50 - City of Albany (University Heights)

July 2016

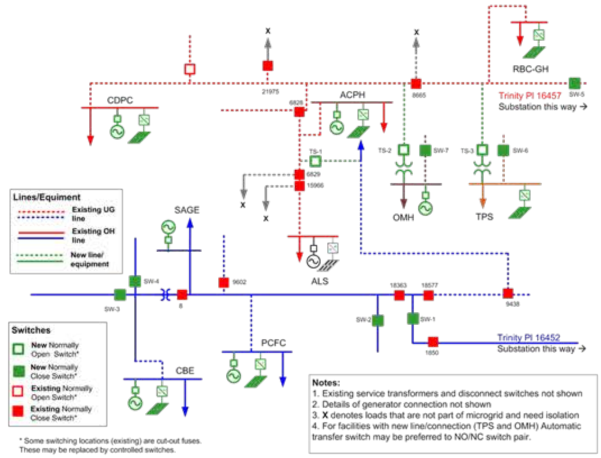
Notice

University Heights Microgrid Feasibility Study

Project 67332 prepared for NYSERDA by Allen Power Inc

End-users

Enablers & Proj Team



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Name of Contractor: Allen Power Inc

Title of Project: City of Albany University Heights Community Microgrid Feasibility Study

Agreement Number: 67332

Reporting Period: Final

Executive Summary:

This NY Prize feasibility study considered nine end-users in the University Heights neighborhood of Albany, NY, for the installation of distributed generation and controls technology necessary for implementing a microgrid. We believe this is a feasible microgrid project with approximately ten-year payback, however, this report will outline technical and commercial risks which we will need to mitigate as this project progresses through Stage 2 engineering and business case development.

Overview:

Scope:

The team defined participants in scope based on geography and willingness to participate. We will revisit scope in coordination with National Grid optimized to their system prior to subsequent development. 9 end-users are currently in-scope with the following risk/opportunities:

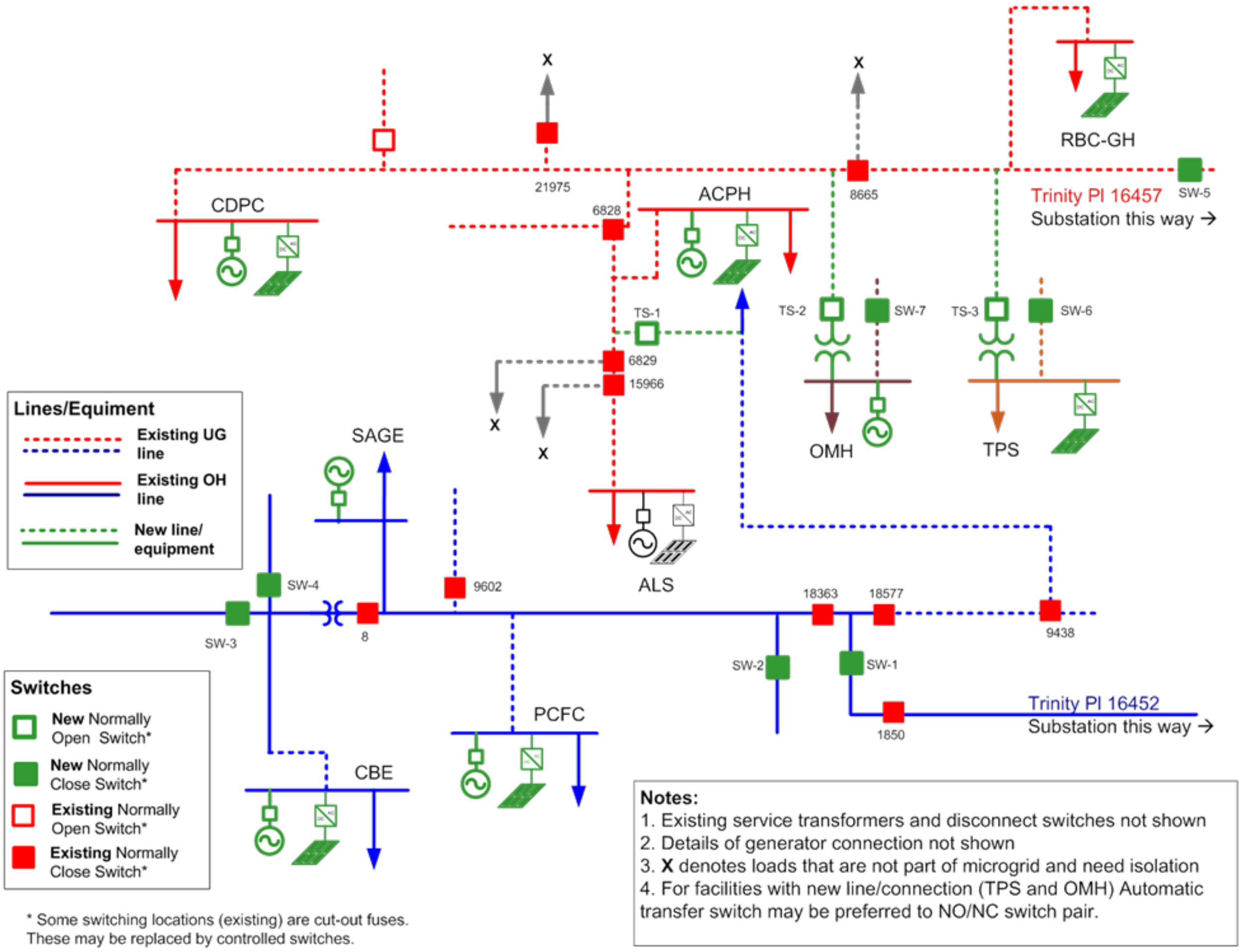
- **Capital District Psychiatric Center** – CHP with absorption chiller and solar is a good fit for this site because of its large size (100,000 sf) and constant loads as a hospital. The Office of Mental Health (OMH) is moving forward with a plan to install new electric chillers to mitigate the risk of Legionnaires disease. We asked the on-site team to reconsider and mitigate risk with rental chillers in the interim. In the meantime, Allen Power Inc will approach agency leadership to present the more beneficial case of our recommended configuration. Should the electric chiller project proceed to completion, we could also work with the team to implement fuel cells instead of CHP.
- **OMH HQ**- We recommend installation of CHP and absorption chiller for this large office building on 44 Holland as well as reconfiguration of their cooling and heating system control loops. The Office of General Services (OGS) Utility team is supportive but unsure of the process to move forward and implement and asked us to present a summary business case upon approval of this report. Solar is not feasible because of the building's green roof.
- **Albany College of Pharmacy and Health Sciences**- This is a good site for CHP, absorbers and solar with very few rights of way between buildings.
- **Albany Law School**- This is a good site for CHP, absorbers and solar.
- **Sage College**- Their Director of Facilities has expressed concern about CHP implementation because he is aware, second-hand, of issues with CHP at another school in the region. We have been in contact with the Director of Facilities at the school who is fairly new to the role and could not provide feedback on why the school went back to the grid. However, he said their 1.3MW of CHP is for sale and will be scrapped this

summer if not sold. Additionally, Sage has recently executed a 2MW remote metering agreement with a solar developer for their Troy and Albany campuses. We have been in touch with the developer and this agreement accounts for 80% of Sage's demand across both campuses. We can fill the remaining 20% with CHP at Albany. We will re-engage Sage following approval of this report to further define next steps.

- **Congregation Beth Emeth**- We initially assumed this is a solar-only site until University Heights transitions to microgrid. Because their boilers are approaching the end of their useful life and they are contemplating purchase of a standby generator because of recent grid outages affecting synagogue operations we will reassess the validity of implementing CHP before microgrid operations take effect.
- **Towneplace suites**- This would be a fairly small solar installation and their owner has expressed a willingness to enter into a PPA for microgrid operations. Their summer demand is lower than winter electric demand because of electric heating.
- **Gallery at Holland**- This site would be solar only and the developer has expressed an interest in off-taking from the microgrid as well as possibly investing.
- **Parsons Family Center**- This site is best served with solar and a small CHP installation. Parsons relies on public and private funding in order to maintain program operations. It's possible funding priorities may change during the course of a PPA period or operational life of power generation equipment.
- **Additional participants**- While there is risk that participants may not participate once we approach them for commitments, we feel we have communicated well the possible next steps and options. As we concluded the feasibility study, an incremental owner provided billing information for their 500kW property on New Scotland Avenue. Also, some potential participants have not said "no" to participating and we will re-engage them in preparation for Stage 2.

- **Distribution infrastructure**:

  The following one-line schematic outlines existing and incremental distribution infrastructure and switches required for microgrid implementation. We expect to heavily utilize the existing National Grid circuits mitigating the need to build out new distribution or cross public rights-of-way.



Technology:

- **CHP-** We are assuming for the sake of this feasibility study Tecogen 100kW and Intelligen 250kW price and performance. We will issue RFPs to multiple engine and microturbine OEMs and make selections during Stage 2. BOP estimates are based on industry standard price and performance.
- **Storage-** For the purposes of this feasibility study we have been working to Apogee Power price and performance assumptions. We understand National Grid will enter into detailed discussions with us on implementing batteries on sites and for the microgrid once we move forward with projects. The PSC 220 tariff is silent on batteries and we need to confirm the value story assumptions with the utility and overall business case.

We will explore the feasibility of storage on all sites with solar in order to ensure we have dispatch-able power in the event solar isn't producing.

- **Fuel Cells-** We have been in contact with Plug Power and GE. We understand Plug does not have a CHP option and GE's is a couple years from commercialization. We will revisit fuel cells if we confirm that we have sites without sufficient thermal load.
- **Building systems and controls-** We will conduct detailed analysis of building controls and an energy audit for sites which move forward in order to confirm whether upgrades are necessary to conform to controllers for distributed generation and the microgrid as well as the potential to enter into demand response programs and capacity markets.

Configuration and performance:

- **Site usage:**

U Heights	Avg Winter Demand (kW)	Avg Summer Demand (kW)	Peak Monthly Demand	Total kWh	Avg $/kWh	Total Fuel (Therm)	Gas/Steam cost/therm
	4,761	6,052	6,845	26,448,000	$0.11	1,099,000	$0.67

- **Microgrid configuration by site:**

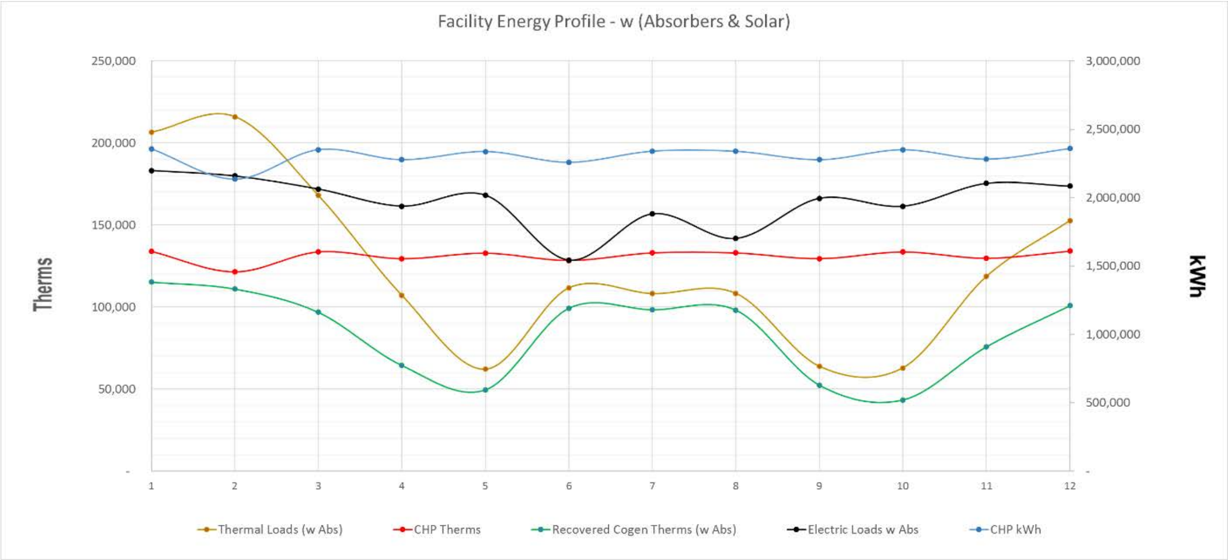
		Power Production Inputs				
		CHP Plant		Absorber Plant		Solar
		CHP Size	Quantity	Abs Size	Quantity	
		kW	#	Tons	#	kW
	Site					
1	Capital District Psych Center	250	4	450	1	175
2	Albany College of Pharmacy	250	3	50	3	175
3	TownePlace Suites - Marriot	No CHP	0	0	0	25
4	The Sage Colleges	100	3	50	2	0
5	Albany Law School	100	3	50	2	75
6	Congregation Beth Emeth	100	1	15	1	50
7	Parsons Child & Family Center	100	1	100	1	75
8	New York State Office of Mental Health (OMH)	250	3	300	1	0
9	RBC - The Gallery on Holland	No CHP	0	0	0	25
		3,300		1,215		600

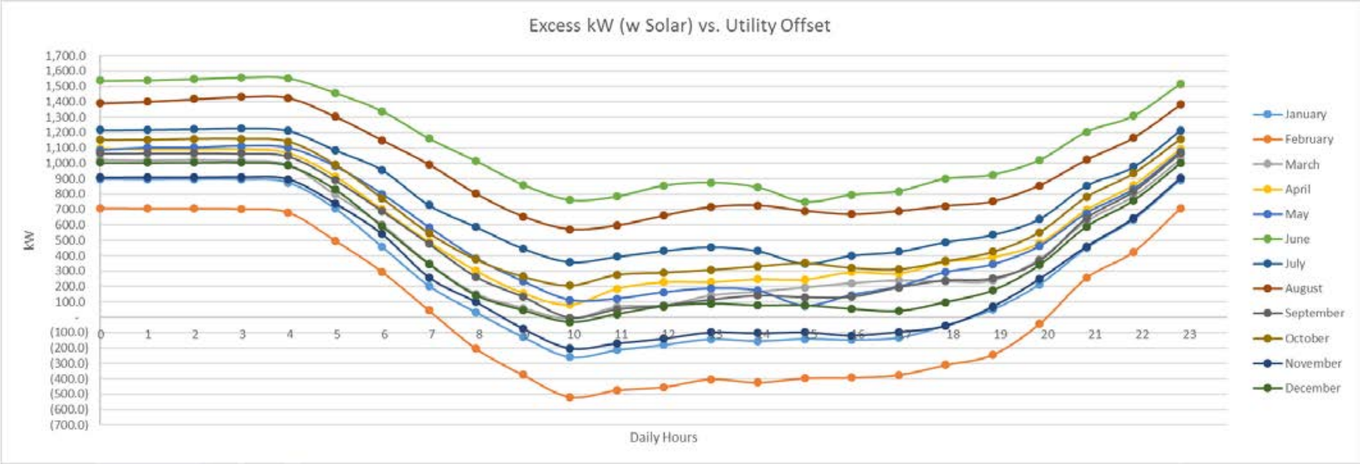
- **Performance**

		CHP Plants												Solar System Production
		Electricity (Annually)					Fuel/Heat						Cogen Plant Efficiency	
		Cogen System Production	Purchase from Utility	CHP Excess Electricity	Absorber Elec Offset	Electric Contribution	Cogen Fuel Input	Cogen Heat Output	Cogen Heat Recovered - w Abs	Absorber Usage	Thermal Contribution	Remaining Boiler Gas		
		kWh	kWh	kWh	kWh	kWh	Therm	Therm	Therm	Therm	Therm	Therm	%	kWh
	Site													
1	Capital District Psych Center	8,322,000	-	2,917,676	1,048,359	100.0%	856,167	446,059	356,144	143,259	92.8%	27,650	74.8%	239,633
2	Albany College of Pharmacy	6,343,496	(249,646)	1,001,664	349,453	95.5%	652,619	340,011	207,166	47,753	92.7%	132,542	64.9%	239,633
3	TownePlace Suites - Marriot	-	(1,002,400)	-	-	N/A	-	-	-	-	N/A	23,614	N/A	34,233
4	The Sage Colleges	2,545,289	(128,105)	375,955	232,969	94.4%	315,107	170,534	115,596	31,835	95.0%	132,982	64.2%	-
5	Albany Law School	2,496,728	-	1,030,337	232,969	100.0%	309,095	167,281	97,551	31,835	93.9%	6,309	59.1%	102,700
6	Congregation Beth Emeth	832,200	-	645,745	34,945	100.0%	103,026	55,757	30,334	4,775	87.9%	4,165	57.0%	68,467
7	Parsons Child & Family Center	864,862	(338,346)	34,664	232,969	71.0%	107,070	57,946	32,342	31,835	75.9%	10,278	57.8%	102,700
8	New York State Office of Mental Health (OMH)	6,260,875	(4,601)	1,698,776	698,906	99.9%	644,119	335,583	166,418	95,506	98.8%	1,952	59.0%	-
9	RBC - The Gallery on Holland	-	(1,933,766)	-	-	N/A	-	-	-	-	N/A	140,570	N/A	34,233
		27,665,450	(3,656,866)	7,704,816	2,830,569	98.0%	2,987,203	1,573,172	1,005,551	386,799	94.6%	480,061	65.3%	821,598

- **Curves**

The following curves extracted from our attached model show the microgrid's expected thermal and electric loads and production over a twelve-month period and electrical balance over a 24-hour period through the year.





Financials:

- **Costs**

Initial Investmant	Unit	$/Unit	Cost	Incentives	Tax Red %	Tax Reduction	Net Initial Cost
CHP (kW)	3,300	3000	$9,900,000	$3,300,000	10%	$990,000	$5,610,000
Chillers (Ton)	1,215	2000	$2,430,000	$607,500	0%	$ -	$1,822,500
Solar System (kW)	600	5000	$3,000,000	$300,000	30%	$810,000	$1,890,000
Other (Microgrid accessories)			$1,500,000				$1,500,000
NY Prize or National Grid				$3,500,000			($3,500,000)
Contingency	5%		$541,125				$541,125
Sub-Total			$17,371,125	$7,707,500		$1,800,000	$7,863,625
Engineering & design		10%	$786,363				$786,363
Grid engineering			$150,000				$150,000
OpCo fees		4%	$314,545				$314,545
Soft Cost Sub-Total			$1,250,908				$1,250,908
PROJECT TOTALS			$18,622,033	$7,707,500		$1,800,000	$9,114,533

- **Rates**

	Utility Rate $	Fraction %	Sell Back Rate to Microgrid $	Sell Back Rate to Utility $
kWh + (10% inflation)	$ 0.12	90%	$ 0.11	$ 0.09
Heating Therm	$ 0.67	80%	$ 0.54	
CHP Therm	$ 0.54	80%		
Cooling Ton		150%	$ 0.16	
CHP Maint $/kWh			$ 0.025	
Abs Maint $/kWh			$ 0.014	
Standby Fee/kW	$ 200.00		$ 50.00	

- **Revenues and return**
  - Note, we have not considered for the sake of this analysis potential incremental revenues such as grid services as well as aggregating end-users to participate in capacity markets and demand response programs.

Investor Annual Revenue	Unit	Revenue
CHP Power Produced to Use at CHP Sites (kWh)	19,960,634	$2,131,784
CHP Excess Power Outside the Need of Microgrid (kWh)	4,540,672	$408,660
CHP Excess Power Within the Need of Microgrid (kWh)	3,164,144	$337,929
Absorber Electric Offset (kWh)	2,830,569	$453,455
Solar Power Used Outside the Need of MicroGrid (kWh)	541,598	$48,744
Solar Power Used Within the Need of MicroGrid (kWh)	280,000	$29,904
CHP Thermal Offset/Heat Recovered w/out Abs (Therms)	625,437	$335,951
CHP Standby Fee		$0
Total Revenue		$3,746,427

Investor Annual Costs	Unit	Expenses
CHP Gas (Therms)	2,987,203	$1,604,564
CHP Maint.		$691,636
Absorber Maint.		$86,921
BMS System Maint.		$75,000
Grid Accessories Maint.		$150,000
General Expenses		$250,000
Total Cost to Investor		$2,858,121
	Net Revenue	**$888,306**
	Payback Period	**10.26**

Environmental:

The expected emissions relative to current operations view extracted from our model:

Emissions Type	Pound per MWh	Metric tons/MWh
CO_2	1500	0.6803880
SO_2	0.009	0.0000041
NO_x	0.247	0.0001120
PM	0.04	0.0000181

Carbon Footprint	Microgrid Production w/out Batteries		CO2 Produced from Natural Gas*		Annual CO2 Production			
	(Therms)	kWh	Pound of CO2 per Therm	Pound of CO2 per kWh	Pounds	KG	Ton	
Current Consumption	1,098,814	26,448,068	11.708	1.5	52,537,014	23,830,369	26,268	
Microgrid (CHP Gas Input + Utility Balance)	3,467,264	212,722	11.708	1.5	40,913,812	18,558,178	20,457	
Annual Saving							**5,812**	**22.1%**

* http://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11

REV and Tariff take-aways:

The needs of both National Grid and the microgrid could be met most effectively through a negotiated PPA, eliminating the need for disconnect equipment, and allowing National Grid to purchase microgrid generation for use in their distribution network. Such an Agreement should provide that:

- the Company which will be formed to own the project assets ("OwnCo") could sell power to the utility at rates to be set by power purchase agreement using National Grid assets to deliver the power;
- National Grid would purchase any excess power at rates that provide OwnCo with fair compensation for the power that is produced;
- National Grid would continue to provide power as needed to the end users under their parent service classifications;
- OwnCo and the end-users could benefit from net metering at the end users' parent rates

- OwnCo and the end users can participate in the emergency demand response curtailment programs described in Rule 54 of the Tariff.

Currently, the National Grid electric tariff does not contemplate microgrids or energy storage. National Grid has been supportive throughout the development of this study, and is confident that an agreement can be reached without action by the Public Service Commission.

In order to provide comfort to outside investors, OwnCo intends to petition the Public Service Commission for a declaratory judgment that neither OwnCo nor the company which operates the equipment is subject to regulation as an Electricity Corporation or as an Energy Service Company within the meaning of the Public Service Law or the General Business Law.

The current design for the University Heights microgrid does not require the construction of distribution facilities (i) in public rights of way; and/or (ii) subject to Article VII of the Ny Public Service Law. If subsequent changes to the design require such construction to be undertaken by OwnCo it will petition the Public Service Commission for permission to do so, if necessary.

The Contractor notes that among the end users is the Gallery at Holland, a 125-unit luxury apartment complex. OwnCo will confirm that the developer of that project is aware of its obligations under Rule 9 of the Tariff regarding residential submetering as well as those under the Home Energy Fair Practice Act.

Choices and commercial strategy:

- **NY Prize vs traditional incentives.** We currently plan to follow the Stage 2 NY Prize RFP process but will work with our partners on whether our best course of action is to pursue microgrid development through the NY Prize, with the utility, or as a phase 1 prior to microgrid development, commercializing distributed generation optimized to sites first.
- **Partnering and project structure.** We have had several local, regional, and global developers reach out to us to consider partnering arrangements. We will continue discussions on this matter once we understand how we will proceed with the project and the likely schedule based on participant speed.
- **NYS site development.** We will most likely engage our network to speak to key agency heads or decision-makers once we understand our preferred plan for development in order to ensure our recommendations receive appropriate due-diligence.
- **Project Team.** Based on the project structure we will build our team leveraging our deep network in the energy space utilizing very experienced project, finance, scheduling, and contract managers comprised mostly of local contracted retirees.

Lessons learned and recommendations:

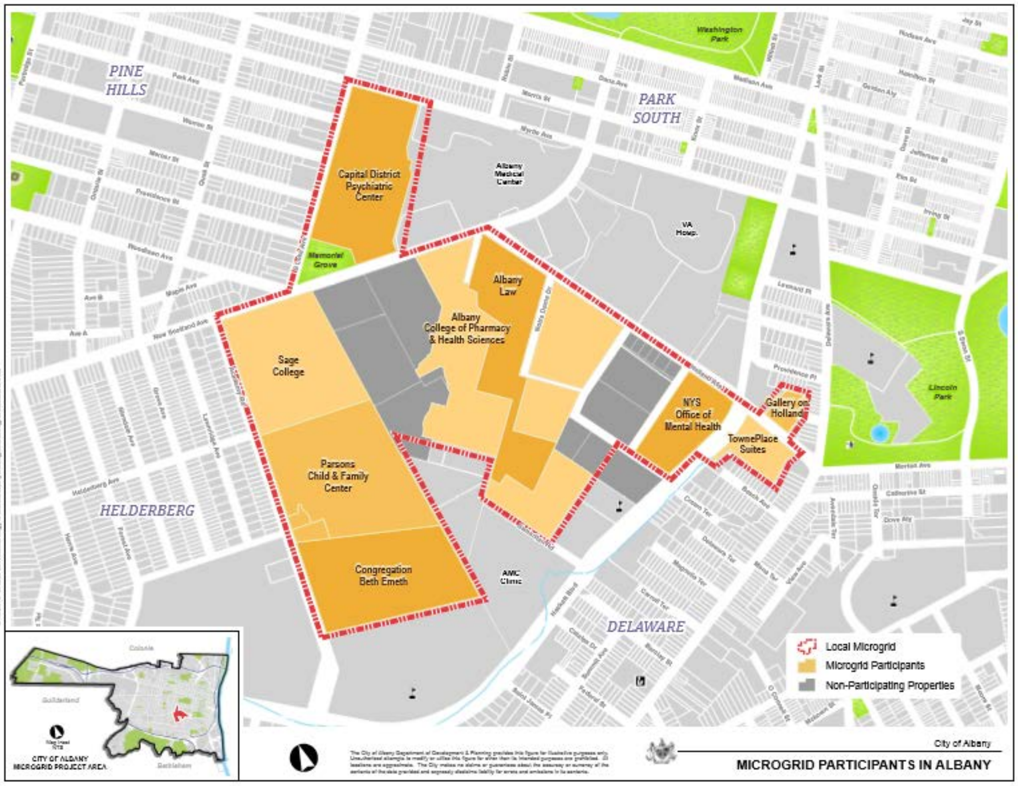
- Fully funding feasibility studies. For the most part, end-users were interested in participating in this study because NYSERDA fully funded it not requiring cost-share. DG development requires upfront engineering studies and cost-benefit analysis which few developers and end-users will fund with the current level of uncertainty in the regulatory frame-work. We recommend the PSC requires utilities to consider microgrid or distributed generation development as a possibly viable alternative to any significant distribution network upgrade or refurbishment.
- Business case uncertainty.
  - Negotiated rates. Even at this point in the study it is not clear what a negotiated rate to exchange electricity from one site in the microgrid to the other would be. While it could be possible to develop complicated formulas, it may be simpler to virtually net meter IAW end-user PPAs approved by the PSC.
  - Incremental CAPEX which improves grid resiliency. If the microgrid installs equipment which reduces network congestion and improves reliability, what is the formula to ensure fair cost-share between owners and the utility? Currently, it's our view that it is a negotiation, however, this continues to present much uncertainty in the business case until later in the project.
  - Changing regulations. Currently, NYS is encouraging further renewable and distributed generation growth across the State. I recently had a customer ask me what is stopping NY from putting a chill on solar ownership such as what has happened in Nevada. Is it possible for owners to enter into PPAs with utilities mitigating this risk for 10-20 years?
  - Storage. Incorporating storage has many benefits to both the utility, owner, and end-user. There should be a formula to determine utility cost-share requirements for implementing storage on sites.
  - Demand response and capacity market participation. By aggregating numerous smaller loads and generation, owners should be able to pass on value to end-users by having clear rules on how to participate in these programs.
  - GHG credits. By aggregating renewables and CHP at several sites, owners and end-users should be able to monetize the benefit of net emission reductions relative to typical emissions from utility-scale power generation and on-site boilers.
  - Federal ITC. We recommend NYS have an ITC in place for CHP in the absence of a federal program which is set to expire in 2016. It may be more advantageous to consider a PTC in order to incentivize production and not just installation of hardware.
- Process and partnering with the Utility. We are happy with the support National Grid provided us in the development of the feasibility study. We feel it would be more beneficial to both parties if there was additional incentive for the Utility to encourage and drive DG development behind the meter as an offset to capital projects which would occur in the absence of DG and microgrids.

Task 1. Development of Microgrid Capabilities

1.1. The Contractor shall demonstrate that the proposed microgrid has the following minimum required capabilities:

- **Serves at least one physically separated critical facilities located on one or more properties**

This proposed microgrid, located in the University Heights section of Albany is roughly bounded by New Scotland, Hackett, Holland, and Academy roads. Of the nine end-users who have agreed to participate in the feasibility study, the following are critical facilities: Capital District Psychiatric Center, Sage College, Albany College of Pharmacy and Health Sciences, and Albany Law School. It's possible Parsons Child and Family Center could qualify as a critical facility as well. The following map generated by the City of Albany Planning Department shows facilities in scope and their distinct boundaries:



- **The primary generation source capacity cannot be diesel-fueled generators**

This project will not consider diesel-fueled generators for primary generation. Diesel engines do not meet New York State emissions requirements without significant and costly exhaust treatment. Economically, diesel fuel is more expensive relative to natural gas and would challenge project economics. Diesel engines are difficult to site relative to renewables and natural gas fired engines and turbines because they typically emit more sound. Mitigating sound and vibration from diesel engines would add more cost to the project as well. Diesel fuel tanks also pose challenges as they require space, introduce EHS compliance risk, and provide only a finite supply of fuel in the event of a power cut. Section 4 clarifies the diesel standby generator footprint in the microgrid scope.

Natural gas engines are typically preferable to diesel gensets provided that there is an existing natural gas network to fuel the machines. Natural gas access is typically highly reliable, with no interruption even during hurricanes and ice storms. We must take care to site units so they are not susceptible to flooding risk driven by lack of drainage or below floodplain. It's possible an emergency, such as an extreme seismic event, could affect the natural gas supply and distribution infrastructure. The team will explore backup fuel and dual-fuel options and trade-offs during detailed design.

One of the factors against selection of diesel engines was the availability of adequate storage to ensure uninterrupted operation of the microgrid for a period of at least two weeks. In most cases, the existing diesel storage systems are sized to enable diesel engine operations for a day or two during short-term grid outages. In the NYSERDA 5-Site study that preceded NY Prize, the New York State Division of Homeland Security and Emergency Services (NYS DHSES) representative stated that during long-term emergences diesel fuel would be regularly trucked to the microgrid sites. However, in the absence of a formal emergency fuel delivery structure, for the purposes of this study (with the objective of replicability and scalability in mind), the Team will not assume continued and extended availability diesel fuel supply.

In any case, assuming availability of natural gas and diesel, other factors being equal, a key driver of the generation technology decision is the comparative price of natural gas to the price of diesel fuel. A natural gas based system, due to its significantly lower variable cost of generation, may allow for economical operation of the microgrid even in grid-connected mode during normal non-emergency periods, particularly during hours when the marginal cost of microgrid generation is lower than the electricity supplier's (or wholesale market) hourly price of electricity. Significantly higher diesel prices would preclude a diesel-based microgrid from economic operation during normal non-emergency periods.

Of course, without natural gas access, the choices are limited to diesel or propane fueled engines in addition to renewable, storage and demand-side resources. In such cases, the overall Benefit/Cost Analysis (BCA) will have to take into account the additional costs associated with emissions, noise and vibration mitigation and large fuel storage installations.

Natural gas generation is the least-cost option while serving thermal and electric needs followed by solar. Existing back-up diesel generators can still be used as a standalone backup generation (as in their pre-microgrid role) as a last resort in the event of both larger grid and microgrid contingencies. This report does not recommend implementation of incremental diesel generation.

Newer natural gas engines could meet the 10-second startup requirements for backup systems, and hence, diesel engines no longer have an inherent startup/ramp-up capability advantage over the gas engines.

- **A combination of generation resources must provide on-site power in both grid connected and islanded mode**

All power generation and supporting grid hardware and software will be specified to operate in both grid connected and islanded mode. Before Stage 2 design, we will survey end-users to confirm their minimum start-up time after a power cut of the main grid. We will weigh and reconcile with customer needs the cost-benefit of UPS and battery storage among other solutions to provide faster conversion from grid to islanded mode. All power generation and the microgrid itself will spec to black-start capability.

Because the "NY Prize" is a high visibility public initiative, numerous vendors, to include ABB and Tangent Energy as well as start-ups have reached out to inform us of their capabilities and experience. GE also has deep experience with grid management software and hardware as well as Alstom. ABB, GE, and Alstom's experience includes managing intermittent renewable generation on the high voltage and distributed network to include islands and remote (weak grid) locations. We are also aware of the advanced microgrid controller being developed in a DOE project by GE, NREL and others. GE Energy Consulting is OEM agnostic regarding microgrid hardware and software so this project will consider all feasible options factoring in, price, performance, and experience.

The available commercial microgrid control platforms vary in functionality, and a complete control solution will typically be comprised of an integrated suite of both hardware and software components. Depending on the microgrid site use cases, the control solution will often require some level of custom code development or configuration scripting to support integration with electric distribution equipment, the building energy management systems (BEMS), controllable loads, and generation assets within to the microgrid, as well as the utility enterprise systems (EMS/DMS/OMS) and the ISO control center.

A key deliverable of Stage 2 is to define functional requirements for the microgrid controller liaised with National Grid and required building upgrades in order to ensure RFPs allow microgrid owners and operators to make the right decisions.

The key components comprising the Microgrid Control System will include one or more of the following platforms as needed to support site-specific requirements:

Microgrid Transfer Switch:
The transfer switch subsystem is the primary integration point between the switching and protection components in the power delivery system and the microgrid controller unit. Key performance aspects being analyzed are: ability to facilitate seamless disconnect/reconnect,

switching transition (make-before-break vs. break-before-make), transfer speed, cost, availability, fault-current contribution, and maintenance requirements. Other performance aspects include coordination with the microgrid controller unit to provide voltage and frequency support at the POC, transfer of critical load, and fast shedding of non-critical load during disconnect. Several commercial transfer switching and interconnection solutions exist. Mechanical switching solutions built on conventional breakers and relays tend to be less expensive and least performing in terms of transfer speed. Higher performance, and higher cost, is offered by advanced solid-state switches that could provide seamless, high-speed disconnect and load transfer in less than a quarter-cycle.

Microgrid Controller:
The microgrid controller unit enables automation of the core microgrid operations and dynamic control of grid support functions. Existing commercial solutions differ by vendor and support various levels of functionality such as: generation optimization and optimal dispatch; renewables integration; asset monitoring and scheduling; and integration adapters for common protocols such as Modbus/DNP3/BACnet. In available commercial microgrid control solutions, renewables are usually integrated via the specific generation system controller (e.g. solar panel and inverter system package and controller). Several commercial microgrid controllers have configuration options for renewables and limited functionality to integrate energy storage. CHP is usually addressed as part of the broader microgrid system design and its integration might span several site-specific generation components and buildings. More advanced microgrid controller units, such as the DOE controller being developed by GE and other evolving systems, are projected to include advanced distribution grid support functions, optimized energy storage and renewables integration, energy market functions supporting dynamic pricing and ancillary services, and tools for advanced data collection, situational awareness, and operations analytics.

Building Energy Management System (BEMS) Adapters:
Several of the commercial microgrid control platforms provide integration with building energy management systems via the BACnet protocol. The vendors which provide these platforms have developed a library of adapters during recent years from participation in various microgrid pilot projects. The adapters offer various levels of control integration between the microgrid controller and the legacy BEMS platforms deployed in facilities within the microgrid. This facilitates control of building systems, such as HVAC and lighting, interfaced through the BEMS in support of microgrid load shedding or routine load shifting/balancing activities. Availability of these adaptors can also enable significant cost savings for an integrated microgrid control solution.

Microgrid Energy Management System (MG EMS):
The Microgrid EMS is an evolving software component. Existing microgrid controller units offer basic tools for configuration of the microgrid asset network and monitoring of operations. The Microgrid EMS is the envisioned next generation of the existing microgrid

management tools. The MG EMS provides an extended suite of automation and grid support functions and visualization and planning tools supporting the configuration and dynamic orchestration of microgrid operations. Current IEEE 1547 and P2030 standards working groups are addressing requirements and data models for microgrid controller interfaces and grid support functions for the evolving Microgrid Controller Unit and the MG EMS solution space. A commercial Microgrid EMS is not available at this time; however, a vendor that provides a microgrid controller and demonstrates that they have a microgrid EMS solution in development for their specific controller platform offers a highly desirable platform with growth potential. The major vendors in the space are in fact working on microgrid EMS applications; the smaller niche players which lack the capital for such development are somewhat static, offering their baseline operator tools and options to purchase customized development for additional functions or asset adapters.

DER Management System (DERMS):
DERMS is another evolving software platform. Some vendors are working to integrate functionality across their demand response platform, microgrid control platform, and various DER controllers (e.g. Battery Energy Storage System, Solar Plant, Wind Farm, etc.) plus provide deep integration with utility DMS/OMS/EMS systems. A DERMS solution is not required for a site specific community microgrid. However, when selecting a microgrid controller, it is important to consider the vendor's development cycle and ultimate vision for the platform. A vendor with a forward looking view of holistically developing their microgrid control solution across their other platforms and ultimately reaching a DERMS enterprise-scale solution, will offer a well thought out and long term solution with great modularity.

- **Must be able to form an intentional island**

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

During our site visit with Sage College, we learned that they are entering into a remote metering PPA with a solar farm in Brunswick, NY. This is the only site with such an agreement and we cannot rely on this power generation in the event of a grid outage. Before applying for Stage 2 feasibility, we will confirm with Sage not only that microgrid generation fill the gap not served by solar but how much more generation we can supply and remain economically feasible for both parties.

- **Must be able to automatically separate from grid on loss of utility source and restore to grid after normal power restored**

It's a critical requirement that the microgrid isolate from the main grid and have the appropriate signaling interface to tie back in with the grid once it is back online and ready to accept the microgrid load. We will generally assume 10 min to transfer from grid sync to island, however, we will survey clients to understand if they need faster times.

We assume we will comply with IEEE 1547 Interconnection Standards, National Grid Interconnection standards, and conditions of NYS SIR (Standard Interconnection Requirements). These standards apply to all on-site power sources including solar, wind and Combined Heat and Power. Additionally, in the case of utilizing a section of the National Grid system for the micro-grid, National Grid requirements for High Voltage protection and coordination will need to be followed and coordinated with the utility. High Voltage protection relays may be required for the protection and control of devices as may be applied on the local National Grid network.

Our design will include power and communication equipment necessary to separate from the grid in the microgrid design. Furthermore, strategies for re-connecting and the equipment necessary to accomplish these strategies will also be considered.

- **Must comply with manufacturer's requirements for scheduled maintenance intervals for all generation; plan on intermittent renewable resources that will be utilized toward overall generation capacity only if paired with proper generation and/or energy storage that will allow 24 hrs/day and seven days per week utilization of the power produced by these resources**

The feasibility study team will apply typical O&M contract assumptions to the model based on our collective experience. As a general rule of thumb, we will look towards committing for at least five-year maintenance agreements not only as an opportunity to fix costs but to ensure we honor warranties with proper servicing and continue to meet performance guarantees. Wherever possible, we will benchmark O&M package pricing with reliability assumptions, manufacturer weibuls as well as catalog expendables, parts and labor pricing. It is also important to consider the location of and reaction times of OEM authorized service personnel.

Generally, the ("blue sky") reliability of the electric supply in Albany is on par with most other upstate communities. The local utility company, National Grid, reported that the average customer in their New York service area experienced one (1) interruption for an average of 108 minutes in 2013. Almost 50% of these interruptions were caused by events on overhead radial lines (tree contact, lightning, accidents). Most of the facilities at the microgrid sites are institutional and health-related and stakeholders have expressed the fact that reliability is a concern. The 2013 New York State Department of Public Services ("DPS") data also clearly shows that the total customer hours of interruption due to major storms has increased substantially over the last two decades, particularly since 2010. With this in mind, the Team will develop a resilient design that incorporates hardening strategies commonly practiced by systems engineers in areas exposed to storms and outage events. This includes flood avoidance and flood control measures applied to generators, transformers, and switchgear, fault-tolerant and self-healing network designs, redundant supply or reconfigurable supply where it makes sense, remote monitoring and diagnostic equipment, robust construction, undergrounding where possible, and a host of other time-tested measures.

History has shown that while blue-sky outage events are stochastic, they can be clustered during times of high demand when the system is stressed. Also, major storm-related events (hurricanes, ice, snow, tornadoes, etc.) are more likely during certain seasons or months of the year than others. The Team will consider reliability-centered maintenance (RCM) strategies that focus more attention on critical pieces of equipment that could affect the microgrid operation (such as rotating machines, transfer switches, breakers) but will recommend periods during the day, week, and year when routine maintenance would be less likely to coincide with an outage event. This is a data driven task that is likely to become more effective given a longer operating history.

ASPs are typically willing to work around the plant owner's schedule to minimize plant down-time. Most routine maintenance can be accomplished during off peak periods, eliminating the possibility of incurring peak demand penalties from system down-time. More lengthy maintenance is also scheduled for off peak hours.

As part of our system analysis, we understand that generation has to be "net-dispatchable." This means that renewable generation modeling should reconcile to load though energy storage, curtailment in gas-fired generation or a reduction in demand.

- **Generation must be able to follow the load while maintaining the voltage and frequency when running parallel connected to grid. It also needs to follow system load and maintain system voltage with the American National Standards Institute (ANSI) c84-1 standards when islanded.**

The functional design will consider both the sufficiency and control and communication capability for generation to maintain voltage and frequency while in islanded mode. The study will also explore the economics of energy storage both as resource for capturing variable renewable energy, if any, to ensure reliability of meeting load during emergency, or to engage in energy arbitrage with the grid, and to provide ancillary services to the grid.

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

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

For instance, previous work by the Team on another microgrid feasibility study indicated that during normal conditions (i.e., non-emergency periods) a natural gas based microgrid may purchase power from the utility or electricity supplier or even the NYISO market at some of the hours, and self-generate or even sell to the grid in other hours; all depending on the relative cost of self-generation compared to the hourly wholesale zonal prices (as buyer of power from either the utility/electricity supplier, or from NYISO); or compared to the locational marginal prices (LMP) (as a wholesale market seller to the NYISO). That analysis was based on simple economic comparison, ignoring regulatory hurdles or ISO qualification requirements.

Dispatch of internal generation will be based on both economic (i.e., efficiency) and reliability considerations, with the least expensive generation resource running as baseload and incrementally more expensive resources running in cycling or peaking mode, and stacked on top of the baseload generation (i.e., microgrid's merit order curve). We look forward to testing the many options we have concerning prioritization of loads and how to optimize the potential "dispatchability" of the micro-grid across different scenarios.

- **Include a means for two-way communication and control between the community microgrid owner/operator and the local distribution utility through automated and seamless integration. Include processes to secure control/communication systems from cyber-intrusions/disruptions and protect the privacy of sensitive data.**

The team's first option is to consider a bespoke and dedicated microgrid communication system in order to optimize security and robustness. As we work further with end-users and National Grid, we will understand what infrastructure is available, cost savings, and performance trade-offs.

The team will also survey end-users at the start of Stage 2 to understand their engagement requirements and how actively engaged they will want to be with grid operations. This will include alarm and report requirements as well as their desire to have a third party manage building loads when conditions warrant.

We have started considering design options for this task. Important information has recently been requested from both the utilities and facilities which, if made available, will provide details on in-place networks and protocols that possibly could be leveraged in support of this requirement (e.g. leverage for cost saving and interoperability purposes). The first step is to determine if the microgrid solution will leverage existing networks or if there is a need to design and deploy new communications systems. Once the network platform is identified we will move to select compatible platform and protocol monitoring services as well as security services to satisfy the cyber security protection functions.

The microgrid control design will utilize distributed utility grade controllers and Intelligent Electronic Devices (IEDs). These devices meet the requirements of NERC CIP-5 and will be shown to meet the requirements of NIST Risk Management Framework. The controller design will utilize redundancy in the server, data collection server, and in the communication system design. This could include redundant fiber rings with redundant Ethernet switches at each key site/facility in the microgrid. Intelligent devices by GE and others, such as UR relays, 8 series relays and controllers, offer redundant communication ports and reduce failover time to zero through IEC 62439-3 Parallel Redundancy Protocol. This feature helps to minimize cost by use of a single, high reliability IED/controller instead of using two devices. The GE URs and 8 Series relays allow for field replacement of failed module assuring a quick return to service. The protection and control design will incorporate the long accepted practice of backup protection for critical devices. These devices will provide time stamped data as well as waveforms for key system events. This data will be automatically retrieved by the control system for post event analysis.

A key facet of this design will be integration with utility enterprise systems such as DMS, OMS and ADMS. This will enable the utility to have visibility into the state of microgrid assets and possibly exercise hierarchical control if appropriate.

The Team will evaluate the use of existing communications systems in two important areas:

Cost Savings and Interoperability:

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

Security and Resilience:

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

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

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

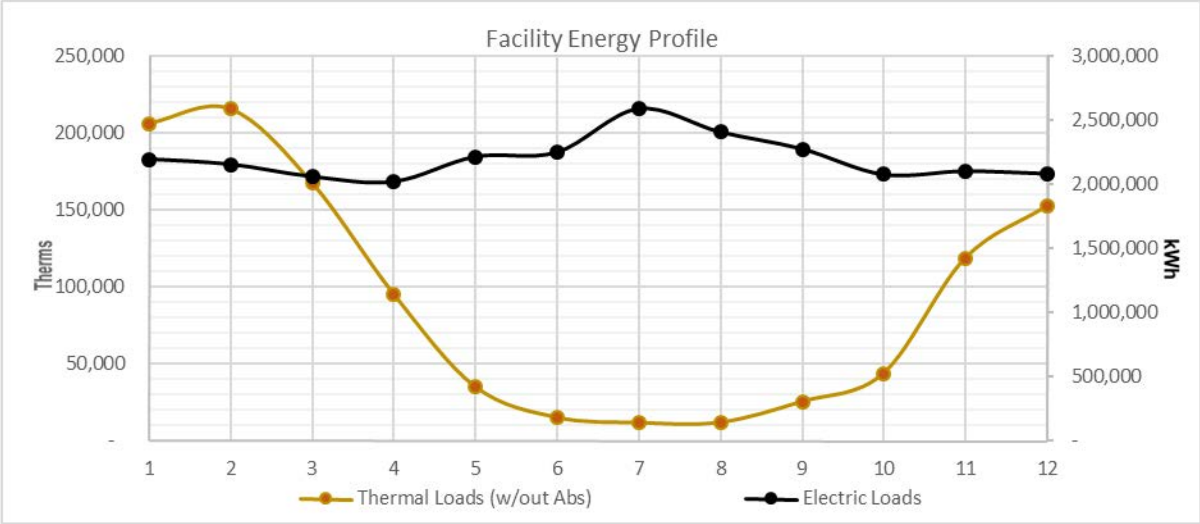
- **Provide power to critical facilities and a diverse group of customers connected directly to the microgrid-diversity should apply to customer type (e.g. residential, small commercial, industrial, institutional, etc) and overall demand and load profile.**

The nine entities, four of which are critical, operate dozens of facilities which fall into the categories of hospital, school, hotel, residential/apartment, and house of worship. This presents the possible benefit of complimentary loads where power generation units can serve multiple facilities, increasing utilization and capacity factor.

The critical facilities are Albany Law School, Albany College of Pharmacy and Health Sciences, Capital District Psychiatric Center, and Sage College. Critical facility electrical consumption and demand:

	Critical Facilities	
Date	**Electric Usage kWh**	**Demand Usage kW**
Jan-15	1,417,860	3,052
Feb-15	1,364,334	2,843
Mar-15	1,319,263	3,037
Apr-15	1,290,489	3,134
May-15	1,352,861	3,461
Jun-15	1,307,769	3,533
Jul-14	1,579,207	3,887
Aug-14	1,489,868	3,997
Sep-14	1,453,883	3,686
Oct-14	1,356,136	3,489
Nov-14	1,398,932	3,202
Dec-14	1,292,791	2,791
Totals	16,623,394	40,112
Monthly Average	1,385,283	3,343

From the tables above, we can conclude that there is net summer peak demand across the microgrid's critical facilities. By deploying solar and absorption chillers, we can reduce the peak electric loads to be more consistent with average and increase the microgrid's thermal utilization.



- **Must include an uninterruptable fuel supply or minimum of one week of fuel supply on-site**

Natural gas fired unit fuel supply is by pipeline. Our assumption is that pipeline gas is reliable and subject to interruption only in the events of: seismic, sabotage, technical failure, or supply constraints. Renewable resources would be constrained by the extent of storage the microgrid deploys and the intermittency of the renewable "fuel."

Our current assumption is that natural gas driving CHP production is "uninterruptable" with the exception of the extremely rare events we just defined. Our secondary power generation would be solar generation possibly with storage coupled with diesel generation. During Stage 2, when participants are more firm, we will define "supercritical" loads which would have priority of service by diesel + solar in the event the grid and gas network were down for a week. While it's possible storage could be a cleaner and more reliable secondary power source once we learn more about how to cost-share storage more effectively with National Grid in Stage 2.

- **Demonstrate that critical facilities and generation are resilient to the forces of nature that are typical to and pose the highest risk to the location/facilities in the community grid. Describe how the microgrid can remain resilient to disruption caused by such phenomenon and for what duration of time**

The City of Albany is susceptible to flooding as well as infrastructure damage from high winds and icing. As the University Heights microgrid is sited in an area with mostly underground distribution and load growth, we also must consider the strain on the system during high demand and high temperature days. This is of particular concern to National Grid which is why they are supportive of this feasibility study. On-site power generation mitigates the risk of excess load on underground wires. While this site is at a high elevation relative to the Hudson River, engineering will confirm floodplain location and ensure units are sited where they're not susceptible to winds and flood. The feasibility study team must also utilize underground distribution as much as possible in order to mitigate the risk of power cuts due to high winds and icing.

We have the expectation that natural gas power generation should be able to run for days without an operator being on-site, however, we will work with the City and site leads to ensure that clearing of snow to solar panels providing access to microgrid assets has high priority.

All systems will be designed to be resilient to forces of nature. This includes, but is not limited to, using existing indoor locations, outdoor enclosures, location above flood plains, and using natural gas as a main source of fuel (CHP). Snowstorms and snow removal will also be addressed for technology located outside (Solar).

The design will take into account GE EC's findings from its NJ Storm Hardening Project performed for the NJ Board of Public Utilities.

- **Provide black-start capability**

Proposed microgrid systems will be designed to provide black start capabilities. Black start capability will be designed to be automatic after either a specified time frame of sustained utility outage and or based on a command from the micro-grid operator to transfer from utility power to micro-grid operations. The on-site power systems will have the ability to start and operate using battery power and UPS devices and controls to start from a state of zero power to a state of sustained power production as matched to the micro-grid load. As may be necessary certain critical loads will be given a priority during black-start operation.

1.2 Preferable Microgrid Capabilities

The Contractor shall indicate to what degree the microgrid includes the following preferred capabilities:

- **Integrate and demonstrate operation of advanced, innovative technologies in electric system design and operations, including, but not limited to, technologies that enable customer interaction with the grid such as, Microgrid Logic Controllers, Smart Grid Technologies, Smart Meters, Distribution Automation, Energy Storage;**

The proposed microgrid is a microcosm of the modern electric power system, and to that extent, the application of advanced automation and control technologies will be explored to enable enhanced visualization, monitoring, control and interaction. The ultimate goal of "advanced, innovative technologies" is to enable safe, reliable, economic operation of the microgrid, in both connected and islanded mode. This includes: consideration of best in class distributed energy resources, including demand response, energy efficiency measures and energy storage, supply the instantaneous demand; smart grid and distribution automation technologies, such as solid-state transfer switches, and automatic fault location isolation and service restoration (FLISR) schemes, to ensure reliability and power quality; smart relays, adaptive protection, special protection schemes, and Smart Grid/Distribution Automation (SG/DA) - Reliability-oriented SG-DA, including automated field devices (switches, sensors, and reclosers) and decentralized or centralized control, improves reliability by accelerating the detection and isolation of faults and reconfiguring the delivery system to restore service more quickly to more customers (wherever feasible). This benefit is now well established for normal “blue sky” operations, with several examples in literature of 20-40% reduction in the standard industry outage metrics, depending on circuit and system characteristics. The precise benefits of DA to storm resiliency and recovery are harder to quantify (due to the lack of available methodologies and metrics) but anecdotal evidence suggests they are real and potentially substantial. The Team will explore the application of SG-DA solutions to the community microgrid to ensure reliability in both connected and islanded mode and to enable rapid, seamless transfer when the grid is out.

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

- **Include an active network control system that optimizes demand, supply and other network operation functions within the microgrid;**

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

- **Involve clean power supply sources that minimize environmental impacts, including local renewable resources as measured by total percentage of community load covered by carbon-free energy generation;**

  As part of this feasibility study, we will use all opportunities to incorporate renewable power generation into the system. We do note that this is an urban, land-constrained area comprised of large institutional buildings requiring generation with high power density. There are several flat roof surfaces and some open fields in the area which could be of use. Congregation Beth Emeth has a field which they are unable to build on and they feel solar would be a good fit. There are several utility-scale as well as distributed generation solar applications in the region. University Heights has taller buildings with flat roofs as well as open parking lots and fields with few tree masks which are conducive to solar applications.

  Our most likely course of action is to optimize CHP applications to facility heat loads. Once we perform this model and understand electric balances from CHP we will supplant electric needs with renewables and storage applications. This will not only ensure the most efficient application of CHP but provide a good natural gas-fired electric baseload.

  The City of Albany falls in a wind regime of ~5.5 m/s wind speed at 80m hub height. Typically, wind turbines are commercially feasible at wind speeds greater than 6.5 m/s and we are not aware of any wind turbines installed in the area so it may be challenging to have a commercially feasible wind turbine application. Per NYSERDA PON 2439, the following benefits could apply, however we would likely see funding applied directly from the NY Prize PON 3044:

  Tier I: 10,000 kWh of expected annual energy production: $3.50/annual kWh
  Tier II: 10,000 kWh - 125,000 kWh of expected annual energy production: $1.00/annual kWh
  Tier III: 125,000 kWh - 1,000,000 kWh of expected annual energy production: $0.30/ annual kWh
  Tier IV: Greater than 1,000,000 kWh of expected annual energy production: $0.15/ annual kWh
  Incentives are additive.

- **Include energy efficiency and other demand response options to minimize new microgrid generation requirements;**

  As of now, during our site visits, we discovered very few have had energy audits performed as per facility managers. We plan on executing energy audits and understanding the business case for improvements during Stage 2 engineering. We will also look at building system measures such as HVAC settings and lighting adjustments we can implement during periods of demand response to further improve the microgrid's economic model.

During Stage 2, after site/building audits, we will incorporate energy efficiency measures that can be done in parallel with new power generation sources in our models and design. As an example, a CHP plant addition to a large central plant may also include other central plant energy efficiency measures such as variable speed drives on existing central plant equipment, computer control expanded to larger components of existing systems to enable demand shedding and other evasive action, new chillers and new boilers and/or boiler controls where applicable.

The energy efficiency of the system will be based on the choice of new equipment and devices that will be included in the microgrid. The designed microgrid will include demand response functionalities for scheduling and control of the demand response resources that API and Energy Concepts will include in the microgrid facilities.

Energy efficiency does not imply any change in operations or consumption behavior. Energy efficiency is driven by equipment choice. It does not impact the comfort of the consumers/occupants or the usage of end-use devices and equipment. Energy efficiency can be achieved through replacement of less energy efficient components or equipment in the microgrid with more efficient components or equipment. These include both electricity producing and consuming elements, and also thermal generation and usage. Energy efficient equipment simply deliver more kWh or Therms for each Therm of primary fuel consumed. The decision to replace existing equipment and systems with more efficient substitutes is based on economic considerations such as net present value comparisons and payback periods, which are in turn influenced by the availability and size of financial incentives, rebates, tax breaks, and such.

Demand response, on the other hand, implies a change in operations and consumption behavior. This study will consider potential options for demand response. In fact, the adoption of capability to treat electric and thermal loads differently according to their classification as critical, discretionary, and curtailable, constitutes demand response functionality of the microgrid. The curtailable load, as the name implies, is the load that can immediately be curtailed (i.e., shed or dropped), similar to interruptible load of the traditional demand-side management programs. Discretionary load is more akin to more recent demand response programs. However, the main signal to activate the demand response's action is the microgrid's own assessment of availability of supply instead of utility's price or event signal.

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

- **Address installation, operations and maintenance and communications for the electric system to which interconnection is planned (e.g., underground networks, overhead loops, radial overhead systems);**

  For the base case, we will assume the microgrid will have its own communications system in order to minimize cyber-threats and outage risks. We will also understand the possibility of using established networks and interfaces and what the savings and trade-offs will be. We also look forward to learning how to best leverage the National Grid distribution network.

  Given the options available for modern microgrid design, the existing infrastructure will often be the differentiating factor in design decisions. Considerations such as the interconnecting network construction and topology will govern many of the design decisions. When feasible, ease of maintenance and installation as well as operational synergy will be factored into design decisions. However, it should be noted that primary microgrid design criteria such as stability and resiliency will generally have priority over operations / maintenance concerns.

- **Coordinate with the Reforming the Energy Vision (REV) work to provide a platform for the delivery of innovative services to the end use customers;**

  Couch White, LLP, as part of the feasibility study team, has identified implantation risks associated with the utility tariff which we address in the report overview and in Task 3. We will share our findings with NYSERDA and coordinate the most effective way to share our risks and mitigation plans with REV and PSC.

  This microgrid study considers a wide variety of end-users ranging from apartment complex, hospital, college, synagogue, troubled youth school and shelter, to hotel. As we define thermal and electric rate structures we need to consider the needs and risks which apply to all and provide a tangible benefit to their balance sheets incremental to greener and more reliable power which may not be immediately felt. If we discover a way to optimize the mutually beneficial value story we can certainly transfer this methodology to other microgrids while leveraging REV as necessary to support implementation.

  As this is an urban environment with a mature physical infrastructure and established gas and electric tariffs, we will work with our end-user and utility partners to ensure that we coordinate efforts with REV and the PSC and look for ways to mitigate risks regulations may have on microgrid implementation. We would expect that metering, rights of way, how to "share" use of distribution lines, and how to interface with and sell/buy power with the grid are all problems we need to solve. Because this is a site experiencing stresses on the distribution system, we seek to work with National Grid to obtain a mutually beneficial solution and apply these solutions to other sites.

- **Take account of a comprehensive cost/benefit analysis that includes, but is not limited to, the community, utility and developer's perspective;**

Our feasibility incorporates organic tools which help us optimize the technical strategy we should apply to the business case for University Heights. Additionally, we use the inputs and outputs from our study to incorporate into the standard NYSERDA cost/benefit analysis tool in order to have a consistent and holistic approach for the overall microgrid case. GE's finance experts are also available to support our work as necessary.

Tangible benefits we analyze includes annual energy savings, utility savings due to infrastructure improvement, specific facility deferred capital cost as may apply to plant upgrades included in the project (example – electric chiller that is budgeted to be replaced by a facility that now gets replaced by an absorber as part of a CHP plant, or an electric service in need of upgrade that is upgraded as part of the micro-grid project). Costs include full implementation costs including, design, financing, miscellaneous soft costs and construction costs. Other semi-tangible costs may include the avoided cost of business disturbances and damage incurred during utility outages that will now be avoided with the micro-grid system.

Intangible benefits can also be described such as increased life safety, facility attractiveness due to standby power ability, and the potential opportunity for emergency shelter operation.

- **Leverage private capital to the maximum extent possible as measured by total private investment in the project and the ratio of public to private dollars invested in the project;**

API has several paths to obtain funding for the University Heights microgrid. First and foremost, we want to define the microgrid which optimizes the business case and meets loads requirements. Once we define the microgrid and business case we want to understand the end-user's appetite for the different commercial options. Based on that outcome we will explore financing options incremental to end-user investment which has the lowest cost of money. Typically, we would expect bank financing with possible Green Bank guarantees for construction loans and any high-risk or less proven technologies. If this project makes business sense for the end-users and investors, it should make sense for banks.

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

In addition, the BCA will include the societal net benefits/costs. The Team's contribution will be based on learnings from the original NYSERDA 5-Site study which includes consideration of various financial benefit and cost streams, and was supplanted by accounting for other non-tangible benefits and costs, including environmental benefits and avoided interruption costs. The latter, which is more difficult to quantify, can be estimated based on available benchmarks depending on the classification of the facility's type, critical loads impacted, number of persons impacted, and the duration of emergency period.

- **Demonstrate tangible community benefits, including but not limited to, (e.g. jobs created, number of customers served, number of buildings affected, scale of energy efficiency retrofits, etc.)**

  The feasibility study should result in a business case for end-users which not only drops energy costs but mitigates energy inflation. Additionally, end-users will find it easier to plan their energy strategy and budget longer than one year if their costs are fixed by the microgrid's CAPEX investment and their only variable cost is fuel. Should this all fall into place, this area of Albany served by a microgrid should have a competitive advantage for growth as future high energy use firms will find the microgrid economic benefits compelling.

- **Incorporate innovation that strengthens the surrounding power grid and increases the amount of actionable information available to customers—providing a platform for customers to be able to interact with the grid in ways that maximize its value.**

  The project team will work with National Grid to understand current distribution network challenges and how the microgrid can mitigate risks. This not only includes current issues but accounting for load growth in the area as well.

  As mentioned earlier, the team will survey end-users during Stage 2 to understand their imperatives and the "dials" they want to control as well as their dashboard, alarms, and reports. The microgrid and relevant building control systems must have the appropriate automation to make correct demand and dispatch decisions, however, reports and alarms must be configured such that building and microgrid managers have the right data to make decisions on how to adjust performance and behaviors to further optimize the system technically and commercially. We don't expect this to be a distraction from daily roles, but rather a way to make intelligent decisions when appropriate and take those decisions through a feedback loop to make change.

Task 2. Develop Preliminary Technical Design Costs and Configuration

2.1 Perform the following:

- **Provide a simplified equipment layout diagram and a simplified one-line diagram of the proposed microgrid, include location of the distributed energy resources (DER) and utility interconnection points. Identify new and existing infrastructure that will a part of the microgrid.**

Figure 2-1 shows a simplified layout diagram of the proposed microgrid electrical infrastructure. Each load point (microgrid facilities) is represented as a square box. The color of the box corresponds to the feeder that is a primary feed to that facility with each feeder represented by a different color as well. The grey colored arrows with an "X" designation represent large facilities/loads that are on the same feeder but currently not part of proposed microgrid. New and existing switches indicate boundary points of the microgrid footprint, where the rest of the feeder load will be isolated from the microgrid generation.

Simplified one-line .pdfs for each facility are available upon request.

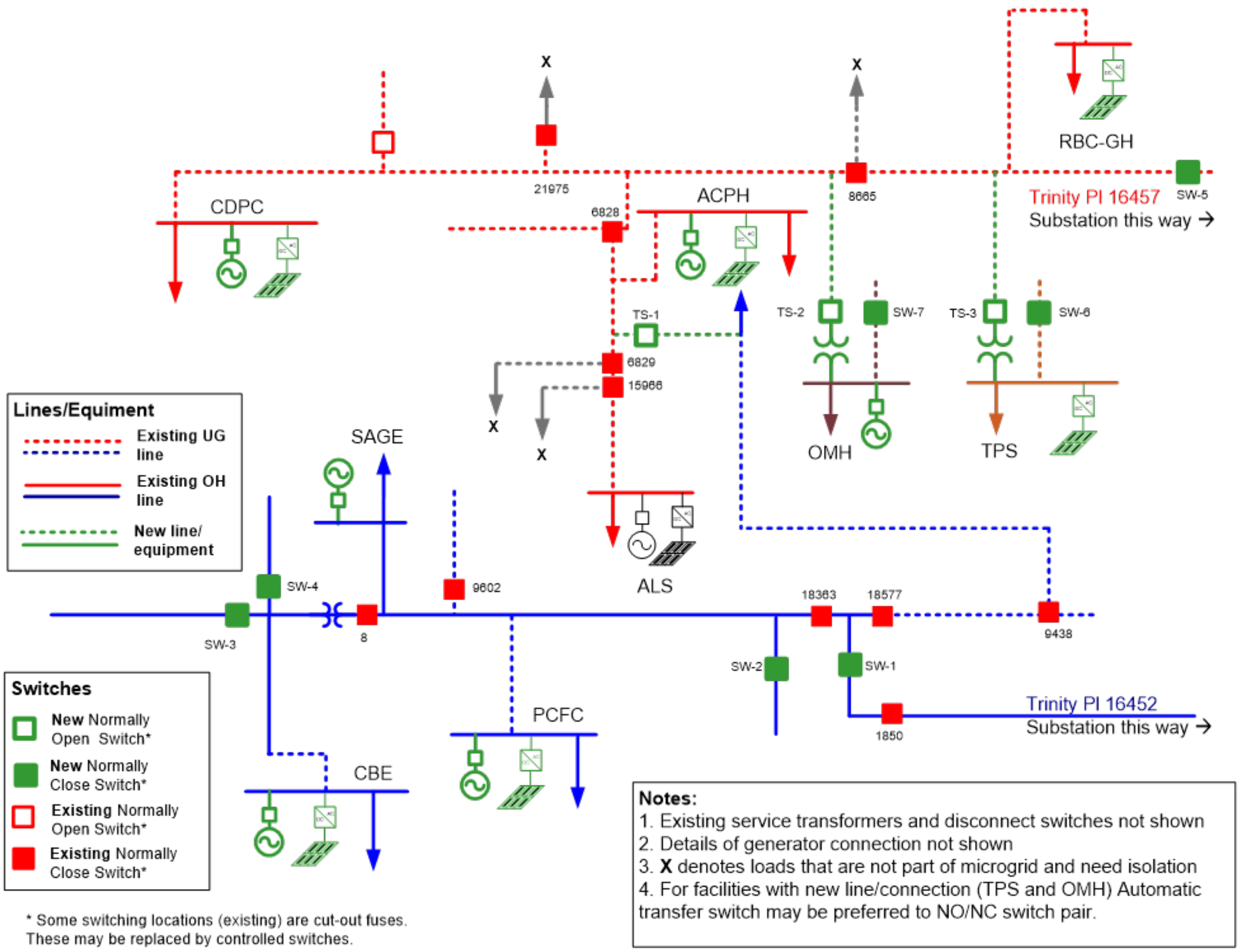


Figure 2-1 Simplified layout diagram (substations not shown)

- **Provide a brief narrative describing how the proposed microgrid will operate under normal and emergency conditions. Include description of normal and emergency operations.**

Normal Condition: Under normal conditions the microgrid will operate as part of the existing power system. Each facility gets power from installed behind-the-meter generation, and from the feeders/substation to which they are connected. Any additional cables, switches or other electrical equipment installed to facilitate operation of the microgrid in emergency conditions will be configured such that they do not change current distribution system topology, operation and protection strategy.

Emergency Condition: In emergency conditions the microgrid will isolate itself from the main grid and operate in islanded mode. The islanded mode will be active and the microgrid power generators (CHP) will match the microgrid electrical demand at an approximate load of 77.8%. During winter months (Nov to Feb) at the peak time (8am to 8pm) the demand could exceed the Solar System production and the Cogen Capacity (maximum of 603 kW at February typical day). The Standby Generators will run to match the demand. With 1,675 kW at 50% Capacity and 146,141 kWh total possible production per existing fuel tanks, the backup generators will be able to handle the microgrid demand for the events following a major power outage. Please refer to the Islanded Mode table for details.

In island mode the facilities will be disconnected from the main grid and other loads by opening normally closed switches at the boundaries of the microgrid in Figure 2-1. These include existing switch locations (1850, 9438) and new switches (SW-1, 2, 3, 4, 5, 6, 7). The facilities will then be interconnected using the existing sections of red and blue feeders (16452 and 16457). This requires installation of additional tie switches (TS-1, 2, 3). In addition, relatively short spans of new lines are required to connect the Office of Mental Health (brown feeder) and Towne Place Suites (orange feeder) to the red feeder.

Service to noncritical loads is either deferred or completely shed during emergency conditions if adequate power generation (CHP, solar, or standby generators) is not available.

Microgrid Operation Notes

• Definite transition to islanded mode during widespread outages (transmission or substation failure)

• Probable transition to islanded mode for common-mode failure of feeders: Trinity Pl 16452 and Trinity Pl 16452. – Tie feeders will likely not be able to pick-up the total load of both feeders. Microgrid formation allows National Grid to pick up some of the remaining load on other feeders. Further analysis is required to assess operation impact.

• Possible transition to partial microgrid for faults upstream (toward the substation) of microgrid tenants on either feeder – Microgrid generation can off-load feeder allowing National Grid to pick up more customers on ties. Further analysis is required to assess operation impact.

• Automation of key existing switches might enable two-stage restoration (automation followed by manual), potentially reducing outage duration.

• Installation of new switches increase reconfiguration options, possibly leading to greater flexibility and reliability

Microgrid transition for widespread outage

- Microgrid generation goes offline
- Individual facility generation back online (per Energy Concept’s outline)
- Existing NC Switches 8665, 21975, 6829, 15966 opened to isolate non-microgrid load (2-3 MVA)

- New NC switches opened to create islanded system
- Transfer switches and microgrid ties closed sequentially to energize island

MG transition for failure of 16452 and 16452

- Microgrid generation goes offline
- Individual facility generation back online (per Energy Concept's outline)
- Existing NC Switches 8665, 21975, 6829, 15966 opened to isolate non-microgrid load
- (2-3 MVA) New NC switches opened to create islanded system
- Transfer switches and microgrid ties closed sequentially to energize island
- NG picks up some load outside of microgrid via ties

Fault on Trinity Pl-16457 upstream of Microgrid

- Fault in zone-9:
- Trinity Pl 16457 Feeder de-energized due to breaker trip
- Switch NG 8665 opened to isolate the fault
- Possible formation of partial microgrid with CDPC, ACPH, OMH, and ALS generation (multiple switching operations)
- RBC-GH in microgrid if fault is upstream of SW-5
- RBC-GH without grid power until fault is repaired if fault between 8665 and SW-5
- NG picks up some load outside of microgrid via ties

Fault on Trinity Pl-16452 upstream of Microgrid

- Fault in zone-1:
- Trinity Pl 16452 Feeder de-energized due to breaker trip
- Switch NG 1850 or SW-1 opened to isolate the fault –Possible formation of partial microgrid with SAGE, PCFC, and CBE generation (multiple switching operations)
- NG picks up some load outside of microgrid via ties

Fault cases where microgrid formation would complicate National Grid restoration:

Faults on Trinity Pl-16457

- Fault in zone 8:
- Feeder down
- Switch 6828 opened manually

- MG tenants ACPH and ALS out of power » Can be powered via new MG tie (Tie Switch TS-1)
- Fault in zone-7:
- Feeder down
- Switch 6829 or 15966 opened manually
- MG tenant ALS out of power

Faults on Trinity Pl-16452

- Fault in zone-2:
- Feeder down » No effect to MG tenants if fault is downstream to fuse (not shown)
- Switch 18363 and 8 opened manually
- Power restored to MG tenant ACPH
- Power restored to MG tenant CBE via alternate/secondary feed
- MG tenants PCFC and Sage out of power » MG switch SW-2 eliminates operation of switch 18363 and 8 and can restore power to all MG tenants without use of alternate/secondary feed

Faults on Trinity Pl-16452

- Fault in zone 3:
- Feeder down
- Switch 18577 or 9438 opened manually
- MG tenant ACPH out of power
- Fault in zone-4:
- Feeder down
- Switch 18363 opened manually
- Switch 8 opened manually
- Power restored to MG tenant CBE via alternate/secondary feed
- MG tenants PCFC and Sage out of power

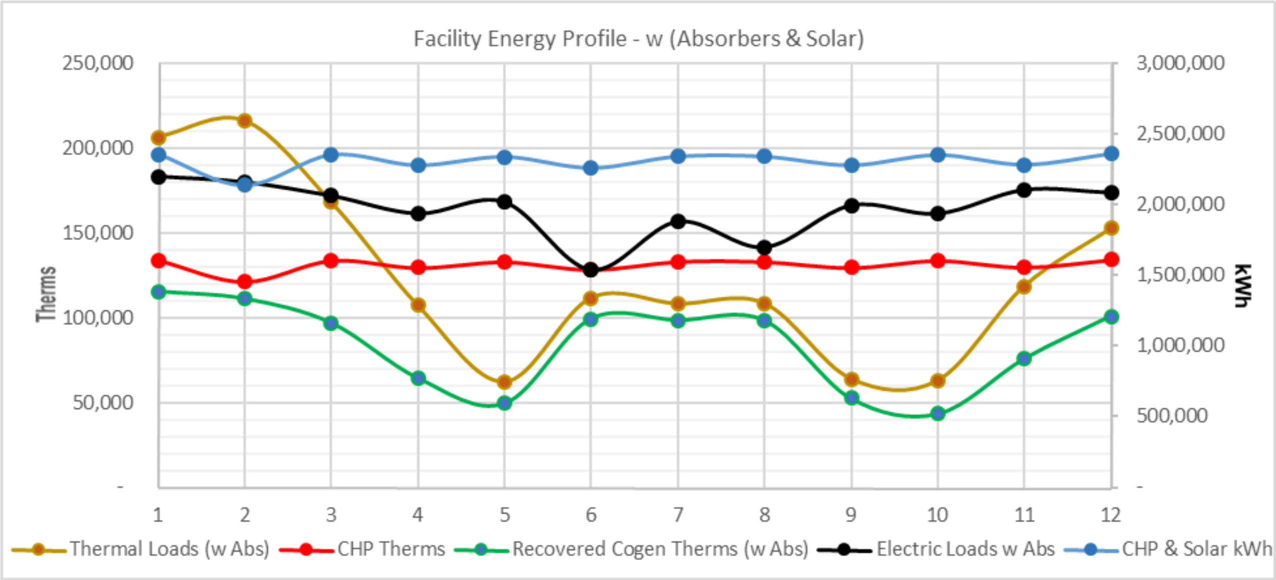
Faults on Trinity Pl-16452

- Fault in zone 5:
- Feeder down
- Switch 8 opened manually
- MG tenant CBE out of power
- Fault in zone-6:
- Feeder down
- Switch 8 opened manually
- MG tenants CBE out of power » MG switch SW-3 eliminates the operation of switch 8, powering MG tenant CBE along with other non-MG customers

2.2 Perform the following:

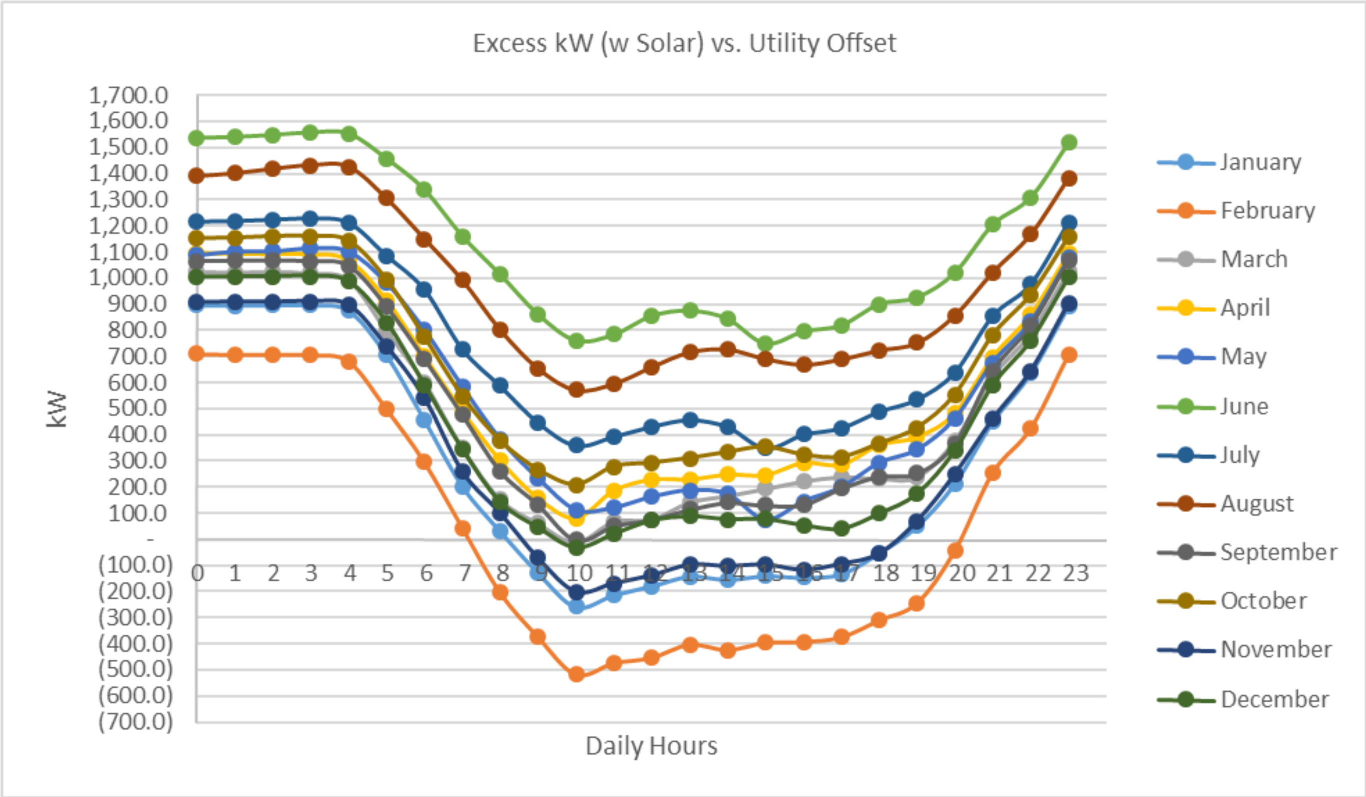
- **Fully describe the electrical and thermal loads served by the microgrid when operating in islanded and parallel modes: Peak KW, Average KW, annual/monthly/weekly KWh, annual/monthly/weekly BTU(consumed and recovered) and identify the location of the electrical loads on the simplified equipment layout and one-line diagrams.**

Graph 2-1 shows how thermal and electric power generation complement each other by month through the year.



Graph 2-1. Facility Energy Profile

Graph 2-2 shows, by, month, through a typical 24 hour day, whether the microgrid is producing enough electricity to satisfy microgrid loads. If a line dips below the x-axis, the microgrid may need to curtail or import electricity from the grid.



Graph 2-2. Microgrid Electric Surplus/Deficit

In parallel mode the microgrid power generators (CHP Units) will be running at full capacity (approximately 95% load) to feed the microgrid sites and send back the excess power to the utility grid. While in the islanded mode when the utility grid is down, the microgrid power generators (CHP Units) will run to match the electrical demand (78% capacity factor) unless it is required to run at full capacity when the demand is high, in this case the backup generators will only run to fill the gap that CHP units would fail to fill. At this point we assume the backup generators' tanks to be fillable. The Electrical table below shows a comparison between the two modes.

Our current DER configuration optimizes financial return, meeting thermal and electrical loads for most of the year, and efficiency. We are keen to apply storage to our microgrid because it is an opportunity to reduce the amount of CHP we may need, flatten our load curve and allow for dispatchable power for export to the grid, compensate for intermittent solar, possible uninterrupted power and ride-through, or meet peak loads within. Despite these benefits, our model shows batteries to not have adequate financial return. We have two open items in order to address this further and improve the business case:

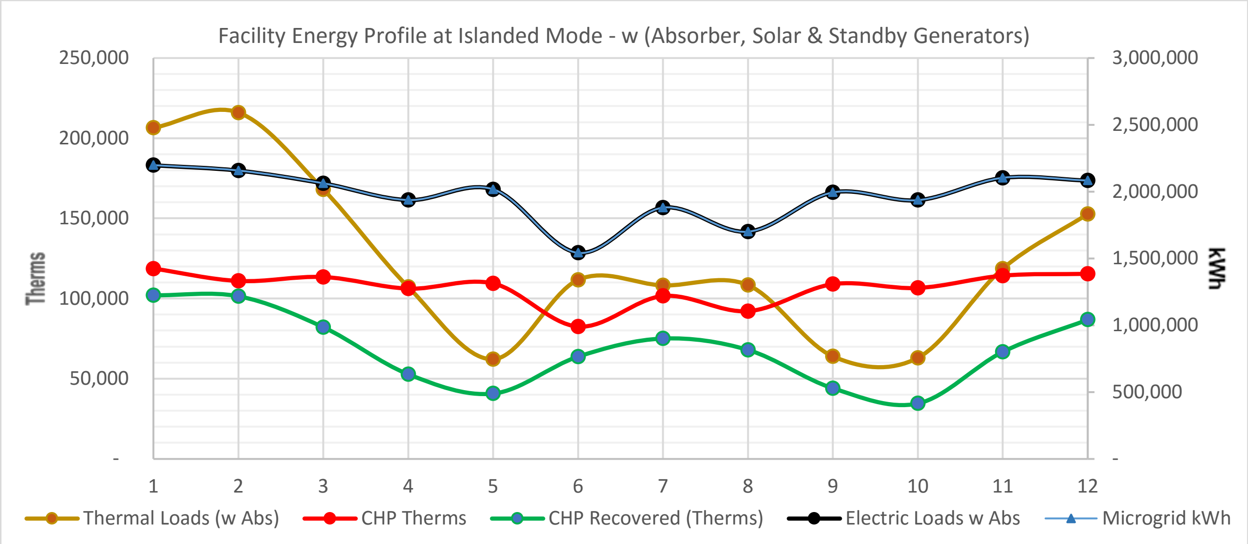
1. National Grid. We have discussed energy storage with National Grid as the PSC 220 Electricity Tariff is silent on storage. Storage has value for both the utility and end-users. Without sharing cost and value, batteries do not seem to help our business case.

2. Battery OEMs. We have presented our configuration to Apogee batteries in order to get a different perspective on the storage business case in the event our model is not capturing and representing value adequately. They are recommending 5 MWh of battery storage with a four-hour discharge rate and ten-year life with unlimited discharge cycling. We will refine our model and work with National Grid.

The Electrical tables (Tables 2-1 and 2-2) below show a comparison between the two operating modes. Graph 2-3 shows electric and thermal generation and load relationships when in islanded mode.

			Parallel Mode			
Date	Electric Usage kWh	Electric Usage w Abs kWh	Solar kWh	CHP kWh	Balance kWh	Excess kWh
January	2,198,150	2,198,150	44,175.0	2,357,022.1	(47,950.8)	250,998.3
February	2,158,137	2,158,137	53,592.0	2,136,067.4	(128,995.9)	160,518.6
March	2,062,745	2,062,745	66,030.0	2,350,978.9	(343.1)	354,607.2
April	2,022,457	1,937,540	70,380.0	2,277,808.2	-	410,648.3
May	2,215,828	2,017,689	93,930.0	2,337,491.9	-	413,733.2
June	2,250,317	1,542,675	91,800.0	2,258,779.5	-	807,904.3
July	2,588,576	1,880,934	94,860.0	2,339,800.1	-	553,726.0
August	2,408,721	1,701,079	81,096.0	2,338,909.2	-	718,926.1
September	2,277,620	1,994,563	76,500.0	2,277,521.9	(95.9)	359,554.4
October	2,078,209	1,936,681	62,310.0	2,350,266.2	-	475,895.4
November	2,103,740	2,103,740	42,750.0	2,281,719.4	(34,338.4)	255,068.1
December	2,083,568	2,083,568	44,175.0	2,359,085.0	(998.2)	320,690.5
Totals	26,448,068	23,617,499	821,598	27,665,450	(212,722)	5,082,270
Monthly Average				2,305,454		
Weekly Average				532,028		
Peak kW				3,230		
Average kW				3,158		
CHP Average Load				95.7%		
CHP Electric Contribution to Microgrid				95.6%		

Table 2-1. Microgrid monthly electric balances when grid-tied



Graph 2-3. Islanded thermal and electric balances

			Islanded Mode				
Date	**Electric Usage kWh**	**Electric Usage w Abs kWh**	**Solar kWh**	**Backup Generation kWh**	**CHP kWh**	**Balance kWh**	**Excess kWh**
January	2,198,150	2,198,150	44,175.0	66,825.0	2,087,149.7	-	-
February	2,158,137	2,158,137	53,592.0	153,533.0	1,951,011.7	-	-
March	2,062,745	2,062,745	66,030.0	2,125.6	1,994,589.2	-	-
April	2,022,457	1,937,540	70,380.0	-	1,867,159.9	-	-
May	2,215,828	2,017,689	93,930.0	-	1,923,758.7	-	-
June	2,250,317	1,542,675	91,800.0	-	1,450,875.1	-	-
July	2,588,576	1,880,934	94,860.0	-	1,786,074.1	-	-
August	2,408,721	1,701,079	81,096.0	-	1,619,983.1	-	-
September	2,277,620	1,994,563	76,500.0	2,025.3	1,916,038.1	-	-
October	2,078,209	1,936,681	62,310.0	-	1,874,370.7	-	-
November	2,103,740	2,103,740	42,750.0	51,588.4	2,009,401.3	-	-
December	2,083,568	2,083,568	44,175.0	9,924.9	2,029,467.7	-	-
Totals	26,448,068	23,617,499	821,598	286,022	22,509,879	-	-
Monthly Average				23,835	1,875,823		
Weekly Average				5,500	432,882		
Peak kW				603	3,135		
Average kW				34	2,572		
CHP Average Load					77.9%		
CHP Electric Contribution to Microgrid					95.3%		

Table 2-2. Islanded electric balances

Due to the difference of the power generation in the two modes, the thermal load consumed and recovered by the CHP units in the islanded mode will be less since less power would be produced when the microgrid isn't feeding back the utility grid. However, more thermal load will be imported from the utility grid for existing boilers to close the gap. Tables 2-3 and 2-4 illustrate thermal balances in grid-tied and islanded mode.

Date	Thermal Usage Therms	Thermal Usage w Abs Therms	Parallel Mode Consumption (Therms) CHP	Parallel Mode Consumption (Therms) Utility Balance	Parallel Mode CHP Recovered (Therms)
January	206,456	206,456	254,529.4	91,180.2	115,275.8
February	215,935	215,935	230,535.7	104,902.1	111,033.1
March	167,983	167,983	253,855.1	71,149.3	96,833.6
April	95,524	107,128	245,890.6	42,685.0	64,443.0
May	35,016	62,092	252,392.8	12,551.0	49,541.3
June	14,887	111,586	243,863.7	12,259.5	99,326.8
July	11,428	108,128	252,701.6	9,716.1	98,411.6
August	11,627	108,327	252,591.3	10,118.6	98,208.0
September	25,205	63,884	245,959.2	11,460.1	52,424.3
October	43,586	62,925	253,802.5	19,551.6	43,373.9
November	118,570	118,570	246,395.9	42,768.2	75,801.8
December	152,598	152,598	254,685.2	51,719.5	100,878.4
Totals	1,098,814	1,485,613	2,987,203	480,061	1,005,551
Monthly Average			248,934	40,005	83,796
Weekly Average			57,446	9,232	19,338
Daily Average			8,184	1,315	2,755
CHP Thermal Contribution to CHP Sites					96.9%
CHP Thermal Contribution to Microgrid					67.7%

Table 2-3. Grid-tied thermal

			Islanded Mode			
	Thermal Usage	Thermal Usage w Abs	Consumption (Therms)			CHP Recovered (Therms)
Date	Therms	Therms	Backup Generation	CHP	Utility Balance	
January	206,456	206,456	4,156.3	225,311.0	104,413.2	102,042.8
February	215,935	215,935	9,549.3	210,614.7	114,496.7	101,438.5
March	167,983	167,983	132.2	215,318.9	85,849.0	82,133.9
April	95,524	107,128	-	201,562.7	54,302.4	52,825.6
May	35,016	62,092	-	207,672.7	21,329.0	40,763.3
June	14,887	111,586	-	156,624.2	47,792.5	63,793.7
July	11,428	108,128	-	192,809.4	33,040.4	75,087.3
August	11,627	108,327	-	174,879.6	40,333.1	67,993.6
September	25,205	63,884	126.0	206,839.2	19,798.2	44,086.2
October	43,586	62,925	-	202,341.2	28,346.1	34,579.3
November	118,570	118,570	3,208.7	216,917.9	51,836.8	66,733.1
December	152,598	152,598	617.3	219,084.1	65,820.8	86,777.1
Totals	1,098,814	1,485,613	17,790	2,429,976	667,358	818,254
Monthly Average			1,482	202,498	55,613	68,188
Weekly Average			342	46,730	12,834	15,736
Daily Average			49	6,657	1,828	2,242
CHP Thermal Contribution to CHP Sites						78.8%
CHP Thermal Contribution to Microgrid						55.1%

Table 2-4. Islanded thermal look

- **Provide a written description of the sizing of the loads to be served by the microgrid including a description of any redundancy opportunities (ex: n-1) to account for equipment downtime.**

The microgrid is designed to provide electricity power to the all sites and to feed the utility grid back with any excess power, however the only sites that will be able to recover the heat from the power generation process would be the same sites where the CHP generators exist since the microgrid design doesn’t provide any district heating.

The CHP sites have been selected based on their thermal load to have the highest possible efficiency of the CHP plant. The more recovered heat can be achieved the higher the efficiency the CHP plant can get. To meet NYSERDA typical minimum efficiency (60%) requirements, all the designed plants shouldn't be oversized, otherwise the produced heat from the power generation process will have a bigger portion of waste heat. Therefore, enlarging the CHP plants might be good economically based on the utility rates however, it is definitely not as good for the environment since more heat will be wasted.

For the current microgrid design, 67.7% of the CHP output heat will be recovered to cover 96.9% of the thermal load in the CHP sites.

We are not considering n+1 power generation at this point. It is our experience that this redundancy usually makes sense when the cost or frequency of failure of generation units is high enough to warrant the additional CAPEX such as an islanded LNG compression station or data center. For this application, the microgrid will be grid-tied and in the event of islanding and power generation failure, there are adequate non-critical loads to curtail.

2.3 Perform the following:

- **Provide the following information regarding Distributed Energy Resources (DER) and thermal generation resources that are a part of the microgrid (subject to data availability): (i) Type (distributed generation (DG), combined heat and power (CHP), photovoltaic (PV), boiler, solar water heater etc.), (ii) rating (KW/BTU), and, (iii) Fuel (gas, oil etc.).**

Table 2-5 illustrates the application of DERs across the microgrid and by site. CHP will be fueled by natural gas

	Site	CHP Size (kW)	Absorbers (Tons)	Solar (kW)
1	**Capital District Psych Center**	1000	450	175
2	**Albany College of Pharmacy**	750	150	175
3	**TownePlace Suites – Marriot**	-	-	25
4	**The Sage Colleges**	300	100	-
5	**Albany Law School**	300	100	75
6	**Congregation Beth Emeth**	100	15	50
7	**Parsons Child & Family Center**	100	100	75
8	**New York State Office of Mental Health (OMH)**	750	300	-
9	**RBC - The Gallery on Holland**	-	-	25

Table 2-5. DER application

- **If new DERs or other thermal generation resources are a part of the microgrid, provide a written description of the approximate location and space available. Identify the DERs on the simplified equipment layout and one-line diagrams. Differentiate between new and existing resources.**

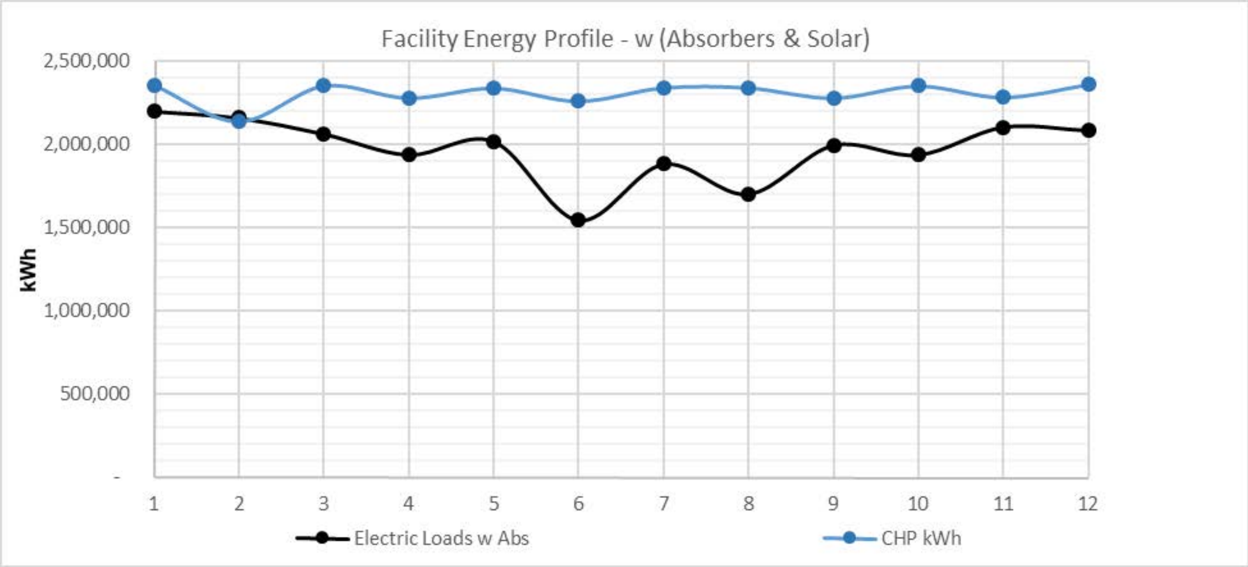
CHP System locations for most facilities will be in existing buildings mechanical rooms where space is available. In the event of a space shortage, some facilities may require a new location or outdoor enclosures for the units.

Solar system locations will either be located on the roof of an existing facility/building or be installed on available land located within the existing facility.

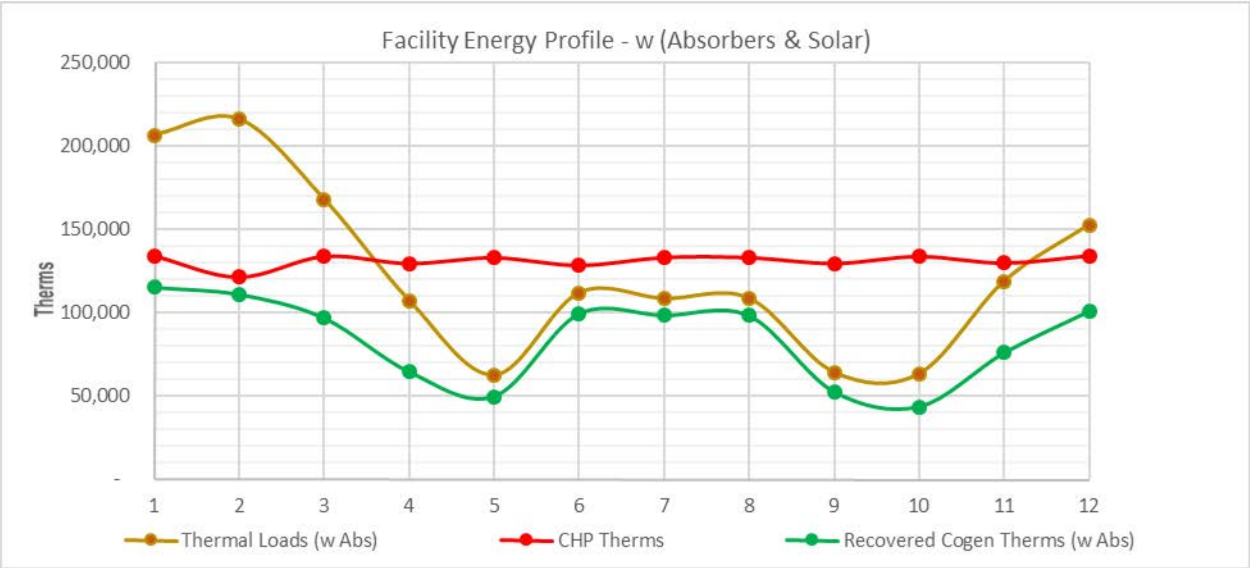
1. **CDPC** – This site has a large existing mechanical building that would be a proposed site for the new CHP system. The CDPC also has a large parking garage with ample room for the proposed 100kW solar system.
2. **Albany College of Pharmacy** – Overall, four (4) buildings at the college were identified as good candidates for the installation of a CHP system. All of these buildings have existing mechanical rooms in the cellar and/or on the rooftop. The college also may provide some rooftop area for the proposed solar system.
3. **Townplace Suites** – The rooftop of the hotel provides a good location for a small solar system. The hotel's individual PTAC units per room to not lend itself to a CHP application.
4. **Sage College** – Two (2) locations/buildings are proposed locations for a CHP system. Both locations have existing mechanical rooms where a small CHP system can be located. Sage also has plenty of other buildings where they would consider a rooftop solar system of around 30kW in total. Sage has executed a remote net metering agreement with Monolith Solar. For the purpose of our modeling we are assuming all of Sage's load is available for distributed generation. We know that their remote net metering agreement is optimized to 80% of Sage's total electric load for both their Troy and Albany Campuses. We are currently assuming that we can serve the remaining 20% of their load optimizing to thermal loads. We will deep dive this assumption and further economics during Stage 2 details.
5. **Albany Law School** – The College has a large existing mechanical room located in the cellar of the main building. This is a good location for the proposed CHP system. Another building on the campus could provide rooftop space for the 40kW solar system.
6. **New York State OMH** – The building currently has a large mechanical room located in the cellar which should be able to provide the space needed for the 750kW CHP system.
7. **Beth Emeth** – The Congregation Beth Emeth synagogue will have a 100kW CHP system and 50kW ground-mounted Solar system.
8. **Parsons C&F** – Parsons Child & Family Center will have 100kW CHP system and 75kW ground-mounted Solar system.
9. **RBC** – The Gallery at Holland will have 25kW roof-mounted Solar system.

- **Provide a written description of the adequacy of the DERs and thermal generation resources to continuously meet electrical and thermal demand in the microgrid.**

As we illustrate in numerous graphs and tables throughout our model and report, we offset much of our peak load throughout summer months with the introduction of thermal absorbers. As a result, our electrical peak load events are mainly during business hours in the winter. See Graph 2-4 and Tables 2-1 and 2-2. Thermally, we introduce thermal generation to not only meet existing boiler and hot water loads but absorption chillers as well. There is more than adequate boiler resources in place to make up for thermal deficits in the winter. See Graph 2-5 and Tables 2-3 and 2-4.



Graph 2-4. Monthly electric balance.



Graph 2-5. Monthly thermal balance

The hourly model takes into consideration the typical thermal profile by building type for each of the buildings and HVAC systems leveraging utility bills. As a result of this hourly look, of 1.57MM therms of CHP output, 1MM therms is captured. Boilers will produce 480k therms of heat not served by CHP because there is not enough production from the CHP units or because the facility is not served by CHP. We are not considering district heating at this point but may take a look as we further optimize our design during Stage 2.

- **Describe how resilient the DERs and thermal generation resources will be to the forces of nature (severe weather) that are typical to and pose the highest risk to their operation (example, reduced or zero output due to snow cover over PV panels, potential flooding of low lying areas, etc.)?**

CHP plants will be located above the current flood plain and will avoid low lying areas. We will ensure during stage two, risk assessments consider possible flood scenarios (natural or from building pipes) and pumping in place to mitigate risks. They will also be located indoors or in an enclosure as to avoid any severe weather events or forces of nature. Solar systems may be at risk for snow cover during the winter which will reduce output. We will liaise with City and facility officials to ensure snow removal around power gen facilities take priority.

We do not expect natural gas supply to be at risk unless there is a severe supply disruption or damage to the distribution network caused by seismic activity or act of war. While it is important to consider these possibilities, their likelihood at this point are so small it does not make sense to incorporate other natural gas redundancies such as propane tanks, CNG, or LNG. In the event of an extreme event impacting natural gas supplies, the microgrid's asset manager will coordinate with end-users and make decisions on curtailment and operation of standby generation according to a pre-arranged curtailment schedule to be defined during Stage 2.

We are assuming that the microgrid does not require onsite personnel and that the asset manager will be notified of issues by alarming through mobile devices. We will explore the design possibilities to mitigate the risk of the plant not functioning should internet or cellular service interrupt dropping typical communications within and to-from site.

- **Provide a description of the fuel sources for DER. Describe how many days of continuous operation of the microgrid can be achieved with current fuel storage capability? If additional fuel storage is required, provide a written description of needs required for this.**

CHP and Solar are the energy resources being investigated for this project, and there are existing standby generators on most sites.

Approximately 3,300 kW of CHP will be supplied with uninterrupted natural gas from the utility and will allow for continuous operation. No additional fuel is required.

Approximately 4,200 kW of existing backup power is also available to the microgrid in the form of diesel and natural gas standby generators.

Natural gas generators can be supplied with uninterrupted natural gas and there are 300kW of natural gas standby generators amongst the microgrid end-users. As per Table 2-6, the total the diesel generators can generate using their full tanks is 161,596 kWh, if they run at 100% load they would produce 64,393 kWh for the 1st day then 28,800 kWh in the 2nd day and 18,240 kWh in the 3rd day then the 500kW generator in the Psych center would be running for 4 more days producing 12,000 kWh a day.

At 50% load, daily production is 43,983 kWh that would last for a day then 20,460 kWh in the 2nd day and 14,400 kWh for almost 4 days before the 500kW generator in the Psych center takes place to produce 250 kW for 8 days.

	Backup Generator				50% Load		50% Operation					
Site Name	Make/Model	Generator Sizes	Fuel	Fuel Tank Size	Estimated Consumption at 50% Load	Estimated Hours of at 50% Load	# of days	kWh per Full Tank	per hour	per day		
		kW	Diesel/ Natural Gas	Gallons	Gallons/Hr	Hours	50% Load	kWh	kW	kWh	Gallon	Therms
Capital District Psychiatric Center												
	CAT/3412	500	Diesel	6000	17.5	342.9	14.3	85,714	250	6,000	420	583
	CAT/3516 SR4B	1750	Diesel	1000	60	16.7	0.7	14,583	875	14,583	1,440	2,000
NYS OMH												
		850	Diesel	1000	27.5	36.4	1.5	15,455	425	10,200	660	917
Albany Law School												
	CAT/C15	400	Diesel	700	6.5	107.7	4.5	21,538	200	4,800	156	217
Albany College of Pharmacy												
	Milton Cat/3406SRAB	300	Diesel	1250	10	125.0	5.2	18,750	150	3,600	240	333
	Allis-Chamers/250.0 DYB-4	250	Diesel	250	9	27.8	1.2	3,472	125	3,000	216	300
	Milton-Cat/D150-8	150	Diesel	125	4.5	27.8	1.2	2,083	75	1,800	108	150
Total								161,596	2,100	43,983	3,240	4,501

Table 2-6. Standby generation

- **Provide a written description of the capability of DERs including, but not limited to the following capabilities; black start, load-following, part-load operation, maintain voltage, maintain frequency, capability to ride-through voltage and frequency events in islanded mode, capability to meet interconnection standards in grid-connected mode.**

The CHP systems designed to be part of the microgrid will have black start, load following, part-load operation, ability to maintain voltage, ability to maintain frequency, the capability to ride-through voltage and frequency events in islanded mode, and the capability to meet interconnection standards in grid-connected mode.

2.4 Perform the following:

- **Provide a high-level written description of the electrical infrastructure (feeders, lines, relays, breakers, switches, current and potential transformers (CTs and PTs) and thermal infrastructure (steam, hot water, cold water pipes) that are a part of the microgrid. Identify the electrical and thermal infrastructure on the simplified equipment layout (with approximate routing) and one-line diagrams (electrical only). Differentiate between new, updated and existing infrastructure.**

The microgrid will utilize utility infrastructure on feeders 16452 and 16457. New additions to the system (such as those described in the following sections) will require additional control and protection CTs /

PTs. Due to high concentration of rotating generation, conventional protection schemes may be utilized. The design will seek to utilize as much of the existing utility protection, monitoring, and control infrastructure as is reasonable (based on technical and policy considerations).

Figure 2-1 shows the proposed locations of the new and existing electrical isolation points. The design calls for up to 9 new switches and will utilize 7 existing switches. Some existing equipment may need to be upgraded to meet control, communication or electrical demands. Further study will determine the adequacy of existing equipment.

- **Describe how resilient the electrical and thermal infrastructure will be to the forces of nature that are typical to and pose the highest risk to the location/facilities. Describe how the microgrid can remain resilient to disruption caused by such phenomenon and for what duration of time. Discuss the impact of severe weather on the electrical and thermal infrastructure.**

The proposed microgrid is currently served by a distribution system that is partially underground, with several extensive overhead sections. These OH segments will be impacted by snow, ice or wind storms. Underground systems are more susceptible to damages from flooding. This Particular microgrid site has historically performed at expected levels relative to the construction. Data from National Grid shows that the blue OH feeder in Figure 2.1 (16452) has experienced 42 events over the last 4 years that resulted in 16,712 sustained customer interruptions for a total of 9,373 hours over the four years. This amounts to a yearly SAIDI of 1.53 hrs/yr and a SAIFI of 2.73 int/yr for the feeder. The SAIFI in particular, is significantly higher than the 2014 National Grid average of 1.17 int/yr reported to DPS. By contrast, the same National Grid data shows that the red UG feeder in Figure 2.1 (16457) experienced one event in 2014 that interrupted 3 customers for 6.45 hours. This amounts to a SAIDI of 0.53 hrs/yr and a SAIFI of 0.24 int/yr. As expected the innate reliability of the UG segments is significantly higher than the OH portions.

From a reliability perspective, the weakest section of the proposed microgrid infrastructure is the overhead portion of Feeder 16452. Across the country overhead lines are disproportionately impacted by vegetation (trees), lightning and animal activity (which is often correlated with trees).

Feeder 16452 runs through a residential area along Heldeberg Ave onto the Sage campus and Parsons, and down Academy Rd to Congregation Beth Emeth. As the overhead picture from Google below shows, there are a number of trees along the right-of-way (ROW), close enough to the lines to create outages from broken branches or fallen trees during windstorms, ice storms or snow storms. Most of the customer interruptions on this feeder that lead to a SAIFI of 2.73 are likely attributable to trees along the ROW. As part of the microgrid design, the overhead sections in the areas indicated by the green rectangles in Figure 2-2 will be evaluated for distribution hardening measures to specifically improve reliability and resiliency. The measures include: aggressive tree trimming; removal of danger and hazard trees; application of covered wire; compact construction with shorter cross-arms; use of spacer cable; upgraded construction with stronger poles; strategic application of sectionalizing and reclosing devices; and, where warranted, targeted undergrounding. The ultimate goal is to insulate the critical infrastructure serving the microgrid facilities from events on the balance of National Grid delivery system in the area.

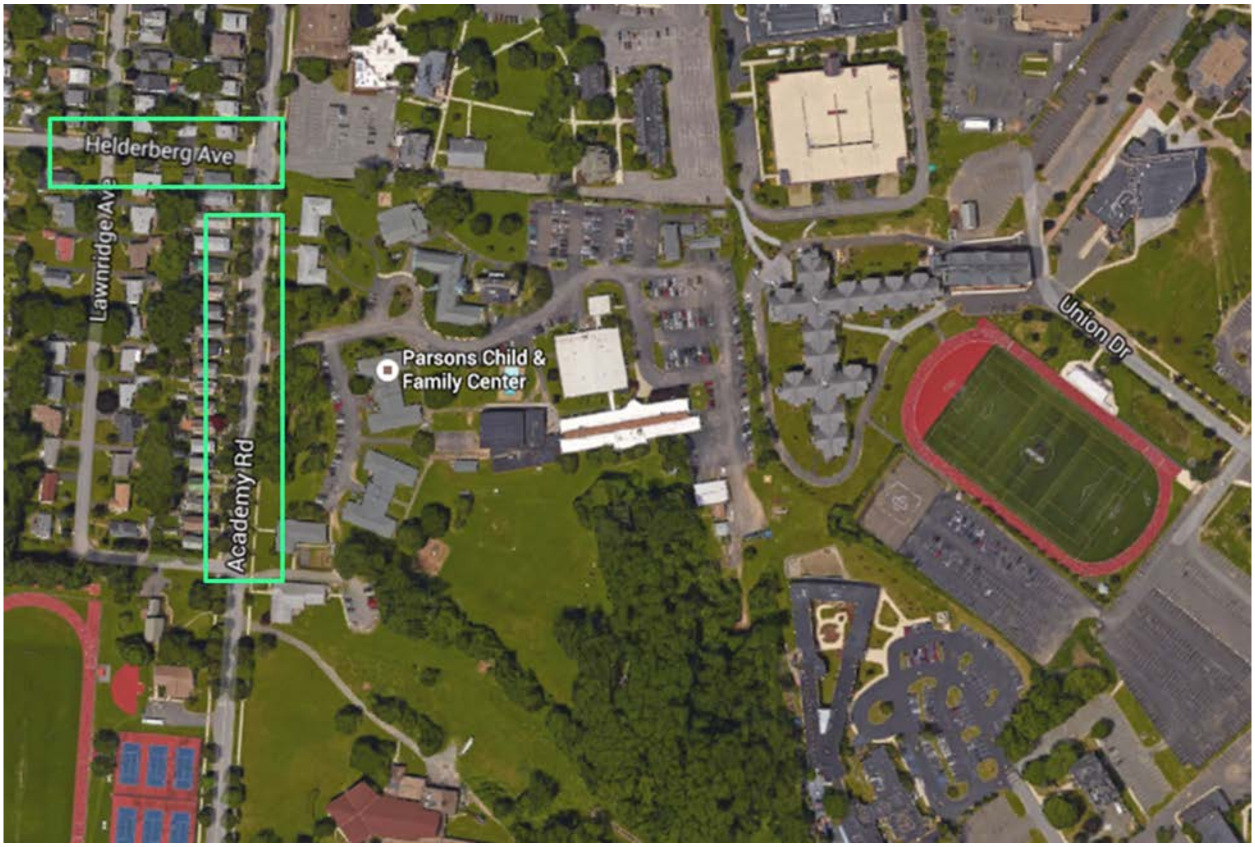


Figure 2-2. Possible distribution network hardening

- **Provide a written description of how the microgrid will be interconnected to the grid. Will there be multiple points of interconnection with the grid. What additional investments in utility infrastructure may be required to allow the proposed microgrid to separate and isolate from the utility grid. Provide a written description of the basic protection mechanism within the microgrid boundary.**

The microgrid will be configured to use on National Grid feeders 16452 and 16457. The microgrid will consist mainly of utility infrastructure as space availability limits the addition of new equipment in this area. A combination of new and existing sectionalizing devices will be used to isolate the microgrid from the rest of the utility system when entering islanded mode. Figure 2-1 shows the proposed locations of the new and existing isolation points.

To form the microgrid, a cable and associated control and protection devices will be added to system to connect the assets on 16452 to the assets on 16457. The proposed location of this connection (shown in Figure 2-1) is in the vicinity of the Albany College of Pharmacy and the Albany Law School. Under normal operating conditions, this section will be open to maintain radial operation of the feeders.

Cables and control and protection devices will also be added to attach microgrid participants not on either feeder 16452 or 16457 to the microgrid. These participants are the Office of Mental Health and the Townplace Suites. Note: The cost / benefit of adding these connections will be evaluated in the final design.

In grid-connected mode, the protection schemes of the utility will be maintained. Since the generation sources are largely rotating machines, traditional protection schemes that rely on large inrush currents may be an option. Some of the utility protection scheme may be used; however, it is likely that most protective devices will need to have both grid-connected and islanded mode set-points due to the change in topology and the lack of the utility source.

2.5 Perform the following:

- **Provide a high-level written description of the microgrid control architecture and how it interacts with DER controls and Building Energy Management Systems (BEMS), if applicable. Identify the locations of microgrid and building controls on the simplified equipment layout diagram. Differentiate between new and existing controls.**

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

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

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

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

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

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

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

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

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

Figure 2-3 shows control devices for the proposed City of Albany University Heights microgrid as an overlay of the electrical one-line diagram. After the design of electrical infrastructure is finalized the location of all nodes including the edge control nodes can be determined.

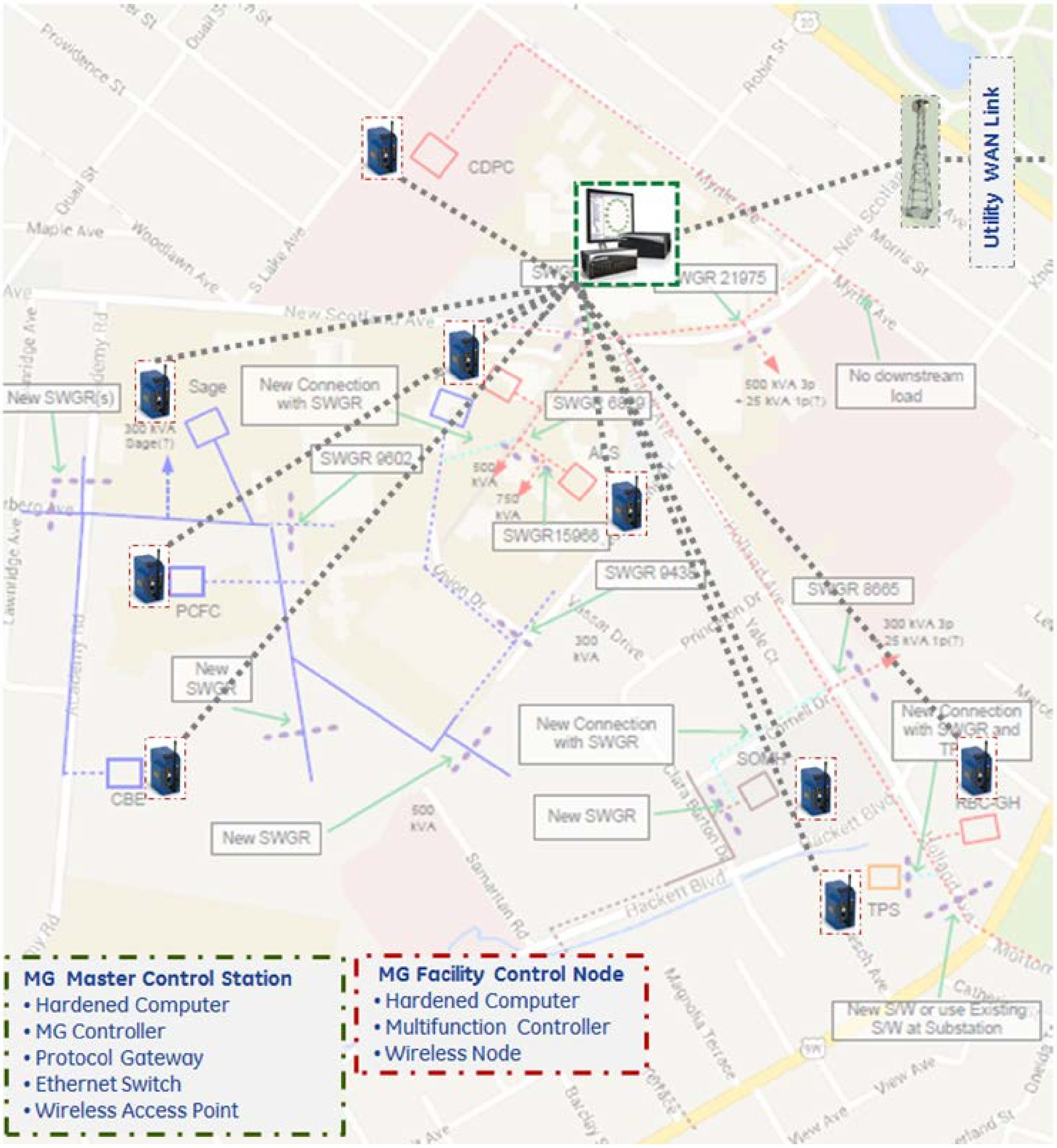


Figure 2-3 Microgrid Electrical One-Line Diagram with Control and Communications Overlay

The microgrid master control station performs economic optimization, i.e. it periodically determines a combination of generation units to bring on or keep on such that the total cost of operation is minimal. The start/stop commands as well as optimal setpoints for real power, and sometimes even for reactive power, are sent to each generation unit.

Both models proposed for the new CHP generation units, Intelligen 250kW and Tecogen InVerde INV-100 cogen units, are equipped with microprocessor-based controllers that regulate both the natural-gas engine and induction generator (or the inverter-based power conditioning system in the InVerde INV-

100 case). During a typical operation, while a unit is in standby or parallel modes, the controller issues power setpoint, while continuously adjusting the engine speed to optimize efficiency. A similar controller exists in each of the Caterpillar generation units (e.g. 3516 SR4B) that are already deployed (e.g. in CDPC) and that are considered for normal microgrid operation.

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

The two new generation units are also equipped with the CAN interface option using which microgrid control system can have direct access to the engine and generator hardware devices. Although this solution might have performance advantages, it would require CAN protocol translation most likely in additional gateway devices.

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

Description of Building Management System (BMS) Additions and Modifications:

The following is a general strategy which the team will use during Stage 2 in order to adequately make the right decisions concerning BMS modifications and upgrades in order to manage and dispatch loads as well as appropriately interface with and report to the microgrid controller and DERs.

At sites that are connected to the microgrid a mix of existing BMS systems upgrades combined with new BMS systems is planned to enhance and supplement Microgrid performance. The scope of the BMS upgrades is subject to specific site logistics, economics, delivered function and value. The scope of new BMS systems and/or significant expansion of existing systems will be largely dependent on the proposed on-site power plant scope and existing central plant systems.

Most sites at the University Heights microgrid will have some form of an onsite power plant which will include a BMS system for plant operation and maintenance. BMS points will be added to such systems to enhance overall site efficiency and energy performance. For those sites without specific on-site power systems BMS systems will be enhanced or added. The general goals and functions of the BMS systems will be as follows. The list is by no means exhaustive but gives the overall scope and scheme:

1.) All sites with or without on-site CHP, solar or other alternative energy:
- Expansion or addition of central station desktop computers, field panels and communications devices to accommodate the new points to be installed and to enable enhanced reporting and communication with the microgrid master computer. Note: all systems will be capable of running independently and will be able to provide function, control and graphics even if the master control station or other systems are out of operation. Field control panels will also be able to operate independently of one another. (This is actually standard BMS protocol.)
- Analog utility grade power monitor/meter at main service panel at each building for both import and export of power. Capable of both Kw and Kwh totalization and analog input to BMS system.
- For campus style sites an import/export power meter.
- Utility power status: Brownout, loss, normal power.
- Status of all on-site emergency generators and ATS switches.
- Fire alarm status.
- For major electrical HVAC equipment over 15 HP ability to load shed and status.
- Status of critical equipment such as HVAC boilers, central plant chillers and other similar equipment.
- MODBUS or other suitable communication firmware and communications interface to accommodate other MODBUS system enabled equipment.
- Communications interface with the microgrid master computer.
- High speed internet interface
- Console with graphics interface. Graphics of all points and systems as listed here will be provided if not already in existing system.
- Full UPS and battery backup of the control system for up to 8 hours. In addition either through an associate site on-site power system or small emergency generator full operational power in the case of a utility failure.

2.) Added systems or significant expansion for sites with CHP and alternative energy:
- Full control of the alternative energy system power production. This may be programmed in a variety of ways to allow load following, export, scheduled export, topping cycle or bottoming cycle and depending on the appropriate parameters.
- Full control of all auxiliary devices as part of the energy plant such as pumps, heat exchangers, valves and so on.
- Electric system utility protective relay status and function monitoring. Also, in some cases, direct control of automated breakers and switches for enhanced operation of on-site power systems and the microgrid.

- Advanced fault protection monitoring, trending and alarming. For example all power production systems will be equipped with advanced power protection relays. (Such as Schweitzer or Beckwith or GE). Upon a power quality or fault alarm by any of these devices that information will be communicated to the on-site BMS and the microgrid master controller and operations center.
- Monitoring of all power operated circuit breakers as part of the CHP or on-site power system.
- Automatic switchover from utility “parallel” operation to “black start” and/or microgrid islanding mode. These controls will be coordinated with the overall University Heights microgrid and commands or pre-established standing protocol of the microgrid master control center.
- Video and audio feed from every CHP plant room incorporated into the BMS system.

3.) Also, for the microgrid master controller and operations center:

- Central desktop computer(s) for monitoring and control functions.
- Communications, high speed internet, also backup Hughes-net interface as well as land-based high speed internet.
- Three approximately 6ft by 4ft color monitors for display of microgrid systems and graphics.
- Full UPS and battery backup of the control system for up to 8 hours. In addition, either through an associate site on-site power system or small emergency generator, full operational power in the case of a utility failure.
- MODBUS interface and leased line/direct line or RF communication with grid-connected (utility connected) microgrid devices.
- Direct communication capability with local utility operations center for coordination of microgrid operation with utility systems.
- Delivery of an integrated stream of SCADA information as may be required by the utility or the NYISO.
- Cell phone and land line and radio communication with local emergency resources including fire department, police and county 911 center. Communications to be available via multiple systems such as internet, phone and radio.
- System displays will include full color graphics of the University Heights microgrid including all buildings, status and power production of each CHP plant, solar system etc.
- Also on user option ability to “zoom in” on particular facilities and buildings for more operational detail.

- **Provide a brief written description of the services that could be provided by the microgrid controls including, but not limited to the following:**
  · Automatically connecting to and disconnecting from the grid

At all times in grid connected mode, the microgrid control scheme must maintain enough generation, storage and generation margin to maintain the uninterruptable microgrid load. For this reason, the seamless transition requirement can greatly restrict the options of grid-connected operation and significantly increase the cost of the microgrid because storage or oversized generation may be required. We are currently revisiting the business case around seamless transition.

The formation of a microgrid generally proceeds as follows:

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

Note: some steps may be performed in parallel.

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

Automatic connection: The microgrid will also be capable of automatically reconnecting to the grid if desired. In such cases, when the microgrid senses that the utility feed has returned to normal (generally for a period of time), the microgrid will sense the phase and magnitude of the voltage at the utility interconnection point. Using either active or passive synchronization, the microgrid controller may close the breaker that ties the microgrid to the utility system.

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

· Load shedding schemes

Load management is also integral in islanded mode and in the transition to islanded mode. During microgrid formation, load will likely be shed to allow seamless transition for the uninterruptable loads on the microgrid. Once the microgrid is established, controllable loads may be used in much the same was spinning reserve generation.

· **Black start and load addition**

In the event that a seamless transition is not successful, or if the microgrid goes down for any reason, the microgrid must be capable of black-starting or energizing without an existing power system. Many grid-forming generators can be used for black-starting. Once the generator has been started and the core microgrid formed, the formation of the microgrid may proceed normally.

For the University Heights microgrid, diesel backup generators are available to black-start the microgrid. Diesel standby generators are located at the Capital District Psychiatric Center, the State Office of Mental Health, the Albany Law School, the Albany College of Pharmacy, and Parsons Child and Family Center.

The largest standby generators are located at the Capital District Psychiatric Center (1,750 kW) and the Office of Mental Health (850 kW). These facilities are also located physically and electrically separated by a large distance which would reduce the likelihood of a single event greatly impacting both generators. However, under this microgrid design, both facilities will be located on Feeder 16457. The largest standby unit located on Feeder 16452 is the Albany College of Pharmacy (300 kW). To have a diverse blackstart solution, the final design will likely primarily utilize these three units (depending on consideration discussed below).

Generators designed for standby operation are capable of maintaining voltage, frequency, and real and reactive power balance when the larger grid is not present; however, protection may be currently in place to prevent feeding a larger grid. The protection and control schemes of the standby generators will be evaluated to make sure the selected standby generators are capable of supporting the blackstart scheme.

Once the standby generation is energized, load and CHP will be added to the system in an incremental process. Standby generators will likely be used to follow load while the microgrid is being formed.

· **Performing economic dispatch and load following**

In grid-connected mode, microgrid assets may be used to participate in various market activities. If eligible to participate in markets, the microgrid will balance this economic objective with the requirements of maintaining a resilient microgrid.

· **Demand response**

As part of our PPA discussions with end-users, we will discuss curtailment possibilities with end-users and confirm whether they could wrap into a micro-grid demand response program. We are not planning on n+1 (in principle) though we have added additional generation, oversized for the sites to ensure the microgrid is served. If facilities curtail, the microgrid could export further to the grid.

Additionally, the microgrid may be useful as in black-starting schemes for the local grid. The local utility will be consulted to see if the microgrid may be useful in their black-starting schemes. In grid-connected mode, the microgrid may respond to signals to reduce demand. This reduction in demand may be from controllable loads or from an increase in generation.

· **Storage optimization**

We are not considering storage at this point unless there is a mutually beneficial business case with National Grid to fund batteries in order to smooth load curves and mitigate renewable intermittency.

If storage proves economical, the microgrid will optimize storage differently for grid-connected and islanded mode. For grid connected mode, storage may be used for economic purposes, but it may also be in an integral part in a seamless transition.

In islanded mode, the storage will be primarily used to maintain the load / generation balance.

· **Maintaining frequency and voltage**

When in grid-connected mode, the primary focus of the microgrid control systems will be to maintain system voltage within the acceptable range. This range is generally specified in ANSI C84.1 but may also be coordinated with utility conservation voltage reduction schemes. Voltage control will be accomplished primarily through autonomous operation of voltage control devices such as capacitors and voltage regulators as is traditionally done on distribution systems. However, the presence of high penetrations of distributed generation on the system may require more advanced techniques for voltage control that may require coordination and communication with voltage control assets such as distributed generation.

When the microgrid is in islanded mode, the primary control objectives expand significantly. As in the grid-connected mode, the control system for the microgrid must maintain voltage within acceptable limits. However, in islanded mode, the voltage control will need to be more carefully coordinated than in the grid-connected mode because events like capacitor switching can be much more difficult for an islanded system to tolerate. In the event of a loss of utility service, the microgrid will automatically disconnect from the grid. Detecting an abnormal condition and forming an island can be a very challenging task, particularly when seamless transition is desired.

For the University Heights microgrid, a large portion of the generation will be CHP. This CHP generation will act as base-load generation and reserve margin. The faster acting generators will be used to manage fluctuations in load as well as variation in power output caused by solar. If additional control is needed, curtailable load may be used to help maintain the microgrid frequency. The microgrid controller will assign the load / generation mix based on what is needed to satisfy the primary control objectives.

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

· PV observability and controllability; forecasting

PV plants are observable, i.e. PV production is monitored, communicated and stored so that it is available to microgrid operators and owners through a web interface. The total rated power of all planned PV plants is only 600kW, so the team does not think that making PV production controllable (e.g. through smart inverter functionality) is justifiable economically.

· Coordination of protection settings

Protection coordination during connected mode should conform to the existing protection strategy set by National Grid. When the microgrid is in islanded mode, some key protection functions will be under the purview of the microgrid controller. Where fault current is insufficient to ensure that secure, safe, dependable, reliable operation of protection systems (such as fuses), the Team may consider another layer of protection that predicated on transfer trip signals from the controller.

· Selling energy and ancillary services

We have concluded our initial technical discussion with National Grid towards coordinating the DER configuration, optimal island, and feeder interface. In subsequent discussions we will discuss mitigation of standby tariffs, import/export kWh & kW pricing, and the potential for entering the capacity markets.

· Data logging features

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

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

- **How resilient are the microgrid and building controls? Discuss the impact of severe weather on the microgrid and building controls.**

The standard industrial-grade control and communication devices can withstand extreme operational temperature range of -40⁰ C to +70⁰ C. In addition, they are often enclosed in rugged aluminum chassis tested for shock and vibration according to military standards. Control boxes will also be elevated for flood avoidance.

2.6 Provide a high-level written description of:

- **IT/Telecommunications Infrastructure (wide area networks, access point, ethernet switch, cables etc.) and protocols. Identify the IT and telecommunications infrastructure on the simplified equipment layout diagram. Differentiate between new and existing infrastructure.**

Due to the lack of existing dedicated communication infrastructure (e.g. fiber optic network), for the microgrid communications backbone we are proposing a wireless field network as shown in the Figure 1.

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

In addition, each microgrid facility is equipped with a Control Node, a hardened computer hosting local control applications with or without BEMS integration. Communication with the master control station is achieved through 900 Mhz or WiMax field network.

The protocols are selected among DNP3, Modbus TCP/IP, Modbus Serial, IEC61850, Ethernet depending on MG deployed devices (e.g. IED's, PLC, switchgear, relay, sensors, meters, etc.).

- **Provide a written brief description of communications within the microgrid and between the microgrid and the utility. Can the microgrid operate when there is a loss in communications with the utility? How resilient are the IT and telecommunications infrastructure?**

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

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

3.1 The Contractor shall describe the commercial terms/relationship between participants in the microgrid project, products expected to be produced by the microgrid and arrangements for sharing of benefits by addressing no less than the following items below:

· Identify any direct/paid services generated by microgrid operation, such as ancillary services, or indirect benefits, such as improved operation, to the utility or New York Independent System Operator (NYISO)? If yes, what are they?

The micro-grid will provide services primarily to the end-users by selling thermal and electric power. We look forward to working with the utility as we launch during Stage 2 and preliminary project planning to quantify the value of existing or incremental hardware which improves:

- Grid stability
- Relieve T&D constraints
- Frequency response
- Regulation reserve
- Spinning & non-spinning reserves
- Peak shaving
- Dispatchable capacity and generation for energy arbitrage

As part of the discussion, we need to understand the financials of onboarding technologies and scope, the impact CAPEX and OPEX has on the business case, and how to share value with incentives should they not be beneficial for the end-user.

Once we define final project scope based on end-user feedback and execution of LOIs, we will also approach NYISO and, working with end-users, understand the possibilities aggregating sites and bidding into capacity markets and entering the demand response programs.

In summary, future services will depend on how the final REV framework is structured.

Assuming a more open market with less stringent size requirements for DER market participation, we expect that behind the meter distributed generation, and in fact all types of DER, including both supply side and demand resources in microgrids, will participate in utility and also NYISO energy, capacity and ancillary services markets.

We understand that NYISO is working on development of market rules for DER participation in its markets. Current thinking on qualification is that behind the meter generation can participate in the NYISO markets if the underlying load has a peak of at least 1 MW, and the net-generation after load to be at least 1 MW.

For instance, such a resource, if it clears the NYISO capacity market, can get paid the NYISO capacity prices.

Microgrid demand side resource can also participate in the utility or NYISO demand response programs – although there are some restrictions for same resources participation in both demand response and other ISO markets. Example demand response programs include price based (such as critical peak pricing or CPP), or event based (such as direct load control or DLC) programs.

The types of ancillary services that a microgrid can provide will depend on the types of resources included in the microgrid that can meet the required qualifications and also have the technical capability of providing the requisite service. These include frequency control and response, regulation up and down, spinning and non-spinning reserve, voltage control, and reactive power.

There are even discussions of microgrids acting as virtual plants – assuming that an autonomous microgrid can be physically formed in normal blue sky days – that can provide various services similar to other individual generators or demand response resources.

· Identify each of the microgrid's customers expected to purchase services from the microgrid.

We expect each of the nine identified end-users will purchase thermal and electric power from the microgrid OwnCo as well as National Grid through a negotiated PPA.

· Identify other microgrid stakeholders; what customers will be indirectly affected (positively or negatively) by the microgrid.

City of Albany – Commercialization of the microgrid will bring economic development to the city. This infrastructure investment will not only bring value to end-users, but as a scalable project, we'd welcome the opportunity to help bring lower and more reliable energy to new users who wish to develop their operations in University Heights.

Neighboring residences – If possible, we'd look forward to the possibility of Over-sizing our generation to not only bring assurance to meet peak loads within the microgrid but to also serve other users we do not seek to enter into a commercial arrangement with by wholesaling excess electricity at an appropriate price to National Grid for sale to residential properties. We would also be interested in whether National Grid would see opportunities to grow the microgrid island in conjunction with this.

New York State- We expect this study to not only present a scalable model for University Heights but one which is replicable elsewhere in New York.

We look forward to finding incremental value for OwnCo and end-users defining capacity markets and a demand response program.

· Identify the number of individuals affected by/associated with critical loads should these loads go unserved (e.g. in a storm event with no microgrid).
· Describe the relationship between the microgrid owner and the purchaser of the power.
· Indicate which party/customers will purchase electricity during normal operation. During islanded operation? If these entities are different, describe why.
· What are the planned or executed contractual agreements with critical and non-critical load purchasers?
· Are there any other energy commodities (such as steam, hot water, chilled water) that the microgrid will provide to customers?

Upon the conclusion of Stage 1, we expect to form a special-purpose limited liability company to own the microgrid assets ("**OwnCo**"). The members of OwnCo will be both independent investors and end users who have also chosen to invest in the project. We expect OwnCo to enter into commercial agreements with the following prior to the conclusion of Stage 2:

An **Operating Company** ("**OpCo**"), which will serve as the asset manager. In that capacity, OpCo will manage the OPEX of the microgrid. It will manage contracts for fuel supply and with providers of routine O&M and outage services (planned and unplanned). It will be responsible to recommend retrofits and upgrades to OwnCo assets as required. It will manage relationships between OwnCo, and end users, National Grid and other stakeholders (including the City of Albany). OpCo will also be responsible for financial management of the mircrogrid, including invoicing, collections, accounting and financial reporting. OpCo would manage the relationship with NYISO should this project enter into the demand response program or capacity wholesale markets.

End-Users. These end users will have power generation assets (solar or CHP) and/or absorbers on their premises, and perhaps batteries or other balance-of-plant equipment as well. If they have standby generators, these will be available to serve the microgrid during islanding. At the conclusion of Stage 1, OwnCo will execute Letters of Intent with these parties to confirm they will host microgrid infrastructure and enter into a 10- to 15-year power purchase agreements with OwnCo for electricity and thermal energy for steam and hot/chilled water. End-users include the following facilities:

- *Capital District Psychiatric Center* (critical), a 200-bed inpatient psychiatric hospital;
- *Albany Law School* (critical), a full-time graduate school with 400-500 students and 50-60 faculty;
- *Albany College of Pharmacy and Health Sciences* (critical), a full-time graduate school with 1400 students and 100 faculty;
- *Sage College of Albany* (critical), an undergraduate college with 900 students and 150 faculty;
- *Parsons Child and Family Center* (critical),an agency which offers family services across a 30-county catchment area and 40 school districts, with approximately 9,000 family members and children receiving services annually;
- *TownePlace Suites* (non-critical), a seven-floor, 106-suite hotel;
- *Gallery at Holland* (non-critical), a 126-unit luxury apartment complex to be completed in 2017;
- *New York State Office of Mental Health* (non-critical), the headquarters for 900 employees who oversee this state agency during regular office hours; and
- *Congregation Beth Emeth* (non-critical), the fourth oldest Reform Synagogue in the United States, with 700 member families.

If National Grid and Allen Power Inc. agree to add additional users or neighborhoods to the microgrid, we may define a Tier 2 end-user who would enter into an agreement only to purchase power from OwnCo.

National Grid. OwnCo will execute an LOI with the utility to provide the framework for:

- Terms and conditions and pricing for microgrid power generation offtake into distribution network for use at other microgrid sites or elsewhere.
- Terms and conditions and distribution costs for electricity which is produced by a microgrid participant and provided to another microgrid load.
- The general schematic and one-line describing incremental hardware which the distribution system will incorporate in order to meet microgrid requirements.
- Software and signaling requirements between the microgrid and distribution network.
- Any improvements or hardening of the existing distribution network to meet microgrid technical and commercial requirements.
- Confirmation that adequate natural gas supply exists to support CHP plants in the microgrid.
- Good-faith discussions on the battery value-story and optimal way to deploy commercially and technically.

See also the discussion of regulatory issues in Section 3.6 below.

Investors. OwnCo will execute LOIs with investors, who may also be end users. Independent investors may include not only private investors but also public agencies who implement energy policy on New York State properties, such as the New York Power Authority. The LOIs will include rough order-of-magnitude microgrid financials and returns as well as commitments. We have had detailed discussions with investors and other developers in order to confirm their sensitivities and assumptions in our business case (cost of money and partnering). In summary, we see the following possibilities in order of preference based on cost of money:

- Incentives
- NYPA financing
- Bank financing
- Owner equity (Sole Allen Power Inc or partnered)
- Investor financing

· How does the applicant plan to solicit and register customers (i.e. purchasers of electricity) to be part of their project?

At the conclusion of this study, applicant will first work with NYSERDA and National Grid on the best approach towards proceeding with this project. We recognize that we need to optimize scope to the National Grid network and needs. The first option is to proceed, subject to approval, with Stage 2 of the NY Prize or via traditional PONs supplemented with incremental National Grid assistance in order to further the utility value story. As part of the process to apply for Stage 2 funding we would:

- Clarify scope and reach out to other potential end-users. We have several other potential participants who have not said “no” to participating and we’d re-engage them after a successful conclusion to this study.

- Request participating end-users sign a PPA or letter of intent which would request good-faith negotiations towards a PPA and an easement for power generation equipment in exchange for savings.

- Finalize rate negotiations and any incremental REV/PSC activities with National Grid prior to Stage 3.

We also feel we need to consider a second option; the possibility of proceeding outside the NY Prize Stage 2 and 3 program. It might not only be more helpful to end-users and National Grid but for the financability of the project if we re-approach end-users and present a two-phased approach to the micro-grid:

Phase 1. Install distributed generation optimized to site needs.

- Present the business case to end-users which shows line-of-sight to energy savings, inflation mitigation, and improved reliability.
- Perform full energy audits on each site to ensure we capture opportunities to reduce load.
- Install distributed generation which satisfies current PON requirements for incentives.
- Install storage at each site which we will nominally size to dispatch electricity in the event solar cannot produce during the day.
- Execute Letters of Intent with end-users as soon as possible at completion of the feasibility study.
- Execute Power Purchase Agreements with end-users for 15 year terms prior to project financing guaranteeing specific energy savings in exchange for site easements and access for power generation equipment.

Phase 2. Install and commission the microgrid.

- Finalize value story with National Grid and the negotiated “virtual metering” rates.
- Install incremental DG equipment optimized to microgrid needs.
- Install microgrid hardware and controls software.
- Finalize agreements with end-users and NYISO on entering the capacity markets and demand response program.

This approach could be faster as well. We could install and commission DG equipment on a design-build basis without waiting for completion of the entire microgrid detailed design with margin in space and interfaces for the microgrid (phase 2) along with the capability to expand in end-user PPAs.

[API Letterhead]

[*Date*]

[*End User*]
[*End User Address*]
[*End User Address*]

Attn: [*End User Contact*]

Re: University Heights Microgrid

Dear [*End User Contact*]:

As part of the NY Prize Competition administered by the New York State Energy Research and Development Authority ("NYSERDA"), Allen Power, Inc. ("API") was awarded a contract by NYSERDA to develop a Stage 1 Feasibility Assessment (the "Assessment") of a community microgrid serving the University Heights section of Albany (the "Project"). The Assessment has been completed and approved by NYSERDA. Based on the results of the Assessment, API intends to submit a proposal to NYSERDA (the "Stage 2 Proposal") to develop a Stage 2 Detailed Engineering Design and Financial/Business Plan (the "Plan").

If API's Stage 2 Proposal is accepted API would form a limited-liability company whose members would be investors in the Project ("OwnCo"). OwnCo would own and operate the Project's assets and would enter into power purchase agreements ("PPAs") with power consumers (the "End Users"). If API believes that the Plan supports further action, API would seek funding to build out and operate the Project, including a Stage 3 Microgrid Build-out and Operation grant from NYSERDA.

While API was developing the Assessment, [*End User*] ("[*End User Name*]") provided data concerning its [*describe*] facility (the "Facility"), including electric and thermal consumption, and among the assumptions underlying the Assessment is that [*End User Name*] would be an End User of the Project. After discussing the Assessment, we understand that it is your present intention to be an End User of the University Heights Microgrid project. Specifically, we have agreed as follows:

(1) *Present Intent*. Upon completion of the Plan and its approval by NYSERDA, is the present intent of [*End User Name*] :

(a) to enter into a PPA with OwnCo , and

(b) to grant to OwnCo an easement on, under, over or across portions of [End User Name]'s property permitting OwnCo to place Project assets on [End User Name]'s property, *provided* that the easement so granted would be extinguished upon termination or expiration of the PPA.

The PPA and the Grant of Easement would be based on parameters established in the Plan, would contain representations, warranties and other provisions customary to the industry and to similar transactions, and would be in form and content mutually acceptable to OwnCo and [*End User Name*].

(2) *Development of the Plan.* If API submits a successful Stage 2 Proposal, [*End User Name*] will continue to cooperate with API in the development of the Plan, and will provide API with all utility bills, plans, plats, drawings, designs, studies, reports and documents associated with the Facility as API may reasonably require. [*End User Name*] will grant API and their consultants and representatives reasonable access to the Facility during normal business hours throughout the development of the Plan.

(3) *Completion of the Plan; Election to Continue Participation*. Upon completion of the Plan API will promptly furnish a copy to [*End User Name*], and upon approval of the Plan by NYSERDA API will promptly notify [*End User Name*]. [*End User Name*] will thereupon decide whether to continue participation in the Project or to withdraw from the Project, and will so notify API within thirty days after receiving of notice of approval by NYSERDA from API.

(4) *Negotiations*. Upon notice from API that OwnCo has secured commitments for funding sufficient to support build-out of the Project, [*End User Name*] will promptly commence good-faith negotiations with OwnCo for a PPA [and a grant of easement] consistent with the Plan and with paragraph (1) above .

(5) *Exclusivity*. [*End User Name*] agrees to deal exclusively with API and OwnCo with respect to participation in any manner in any microgrid or distributed generation project, for a period ("Exclusivity Period") which begins upon execution of this letter by you and ends on the last to occur of the following:

(a) *if API does not submit a Stage 2 Proposal because it failed to obtain commitments to fund the required community cost share of 25% of Stage 2 costs or for any other reason:* 120 days after the deadline set by NYSERDA for submission of Stage 2 proposals; or

(b) *if NYSERDA does not accept the Stage 2 Proposal:* sixty days after notice from NYSERDA that the Stage 2 Proposal was not accepted; or

(c) *if NYSERDA does not approve the Plan:* sixty days after notice from NYSERDA that the Plan was not approved; or

(d) *if [End User Name] elects to withdraw from the Project pursuant to paragraph (3) above:* thirty days after API receives notice of withdrawal from [*End User Name*]; or

(e) *if API and OwnCo fail to secure commitments for funding sufficient to support build-out of the Project by such date:* ninety days after approval of the Plan by NYSERDA; or

(f) when the Project achieves commercial operation.

(6) *Expenses*. The parties will each pay their own transaction expenses, including the fees and expenses of brokers, bankers, legal counsel, accounting counsel and other advisors, incurred in connection with the proposed transactions.

(7) *Term*. The terms of our agreement will take effect as of the date of this letter, and will expire at the end of the Exclusivity Period.

(8) *Binding Agreement*. For the avoidance of doubt, paragraph (1) of this letter merely reflects the present intention of the parties, and is not intended to give rise to any legally binding or enforceable obligation on either party. Paragraphs (2) through (9) are intended by the parties to create legally binding obligations, subject to the conditions therein set forth.

(9) *Governing Law*. The agreements set forth in this letter will be governed by and construed in accordance with the laws of the State of New York, without giving effect to choice of law principles. Any dispute arising from the agreement set forth in this letter will be finally determined by the courts of the State of New York in Albany County.

If the foregoing accurately reflects your understanding of our agreement, please so indicate by signing a copy of this letter where indicated below and returning it me. We at API look forward to working with you to make the University Heights Mircrogrid a reality.

Sincerely yours,

Allen Power, Inc.

by Jason Allen
President

Accepted and agreed,

[*End User*]

by ___________________________
[*End User Contact*]

3.2 Describe the value the microgrid is expected to provide directly to its participants, to the community at large, the local electric distribution utility and the State of New York by addressing no less than the following items below:
· What benefits and costs will the community realize by the construction and operation of this project?

This project will come at no cost to the community. We expect in-kind work, owner-equity, grants, incentives, loans, and outside investment to fund this project. As discussed elsewhere in this report, a large community in Albany, NY will receive significant investment and benefit from lower cost and more reliable electricity less subject to inflation and significantly greener than typical boilers and grid power.

· How would this project promote new technology (including, but not limited to, generation, storage, controls, IT, AMI, other)? What are they?

In the first phase of implementation, we expect to install and commission proven CHP power generation such as engines and its associated balance of plant as well as solar optimized to sites and to not export power to the grid. As we perform further due diligence on our possible OEM providers we may make a decision to help a supplier validate a new model, but for the most part, we want to minimize technology risk and instead focus on mitigating commercial, finance, and site interface risk (mechanical and controls). Further to this risk, we will also develop a plan to validate the interface with and value story of energy storage optimized to supplant solar when it is unavailable. We would also ensure that building and DG control systems could interface with possible microgrid controls architecture which would also be our ticket to play in demand response and capacity markets.

Once we validate the first phase business case and technology and move forward to Stage 2, we would seek to incorporate proven microgrid hardware and controls architecture to the microgrid. We would work with our design engineers, OEMs, and National Grid to ensure we had appropriate bench and field testing plans in place as well as certifications to ensure our microgrid conformed to utility requirements and that it worked. We would also want to understand the testing requirements post-commissioning of the microgrid minimizing disruption to our end-users while ensuring the microgrid could island in the event of a significant grid event.

· How does the proposed project promote state policy objectives (e.g. NY REV, Renewable Portfolio Standard (RPS))?

We expect the distributed generation and microgrid will provide:

- Lower cost thermal and electric energy to end-users.
- More reliable power to end-users.
- "Greener" and more efficient power generation to the state and regional power gen portfolio.
- More stable and predictable end-user energy costs over longer periods.
- Generally, more grid resiliency, and specifically a suite of benefits to the utility and society to incude Var and frequency control among others.

- A means to aggregate power consumers and participate in demand response programs and capacity markets who otherwise would not participate.
- Lower cost and higher value infrastructure. Every kW of power generation installed behind the meter is a kW which does not have to stress the distribution network. Incremental switching and controls not only improves end-user reliability but National Grid's ability to control their network. Without considering a microgrid and DG behind the meter, it's possible National Grid would have to excavate and refurbish much of an underground network at significant cost and disruption.

· What added revenue streams, savings, and/or costs will this microgrid create for the purchaser of its power?

We look forward to working with end-users in coordination with NYISO and National Grid on participating in the demand response and capacity markets and sharing that value. We do not expect our end-users to incur incremental direct costs. Their indirect costs will be any time we require to further understand and design systems into their facilities and dedicating currently under-utilized space towards DG equipment.

· Describe the proposed business model for this project. Include an analysis of strengths, weaknesses, opportunities and threats (SWOT) for the proposed business model.

Business model:

OwnCo will contract with OpCo to manage the operations of the microgrid at either a fixed ($/yr) or variable ($/kWh) fee. OwnCo will enter into PPAs with end-users which improve their energy costs over the term of the agreement. In exchange, end-users agree to host power generation equipment and balance of plant at no-cost, interface BMS with the microgrid controller, curtail in the event load exceeds capacity, and be under variable pricing formulas to mitigate the risk of load exceeding capacity.

Strengths:

- Inclusive and collaborative OwnCo. Investors will have the majority vote for microgrid decisions. End-users will also have voting authority for decisions which affect financials directly, such as fuel and O&M as well as available loads to curtail for capacity market and demand response programs. End-users will have the opportunity to purchase shares.
- Predictable financials. By entering into long-term O&M, financing, and PPA agreements, as well as annual fuel hedges, OwnCo will be able to derive fairly stable business financials. The PPA should adjust end-user pricing if any of the drivers change during the term.

Weaknesses:

- Housing power generation assets. One of the imperatives for this project is to keep costs low. This includes the need to house equipment on end-user sites which has the potential to affect

microgrid personnel access. There should also be terms in the PPA, mutually beneficial to OwnCo and end-user which evergreen the contract should OwnCo continue to operate the most cost-effective energy supply to sites.
- Incremental easements. Should the microgrid benefit from new transmission, it will be difficult to obtain new easements, even if the utility owns the rights.

Opportunities:

- Scalability. The microgrid can grow in scope if successful and mutually beneficial to National Grid and OwnCo to take on additional areas within or adjacent to University Heights.
- Growth within the microgrid. Should lower and more predictable energy costs have desired economic growth results, the microgrid OwnCo will install new generation equipment in order to serve the load growth.
- Mitigating risk and costs with experience. As the microgrid operates and becomes more proven, OwnCo will be able to lower reserves and look for opportunities to cost-out.

Threats:

- Regulatory. Variable pricing, crossing rights of way, off-taking to residential customers and grid buy-back rates will require exception and approval by the PSC. Energy storage is not mentioned in the electricity tariff. We would seek to have certainty around these aspects through the useful life of the equipment and PPA to mitigate the risk of subsequent changes in regulations and tariffs which would negatively affect our model such as what has happened to solar in Nevada.
- Natural gas inflation. Conventional wisdom predicts stable gas prices at their current low levels for many years. It is wise to consider the risk of inflation occurring sooner than expected and the impact on the microgrid's business model, however, the majority of New York's electricity generation is from natural gas. End-users must understand they are exposed to this risk should they remain with the status quo. OwnCo should hedge commodity pricing and have electric/thermal pricing adjustment mechanisms in the PPA to account for changes in fuel price.
- Equipment failure. While the CHP space consists of many suppliers with proven products, the failure of one unit can have a significant effect on microgrid performance. During the early phase of Stage 2, we will look at the business cases of scenarios of 4X250 kW vs 1X1MW for example in order to ensure it makes good sense to have configurations where one unit down means generation is down 25% and not 100%. We can also mitigate much of this risk by installing a majority of units with proven experience and robust O&M terms and conditions covering planned and unplanned events as well as local authorized service personnel.

· How would installing this microgrid benefit the utility? (E.g. reduce congestion or defer upgrades)? What costs would the utility incur as a result of this project?

Utility benefits follow and we would work with National Grid to understand how to integrate reconciled with the business case and available incentives.

- Mitigate load growth. National Grid can leverage this project to mitigate load growth concerns on their underground network and avoid retrofits and upgrades as well as the need to dispatch generation from distant utility scale power plants along the high voltage network. Every kW generated and consumed onsite is a kW which does not have to travel on the distribution network. We would expect to share in the value of avoided distribution network upgrades towards the cost of implementing the microgrid.
- State-of-the-art technology. Additionally, by implementing state-of-the-art microgrid control software and hardware into the distribution network which interfaces with BMS and power generation, it will allow the system to dispatch the most efficient and lowest cost generation to meet load requirements.
- Battery storage to reduce peak demand. Battery storage is still an open issue with the engineering team. We would like to learn more from the utility during Stage 2 what benefit they would have to their distribution network and if National Grid would help fund implementation. Alternatively, the microgrid could look to import electricity from the grid when grid-connected or run standby generators when islanded.
- A more secure grid. We will specify the highest standards of cybersecurity in order to ensure that the microgrid continues to run should the main grid suffer from a cyberattack.
- A more resilient grid. Onsite power generation and possibly storage will ensure the main grid is more resilient and not as likely to suffer outages during unforeseen events.
- This microgrid is located in an area of stress for National Grid's network. We have had some end-users uncharacteristically explicitly state to us that reliability is more of a concern to them than economics. Typically, other DG customers are more motivated by costs. One director of facilities for a college told us they lose power too often and he dreads the day it happens on a -10F night the day before finals. The costs to refurbish the underground network in this area is quite high and disruptive for the City.

· Are there any characteristics of the site or technology (including, but not limited to, generation, storage, controls, information technology (IT), automated metering infrastructure (AMI), other, that make this project unique?

Because this microgrid is fairly compact and with high energy density, it could be reasonable to enter into a "virtual metering:" arrangement with National Grid or strictly PPA end-users with onsite power generation for export into the distribution network. We look forward to ensuring that the microgrid control architecture not only interfaces with DG and National Grid infrastructure but also complies with requirements to track and report electric import/export between sites for billing purposes. When we spec the required hardware and software, we will work closely with National Grid to ensure it complies with and interfaces with their equipment and software. Additionally, we will ensure that if relatively unproven equipment is the best fit on price and performance that we have a validation plan in place to mitigate risk.

· **What makes this project replicable? Scalable?**

Technically, we are applying packaged CHP, solar and batteries optimized to each site which we can expand after Stage 1 on a limited basis in order to optimize to the microgrid. As we take on new sites in the microgrid we can apply a similar strategy to each site. What's more important is we spec microgrid controls equipment which can serve additional facility DG and BMS.

Commercially, we will have agreement in our PPA to allow for export of electricity to other sites when the home site does not have load at no cost to end-user. We do not plan on using district heat between sites.

This is a replicable project as we are using DG and controls which can be applied to any facility and distribution network. What will be unique will be the commercial arrangement and negotiated rates to virtually meter between sites.

· **What is the purpose and need for this project? Why is reliability/resiliency particularly important for this location? What types of disruptive phenomenon (weather, other) will the microgrid be designed for? Describe how the microgrid can remain resilient to disruption caused by such phenomenon and for what duration of time.**

This project will:

- Improve end-user economics (as we have discussed in detail elsewhere in the report)
- Improve distribution network reliability
- Inject economic development funds to Albany
- Mitigate distribution network stress due to load growth
- Improve grid resiliency and reliability
- Make the area attractive for further development
- Improve power generation efficiency and add renewables to the network
- Peak shave and have reserve for capacity markets and demand response.

Potential disruptive phenomena (and mitigations):

- Snow storms (ensure DG has priority of plowing and not sited where drifts occur)
- High winds events (most transmission is underground, however there is some overhead we are recommending to go underground)
- Short-term floods (Ensure DG equipment on foundations are tall enough to put off flood plains, avoid basements unless robust pumps in place, understand flood-resistance of the underground network)
- Greater (macro) grid failure (Work with National Grid to confirm periodic tests of hardware and software to confirm islanding will perform as expected)

- Hacking (Ensure equipment connectivity is on dedicated wires as much as possible. Confirm with outside experts that our equipment conforms to the highest standards of firewalls and protection from unauthorized access)

During any of these events, except hacking, our DG and microgrid controllers should remain operational indefinitely provided natural gas supply remains in place, personnel can access units, and we have methods in pace to access units remotely. We may need to have a contingency in pace to man the micro-grid should there be a telecom or internet system failure.

· Describe the project's overall value proposition to each of its identified customers and stakeholders, including, but not limited, the electricity purchaser, the community, the utility, the suppliers and partners, and NY State.

Participant value:

- Decrease energy costs. Electric and thermal pricing will be less than the status quo.
- Mitigate inflation risk. By investing in power generation CAPEX the OwnCo will mitigate many inflation risks for the end-user. The PPA OwnCo will enter into with end-users will reflect this and allow end-users to plan their energy buy for years rather than months.
- Improve reliability. A well-running grid connected micro-grid with onsite power is more reliable than grid electricity alone.
- A sustainable and greener brand. End-users participating in a micro-grid with CHP optimized to thermal loads and renewables will be able to brand their greener approach for the benefit of customers and users of the site.
- Implement new technology towards standby generation. API has discussed with Advanced Green Innovations on the suitability of the ZHRO retrofit to the microgrid's diesel standby generation which will convert the units to natural gas with an injector change-out and compressor skid. This will mean that units can run on cleaner and less expensive natural gas, not requiring refuel during extended operations, and present fewer EHS risks to owners. We would be keen to implement and help validate new technologies, consisting of a minority of power generation, with the appropriate terms and conditions (mitigating our risk), pricing and OEM or Green Bank guaranteed financing.

The community at large:

- Economic development. By implementing a lower cost, more reliable power generation solution to an area of Albany, NY, this could be an economic driver and attract high-energy commercial users such as light industrial or commercial.
- Residential development. Less expensive, greener, and more reliable power will appeal to residents as well as developers.

New York State and REV:

- Revisit the regulatory framework. One goal of this feasibility study is to understand implementation obstacles within regulations and tariffs with our utility partners. This report is the first step in presenting the systemic and project-specific issues to REV and the PSC through NYSERDA with the appropriate business cases. During Stage 2, we will work with NYSERDA and National Grid to gain project-specific exceptions and approvals which should serve as important precedents in NYS to allow for more systemic changes to tariffs and regulations to ease implementation for future projects.
- Mitigate load growth. Every kW installed to power on-site or local loads is a kW which does not have to load the high voltage transmission network or distribution network. This mitigates the need to build out transmission with load growth and reduces transmission bottle-necks.
- Sustainable power generation. Implementing greener and more sustainable power generation across the state will help NY meet emissions and renewable energy targets. While there are some aspects of this which do not affect end-user's balance sheets, OwnCo will structure the business case for the microgrid so that end-users will buy kWhs and therms at a lower cost than status quo.

Utility Value

We discussed utility value and look forward to further quantifying it as we negotiate rates with National Grid post-feasibility study. These include:

- **Mitigate load growth.** Incremental DG will mitigate load growth and the need to refurbish National Grid's underground network.
- **State-of-the-art technology.** Incremental controls and switching will enhance National Grid's network reliability and enhance their ability to segregate grid faults.
- **Battery storage to reduce peak demand.** There are numerous advantages to storage discussed elsewhere in the report which will not only enhance customer value but National Grid's reliability, resiliency, power quality, and "dispatchability" of renewables.
- **A more secure grid.** The microgrid will incorporate appropriate internet security protocols to ensure it is not a hacking path and can continue to operate and island should the main grid suffer an attack.
- **A more resilient grid.** Incremental controls and switches will improve grid dispatching and isolation. Storage and distributed generation will remove load from the distribution network lowering stress and improving power quality.

3.3. The Contractor shall address no less than each of the following items below in describing the structure of the project team and the roles, strengths and resources of its members and other necessary partners.
· Describe the current status and approach to securing support from local partners such as municipal government? Community groups? Residents?

City of Albany. Allen Power Inc has been in close contact with the City of Albany Planning Department on project status and progress. The City Planner assigned to assist in this effort was key in helping Allen Power meet end-users and to get them to agree to support the study. Additionally, when Allen Power recently sat with end-users to update them on the concept, the planner attended one of the meetings. Allen Power has also reached out to the local Councilwoman and will re-engage with her once the microgrid island scope is defined.

Albany County. The County Executive's Director of Research attended the project launch meeting and is aware of the progress we've made on this study.

Community groups and residents. Allen Power Inc will engage with residents and groups once the scope of the island is confirmed and especially if it includes residential. Currently, there are no active residential units in-scope with the exception of the Gallery at Holland apartments which have not been built yet. Jason Allen used to be the Chairman of an Albany city board and has experience with several Councilmen and reviewing issues with them and community organizations.

· What role will each team member (including, but not limited to, applicant, microgrid owner, contractors, suppliers, partners) play in the development of the project? Construction? Operation?
· Are public/private partnerships used in this project? If yes, describe this relationship and why it will benefit the project.
· Describe the financial strength of the applicant. If the applicant is not the eventual owner or project lead, describe the financial strength of those entities.
· For identified project team members, including, but not limited to, applicant, microgrid owner, contractors, suppliers, partners, what are their qualifications and performance records?
· Are the contractors and suppliers identified? If yes, who are they, what services will each provide and what is the relationship to the applicant? If no, what types of team members will be required and what is the proposed approach to selecting and contracting?
· Are the project financiers or investors identified? If yes, who are they and what is their relationship to the applicant? If no, what is the proposed approach to securing proposed financing? Will other members of the project team contribute any financial resources?
· Are there legal and regulatory advisors on the team? If yes, please identify them and describe their qualifications. If no, what is the proposed approach to enlisting support in this subject area?

Team structure. Allen Power will continue to drive the Stage 2 design with the appropriate team in place to manage subcontractors. We are also considering partner arrangements as well.

Individuals we would contract for HQ PM responsibilities includes:

Project Director. We will contract with or hire a person who has deep experience fulfilling utility-scale combined-cycle and distributed generation projects to manage other HQ staff and subcontractors. We have a verbal commitment with a retired GE Combined-Cycle Project Director who also was the PM for implementing all of the DG across sports venues fulfilling GE's contract at the Athens Olympics.

Scheduler. We will contract with or hire a part-time scheduler to integrate schedules as required and ensure we have our required reporting. Additionally, this person could also fulfill a project and document coordinator role. We have a verbal commitment from an individual who, before retirement, managed a team of 19 project coordinators and document control personnel who were responsible for tracking, transmitting, and issuing all of the engineering documentation across GE's combined cycle project portfolio and maintained the engineering schedules.

Legal and regulatory advisors- API has contracted with Couch White, L.L.P. for legal services concerning this report. We originally reached out to this firm because of their deep energy practice. As this study wound down, our main point of contact, Michael Barnas, has left the firm to set up his own practice. Mike has deep experience in energy project development and corporate law after over 30 years at GE culminating as Corporate Council for GE Renewables. Our current plan is to continue using Mr. Barnas as our lead council while he leverages Couch White for further resources to support additional due diligence, expertise gaps, and PSC filings.

Contract manager. This person would manage our requisition documentation and contracts as well as risk and issue resolution. We have line-of-sight to securing the resources of a former Contract Manager who retired from GE and is very experienced in managing contract issues with suppliers and customers.

Subcontracted scope for project fulfillment includes:

Engineering- Allen Power Inc will revisit the engineering structure for stage 2 to include whether it will be one firm as lead which could mitigate interface and division of responsibility issues or multiple firms, each with discipline expertise, integrating technically with an A/E and commercially with API. API will base its selection criteria on objective factors such as price and scope as well as subjective scope such as experience in the DG and distribution network space, references, and geographic proximity to our site.

Construction- Allen Power Inc will work with engineering and its contract manager to issue RFP packages to construction firms in accordance with engineering, NYSERDA, National Grid, local and municipal codes and standards, and end-user requirements. We will base our selection, similar to engineering, on price as well as experience, references, and geographical proximity. Following selection of our contractor, we will finalize our procurement strategy and scope split. We will also ask our contractor to manage the project's integrated schedule and report percent completion unless API finds it more feasible to contract this work within API.

Finance & accounting- API will purchase accounting and finance services in order to finalize project pro-formas. We will seek professional firms who understand energy markets and tax credit valuations as well as being able to plan and manage overall project accounting both in developing the pro-forma and managing the transactions should the project proceed to include AP, AR, billing and collections, tax compliance, and reporting.

Prior to commencing Stage 2 and as part of its application for funding, Allen Power Inc will plan the organizational structure and subcontract detailed engineering and financial services scope. This will be the first iteration of Allen Power Inc taking on OpCo scope and will be staffed accordingly drawing on API's network. API will also manage the formation and operations of the OwnCo and will obtain executed letters of intent from investors, end-users, NYPA (as implementer in NYS buildings) and National Grid ensuring the necessary commitment is in place for investors to cost-share Stage 2 and 3 with NYSERDA.

Allen Power Inc plans to engage investors in greater detail once the scope and financials of this project are known during Stage 1. Allen Power Inc will contribute towards Stage 2 and Stage 3 in conjunction with other investors, NYPA, NYSERDA, and National Grid. Allen Power Inc has line of site to several investors who are interested in this project and understands their sensitivities. Additionally, Allen Power Inc has held discussions with M&T Bank and looks forward to considering bank financing towards Stage 3 as well as investment.

Financial Strength of applicant and investor strategy.

Jason Allen formed Allen Power Inc in 2013 after a successful career at GE Energy to include roles as the Consortium Manager for the Grand Coulee Dam turbine retrofit for the USBR, the Product Line Leader for GE's 1.5MW series of wind turbines growing the platform from 1.5MW to 1.62 MW and growing the rotor from 77m and 82.5m to 100m in Type Class II and III winds as well as implementing the GE Mark VIe controller as a replacement for the Bachman. His final role was as manager of the combined cycle project engineering and coordinator team based in Schenectady, Atlanta, and Dubai.

Allen Power Inc currently has 2MW of behind-the-meter CHP and Renewables under development at three different sites incremental to the ~4MW of CHP and Renewables at the University Heights site. Currently, API's founder is finalizing a new operating agreement in order to onboard a new partner who will not only bring significant liquidity to the company but deep HVAC and building systems technical expertise as well.

Allen Power Inc has zero debt as well as the ability to draw on personal liquidity, and access to a deep network which includes some of the leading businessmen of the Capital Region who could provide additional liquidity should the project and financiers require it. API has already had preliminary discussions with a strong local utility-scale power generation developer as well as a European utility and global developer on this project and there seems to be interest should API decide it makes commercial and technical sense to tie-up with either party.

If the project is a net $10MM build after incentives (a conservative rough order of magnitude and rounding up) and bank and NYPA financing require 70% loan to value, API would fund the $3MM from personal funds, end-users who have expressed an interest in investing such as RBC, the sale of tax credits, API operations, and outside investment. Additionally, banks offer lease-buyback programs which could mitigate the amount of equity OWNCO will have to provide.

Allen Power sat with NYPA on 15 December 2015 in order to review the project and understand how NYPA would implement power generation on NYS facilities and the commercial relationship. Nate Anctil informed us that NYPA's role would be of financier for CAPEX installed on NYS and not-for-profit facilities (except for religious organizations). As such, Congregation Beth Emeth, TownePlace Suites, and Gallery at Holland would be out of scope for NYPA financing.

NYPA has two different approval processes for financing. For NYS facilities, approval will take approximately four months at a current interest rate of 0.6%. Not-for-profit facility financing approval will take two months at a slightly higher (less than 1%) interest rate. Total financed will also include a 5% funding fee which will roll into the principal.

Additionally, NY Prize incentives for detailed design (Stage 2) and the main project (Stage 3), while they do not constitute a formal partnership, aid project financials considerably as well as provide incremental oversight on project performance before and after commissioning. The City of Albany has not demonstrated interest in partnering as an investor at this point but we will revisit when the financials are more clear.

The other partner for this project is National Grid. As we discuss in several places in this report, there are mutually beneficial additions to the microgrid incremental to behind the meter DG which we expect to cost-share with them. I expect that prior to Stage 2, we will enter into an MOU with National Grid which demonstrates our mutual desire to develop this microgrid and in good faith define scope split, a mutually beneficial business case and operating agreement.

Allen Power Inc has also reviewed this project's financials at a rough order of magnitude with outside investors and understands they would seek a 5-7 year return on investment. We currently see an eight year return not including additional National Grid incentives or other sources of incentives. We are certainly close to meeting these expectations with fairly conservative assumptions and minimal due diligence.

Upon finalizing the project's financial interfaces, specifically, National Grid assistance and PPA assumptions, Allen Power Inc will ensure its balance sheet will support Stage 2 activities via organic cash-flow through other projects and outside investment. Additionally, long-term PPAs with end-users and National Grid will serve as financial instruments to enable NYPA and bank financing as required.

3.4. The Contractor shall describe the mechanics of ensuring that expected value is delivered to project participants, by addressing no less than the following items below:
· What assets does the applicant and/or microgrid owner already own that can be leveraged to complete this project?

The applicant and proposed microgrid owner brings knowledge of a career leading projects and product commercialization in the power gen industry. Similar to our approach to fulfill the requirements of this feasibility study, members of the team will include known industry leaders with deep experience in their segment and design, construction, and equipment firms who will win on price and performance. Our strength lies in being technology, OEM and contractor agnostic which drives down costs and allows more options towards optimization.

Allen Power Inc can draw upon its own cash reserves or personal real estate equity towards providing microgrid owner equity prior to reaching out to partners or outside investors. Currently, API doesn't not have physical assets under ownership or in operation but is in the process of developing 2MW at various sites. Any equity or future operations of these sites could further aid in balance sheet financing from banks and investors. However, depending on subsequent project planning, we may consider partnering as well. Partnering could not only provide further expertise but financial reserves and risk mitigation as well.

· What permits and/or special permissions will be required to construct this project? Are they unique or would they be required of any microgrid? Why?

We would expect to follow typical NYS standard interconnection requirements for behind the meter DG installation. We would also need to adhere to NYSDEC Permits/SEQR permitting requirements as well as National Grid's standard process. We would not expect issues with DEC permitting since our NOx levels should be well below DEC thresholds. All of the CHP systems being considered will fueled with natural gas and be less than 10 million Btu/hr heat input. As per 6 CRR-NY 201-3.2 systems of this size are considered exempt activities.

"Stationary combustion installations with a maximum rated heat input capacity less than 10 million Btu/hr burning fuels other than coal or wood..."

There is therefore no requirement to obtain a permit from the NYSDEC for the microgrid.

For the microgrid, we would look forward to partnering with National Grid to obtain necessary PSC approvals for storage, negotiated rates, and implementation of incremental controls and switches which would interface with the National Grid network.

The City of Albany does not treat photovoltaic installation differently from any other work involving electricity. Basically, the person doing the work submits a permit for review for compliance with the relevant building codes and zoning laws. Practically speaking, the relevant building codes are state wide so there aren't any incremental requirements unique to Albany.

As for Albany specific regulations, the can be found at Albany City Code 375-93 (http://ecode360.com/7688014). The city ordinance distinguishes between roof top and ground mounted solar collectors. Rooftop units are allowed anywhere (including the University Heights area) without restriction (subject to permitting) except in residential districts where they're allowed but with some restrictions. As for ground mounted collectors, they're explicitly allowed anywhere subject to some restrictions related to placement, etc.

· What is the proposed approach for developing, constructing and operating the project?

Allen Power will drive development of the microgrid in parallel with applying for Stage 2 funding. Steps include:

Secure an MOU with National Grid in order for us to:

- **Finalize end-user scope.** Jointly (or with National Grid support) approach other end-users who are geographically located on the same affected feeder network to confirm they would like to participate in the microgrid.
- **Scope Split.** The general concept of scope split between API (and the project) and National Grid to include not only procurement but installation, and O&M.
- **Business case development.** A commitment from National Grid to enter into good-faith negotiations to formalize cost-share based on value split as well as how to commercialize the exchange of electricity on the National Grid system between sites and for export to the general network as well as a path to bring incremental value to the project through entering the demand response and capacity markets.

Finalize modeling and the high level business case and configuration based on new and departing participants.

Secure PPAs and commitments from end-users in order to secure financing. Ensure PPAs offer flexibility for API and end-user to exit should desired benefits not come to pass during Stage 2.

Confirm investment for Stage 2 cost-share.

Issue RFPs to engineering and confirm strategy of E&D execution.

Upon finalizing scope and strategy with NYSERDA and National Grid and ensuring end-user and investor comments are baked into the plan, Allen Power Inc will form the OwnCo and OpCo and finalize Stage 2 planning with robust project management resources and tools.

Issue OEM RFPs and select PV and CHP suppliers in order to define power gen performance.

Execute detailed design planning and financial analysis.

Issue RFPs for construction and down-select contractors, strategy, and scope-split.

Confirm construction financing and incentive plan.

Plan phased approach to construction:

- Execute POs for scope of supply and contractors
- Install and commission DG optimized to sites.
- Validate DG.
- Install, test, validate and commission distribution network controls and hardware.
- Install incremental DG on sites optimized to microgrid.
- Commission microgrid.

OpCo runs the microgrid and manages:

- Phased approach … asset management as systems are commissioned.
- AP/AR.
- OwnCo financial management
- OwnCo meetings.
- O&M contracts and execution.
- End-user contracts and relations.
- National Grid relations.
- Performance and outage planning and resoluition.

· How are benefits of the microgrid passed to the community? Will the community incur any costs? If so, list the additional costs.

We do not expect the community to incur costs. In fact, by mitigating underground network refurbishment, City taxpayers and NYS ratepayers will avoid significant expense and disruption. The community will benefit by having a power generation paradigm which will drop costs, mitigate inflation and de-stress a distribution network seeing growth.

· What will be required of the utility to ensure this project creates value for the purchaser of the electricity and the community?

We will negotiate a PPA in the event we import/export electricity between sites. This includes favorable electric buy-back rates in the event we export power and ensuring charges are fair and reasonable in the event units have planned or unplanned maintenance events. We would like to discuss possibly a "virtual" metering arrangement with National Grid with negotiated rates in order to monetize electricity exported from one site to another site along National Grid lines. We plan on avoiding standby tariffs by wrapping generation under the Environmentally Advantageous Technology (EAT) exemption.

Additionally, we would work with National Grid on the value of energy storage and other equipment which enhances the utility's value story in the overall PPA package.

· Have the microgrid technologies (including but limited to: generation, storage, controls) been used or demonstrated before? If yes, describe the circumstances and lessons learned.

Power Generation:

CHP: We will consider microturbines and recip engines for sites which have both heat and electric loads. There are countless experiences in the cogen space both in small and large utility-scale applications. We have learned in our work with clients and studies of the industry that it's critical in the planning process to ensure temporal load modeling is accurate and representative of true site conditions. Furthermore, it is important to have asset management in place which will maintain the units well and longer-term ensure appropriate upgrades and retrofits occur in order units continue to meet performance.

Fuel Cells: We will consider fuel cell applications if there are sites which require non-intermittent generation, do not have significant thermal loads, and where storage is not feasible. Fuel cells will require the same lessons learned as we just discussed with CHP.

Renewables: This site will not consider wind because it does not have strong enough winds nor available land. For solar planning and effectiveness we need to ensure appropriate structure, shade, and roof analysis occurs to confirm the assets will be in place through the 20+ years of panel effectiveness. Since our climate is not particularly dusty and it rains fairly often, cleaning panels should not be a consideration, however, we need to ensure panels have priority of access after snow and ice storms and resources are available to clean them off. Monitoring technology will allow us to understand the continuous status of each individual panel.

Distribution network hardware and controls: As we discussed in Task 1, there are several possible microgrid controls and hardware technologies which are proven in island, remote, and campus settings. We must work with National Grid on our selection and validation plan to include bench testing, pre-commissioning, and post-commissioning test and validation plan in order to ensure the microgrid will perform as expected across all of our performance and security imperatives. The Microgrid Control design in Stage 2 might incorporate GE's proven U90Plus Microgrid Cost Minimizer to dispatch the DERs, and the D400 RTU/Controller to implement various operational control strategies. GE is currently developing a DoE funded eMCS controller that expands upon the algorithms implemented in the U90Plus and incorporates many of the control functions that now reside in the D400. The eMCS is currently being tested at NREL and will be applied at a microgrid site in Potsdam, NY. The U90Plus algorithm is being incorporated into the D400 controller, and this solution will be deployed in mid-2016 in a Microgrid at the University of Ontario in Toronto.

Another proven solution that could be utilized is GE's proven C90Plus Fast Load Shed Controller. The C90Plus provides adaptive load shedding for loss of generation and/or a utility tie to trip non-critical load. The IEDs/relays communicate real-time load and generation values as well as status to the C90Plus via IEC 61850 GOOSE messaging. The C90Plus evaluates this information and will issue a fast trip GOOSE message to the IEDs/relays to trip non-critical loads to assure a generation-load balance. The tripping of the load breakers is initiated in less than 20 ms from detection of the triggering event. This compares to 200 ms to 400 ms for conventional load shedding schemes. This solution was recently successfully deployed and demonstrated at the Portsmouth Naval Shipyard under a DoD Environmental Security Technology Certification Program (ESTCP) contract in 2015.

· Describe the operational scheme, including, but not limited to, technical, financial, transactional and decision making responsibilities that will be used to ensure this project operates as expected.

The OpCo will be the asset manager for the microgrid. During Stage 2, OpCo will define the "make/buy" strategy in order to understand how the different responsibilities the OpCo has will be fulfilled. OpCo may choose to fulfill roles organically or sub out the work with decision-making residing with the OpCo and OwnCo.

During project execution, OpCo will recommend decisions to OwnCo which affect microgrid performance, financials and strategy for final disposition. OpCo will execute the project and manage relationships with suppliers, contractors, National Grid, endusers, and stakeholders.

As units and assets are commissioned, OpCo will execute O&M contracts and ensure all contract requirements to include AP/AR are met. As during project execution, OpCo will make recommendations to OwnCo which affect microgrid strategy, financials, and performance (aka risk) for OwnCo disposition.

OwnCo will consist of investor members with voting share proportional to investment and any other terms of the operating agreement. OwnCo will meet quarterly or as necessary at a meeting managed by OpCo to confirm microgrid performance, mitigate issues, and make decisions which affect microgrid strategy, performance, and financials.

From a technical perspective, the microgrid control system will oversee operation during normal and emergency conditions, as well as the transition between states. This was described in detail earlier in this document. When an event occurs, the microgrid controller, which is monitoring voltage and frequency at the POIs, would initiate a sequence of operations to transition from grid-connected to islanded mode. During islanded mode, the load-generation balance is managed in real-time by the microgrid controller which interacts with generation control systems and facility energy management systems. The transition back to grid connected mode is also managed by the microgrid controller.

· How does the project owner plan to charge the purchasers of electricity services? How will the purchasers' use be metered?

This is TBD with National Grid, however, our initial plan is to:

- Ensure metering is in place which ensures we can remote monitor performance and net import/export continuously.
- Confirm with National Grid that we can utilize their meters, if suitable, and install owner meters as required to ensure each power gen asset is measured continuously.
- Establish a reconciliation process with National Grid that not only monthly, but continuously, ensures net power gen at each site, between sites, and import/export from microgrid reconciles with National Grid data.
- Ensure instrumentation is in place to measure therm loads at each site served by microgrid assets.
- Invoice end-users either monthly or quarterly, consistent with PPAs and rates, on their usage. We expect to have PPAs which optimize and encourage end-users stay to plan with incremental benefits to any demand response or capacity market value we share with them.

· Are there business/commercialization and replication plans appropriate for the type of project?

Allen Power Inc is aware of other areas with mixed-use and complimentary loads (residential, retail, and commercial) in the Capital District at points of distribution network stress based on media reports of outages. National Grid has confirmed they may be suitable to a similar microgrid model. We plan to begin discussions at the other sites upon completion of planning and application for this Stage 2 study.

· How significant are the barriers to market entry microgrid participants?

The first discussion point should be, how to create the market. Most end-users do not place value on the incremental reliability a microgrid will bring unless they currently face issues or place a high value on reliability such as a high-tier datacenter. For this study, we have end-users who are concerned about reliability based on frequent outages and the impact they could have on their large served populations of patients, worshippers, and students. Otherwise, Microgrids are difficult to develop without significant if not 100% feasibility study funding by outside parties or developers and there must be line of site to energy savings.

Credibility is another barrier to entry. Most facility directors get constant solicitations from solar, CHP and ESCO providers promising energy savings. How does a microgrid developer differentiate and get past the initial phone call? Having the utility and City of Albany support was instrumental in getting end-users to agree to sit with me and listen. In my view, it's critical for the development lead to be local and present as well as leverage good project management, community relations, and energy sector experience. They also need to have a strong cross-discipline network within their company or working for them. Informal networks are also important for the developer to have.

Microgrid equipment and engineering firms need to have deep experience in the distributed generation space or else be prepared to take considerable price reductions or warranty risk in order to buy their way into the market.

As we discussed, tariff uncertainty adds upfront risk to projects as well increasing planning cycles, project duration, and financing risk. Tariff certainty will enable development to become more mainstream and improve the options end-users have when considering microgrid participation.

Lastly, the developer needs to have the necessary assurances in place with end-users in order to confirm revenues and easements for equipment over a 10-20 year term in order to assuage investors a relative degree of certainty and lower cost of money. We find, typically, that most parties are skeptical of entering into agreements longer than 10 years.

· Does the proposer demonstrate a clear understanding of the steps required to overcome these barriers?

The University Heights microgrid project is in an area of grid stress and end-users have been candid about their concerns about reliability; there is a market. In fact, some have said reliability trumps cost savings.

The Contractor shall describe the mechanics of ensuring that expected value is delivered to project participants, by addressing no less than the following items below:
· How were the specific microgrid technologies chosen? Specifically discuss benefits and challenges of employing these technologies.
· How do the design, technology choice, and/or contracts ensure that the system balances generation and load?

The team's first power generation strategy was to optimize CHP around site thermal requirements. After solving for CHP and adjusting thermal loads with the implementation of absorbers, we modeled renewables in order to account for shortages in electricity generation during the day. Currently, we are in discussions with National Grid on microgrid scope and will revisit our model results if scope changes. We will also get a better view from National Grid on the value of energy storage to the distribution network at University Heights and if they can help fund batteries.

There are several challenges and complexities to the system that the microgrid controller will have to manage. If one were to call them performance "dials," they are:

- Thermal production. Will the system have thermal generation when the buildings require it or will it have to rely on boilers or electric chillers in place?

- Electric production. Will the system have generating capacity available for dispatch when necessary and ideally, in order to maximize efficiency, when there is a thermal load?
- Efficiency. Is there appetite at buildings for thermal load when there is electric demand? Is there tolerance at the BMS to allow for slightly cooler settings in the summer or slightly warmer in the winter to allow for a slight degree of thermal storage in the buildings without sacrificing comfort?
- Demand response and capacity programs. The system must have the appropriate settings and protocols to react appropriately to manage load and generation in order to effectively participate in these programs and capture value.
- Load triage or priority of curtailment. During period of grid stress or islanding, the microgrid controller must interface with BMS and curtail lower priority loads there isn't generation available or dedicated to serve.

It is critical the microgrid controller optimize these different imperatives in the system in order to optimize the business case for the owners and end-users while continuing to stay in harmony with National Grid's network. If the units don't run as efficiently as they should it could net into higher fuel and O&M costs as well as unnecessary emissions. The microgrid controller must be able to report but direct the power generation controllers, BMS, and National Grid interfaces concurrently.

3.5 Describe the case for financial viability for development and operation of the microgrid by addressing no less than the following items below:
· What are the categories and relative magnitudes of the revenue streams and/or savings that will flow to the microgrid owner? Will they be fixed or variable?
· What other incentives will be required or preferred for this project to proceed? How does the timing of those incentives affect the development and deployment of this project?
· What are the categories and relative magnitudes of the capital and operating costs that will be incurred by the microgrid owner? Will they be fixed or variable?
· How does the business model for this project ensure that it will be profitable?
· Describe the financing structure for this project during development, construction and operation.

Initial Investmant	Unit	$/Unit	Cost	Incentives	Tax Red %	Tax Reduction	Net Initial Cost
CHP (kW)	3,300	3000	$9,900,000	$3,300,000	10%	$990,000	$5,610,000
Chillers (Ton)	1,215	2000	$2,430,000	$607,500	0%	$ -	$1,822,500
Solar System (kW)	600	5000	$3,000,000	$300,000	30%	$810,000	$1,890,000
Other (Microgrid accessories)			$1,500,000				$1,500,000
NY Prize or National Grid				$3,500,000			($3,500,000)
Contingency	5%		$541,125				$541,125
Sub-Total			$17,371,125	$7,707,500		$1,800,000	$7,863,625
Engineering & design		10%	$786,363				$786,363
Grid engineering			$150,000				$150,000
OpCo fees		4%	$314,545				$314,545
Soft Cost Sub-Total			$1,250,908				$1,250,908
PROJECT TOTALS			$18,622,033	$7,707,500		$1,800,000	$9,114,533

Table 3-1. CAPEX costs

Costs:

- *Equipment costs and logistics to site (fixed).*
- Engineering and Design (fixed).
- Construction (fixed).
- Commissioning (fixed).
- National Grid transmission line usage (variable)
- *CHP Fuel (variable)*
- *OEM O&M (variable)*
- OpCo Asset Management and system performance (variable)
- Software and remote monitoring subscriptions (fixed)
- *Electricity import (variable)*
- Supplemental boiler or electric chiller use (variable)

Revenue:

- *NYSERDA such as typical PON or NY Prize (fixed)*
- *National Grid for cost-share of mutually beneficial equipment (fixed)*
- ITC (fixed) where applicable.
- PTC (variable) where applicable.
- *End-user billing for electric and thermal use (variable)*
- Participation in demand response and capacity market programs (variable)
- *Electricity export (variable)*

Table 3-1 takes the relative magnitude of these costs and revenues into consideration with some aggregation. Our business model is particularly sensitive to the costs and revenue bullets italicized. When we apply for Stage 2 financing, we will re-cast our assumptions and values based on any changes we have in commitments from end-users.

Project incentives, pre-commissioning, should be consistent with payment milestones to OEMs and contracts, otherwise, Owners will have to have a larger reserve in order to manage cash-flow gaps. Performance criteria to meet incentive milestones should also flow through to OEMs and contractors in order to mitigate OwnCo risk. PPA modeling should consider timing issues between variable accounts payable and receivable timing and account for the near simultaneous if not unfavorable timing of billing from customers and suppliers. A "budget billing" or flat monthly billed amount could allow OwnCo to build reserves for higher consumption months if this is more favorable than holding reserves in order to pay suppliers on time.

Typically, banks require 70% LTV on power generation projects as per M&T Bank. Construction loans will require a 3rd party or Green Bank guarantee for the bank to finance. Additionally, it is also to enter into a ten-year lease buy-back agreement with the bank which would minimize owner equity requirements. The bank is available to purchase tax credits, should the microgrid not have appetite, lowering payments.

We have not finalized our Stage 2 project development financing plans. We have a number of options which we will pursue and select the optional configuration.

- API cost share and in-kind work.
- Investor financing.
- National Grid cost share.
- Identifying scope which qualifies for construction financing such as engineering.
- Development partners.

NY Prize

Note typical NYSERDA incentives in this table to not take into account the full NY Prize potential benefit. We added an additional line to capture potential National Grid and NYSERDA incentives incremental to typical NYSERDA PONs. This will help us adjust our model should this project proceed past Stage 1 outside the NY Prize paradigm. We would also like to understand the magnitude of avoided cost and benefit to National Grid and if there is value to share. Adding $5MM in incentives drops the payback period eight years. We will load in battery cost and value once we understand from National Grid what the value is to the grid.

Investor Annual Revenue	Unit	Revenue
CHP Power Produced to Use at CHP Sites (kWh)	19,960,634	$2,131,784
CHP Excess Power Outside the Need of Microgrid (kWh)	4,540,672	$408,660
CHP Excess Power Within the Need of Microgrid (kWh)	3,164,144	$337,929
Absorber Electric Offset (kWh)	2,830,569	$453,455
Solar Power Used Outside the Need of MicroGrid (kWh)	541,598	$48,744
Solar Power Used Within the Need of MicroGrid (kWh)	280,000	$29,904
CHP Thermal Offset/Heat Recovered w/out Abs (Therms)	625,437	$335,951
CHP Standby Fee		$0
Total Revenue		$3,746,427
Investor Annual Costs	Unit	Expenses
CHP Gas (Therms)	2,987,203	$1,604,564
CHP Maint.		$691,636
Absorber Maint.		$86,921
BMS System Maint.		$75,000
Grid Accessories Maint.		$150,000
General Expenses		$250,000
Total Cost to Investor		$2,858,121
	Net Revenue	**$888,306**
	Payback Period	**10.26**

Table 3-2. Annual costs and revenues

3.6 The Contractor shall describe the legal terms and conditions and other requirements necessary to develop and operate the microgrid by addressing no less than the items below:
· Describe the proposed project ownership structure and project team members that will have a stake in the ownership.

As noted in section 3.1 above, the project assets will be owned by a special-purpose limited liability company ("**OwnCo**"). Owners of a limited liability company are referred to as "members"; the members of OwnCo will be independent investors. Tier 1 end users who elect to invest in the project may also become members of OwnCo. [Allen Power, Inc. will retain a carried interest in OwnCo.]

· Has the project owner been identified? If yes, who is it and what is the relationship to the applicant? If no, what is the proposed approach to securing the project owner?

Allen Power Inc. currently plans to have the controlling ownership stake in the microgrid. As a means to mitigate risk, raise additional capital, and bring additional expertise to the project, we have identified several entities with a strong interest in the project who could be potential members of the OwnCo. These potential partners include investors, end-users and development firms. They will be asked to commit to the project for as part of the Stage 2 application process.

· Does the project owner (or owners) own the site(s) where microgrid equipment/systems are to be installed? If not, what is the plan to secure access to that/those site(s)?

Neither OwnCo nor Allen Power Inc. will own the sites where project assets will be installed. The power purchase agreement with each Tier 1 end user will include a grant of easement or other similar real property interest to OwnCo to locate project assets on the end-user site in exchange for lower and more reliable energy costs.

· What is the approach to protecting the privacy rights of the microgrid's customers?

In addition to electricity and natural gas consumption data which it will obtain in the course of operating the generating assets, OwnCo and OpCo will require from the end users only such information as would be necessary for any other commercial transaction. Access to all end user information will be limited to employees and agents of OpCo on a need-to-know basis and the contracts between OwnCo, OpCo, and the end-users will likely contain confidentiality clauses common to the industry. During Stage 2 the end users will be surveyed to determine any specific confidentiality concerns.

· Describe any known, anticipated, or potential regulatory hurdles, as well as their implications that will need to be evaluated and resolved for this project to proceed. What is the plan to address them?

The University Heights microgrid, like every microgrid is unique – it provides a tailored solution to a specific set of technical and commercial requirements. For this reason, the needs of both National Grid and the microgrid could be met most effectively through a negotiated PPA. Such an Agreement should provide:

- that OwnCo could sell power to the end users at rates to be set by power purchase agreements between them, using National Grid assets to deliver the power;
- that National Grid would purchase any excess power at rates that provide OwnCo with fair compensation for the power that is produced and network reliability enhancements;
- that National Grid would continue to provide power as needed to the end users under their parent service classifications;
- that OwnCo and the end-users could benefit from net metering at the end users' parent rates
- that OwnCo and the end users can participate in the emergency demand response curtailment programs described in Rule 54 of the Tariff.

Currently, the National Grid electric tariff does not contemplate microgrids or energy storage. The Contractor notes that National Grid has been supportive throughout the development of this study, and is confident that an agreement can be reached without action by the Public Service Commission.

In order to provide comfort to outside investors, OwnCo intends to petition the Public Service Commission for a declaratory judgment that neither OwnCo nor OpCo is subject to regulation as an Electricity Corporation or as an Energy Service Company within the meaning of the Public Service Law or the General Business Law.

The current design for the University Heights microgrid does not require the construction of transmission facilities (i) in public rights of way; and/or (ii) subject to Article VII of the Ny Public Service Law. If subsequent changes to the design require such construction to be undertaken by OwnCo it will petition the Public Service Commission for permission to do so, if necessary.

The Contractor notes that among the end users is the Gallery at Holland, a 125-unit luxury apartment complex. OwnCo will confirm that the developer of that project is aware of its obligations under Rule 9 of the Tariff regarding residential submetering as well as those under the Home Energy Fair Practice Act.

4.0 Develop Information for Benefit Cost Analysis

4.1 List and describe all facilities that will be served by the microgrid. For each facility the Contractor shall:
· Indicate the rate class to which the facility belongs (i.e., residential, small commercial/industrial, large commercial/industrial).
· Indicate the economic sector to which the facility belongs (e.g., manufacturing, wholesale and retail trade, etc.).
· Indicate whether multiple ratepayers are present at the facility (e.g., multi-family apartment buildings). · Indicate the facility's average annual electricity demand (MWh) and peak electricity demand (MW). For facilities with multiple ratepayers, indicate average annual and peak demand per customer, rather than for the facility as a whole.
· Indicate the percentage of the facility's average demand the microgrid would be designed to support during a major power outage.
· In the event of a multi-day outage, indicate the number of hours per day, on average, the facility would require electricity from the microgrid.

Please reference Table 4-1

Facility Name	Rate Class	Facility/Customer Description (Specify Number of Customers if More Than One)	Economic Sector Code	Average Annual Electricity Usage Per Customer (MWh)	Peak Electricity Demand Per Customer (MW)	Percent of Average Usage Microgrid Could Support During Major Power Outage	Hours of Electricity Supply Required Per Day During Major Power Outage
Capital District Psych Center	Large Commercial/Industrial (>50 annual MWh)	(1) Psychiatric Hospital	*All other industries*	6,453	1.47	100%	24
Albany College of Pharmacy	Large Commercial/Industrial (>50 annual MWh)	(8) Educational Facilities	*All other industries*	743	0.20	97%	24
TownePlace Suites	Large Commercial/Industrial (>50 annual MWh)	(1) Hotel	*All other industries*	1,002	0.32	100%	24
The Sage College	Large Commercial/Industrial (>50 annual MWh)	(9) Educational Facilities	*All other industries*	281	0.07	98%	24
Albany Law School	Large Commercial/Industrial (>50 annual MWh)	(3) Educational Facilities	*All other industries*	556	0.21	100%	24
Congregation Beth Emeth	Large Commercial/Industrial (>50 annual MWh)	(1) Religious Facility	*All other industries*	221	0.05	100%	24
Parsons Child & Family Center	Large Commercial/Industrial (>50 annual MWh)	(4) Educational Facilities	*All other industries*	350	0.08	97%	24
New York State Office of Mental Health	Large Commercial/Industrial (>50 annual MWh)	(1) Office Building	*All other industries*	5,266	1.35	100%	24
The Gallery on Holland	Residential	(126) Residential Apartments	*Residential*	15	0.004	100%	24

Table 4-1. Facility type, demand, and requirements

Note that usage and demand values are per customer (in parenthesis in the third column).

4.2 Describe the distributed energy resources (DER) the microgrid would incorporate, including for each the items below:
· Energy/fuel source.
· Nameplate capacity.
· Estimated average annual production (MWh) under normal operating conditions.
· For fuel-based DER, fuel consumption per MWh generated (MMBtu/MWh).

Please reference Table 4-2. We base the following report how we optimized DG implementation across the sites optimizing efficiency and economics for the microgrid. Site optimization would be different.

Distributed Energy Resource Name	Facility Name	Energy Source	Nameplate Capacity (MW)	Average Annual Production Under Normal Conditions (MWh)	Average Daily Production During Major Power Outage (MWh)	Fuel Consumption per MWh	
						Quantity	Unit
CHP Generator	Albany College of Pharmacy	*Natural Gas*	0.75	6,343	17.4	11.8	MMBtu/MWh
CHP Generator	New York State Office of Mental Health	*Natural Gas*	0.75	6,261	17.2	11.8	MMBtu/MWh
CHP Generator	Capital District Psych Center	*Natural Gas*	1.00	8,322	22.8	9.8	MMBtu/MWh
CHP Generator	Albany Law School	*Natural Gas*	0.30	2,497	6.8	11.8	MMBtu/MWh
CHP Generator	The Sage College	*Natural Gas*	0.30	2,545	7.0	11.8	MMBtu/MWh
CHP Generator	Congregation Beth Emeth	*Natural Gas*	0.10	832.2	2.3	9.8	MMBtu/MWh
CHP Generator	Parsons Child & Family Center	*Natural Gas*	0.10	864.9	2.4	9.8	MMBtu/MWh
Solar System	Albany College of Pharmacy	*Solar*	0.175	239.6	0.66		Choose an item.
Solar System	Capital District Psych Center	*Solar*	0.175	239.6	0.66		Choose an item.
Solar System	Albany Law School	*Solar*	0.075	102.7	0.28		Choose an item.
Solar System	Congregation Beth Emeth	*Solar*	0.050	68.5	0.19		Choose an item.
Solar System	Parsons Child & Family Center	*Solar*	0.075	102.7	0.28		Choose an item.
Solar System	TownePlace Suites	*Solar*	0.025	34.2	0.09		Choose an item.
Solar System	The Gallery on Holland	*Solar*	0.025	34.2	0.09		Choose an item.

Table 4-2. DER configuration

4.3 Provide estimates or high-level descriptions of the following services/value the microgrid is expected to provide, as applicable (subject to data availability and utility support):
· The impact of the expected provision of peak load support on generating capacity requirements (MW/year).
· Capacity (MW/year) of demand response that would be available by each facility the microgrid would serve.
· Associated impact (deferral or avoidance) on transmission capacity requirements (MW/year).
· Associated impact (deferral or avoidance) on distribution capacity requirements (MW/year).
· Ancillary services to the local utility (e.g., frequency or real power support, voltage or reactive power support, black start or system restoration support)
· Estimates of the projected annual energy savings from development of a new combined heat and power (CHP) system relative to the current heating system and current type of fuel being used by such system
· Environmental regulations mandating the purchase of emissions allowances for the microgrid (e.g.,

due to system size thresholds)

· Emission rates of the microgrid for CO2, SO2, NOx, and Particulate Matter (emissions/MWh).

Please reference Tables 4-3 through 4-7.

Distributed Energy Resource Name	Facility Name	Available Capacity (MW/year)	Does distributed energy resource currently provide peak load support?
CHP Generator	Albany College of Pharmacy	0.75	☐ Yes
CHP Generator	New York State Office of Mental Health	0.75	☐ Yes
CHP Generator	Capital District Psych Center	1.00	☐ Yes
CHP Generator	Albany Law School	0.30	☐ Yes
CHP Generator	The Sage College	0.30	☐ Yes
CHP Generator	Congregation Beth Emeth	0.10	☐ Yes
CHP Generator	Parsons Child & Family Center	0.10	☐ Yes
Solar System	Albany College of Pharmacy	0.175	☐ Yes
Solar System	Capital District Psych Center	0.175	☐ Yes
Solar System	Albany Law School	0.075	☐ Yes
Solar System	Congregation Beth Emeth	0.050	☐ Yes
Solar System	Parsons Child & Family Center	0.075	☐ Yes
Solar System	TownePlace Suites	0.025	☐ Yes
Solar System	The Gallery on Holland	0.025	☐ Yes

Table 4-3. Facility annual DER Capacity

We are assuming that if we approach end-users regarding participation in a DR program, we can share the value in having 10% of their load available. The values in table 4-4 are per month and are 10% of the monthly peak load.

Facility Name	Capacity Participating in Demand Response Program (MW/month)	
	Following Development of Microgrid	Currently
Capital District Psych Center	0.15	0
Albany College of Pharmacy	0.16	0
TownePlace Suites	0.035	0
The Sage College	0.065	0
Albany Law School	0.065	0
Congregation Beth Emeth	0	0
Parsons Child & Family Center	0.030	0
New York State Office of Mental Health	0.14	0
The Gallery on Holland	0.06	0

Table 4-4. Demand Response assumption

Impact of Microgrid on Utility Transmission Capacity	Unit
3.42	MW/year

Table 4-5. Impact of microgrid on transmission capacity

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

Table 4-6. Impact of microgrid on distribution capacity.

Current heating throughout the microgrid is by natural gas. We project an annual energy savings relative to the current heating system of 62,472 mmBTU.

We do not expect to purchase emissions allowances.

Emissions Type	Emissions per MWh	Unit
CO_2	0.6803880	Metric tons/MWh
SO_2	0.0000041	Metric tons/MWh
NO_x	0.0001120	Metric tons/MWh
PM	0.0000181	Metric tons/MWh

Table 4-7. Expected DER emissions

We do not expect to provide frequency/real power, voltage/reactive power, or black start /system restoration support pending further discussions with National Grid.

4.4 Provide the following cost information for the microgrid:
· Fully installed costs and engineering life span of all capital equipment.
· Initial planning and design costs.
· Fixed operations and maintenance (O&M) costs ($/year).
· Variable O&M costs, excluding fuel costs ($/MWh).
· What is the maximum amount of time each DER would be able to operate in islanded mode without replenishing its fuel supply? How much fuel would the DER consume during this period?

Please reference Tables 4-8 through 4-12. This is a conservative estimate and does not consider incentives, tax, depreciation, contingency. We will recast these values prior to reapplying for Stage 2 funding in order to confirm we have the most accurate baseline of committed end-users and that the model incorporates our most up-to-date assumptions. By being conservative, the BCA includes costs which net higher than our internal models.

Capital Component	Installed Cost ($)	Component Lifespan (round to nearest year)	Description of Component
All CHP Units	9,900,000	20 years	3,300 kW CHP System
All Absorption Chillers	2,500,000	20 years	1,250 Tons of Absorption Chillers
Solar System	3,000,000	20 years	600 kW Solar System
Grid & Communications Accessories	1,500,000	20 years	All other equipments incorporated with the Microgrid

Table 4-8. CAPEX projection

Initial Planning and Design Costs ($)	What cost components are included in this figure?
1,265,908	Design + Consultancy + Project Management

Table 4-9. CAPEX soft costs

Fixed O&M Costs ($/year)	What cost components are included in this figure?
150,000	Grid accessories, microgrid controller, communications

Table 4-10. Fixed O&M costs

Variable O&M Costs ($/Unit of Energy Produced)	Unit	What cost components are included in this figure?
25	$/MWh	O&M cost to produce 1MWh from the CHP System
$0.014	Other - please specify	O&M cost per 1 Ton of cooling. 1,215 tons total capacity. 5,110 hours per year expected.

Table 4-11. Variable O&M costs

Distributed Energy Resource Name	Facility Name	Duration of Design Event (Days)	Quantity of Fuel Needed to Operate in Islanded Mode for Duration of Design Event	Unit
CHP Generator	Albany College of Pharmacy	Indefinite(1 day)	1,788.0	Other - please specify (Therms)
CHP Generator	New York State Office of Mental Health	Indefinite (1 day)	1,764.7	Other - please specify (Therms)
CHP Generator	Capital District Psych Center	Indefinite (1 day)	2,345.7	Other - please specify (Therms)
CHP Generator	Albany Law School	Indefinite (1 day)	846.8	Other - please specify (Therms)
CHP Generator	The Sage College	Indefinite (1 day)	863.3	Other - please specify (Therms)
CHP Generator	Congregation Beth Emeth	Indefinite (1 day)	282.3	Other - please specify (Therms)
CHP Generator	Parsons Child & Family Center	Indefinite (1 day)	293.3	Other - please specify (Therms)

Table 4-12. Fuel requirements

4.5 For each facility the microgrid would serve, describe its current backup generation capabilities, if any, by providing the following information:
· Fuel/energy source of each existing backup generator.
· Nameplate capacity of each existing backup generator.
· The percentage of nameplate capacity at which each backup generator is likely to operate during an extended power outage.
· Average daily electricity production (MWh/day) for each generator in the event of a major power outage, and the associated amount of fuel (MMBtu/day) required to generate that electricity.
· Any one-time costs (e.g., labor or contract service costs) associated with connecting and starting each backup generator.
· Any daily costs ($/day) (e.g., maintenance costs) associated with operating each backup generator, excluding fuel costs.
· Given a widespread power outage (i.e., a total loss of power in the surrounding area), describe and estimate the costs of any emergency measures that would be necessary for each facility to maintain operations, preserve property, and/or protect the health and safety of workers, residents, or the general public. Please include costs for one-time measures (e.g., total costs for connecting backup power) and any ongoing measures (expressed in terms of average costs per day). Specify these costs for two scenarios: (1) when the facility is operating on backup power, if applicable, and (2) when backup power is not available.

Please see Tables 4-13 through 4-15.

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		
Capital District Psychiatric Center	Unit 1	Diesel	1.75	100	42.0	403	MMBtu/ Day	$0	$800
Capital District Psychiatric Center	Unit 2	Diesel	0.5	50	6.0	62	MMBtu/ Day	$0	$200
NYS OMH	Unit 1	Diesel	0.85	100	20.4	170	MMBtu/ Day	$0	$400
Albany Law School	Unit 1	Diesel	0.40	50	5.0	50	MMBtu/ Day	$0	$150
Albany College of Pharmacy	Unit 1	Natural Gas	0.025	100	0.6	9	MMBtu/ Day	$0	$10
Albany College of Pharmacy	Unit 2	Diesel	0.25	100	6	60	MMBtu/ Day	$0	$100
Albany College of Pharmacy	Unit 3	Natural Gas	.125	100	3	36	MMBtu/ Day	$0	$50
Albany College of Pharmacy	Unit 4	Diesel	.150	100	3.6	33	MMBtu/ Day	$0	$50
Albany College of Pharmacy	Unit 5	Natural Gas	.060	100	1.4	20	MMBtu/ Day	$0	$20
Albany College of Pharmacy	Unit 6	Diesel	.3	100	7.2	70	MMBtu/ Day	$0	$125
Albany College of Pharmacy	Unit 7	Natural Gas	0.011	100	.26	4.5	MMBtu/ Day	$0	$5
Parsons	Unit 1	Natural Gas	.038	100	.91	15	MMBtu/ Day	$0	$5
Parsons	Unit 2	Natural Gas	.038	100	.91	15	MMBtu/ Day	$0	$5

Table 4-13. Existing Standby Generation config and costs

The cost of maintaining service while operating on backup power will consist of planned maintenance (O&M) and fuel. Existing standby generators are in working order and hooked up. Incremental heating units are ot required by facilities if they continue to receive electric service. See tables below for costs of importing standby generators on a temporary basis to serve facilities who do not have standby generators.

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
Gallery at Holland	One-Time Measures	125 kW generator transpo & hookup	1500	$	Year-round, 24/7
Gallery at Holland	Ongoing Measures	125 kW generator rental per week (triple shift)	1800	$	Year Round, 24/7
Gallery at Holland	Ongoing Measures	125kW diesel fuel per day	550	$	Year Round, 24/7
Towneplace Suites	One-Time Measures	125 kW generator transpo & hookup	1500	$	Year Round, 24/7
Towneplace Suites	Ongoing Measures	125 kW generator rental per week (triple shift)	1800	$	Year Round, 24/7
Towneplace Suites	Ongoing Measures	125 kW diesel fuel per day	550	$	Year Round, 24/7
Cong Beth Emeth	One-Time Measures	60 kW generator transpo & hookup	1500	$	Year Round, 24/7
Cong Beth Emeth	Ongoing Measures	60 kW generator rental per week (single shift)	500	$	Year Round, 24/7
Cong Beth Emeth	Ongoing Measures	60 kW diesel fuel per day	100	$	Year Round, 24/7
Sage College	One-Time Measures	300 kW generator transpo & hookup	1500	$	Year Round, 24/7
Sage College	Ongoing Measures	300 kW generator rental per week (triple shift)	2800	$	Year Round, 24/7
Sage College	Ongoing Measures	300 kW diesel fuel per day	1110	$	Year Round, 24/7

Table 4-14. Costs to mobilize portable standby generation

We would not expect facilities to lose a level of service should they have standby generation in effect. Residences, hotels, and group housing would have to remain open with diminished quality of life in the absence of HVAC. Colleges, hospitals, and office buildings must close if there is no power available. M Wagner from Aggreko provided quotes, however, he urged us to keep in mind that costs could escalate substantially if the power cut was wide-spread and they had to bring units from further in the US.

Facility Name	Percent Loss in Services When Backup Gen. is Not Available
Capital District Psychiatric Center	100%
NYS OMH	100%
Albany Law School	100%
Albany College of Pharmacy	100%
Parsons	100%
Sage College	100%
Gallery at Holland	50%
TownePlace Suites	90%
Cong Beth Emeth	50%

Table 4-15. Loss of service during power-cut

Appendix A - Benefit-Cost Analysis Summary Report

Site 50 – City of Albany (University Heights)

PROJECT OVERVIEW

As part of NYSERDA's NY Prize community microgrid competition, the City of Albany has proposed development of a microgrid that would serve several major facilities in the University Heights neighborhood, which has seen recent load growth. The University Heights region features a variety of commercial, educational, and medical facilities clustered in a roughly one-square-mile area bounded by Academy Road, Holland Boulevard, and Lake, Myrtle and Holland Avenues. Specifically, the proposed microgrid would support the following facilities:

- The Capital District Psychiatric Center, a mental health facility caring for roughly 500 individuals on an inpatient and outpatient basis;
- Several academic institutions, including Sage College of Albany, the Albany College of Pharmacy, and the Albany School of Law;
- TownePlace Suites, a hotel;
- Congregation Beth Emeth, a synagogue;
- The Parsons Child and Family Center, a multi-services agency providing counseling, education, and mental health services;
- The New York State Office of Mental Health, a large government office building; and
- The Gallery on Holland, an apartment complex with 126 units.

The microgrid would combine CHP and solar capabilities to provide base load power. Seven natural gas CHP units would be distributed among the participating facilities, and would range in capacity from 0.1 MW (at Parsons and Congregation Beth Emeth) to 1.0 MW (at the Capital District Psychiatric Center). Solar capability would supplement the microgrid, with PV equipment distributed among the facilities. The solar installations would add 0.6 MW of capacity to the microgrid.

METHODOLOGY AND ASSUMPTIONS

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

Costs represent the value of resources consumed (or benefits forgone) in the production of a good or service.

Benefits are impacts that have value to a firm, a household, or society in general.

Net benefits are the difference between a project's benefits and costs.

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

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

The BCA model is structured to analyze a project's costs and benefits over a 20-year operating period. The model applies conventional discounting techniques to calculate the present value of costs and benefits, employing an annual discount rate that the user specifies – in this case, seven percent.[1] It also calculates an annualized estimate of costs and benefits based on the anticipated engineering lifespan of the system's equipment. Once a project's cumulative benefits and costs have been adjusted to present values, the model calculates both the project's net benefits and the ratio of project benefits to project costs. The model also calculates the project's internal rate of return, which indicates the discount rate at which the project's costs and benefits would be equal. All monetized results are adjusted for inflation and expressed in 2014 dollars.

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

The BCA considers costs and benefits for two scenarios:

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

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

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

RESULTS

Table 1 summarizes the estimated net benefits, benefit-cost ratios, and internal rates of return for the scenarios described above. The results suggest that if no major power outages occur over the microgrid's assumed 20-year operating life, 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 exceed approximately 2.6 days per year (Scenario 2). The discussion that follows provides additional detail on the findings for these two scenarios.

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: 2.6 DAYS/YEAR
Net Benefits - Present Value	-$24,300,000	$858,000
Benefit-Cost Ratio	0.7	1.0
Internal Rate of Return	N/A	8.1%

Scenario 1

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

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

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

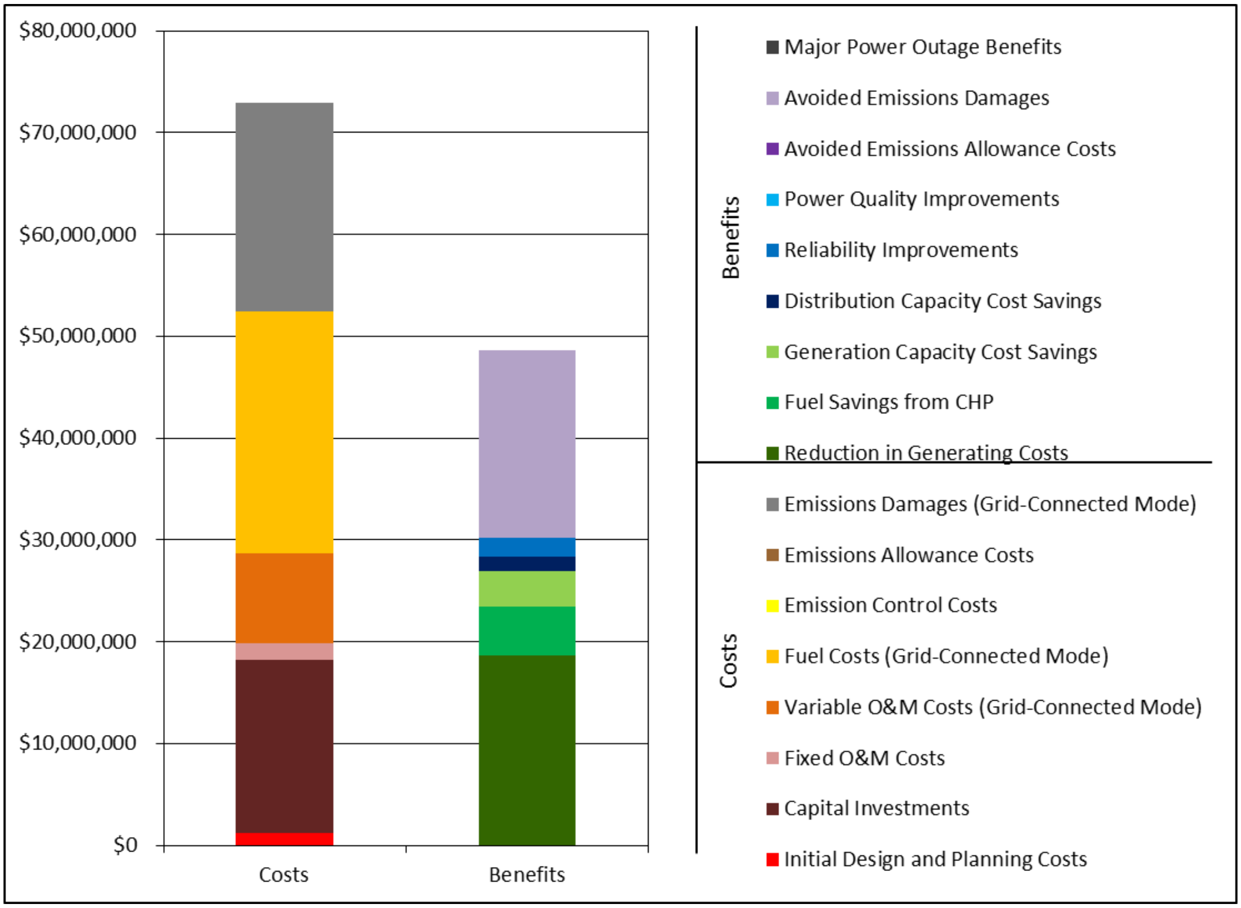


Table 2. Detailed BCA Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
	Costs	
Initial Design and Planning	$1,270,000	$112,000
Capital Investments	$16,900,000	$1,490,000
Fixed O&M	$1,700,000	$150,000
Variable O&M (Grid-Connected Mode)	$8,830,000	$779,000
Fuel (Grid-Connected Mode)	$23,700,000	$2,090,000
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$20,500,000	$1,340,000
Total Costs	**$73,000,000**	
	Benefits	
Reduction in Generating Costs	$18,600,000	$1,640,000

Fuel Savings from CHP	$4,840,000	$427,000
Generation Capacity Cost Savings	$3,480,000	$307,000
Distribution Capacity Cost Savings	$1,400,000	$124,000
Reliability Improvements	$1,890,000	$166,000
Power Quality Improvements	$0	$0
Avoided Emissions Allowance Costs	$9,660	$852
Avoided Emissions Damages	$18,400,000	$1,200,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$48,600,000**	
Net Benefits	**-$24,300,000**	
Benefit/Cost Ratio	**0.7**	
Internal Rate of Return	**N/A**	

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 $1.3 million. The present value of the project's capital costs is estimated at approximately $16.9 million. These costs are dominated by the seven CHP units that would supply the majority of the microgrid's production; these units have a combined capacity of 3.3 MW and account for roughly 60 percent of all capital costs. Other major capital cost elements include the absorption chillers for the CHP systems (which allow conversion of hot water for summertime cooling applications); the purchase of PV equipment; and the distribution and communications equipment.

The present value of the microgrid's fixed operations and maintenance (O&M) costs (i.e., O&M costs that do not vary with the amount of energy produced) is estimated at $1.7 million, or $150,000 annually.

Variable Costs

The most significant variable cost associated with the proposed project is the cost of natural gas for the CHP units. To characterize these costs, the BCA relies on estimates of fuel consumption provided by the project team and projections of fuel costs from New York's 2015 State Energy Plan (SEP), adjusted to reflect recent market prices.[3] The present value of the project's fuel costs over a 20-year operating period is estimated to be approximately $23.7 million.

The BCA also considers the project team's best estimate of the microgrid's variable O&M costs (i.e., O&M costs that vary with the amount of energy produced). The present value of these costs is estimated at $8.8 million.

In addition, the analysis of variable costs considers the environmental damages associated with pollutant emissions from the distributed energy resources that serve the microgrid, based on the operating

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

scenario and emissions rates provided by the project team and the understanding that none of the system's generators would be subject to emissions allowance requirements. In this case, the damages attributable to emissions from the microgrid's fuel-based generators are estimated at approximately $1.3 million annually. These damages are primarily attributable to the emission of CO_2. Over a 20-year operating period, the present value of emissions damages is estimated at approximately $20.5 million.

Avoided Costs

The development and operation of a microgrid may avoid or reduce a number of costs that otherwise would be incurred. These include generating cost savings resulting from a reduction in demand for electricity from bulk energy suppliers. The BCA estimates the present value of these savings over a 20-year operating period to be approximately $18.6 million. Cost savings would also result from fuel savings due to the combined heat and power systems. The BCA estimates the present value of fuel savings over the 20-year operating period to be approximately $4.8 million. These reductions in demand for electricity from bulk energy suppliers and heating fuel would also avoid emissions of CO_2, SO_2, NO_x, and particulate matter, yielding emissions allowance cost savings with a present value of approximately $9,660 and avoided emissions damages with a present value of approximately $18.4 million.[4]

In addition to the savings noted above, development of a microgrid could yield cost savings by avoiding or deferring the need to invest in expansion of the conventional grid's energy generation or distribution capacity.[5] The analysis estimates the impact on available generating capacity to be approximately 3.4 MW per year, based primarily on estimates of output from the new CHP units.[6] In addition, the project team expects development of the microgrid to reduce the conventional grid's demand for generating capacity by an additional 0.71 MW as a result of new demand response capabilities. Based on these figures, the BCA estimates the present value of the project's generating capacity benefits to be approximately $3.5 million over a 20-year operating period. The present value of the project's potential distribution capacity benefits is estimated to be approximately $1.4 million.

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 $166,000 per year, with a present value of $1.9 million over a 20-year operating period. This estimate is calculated

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

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

[6] The capacity availability figure assumes a capacity factor of 15 percent for the solar arrays, a figure consistent with the project team's analysis of average annual energy production.

using the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator, and is based on the following indicators of the likelihood and average duration of outages in the service area:[7]

System Average Interruption Frequency Index (SAIFI) – 0.96 events per year.

Customer Average Interruption Duration Index (CAIDI) – 116.4 minutes.[8]

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

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

Summary

The analysis of Scenario 1 yields a benefit/cost ratio of 0.7; i.e., the estimate of project benefits is about 70 percent 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

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

[7] www.icecalculator.com.
[8] SAIFI and CAIDI values were provided by the project team for National Grid.
[9] http://www.businessweek.com/articles/2012-12-04/how-to-keep-a-generator-running-when-you-lose-power#p1.

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

As noted above, the microgrid project would serve a variety of medical, educational, and other facilities. The project's consultants indicate that several of the facilities – the Capital District Psychiatric Center, the College of Pharmacy, Albany Law School, the Parson's Center, and the NYS Office of Mental Health – all have either natural gas or diesel generators present onsite. These generators provide sufficient power to ensure that no service loss occurs when they are in use. For the remaining facilities – the Gallery at Holland, TownePlace Suites, Congregation Beth Emeth, and Sage College – the project team indicates that rental of emergency generators would be necessary in the event of a major outage. In the absence of backup power – i.e., if existing or rental backup generators failed and no replacement was available – most of the facilities would experience a total loss in service capabilities. The exceptions include the apartments and synagogue, which would maintain approximately half of their services, and the hotel, which could maintain ten percent of its services.

For the Albany microgrid, the primary economic consequences of a major power outage depend on the value of the services the facilities of interest provide. For all the non-residential facilities, the analysis values a loss of service based on an estimate of the cost of power interruption at large commercial and industrial facilities using the Department of Energy's ICE Calculator. For the residential facility (the Gallery on Holland apartment complex), the analysis assumes that residents left without power incur social welfare losses. Consistent with the information provided by the project team, the analysis assumes that all facilities require a full 24 hours of service per day.

Based on the estimated value of service as well as the backup power capabilities and operational features of the facilities, the analysis estimates that in the absence of a microgrid, the average cost of an outage is approximately $859,000 per day.

Summary

Figure 2 and Table 3 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 2.6 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.

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

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

Figure 2. Present Value Results, Scenario 2 (Major Power Outages Averaging 2.6 Days/Year; 7 Percent Discount Rate)

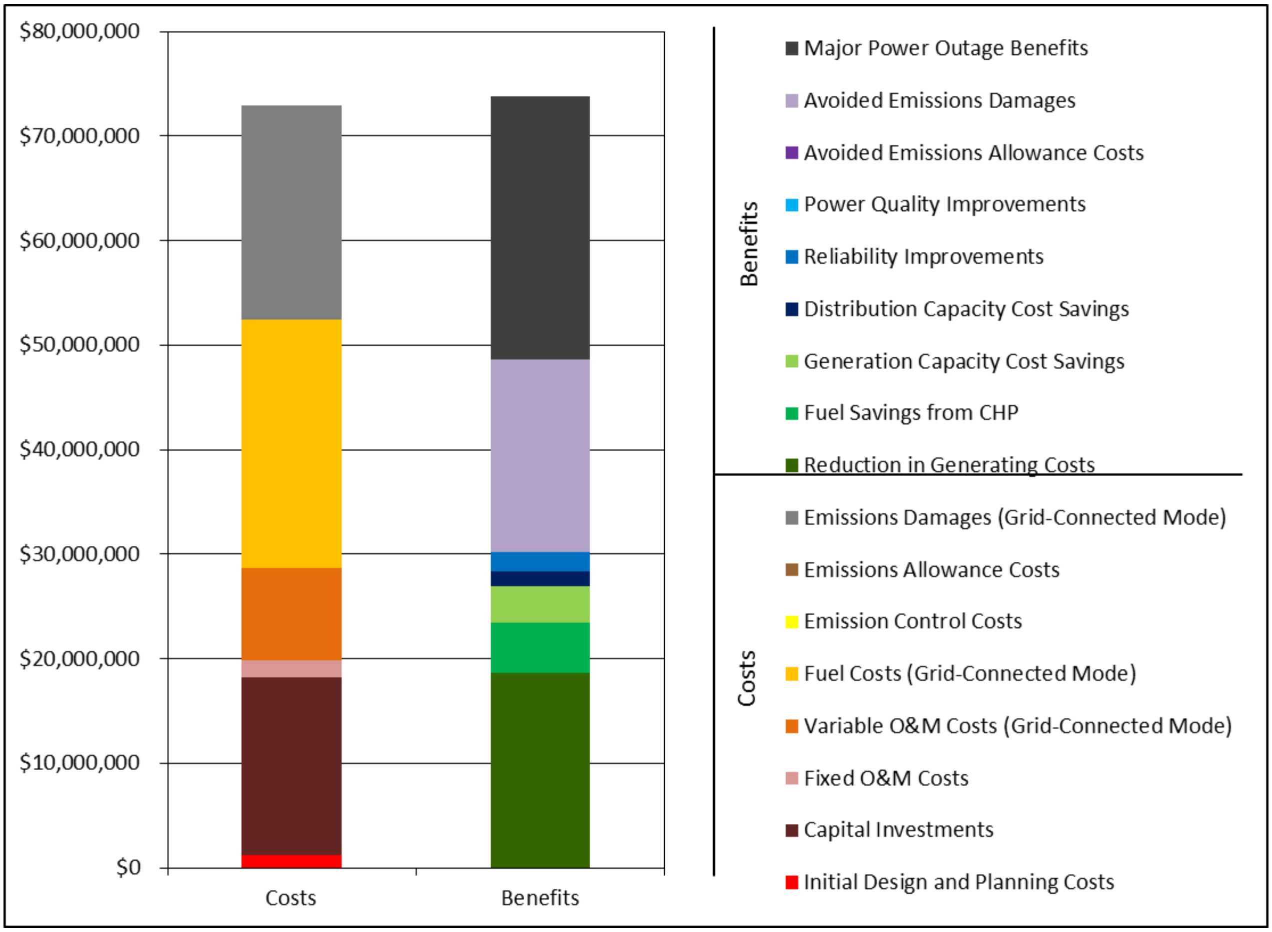

Table 3. Detailed BCA Results, Scenario 2 (Major Power Outages Averaging 2.6 Days/Year; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$1,270,000	$112,000
Capital Investments	$16,900,000	$1,490,000
Fixed O&M	$1,700,000	$150,000
Variable O&M (Grid-Connected Mode)	$8,830,000	$779,000
Fuel (Grid-Connected Mode)	$23,700,000	$2,090,000
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$20,500,000	$1,340,000
Total Costs	**$73,000,000**	
Benefits		
Reduction in Generating Costs	$18,600,000	$1,640,000
Fuel Savings from CHP	$4,840,000	$427,000
Generation Capacity Cost Savings	$3,480,000	$307,000
Distribution Capacity Cost Savings	$1,400,000	$124,000
Reliability Improvements	$1,890,000	$166,000
Power Quality Improvements	$0	$0
Avoided Emissions Allowance Costs	$9,660	$852
Avoided Emissions Damages	$18,400,000	$1,200,000
Major Power Outage Benefits	$25,200,000	$2,220,000
Total Benefits	**$73,800,000**	
Net Benefits	**$858,000**	
Benefit/Cost Ratio	**1.0**	
Internal Rate of Return	**8.1%**	

Appendix B – Resumes

Allen Power Inc

JASON S. ALLEN

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EDUCATION

Masters Business Administration 2003
Union College/College of St. Rose
Schenectady/Albany, New York

BS Environmental Engineering 1994
United States Military Academy
West Point, New York

EXPERIENCE

11/13- Present – Founder & Director, Allen Power Inc
4/99-11/13 - General Electric Company
5/94-4/99 - Officer, Field Artillery, United States Army

11/13-Present: Director, Allen Power Consulting Inc: Founded Allen Power Inc in 2013 with the mission of identifying opportunities and providing on-site electric and heat generation resources as a service for industrial and commercial sites. Also available to provide project management, project engineering, and product management consulting services based on my over 14 years of OEM cross-functional leadership experience.

- Executed a commercial and technical feasibility study for implementing a 1MW CHP project at AMRI, Rensselaer.
- Successfully launched a NYSERDA funded feasibility study for University Heights, Albany towards implementing a microgrid across nine institutional and commercial end-users. Project is over 80% complete and integrates the engineering work of two firms.
- Provided New Product Introduction process as well as initial product specifications and product requirements document to a power generation technology customer with "nine-figure" investment. Client successfully executed a "Tollgate 1" New Product Introduction launch utilizing my guidelines.
- Leveraged my network to liaise with multiple New York State agencies to navigate through regulatory ambiguity concerning cogen and microgrid applications in certain industrial and commercial applications.
- Currently in active discussions with several customers to launch feasibility studies for industrial, commercial office, and institutional applications.

06/11-11/13: Manager, Project Engineering: Manage GE Power & Water's Global Projects Organization's 28 Project Engineers and Coordinators based in the US and Dubai driving engineering execution for approximately 30 combined and simple cycle thermal projects around the world.

- Implemented "Sharpen the Pencil" process across the team as a basis to reconcile to-go budgets with scope and assumptions ensuring the PM and PE are tied off and excess budgets returned to team reserve.

- Team managed ~$40MM of engineering budgets in 2012 & 2013; almost $4MM savings returned to Project Management.
- Implemented the "Launch Well" process across the team and several projects standardizing a weekly review scheme with PEs and engineering management at launch to ensure the PE understands budget, scope, schedule, and risk.
- Coordinated process updates to ensure the engineering team signed-off on review of the customer and consortium contracts highlighting risks.
- Made tough personnel decisions to ensure the appropriate PE was assigned to projects and team resourced appropriately.
- Brought over $300k in project savings to the business in 2013 by changing document management process.
- Resource and drive technical issue resolution for active and warranty projects.

12/09-06/11: 1-2MW Wind Turbine Product Manager: Define and manage the multi-generational product plan for GE's multi-billion dollar 1.5MW wind turbine product series and lead a team of three direct report product managers who are responsible for managing four product lines in different stages of the product life-cycle as well as a multi-million dollar new product introduction engineering budget.

- Led the specification and launch of the 1.6-100, a new product to re-establish our competitive leadership position in our main market segment in 2010 which has since received billions in sales. Received the business' approval to quote within four months of launching the program with a prototype erected six months later.
- Plan and manage the commercialization plan for this new product to include global cost targets, pricing, segmentation, customer and independent engineer communications, demand and supply line reconciliation, product validation and approval to ship dates.
- Ensured program management rigor and met all commercialization baseline milestones on an aggressive 18-month program 'launch-to-serial-production' schedule.
- Led the specification and launch of GE's new wind turbine product subsequent to the 1.6-100.
- Ensure products shipping in 2010 and 2011 are properly validated with cross-functional deliverables, to include engineering, global supply chain, project management, and services.
- Developed a new paradigm for a market view based on product cost-drivers in order to optimize product specifications.
- Led the business to identify an underserved market segment and developed the appropriate strategy to define turbine requirements which will win in that space.
- Met with and led sessions with multiple key customer CEO/VPs to introduce new products and familiarize them with the product line strategy.

9/07-12/09: 1.5MW Wind Turbine NPI Program Manager: Drive processes in multi-billion dollar business ensuring cross-functional transparency, communications, and decisions as well as managing complex new product introduction programs from inception through commercialization.

- Leader of the business' largest and most complex new technology and product introduction programs, managing cross-functional planning, budget, schedule, risk and fulfillment reviews.
- Led regular sessions with beta-customer, to include their VP of Wind Operations, during the one year reliability growth and evaluation period of beta site.

- Led cross-functional team to commercialize multiple new technology programs, each driving several hundred percent IRR or increasing value at little cost preserving backlog.
- Led program initiatives to define multi-generational product planning and identify a subsequent option upgrade pipeline.
- Attend industry events, to include AWEA Wind Power, growing network and actively participate in private customer strategy sessions with VP of Renewables and CEO/VPs of IPPs and utilities.
- Drove and implemented initiative to standardize cross-functional product change control across multiple change agents bringing business visibility to change pipeline as well as appropriate coordination and planning rigor.

5/06-9/07: Program Manager: Selected by the General Manager, Hydro, to lead initiatives to drive improvements in the business.

- Developed and drove process for: business budget, estimate at completion (EAC) accountability, and design changes during project lifecycle to improve proactive mitigation as well as EAC accuracy.
- Improved and presented weekly cost of quality and margin erosion drivers by function and root cause, weekly to business leadership.

12/05-5/06: Consortium Manager: Selected by Director, Hydro Projects, to lead Grand Coulee Runner Replacement Consortium

- GE lead with VA Tech USA providing installation and VA Tech Linz providing some supply scope.
- Resourced and led team to relieve project of several million dollars of performance LD risk and provided first integrated consortium P3 schedule to client.
- The fifth Consortium Manager, I was credited by leadership as turning the project around and trained successor to lead Consortium through completion in 2011.

7/04-12/05: Project Management Leadership Program: Nominated by higher management, with CEO approval, as one of only nineteen employees in GE Energy worldwide to kick off this program to train and prepare employees to become project managers.

- Completed Project Finance, Commercial Ops, Contract Management, and Engineering rotations.
- Organized and tested Finance processes within Projects to kick-off Sarbanes-Oxley auditing earning commendation from Corporate Audit Staff and management award.
- Organized and presented global resource loading model outputs to the GM of Global Projects.
- Developed costs, technical proposals for four thermal power plant projects.
- Led a small team to successfully develop a response to an insurance company over their refusal to honor the Company's $3MM claim earning a management award.

12/02-7/04: Production Leader: Schedule, plan, and resource in-process tests for GE Generator and Steam Turbine manufacturing.

- In first month, decreased manufacturing balance cycle on rotating high speed balance tests by 20%.
- Developed headcount and scheduling modeling for department. Dropped hourly headcount over 10% and overtime 48% from 1Q to 2Q 2003.
- Schedule and resource the generator test stand, steam turbine and generator rotor high speed balance test bunkers and in-process tests across six different departments.

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10/00-12/02: Quality Engineer: Responsible for the Generator Stator Manufacturing quality program.

- Responsible for communicating quality trends and corrective actions to these inspectors and over 100 hourly workers in order to prevent defect recurrence utilizing Six Sigma quality tools.
- Use Six Sigma tools to analyze quality trends and brief upper management on process projects undertaken to prevent negative recurrences.
- Interface with the utility customer during manufacturing witness points and respond to concerns regarding quality dispositions that may arise.
- Responsible for the quality of almost 200 generator stators (200-500 MW each).

4/99-10/00: Methods Engineer: Responsible for the manufacturing process and tooling in the Generator Rotor Wind Center.

- Planned, specified, and purchased equipment worth over $500K in investment to increase manufacturing capacity by 50% for increased line rate.
- Recommended alternative plan to expand the shop's line-rate saving the business in excess of $3MM earning management award and closed seven projects resulting in $900K of cost savings.
- Designated representative to coordinate quality plan with Japanese outsourcing company.

6/94-4/99: Officer, U.S. Army: Plt Ldr, Ops Officer, and Fire Support Officer.

- At one time responsible for over 50 soldiers and equipment worth over seven million dollars.
- Earned Army Commendation Medal for synchronizing and supervising the no-notice contingency deployment of battery to Kuwait for Operation Desert Thunder in 1998.
- Instilled focus and teamwork in staff resulting in "Best Battery Training Room" (of 18) in Division Artillery accolades during command inspection for the first time in at least four years.
- Cited on report as "The most tactically and technically proficient platoon leader" in the battery (of 5).
- "Best Arms Room and Security Program in Division Artillery" (of 18) during command inspection.

Additional Information: Proficient in MS Office Suite. GE Six Sigma (Green Belt) certified. Working knowledge of the Greek language. Basic Spanish. Have served on the following Boards: City of Albany Citizens' Police Review Board (Chair), Empire State Youth Orchestra, and West Point Society of the Capital Region.

GE Energy Consulting

LAVELLE A. FREEMAN

Manager, Transmission & Distribution
Energy Consulting
GE Energy Management

EDUCATION

M.S.Cp.E., North Carolina State University, 1997
M.S.E.E., University of North Carolina, Charlotte, 1995
B.S.E.E., University of Alabama, 1992

EXPERIENCE

Mr. Freeman joined GE EC in 2003 as a Senior Engineer with expertise in distribution planning and engineering, and quickly expanded his scope of responsibilities to include power systems operation, renewables integration, and grid modernization. In his current role as Manager of Transmission and Distribution in GE Energy's Energy Consulting group, he is responsible for directing a broad spectrum of client activities in the Teaching and Design space, with emphasis on power systems operation and planning, equipment application, renewables impact, and systems analysis.

For the past five years he has served as Program Manager for DSTAR (Distribution Systems Testing Application and Research), a consortium of U.S. utilities funding R&D projects of common interest (www.dstar.org).

Prior to joining GE, Mr. Freeman was a Senior Consulting Engineer for the utility consulting group of ABB, Inc.. In this capacity, he consulted to perform studies in distribution and transmission planning for utility customers; worked with customers to improve system reliability; and developed and supported software applications for improving efficiency, marketability, and value. As an R&D Engineer for ABB Power T&D Company, Inc., he executed many projects, including: developing and testing a new relay algorithm for double-circuit line protection; developing processes and tools for implementing predictive reliability maintenance strategies; and designing and implementing a knowledge–based system for conceptual substation design. In 1992 Mr. Freeman joined Matsushita Electric Industrial, Ltd. as a production engineer where he executed several successful projects to improve plant production capability, increase reliability, and improve the quality of the plant power supply..

AFFILIATIONS

Mr. Freeman is a registered Intern Engineer in North Carolina, a member of the Institute of Electrical and Electronics Engineers, and a member of Tau Beta Pi and Eta Kappa Nu. He has authored over 25 technical papers on power system planning, computer applications, and renewable energy integration, and holds a patent and an invention disclosure.

BAHMAN DARYANIAN
Technical Director
Energy Consulting Group, Grid Solutions, GE Energy Connections

EDUCATION

B.S., Mechanical Engineering, MIT, 1977
M.S., Mechanical Engineering, MIT, 1980
M.S., Technology & Policy Program, MIT, 1986
Ph.D., Mechanical Engineering, MIT, 1989

EXPERIENCE

Dr. Daryanian joined GE Energy Consulting in 2010 as a Technical Director, focusing on Power Economics (electricity market modeling, asset valuation, and renewable integration studies), and Smart Power (smart grid, microgrids, and demand response). His current responsibilities include managing CanWEA Pan Canadian Wind Integration Study (PCWIS), NYSERDA/National Grid Potsdam Microgrid Feasibility Study, and a number of NY Prize Microgrid Feasibility Studies. He is a principal instructor of two GE PSEC courses: (a) Demand Response & Dynamic Pricing, and (b) Distributed Energy Resources, Microgrids, Energy Storage, and Electric Vehicles.
Dr. Daryanian was a principal team member of the NYSERDA 5-Site feasibility study on Microgrids for Critical Facility Resiliency in New York State. His other completed projects include the PJM Renewable Integration Study (PRIS), a review of best practices for the customer-side of smart grid for China Electric Energy Research Institute (CEPRI), and performing a Zero-Net-Energy study for a UC Davis residential/commercial community development.
Prior to GE, he was an energy consultant at R. W. Beck (Now, Leidos/SAIC), PA Consulting Group, PHB Hagler Bailly, and Tabors Caramanis & Associates.
In mid 1990s, Dr. Daryanian was a USAID Resident Advisor on the Russian electricity market restructuring in Moscow, Russia, and a USAID Advisor to the Ukraine Energy Commission in Kiev, Ukraine. In early 1990s Dr. Daryanian performed one of the earliest multi-client studies of storage type demand response under real time pricing, jointly supported by NYSERDA, EPRI, Consolidated Edison, and NYSEG.

AFFILIATIONS/PUBLICATIONS/AWARDS

Dr. Daryanian is a member of ASME, CIGRE, IAEE/USAEE, IEEE, INFORMS, and Sigma Xi. Dr. Daryanian has published refereed articles in IEEE, CIGRE, ASHRAE, and other industry publications.
Dr. Daryanian was a recipient of the 2014 Annual Achievement Awards of the Utility Variable-Generation Integration Group (UVIG) for his work on the PJM Renewable Integration Study (PRIS).
He was also a recipient of the 2016 Annual Achievement Awards of the Utility Variable-Generation Integration Group (UVIG) for his work on the Pan-Canadian Wind Integration Study (PCWIS).

JOSHUA C. HAMBRICK

Principal, Distribution Planning and Engineering
GE Energy Consulting

EDUCATION

Ph.D., EE Virginia Tech, 2010
M.S.E.E., Virginia Tech, 2006
B.S.E.E., Virginia Tech, 2000

EXPERIENCE

Dr. Hambrick joined GE Energy Consulting in 2015 as a Principal with expertise in distribution modeling and simulation. His primary focus areas include modeling and simulation of distribution systems and microgrids and design and analysis of systems with high penetrations of distributed resources.

Dr. Hambrick has research experience (8 years) as well as field service experience (4 years). Prior to joining GE, Dr. Hambrick was a Senior Engineer for Electrical Distribution Design. In this capacity, he managed research and development projects related to high penetrations of distributed renewable resources and distributed power flow devices on transmission systems. He also developed custom planning, analysis and optimization tools for various distribution and transmission scenarios. At the National Renewable Energy Laboratory, Dr. Hambrick lead a number of projects related to modeling and simulation of high penetrations of PV. He developed co-simulation techniques for distribution modeling software and real-time, power hardware-in-loop simulators. He also worked on task forces to guide DOE research and development and standards development working groups related to distributed generation interconnection, distributed generation impact studies, and smart grid interoperability. As a field service engineer for Siemens, Dr. Hambrick was responsible for testing and commissioning excitation systems and power system stabilizers.

AFFILIATIONS

Dr. Hambrick is a registered engineering intern in Virginia, and a member of the Institute of Electrical and Electronics Engineers Power and Energy Society and Standards Association. He has published a number of articles and technical reports on distributed generation, renewable integration, and distribution automation.

SURESH GAUTAM

Senior Engineer, Power Systems Operations & Planning
Energy Consulting
GE Energy Management

EDUCATION

Ph.D., New Mexico State University, 2012
M.S.E.E., New Mexico State University, 2010
M.S.E.E., Trubhuvan University, Nepal, 2008

EXPERIENCE

Dr. Gautam joined GE's Energy Consulting group in 2013. His principle areas of responsibility include power distributions systems, microgrids, contract studies, and research projects for utility, industrial, and GE-client businesses. Three of the most recently completed projects are: a GE Digital Energy project, developing a tool to estimate potential benefits of implementing distribution automation (DA) solutions (DMS, OMS, ADMS), where Dr. Gautam was responsible for mapping benefits of DA solutions to prototype distribution system circuits, performing simulations for various stages of DA implementation and determining their impact on the reliability of the system; a set of ten New York Prize microgrid feasibility study projects spread around various part of New York State, where Dr. Gautam was responsible for design and cost estimate of electrical infrastructure, and an ongoing microgrid project at Potsdam village of New York, where Dr. Gautam's responsibility is similar to New York Prize projects but in much more details.

Dr. Gautam has both utility experience (3 years) and research experience (5 years). During his work as an electrical engineer at Nepal's Electricity Authority, he performed interconnection studies for new transmission line and generating stations; he supervised several distribution system projects specifically designed for rural electric cooperatives (RECs). During his Ph.D. study at New Mexico State University, Dr. Gautam developed algorithms for an out-of-step blocking function in transmission line-protection, and the application of high-impedance fault detection in distribution systems. He also performed electromagnetic transients program (EMTP) studies and modeled inverter-based distributed generators (DG) for short-circuit and transient studies.

AFFILIATIONS

Dr. Gautam is a member of IEEE, the IEEE Smart Grid Community and the IEEE PES Distribution Subcommittee, and has published several research articles in IEEE and IET journals and conference proceedings. He is also an engineer intern in the State of New Mexico.

SLOBODAN MATIC
Senior Engineer, Power System Operation and Planning
Energy Consulting, USA
GE Energy Management

EDUCATION

Ph.D., Electrical Engineering & Computer Sciences, University of California Berkeley, 2008
B.S., Electrical Engineering, University of Belgrade, 2001

EXPERIENCE

Mr. Matic joined GE Energy Consulting in 2012 after doing postdoctoral research in cyber-physical systems at the University of California, Berkeley. His expertise encompasses: the area of distributed, real-time control systems; model-based design for safety-critical systems; and smart grid computing/communication platforms. He has contributed to various GE projects, including astudy on dynamic boundary of high PV penetration in distribution power systems, as well as several PV inverter stability studies. He has also participated in the effort to design and deploy controls for solar plants that can be integrated with energy storage.

At UC Berkeley Mr. Matic was affiliated with the Center for Hybrid and Embedded Software Systems where he was the principal researcher in the Programming Temporally Integrated Distributed Embedded Systems PTIDES project. His work concentrated on programming and networking methodologies for distributed control systems. Specifically, the PTIDES workflow addresses modeling, implementation and analysis of cyber-physical systems including the applications in energy and power systems.

AFFILIATIONS

IEEE, Senior Member

PUBLICATIONS / AWARDS

In 2010 Mr. Matic completed Green Technology Entrepreneurship Academy at University of California, Davis. In 2011 Mr. Matic took part in the Siemens Smart Grid Innovation Contest. His idea, titled “Integrated Architecture for Distribution Automation”, reached the finals and placed third.

STEVEN OLTMANNS
Principal Consultant
Energy Consulting - Power Economics
GE Energy Management

EDUCATION

M.S., Resource Economics, University of Maine
B.S., Natural Resources, University of Maine

EXPERIENCE

Mr. Oltmanns joined GE in 2008. He brings more than 30 years of power industry analytical experience in competitive and regulated markets to his current role, Principal Consultant with GE Energy Consulting Power Economics. Mr. Oltmanns directs the use of detailed market models for the energy industry in support of delivering customer solutions, evaluating impacts of structural changes in wholesale power markets, and evaluating investment opportunities for GE clients and GE businesses (Commercial Finance, Global Project Development).

The many educational seminars and training programs taught by Mr. Oltmanns over the course of his career include topics such as: competitive and regulated market structures; economic theory and analysis techniques; wholesale and retail pricing and structuring, advanced industry planning and analytical software applications; and current industry topics such renewable energy resources and environmental regulation impact analysis.

Prior joining GE Mr. Oltmanns was the Director of Analysis for Reliant Energy's Regulatory Strategy and Advocacy Group in Houston, Texas, where his responsibilities included conducting non-routine, economic, financial and statistical analysis in support of the company's legislative and regulatory advocacy in regulated and restructured retail markets. Other positions held by Mr. Oltmanns at Reliant Energy included: management of retail pricing and structure support for the company's North American competitive retail power business. Mr. Oltmanns' industry experience includes integrated power systems planning and analysis with EDS Utilities Division and Central Maine Power Company, retail rates and pricing analysis with the Municipal Electric Authority of Georgia and UNITIL Service Corp., and regulatory analysis with the Massachusetts Energy Facilities Siting Council.

William H. Cristofaro, PE

President/ Lead Mechanical Engineer

Education

Civil/Mechanical Engineering
University of Miami
Miami, Florida 1976
BS/1976

Engineering Technology
Corning Community College
Corning, New York
AS/1972

Professional Affiliations

American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

Automated Procedures for Engineering Consultants – Chairman of Committee for Development of Computer Programs for Design and Analysis of Fluid Systems and Piping Networks (APEC)

American Institute of Plant Engineers (AIPE, AFE)

Association of Energy Engineers (AEE), Senior Member

Clean Low-cost Energy Alternatives Network (CLEAN)

Organizations

Active in providing legal testimony before the NYS Public Service Commission and NYS Legislature regarding utility deregulation and on-site cogeneration.

Publications

"On-Site Cogeneration, New Technologies for Smaller Facilities", December 1994. *Consulting Specifying Engineer*

"Piping Systems Analysis Program", 1993. *APEC Journal*

"CABDS, A System for Integrated Engineering Design, 1992. *HPAC*

"Capitalizing on Cogeneration" (co-authored), March 1994. *Engineered Systems*

Professional Licenses

State	License	1st Reg.
New York	**058648**	**9/30/81**
Connecticut	PEN0017551	2/1/05
District of Columbia	PE904939	6/30/08

ENERGY CONCEPTS

As Senior Partner at Integrated Energy Concepts Engineering, P.C., Mr. Cristofaro is responsible for mechanical engineering with emphasis on energy conservation, energy feasibility studies, cogeneration, HVAC/mechanical design and computer control systems. Mr. Cristofaro's experience and capabilities includes mechanical design for central chiller and boiler plants, cogeneration plants, combined energy plants, a large variety of HVAC systems, small- to large-scale energy studies and extensive energy conservation design, EMS and DDC systems, fire protection systems, plumbing systems and high-tech industrial systems. Mr. Cristofaro has extensive experience with schools and NYSSED requirements, hospitals, health care and NYSDOH requirements, including NYSDOH certificate of need applications. Mr. Cristofaro is also a NYS certified asbestos abatement designer. **A sampling of projects Mr. Cristofaro has been responsible for the mechanical systems designs are as follows:**

- **Health Care Facilities:** Clifton Springs Hospital and Clinic, Geneva General Hospital, St. James Mercy Hospital, St. Jerome Hospital, St. John's Nursing Home, Wartburg SNF, Silvercrest Center SNF, Watchtower SNF, Southside Hospital, South Oaks Hospital/Long Island Home, St. James SNF, Regis SNF, Niagara Rehab Institute, Terrace SNF
- **Schools:** Byron Bergen CSD, Cleveland Hill Schools, Cuba Rushford CSD, Fonda Fultonville CSD, Greece CSD, Lakeland CSD, Marion CSD, Penfield High, Potsdam CSD, Ravena-Coeymans -Selkirk CSD, Rondout Valley CSD, Waterloo CSD
- **Colleges:** Corning Community College, Hobart and William Smith College, St. Peters College
- **Commercial Facilities:** Citizens Communications, Strathallan Hotel, Delta Sonic Carwash, Park 80, Roosevelt Apartments, Oceanside, Hudson Hotel, Canandaigua Wine, Macy's East Brooklyn, Grumman Bethpage, Crestwood Lake Apartments, RedHook Stores, LLC, Bank of New York, Bank of New York Globe Mills Facility, Renaissance Westchester
- **Industrial/Corporate Facilities:** Case-Hoyt Corporation, Eastman Kodak Company, ENBI Manufacturing and US Headquarters Facility, Forest City Ratner Corporation, PC Richards, The Galleries, 4C Foods, Arrow Linen, Hiram G. Andrews, Jonathan Woodner, Sea Crest Linen, Acme Smoked Fish, Colonial Glass and Mirror
- **Municipal:** NYS Energy Office, Greater Rochester International Airport
- **Energy Management Systems (EMS) and Computer Control Systems (DDC):** Corning Community College, Sweethome Central High School, Chemung County Library, Eastern Artificial Insemination Center, ENBI Manufacturing Facility

John M. Bailes

Mechanical Engineer

Education

Mechanical Engineering Technology
Rochester Institute of Technology
Rochester, New York
BS/2007

Professional Affiliations

Mr. Bailes has over seven (7) years of experience in energy conservation and mechanical systems projects. His mechanical design experience includes design for new construction and renovation projects, as well as cost estimating and equipment specification.

Mr. Bailes has extensive experience with energy feasibility studies including on-site cogeneration analysis, industrial process analysis and general energy conservation measures, as well as experience with the New York State Energy and Research and Development Authority (NYSERDA) grant programs and funding opportunities. A sampling of projects and programs Mr. Bailes has been involved in are as follows:

- Health Care Facilities: Clifton Springs Hospital and Clinic, Silvercrest SNF, Wartburg Lutheran Home for the Aging, St. Joachim and Anne Nursing, Regis SNF
- Industrial/Corporate Facilities: Arrow Linen Supply Co., Birdseye Foods, Inc., Twin Marquis, ACME Smoked Fish, Pier 7 – Phoenix Beverages, FDR Services, Ultra Flex Packaging, VBC Industries, Prestige Corp.
- Residential: The Third Brevoort Corp. , The Americana, Winston Towers, Findlay Plaza, Rivera Towers
- Schools: Harley School, Greece Central Schools
- Colleges/Universities: Wagner College
- Other: Ronald McDonald House – NYC, New York Racquet & Tennis Club
- Program Experience: NYSERDA Existing Facilities Program, NYSERDA Multifamily Performance Program, U.S. Department of the Treasury 1603 Program, Energy Cost Savings Program (ECSP), ICIP, New Jersey Commercial & Industrial Programs (P4P, Smart Start, CHP)

ENERGY CONCEPTS

Khaled Fouda

Mechanical Engineer

Education

Mechanical Engineering
United Arab Emirates University
Alain City, UAE
BS/2011

Mechanical Engineering
Rochester Institute of Technology
Rochester, New York
MEng/2014

Mr. Fouda has over four (4) years experience as a Mechanical Engineer, two of those years overseas in the Construction field. Mr. Fouda's experience includes designing HVAC systems, Cogeneration systems, Fire Alarm, Lighting and Low Voltage Power Distribution for New Construction and Renovation Projects. In addition, Mr. Fouda has experience in conducting Energy Feasibility studies for various projects including Microgrid studies and NYSERDA CHP Acceleration Programs as well as Energy Modeling for LEED Certification.

A sampling of projects and programs Mr. Fouda has been involved in are as follows:

- Industrial/Corporate Facilities: Draftkings Co., Cubit Power Systems.
- Residential: The Macedonia Plaza, Fulton South, 54 Canal St., The Lafayette/Aurum Apartments, Vendors Market.
- Cogen: The Crossing at Jamaica Station. Two Trees Williamsburg. Greylock Mill.

ENERGY CONCEPTS

Legal

Michael C. Barnas

10 Linden Road
Albany, New York 12208
+1 518 459 7731
e-mail: michael.c.barnas@gmail.com

TRANSACTION ATTORNEY

DOMESTIC AND CROSS-BORDER TRANSACTIONS
ENGINEERING, PROCUREMENT AND CONSTRUCTION CONTRACTS
ENERGY, RENEWABLE ENERGY AND INFRASTRUCTURE PROJECTS

- More than twenty-five years' experience assessing legal and commercial risks and developing mitigation strategies.
- Structuring and documenting technically complex, large-scale infrastructure projects involving commercial, export credit agency and project-based financing.
- Structuring and documenting contractual joint ventures and consortia.
- Drafting and negotiating long-term service and maintenance agreements.
- Applying legal skills and analytic abilities in support of business objectives.

EDUCATION

J.D., 1978, FORDHAM UNIVERSITY SCHOOL OF LAW, New York, New York

B.A., 1974, COLUMBIA COLLEGE *of* COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK
(English and Comparative Literature)

PRATT INSTITUTE SCHOOL OF ARCHITECTURE, Brooklyn, New York

LICENSES AND AFFILIATIONS

LICENSED ATTORNEY AND COUNSELLOR AT LAW, STATE OF NEW YORK

Member, NEW YORK STATE BAR ASSOCIATION
Business Law Section
International Section

PUBLICATIONS

Contributor, "RECENT DEVELOPMENTS IN PUBLIC UTILITY, COMMUNICATIONS AND TRANSPORTATIONS INDUSTRIES," Section of Public Utility, Communications and Transportation Law, American Bar Association (2010, 2011, 2012 and 2013)

"THE ANSWER, MY FRIEND, IS BLOWING IN THE WIND: WIND POWER --THE RENEWABLE ENERGY," *Proceedings of the Annual Institute of the Rocky Mountain Mineral Law Foundation*, Vol. 50 (2004)

PRESENTATIONS

Panelist, "FROM IDEA TO INNOVATIVE PARTNERSHIP — HOW TO PREPARE FOR SUCCESSFUL RESULTS AND ESTABLISH THE RIGHT MODEL," Annual Meeting of the Licensing Executives Society; San Diego, California, October 2011

"RENEWABLE PORTFOLIO STANDARDS", a segment of "State Incentives for Renewable Energy," a EUCI, Inc. webinar; July 2010

"PROSPEROUS PROJECTS: FROM NEGOTIATION TO COMPLETION WITHOUT DISPUTES", a segment of "Minimising Contractual Risks in Construction Projects," a Marcus Evans seminar; London, England, March 2008

Panelist, TECH VALLEY ENERGY FORUM, New Energy New York; Albany, New York, March 2007

"BUILDING WIN/WIN WIND (OR, WHAT GOES AROUND, COMES AROUND)," Canadian Wind Energy Association; Toronto, Ontario, October 2005

"THE ANSWER, MY FRIEND, IS BLOWING IN THE WIND: WIND POWER -- THE RENEWABLE ENERGY," Annual Institute of the Rocky Mountain Mineral Law Foundation; Aspen, Colorado, June 2004

EXPERIENCE

THE MICHAEL BARNAS LAW FIRM, PLLC

2013 -present **MEMBER**

Albany, New York

Solo practice focusing on commercial law, including energy infrastructure projects and cross-border transactions.

COUCH WHITE, L.L.P.

2013 -2016 **OF COUNSEL**
PARTNER

Albany, New York

Counsel clients involved in domestic and international transactions in the energy and infrastructure space. Couch White's business law practice areas include banking, commercial and corporate law, environmental law, renewable energy, land use, zoning and real estate development, government contracts, labor and employment, litigation, real estate and trusts, estates and business succession planning.

Accomplishments:

- Advised a supplier of construction services and technology regarding transactions in Iraq and Singapore.
- Counselled an EPC contractor in negotiations with a major renewable energy developer.
- Provided opinions of counsel in support of project financings in Kenya and Australia.
- Provide ongoing advice to a startup distributed generation developer.
- Developed and presented client training materials covering basic contract law and antitrust compliance.

General Electric Company

2003-2012 **Senior Counsel – Renewables**
General Counsel – GE Wind Energy

Schenectady, New York

Responsible for the legal affairs of GE's renewable energy business during its growth from a $250 million wind turbine business to a $6 billion+ global wind and solar energy business.

Accomplishments:

- Managed GE's response to ongoing investigations by the United States International Trade Commission regarding wind towers from China and Vietnam and polycrystalline silicon photovoltaic cells from China.
- Represented GE in an ICC arbitration arising from the solar business.
- Negotiated equipment supply and services contracts for Caithness Energy's Shepherd's Flat project, the largest wind farm in North America.
- Managed GE's response to an investigation by the German *Bundeskartellamt* (Cartel Office), resulting in no action taken against GE.
- Supported the development of a 25.2MW offshore wind farm near Arklow, Ireland.
- Led the legal integration of the wind turbine energy development and manufacturing business acquired from Enron into GE.
- Negotiated the restructuring of GE's hydroelectric manufacturing joint venture in Brazil, and managed the disposition of GE's hydro assets in Sweden.

1999-2003 **Counsel - Commercial Operations**

Schenectady, New York

Provided legal and commercial advice to sales and operating managers of a global business with over $7 billion annual turnover. Core member of risk review team, which examined, analyzed and approved all bids and final contracts and reported weekly to senior management. Coordinated regional legal resources to assure timely reviews of all appropriate project documentation. Structured related-company transactions for optimal tax efficiency. Provided counsel to marketing, product line management and risk management teams. Supported individual transactions as required.

Accomplishments:

- Supported the integration of four major acquisitions.
- Led the development of interactive web-based tools to guide account managers in negotiating contract provisions with customers.
- In addition to primary duties, served as general counsel to a subsidiary business which generated $140 million in annual revenues in the water treatment industry.

1989 - 1999 **COUNSEL - AFRICA, INDIA, MIDDLE EAST**
COUNSEL - TRANSACTIONS
COUNSEL - INTERNATIONAL POWER GENERATION SALES

Schenectady, New York

Advised field sales, headquarters support teams and senior management regarding legal and commercial aspects of major power plant transactions. Drafted and negotiated contracts of sale, long-term service and maintenance contracts and other related documents. Structured and documented tax-efficient sourcing, consortium and contractual joint venture arrangements. Monitored emerging policy and legislative developments in assigned regions and assisted in developing business responses. Managed litigation arising from commercial activities as required. Provided counsel with respect to policy compliance and business integrity issues.

Accomplishments:

- Served as interim counsel to the power plant construction business of Nuovo Pignone, S.p.A., a GE subsidiary based in Florence, Italy.
- Negotiated EPC contract package for Phase II of the Dabhol Power Company independent power plant in Maharastra State, India; developed a deal structure which permitted the use of Japan Export-Import Bank credit support.
- Negotiated EPC contract for Riyadh Power Plant No. 9, a $1.4 billion infrastructure project in Saudi Arabia.
- Negotiated EPC contracts for projects in countries including Hungary, the United Kingdom and Uruguay.
- Negotiated consortium agreements with partners from countries including Italy, Japan, Saudi Arabia and the United Kingdom.
- Negotiated sales agreements for capital goods to be exported to countries including Austria, Hong Kong, India and Saudi Arabia.
- Negotiated operation and maintenance contracts for projects in the United Kingdom and the United States.
- Served as a director of Middle East Engineering Limited Saudi Arabia, a GE joint venture in Dammam, Saudi Arabia.
- Developed standardized plain-language documents to facilitate commercial objectives.

Geographic concentrations:

Latin America (1989 - 1992); Middle East (1989 - 1999);
Western and Central Europe (1992 - 1997); India (1995 - 1999).

1988 - 1989 **ATTORNEY, APPARATUS SERVICE BUSINESS DEPARTMENT**

Schenectady, New York

Assisted Department Counsel in managing day-to-day legal affairs for $400 million multi-location service business. Practice included commercial, labor and employment, environmental and real property law.

Accomplishments:

- Helped manage litigation in which portions of New York State's Prevailing Area Wage statute were declared unconstitutional by the United States Court of Appeals for the Second Circuit.

1981 - 1988 **MANAGER - EMPLOYEE RELATIONS**
SPECIALIST - EMPLOYEE RELATIONS

North Bergen, New Jersey and Paramus, New Jersey

Responsible for labor and hourly relations at fourteen shop facilities in the northeast United States employing over 900 people. Served as company spokesman in contract negotiations with unions. Represented the company in administrative proceedings before state agencies in Massachusetts, New York, New Jersey and Pennsylvania.

GENERAL FELT INDUSTRIES, INC.

1978 - 1981 **ASSISTANT TO THE VICE PRESIDENT - INDUSTRIAL RELATIONS**

Saddle Brook, New Jersey

Assisted in all aspects of labor and industrial relations activities for manufacturing company with nine locations nationwide. Assisted in labor negotiations. Represented the company in labor arbitration proceedings.

COMMUNITY INVOLVEMENT

2014 - present Member, Steering Committee, **TECH VALLEY GLOBAL BUSINESS NETWORK**
Colonie, New York

2012 - present Director, **MUSICIANS OF MA'ALWYCK**
Schenectady, New York
Chairman of the Board (2013 – present)

2005 - 2013 Trustee, **CONGREGATION BETH EMETH**
Albany, New York
President, Men of Reform Judaism, Beth Emeth chapter (2005 -- 2007)
Chair, Cemetery Committee (2007 – 2013)

MEMBERSHIPS

2000 - present **FORT ORANGE CLUB**
Albany, New York
