale Rate				Net Meter w/ export at retail
Electric Distribution		Connect Partial 783 to Partial 784 Feeder				
Heat Recovery		None	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water
Heat Recovery Distribution		N/A	IAWWTF & High School	High School	IAWWTF & Waterfront Development	IAWWTF & Waterfront Development
Heat Recovery Revenue Source		N/A	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate
PV Location		IAWWTF				
PV Revenue Source		Net Meter at Retail Rate or Communicty DG Tariff				
Project Term (yrs)		20	20	20	20	20
WACC		5%	5%	5%	5%	5%
Anaerobic Digester Gas to Electricity						
Total New Biogas Available for Export	MMBTU/Yr	41,230	41,230	41,230	41,230	41,230
Estimated Generator Heat Rate	BTU/KWH	8,248	8,248	8,248	8,248	8,248
New Biogas Production Capacity Factor	%	90%	90%	90%	90%	90%
Maximum Biogas Generator Capacity	KW	571	571	571	571	571
Proposed Installed Biogas Capacity	KW	550	550	550	550	550
Biogas Electrical Generation	KWH/Year	4,336,200	4,336,200	4,336,200	4,336,200	4,336,200
Biogas Routing System	$	-	-	728,000	-	-
Estimated Total Project Cost - Gross	$	$1,709,500	$1,839,500	$2,567,500	$1,839,500	$1,839,500
District Energy & Thermal Distribution System						
Potential Heat Recovery	MMBTU/HR	1.9	1.9	1.9	1.9	1.9
Potential Recoverable Heat	MMBTU/Yr	16,678	16,678	16,678	16,678	16,678
Utilization Factor of Recoverable Heat	%	0%	75%	75%	75%	75%
Useful Heat Recovered	MMBTU/Yr	-	12,509	12,509	12,509	12,509
Load Diversification Factor	%	100%	90%	90%	100%	100%
Distribution Network Length	Ft	-	1,700	-	500	500
Estimated Total Component Cost - Gross	$	$0	$2,470,000	$260,000	$910,000	$910,000
PV System						
Installed Solar Capacity	KW	430	430	430	430	430
Annual Capacity Factor Solar	%	15%	15%	15%	15%	15%
Solar Generation	KWH	565,020	565,020	565,020	565,020	565,020
Estimated Total Project Cost - Gross	$	$1,303,029	$1,303,029	$1,303,029	$1,303,029	$1,303,029
EPC Package	$	$1,400,000	$1,400,000	$1,400,000	$1,400,000	$1,400,000
Microgrid System						
Estimated Total Project Cost - Gross		$1,222,650	$1,222,650	$1,222,650	$1,222,650	$1,222,650
Project Financial Summary Metrics						
Total Project Cost		$ 4,235,179	$ 6,835,179	$ 5,353,179	$ 5,275,179	$ 5,275,179
Year 1 Value of Electricity Generated		$ 429,233	$ 429,233	$ 451,551	$ 429,233	$ 487,278
Year 1 Value of Heat Recovered		$ -	$ 106,474	$ 110,882	$ 66,803	$ 154,962
Year 1 Operting Costs		$ 342,167	$ 355,294	$ 350,294	$ 355,294	$ 355,294
Year 1 Cash Flow		$ 87,066	$ 180,413	$ 212,139	$ 140,741	$ 286,946
Net Present Value (SourceOne Forecasts)		$ (2,352,870)	$ (3,156,708)	$ (623,428)	$ (1,612,059)	$ (144,168)
Required Incentive for Zero NPV		$ 2,470,514	$ 3,314,544	$ 654,599	$ 1,692,662	$ 151,377

Conceptual Microgrid Deployment Scenarios

Operations and Maintenance Cost Estimates

Scenario	1	2	3	4	5
Prime Mover	Duel Fueled Natural Gas/Biogas Reciprocating Engine				
Prime Mover Location	IAWWTF	IAWWTF	High School	IAWWTF	IAWWTF
Electric Revenue Source	Net Meter at Retail Rate w/ Export at Wholesale Rate				Net Meter w/ export at
Electric Distribution	Connect Partial 783 to Partial 784 Feeder				
Heat Recovery	None	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water
Heat Recovery Distribution	N/A	IAWWTF & High School	High School	IAWWTF & Waterfront Development	IAWWTF & Waterfront Development
Heat Recovery Revenue Source	N/A	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate
PV Location	IAWWTF				
PV Revenue Source	Net Meter at Retail Rate or Communicty DG Tariff				
Project Term (yrs)	20	20	20	20	20
WACC	5%	5%	5%	5%	5%

Biogas												
Fixed O&M	$5,000.00	L.S	0	$0	0	$0	1	$5,000	0	$0	0	$0
Variable O&M	$0	$/MMBTU	0	$0	0	$0	1	$0	0	$0	0	$0
Total Biogas				$0		$0		$5,000		$0		$0
CHP Plant - AEDG												
FTE	$100,000	$/yr	1	$100,000	1	$100,000	1	$100,000	1	$100,000	1	$100,000
Engine Maintenance	$14.000	$/MWh	4,336	$60,707	4,336	$60,707	4,336	$60,707	4,336	$60,707	4,336	$60,707
HRU Maintenance	$0.2500	$/MMBTU	0	$0	12,509	$3,127	12,509	$3,127	12,509	$3,127	12,509	$3,127
Total CHP Plant - AEDG				$160,707		$163,834		$163,834		$163,834		$163,834
District Thermal Energy System												
Fixed O&M	$10,000.00	L.S	0	$0	1	$10,000	0	$0	1	$10,000	1	$10,000
Variable O&M	$0	$/MMBTU	0	$0	0	$0	0	$0	0	$0	0	$0
Total District Thermal Energy System				$0		$10,000		$0		$10,000		$10,000
PV Array												
PV Fixed O&M	15.00	$/kW	430	$6,450	430	$6,450	430	$6,450	430	$6,450	430	$6,450
PV Variable O&M	-	$/kWh	430	$0	430	$0	430	$0	430	$0	430	$0
Total PV Array				$6,450		$6,450		$6,450		$6,450		$6,450
Microgrid System												
Fixed O&M	$5,000	L.S	1	$5,000	1	$5,000	1	$5,000	1	$5,000	1	$5,000
	$0	L.S	1	$0	1	$0	1	$0	1	$0	1	$0
Total Microgrid System				$5,000		$5,000		$5,000		$5,000		$5,000
Total Project Operations and Maintenance Estimate				$172,157		$185,284		$180,284		$185,284		$185,284

Conceptual Microgrid Deployment Scenarios

Project Cost Estimates

Scenario	1	2	3	4	5
Prime Mover	Duel Fueled Natural Gas/Biogas Reciprocating Engine				
Prime Mover Location	IAWWTF	IAWWTF	High School	IAWWTF	IAWWTF
Electric Revenue Source	Net Meter at Retail Rate w/ Export at Wholesale Rate				Net Meter w/ export at
Electric Distribution	Connect Partial 783 to Partial 784 Feeder				
Heat Recovery	None	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water
Heat Recovery Distribution	N/A	IAWWTF & High School	High School	IAWWTF & Waterfront Development	IAWWTF & Waterfront Development
Heat Recovery Revenue Source	N/A	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate
PV Location	IAWWTF				
PV Revenue Source	Net Meter at Retail Rate or Communicty DG Tariff				
Project Term (yrs)	20	20	20	20	20
WACC	5%	5%	5%	5%	5%

Biogas Routing	Unit Cost	Unit	Qty (1)	Cost (1)	Qty (2)	Cost (2)	Qty (3)	Cost (3)	Qty (4)	Cost (4)	Qty (5)	Cost (5)
Gas Distribution Piping, 4" Polyethlene SDR-10	$300	$/ft	0	$0	0	$0	1,700	$510,000	0	$0	0	$0
Piping specialties, trim and interconnect	$50,000	$/UNIT	0	$0	0	$0	1	$50,000	0	$0	0	$0
Total Hard Costs				$0		$0		$560,000		$0		$0
Engineering	12%	%	1	$0	1	$0	1	$67,200	1	$0	1	$0
Construction and Project Management	10%	%	1	$0	1	$0	1	$56,000	1	$0	1	$0
Start-Up and Commissioning	3%	%	1	$0	1	$0	1	$16,800	1	$0	1	$0
Legal/Permits/Permissions	5%	%	1	$0	1	$0	1	$28,000	1	$0	1	$0
Total Soft Costs				$0		$0		$168,000		$0		$0
Total Biogas Routing				$0		$0		$728,000		$0		$0

ADG CHP Plant	Unit Cost	Unit	Qty (1)	Cost (1)	Qty (2)	Cost (2)	Qty (3)	Cost (3)	Qty (4)	Cost (4)	Qty (5)	Cost (5)
Prime Movers	$800	$/kW	550	$440,000	550	$440,000	550	$440,000	550	$440,000	550	$440,000
Heat Recovery Unit	$100,000	$/MMBTU	0	$0	1	$100,000	1	$100,000	1	$100,000	1	$100,000
SCR / Emission System	$500	$/kW	550	$275,000	550	$275,000	550	$275,000	550	$275,000	550	$275,000
Electrical Scope of Work	$150,000	L.S	1	$150,000	1	$150,000	1	$150,000	1	$150,000	1	$150,000
Mechanical Scope of Work	$175,000	L.S	1	$175,000	1	$175,000	1	$175,000	1	$175,000	1	$175,000
Civil Scope of Work	$50,000	L.S	1	$50,000	1	$50,000	1	$50,000	1	$50,000	1	$50,000
Control System Scope of Work	$125,000	L.S	1	$125,000	1	$125,000	1	$125,000	1	$125,000	1	$125,000
Building/Enclosure	$200	$/sq ft	500	$100,000	500	$100,000	500	$100,000	500	$100,000	500	$100,000
Total Hard Costs				$1,315,000		$1,415,000		$1,415,000		$1,415,000		$1,415,000
Engineering	12%	%	1	$157,800	1	$169,800	1	$169,800	1	$169,800	1	$169,800
Construction and Project Management	10%	%	1	$131,500	1	$141,500	1	$141,500	1	$141,500	1	$141,500
Start-Up and Commissioning	3%	%	1	$39,450	1	$42,450	1	$42,450	1	$42,450	1	$42,450
Legal/Permits/Permissions	5%	%	1	$65,750	1	$70,750	1	$70,750	1	$70,750	1	$70,750
Total Soft Costs				$394,500		$424,500		$424,500		$424,500		$424,500
Total ADG CHP Plant				$1,709,500		$1,839,500		$1,839,500		$1,839,500		$1,839,500

Conceptual Microgrid Deployment Scenarios

Project Cost Estimates

Scenario	1	2	3	4	5
Prime Mover	Duel Fueled Natural Gas/Biogas Reciprocating Engine				
Prime Mover Location	IAWWTF	IAWWTF	High School	IAWWTF	IAWWTF
Electric Revenue Source	Net Meter at Retail Rate w/ Export at Wholesale Rate				Net Meter w/ export at
Electric Distribution	Connect Partial 783 to Partial 784 Feeder				
Heat Recovery	None	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water
Heat Recovery Distribution	N/A	IAWWTF & High School	High School	IAWWTF & Waterfront Development	IAWWTF & Waterfront Development
Heat Recovery Revenue Source	N/A	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate
PV Location	IAWWTF				
PV Revenue Source	Net Meter at Retail Rate or Communicty DG Tariff				
Project Term (yrs)	20	20	20	20	20
WACC	5%	5%	5%	5%	5%

District Thermal Energy System												
Two pipe hot water system	$1,000	$/UNIT	0	$0	1,700	$1,700,000	0	$0	500	$500,000	500	$500,000
Piping trim, valves, metering and interconnect	$200,000	L.S	0	$0	1	$200,000	1	$200,000	1	$200,000	1	$200,000
Total Hard Costs				$0		$1,900,000		$200,000		$700,000		$700,000
Engineering	12%	%	1	$0	1	$228,000	1	$24,000	1	$84,000	1	$84,000
Construction and Project Management	10%	%	1	$0	1	$190,000	1	$20,000	1	$70,000	1	$70,000
Start-Up and Commissioning	3%	%	1	$0	1	$57,000	1	$6,000	1	$21,000	1	$21,000
Legal/Permits/Permissions	5%	%	1	$0	1	$95,000	1	$10,000	1	$35,000	1	$35,000
Total Soft Costs				$0		$570,000		$60,000		$210,000		$210,000
Total District Thermal Energy System				$0		$2,470,000		$260,000		$910,000		$910,000
PV Array (w or w/o storage)												
Indicative EPC Pricing - PV	$2,730	$/KW	430	$1,173,900	430	$1,173,900	430	$1,173,900	430	$1,173,900	430	$1,173,900
Total Hard Costs				$1,173,900		$1,173,900		$1,173,900		$1,173,900		$1,173,900
Engineering	5%	%	1	$58,695	1	$58,695	1	$58,695	1	$58,695	1	$58,695
Construction and Project Management	3%	%	1	$35,217	1	$35,217	1	$35,217	1	$35,217	1	$35,217
Start-Up and Commissioning	2%	%	1	$23,478	1	$23,478	1	$23,478	1	$23,478	1	$23,478
Legal/Permits/Permissions	1%	%	1	$11,739	1	$11,739	1	$11,739	1	$11,739	1	$11,739
Total Soft Costs				$129,129		$129,129		$129,129		$129,129		$129,129
Total PV Array (w or w/o storage)				$1,303,029		$1,303,029		$1,303,029		$1,303,029		$1,303,029

Conceptual Microgrid Deployment Scenarios

Project Cost Estimates

Scenario	1	2	3	4	5
Prime Mover	Duel Fueled Natural Gas/Biogas Reciprocating Engine				
Prime Mover Location	IAWWTF	IAWWTF	High School	IAWWTF	IAWWTF
Electric Revenue Source	Net Meter at Retail Rate w/ Export at Wholesale Rate				Net Meter w/ export at
Electric Distribution	Connect Partial 783 to Partial 784 Feeder				
Heat Recovery	None	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water	Low Enthalpy Hot Water
Heat Recovery Distribution	N/A	IAWWTF & High School	High School	IAWWTF & Waterfront Development	IAWWTF & Waterfront Development
Heat Recovery Revenue Source	N/A	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate	Avoided Retail Natural Gas Rate
PV Location	IAWWTF				
PV Revenue Source	Net Meter at Retail Rate or Communicty DG Tariff				
Project Term (yrs)	20	20	20	20	20
WACC	5%	5%	5%	5%	5%

Microgrid System												
Host Facility System Upgrades												
15-kV Switchgear with 6 Breakers	-	L.S	1	$300,000	1	$300,000	1	$300,000	1	$300,000	1	$300,000
3000 KVA Transformer	-	L.S	1	$70,000	1	$70,000	1	$70,000	1	$70,000	1	$70,000
15-kV Cabling and Terminations	-	L.S	1	$17,500	1	$17,500	1	$17,500	1	$17,500	1	$17,500
Emergency Generator	-	L.S	1	$50,000	1	$50,000	1	$50,000	1	$50,000	1	$50,000
Microgrid Controller - Hardware & Software	-	L.S	1	$100,000	1	$100,000	1	$100,000	1	$100,000	1	$100,000
Metering	-	L.S	1	$25,000	1	$25,000	1	$25,000	1	$25,000	1	$25,000
Host Engineering and Overhead	-	L.S	1	$80,000	1	$80,000	1	$80,000	1	$80,000	1	$80,000
NYSEG System Upgrades												
500-ft Line Extension (336 Bare AL)	-	L.S	1	$23,000	1	$23,000	1	$23,000	1	$23,000	1	$23,000
(2) 15-kV Load-break Switches (Replace poles)	-	L.S	1	$25,000	1	$25,000	1	$25,000	1	$25,000	1	$25,000
Feeder 784 Interconnection with Direct Transfer Trip	-	L.S	1	$200,000	1	$200,000	1	$200,000	1	$200,000	1	$200,000
NYSEG Engineering and Overhead	-	L.S	1	$50,000	1	$50,000	1	$50,000	1	$50,000	1	$50,000
Total Hard Costs				$940,500		$940,500		$940,500		$940,500		$940,500
System Engineering - Additional	12%	%	1	$112,860	1	$112,860	1	$112,860	1	$112,860	1	$112,860
Construction and Project Management	10%	%	1	$94,050	1	$94,050	1	$94,050	1	$94,050	1	$94,050
Start-Up and Commissioning	3%	%	1	$28,215	1	$28,215	1	$28,215	1	$28,215	1	$28,215
Legal/Permits/Permissions	5%	%	1	$47,025	1	$47,025	1	$47,025	1	$47,025	1	$47,025
Total Soft Costs				$282,150		$282,150		$282,150		$282,150		$282,150
NYSEG Hard Costs to Project	-	L.S	1	$0	1	$0	1	$0	1	$0	1	$0
NYSEG Soft Costs to Project	-	L.S	1	$0	1	$0	1	$0	1	$0	1	$0
Total Microgrid System				$1,222,650		$1,222,650		$1,222,650		$1,222,650		$1,222,650
Total Project Cost Estimate				$4,235,179		$6,835,179		$5,353,179		$5,275,179		$5,275,179

APPENDIX D. INDICATIVE PROJECT PROFORMAS

Indicative Project Proforma

North Energy District - Scenario 1

Generation Breakdown

Generation Source	Nominal Capacity (kW)	Heat Recovery	Location
PV- Proposed	430	n/a	WWTF
Biogas Reciprocating Engine - Proposed	550	None	WWTF
Biogas Microturbines - Existing	260	Yes	WWTF
Emergency Generators - Existing & Proposed	1325	None	Multiple

Financial Performance

Commodity Forecast:	SourceOne	NYSERDA
WACC:	5%	5%
Cash Positive Year:	N/A	N/A
ROI:	-27%	-97%
IRR:	-2%	-
NPV:	($2,352,870)	($3,956,393)
Zero NPV Incentive:	$2,470,514	$4,154,212

Escalation Schedule

Wholesale Electricity:	per SourceOne or NYSERDA forecast
Natural Gas:	per SourceOne or NYSERDA forecast
Retail Electricity Delivery	2.0%
Retail Natural Gas Delivery	2.0%
Operations & Maintenance:	1.5%
Tipping Fees	2.0%
Biogas	2.0%

Commodity Baselines

Electric Baseline Year 2015 Rates	
NSYEG	28 $/MWH
Third Party Supply	61 $/MWH
Natural Gas Baseline Year 2015 Rates	
NSYEG	2.60 $/MMBTU
Third Party Supply	4.00 $/MMBTU
Biogas Baseline Rate	4.04 $/MMBTU

Project Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Calender Year		2016	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Commodity Forecasts																						
NYSERDA Forecasts																						
Wholesale Energy	$/MWH	41.5	43.7	44.8	45.9	47.1	48.3	49.5	50.7	52.0	52.7	53.4	54.2	54.9	55.7	56.1	56.4	56.8	57.2	57.6	57.6	57.6
Wholesale Capacity	$/KW-Yr	8.5	47.1	66.3	85.6	87.4	89.3	91.1	92.9	94.8	94.8	94.8	94.8	94.8	94.8	95.1	95.5	95.8	96.2	96.5	96.5	96.5
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	42.5	49.0	52.3	55.6	57.1	58.5	59.9	61.3	62.8	63.5	64.3	65.0	65.7	66.5	66.9	67.3	67.8	68.2	68.6	68.6	68.6
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	71.1	78.3	82.1	86.0	88.1	90.1	92.2	94.3	96.3	97.8	99.2	100.6	102.1	103.5	104.7	105.9	107.1	108.3	109.5	110.3	111.2
Natural Gas Rate: Commercial	$/MMBTU	9.76	9.82	9.91	10.00	10.18	10.39	10.55	10.65	10.78	10.88	11.01	11.07	11.16	11.27	11.36	11.48	11.58	11.84	12.07	12.07	12.07
SourceOne Forecasts																						
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	62.2	70.2	70.6	72.5	74.9	77.6	80.3	82.9	85.6	88.1	90.6	93.5	96.4	99.3	102.3	105.4	108.6	111.9	115.3	118.8	122.4
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	91	99	100	103	106	109	113	116	119	122	126	129	133	136	140	144	148	152	156	161	165
Wholesale Natural Gas (HH, Basis, Bal.)	$/MMBTU	4.0	4.8	5.1	5.3	5.4	5.6	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.8	7.0	7.1	7.3	7.5	7.7	7.9	8.1
NYSEG Delivery (Blended / Representative $/MMBTU)	$/MMBTU	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.8	3.9	3.9
Natural Gas Rate: Commercial	$/MMBTU	6.61	7.5	7.8	8.1	8.3	8.5	8.7	8.9	9.2	9.4	9.6	9.8	10.0	10.2	10.5	10.7	11.0	11.2	11.5	11.8	12.1
Biogas from WWTF	$/MMBTU	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.7	5.8	5.9	6.0
Energy Loads and Consumption																						
WWTF - Annual Electric Consumption	MWH	0	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803
WWTF - Existing Biogas CHP Electric Generation	MWH	0	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453
WWTF - Existing NYSEG Supplied Electric	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
High School - Annual Electric Consumption	MWH	0	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113
WWTF - Annual Thermal Load	MMBTU	0	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536
High School - Annual Thermal Load	MMBTU	0	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805
Plant Production Volumes																						
PV Generation	MWH	**0**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**
Total New Biogas CHP Generation	MWH	**0**	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336
Biogas Electric Generation - Avoided Retail Power	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Biogas Electric Generation - Exported	MWH	0	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987
Thermal Energy - Recoverable Useful Heat	MMBTU	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thermal Energy - Exported	MMBTU	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
(A)	**Revenues**																							
	Avoided Costs	Per SourceOne Forecasts																						
		Electric - PV	$	-	56,174	56,708	58,162	59,861	61,705	63,589	65,457	67,311	69,096	70,940	72,979	74,978	77,035	79,151	81,329	83,569	85,875	88,248	90,690	93,203
		Electric - CHP	$	-	233,600	235,821	241,864	248,930	256,601	264,434	272,204	279,913	287,334	295,003	303,482	311,795	320,348	329,149	338,204	347,522	357,111	366,978	377,133	387,583
		Thermal - NG	$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Per NYSERDA Forecasts																						
		Electric - PV	$	-	44,223	46,413	48,610	49,761	50,918	52,083	53,254	54,433	55,232	56,038	56,853	57,674	58,504	59,161	59,826	60,500	61,182	61,873	62,336	62,807
		Electric - CHP	$	-	183,902	193,009	202,144	206,929	211,743	216,586	221,458	226,361	229,682	233,036	236,421	239,839	243,291	246,021	248,787	251,588	254,425	257,299	259,222	261,183
		Thermal - NG	$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Export Revenues	Per SourceOne Forecasts																						
		Electric - CHP	$	-	139,458	140,175	144,101	148,867	154,120	159,487	164,775	169,985	174,926	180,049	185,831	191,444	197,232	203,201	209,355	215,701	222,246	228,995	235,955	243,132
		Thermal Export - Hot Water	$		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Per NYSERDA Forecasts																						
		Electric - CHP	$		97,440	103,979	110,518	113,356	116,194	119,032	121,870	124,707	126,182	127,657	129,132	130,607	132,082	132,918	133,754	134,591	135,427	136,264	136,264	136,264
		Thermal Export - Hot Water			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Total Revenue (per SourceOne Forecasts)	$	-	429,233	432,705	444,127	457,658	472,426	487,510	502,437	517,210	531,355	545,992	562,292	578,217	594,616	611,501	628,888	646,793	665,232	684,221	703,777	723,918
		Total Revenue (per NYSERDA Forecasts)	$	-	325,565	343,402	361,273	370,046	378,855	387,700	396,582	405,502	411,097	416,731	422,405	428,120	433,877	438,101	442,367	446,678	451,034	455,436	457,821	460,254
(B)	**Expenses**																							
	Fuel	BioGas	$		170,010	173,410	176,878	180,416	184,024	187,705	191,459	195,288	199,194	203,178	207,241	211,386	215,614	219,926	224,325	228,811	233,387	238,055	242,816	247,672
	Capital Costs	PV Capital Cost	$	1,303,029	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CHP Capital Cost	$	1,709,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		District Energy Capital Cost	$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Microgrid Capital Cost	$	1,222,650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	O&M	O&M - PV	$	-	6,450	6,547	6,645	6,745	6,846	6,948	7,053	7,158	7,266	7,375	7,485	7,598	7,712	7,827	7,945	8,064	8,185	8,308	8,432	8,559
		O&M - CHP Plant	$	-	160,707	163,117	165,564	168,048	170,568	173,127	175,724	178,360	181,035	183,751	186,507	189,304	192,144	195,026	197,952	200,921	203,935	206,994	210,099	213,250
		O&M - Microgrid Components			5,000	5,075	5,151	5,228	5,307	5,386	5,467	5,549	5,632	5,717	5,803	5,890	5,978	6,068	6,159	6,251	6,345	6,440	6,537	6,635
		O&M - District Energy Plant	$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Total Expenses	$	4,235,179	342,167	348,149	354,239	360,437	366,745	373,167	379,703	386,355	393,127	400,020	407,036	414,178	421,448	428,847	436,380	444,047	451,852	459,796	467,884	476,116
	Cash Flow																							
(C)		Annual Cash Flow (per SourceOne Forecasts)	$	(4,235,179)	87,066	84,555	89,888	97,222	105,681	114,344	122,734	130,854	138,228	145,972	155,255	164,039	173,168	182,653	192,508	202,746	213,380	224,424	235,893	247,802
(D)		Cumulative Cash Flow (per SourceOne Forecasts)	$	(4,235,179)	(4,148,113)	(4,063,558)	(3,973,670)	(3,876,448)	(3,770,767)	(3,656,424)	(3,533,690)	(3,402,835)	(3,264,607)	(3,118,635)	(2,963,380)	(2,799,340)	(2,626,172)	(2,443,519)	(2,251,010)	(2,048,264)	(1,834,884)	(1,610,460)	(1,374,567)	(1,126,765)
(E)		Annual Cash Flow (per NYSERDA Forecasts)	$	(4,235,179)	(16,602)	(4,748)	7,034	9,610	12,110	14,534	16,880	19,146	17,970	16,711	15,369	13,942	12,429	9,253	5,988	2,632	(817)	(4,360)	(10,062)	(15,862)
(F)		Cumulative Cash Flow (per NYSERDA Forecasts)	$	(4,235,179)	(4,251,781)	(4,256,529)	(4,249,495)	(4,239,885)	(4,227,776)	(4,213,242)	(4,196,362)	(4,177,216)	(4,159,247)	(4,142,535)	(4,127,166)	(4,113,224)	(4,100,795)	(4,091,542)	(4,085,554)	(4,082,922)	(4,083,740)	(4,088,100)	(4,098,162)	(4,114,024)

Indicative Project Proforma

North Energy District - Scenario 2

Generation Breakdown

Generation Source	Nominal Capacity (kW)	Heat Recovery	Location
PV- Proposed	430	n/a	WWTF
Biogas Reciprocating Engine - Proposed	550	Yes	WWTF
Biogas Microturbines - Existing	260	Yes	WWTF
Emergency Generators - Existing & Proposed	1325	None	Multiple

Financial Performance

Commodity Forecast	SourceOne	NYSERDA
WACC:	5%	5%
Cash Positive Year:	N/A	N/A
ROI:	-10%	-49%
IRR:	-1%	-5%
NPV:	($3,156,708)	($4,519,346)
Required Incentive:	$3,314,544	$4,745,314

Escalation Schedule

Wholesale Electricity:	per SourceOne or NYSERDA forecast
Natural Gas:	per SourceOne or NYSERDA forecast
Retail Electricity Delivery	2.0%
Retail Natural Gas Delivery	2.0%
Operations & Maintenance:	1.5%
Tipping Fees	2.0%
Biogas	2.0%

Commodity Baselines

Electric Baseline Year 2015 Rates	
NSYEG	28 $/MWH
Third Party Supply	61 $/MWH
Natural Gas Baseline Year 2015 Rates	
NSYEG	2.60 $/MMBTU
Third Party Supply	4.00 $/MMBTU
Biogas Baseline Rate	4.04 $/MMBTU

Project Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Calender Year		2016	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Commodity Forecasts																						
NYSERDA Forecasts																						
Wholesale Energy	$/MWH	41.5	43.7	44.8	45.9	47.1	48.3	49.5	50.7	52.0	52.7	53.4	54.2	54.9	55.7	56.1	56.4	56.8	57.2	57.6	57.6	57.6
Wholesale Capacity	$/KW-Yr	8.5	47.1	66.3	85.6	87.4	89.3	91.1	92.9	94.8	94.8	94.8	94.8	94.8	94.8	95.1	95.5	95.8	96.2	96.5	96.5	96.5
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	42.5	49.0	52.3	55.6	57.1	58.5	59.9	61.3	62.8	63.5	64.3	65.0	65.7	66.5	66.9	67.3	67.8	68.2	68.6	68.6	68.6
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	71.1	78.3	82.1	86.0	88.1	90.1	92.2	94.3	96.3	97.8	99.2	100.6	102.1	103.5	104.7	105.9	107.1	108.3	109.5	110.3	111.2
Natural Gas Rate: Commercial	$/MMBTU	9.76	9.82	9.91	10.00	10.18	10.39	10.55	10.65	10.78	10.88	11.01	11.07	11.16	11.27	11.36	11.48	11.58	11.84	12.07	12.07	12.07
SourceOne Forecasts																						
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	62.2	70.2	70.6	72.5	74.9	77.6	80.3	82.9	85.6	88.1	90.6	93.5	96.4	99.3	102.3	105.4	108.6	111.9	115.3	118.8	122.4
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	90.8	99.4	100.4	102.9	105.9	109.2	112.5	115.8	119.1	122.3	125.6	129.2	132.7	136.3	140.1	143.9	147.9	152.0	156.2	160.5	165.0
Wholesale Natural Gas (HH, Basis, Bal.)	$/MMBTU	4.0	4.8	5.1	5.3	5.4	5.6	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.8	7.0	7.1	7.3	7.5	7.7	7.9	8.1
NYSEG Delivery (Blended / Representative $/MMBTU)	$/MMBTU	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.8	3.9	3.9
Natural Gas Rate: Commercial	$/MMBTU	6.6	7.5	7.8	8.1	8.3	8.5	8.7	8.9	9.2	9.4	9.6	9.8	10.0	10.2	10.5	10.7	11.0	11.2	11.5	11.8	12.1
Biogas from WWTF	$/MMBTU	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.7	5.8	5.9	6.0
Energy Loads and Consumption																						
WWTF - Annual Electric Consumption	MWH	0	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803
WWTF - Existing Biogas CHP Electric Generation	MWH	0	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453
WWTF - Existing NYSEG Supplied Electric	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
High School - Annual Electric Consumption	MWH	0	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113
WWTF - Annual Thermal Load	MMBTU	0	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536
High School - Annual Thermal Load	MMBTU	0	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805
Plant Production Volumes																						
PV Generation	MWH	**0**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**
Total New Biogas CHP Generation	MWH	**0**	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336
Biogas Electric Generation - Avoided Retail Power	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Biogas Electric Generation - Exported	MWH	0	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987
Thermal Energy - Recoverable Useful Heat	MMBTU	**0**	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509
Thermal Energy - Exported	MMBTU	0	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475	4,475

				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
(A)	**Revenues**																							
	Avoided Costs	Per SourceOne Forecasts																						
		Electric - PV	$	-	56,174	56,708	58,162	59,861	61,705	63,589	65,457	67,311	69,096	70,940	72,979	74,978	77,035	79,151	81,329	83,569	85,875	88,248	90,690	93,203
		Electric - CHP	$	-	233,600	235,821	241,864	248,930	256,601	264,434	272,204	279,913	287,334	295,003	303,482	311,795	320,348	329,149	338,204	347,522	357,111	366,978	377,133	387,583
		Thermal - NG	$	-	66,803	69,597	71,630	73,585	75,542	77,366	79,327	81,184	82,901	84,717	86,778	88,758	90,804	92,910	95,081	97,319	99,626	102,005	104,457	106,985
		Per NYSERDA Forecasts																						
		Electric - PV	$	-	44,223	46,413	48,610	49,761	50,918	52,083	53,254	54,433	55,232	56,038	56,853	57,674	58,504	59,161	59,826	60,500	61,182	61,873	62,336	62,807
		Electric - CHP	$	-	183,902	193,009	202,144	206,929	211,743	216,586	221,458	226,361	229,682	233,036	236,421	239,839	243,291	246,021	248,787	251,588	254,425	257,299	259,222	261,183
		Thermal - NG	$	-	87,088	87,876	88,664	90,239	92,143	93,522	94,441	95,557	96,476	97,592	98,183	98,971	99,890	100,744	101,794	102,648	104,946	106,981	106,981	106,981
	Export Revenues	Per SourceOne Forecasts																						
		Electric - CHP	$	-	139,458	140,175	144,101	148,867	154,120	159,487	164,775	169,985	174,926	180,049	185,831	191,444	197,232	203,201	209,355	215,701	222,246	228,995	235,955	243,132
		Thermal Export - Hot Water	$		39,671	41,331	42,538	43,699	44,862	45,944	47,109	48,212	49,232	50,310	51,534	52,710	53,925	55,175	56,465	57,794	59,164	60,576	62,033	63,534
		Per NYSERDA Forecasts																						
		Electric - CHP	$		97,440	103,979	110,518	113,356	116,194	119,032	121,870	124,707	126,182	127,657	129,132	130,607	132,082	132,918	133,754	134,591	135,427	136,264	136,264	136,264
		Thermal Export - Hot Water			51,718	52,186	52,654	53,590	54,720	55,539	56,085	56,748	57,293	57,956	58,307	58,775	59,321	59,828	60,451	60,958	62,323	63,532	63,532	63,532
		Total Revenue (per SourceOne Forecasts)	$	-	535,707	543,632	558,295	574,943	592,830	610,820	628,872	646,605	663,489	681,020	700,603	719,685	739,345	759,586	780,434	801,906	824,022	846,802	870,266	894,437
		Total Revenue (per NYSERDA Forecasts)	$	-	464,371	483,463	502,590	513,875	525,718	536,761	547,108	557,806	564,867	572,280	578,896	585,866	593,088	598,672	604,613	610,284	618,303	625,949	628,334	630,766
(B)	**Expenses**																							
	Fuel	BioGas	$		170,010	173,410	176,878	180,416	184,024	187,705	191,459	195,288	199,194	203,178	207,241	211,386	215,614	219,926	224,325	228,811	233,387	238,055	242,816	247,672
	Capital Costs	PV Capital Cost	$	1,303,029	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CHP Capital Cost	$	1,839,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		District Energy Capital Cost	$	2,470,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Microgrid Capital Cost	$	1,222,650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	O&M	O&M - PV	$	-	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450
		O&M - CHP Plant	$	-	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834
		O&M - Microgrid Components			5,000	5,075	5,151	5,228	5,307	5,386	5,467	5,549	5,632	5,717	5,803	5,890	5,978	6,068	6,159	6,251	6,345	6,440	6,537	6,635
		O&M - District Energy Plant	$	-	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
		Total Expenses	$	6,835,179	355,294	358,769	362,313	365,928	369,615	373,375	377,210	381,121	385,110	389,179	393,328	397,560	401,876	406,278	410,767	415,346	420,016	424,779	429,637	434,591
	Cash Flow																							
(C)		Annual Cash Flow (per SourceOne Forecasts)	$	(6,835,179)	180,413	184,863	195,981	209,014	223,215	237,445	251,662	265,484	278,378	291,841	307,276	322,125	337,469	353,308	369,666	386,560	404,006	422,023	440,630	459,846
(D)		Cumulative Cash Flow (per SourceOne Forecasts)	$	(6,835,179)	(6,654,766)	(6,469,903)	(6,273,922)	(6,064,908)	(5,841,693)	(5,604,248)	(5,352,586)	(5,087,102)	(4,808,723)	(4,516,882)	(4,209,606)	(3,887,481)	(3,550,012)	(3,196,703)	(2,827,037)	(2,440,477)	(2,036,471)	(1,614,448)	(1,173,819)	(713,973)
(E)		Annual Cash Flow (per NYSERDA Forecasts)	$	(6,835,179)	109,077	124,694	140,277	147,947	156,103	163,386	169,898	176,685	179,756	183,101	185,568	188,307	191,212	192,394	193,846	194,938	198,287	201,169	198,697	196,175
(F)		Cumulative Cash Flow (per NYSERDA Forecasts)	$	(6,835,179)	(6,726,102)	(6,601,408)	(6,461,132)	(6,313,185)	(6,157,082)	(5,993,696)	(5,823,798)	(5,647,113)	(5,467,356)	(5,284,255)	(5,098,687)	(4,910,381)	(4,719,169)	(4,526,775)	(4,332,929)	(4,137,991)	(3,939,704)	(3,738,534)	(3,539,838)	(3,343,663)

Indicative Project Proforma

North Energy District - Scenario 3

Generation Breakdown

Generation Source	Nominal Capacity (kW)	Heat Recovery	Location
PV- Proposed	430	n/a	WWTF
Biogas Reciprocating Engine - Proposed	550	Yes	High School
Biogas Microturbines - Existing	260	Yes	WWTF
Emergency Generators - Existing & Proposed	1325	None	Multiple

Financial Performance

Commodity Forecast	SourceOne	NYSERDA
WACC:	5%	5%
Cash Positive Year:	16	N/A
ROI:	48%	-8%
IRR:	4%	-1%
NPV:	($623,428)	($1,976,094)
Required Incentive:	$654,599	$2,074,898

Escalation Schedule

Wholesale Electricity:	per SourceOne or NYSERDA forecast
Natural Gas:	per SourceOne or NYSERDA forecast
Retail Electricity Delivery	2.0%
Retail Natural Gas Delivery	2.0%
Operations & Maintenance:	1.5%
Tipping Fees	2.0%
Biogas	2.0%

Commodity Baselines

Electric Baseline Year 2015 Rates	
NSYEG	28 $/MWH
Third Party Supply	61 $/MWH
Natural Gas Baseline Year 2015 Rates	
NSYEG	2.60 $/MMBTU
Third Party Supply	4.00 $/MMBTU
Biogas Baseline Rate	4.04 $/MMBTU

Project Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Calender Year		2016	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Commodity Forecasts																						
NYSERDA Forecasts																						
Wholesale Energy	$/MWH	41.5	43.7	44.8	45.9	47.1	48.3	49.5	50.7	52.0	52.7	53.4	54.2	54.9	55.7	56.1	56.4	56.8	57.2	57.6	57.6	57.6
Wholesale Capacity	$/KW-Yr	8.5	47.1	66.3	85.6	87.4	89.3	91.1	92.9	94.8	94.8	94.8	94.8	94.8	94.8	95.1	95.5	95.8	96.2	96.5	96.5	96.5
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	42.5	49.0	52.3	55.6	57.1	58.5	59.9	61.3	62.8	63.5	64.3	65.0	65.7	66.5	66.9	67.3	67.8	68.2	68.6	68.6	68.6
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	71.1	78.3	82.1	86.0	88.1	90.1	92.2	94.3	96.3	97.8	99.2	100.6	102.1	103.5	104.7	105.9	107.1	108.3	109.5	110.3	111.2
Natural Gas Rate: Commercial	$/MMBTU	9.76	9.82	9.91	10.00	10.18	10.39	10.55	10.65	10.78	10.88	11.01	11.07	11.16	11.27	11.36	11.48	11.58	11.84	12.07	12.07	12.07
SourceOne Forecasts																						
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	62.2	70.2	70.6	72.5	74.9	77.6	80.3	82.9	85.6	88.1	90.6	93.5	96.4	99.3	102.3	105.4	108.6	111.9	115.3	118.8	122.4
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	91	99	100	103	106	109	113	116	119	122	126	129	133	136	140	144	148	152	156	161	165
Wholesale Natural Gas (HH, Basis, Bal.)	$/MMBTU	4.0	4.8	5.1	5.3	5.4	5.6	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.8	7.0	7.1	7.3	7.5	7.7	7.9	8.1
NYSEG Delivery (Blended / Representative $/MMBTU)	$/MMBTU	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.8	3.9	3.9
Natural Gas Rate: Commercial	$/MMBTU	6.6	7.5	7.8	8.1	8.3	8.5	8.7	8.9	9.2	9.4	9.6	9.8	10.0	10.2	10.5	10.7	11.0	11.2	11.5	11.8	12.1
Biogas from WWTF	$/MMBTU	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.7	5.8	5.9	6.0
Energy Loads and Consumption																						
WWTF - Annual Electric Consumption	MWH	0	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803
WWTF - Existing Biogas CHP Electric Generation	MWH	0	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453
WWTF - Existing NYSEG Supplied Electric	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
High School - Annual Electric Consumption	MWH	0	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113
WWTF - Annual Thermal Load	MMBTU	0	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536
High School - Annual Thermal Load	MMBTU	0	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805
Plant Production Volumes																						
PV Generation	MWH	**0**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**
Total New Biogas CHP Generation	MWH	**0**	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336
Biogas Electric Generation - Avoided Retail Power	MWH	0	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113
Biogas Electric Generation - Exported	MWH	0	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223	1,223
Thermal Energy - Recoverable Useful Heat	MMBTU	**0**	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509
Thermal Energy - Exported	MMBTU	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
(A)	**Revenues**																							
	Avoided Costs	Per SourceOne Forecasts																						
		Electric - PV	$	-	56,174	56,708	58,162	59,861	61,705	63,589	65,457	67,311	69,096	70,940	72,979	74,978	77,035	79,151	81,329	83,569	85,875	88,248	90,690	93,203
		Electric - CHP	$	-	309,540	312,483	320,491	329,854	340,018	350,398	360,694	370,909	380,742	390,904	402,140	413,155	424,489	436,150	448,150	460,497	473,202	486,277	499,733	513,581
		Thermal - NG	$	-	110,882	115,520	118,894	122,140	125,388	128,415	131,670	134,752	137,604	140,618	144,038	147,324	150,721	154,216	157,819	161,535	165,364	169,312	173,382	177,578
		Per NYSERDA Forecasts																						
		Electric - PV	$	-	44,223	46,413	48,610	49,761	50,918	52,083	53,254	54,433	55,232	56,038	56,853	57,674	58,504	59,161	59,826	60,500	61,182	61,873	62,336	62,807
		Electric - CHP	$	-	243,685	255,754	267,858	274,199	280,577	286,994	293,451	299,947	304,349	308,792	313,278	317,807	322,381	325,999	329,664	333,375	337,135	340,944	343,491	346,090
		Thermal - NG	$	-	144,553	145,860	147,168	149,783	152,943	155,232	156,757	158,610	160,136	161,988	162,969	164,277	165,802	167,219	168,962	170,379	174,193	177,571	177,571	177,571
	Export Revenues	Per SourceOne Forecasts																						
		Electric - CHP	$	-	85,837	86,278	88,694	91,628	94,861	98,165	101,419	104,626	107,667	110,821	114,379	117,834	121,397	125,071	128,859	132,765	136,793	140,947	145,231	149,649
		Thermal Export - Hot Water	$		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Per NYSERDA Forecasts																						
		Electric - CHP	$		59,974	63,999	68,024	69,771	71,518	73,264	75,011	76,758	77,665	78,573	79,481	80,389	81,297	81,811	82,326	82,841	83,356	83,871	83,871	83,871
		Thermal Export - Hot Water			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Total Revenue (per SourceOne Forecasts)	$	-	562,433	570,989	586,241	603,483	621,973	640,566	659,241	677,599	695,108	713,282	733,535	753,292	773,642	794,588	816,156	838,366	861,234	884,784	909,035	934,010
		Total Revenue (per NYSERDA Forecasts)	$	-	492,435	512,026	531,660	543,514	555,957	567,573	578,474	589,748	597,382	605,392	612,580	620,147	627,984	634,191	640,779	647,095	655,866	664,259	667,269	670,339
(B)	**Expenses**																							
	Fuel	BioGas	$		170,010	173,410	176,878	180,416	184,024	187,705	191,459	195,288	199,194	203,178	207,241	211,386	215,614	219,926	224,325	228,811	233,387	238,055	242,816	247,672
	Capital Costs	PV Capital Cost	$	1,303,029	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CHP Capital Cost	$	1,839,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		District Energy Capital Cost	$	260,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Microgrid Capital Cost	$	1,222,650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	O&M	O&M - PV	$	-	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450
		O&M - CHP Plant	$	-	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834
		O&M - Biogas Piping			5,000	5,075	5,151	5,228	5,307	5,386	5,467	5,549	5,632	5,717	5,803	5,890	5,978	6,068	6,159	6,251	6,345	6,440	6,537	6,635
		O&M - Microgrid Components			5,000	5,075	5,151	5,228	5,307	5,386	5,467	5,549	5,632	5,717	5,803	5,890	5,978	6,068	6,159	6,251	6,345	6,440	6,537	6,635
		O&M - District Energy Plant	$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Total Expenses	$	4,625,179	350,294	353,844	357,465	361,157	364,922	368,762	372,677	376,670	380,743	384,896	389,131	393,450	397,854	402,346	406,926	411,597	416,361	421,219	426,173	431,226
	Cash Flow																							
(C)		Annual Cash Flow (per SourceOne Forecasts)	$	(4,625,179)	212,139	217,145	228,777	242,326	257,051	271,805	286,564	300,928	314,366	328,387	344,405	359,842	375,788	392,242	409,230	426,768	444,873	463,564	482,862	502,784
(D)		Cumulative Cash Flow (per SourceOne Forecasts)	$	(4,625,179)	(4,413,040)	(4,195,895)	(3,967,118)	(3,724,793)	(3,467,742)	(3,195,937)	(2,909,373)	(2,608,445)	(2,294,079)	(1,965,693)	(1,621,288)	(1,261,445)	(885,658)	(493,415)	(84,185)	342,583	787,456	1,251,020	1,733,882	2,236,666
(E)		Annual Cash Flow (per NYSERDA Forecasts)	$	(4,625,179)	142,142	158,182	174,196	182,357	191,035	198,812	205,796	213,078	216,639	220,496	223,450	226,697	230,130	231,845	233,852	235,498	239,505	243,040	241,095	239,113
(F)		Cumulative Cash Flow (per NYSERDA Forecasts)	$	(4,625,179)	(4,483,037)	(4,324,855)	(4,150,659)	(3,968,302)	(3,777,268)	(3,578,456)	(3,372,659)	(3,159,581)	(2,942,942)	(2,722,446)	(2,498,996)	(2,272,299)	(2,042,168)	(1,810,323)	(1,576,471)	(1,340,973)	(1,101,468)	(858,429)	(617,333)	(378,220)

Indicative Project Proforma

North Energy District - Scenario 4

Generation Breakdown

Generation Source	Nominal Capacity (kW)	Heat Recovery	Location
PV- Proposed	430	n/a	WWTF
Biogas Reciprocating Engine - Proposed	550	Yes	WWTF
Biogas Microturbines - Existing	260	Yes	WWTF
Emergency Generators - Existing & Proposed	1325	None	Multiple

Financial Performance

Commodity Forecast	SourceOne	NYSERDA
WACC:	5%	5%
Cash Positive Year:	19	N/A
ROI:	17%	-45%
IRR:	1%	-4%
NPV:	($1,612,059)	($3,013,316)
Required Incentive:	$1,692,662	$3,106,488

Escalation Schedule

Wholesale Electricity:	per SourceOne or NYSERDA forecast
Natural Gas:	per SourceOne or NYSERDA forecast
Retail Electricity Delivery	2.0%
Retail Natural Gas Delivery	2.0%
Operations & Maintenance:	1.5%
Tipping Fees	2.0%
Biogas	2.0%

Commodity Baselines

Electric Baseline Year 2015 Rates	
NSYEG	28 $/MWH
Third Party Supply	61 $/MWH
Natural Gas Baseline Year 2015 Rates	
NSYEG	2.60 $/MMBTU
Third Party Supply	4.00 $/MMBTU
Biogas Baseline Rate	4.04 $/MMBTU

Project Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Calender Year		2016	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Commodity Forecasts																						
NYSERDA Forecasts																						
Wholesale Energy	$/MWH	41.5	43.7	44.8	45.9	47.1	48.3	49.5	50.7	52.0	52.7	53.4	54.2	54.9	55.7	56.1	56.4	56.8	57.2	57.6	57.6	57.6
Wholesale Capacity	$/KW-Yr	8.5	47.1	66.3	85.6	87.4	89.3	91.1	92.9	94.8	94.8	94.8	94.8	94.8	94.8	95.1	95.5	95.8	96.2	96.5	96.5	96.5
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	42.5	49.0	52.3	55.6	57.1	58.5	59.9	61.3	62.8	63.5	64.3	65.0	65.7	66.5	66.9	67.3	67.8	68.2	68.6	68.6	68.6
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	71.1	78.3	82.1	86.0	88.1	90.1	92.2	94.3	96.3	97.8	99.2	100.6	102.1	103.5	104.7	105.9	107.1	108.3	109.5	110.3	111.2
Natural Gas Rate: Commercial	$/MMBTU	9.76	9.82	9.91	10.00	10.18	10.39	10.55	10.65	10.78	10.88	11.01	11.07	11.16	11.27	11.36	11.48	11.58	11.84	12.07	12.07	12.07
SourceOne Forecasts																						
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	62.2	70.2	70.6	72.5	74.9	77.6	80.3	82.9	85.6	88.1	90.6	93.5	96.4	99.3	102.3	105.4	108.6	111.9	115.3	118.8	122.4
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	91	99	100	103	106	109	113	116	119	122	126	129	133	136	140	144	148	152	156	161	165
Wholesale Natural Gas (HH, Basis, Bal.)	$/MMBTU	4.0	4.8	5.1	5.3	5.4	5.6	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.8	7.0	7.1	7.3	7.5	7.7	7.9	8.1
NYSEG Delivery (Blended / Representative $/MMBTU)	$/MMBTU	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.8	3.9	3.9
Natural Gas Rate: Commercial	$/MMBTU	6.6	7.5	7.8	8.1	8.3	8.5	8.7	8.9	9.2	9.4	9.6	9.8	10.0	10.2	10.5	10.7	11.0	11.2	11.5	11.8	12.1
Biogas from WWTF	$/MMBTU	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.7	5.8	5.9	6.0
Energy Loads and Consumption																						
WWTF - Annual Electric Consumption	MWH	0	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803
WWTF - Existing Biogas CHP Electric Generation	MWH	0	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453
WWTF - Existing NYSEG Supplied Electric	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
High School - Annual Electric Consumption	MWH	0	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113
WWTF - Annual Thermal Load	MMBTU	0	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536
High School - Annual Thermal Load	MMBTU	0	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805
Plant Production Volumes																						
PV Generation	MWH	**0**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**
Total New Biogas CHP Generation	MWH	**0**	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336
Biogas Electric Generation - Avoided Retail Power	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Biogas Electric Generation - Exported	MWH	0	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987
Thermal Energy - Recoverable Useful Heat	MMBTU	**0**	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509
Thermal Energy - Exported	MMBTU	0	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973

				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
(A)	**Revenues**																							
	Avoided Costs	Per SourceOne Forecasts																						
		Electric - PV	$	-	56,174	56,708	58,162	59,861	61,705	63,589	65,457	67,311	69,096	70,940	72,979	74,978	77,035	79,151	81,329	83,569	85,875	88,248	90,690	93,203
		Electric - CHP	$	-	233,600	235,821	241,864	248,930	256,601	264,434	272,204	279,913	287,334	295,003	303,482	311,795	320,348	329,149	338,204	347,522	357,111	366,978	377,133	387,583
		Thermal - NG	$	-	66,803	69,597	71,630	73,585	75,542	77,366	79,327	81,184	82,901	84,717	86,778	88,758	90,804	92,910	95,081	97,319	99,626	102,005	104,457	106,985
		Per NYSERDA Forecasts																						
		Electric - PV	$	-	44,223	46,413	48,610	49,761	50,918	52,083	53,254	54,433	55,232	56,038	56,853	57,674	58,504	59,161	59,826	60,500	61,182	61,873	62,336	62,807
		Electric - CHP	$	-	183,902	193,009	202,144	206,929	211,743	216,586	221,458	226,361	229,682	233,036	236,421	239,839	243,291	246,021	248,787	251,588	254,425	257,299	259,222	261,183
		Thermal - NG	$	-	87,088	87,876	88,664	90,239	92,143	93,522	94,441	95,557	96,476	97,592	98,183	98,971	99,890	100,744	101,794	102,648	104,946	106,981	106,981	106,981
	Export Revenues	Per SourceOne Forecasts																						
		Electric - CHP	$	-	139,458	140,175	144,101	148,867	154,120	159,487	164,775	169,985	174,926	180,049	185,831	191,444	197,232	203,201	209,355	215,701	222,246	228,995	235,955	243,132
		Thermal Export - Hot Water	$		-	-	-	-	-	51,049	52,343	53,569	54,702	55,900	57,260	58,566	59,917	61,306	62,739	64,216	65,738	67,307	68,925	70,593
		Per NYSERDA Forecasts																						
		Electric - CHP	$		97,440	103,979	110,518	113,356	116,194	119,032	121,870	124,707	126,182	127,657	129,132	130,607	132,082	132,918	133,754	134,591	135,427	136,264	136,264	136,264
		Thermal Export - Hot Water			-	-	-	-	-	61,710	62,316	63,053	63,659	64,396	64,786	65,306	65,912	66,475	67,168	67,731	69,248	70,591	70,591	70,591
		Total Revenue (per SourceOne Forecasts)	$	-	496,035	502,301	515,757	531,243	547,968	615,925	634,107	651,962	668,959	686,610	706,329	725,542	745,337	765,717	786,707	808,328	830,596	853,532	877,159	901,496
		Total Revenue (per NYSERDA Forecasts)	$	-	412,653	431,277	449,936	460,285	470,998	542,932	553,340	564,112	571,232	578,719	585,374	592,397	599,679	605,319	611,330	617,058	625,228	633,008	635,393	637,825
(B)	**Expenses**																							
	Fuel	BioGas	$		170,010	173,410	176,878	180,416	184,024	187,705	191,459	195,288	199,194	203,178	207,241	211,386	215,614	219,926	224,325	228,811	233,387	238,055	242,816	247,672
	Capital Costs	PV Capital Cost	$	1,303,029	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CHP Capital Cost	$	1,839,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		District Energy Capital Cost	$	-	-	-	-	-	910,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Microgrid Capital Cost	$	1,222,650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	O&M	O&M - PV	$	-	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450
		O&M - CHP Plant	$	-	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834
		O&M - Microgrid Components			5,000	5,075	5,151	5,228	5,307	5,386	5,467	5,549	5,632	5,717	5,803	5,890	5,978	6,068	6,159	6,251	6,345	6,440	6,537	6,635
		O&M - District Energy Plant	$	-	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
		Total Expenses	$	4,365,179	355,294	358,769	362,313	365,928	1,279,615	373,375	377,210	381,121	385,110	389,179	393,328	397,560	401,876	406,278	410,767	415,346	420,016	424,779	429,637	434,591
	Cash Flow																							
(C)		Annual Cash Flow (per SourceOne Forecasts)	$	(4,365,179)	140,741	143,532	153,443	165,315	(731,647)	242,550	256,897	270,841	283,849	297,431	313,002	327,982	343,461	359,439	375,940	392,982	410,580	428,753	447,522	466,905
(D)		Cumulative Cash Flow (per SourceOne Forecasts)	$	(4,365,179)	(4,224,438)	(4,080,905)	(3,927,462)	(3,762,147)	(4,493,794)	(4,251,244)	(3,994,347)	(3,723,506)	(3,439,658)	(3,142,227)	(2,829,225)	(2,501,243)	(2,157,782)	(1,798,343)	(1,422,403)	(1,029,421)	(618,842)	(190,088)	257,434	724,339
(E)		Annual Cash Flow (per NYSERDA Forecasts)	$	(4,365,179)	57,359	72,508	87,623	94,357	(808,617)	169,557	176,130	182,990	186,122	189,541	192,046	194,837	197,803	199,042	200,563	201,711	205,211	208,229	205,756	203,234
(F)		Cumulative Cash Flow (per NYSERDA Forecasts)	$	(4,365,179)	(4,307,820)	(4,235,312)	(4,147,689)	(4,053,332)	(4,861,949)	(4,692,392)	(4,516,263)	(4,333,272)	(4,147,150)	(3,957,609)	(3,765,563)	(3,570,726)	(3,372,922)	(3,173,881)	(2,973,318)	(2,771,607)	(2,566,395)	(2,358,167)	(2,152,411)	(1,949,177)

Indicative Project Proforma

North Energy District - Scenario 5

Generation Breakdown

Generation Source	Nominal Capacity (kW)	Heat Recovery	Location
PV- Proposed	430	n/a	WWTF
Biogas Reciprocating Engine - Proposed	550	Yes	WWTF
Biogas Microturbines - Existing	260	Yes	WWTF
Emergency Generators - Existing & Proposed	1325	None	Multiple

Financial Performance

Commodity Forecast	SourceOne	NYSERDA
WACC:	5%	5%
Cash Positive Year:	14	12
ROI:	67%	20%
IRR:	5%	2%
NPV:	($144,168)	($1,397,110)
Required Incentive:	$151,377	$1,466,966

Escalation Schedule

Wholesale Electricity:	per SourceOne or NYSERDA forecast
Natural Gas:	per SourceOne or NYSERDA forecast
Retail Electricity Delivery	2.0%
Retail Natural Gas Delivery	2.0%
Operations & Maintenance:	1.5%
Tipping Fees	2.0%
Biogas	2.0%

Commodity Baselines

Electric Baseline Year 2015 Rates	
NYSEG	28 $/MWH
Third Party Supply	61 $/MWH
Natural Gas Baseline Year 2015 Rates	
NYSEG	2.60 $/MMBTU
Third Party Supply	4.00 $/MMBTU
Biogas Baseline Rate	4.04 $/MMBTU

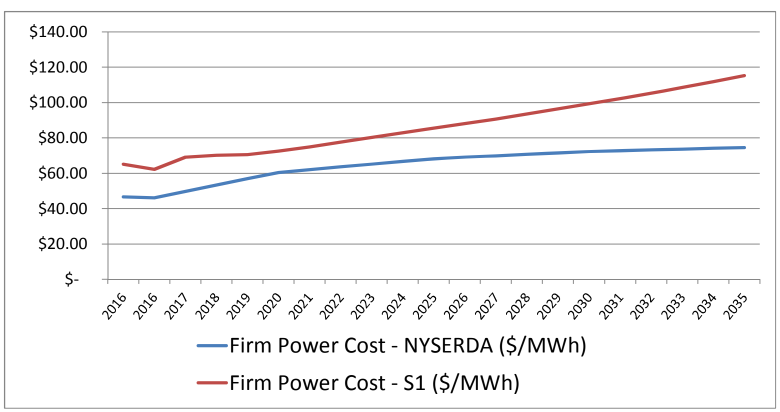
	Project Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Calender Year	2016	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Commodity Forecasts																						
NYSERDA Forecasts																						
Wholesale Energy	$/MWH	41.5	43.7	44.8	45.9	47.1	48.3	49.5	50.7	52.0	52.7	53.4	54.2	54.9	55.7	56.1	56.4	56.8	57.2	57.6	57.6	57.6
Wholesale Capacity	$/KW-Yr	8.5	47.1	66.3	85.6	87.4	89.3	91.1	92.9	94.8	94.8	94.8	94.8	94.8	94.8	95.1	95.5	95.8	96.2	96.5	96.5	96.5
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	42.5	49.0	52.3	55.6	57.1	58.5	59.9	61.3	62.8	63.5	64.3	65.0	65.7	66.5	66.9	67.3	67.8	68.2	68.6	68.6	68.6
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	71.1	78.3	82.1	86.0	88.1	90.1	92.2	94.3	96.3	97.8	99.2	100.6	102.1	103.5	104.7	105.9	107.1	108.3	109.5	110.3	111.2
Natural Gas Rate: Commercial	$/MMBTU	9.76	9.82	9.91	10.00	10.18	10.39	10.55	10.65	10.78	10.88	11.01	11.07	11.16	11.27	11.36	11.48	11.58	11.84	12.07	12.07	12.07
SourceOne Forecasts																						
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	62.2	70.2	70.6	72.5	74.9	77.6	80.3	82.9	85.6	88.1	90.6	93.5	96.4	99.3	102.3	105.4	108.6	111.9	115.3	118.8	122.4
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.6	29.2	29.8	30.4	31.0	31.6	32.3	32.9	33.6	34.2	34.9	35.6	36.3	37.1	37.8	38.6	39.3	40.1	40.9	41.7	42.6
Retail Electric Rate (Firm Power)	$/MWH	91	99	100	103	106	109	113	116	119	122	126	129	133	136	140	144	148	152	156	161	165
Wholesale Natural Gas (HH, Basis, Bal.)	$/MMBTU	4.0	4.8	5.1	5.3	5.4	5.6	5.7	5.9	6.0	6.2	6.3	6.5	6.6	6.8	7.0	7.1	7.3	7.5	7.7	7.9	8.1
NYSEG Delivery (Blended / Representative $/MMBTU)	$/MMBTU	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.2	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.8	3.9	3.9
Natural Gas Rate: Commercial	$/MMBTU	6.6	7.5	7.8	8.1	8.3	8.5	8.7	8.9	9.2	9.4	9.6	9.8	10.0	10.2	10.5	10.7	11.0	11.2	11.5	11.8	12.1
Biogas from WWTF	$/MMBTU	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.7	5.8	5.9	6.0
Energy Loads and Consumption																						
WWTF - Annual Electric Consumption	MWH	0	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803	3803
WWTF - Existing Biogas CHP Electric Generation	MWH	0	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453	1,453
WWTF - Existing NYSEG Supplied Electric	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
High School - Annual Electric Consumption	MWH	0	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113	3,113
WWTF - Annual Thermal Load	MMBTU	0	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536	7,536
High School - Annual Thermal Load	MMBTU	0	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805	21,805
Plant Production Volumes																						
PV Generation	MWH	**0**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**	**565**
Total New Biogas CHP Generation	MWH	**0**	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336	4,336
Biogas Electric Generation - Avoided Retail Power	MWH	0	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350	2,350
Biogas Electric Generation - Exported	MWH	0	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987	1,987
Thermal Energy - Recoverable Useful Heat	MMBTU	**0**	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509	12,509
Thermal Energy - Exported	MMBTU	0	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973	4,973

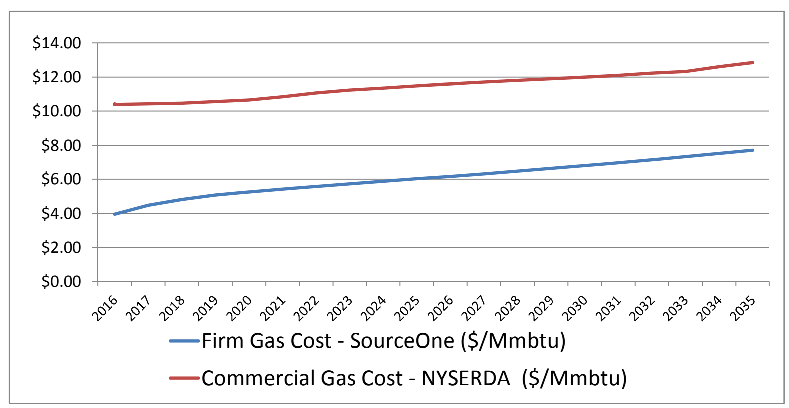
				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
(A)	**Revenues**																							
	Avoided Costs	Per SourceOne Forecasts																						
		Electric - PV	$	-	56,174	56,708	58,162	59,861	61,705	63,589	65,457	67,311	69,096	70,940	72,979	74,978	77,035	79,151	81,329	83,569	85,875	88,248	90,690	93,203
		Electric - CHP	$	-	233,600	235,821	241,864	248,930	256,601	264,434	272,204	279,913	287,334	295,003	303,482	311,795	320,348	329,149	338,204	347,522	357,111	366,978	377,133	387,583
		Thermal - NG	$	-	110,882	115,520	118,894	122,140	125,388	128,415	131,670	134,752	137,604	140,618	144,038	147,324	150,721	154,216	157,819	161,535	165,364	169,312	173,382	177,578
		Per NYSERDA Forecasts																						
		Electric - PV	$	-	44,223	46,413	48,610	49,761	50,918	52,083	53,254	54,433	55,232	56,038	56,853	57,674	58,504	59,161	59,826	60,500	61,182	61,873	62,336	62,807
		Electric - CHP	$	-	183,902	193,009	202,144	206,929	211,743	216,586	221,458	226,361	229,682	233,036	236,421	239,839	243,291	246,021	248,787	251,588	254,425	257,299	259,222	261,183
		Thermal - NG	$	-	144,553	145,860	147,168	149,783	152,943	155,232	156,757	158,610	160,136	161,988	162,969	164,277	165,802	167,219	168,962	170,379	174,193	177,571	177,571	177,571
	Export Revenues	Per SourceOne Forecasts																						
		Electric - CHP	$	-	197,504	199,382	204,491	210,466	216,951	223,574	230,143	236,661	242,935	249,419	256,588	263,617	270,848	278,289	285,945	293,823	301,930	310,272	318,858	327,694
		Thermal Export - Hot Water	$		44,079	45,923	47,265	48,555	49,846	51,049	52,343	53,569	54,702	55,900	57,260	58,566	59,917	61,306	62,739	64,216	65,738	67,307	68,925	70,593
		Per NYSERDA Forecasts																						
		Electric - CHP	$		155,485	163,185	170,909	174,955	179,024	183,119	187,238	191,383	194,192	197,027	199,889	202,779	205,697	208,006	210,344	212,712	215,111	217,541	219,167	220,825
		Thermal Export - Hot Water			57,465	57,984	58,504	59,544	60,800	61,710	62,316	63,053	63,659	64,396	64,786	65,306	65,912	66,475	67,168	67,731	69,248	70,591	70,591	70,591
		Total Revenue (per SourceOne Forecasts)	$	-	642,240	653,354	670,676	689,951	710,491	731,062	751,819	772,207	791,671	811,880	834,347	856,281	878,869	902,111	926,036	950,665	976,018	1,002,117	1,028,987	1,056,651
		Total Revenue (per NYSERDA Forecasts)	$	-	585,627	606,453	627,335	640,972	655,429	668,729	681,025	693,841	702,901	712,485	720,917	729,875	739,207	746,883	755,088	762,911	774,159	784,876	788,887	792,977
(B)	**Expenses**																							
	Fuel	BioGas	$		170,010	173,410	176,878	180,416	184,024	187,705	191,459	195,288	199,194	203,178	207,241	211,386	215,614	219,926	224,325	228,811	233,387	238,055	242,816	247,672
	Capital Costs	PV Capital Cost	$	1,303,029	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		CHP Capital Cost	$	1,839,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		District Energy Capital Cost	$	910,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Microgrid Capital Cost	$	1,222,650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	O&M	O&M - PV	$	-	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450	6,450
		O&M - CHP Plant	$	-	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834	163,834
		O&M - Microgrid Components			5,000	5,075	5,151	5,228	5,307	5,386	5,467	5,549	5,632	5,717	5,803	5,890	5,978	6,068	6,159	6,251	6,345	6,440	6,537	6,635
		O&M - District Energy Plant	$	-	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
		Total Expenses	$	5,275,179	355,294	358,769	362,313	365,928	369,615	373,375	377,210	381,121	385,110	389,179	393,328	397,560	401,876	406,278	410,767	415,346	420,016	424,779	429,637	434,591
	Cash Flow																							
(C)		Annual Cash Flow (per SourceOne Forecasts)	$	(5,275,179)	286,946	294,585	308,363	324,023	340,876	357,686	374,609	391,086	406,560	422,701	441,019	458,721	476,993	495,833	515,268	535,319	556,001	577,338	599,351	622,060
(D)		Cumulative Cash Flow (per SourceOne Forecasts)	$	(5,275,179)	(4,988,233)	(4,693,649)	(4,385,286)	(4,061,263)	(3,720,387)	(3,362,701)	(2,988,092)	(2,597,007)	(2,190,446)	(1,767,745)	(1,326,727)	(868,006)	(391,013)	104,821	620,089	1,155,408	1,711,410	2,288,748	2,888,098	3,510,158
(E)		Annual Cash Flow (per NYSERDA Forecasts)	$	(5,275,179)	230,333	247,683	265,022	275,043	285,814	295,354	303,815	312,719	317,791	323,306	327,589	332,315	337,331	340,605	344,321	347,565	354,143	360,097	359,250	358,386
(F)		Cumulative Cash Flow (per NYSERDA Forecasts)	$	(5,275,179)	(5,044,846)	(4,797,162)	(4,532,141)	(4,257,097)	(3,971,284)	(3,675,930)	(3,372,115)	(3,059,396)	(2,741,605)	(2,418,298)	(2,090,709)	(1,758,394)	(1,421,063)	(1,080,458)	(736,138)	(388,573)	(34,430)	325,667	684,917	1,043,303

APPENDIX E. COMMODITY FORECASTS

Commodity Forecasts	YEAR	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
NYSERDA Forecasts												
Wholesale Energy	$/MWH	40.05	41.49	42.58	43.68	44.77	45.86	47.08	48.30	49.52	50.74	51.96
Wholesale Capacity	$/KW-Yr	24.43	8.53	27.80	47.07	66.34	85.61	87.44	89.27	91.10	92.93	94.76
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	42.84	42.47	45.76	49.05	52.34	55.63	57.06	58.49	59.92	61.35	62.78
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08
NYSERDA Retail Electric Rate	$/MWH	70.93	70.55	73.84	77.13	80.43	83.72	85.15	86.57	88.00	89.43	90.86
NYSERDA Retail Natural Gas Rate	$/MMBTU	9.79	9.76	9.79	9.82	9.91	10.00	10.18	10.39	10.55	10.65	10.78
SourceOne Forecasts												
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	62.17	69.19	70.20	70.56	72.54	74.94	77.58	80.28	82.94	85.57	88.05
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08
SourceOne Retail Electric Rate	$/MWH	90.26	97.27	98.29	98.65	100.62	103.02	105.67	108.37	111.03	113.65	116.14
Wholesale Natural Gas (HH, Basis, Bal.)	$/MMBTU	3.95	4.48	4.82	5.09	5.26	5.42	5.59	5.73	5.90	6.04	6.18
NYSEG Delivery (Blended / Representative $/MMBTU)	$/MMBTU	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
SourceOne Retail Natural Gas Rate	$/MMBTU	6.56	7.09	7.43	7.69	7.86	8.03	8.19	8.34	8.50	8.65	8.78
Biogas from WWTF	$/MMBTU	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04
NYSERDA Market Implied Heat Rate	MMBTU/MWH	7.25	7.23	7.55	7.85	8.11	8.37	8.37	8.33	8.34	8.40	8.43
SourceOne Market Implied Heat Rate	MMBTU/MWH	13.76	13.72	13.23	12.83	12.79	12.83	12.90	13.00	13.06	13.14	13.23
NYSERDA Project Implied Heat Rate (Using Biogas)	MMBTU/MWH	17.54	17.45	18.27	19.08	19.89	20.71	21.06	21.42	21.77	22.12	22.48
SourceOne Project Implied Heat Rate (Using Biogas)	MMBTU/MWH	22.33	24.06	24.31	24.40	24.89	25.48	26.14	26.81	27.46	28.11	28.73

Commodity Forecasts (Cont.)	YEAR	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
NYSERDA Forecasts												
Wholesale Energy	$/MWH	52.70	53.44	54.19	54.93	55.67	56.05	56.43	56.81	57.19	57.57	57.57
Wholesale Capacity	$/KW-Yr	94.76	94.76	94.76	94.76	94.76	95.12	95.47	95.83	96.18	96.54	96.54
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	63.52	64.26	65.00	65.74	66.49	66.91	67.33	67.75	68.17	68.59	68.59
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08
NYSERDA Retail Electric Rate	$/MWH	91.60	92.34	93.09	93.83	94.57	94.99	95.41	95.83	96.26	96.68	96.68
NYSERDA Retail Natural Gas Rate	$/MMBTU	10.88	11.01	11.07	11.16	11.27	11.36	11.48	11.58	11.84	12.07	12.07
SourceOne Forecasts												
Wholesale Electric Rate (Firm Power: Energy + Capacity)	$/MWH	90.63	93.54	96.37	99.28	102.29	105.39	108.58	111.87	115.27	118.78	122.39
NYSEG Delivery (Blended / Representative $/MWH)	$/MWH	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08	28.08
SourceOne Retail Electric Rate	$/MWH	118.72	121.63	124.45	127.37	130.37	133.47	136.66	139.96	143.36	146.86	150.47
Wholesale Natural Gas (HH, Basis, Bal.)	$/MMBTU	6.32	6.48	6.64	6.81	6.97	7.15	7.33	7.52	7.71	7.91	8.12
NYSEG Delivery (Blended / Representative $/MMBTU)	$/MMBTU	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
SourceOne Retail Natural Gas Rate	$/MMBTU	8.92	9.09	9.25	9.41	9.58	9.75	9.93	10.12	10.32	10.52	10.72
Biogas from WWTF	$/MMBTU	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04	4.04
NYSERDA Market Implied Heat Rate	MMBTU/MWH	8.42	8.39	8.41	8.41	8.39	8.36	8.31	8.28	8.13	8.01	8.01
SourceOne Market Implied Heat Rate	MMBTU/MWH	13.31	13.38	13.46	13.54	13.61	13.68	13.76	13.83	13.90	13.97	14.03
NYSERDA Project Implied Heat Rate (Using Biogas)	MMBTU/MWH	22.66	22.84	23.03	23.21	23.39	23.50	23.60	23.71	23.81	23.91	23.91
SourceOne Project Implied Heat Rate (Using Biogas)	MMBTU/MWH	29.37	30.09	30.79	31.51	32.25	33.02	33.81	34.62	35.46	36.33	37.22



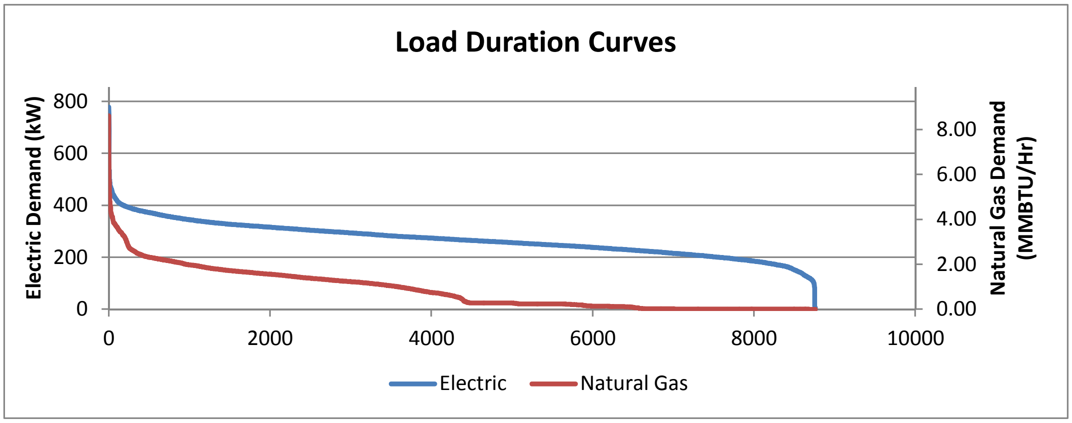


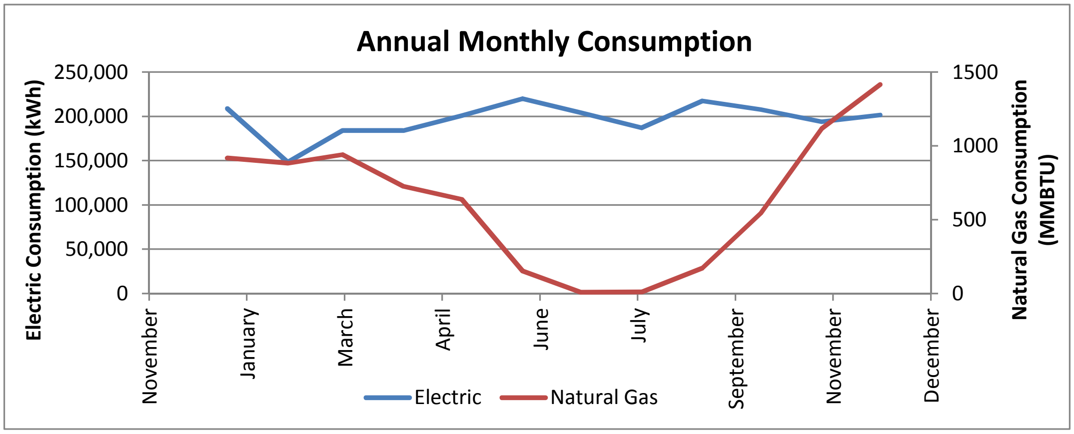
APPENDIX F. FACILITY ENERGY PROFILES

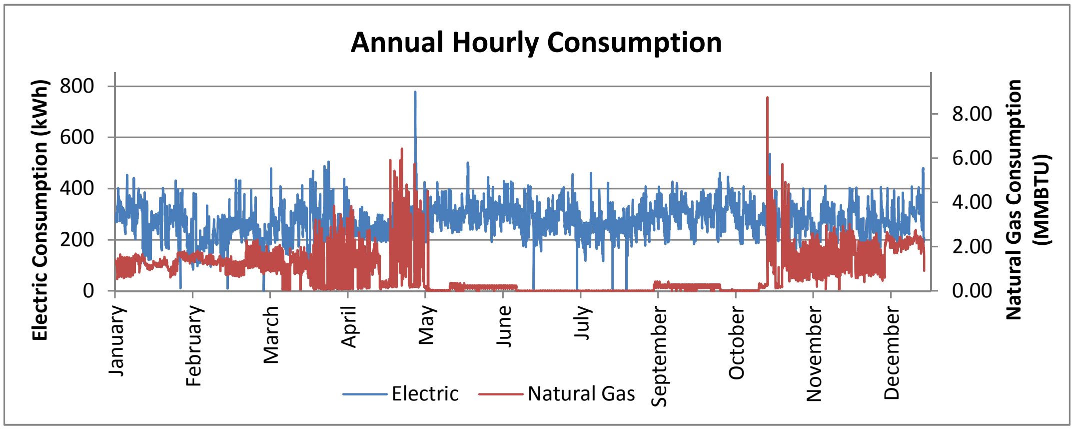
Ithaca Area Wastewater Treatment Facility Energy Profile

Facility Study ID #	1	NYSEG Gas Account #	1001-2456-348
Facility Name	Ithaca Area Wastewater Treatment Facility	Gas Meter #	NRT0000580289
Facility Address	525 3rd St, Ithaca, NY 14850	Gas Service Classification	SC2
		NYSEG Electric Account #	1001-2456-355
Emergency Generator	Y | 750kW | Diesel	Electric Meter #	TBD
NYSEG Circuit #	784	Electric Service Classification	SC7

	Electricity		Natural Gas	
Peak Demand	778	kW	8.61	MMBTU
Annual Consumption	2,359,697	kWh	7,536	MMBTU
Average Demand	269	kW	0.86	MMBTU
Load Factor	35%		10%	





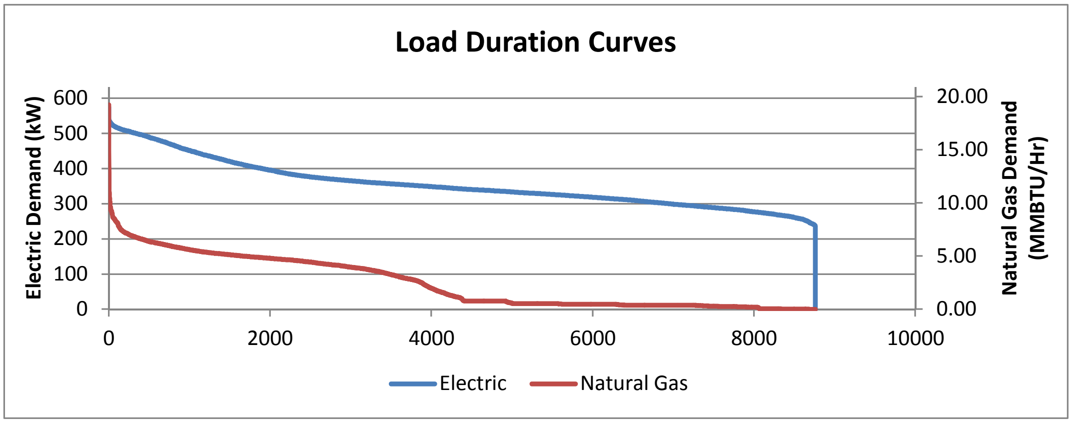


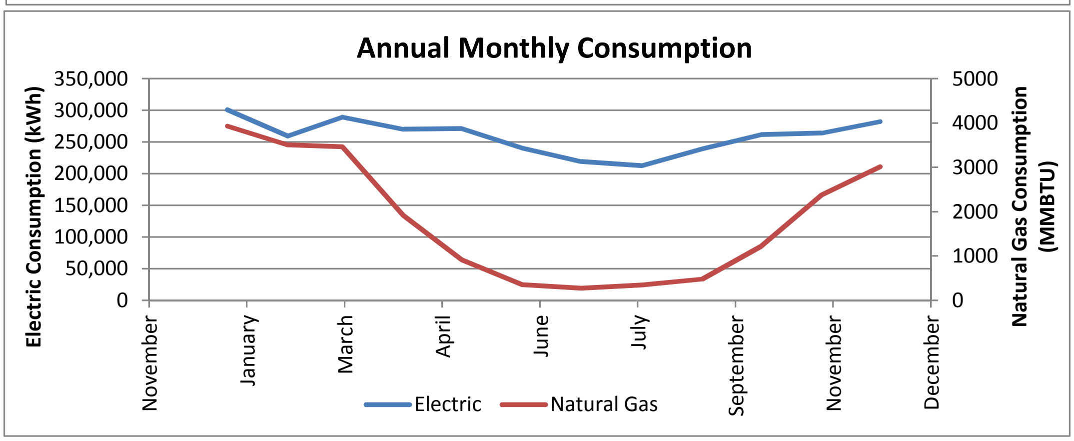
Data sources: NYSEG electric interval meter, NYSEG monthly gas meter
For purposes of this study 1 cf natural gas = 102,800 Btu

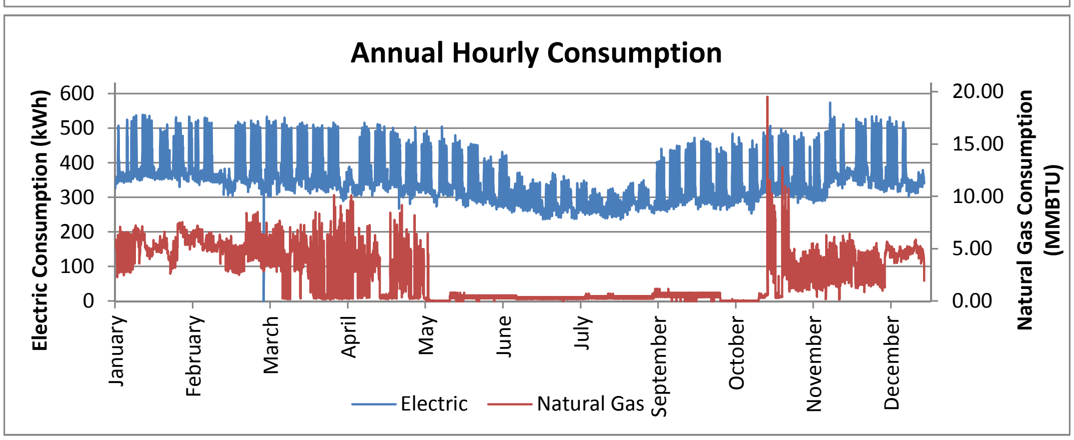
Ithaca High School and Administration Building Complex Energy Profile

Facility Study ID #	2	NYSEG Gas Account #	1001-0013-778
Facility Name	Ithaca High School and Administration Building Complex	Gas Meter #	NMR0008804312
Facility Address	1401 N Cayuga St, Ithaca, NY 14850	Gas Service Classification	SC2
		NYSEG Electric Account #	1001-2133-509
Emergency Generator	Y | 300kW | Diesel	Electric Meter #	NAB0014860651
NYSEG Circuit #	783	Electric Service Classification	SC2

	Electricity		Natural Gas	
Peak Demand	575	kW	19.22	MMBTU
Annual Consumption	3,113,463	kWh	21,805	MMBTU
Average Demand	355	kW	2.49	MMBTU
Load Factor	62%		13%	





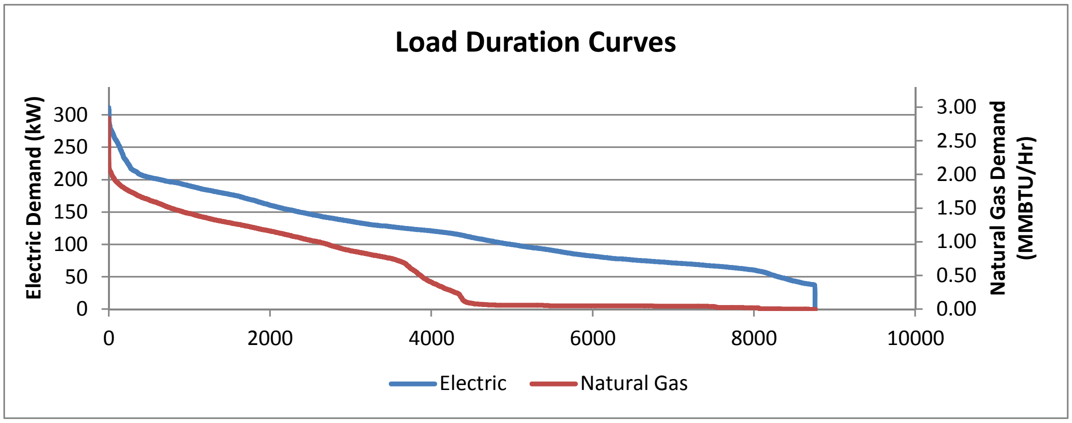


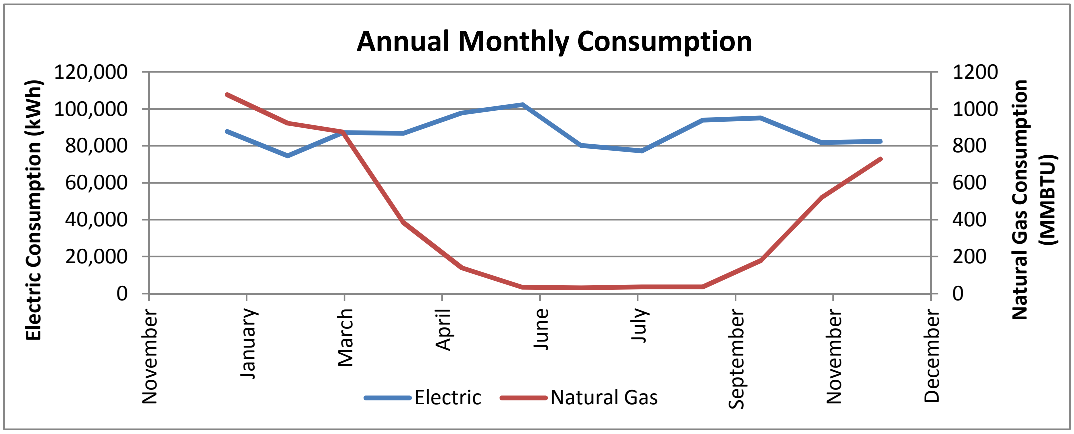
Data sources: NYSEG electric interval meter, NYSEG monthly gas meter
For purposes of this study 1 cf natural gas = 102,800 Btu

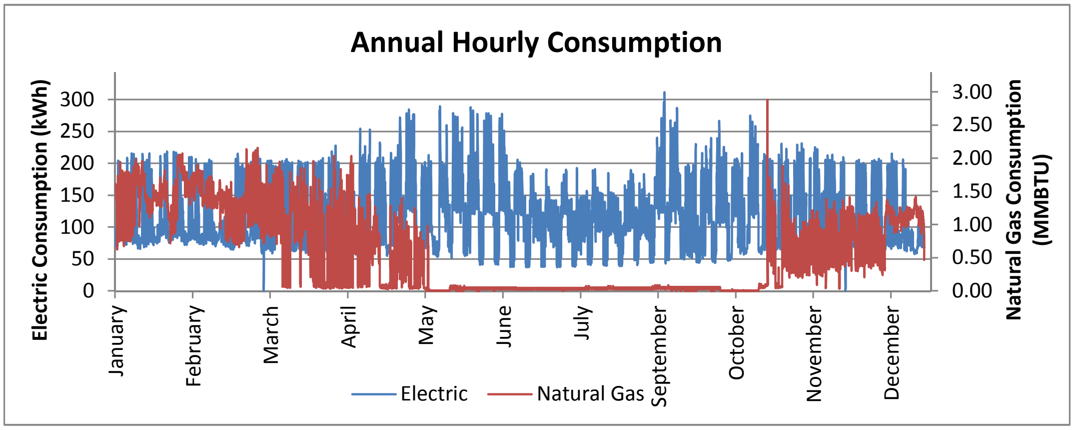
Boynton Middle School Energy Profile

Facility Study ID #	3	NYSEG Gas Account #	TBD
Facility Name	Boynton Middle School	Gas Meter #	NMT00A1330038
Facility Address	1601 N Cayuga St, Ithaca, NY 14850	Gas Service Classification	SC2
		NYSEG Electric Account #	1001-2133-483
Emergency Generator	N	Electric Meter #	NAB0018704584
NYSEG Circuit #	785	Electric Service Classification	SC2

	Electricity		Natural Gas	
Peak Demand	312	kW	2.83	MMBTU
Annual Consumption	1,047,501	kWh	4,972	MMBTU
Average Demand	120	kW	0.57	MMBTU
Load Factor	38%		20%	





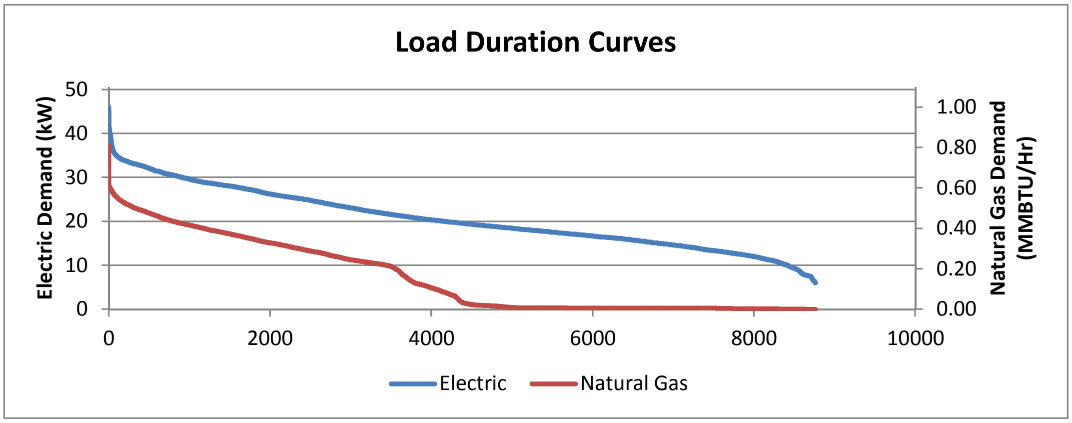


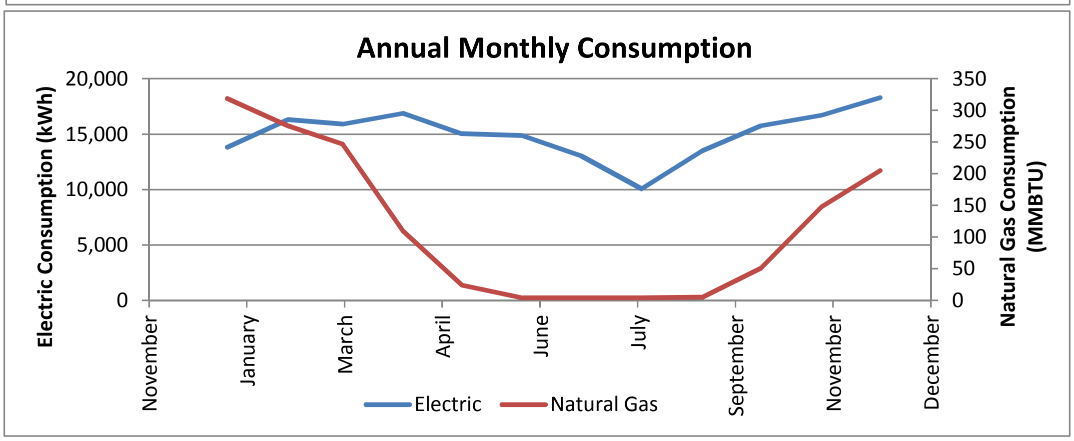
Data sources: NYSEG electric interval meter, NYSEG monthly gas meter
For purposes of this study 1 cf natural gas = 102,800 Btu

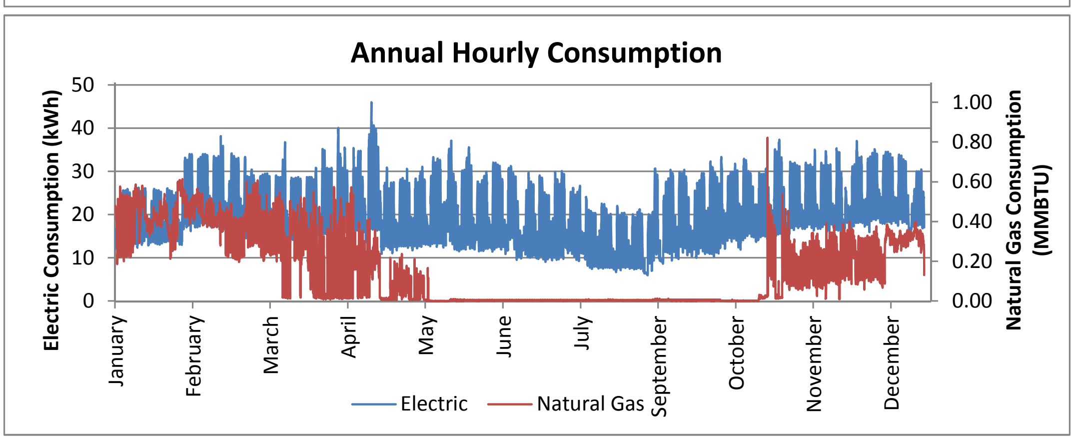
Fall Creek Elementary School Energy Profile

Facility Study ID #	4	NYSEG Gas Account #	1001-0013-745
Facility Name	Fall Creek Elementary School	Gas Meter #	NAM0005400368
Facility Address	202 King St, Ithaca, NY 14850	Gas Service Classification	SC2
		NYSEG Electric Account #	1001-2795-739
Emergency Generator	N	Electric Meter #	NAB0004358510
NYSEG Circuit #	784	Electric Service Classification	SC2

	Electricity		Natural Gas	
Peak Demand	46	kW	0.81	MMBTU
Annual Consumption	180,320	kWh	1,395	MMBTU
Average Demand	21	kW	0.16	MMBTU
Load Factor	45%		20%	





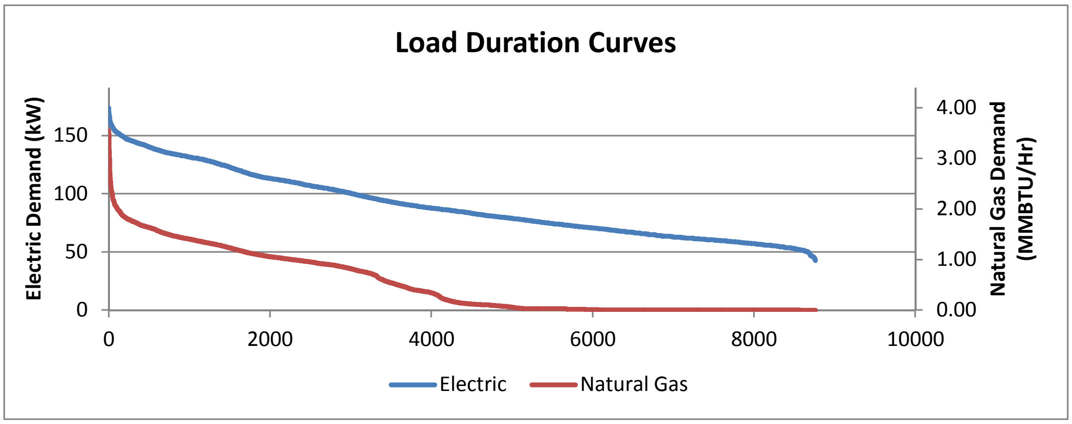


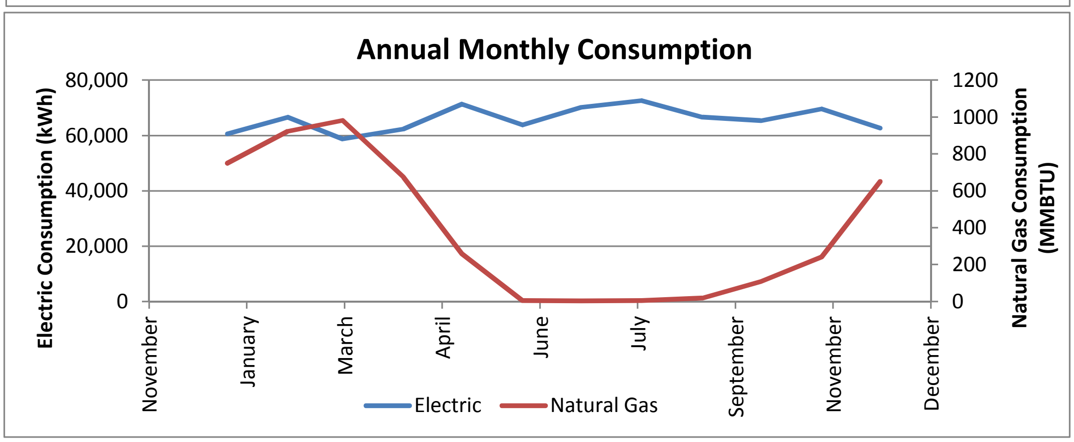
Data sources: NYSEG monthly electric meter, NYSEG monthly gas meter
For purposes of this study 1 cf natural gas = 102,800 Btu

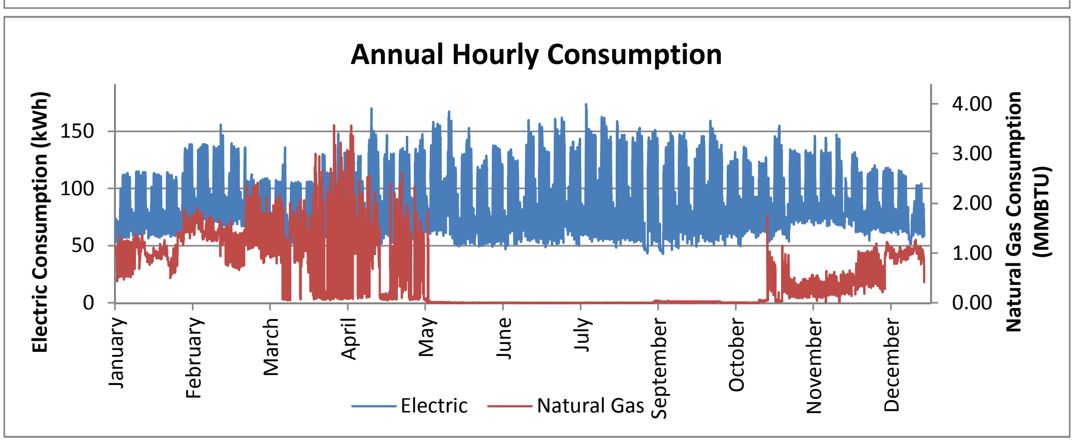
Tompkins Consolidated Area Transit (TCAT) Energy Profile

Facility Study ID #	5	NYSEG Gas Account #	1001-2456-477
Facility Name	Tompkins Consolidated Area Transit (TCAT)	Gas Meter #	NRT0008070633
Facility Address	737 Willow Ave, Ithaca, NY 14850	Gas Service Classification	SC2
		NYSEG Electric Account #	1001-2456-477
Emergency Generator	N	Electric Meter #	NGE0051040272
NYSEG Circuit #	783	Electric Service Classification	SC2

	Electricity		Natural Gas	
Peak Demand	174	kW	3.55	MMBTU
Annual Consumption	790,800	kWh	4,625	MMBTU
Average Demand	90	kW	0.53	MMBTU
Load Factor	52%		15%	





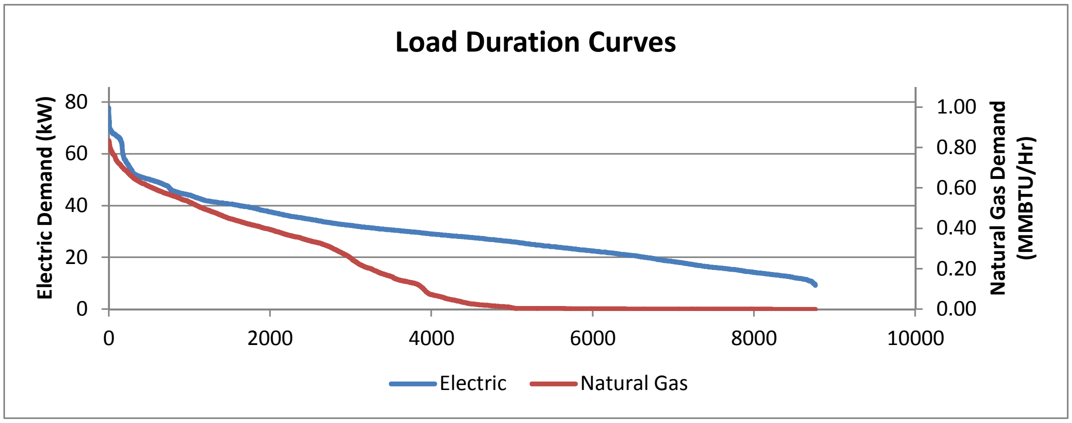


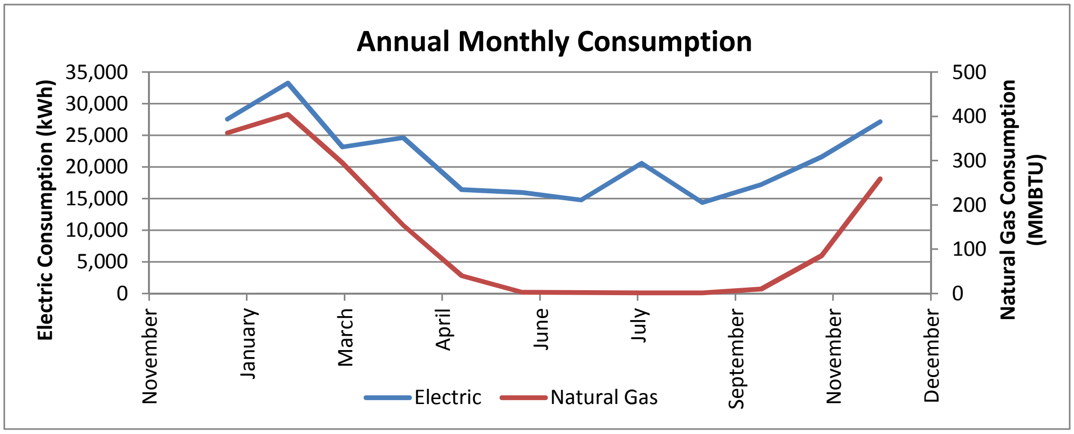
Data sources: NYSEG monthly electric meter, NYSEG monthly gas meter
For purposes of this study 1 cf natural gas = 102,800 Btu

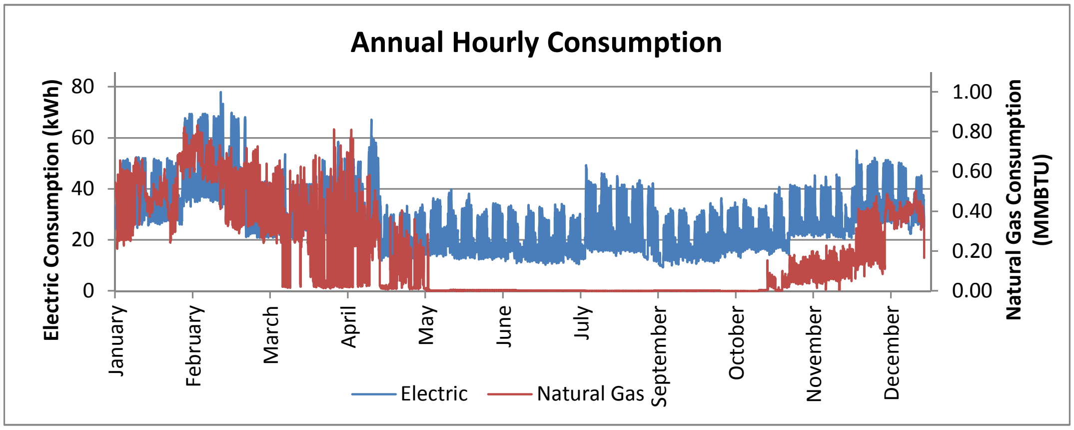
City of Ithaca Department of Public Works Energy Profile

Facility Study ID #	6	NYSEG Gas Account #	TBD
Facility Name	City of Ithaca Department of Public Works	Gas Meter #	NRT0001480318
Facility Address	245 Pier Road, Ithaca, NY 14850255 Pier Road, Ithaca, NY 14	Gas Service Classification	SC2
		NYSEG Electric Account #	TBD
Emergency Generator	Y | 150kW | Natural Gas	Electric Meter #	4, NGE0079154325
NYSEG Circuit #	783	Electric Service Classification	SC2

	Electricity		Natural Gas	
Peak Demand	78	kW	0.83	MMBTU
Annual Consumption	256,906	kWh	1,619	MMBTU
Average Demand	29	kW	0.18	MMBTU
Load Factor	38%		22%	





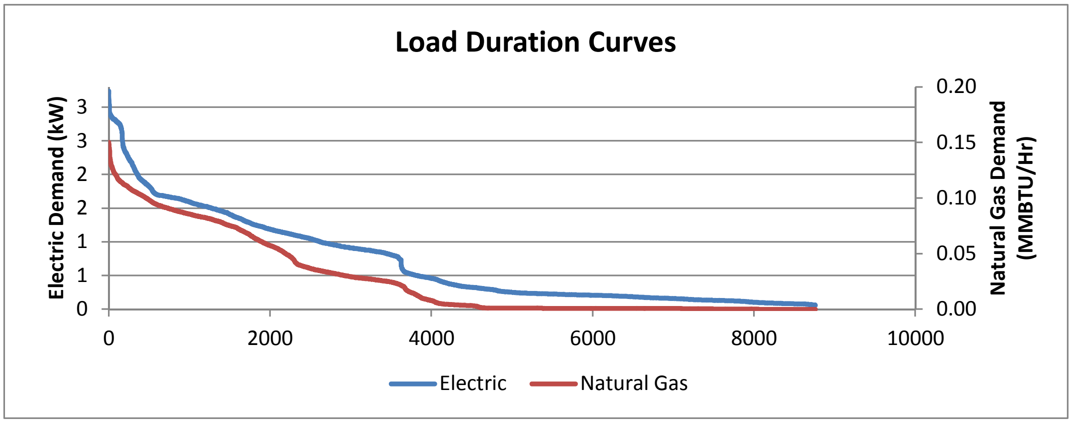


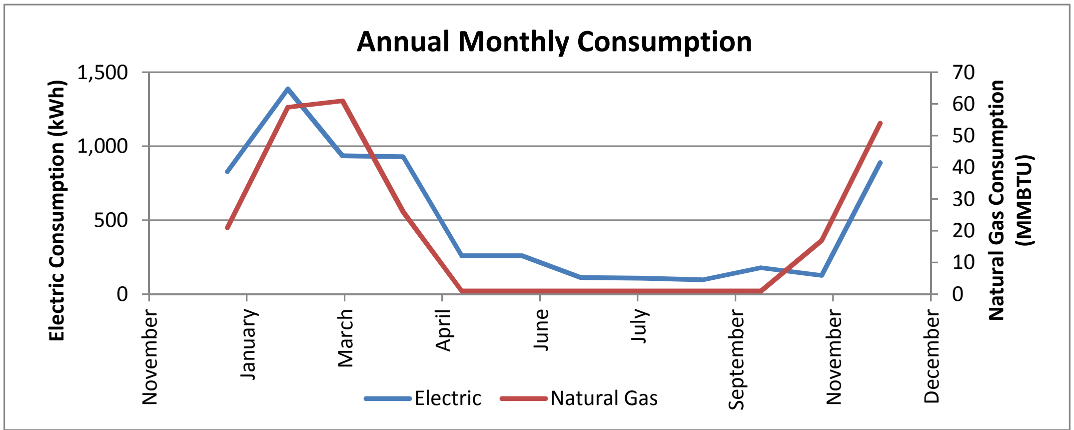
Data sources: NYSEG monthly electric meter, NYSEG monthly gas meter
For purposes of this study 1 cf natural gas = 102,800 Btu

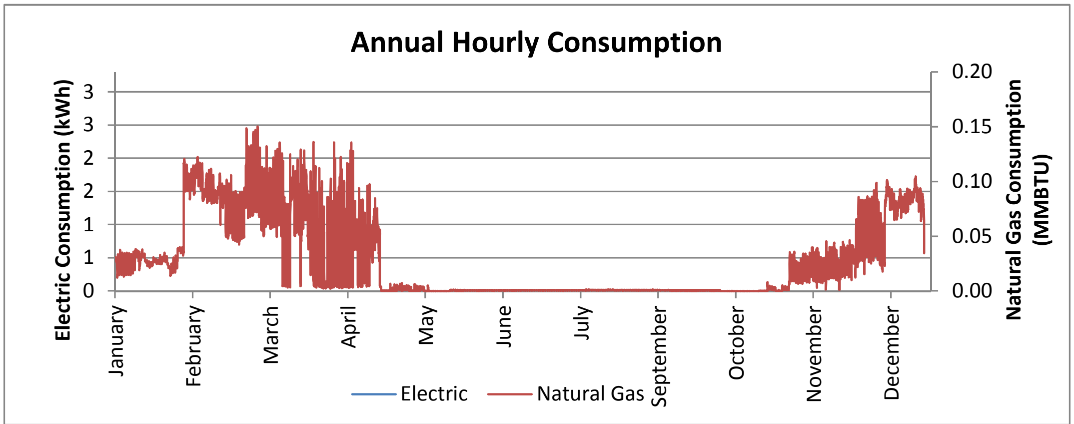
Storage Building First St. Energy Profile

Facility Study ID #	7	NYSEG Gas Account #	TBD
Facility Name	Storage Building First St.	Gas Meter #	NAM0070000360
Facility Address	300 Franklin Street, Ithaca, NY 14850	Gas Service Classification	SC2
		NYSEG Electric Account #	TBD
Emergency Generator	N	Electric Meter #	NGE0069066817
NYSEG Circuit #	784	Electric Service Classification	SC6

	Electricity		Natural Gas	
Peak Demand	3	kW	0.15	MMBTU
Annual Consumption	6,114	kWh	242	MMBTU
Average Demand	1	kW	0.03	MMBTU
Load Factor	22%		18%	





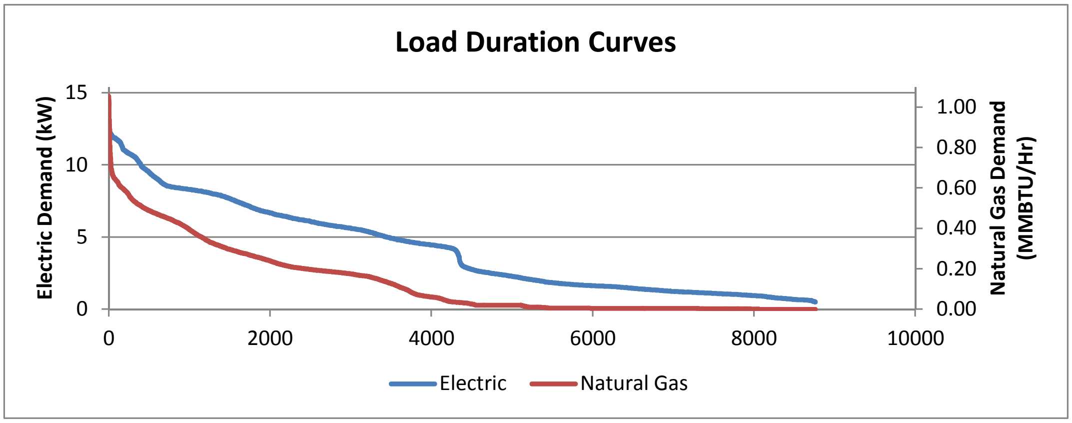


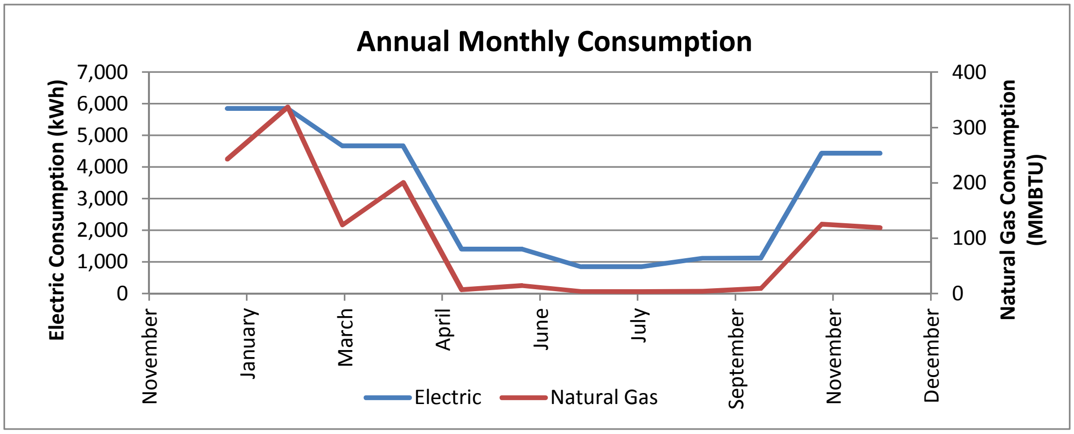
Data sources: NYSEG monthly electric meter, NYSEG monthly gas meter
For purposes of this study 1 cf natural gas = 102,800 Btu

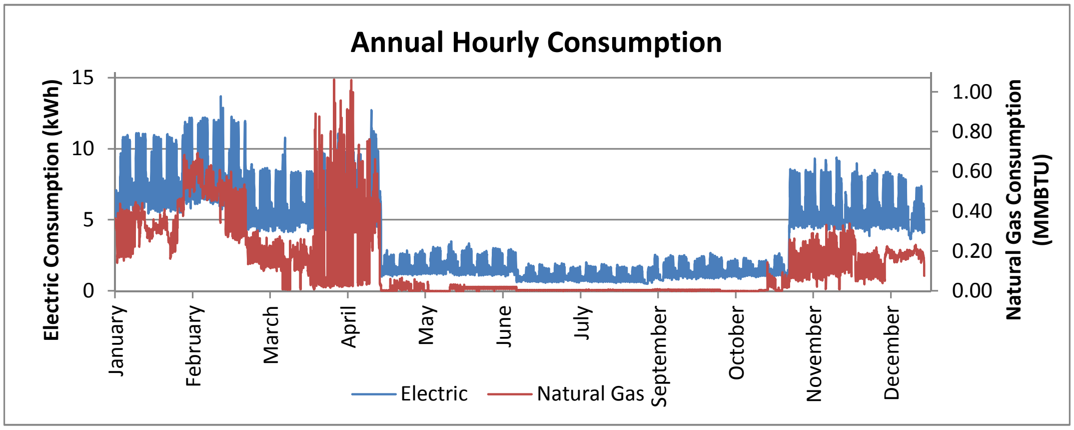
600 First St. Energy Profile

Facility Study ID #	8	NYSEG Gas Account #	TBD
Facility Name	600 First St.	Gas Meter #	NRT0000880185
Facility Address	600 First St, Ithaca, NY 14850	Gas Service Classification	SC2
		NYSEG Electric Account #	TBD
Emergency Generator	N	Electric Meter #	NAB0009642273
NYSEG Circuit #	785	Electric Service Classification	SC2

	Electricity		Natural Gas	
Peak Demand	14	kW	1.05	MMBTU
Annual Consumption	36,649	kWh	1,189	MMBTU
Average Demand	4	kW	0.14	MMBTU
Load Factor	31%		13%	







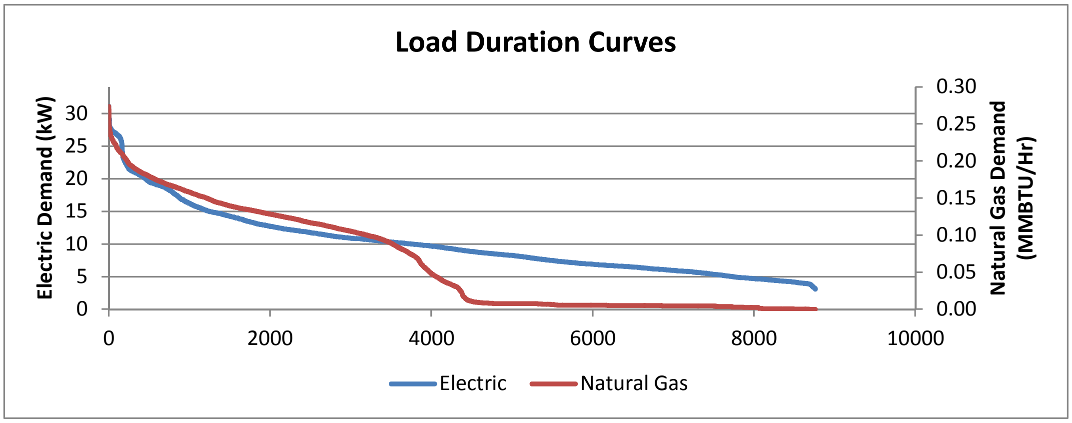
Data sources: NYSEG monthly electric meter, NYSEG monthly gas meter

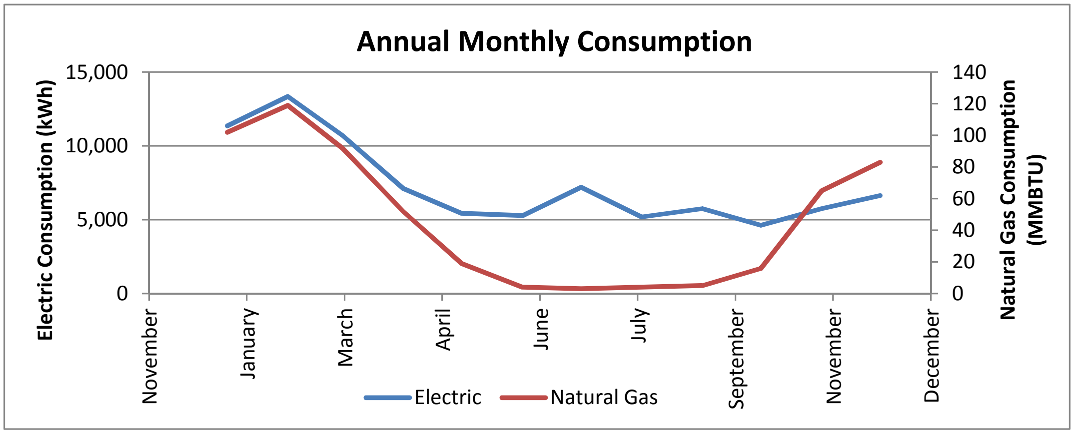
For purposes of this study 1 cf natural gas = 102,800 Btu

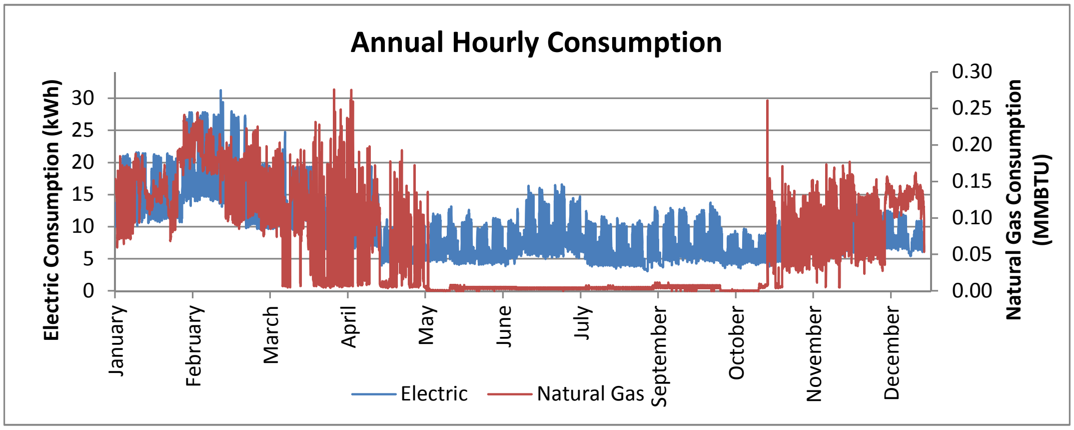
Water & Sewer Energy Profile

Facility Study ID #	9	NYSEG Gas Account #	TBD
Facility Name	Water & Sewer	Gas Meter #	NRT0000580037
Facility Address	510 1st St, Ithaca, NY 14850	Gas Service Classification	SC2
		NYSEG Electric Account #	TBD
Emergency Generator	N	Electric Meter #	NGE0076704614
NYSEG Circuit #	785	Electric Service Classification	SC2

	Electricity	Natural Gas
Peak Demand	31 kW	0.27 MMBTU
Annual Consumption	88,480 kWh	565 MMBTU
Average Demand	10 kW	0.06 MMBTU
Load Factor	32%	24%







Data sources: NYSEG monthly electric meter, NYSEG monthly gas meter

For purposes of this study 1 cf natural gas = 102,800 Btu

APPENDIX G. PROPERTY OWNERS INCLUDED IN MICROGRID

Property Name	Owner(s)	Address	Tax ID	ZONING	PROPCLASS	DESCRIPTIO
	Suits, Genevieve E & Burkett, Travis A	1306 CAYUGA ST N	13.-1-10	R-2b	Residential	1 Family Res
	Davenport, Lynn Marie	1304 CAYUGA ST N	13.-1-11	R-2b	Residential	1 Family Res
	Nicholas, Joseph C & Nicholas, George & Rita	1302 CAYUGA ST N	13.-1-12	R-2b	Residential	2 Family Res
	Powers, Judson & Megan	106 YORK ST W	13.-1-13.1	R-2b	Residential	1 Family Res
	Appleton, Anne C	110 YORK ST W	13.-1-13.2	R-2b	Residential	1 Family Res
	Zager, Dr. Joanne	112 YORK ST W	13.-1-14	R-2b	Residential	1 Family Res
	Merson, Stuart & Esa	5 WOODLAND PL	13.-1-6	R-2b	Residential	2 Family Res
	Murphy, William J & Joan E	1308 CAYUGA ST N	13.-1-9	R-2b	Residential	1 Family Res
	Church of Christ of Ithaca	1206 CAYUGA ST N	13.-2-10	R-2b	Residential	1 Family Res
	Willford, Andrew C & Narayanan, Vasanda Devi	1204 CAYUGA ST N	13.-2-11	R-2b	Residential	1 Family Res
	Bartell, Jason & Bradley, Lena	102 FALLS ST W	13.-2-12	R-2b	Residential	1 Family Res
	Heliseva, Carlton D	115 YORK ST W	13.-2-3	R-2b	Residential	1 Family Res
	Dolker, Pema & Zingshuk, Karma	113 YORK ST W	13.-2-4	R-2b	Residential	1 Family Res
	Jemetz, Bohdan	109 YORK ST W	13.-2-6	R-2b	Residential	1 Family Res
	Church of Christ of Ithaca	1208-10 CAYUGA ST N	13.-2-9	R-2b	Community Srvcs	Religious
	Schuller, David J	1207 CAYUGA ST N	13.-3-1	R-2b	Residential	1 Family Res
	Mad 2nd, LLC	104 FALLS ST E	13.-3-18	R-2b	Residential	2 Family Res
	Lucier, Casey U	102 FALLS ST E	13.-3-19	R-2b	Residential	1 Family Res
	Hansteen, Henry	103 YORK ST E	13.-3-2	R-2b	Residential	3 Family Res
	Carach, Pauline M & Miller, Gina M	1203 CAYUGA ST N	13.-3-20	R-2b	Residential	1 Family Res
	LaRocque, Eleanor E	1205 CAYUGA ST N	13.-3-21	R-2b	Residential	1 Family Res
	Semp, James E	105-07 YORK ST E	13.-3-3	R-2b	Residential	3 Family Res
	Buffam, Larry & Laura	109 YORK ST E	13.-3-4	R-2b	Residential	2 Family Res
	Cook, Robert W & Sandra T	115 YORK ST E	13.-3-5	R-2b	Residential	1 Family Res
	Nunez Rodolfo R	117-19 YORK ST E	13.-3-6	R-2b	Residential	2 Family Res
	Paisley, Mary	121 YORK ST E	13.-3-7	R-2b	Residential	1 Family Res
	Graw, Emily	123 YORK ST E	13.-3-8	R-2b	Residential	1 Family Res
	Adelewitz, Andrew & Michelle	1102 CAYUGA ST N	14.-1-10	R-2b	Residential	1 Family Res
	Longo, Michael & Amici, Gina	1110 CAYUGA ST N	14.-1-6	R-2b	Residential	1 Family Res
	Izzo, Charles V & Sanfilippo, Lisa S	1108 CAYUGA ST N	14.-1-7	R-2b	Residential	1 Family Res
	Cummings, Craig & Sarah	1106 CAYUGA ST N	14.-1-8	R-2b	Residential	1 Family Res
	Freeman, Helen	1104 CAYUGA ST N	14.-1-9	R-2b	Residential	2 Family Res
	Clinton, Jacquelyn	1109 CAYUGA ST N	14.-2-1	R-2b	Residential	1 Family Res
	Corvus Properties LLC	1101 CAYUGA ST N	14.-2-20	R-2b	Residential	2 Family Res
	Donovan, Charles & Christine	1103 CAYUGA ST N	14.-2-21	R-2b	Residential	1 Family Res
	Arif, Muhammed	1105 CAYUGA ST N	14.-2-22	R-2b	Residential	1 Family Res
TCAT/DPW	City of Ithaca	725-45 WILLOW AVE	16.-1-3	P-1	Community Srvcs	Highway gar
	City of Ithaca	715-21 WILLOW AVE	16.-1-4.2	P-1	Vacant	Vacant comm
	Kasian, Lee	707 WILLOW AVE	16.-1-5.1	I-1	Commercial	1 use sm bld
	Coates, Kendall & Michelle	709 WILLOW AVE	16.-1-5.2	I-1	Commercial	Mult-use bld
	Lansing Instrument Corp	703 WILLOW AVE	16.-1-6	I-1	Industrial	Manufacture
	Lansing Instrument Corp	705 WILLOW AVE	16.-1-8	I-1	Industrial	Manufacture
	The Haunt of New York, Inc	702 WILLOW AVE	16.-2-1.1	M-1	Commercial	Night club
	Pier Rd Properties, LLC	101 PIER RD	17.-1-1.2	M-1	Recreation	Marina
	730 Willow Ave LLC c/o Robert Haney	726-30 WILLOW AVE	17.-1-2	M-1	Commercial	>1use sm bld
	City of Ithaca	STEWART PARK RD	2.-2-2	P-1	Recreation	Park
IAWWTF	City/Town Ithaca & Town Dryden	545 THIRD ST	24.-1-1.2	P-1	Community Srvcs	Government
Ithaca High School	Ithaca City School District	1375-1401 CAYUGA ST N	5.-1-1	P-1	Community Srvcs	School
	Cohen, B & Dillmann, G	1309 CAYUGA ST N	5.-2-2	R-2b	Residential	1 Family Res
	Lama, Gopini & Nelson, Zachary	1307 CAYUGA ST N	5.-2-3	R-2b	Residential	1 Family Res
	Gruen, Douglas & Nancy	1303 CAYUGA ST N	5.-2-4	R-2b	Residential	1 Family Res
	Mitchell, Emerson & Holley	1301 CAYUGA ST N	5.-2-5	R-2b	Residential	1 Family Res
	Bell, Mary & Andrulis, Richard	112 YORK ST E	5.-2-6	R-2b	Residential	1 Family Res
	Darling, Parricia S	114 YORK ST E	5.-2-7	R-2b	Residential	1 Family Res
	Eckenrode, Catherine	116 YORK ST E	5.-2-8	R-2b	Residential	1 Family Res
	Edmunds, Emme	118 YORK ST E	5.-2-9	R-2b	Residential	1 Family Res
	Ithaca City School District	ROSEMARY LN	16.-1-5		Community Srvcs	School
Boynton Middle School	Ithaca City School District	400 LAKE ST	17.-1-1.2		Community Srvcs	School

APPENDIX H. NYSERDA COST BENEFIT REPORT

Benefit-Cost Analysis Summary Report

Site 68 – City of Ithaca

PROJECT OVERVIEW

As part of NYSERDA's NY Prize community microgrid competition, the City of Ithaca has proposed development of a microgrid that would serve five local facilities:

- The Ithaca Area Wastewater Treatment Facility (IAWWTF), which provides wastewater treatment services to 40,000 customers in the City of Ithaca, the Town of Ithaca, and the Town of Dryden;
- Ithaca High School, a public secondary school with a total enrollment of approximately 1,400 students;[1]
- Tompkins Consolidated Area Transit (TCAT), a not-for-profit corporation that provides public transportation for Tompkins County, New York;
- The Department of Public Works for the City of Ithaca; and
- The Balance of Feeder 783, which serves a combination of 40 residential homes and four small commercial entities.

The microgrid would be powered by two existing distributed energy resources - a 260 kW biogas microturbine and a 7.5 kW photovoltaic (PV) array - and two new distributed energy resources - a 550 kW reciprocating biogas engine and a 435 kW PV array. [2,3] The two biogas units would incorporate combined heat and power (CHP) systems that would produce thermal energy as well as electricity. In addition, the microgrid would incorporate backup generators, including an existing 750 kW diesel backup unit at the IAWWTF, a new 125 kW diesel backup unit at the IAWWTF, an existing 300 kW diesel backup generator at the Ithaca High School, and an existing 150 kW natural gas backup generator at the Department of Public Works. The project's proponents anticipate that the biogas and PV units would produce electricity for consumption during periods of normal operation. In contrast, the backup generators would produce power only during an outage, when the microgrid would operate in islanded mode. The system as designed would have sufficient generating capacity to meet average demand for electricity from the five facilities during a major outage. The project team also indicates that the system could provide 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 the project's potential costs and benefits. This report describes the results of that analysis, which is based on the methodology outlined below.

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[1] New York State Education Department. 2016. Ithaca Senior High School Enrollment (2014-15). Accessed March 17, 2016 at http://data.nysed.gov/enrollment.php?year=2015&instid=800000036423.

[2] Because the existing 260 kW biogas microturbine and 7.5 kW PV array are already in operation, the energy they currently generate is not treated as a benefit of the microgrid. However, as part of the microgrid project, the existing biogas unit is projected to increase its annual electricity production by 775 MWh. This incremental increase in energy generation is treated as a benefit of the microgrid.

[3] The existing biogas microturbine utilizes anaerobic digester gas produced by the IAWWTF. Currently, the IAWWTF flares off excess anaerobic digester gas. The new reciprocating biogas engine will also utilize anaerobic digester gas produced by the IAWWTF. Once this new biogas unit is operating, the IAWWTF will no longer produce excess anaerobic digester gas.

METHODOLOGY AND ASSUMPTIONS

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

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

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

The BCA model is structured to analyze a project's costs and benefits over a 20-year operating period. The model applies conventional discounting techniques to calculate the present value of costs and benefits, employing an annual discount rate that the user specifies – in this case, seven percent.[4] It also calculates an annualized estimate of costs and benefits based on the anticipated engineering lifespan of the system's equipment. Once a project's cumulative benefits and costs have been adjusted to present values, the model calculates both the project's net benefits and the ratio of project benefits to project costs. The model also calculates the project's internal rate of return, which indicates the discount rate at which the project's costs and benefits would be equal. All monetized results are adjusted for inflation and expressed in 2014 dollars.

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

The BCA considers costs and benefits for two scenarios:

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

- Scenario 1: No major power outages over the assumed 20-year operating period (i.e., normal operating conditions only).
- Scenario 2: The average annual duration of major power outages required for project benefits to equal costs, if benefits do not exceed costs under Scenario 1.[5]

RESULTS

Table 1 summarizes the estimated net benefits, benefit-cost ratios, and internal rates of return for the scenarios described above. The results indicate that if there were no major power outages over the 20-year period analyzed (Scenario 1), the project's costs would exceed its benefits. In order for the project's benefits to outweigh its costs, the average duration of major outages would need to equal or exceed 0.2 days per year (Scenario 2). The discussion that follows provides additional detail on these findings.

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

ECONOMIC MEASURE	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES	
	SCENARIO 1: 0 DAYS/YEAR	SCENARIO 2: 0.2 DAYS/YEAR
Net Benefits - Present Value	-$534,000	$467,000
Benefit-Cost Ratio	0.96	1.0
Internal Rate of Return	6.2%	8.2%

Scenario 1

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

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

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

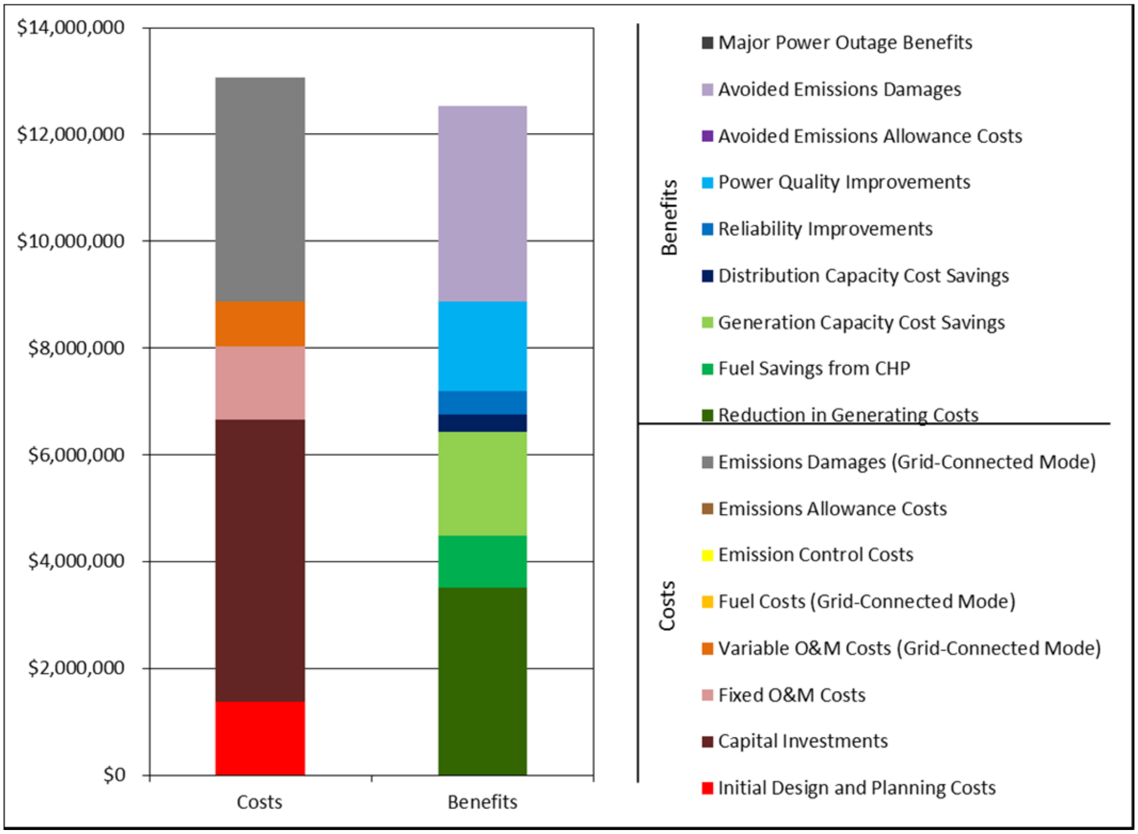

Table 2. Detailed BCA Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$1,380,000	$122,000
Capital Investments	$5,280,000	$465,000
Fixed O&M	$1,380,000	$121,000
Variable O&M (Grid-Connected Mode)	$839,000	$74,000
Fuel (Grid-Connected Mode)	$0	$0
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$4,200,000	$274,000
Total Costs	**$13,100,000**	
Benefits		
Reduction in Generating Costs	$3,510,000	$310,000
Fuel Savings from CHP	$969,000	$85,500
Generation Capacity Cost Savings	$1,960,000	$173,000
Distribution Capacity Cost Savings	$315,000	$27,800
Reliability Improvements	$434,000	$38,300
Power Quality Improvements	$1,680,000	$148,000
Avoided Emissions Allowance Costs	$1,930	$170
Avoided Emissions Damages	$3,680,000	$240,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$12,500,000**	
Net Benefits	**-$534,000**	
Benefit/Cost Ratio	**0.96**	
Internal Rate of Return	**6.2%**	

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 $1.4 million. The present value of the project's capital costs is estimated at approximately $5.3 million, including costs associated with acquiring and installing the new PV array and biogas CHP system; a district energy system; electrical upgrades at the host facilities; upgrades and modifications to the local distribution system; and hardware and software equipment for microgrid operation and control. The present value of fixed operation and maintenance (O&M) costs over a 20-year operating period is estimated to be approximately $1.4 million.

Variable Costs

The project team estimates that it will cost approximately $13.02 per MWh of electricity produced to cover variable O&M costs associated with operating the biogas CHP systems, the PV arrays, and the district energy system (e.g., labor, maintenance, and administration). Given the microgrid's projected annual electricity production, this would translate to variable O&M costs of approximately $74,000 annually. The present value of the project's variable O&M costs over a 20-year operating period is estimated to be approximately $839,000.

The analysis of variable costs also considers the environmental damages associated with pollutant emissions from the distributed energy resources that serve the microgrid, based on the operating scenario and emissions rates provided by the project team and the understanding that the biogas units would not be subject to emissions allowance requirements. In this case, the damages attributable to emissions from the biogas units are estimated at approximately $274,000 annually. The majority of these damages are attributable to the emission of CO_2 and $PM_{2.5}$. Over a 20-year operating period, the present value of emissions damages is estimated at approximately $4.2 million.

Avoided Costs

The development and operation of a microgrid may avoid or reduce a number of costs that otherwise would be incurred. In the case of the City of Ithaca's proposed microgrid, one of the primary sources of cost savings would be a reduction in demand for electricity from bulk energy suppliers, with a resulting reduction in generating costs. The BCA estimates the present value of these savings over a 20-year operating period to be approximately $3.5 million; this estimate assumes the microgrid provides base load power, consistent with the operating profile upon which the analysis is based. The reduction in demand for electricity from bulk energy suppliers would also reduce emissions of CO_2 and particulate matter from these sources, and produce a shift in demand for SO_2 and NO_x emissions allowances. The present value of these benefits is approximately $3.7 million.[6]

The microgrid's CHP systems could deliver additional cost savings over the microgrid's 20-year operating period. The fuel savings provided by the CHP system would lead to avoided natural gas fuel costs with a present value of approximately $969,000.[7]

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.[8] Based on standard capacity factors for the solar and biogas generators, the project team estimates the project's impact on demand for generating capacity to be approximately 2.3005 MW per year[9]. Based on this figure, the BCA estimates the present value of the project's generating capacity benefits to be approximately $2.0 million over a 20-year operating period. Similarly, the project team estimates that the microgrid project will impact distribution capacity by approximately 0.762 MW per year. Based on this estimate, the BCA estimates the present value of the project's distribution capacity benefits to be approximately $315,000 over a 20-year operating period.

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

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

[9] This projected impact on demand for generating capacity includes the peak load support capacity that will be provided by the existing 260 kW biogas microturbine and 7.5 kW PV array. Though these existing DER units are already in operation, they do not currently provide peak load support. They will begin providing peak load support when integrated into the microgrid.

The project team has indicated that the proposed microgrid would be capable of providing ancillary services (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 market for ancillary services is 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 $38,300 per year, with a present value of $434,000 over a 20-year operating period. This estimate is calculated using the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator, and is based on the following indicators of the likelihood and average duration of outages in the service area:[10]

- System Average Interruption Frequency Index (SAIFI) – 1.03 events per year.
- Customer Average Interruption Duration Index (CAIDI) – 118.2 minutes.[11]

The estimate takes into account the number of residential customers the project would serve; the number of small and large commercial or industrial customers the project would serve; the distribution of these customers by economic sector; average annual electricity usage per customer, as provided by the project team; and the prevalence of backup generation among these customers. It also takes into account the variable costs of operating existing backup generators, both in the baseline and as an integrated component of a microgrid. Under baseline conditions, the analysis assumes a 15 percent failure rate for backup generators.[12] It assumes that establishment of a microgrid would reduce the rate of failure to near zero.

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

Summary

The analysis of Scenario 1 yields a benefit/cost ratio of 0.96; i.e., the estimate of project benefits is approximately 96 percent that of project costs. Accordingly, the analysis moves to Scenario 2, taking into account the potential benefits of a microgrid in mitigating the impact of major power outages.

Scenario 2

Benefits in the Event of a Major Power Outage

As previously noted, the estimate of reliability benefits presented in Scenario 1 does not include the benefits of maintaining service during outages caused by major storm events or other factors generally

[10] www.icecalculator.com.

[11] The analysis is based on DPS's reported 2014 SAIFI and CAIDI values for New York State Electric & Gas.

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

considered beyond the control of the local utility. These types of outages can affect a broad area and may require an extended period of time to rectify. To estimate the benefits of a microgrid in the event of such outages, the BCA methodology is designed to assess the impact of a total loss of power – including plausible assumptions about the failure of backup generation – on the facilities the microgrid would serve. It calculates the economic damages that development of a microgrid would avoid based on (1) the incremental cost of potential emergency measures that would be required in the event of a prolonged outage, and (2) the value of the services that would be lost.[13,14]

As noted above, the City of Ithaca's microgrid project would serve five facilities. The project's consultants indicate that at present, three of these facilities are equipped with backup generators: the IAWWTF, Ithaca High School, and the Department of Public Works. Should there be a power outage, these facilities would maintain some level of operations by using their backup generators. The analysis assumes that the supply of fuel necessary to operate backup generators would be maintained indefinitely, and each generator is assumed to have a 15 percent chance of failing. The other two facilities - the Tompkins Consolidated Area Transit and the Balance of Feeder 783 - have no backup generators and would experience a complete loss in service capabilities during a power outage. For the three facilities with backup power, Table 3 summarizes the project team's estimates for the costs of operating backup generators, the cost of emergency measures necessary while on backup power, and the percent loss in service capabilities while on backup power:

Table 3. Backup Power: Operating Costs, Emergency Measure Costs, and Level of Service, Scenario 2

FACILITY NAME	ONE-TIME COST OF MAINTAINING SERVICE WITH BACKUP GENERATOR ($)	ONGOING COST OF MAINTAINING SERVICE WITH BACKUP GENERATOR ($/DAY)*	ONGOING COSTS OF EMERGENCY MEASURES WHILE ON BACKUP POWER ($/DAY)	PERCENT LOSS IN SERVICE WHEN ON BACKUP GENERATION
IAWWTF	$480	$1,100	$0	0%
Ithaca High School	$160	$1,422	$1,000	50%
Department of Public Works	$160	$145	$500	0%
** The ongoing costs for operating backup generators include fuel costs.*				

In the absence of backup power - i.e., if the backup generators failed and no replacement was available - all of the facilities would experience a 100 percent loss in service capabilities. In addition:

- Ithaca High School would incur emergency measure costs of $2,000 per day.
- The Department of Public Works would incur emergency measure costs of $1,000 per day.

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

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

The economic consequences of a major power outage also depend on the value of the services the facilities of interest provide. The analysis calculates the impact of a loss in the city's wastewater and electric services using standard FEMA methodologies that characterize the value of these services.[15]

The impact of a loss in service at Ithaca High School is valued at approximately $86,000 per day. This figure is based on the school district's budget for the current school year, scaled to an average daily value and prorated by the percentage of the district's student body attending the high school. [16,17,18]

For the other facilities, the impact of a loss in service is based on the following value of service estimates, which were developed using the U.S. Department of Energy's ICE Calculator:

- For the Tompkins Consolidated Area Transit, a value of approximately $85,000 per day.
- For the Department of Public Works, a value of approximately $52,000 per day.
- For the four small commercial entities served by the Balance of Feeder 783, a value of approximately $22,000 per day.

Based on these values, the analysis estimates that in the absence of a microgrid, the average cost of an outage for the six facilities is approximately $439,000 per day.

Summary

Figure 2 and Table 4 present the results of the BCA for Scenario 2. The results indicate that the benefits of the proposed project would equal or exceed its costs if the project enabled the facilities it would serve to avoid an average of 0.2 days per year without power. If the average annual duration of the outages the microgrid prevents is less than this figure, its costs are projected to exceed its benefits.

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[15] The BCA uses FEMA methodologies that characterize the value of electric service to evaluate the impact of a loss in service for the 40 residences served by the Balance of Feeder 783. The loss in service for the four small commercial entities served by the Balance of Feeder 783 is evaluated separately.

[16] FY2015-2016 Budget Brochure - Proposed School District Budget for Ithaca City School District. Accessed March 17, 2016 at https://www.dropbox.com/sh/gs779mqas8kr2zs/AADg50870u4c_0M9p_3CrP7Ka?dl=0.

[17] New York State Education Department. 2016. Ithaca City School District Enrollment (2014-15). Accessed March 17, 2016 at http://data.nysed.gov/enrollment.php?year=2015&instid=800000036448.

[18] New York State Education Department. 2016. Ithaca Senior High School Enrollment (2014-15). Accessed March 17, 2016 at http://data.nysed.gov/enrollment.php?year=2015&instid=800000036423.

Figure 2. Present Value Results, Scenario 2 (Major Power Outages Averaging 0.2 Days/Year; 7 Percent Discount Rate)

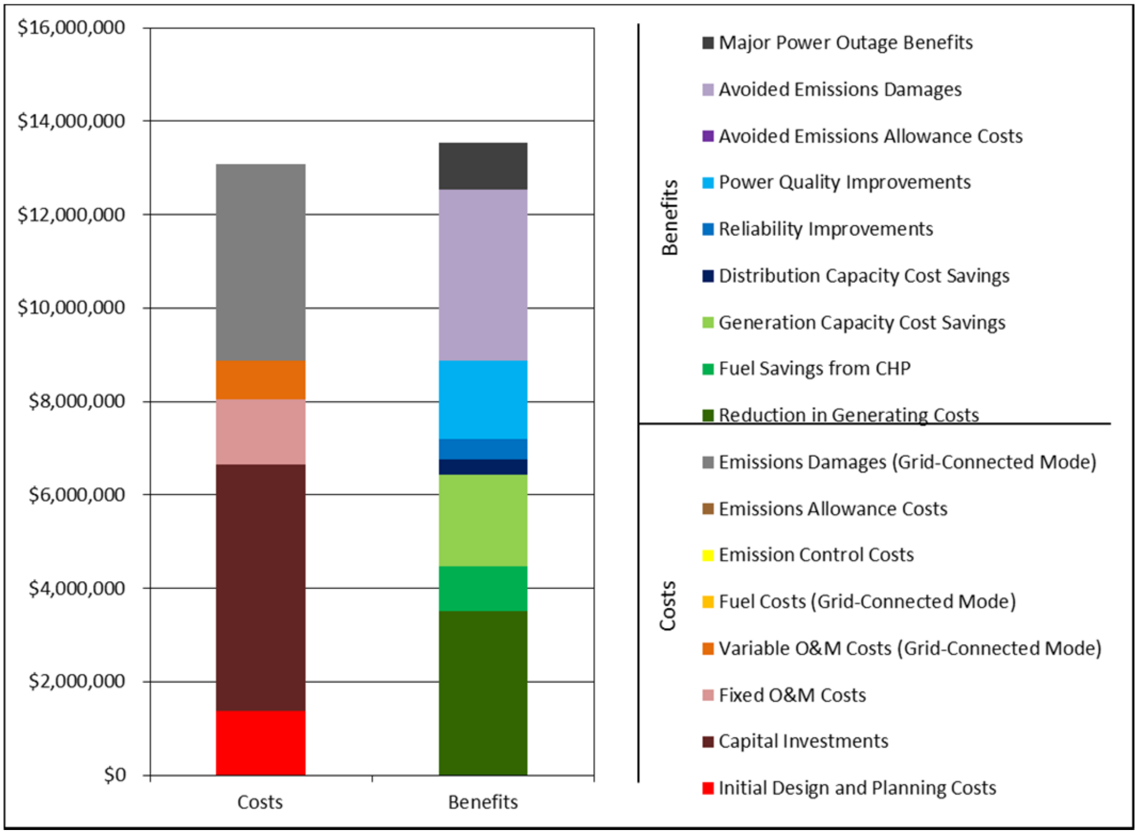

Table 4. Detailed BCA Results, Scenario 2 (Major Power Outages Averaging 0.2 Days/Year; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$1,380,000	$122,000
Capital Investments	$5,280,000	$465,000
Fixed O&M	$1,380,000	$121,000
Variable O&M (Grid-Connected Mode)	$839,000	$74,000
Fuel (Grid-Connected Mode)	$0	$0
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$4,200,000	$274,000
Total Costs	**$13,100,000**	
Benefits		
Reduction in Generating Costs	$3,510,000	$310,000
Fuel Savings from CHP	$969,000	$85,500
Generation Capacity Cost Savings	$1,960,000	$173,000
Distribution Capacity Cost Savings	$315,000	$27,800
Reliability Improvements	$434,000	$38,300
Power Quality Improvements	$1,680,000	$148,000
Avoided Emissions Allowance Costs	$1,930	$170
Avoided Emissions Damages	$3,680,000	$240,000
Major Power Outage Benefits	$1,000,000	$88,400
Total Benefits	**$13,500,000**	
Net Benefits	**$467,000**	
Benefit/Cost Ratio	**1.0**	
Internal Rate of Return	**8.2%**	

APPENDIX I. NYSERDA COST BENEFIT QUESTIONNAIRES

NY Prize Benefit-Cost Analysis: 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). The information in this questionnaire will be used to develop a preliminary benefit-cost analysis of the community microgrid you are proposing for the NY Prize competition. Please provide as much detail as possible.

For each facility that will be served by the microgrid, 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.

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: 68. City of Ithaca

Point of contact for this questionnaire:

Name: Dan Ramer
Address: 525 3rd St, Ithaca, NY 14850
Telephone: 607.273.8381

Email: dramer@cityofithaca.org

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		
IAWWTF	*EGEN 1*	*Diesel*	*.750*	*80%*	*14.4*	*83.9*	*MMBtu/ Day*	*3 man x 4 hours/day x $40/hr*	*$100*
High School	EGEN1	Diesel	.300	80%	5.76	110.89	MMBtu/ Day	*1 man x 4 hours/day x*	*$100*

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		
Department of Public Works (Streets & Facilities)	EGEN1	Natural Gas	.15	80%	0.70	7.03	*MMBtu/ Day*	*1 man x 4 hours/day x*	*$100*
		57T							

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?
IAWWTF	*One-Time Measures*	*N/A*	*0*	*$*	*All measures associated with running the process are accounted for regardless of emergency status*

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
High School	*Ongoing Measures*	*Costs for meeting the operational requirements of the microgrid using High School facility staff.* *O&M of microgrid is by others, however system checks at the High School will be required to verify micrigrid power and functionality is satisfactory during the duration of the outage.*	*$1000*	*$/day*	*The proposed microgrid will provide 100% of the High School's power requirements therefore it is assumed there would be no incremental costs as the same facility staffing and operational procedures would be executed as if there were no power outage.* *The cost estimate of $1000/day for High School staff/facility represents costs associated with meeting the operational requirements during microgrid operation, once the existing emergency generators have come offline and the highschool is ready to sync to the microgrid.*

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
Department of Public Works (Steets & Facilities)	Ongoing Measures	*Costs for meeting the operational requirements of the microgrid using Department of Public Works facility staff.* *O&M of microgrid is by others, however system checks at the DPW will be required to verify micrigrid power and functionality is satisfactory during the duration of the outage.*	$500	*$/day*	*The proposed microgrid will provide 100% of the Department of Public Works power requirements therefore it is assumed there would be no incremental costs as the same facility staffing and operational procedures would be executed as if there were no power outage.* *The cost estimate of $500/day for Department of Public Works staff/facility represents costs associated with meeting the operational requirements during microgrid operation, once the existing emergency generators have come offline and the highschool is ready to sync to the microgrid.*
	57T				

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?
IAWWTF	*One-Time Measures*	*Renting additional portable generator*	*1500*	*$/day*	*24/7 when installed egen not available*
IAWWTF	*One-Time Measures*	*Hooking up additional portable generation*	*500*	*$/day*	*One Time*
IAWWTF	Ongoing Measures	Staff and operations during outage	*3 man x $40/hr*	*$/hr*	Exclusive of fuel, these are operating costs during egen outage
High School	*One-Time Measures*	*Renting additional portable generator*	*1500*	*$/day*	*24/7 when installed egen not available*
High School	*One-Time Measures*	*Hooking up additional portable generation*	*500*	*$/day*	*One Time*
High School	*Ongoing Measures*	*Costs for meeting the operational requirements of the High School during outage with no backup generation available. Assumes twice that of when backup generation is avaiallbe due to additional operational and administrative requirements to either procure emergency backup power or evacuate if not available.*	*$2000*	*$/day*	*In the event backup power is not available*
Department of Public Works (Steets & Facilities)	*One-Time Measures*	*Renting additional portable generator*	*1500*	*$/day*	*24/7 when installed egen not available*

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
Department of Public Works (Steets & Facilities)	*One-Time Measures*	*Hooking up additional portable generation*	*500*	*$/day*	*One Time*
Department of Public Works (Steets & Facilities)	*Ongoing Measures*	*Costs for meeting the operational requirements of the High School during outage with no backup generation available. Assumes twice that of when backup generation is avaiallbe due to additional operational and administrative requirements to either procure emergency backup power or evacuate if not available.*	*$1000*	*$/day*	*In the event backup power is not available*

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 <u>when using backup generation</u> 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.
IAWWTF	*0%*
High School	50%
Department of Public Works (Steets & Facilities)	0%
Tompkins Consolidated Area Transit (TCAT	100%
Balance of Feeder 783 Boatyard & Boat Center Hydroponics Shop Golfcourse Church 40 Residential Single Family Homes	100%

6. During a power outage, <u>if backup generation is not available</u>, 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
IAWWTF	*100%*
High School	*100%*
Department of Public Works (Steets & Facilities)	*100%*
Tompkins Consolidated Area Transit (TCAT	100%
Balance of Feeder 783 Boatyard & Boat Center Hydroponics Shop Golfcourse Church 40 Residential Single Family Homes	100%

B. Questions for facilities that provide: Fire Services

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

N/A

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

N/A

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

N/A

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

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

N/A

11. Is the area served by the facility primarily (check one):

☐ Urban

☐ Suburban

☐ Rural

☐ Wilderness

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

N/A

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

N/A

D. Questions for facilities that provide: Hospital Services

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

N/A

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

N/A

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

N/A

E. ***Questions for facilities that provide: Police Services***

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

N/A

18. Is the facility located in a (check one):

☐ 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.

N/A

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

N/A

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

N/A

F. ***Questions for facilities that provide: Wastewater Services***

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

40,000

21. Does the facility support (check one):

☐ Residential customers

☐ Businesses

☒ Both

G. Questions for facilities that provide: Water Services

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

N/A as multiple water suppliers, none of which part of MG

23. Does the facility support (check one):

☐ 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.)?

40 residential 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).

120, assume 3 members per household.