48 - City of Albany (Empire State Plaza)

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NY PRIZE STAGE 1 FEASIBILITY ASSESSMENT

FINAL REPORT



CITY OF ALBANY

NYSERDA AGREEMENT NO. 65038

APRIL 22, 2015

SUBMITTED BY COGEN POWER TECHNOLOGIES



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EXECUTIVE SUMMARY

PROPOSED MICROGRID CONFIGURATION

The microgrid to serve downtown Albany could include the following facilities: the Empire State Plaza (ESP), the Alfred E. Smith Building, the New York State Capitol Building, the New York State Department of Education, the Times Union Center, the Albany Capital Center, the New York State Comptrollerc Office (110 State Street), an Albany County office building (112 State Street), City Hall, the Albany County Courthouse, and the Sheridan Avenue Steam Plant (SASP). An aerial map of the proposed microgrid is included in Appendix A. This location was highlighted in the Opportunity Zones map provided by NYSERDA on the NY Prize website.¹ Each of the microgrid customers will be electrically connected behind the ESP meter.

It is the intention that a 16 MW Combined Heat and Power (CHP) Plant will be installed by the Office of General Services (OGS) and the New York Power Authority (NYPA) on Sheridan Avenue at the decommissioned Refuse Derived Fuel (RDF) building. The CHP Plant will be comprised of two (2) 8 MW Gas Turbine Generators (GTGs) that will operate on natural gas during normal operations but have dual fuel capabilities in times of natural gas curtailment. The existing backup No. 2 Fuel storage at the SASP has enough capacity to run the CHP system for a week without any refills or daily deliveries.

Electricity will be generated at the CHP Plant on Sheridan Avenue, and then be distributed to the additional microgrid customers through either existing infrastructure (OGS utility tunnels or Times Union Center walkway) or new underground concrete encased duct bank. Steam generated by the CHP Plant will serve the Empire State Plaza existing steam distribution system. The microgrid is anticipated to produce 118,850,000 kWh or 81.38% of total electricity annually for these ten facilities with the remainder of power imported through National Grid. This system will remove 15 MW of demand from the utility system. With an electric reduction of this magnitude on the distribution system, the utility will have more capacity for other customers on the National Grid utility system.

The microgrid analyzed for this Stage 1 Feasibility Assessment of NY Prize includes the design and costs associated with the microgrid only, not the &ase+ CHP project to be installed by OGS and NYPA via a separate project. The microgrid capital costs for the design, build, and financing through NYPA is

¹ Accessed at <u>http://www.nyserda.ny.gov/All-Programs/Programs/NY-Prize/Opportunity-Zones-Map</u>



expected to be \$16.74M (+/- 30%), with an estimated annual savings of up to \$4.5M assuming all of the aforementioned microgrid customers participate.

NY PRIZE BENEFITS

The Empire State Plaza microgrid is an ideal candidate for selection for NY Prize for several reasons. NY Prize seeks to demonstrate the viability of microgrids as an important component of a critical infrastructure resiliency strategy.

Superior microgrid projects at this early stage of market deployment are those that can address and test a variety of technical, legal/regulatory and business model challenges. All else being equal an ideal project is one that tests the multiple aspects of the value proposition to the end-user, the utility, and to society at large while doing so at reasonable total cost. This proposed system is an ideal test case in purchasing major resiliency benefits, positively affecting thousands of New Yorkers, at a modest incremental cost.

Because there are sizeable end-user benefits that accrue from the CHP investment at this site, the hase+CHP project will be undertaken by OGS regardless of whether or not the multi-party microgrid is funded through Stage 3 of NY Prize. The close proximity of additional customers, who can be served at a modest incremental cost, represents a sizeable resiliency benefit with an atypically small price tag for the size.

Additionally, the cost of financing is a major component of operating costs. When considering the ‰ost stack+, the cost of capital is near the top. In order to lower the total cost of operation, to improve economic viability and return on investment, itcs critical to focus on the optimal financing plan. The microgrid project will be fortunate to benefit from very attractive financing available from NYPA. The low cost of financing creates for this proposed development is an important advantage that markedly improves the economic viability.

When projects are being ranked, scored and considered for Stage 2 of NY Prize, it is suggest that an important metric is per-capita resiliency+benefit per state dollar invested. This cost effective microgrid project should rank well on the number of people that can be provided with a resiliency benefit per incremental dollar spent.

It is anticipated that the ‰ase+CHP project for OGS will move forward with or without the addition of the other microgrid customers that NY Prize would enable. It is also suggested that when rating and scoring projects, weight should be given to developments with a high probability of occurrence.



State incentive programs, whether in NY or any other jurisdiction, are prone to some degree of project attrition risks. Before the development of its highly successful Market Acceleration Program, historic CHP programs had an attrition rate of greater than 50%, that is, more than half of those earlier generation awarded projects never made it to being operational . typically never even ordered equipment. It is typical that the more complex the project, there is greater risk that it doesn**q** proceed to completion. Multi-user microgrids are particularly challenging insofar as they involve organizing the interests of multiple unaffiliated entities, combining a suite of technologies and operating within a current regulatory environment that has not been designed to accommodate microgrids. Given the stand-alone viability of the CHP system and the commitment of OGS and NYPA, the ESP microgrid project should rank well when compared to other Stage 2 candidates on the probability of moving to completion.

UTILITY INVOLVEMENT

The Empire State Plaza microgrid provides a unique opportunity for developing and testing the necessary systems and processes for National Grid to become a microgrid platform provider in New York State. As the microgrid system owner/operator, OGS will work with National Grid and the Department of Public Service (DPS) staff to think creatively on how to integrate the team to create the most beneficial learning scenarios from this installation. The DPS will be in a unique position to be more directly involved in any potential utility services associated with this installation.

The ESP microgrid project has the potential to benefit from the National Grid Reforming the Energy Vision (REV) demonstration project in Potsdam, NY. One particular opportunity would be associated with metering and billing. Since National Grid already has existing metering and billing practices in place for the proposed microgrid customers, this would create a new utility revenue in the form of service fees. For this particular project, it is possible for National Grid to be the service provider of billing and financial transaction services.

Additionally, a significant issue remains regarding the ownership of the Medium Voltage (MV) switches and step down transformers at each microgrid facility substation. There would be a financial burden for the existing National Grid unit station services to be removed and replaced with a privately owned facility substation. Also, there are significant space constraints to install an additional station service in parallel. This project would be an opportunity to work out a structured procedure to buy, rent, or lease the facility substations from National Grid. This could create another new utility revenue in the form of monthly fees and



save the project the associated debt service to buy out the utility or replace with new.

Lastly, while this microgrid project would potentially eliminate some revenue streams from National Grid in terms of lost electrical customers, there is the additional revenue stream created to supply fuel to the CHP Plant from the National Grid natural gas distribution system. This project presents an opportunity to demonstrate revenue balancing implications between the two utility services (electrical vs. natural gas) to clearly show an overall financial impact to the utility company. A more holistic approach to microgrid services should look at all levels of potential revenue to the utility company.

EXPLORING OPPORTUNITIES FOR TESTING REV CONCEPTS

The projects selected for NY Prize can and will provide information for refining the concepts and the regulatory structures that will be the future foundation for New York State¢ Reforming the Energy Vision (REV). Maximizing the value of Distributed Energy Resources (DER) as dynamic assets serving the grid requires new systems that integrate traditional utility tools such as DMS and SCADA systems, and leveraging existing and emerging utility databases and other systems such as Computer Information Systems (CIS), Utility Outage Management Server (OMS) and Advanced Metering Infrastructure (AMI).

As this project proceeds, the development team will make a concerted effort to collaborate with National Grid (NG) to identify and test new market concepts. As one example, there has been some discussion of National Grid hosting a pilot that might include collection of detailed information regarding the interaction of a microgrid with the distribution system for the purpose of developing a knowledge base that can optimize distributed energy management, grid operations, and planning.

The Empire State Plaza, as home to State Government, is an ideal location to serve as a test bed. Siting a multi-user microgrid at the ESP and embedding in the project design a set of hypothesis for testing offers multiple advantages. DPS staff and the PSC are in close proximity to the site, permitting close engagement with testing protocols that are put in place. Top executive and legislative leaders have ready access facilitating education and outreach and rapid dissemination of lessons learned.

As the owner and operator of the microgrid, the State removes many of the constraints to site access that would otherwise be the case with a third party. This offers a much greater degree of flexibility in how tests can be conducted. Should



this project move to Stage 2, it would be sought to collaborate with National Grid and perhaps Electric Power Research Institute (EPRI) to conduct empirical analysis on the value that this particular microgrid provides to the network in which it operates.

Should this project be fortunate to NY Prize Stage 2, the team suggests building into the design, to the extent feasible and cost justified, an analysis of the value of \$2+ That is an empirical analysis of the \$4 alue of distributed energy resources+, that may provide lessons learned, generalizable to the larger REV process. The following quotes from various Commission orders, demonstrates that establishing a sound rationale and empirical basis for LMP+D gis integral to the entire REV process:

Whe Commission has stated that achieving a more precise articulation of the full value of distributed energy resources (%DER+) is ± cornerstone REV issue.q²

57 The development of the tools and methodologies required to fully implement an approach [for valuation of DER] on the Halue of Dqis likely a long term effort.+³

%the] ±alue of Dgcan include load reduction, frequency regulation, reactive power, line loss avoidance, resilience and locational values as well as values not directly related to delivery service such as installed capacity and emission avoidance.+

Whe walue of D+takes different forms and values depending on the application. For example, the first major application for the % alue of D+is valuing alternatives to long term investments such as traditional utility investment, investment in DSP infrastructure and non-wire alternatives. A second application is compensation mechanisms, which includes rate design, LMP+D payments, as the basis for the transition from NEM.+⁵

² NYS PSC, Case 15-E-0082, Proceeding on a Community Net Metering Program, Order Establishing a Community Distributed Generation Program and Making Other Findings, (July 17, 2015) p. 24 (CDG Order) NYS PSC, CASE 15-E-0751, In the Matter of the Value of Distributed Energy Resources, Dec 23, 2015, Attachment A

Page 1 ⁴ NYS PSC, NEM Interim Ceilings Order, p. 9.

⁵ NYS PSC, CASE 15-E-0751, In the Matter of the Value of Distributed Energy Resources, Dec 23, 2015, Attachment A Page 3



For each of the REV goals, below is a summary table outlining how this project would address each of the items:

REV Goal	Advancement of that Goal	
Cutting Greenhouse Gas Emissions 50% by 2050	[~] Large scale combined heat and power (CHP) is core to the project providing significant efficiency benefits [~] 16MW CHP Plant will save 25,642 tons per year of CO2equivalent	
Making energy more affordable for all New Yorkers	 [~] This NY Prize project may be one of the most cost effective developments available to the State [~] If an important NY prize selection metric is cost effective+ resiliency, the ESP project is likely to score well. [~] Large CHP installation reduces energy spending for 10 customers, most of them government buildings including Empire State Plaza and the Capitol Building. Lower government spending means more efficient use of taxpayer dollars [~] Reduced local demand has the potential to defer local utility capital spending, saving money for all ratepayers in the National Grid territory 	
Improving our existing initiatives and infrastructure	 [~] Project will be one of the largest district energy systems in the state [~] Located in Albany, proximity allows for easy evaluation by, and collaboration with, NYSERDA, PSC, and Governorqs Office [~] An ideal location for setting up a market testbed+in collaboration with National Grid a potential showcase model 	
Helping clean energy innovation grow	["] Innovative business model provides a template for others to follow by incorporating building owners from city government, state government, and county agencies	
Building a more resilient energy system	 ["] Dual fuel CHP systems will be able to completely island from utility in cases of grid outage or gas curtailment ["] Provides backup electrical power to numerous state and city buildings allowing for continuity of government services during extended grid outages, including comptrollerce offices (state government payments) and capitol building ["] Connected buildings could provide shelter for over 30,500 people during outages of extended duration ["] Empire State Plaza CHP plant is cost effective without NV 	
Creating new jobs and business opportunities	Prize award. Prize funding enables a significant expansion, at a very modest incremental cost to an innovative, world class community microgrid system serving the center of New York State government	

E)



RECOMMENDED REGULATORY AND POLICY CHANGES

The known regulatory and policy changes that would need to be evaluated and resolved for this project to proceed include those that lie with National Grid. After preliminary discussions with the utility and receiving feedback on a series of questions regarding the existing system, a list of the regulatory hurdles are below:

- 1) Rights of Way for crossing public roads
- 2) The aggregation of multiple electric services
- 3) Buying or leasing existing utility equipment

Issues one and two identified above have been successfully overcame at the Burrstone Energy Center, located in Utica, NY.

FAVORABLE FINANCING, INCENTIVES AND FUTURE REVENUE STREAMS

The cost of capital is an important factor in the economic viability of a microgrid. After fuel cost, financing costs could be the second largest component of cost. As a consequence, the obvious opportunities for a project to bring down costs is to address fuel cost and financing charges.

The strategic advantage of NYPA financing the ESP microgrid project will benefit significantly from access to low cost financing available from NYPA. The cost of capital at today a rates for projects of similar scale and of a similar credit rating would likely be significantly greater, absent the NYPA financing.

Several initiatives are underway that are expected to create new markets and revenue opportunities for microgrids and distributed energy resources generally.

New markets will take some time to develop. They are likely to take shape over a multi-year time frame. However there are some areas where DERs and microgrids can provide demonstrable support and value to the distribution utility.

Targeted Utility/DSP DG Incentives

Strategically sited, appropriately configured and operated microgrids can allow the utility to defer or avoid significant distribution system capital expenditures. An example of one such program, now in existence is Con Edison¢ Case 14-E-0302. Order Establishing Brooklyn/Queens Demand Management Program, issued and effective December 12, 2014. The BQDM program, currently in process with ConEd, offers a glimpse into how REV may drive incentives for CHP and DER. Announced on December 8, 2015, qualifying CHP projects were being offered an incentive of \$1,800/Kw. Projects will have to meet Con Ed and NYSERDA terms of performance and be operational by June 1, 2017, the start of the 2017 Summer Capability period.



Distribution utilities are being encouraged to submit ‱n-wires+pilots. The incentive levels will vary from location to location as the value of avoided marginal distribution capacity costs are highly variable across the State.

The value of Microgrids, operating in the right locations and at the right time of day and season of the year is now being realized in New York State.

Operational Services

REV envisions new markets, at the distribution system level and in concert with the NYISO, to mirror new wholesale markets for DER services. Some of the new services that might be offered by appropriately designed, configured and operated microgrids include:

- ["] Frequency regulation
- "Volt-ampere reactive (VARs) compensation
- " Demand response services

Princeton University reports that they first implemented FERC 755 Frequency Regulation in January 2013. They initially started by offering a 1 MW grid load change, accomplished by changing gas combustion turbine output (up / down). They report⁶ that payments were averaging \$200,000 per MW/year PLUS a performance multiplier of up to 3X (\$600,000). In addition to utilization of the gas turbine for measured grid load changes, they expect also to be utilizing VFD¢ for this purpose. Princeton is also providing Synchronous Reserves (FERC 755) in the PJM market. They entered the Synchronous Reserves market in October 2012. They report that potential savings are \$30,000/MW-year.⁷

⁶ Wew Market Opportunities for CHP: Next Steps in Market Participation at Princeton and MIT. Presented at the International District Energy Associations 26th Annual Campus Energy Conference. February 18-22, 2013 ⁷ Ibid.



SECTION I DEVELOPMENT OF MICROGRID CAPABILITIES

SUBTASK 1.1 MINIMUM REQUIRED CAPABILITIES

The microgrid to serve downtown Albany could include the following facilities: the Empire State Plaza (ESP), the Alfred E. Smith Building, the New York State Capitol Building, the New York State Department of Education, the Times Union Center, the Albany Capital Center, the New York State Comptroller& Office (110 State Street), an Albany County office building (112 State Street), City Hall, the Albany County Courthouse, and the Sheridan Avenue Steam Plant (SASP). An aerial map of the proposed microgrid is included in Appendix A.

The Empire State Plaza, Times Union Center, and the Albany Capital Center can all serve as critical facilities in the event of a natural disaster or prolonged utility outage. The population of Albany, NY is approximately 98,566 people⁸. Below is a table stating the capacity of the aforementioned facilities and the percentage of community members it could provide a safe and energized shelter for.

Facility	Available Capacity	Percent of Community Members
Empire State Plaza 9	10,000	10 %
Times Union Center ⁹	17,500	18 %
Albany Capital Center ¹⁰	3,000	3 %
Total	30,500	31 %

It is worthy to note that the Albany Capital Center is currently under construction and the available capacity stated above is an estimate of the capacity of the meeting/multipurpose rooms only. In the event of a natural disaster or prolonged emergency in Albany, the capacity of the Albany Capital Center could be increased to provide shelter for more community members.

The primary generation source for the microgrid will be two (2) dual-fuel Solar Taurus 70 gas turbine generators (GTGs), capable of generating an average of 16 MW to be distributed to microgrid customers. The GTGs and duct burners will be fueled with natural gas. During periods of gas curtailment, the GTGs only will be fueled by No. 2 fuel oil. The SASP has 300,000 gallons of existing fuel oil storage capacity readily available.

10 Preliminary estimates of the capacity available for the Albany Capital Center provided by Director of Sales for the Albany Capital Center. The supporting reference material is included in Appendix D.

⁸ July 2014 population of Albany, NY cited from the U.S. Census Bureau.

⁹ Empire State Plaza and Times Union Center capacity cited from the Albany Capital Center website. The supporting reference materials are included in Appendices B and C.



The GTGs will be operating and supplying power to the ESP electrical distribution system, which will normally be grid-connected. When the system is disconnected from the grid, it will be powered by the GTGs operating in islanded mode.

When required, the ESP microgrid can be intentionally separated from the utility grid, shed load, as required, and operate in islanded mode.

Under control of a Load Management System (LMS), the ESP microgrid will have the capability to automatically separate from the grid on loss of utility power, shed load, as required, and operate in islanded mode. When normal utility power is restored, the LMS can automatically synchronize the generators to the grid and restore the shed loads.

Maintenance of the GTGs will be provided under the manufacturer c extended service agreement, which includes OEM recommended preventative maintenance service inspections, parts and components, remote monitoring, reporting and troubleshooting, and on-site trouble calls. When an engine overhaul is required after 30,000 operating hours, a refurbished engine will be provided on an exchange basis to reduce the duration of the maintenance outage. With two GTGs, one GTG can undergo maintenance while the other remains in service.

When connected to the grid, power generated by the GTGs will be used for utility load displacement only, load following as required up to the maximum generation capacity. On reduced loads, the LMS will control the output of the generators to ensure no power is exported to the grid. When islanded, the generators will follow the system load and maintain voltage within the limits of ANSI C84-1 standards. Non-essential load will be shed to ensure that the islanded system load does not exceed the capacity of the generators.

It is expected that two-way communication between the microgrid and National Grid could be either Direct Transfer Trip (DTT) or Remote Terminal Unit (RTU). At this phase of the microgrid study, the communication requirements from National Grid have not been identified. However, the CHP Plant will have the full capabilities to meet DTT or RTU requirements from the utility. The microgrid can provide power to potentially ten (10) different facilities in downtown Albany. The diversity of the customers includes several large office complexes, large arenas, and various small commercial buildings. The mixes of ownership of these facilities are through the New York State Office of General Services (OGS), the City of Albany, and Albany County.



The GTGs will operate on natural gas during normal operations. However, as dual fuel units, they will be able to operate on No. 2 fuel oil during times of natural gas curtailment. Without natural gas, steam generation in the heat recovery steam generators (HRSGs) will be limited to the unfired capacity as capability of supplemental firing with liquid fuel will not be included on these units. The SASP boilers will fire No. 2 fuel oil, as required, to meet the remaining steam load. The SASP building houses 300,000 gallons of fuel oil storage capacity allowing the Combined Heat and Power (CHP) plant and the SASP boilers to operate for extended periods when no natural gas is available. For example, assuming that a natural gas curtailment occurs during a cold winter period where the average steam demand for the Empire State Plaza is 160,000 lb/hr, the HRSGs for the two (2) GTGs will generate 70,000 lb/hr, requiring the SASP boilers to produce the remaining 90,000 lb/hr. The total fuel oil consumption for the SASP and CHP Plant would be 51,790 gal/day. The CHP Plant and the SASP boilers would be able to provide all of the thermal energy required for the ESP and the electrical energy required for the microgrid with the necessary load shedding in effect.

Forces of nature typical to the Albany area include heavy precipitation, lightning and high winds associated with severe weather conditions. This could lead to downed power lines, flooding in some areas and travel disruptions due to heavy snow accumulations. Ice jams in the Hudson River during the spring thaw can also lead to flooding in some parts of Albany.

The location of the CHP Plant will be at the existing, well maintained, Refuse Derived Fuel (RDF) Building located at 79 Sheridan Avenue, next door to the existing SASP. One GTG/HRSG set with auxiliary equipment will be installed on each of the (east and west) truck decks and (refuse) fuel pits of the facility. Interconnecting services between the buildings will pass through a below-grade passageway while electricity and steam generated by the CHP and SASP boilers will be delivered to the Empire State Plaza through underground tunnels. Electrical distribution equipment at the Empire State Plaza is also located in underground vaults. These features will protect against disruption of services due to severe weather conditions.

The flood level for the Hudson River at Albany is 11 feet above mean sea level (amsl). Included in Appendix E is a list of historic Hudson River crests and recent crests for Albany from the National Weather Service database. The SASP and RDF Building/CHP Plant both sit at a low point elevation of 43 feet amsl, sufficient to protect them from flooding disruptions to the facilities.



There have not been any additional weather events that have caused upsets in electrical supply to the SASP for extended periods. The typical scenario would be a power dip due to a feeder issue (lightning, ice) but that in most cases is momentary and returns. In the case of an extended feeder loss (cable failure), the second feeder was available and took care of the load. Several Office of General Services (OGS) employees cannot recall a time (over a 35+ year period) when both feeders were lost and the SASP was powered with emergency power.

The most common weather event to disturb the SASP would be extreme cold winter months and snow storms resulting in gas curtailment from the utility. When a gas curtailments and snow storm occur simultaneously, the storm often slows down the delivery of fuel oil. However, the SASP operation has never been hampered, due to the 300,000 gallons of fuel oil reserve on site.

The project would include a 1 MW black start diesel generator to allow the CHP to be started and operated in islanded mode to provide power and thermal energy supply to the ESP and microgrid customers.

The black start generator would be capable of providing sufficient power to supply the loads required to start up one of the GTGs. With one GTG running, the loads required to start up the second GTG would be started, allowing both generators to supply the ESP Main Switchgear in an islanded mode. The loads of all microgrid customers would be adjusted using a Load Management System (LMS) to ensure the remaining loads do not exceed the power delivered by the GTGs.

SUBTASK 1.2 PREFERABLE MICROGRID CAPABILITIES

A state-of-the-art plant control system (PCS) for the microgrid CHP equipment would provide supervisory controls and monitoring for two gas turbine generators (GTGs), two heat recovery steam generators (HRSGs), two gas compressors and a black start diesel generator. The PCS will also control and monitor the load management system (LMS).

The load management system (LMS) is a custom logic controller-based automated system that will be used to monitor the available power supplies and loads making up the microgrid distribution system. A fiber optic network will connect the meters to the LMS to monitor these loads. If an event causes the power available to the distribution system to be less than the power required by loads connected to the system, the LMS would drop loads in accordance with a prearranged load shedding priority. This would occur when one or more utility feeds are lost and the load is greater than the power output of the GTGs. The LMS uses a high-speed automation controller to monitor and shed loads in

milliseconds of an upset event.

The LMS performs the following functions in addition to load shed:

- Control the import/export of real and reactive power from the utility by controlling the output of gas turbine generators (GTGs);
- Automatically shed load (with an LMS response time of 38 msec or less) upon loss of the utility;
- Automatically shed load to maintain a minimum GTG capacity reserve;
- Provide manually initiated, automatic synchronization across breaker main feeder breakers
- Provide automatic bus transfer control that will automatically close incoming breakers to restore power to either of the 13.2 kV busses 1 or 2 that has lost its supply;
- The main LMS panel would connect to the microgrid data centerc power monitoring system to receive load and supply information.
- Monitor and display the open / closed status and power levels of 34.5 kV and 13.2 kV breakers.

The CHP Plant will be installed as an energy efficient operation to minimize any additional new microgrid generation.

The portion of the microgrid on the North side of the Plaza (City Hall, County Courthouse, AE Smith, Capitol Building and the Education Building) would be powered from breakers installed in the 13.8kv Unit A and Unit B cogen switchgear utilizing existing tunnels and the installation of new underground ductbanks. The remainder of the microgrid on the South side of the Plaza (Times Union Center, Convention Center, 110 State Street, and 112 State Street) would be powered by breakers located in the ESP Unit D and Unit C electrical vaults utilizing the existing walkway to the Times Union Center and underground ductbanks. The utility power for all of the microgrid customers would come from the existing four National Grid feeds powering the Empire Plaza.

Cogen Power Technologies has subcontracted the Pace Energy and Climate Center (Pace) to assist in the analysis of the Reforming Energy Vision (REV) as part of this study. Included as a part of the Pace energy analysis team are Thomas Bourgeois, Deputy Director; Daniel Leonhardt, Senior Energy Analyst; and Dr. Henrietta de Veer, Founder and Managing Partner of Adaptive Energy. Dr. Henrietta de Veer has been involved with the REV proceedings and will provide this microgrid project with the innovative ideas to embrace the REV



platform. Further comments on the inclusion of REV ideas for the proposed microgrid will be addressed in the final report.

It is the responsibility of Cogen Power Technologies to provide the Facility Questionnaire and Microgrid Questionnaire to IEC to complete the CBA. These documents will be completed with respect to the microgrid customers, community, and utility. The report provided by IEC for the Cost-Benefit Analysis will be included in the final report for the feasibility study.

This project is expected to qualify for \$2.4 million from NYSERDA under PON-2701 the Combined Heat and Power (CHP) Performance Program. It is assumed that the funding available under this program is public dollars which will be used for this project. The remainder cost of the project will be provided through the New York Power Authority (NYPA) BuildSmart NY Program.

The ESP microgrid will be powered by a combined heat and power (CHP) facility using gas turbine generators with low NOx burner technology and selective catalytic reduction (SCR) exhaust gas NOx reduction systems. By displacing purchased electricity from the power grid and steam generated by gas and oil fired boilers, reductions in carbon dioxide emissions will be achieved.;

The number of jobs created for operating the CHP Plant will be dependent on the operations and maintenance plan of the OGS staff as owners and operators of the plant. OGS will leverage their existing staff members to operate the plant as necessary but may need to hire additional personnel.

The CHP Plant has the capability to serve over ten different facilities and three different customers including the New York State Office of General Services (OGS), the City of Albany, and Albany County. The Empire State Plaza alone serves over 13,000 state employees which can be fully energized year-round.

The existing power grid will be strengthened by the microgrid due to the reduced load stress on the utility system. The innovative technology of the LMS and PCS system will be utilized to monitor the electrical systems of the entire microgrid.



SECTION II DEVELOP PRELIMINARY TECHNICAL DESIGN COSTS AND CONFIGURATION

SUBTASK 2.1 PROPOSED MICROGRID INFRASTRUCTURE AND OPERATIONS

The combined heat and power plant (CHP), the distributed energy resource (DER) for this microgrid, is located in the Refuse Derived Fuel (RDF) building adjacent to the Sheridan Avenue Steam Plant (SASP). The switchgear for the utility interconnection and distribution of electricity to the microgrid customers is located in the Central Air Conditioning Plant (CACP) in the Empire State Plaza (ESP). The plan showing the locations of these facilities and the microgrid customers is included in Appendix F. The equipment layout drawing for the new CHP Plant is included in Appendix G and the simplified electrical single line diagrams of the proposed microgrid is included in Appendix H.

The CHP plant will operate continuously to supply electricity to the microgrid and steam to the Empire State Plaza. The system would not export energy outside of the microgrid. The **normal CHP plant operation** modes are as follows:

- ["] The gas turbine generators (GTGs) would operate in electrical load follow mode to supply power to the microgrid. When the microgrid electrical load is high, the turbine generators would operate at full output with additional load supplied by import power from the utility. When the microgrid load is low, the GTGs would operate at part load and the load management system would reduce the CHP plant output to prevent power export to the utility.
- Steam generated by the CHP would be distributed to the ESP using the existing steam distribution system. Steam output from the HRSGs can be increased by firing the duct burners. It is expected that the ESP steam load will usually be greater than the unfired steam output of the HRSGs. If necessary, on rare occasions, excess steam can be vented.

The existing steam boilers would continue to operate when the CHP plant is in operation. The plant operator would maintain a sufficient number of steam boilers on hot standby to allow for fast pickup of the total steam load in the event of the CHP units tripping out of service. The existing heating equipment would have adequate capacity to supply the full ESP heating load when CHP units are not available during scheduled maintenance or forced outage.

A plant configuration consisting of two (2) GTGs provides operational flexibility during scheduled maintenance periods. While one GTG is down, the second unit can continue to operate, supplying one half of the plant energy output. This



practice, during the maintenance period, would reduce the impact on plant demand charges and improve plant efficiency by continuing to minimize the steam generation from the existing less efficient SASP boilers.

For emergency conditions:

Upon the loss of one utility feed, the Load Management System (LMS) would automatically attempt to shed ESP loads and any shedable microgrid loads connected to the bus with the lost utility feed such that the GTG connected to this bus can operate in islanded mode with the remaining load. The would have computational characteristics and would determine the priority scheme of shedding breakers such that the generator would not be overloaded and at the same time would have some spinning reserve to support starting of certain loads. The emergency power system would pick up any life safety loads of the shed loads. If the other utility feed connected to this bus is available, the lost feeder breaker would automatically be opened, the available feeder breaker would be closed and the removed loads would be brought back on-line.

Upon the loss of all utility feeds, the LMS would automatically attempt to shed facility loads connected to each bus such that the GTGs can operate in islanded mode with the remaining load. The LMS would have computational characteristics and would determine the priority scheme of shedding breakers such that the generators would not be overloaded and at the same time would have some spinning reserve to support starting of certain loads.

Upon restoration of the Utilities, the LMS would synchronize the facility distribution system with the utility through the utility breakers. After the utility breakers are closed, the facility distribution system would revert to normal operation with the gas turbine generators running in parallel with the utility.

In the event of both GTGs being off-line or a turbine trip during a utility outage, the black start generator would start up automatically on a dead bus to supply the emergency CHP loads and power required to start an available gas turbine generator. The automatic start would be initiated by its own synchronization panel. Once the GTG is up and running, the second GTG would be started if available.

If a GTG trips during a utility outage and once the gas turbine generator fault conditions are corrected, and the other GTG is running and has already picked up the auxiliary loads of the tripped gas turbine generator and other MCCs, the operator can then start up the tripped GTG and close its breaker.



SUBTASK 2.2 LOAD CHARACTERIZATION

The microgrid electrical load includes all of the loads of the ESP and the microgrid customer facilities. The monthly and annual loads are summarized in Table 1 of Appendix I giving average, minimum and maximum for each facility. These loads are presented graphically in Chart 1 in Appendix J. The monthly and annual electrical consumption for the individual facilities and the entire microgrid are provided in Table 2 of Appendix J.

The microgrid thermal load includes only the steam generated for the Empire State Plaza and a few government facilities which are already thermally connected. As part of the microgrid, these facilities can now be connected electrically as well. Chilled water for cooling in the Empire State Plaza complex and the associated government facilities is produced by steam turbine-driven centrifugal chillers. Steam and chilled water will not be provided to the other microgrid customer facilities.

The microgrid monthly and annual thermal loads are summarized in Table 3 listing average, minimum and maximum for the system. This information is presented graphically in Chart 2 of Appendix J.

Chart 3 in Appendix J shows the combined electrical load profile for the Empire State Plaza microgrid for one year. The loads for the ESP were provided by OGS on a 15 minute interval basis from their Process Information System. Loads for most of the other facilities were provided on an hourly basis from National Grid. Times Union Center and the Education Building Annex load data were downloaded from the National Grid website on a 15-minute interval basis. Loads for the Albany Capital Center were estimated based on design loads and the load profile for the Times Union Center.

Chart 4 in Appendix J shows the steam load profile for the Empire State Plaza for one year. The loads for the ESP were provided by OGS on a 15 minute interval basis from their Process Information system.

SUBTASK 2.3 DISTRIBUTED ENERGY RESOURCES CHARACTERIZATION

The Distributed Energy Resources (DER) for the Empire State Plaza microgrid will include a combined heat and power (CHP) facility generating electricity and steam associated with an existing steam generating boiler plant, the Sheridan Avenue Steam Plant (SASP). The CHP will be located in the RDF building adjacent to the SASP. Both facilities will supply steam through a common distribution system to the Empire State Plaza.



The SASP houses six (6) dual fuel steam boilers which can each generate 80,000 lb/hr of steam at a pressure of 250 psig and a temperature of 450°F while firing natural gas or No. 2 fuel oil. Auxiliary systems in the SASP, shared with the CHP include, a makeup water treatment system, a condensate return system, a boiler feedwater system and fuel oil storage and pumping system.

The CHP will include two dual fuel gas turbine generators (GTGs), each discharging exhaust gases to a heat recovery steam generator (HRSG) equipped with gas-fired duct burners. The GTGs are nominally rated at 8 MW each but at site conditions will typically generate 7.6 MW at the generator terminals. The HRSGs can each generate 32,800 lb/hr of steam with no duct firing but are rated for 70,000 lb/hr of steam with maximum duct firing. Steam will be delivered from the HRSGs at a pressure of 250 psig and a temperature of 450°F.

The RDF building houses a refuse derived fuel (RDF) steam generation plant which ceased operations in 2012. The boilers and some of the other major auxiliary equipment are still in place. For the CHP addition, one GTG/HRSG combination would be installed on each side of the plant in the fuel delivery and storage areas, which are clear of equipment and require little building modification. The location of the CHP is indicated on the simplified equipment layout in Appendix G.

The average microgrid electrical load will be 16.7 MW with peaks to around 25 MW. The CHP on average can deliver 14.7 MW to the system from the two gas turbine generators (GTG). However, the CHP output will at times be limited by low demand on the system and the requirement to maintain a minimum amount of imported electricity. Average output of the CHP will be around 13.5 MW, about 81% of the microgrid average load.

Under normal conditions when the microgrid load exceeds the capability of the CHP, additional electricity, as required, will be imported from the electrical utility feed. If one of the GTGs is down for maintenance or emergency repairs, additional electricity import will be required.

During emergency conditions where the electrical utility is unable to deliver electricity to the microgrid, the CHP will island from the system and generate electricity to meet the demand of the microgrid up to the full load output of the two GTGs. Loads in the Empire State Plaza will be shed as necessary to ensure that the microgrid demand will not exceed the capability of the GTGs. Based on



average annual loads, the CHP could meet about 75% of the Empire State Plaza load while satisfying 100% of the loads of the microgrid customers.

If an emergency event with loss of utility power occurred while one of the GTGs was down for maintenance or emergency repairs, the CHP output would be reduced by 50%. This would require additional load shedding in the Empire State Plaza.

It should be noted that during a major emergency event, most facilities would not be maintaining business as usual. This would lead to a natural reduction in electrical load, apart from load shedding.

The operation of the CHP and the SASP is not expected to be impacted by forces of nature. All of the critical equipment is located indoors or in suitable enclosures, protected from high winds and precipitation. Due to the elevation of the site, flooding has not previously occurred and is not anticipated in the future.

The primary fuel for the CHP is natural gas, delivered through an underground piping network and supplied by a system of underground pipelines. Disruptions in the gas supply are rare but can occur and could be precipitated by a natural disaster at some point along the supply system. Gas may be curtailed from time to time due to heavy demand or shortage of supply.

The backup fuel for the CHP and the SASP is No. 2 fuel oil stored in five (5) 60,000 gallon tanks located inside the SASP. This is sufficient fuel storage to operate the CHP for at least 7 days. Additional fuel will be available for some steam generation from the SASP, however, in a period with a high steam demand, steam generation by the boilers may be limited by liquid fuel available in storage and some non-critical steam loads would be limited or shutdown. In the event of loss of grid power along with the shutdown (trip) of the CHP generators, a black start diesel generator will be available to restart one of the GTGs and the auxiliary equipment needed to operate the HRSG. Sufficient power would then be available to start the second GTG and to operate the SASP boilers.

The GTGs are capable of part load operation from 50% load to 100% load allowing them to load-follow over a wide range. Under normal conditions, when the electrical load exceeds the combined capacity of the GTGs, the GTGS will operate at full load and load variations will be accommodated from the grid supply. If the load is less than the combined capacity of the GTGs, the output of the GTGs will be regulated to follow the load while controlling the supply from the grid to a minimum value to ensure that there is no electricity export from the CHP.



The HRSG steam generation can be varied between the unfired output to fully fired output by modulating duct burner firing between 0 and 100%. Each of the SASP boilers can operate between 20% and 100% output. When the steam load exceeds the fired capacity of the HRSGs, the duct burners will fire at 100%. Variations in the steam load will be followed by regulating the steam output of the SASP boilers and changing the number of boilers operating. When the steam load is less than the output of the fully fired HRSGs, the minimum number of SASP boilers will operate at minimum load and the steam output of the HRSGs will be controlled by regulating the duct burner firing rate. If the steam load falls below the unfired output of the HRSGs excess steam will be vented.

The microgrid¢ voltage and frequency are not expected to vary greatly from nominal as there are many loads and none of the loads are large enough to have any great effect on the voltage and frequency during load start-up or being taken off line. When connected to the utility, the microgrid¢ voltage and frequency will be controlled by the utility grid. When in islanded mode, the generator AVR and frequency control system will regulate the voltage and frequency and will be able to ride through voltage and frequency deviations. In an emergency event if the voltage or frequency were to deviate largely from normal, the generator protection relays will shut down the system.

SUBTASK 2.4 ELECTRICAL AND THERMAL INFRASTRUCTURE CHARACTERIZATION

Electrical Infrastructure

The ESP facility¢ normal electrical sources are from four National Grid (NGRID) 34.5 kV feeders from three different substations (Riverside feeders 38 & 35, Menands feeder 36 and Delaware feeder 37) via underground feeders. See single line diagram 30604-6001 in Appendix B. These feeds connect to four utility (normal source) 34.5-13.8 kV transformers (A, B, C, & D) each with 13.8 kV switchgear lineups that feed two separate 13.8 kV buses. Units A & B feed Bus 1 and units C & D feed Bus 2. These transformers are rated up to 29 MW each and are each capable of feeding the entire facility. The transformers and switchgear are located in the Central Air Conditioning Plant (CACP) building. Unit D also feeds a recently added 1750 hp CACP chiller via a 13.8 kV-4.16 kV transformer.

Sixteen substations located around the ESP are fed from the CACP 13.8 kV switchgear bus system. Each substation has four 13.8 kV-480/277 V transformers feeding two switchboards connected to Bus 1 and Bus 2 through network protector circuit breakers to prevent back feeds from to the two NGRID sources feeding the switchboards.



An emergency power supply system (EPSS) provides emergency power to the facility. The EPSS is fed by two 13.8 kV, 3.25 MW diesel generators located in a building next to the Sheridan Ave. Steam Plant (SASP). Cabling from the EPSS generators at Sheridan Ave. runs through an underground tunnel to a main-tiemain switchgear arrangement in the CACP building, a distance of about one mile. The normal power to the SASP buildings is fed from a pair of NGRID 13.2 kV feeders supplying power to the SASP and RDF buildings.

For the most part, the existing microgrid load infrastructure will remain in place but will be disconnected from the present utility grid connection and reconnected to the microgrid distribution system. Some of the electrical equipment for the larger loads will be modified to incorporate the load management system.

Thermal Infrastructure

The ESP thermal energy infrastructure serves only the ESP facilities and related government buildings; the NY State Capitol Building, the A.E., Smith Building and the Old Education Building. Other electrical consumers on the microgrid will not be connected to the thermal energy distribution systems.

Thermal energy is delivered from the SASP through two parallel steam pipes which are routed through underground tunnels to the ESP with branches, also in tunnels, to the NY State Capitol Building, the A.E. Smith Building and the Old Education Building. At the ESP the steam piping is routed as a loop around the lower levels of the plaza from the Central Air Conditioning Plant location to serve multiple facilities. The condensate return piping parallels the steam piping from the users back to the SASP.

Chilled water for the ESP is produced in the CACP using condensing steam turbine driven centrifugal chillers which are powered by steam from the SASP. One chiller also has an electric motor drive which can power about half of its design output if required. Chilled water supply and return piping is routed in a loop around the ESP at the lower levels. Supply and return piping is also routed through the tunnel systems to serve the State Capitol Building, the A.E, Smith Building and the Old Education Building.

Electrical infrastructure associated with delivery of CHP generated electricity to the ESP and distribution throughout the ESP is routed through tunnels or the lower levels of the ESP. This infrastructure will not be exposed to the forces of nature as it is sheltered from severed weather conditions and the area is not prone to flooding.



The additional microgrid loads will be connected to the ESP distribution system in two groups. One group will be fed from the two new sections added to the existing ESP building 13.8kV switchgear. The other group will be fed from the new CHP 13.8 kV switchgear located at Sheridan Avenue. This is arrangement is shown on the single line diagram 30604-6001 in Appendix H.

The 13.8kV switchgear lineups will connect to each group via underground feeders. The feeders will connect to each of the microgrid loadsqlocal step-down transformers, which will be connected to the building loads.

All thermal energy distribution infrastructure is located in underground tunnels and in the lower levels of the ESP. These too are protected from the forces of nature.

The microgrid will be interconnected to the grid via the existing ESP connections located in the ESP Central Air Conditioning Plant (CACP) building 34.5 kV substation. ESP facility normal electrical sources are from four National Grid (NGRID) 34.5 kV feeders from three different substations (Riverside feeders 38 & 35, Menands feeder 36 and Delaware feeder 37) via underground feeders. See single line diagram 30604-6001 in Appendix H. These feeds connect to four utility (normal source) 34.5-13.8 kV transformers (A, B, C, & D) each with 13.8 kV switchgear line ups that feed two separate 13.8 kV buses.

The microgrid loads will be connected to the ESP distribution system in two groups. One group will be fed from the two new sections added to the existing ESP building 13.8kV switchgear lineups. The other group will be fed from the new CHP 13.8 kV switchgear as shown on the single line diagram 30604-6001.

No new investments in utility infrastructure will be required for the interconnection of the microgrid to the utility grid. The existing protection system of the four incoming 34.5 kV feeders will be updated in the ESP switchgear.

The current protection relay will be replaced with new redundant relays and will incorporate normal line protection functions as well as import/export control to prevent power from microgrid to flow back into the utility grid.

Power available to the facility 13.8 kV electrical distribution system would be used for utility load displacement only. Directional relays will be added to the 13.8 kV switchgear main incoming feeders to ensure no power exporting to the utilities occurs and to provide backup protection to the synchronizing relays. Synchronizing the CHP generators to the utility feeders will take place at new synchronizing and protection relays located on the 13.8 kV side of the Unit



transformers.

SUBTASK 2.5 MICROGRID AND BUILDING CONTROLS CHARACTERIZATION

The microgrid will be controlled from the CHP control room which will be constantly manned by operators. If the grid supplies are lost, disconnecting from the grid will take place automatically via the protection relay system and will be sensed by the load management system which will shed the microgrid loads to match the generated supply with the remaining loads. Upon return of grid supply, the operators will be notified and they will initiate an auto-synchronization sequence via the LMS control system to close the utility breaker and reenergize any loads dropped by the LMS.

The configuration of the distribution system will allow various configurations to allow the microgrid system to operate with one, two or no grid feeders available.

A black start condition exists, if all four utility sources went offline and both GTGs went (or were) offline at the same time. If this situation were to happen, the existing Emergency power supply system (EPSS) would provide power to life-safety load by switching power from the normal power supply via auto transfer switches (ATS) located throughout the ESP until the normal supply could be restored.

A black start generator, capable of providing sufficient power to supply the loads required to start up one GTG would be provided. With one GTG running, the loads required to start up the second GTG would be started allowing both generators to supply the CACP 13.8kV in an islanded mode. The loads of the CACP would be adjusted using a Load Management System (LMS) to ensure the CACP loads remaining do not exceed the power delivered by the GTGs.

The microgrid¢ voltage and frequency are not expected to vary greatly from nominal as there are many loads and none of the loads are large enough to have any great effect on the voltage and frequency during load start-up or being taken off line. When connected to the utility, the microgrid¢ voltage and frequency will be controlled by the utility grid.

When in islanded mode, the generator AVR and frequency control system will regulate the voltage and frequency and will be able to ride through voltage and frequency deviations. In an emergency event if the voltage or frequency were to deviate largely from normal, the generator protection relays will shut down the system.



During the design phase of the project, the system will be modelled and a protection and coordination study will be undertaken to provide the protection settings for the various protection systems throughout the microgrid distribution system.

Data logging features will take place in the CHP control system splant historian.

The microgrid and building controls will not be impacted by severe weather. The controls will be run off its own UPS supplies fed from 125 VDC battery and charger system. Both the LMS and PCS control systems will have redundant processes.

SUBTASK 2.6 INFORMATION TECHNOLOGY (IT)/TELECOMMUNICATIONS INFRASTRUCTURE CHARACTERIZATION

The microgrid¢ control systems will operate on a system consisting of managed switches, various cable types and protocols. The CHP building plant control system (PCS) will allow supervisory control and monitoring of the CHP equipment from a centralized control room via operator workstations connected via a network switch. The two generators will each have a remote workstation allowing them to be controlled locally or from the control room. The black start diesel generator, gas compressors, HRSGs and the 13.8 kV and the 480V switchgear can all be controlled and monitored from the control room as well as locally.

The LMS will be connected to the PCS allowing the LMS to be controlled and monitored from the CHP building plant control system. A fiber optic communication system will connect all the microgrid building equipment to the LMS system and to the ESP Data center for load management signals as well as power monitoring. Remote IO equipment will be located at each building in the system to allow the control systems to monitor the buildingsqcircuit breakersq positions and to open or close the breakers. A variety of control protocols may be used such as Ethernet IP, Modbus TCP/IP and Control Net using a variety of mediums such as copper Cat 6, hardwired analog and digital points, fiber optic multi- or single mode etc. The final configurations will depend on equipment and vendors selected.

The communications between the microgrid and the utility will be in accordance with the utility procedures and protocols. A phone will be available in the operator control room to call the grid control center if communications are required.

The operation of the microgrid is not effected by any loss of communications with the utility. The grid sources are detected by the protection relays (dead bus) to

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determine if the grid is offline or online. If the source has been offline and the operator wishes to synchronize to the grid when the grid is reenergized, the operator may call the grid control center to confirm if it is okay to do so. Communications with the utility will be in accordance with the utility procedures and protocols which have not yet been identified by the utility.

E)



SECTION III ASSESSMENT OF MICROGRID'S COMMERCIAL AND FINANCIAL FEASIBILITY

SUBTASK 3.1 COMMERCIAL VIABILITY – CUSTOMERS

At a minimum, the number of individuals affected by these loads should they go unserved is 30,500¹¹ people. It is the total capacity of the three main facilities identified to hold community members (Empire State Plaza, Times Union Center and Albany Capital Center). Possibly, additional facilities of the microgrid could house community members and increase the number of individuals affected. Outside of the direct population of the City of Albany, there are a variety of agencies within these facilities that could affect operations in different areas of the state and nation. A list of these agencies has been included in Section 3.2.

Ancillary services that will be provided by this microgrid include the option to black start the CHP plant. Improved operation of the utility system will be realized due to the CHP Plant generating 118,850,000 kWh that the utility will no longer have to generate and/or provide the generated electricity to other customers. The plant will take approximately 15 MW of demand off the utility system.

All of the customers will purchase electricity only from the microgrid. The Empire State Plaza will continue to receive the steam generated from the CHP Plant and SASP.

Installation of this project will benefit the New York State agencies as mentioned in Section 3.2 without being directly involved in the installation of the project.

The Office of General Services (OGS) will be the owner of the CHP Plant generating the power and the cables, conduits, and other equipment necessary for providing each of the customers with electricity. CPT will work with OGS to develop a Power Purchase Agreement (PPA) with each of the customers to recover the capital required for the project, the cost of generating power, and annual maintenance fees. CPT will work with OGS to assist in where appropriate meters should be located to ensure that proper energy measurements are recorded for billing purposes. In addition, CPT will assist OGS in the development of monthly bills to each of the customers and additional administrative help. This will be a significant step towards success of the overall microgrid project since OGS will need to be efficient at being an energy provider.

11 Appendix Q includes references for the City of Albany population.



All microgrid customers will purchase electricity from the microgrid during normal operation. During islanded operation, there are two potential scenarios which could occur:

- 1) The CHP Plant could supply 75% of total ESP power and 100% of electric consumption to all other customers. In this scenario, the ESP would shed load to reduce its consumption.
- 2) If the CHP Plant was to provide the same percentage of power to each facility, the output is 81.4% to each facility. Each of the included facilities would need to shed load to reduce consumption.

As mentioned previously, OGS will have a PPA with these customers and will manage each of the PPAs with the individual customers. Due to the size of the OGS electric load, none of these customers are recognized as critical load purchasers for the installation of the CHP Plant. Therefore, due to the ESP consuming 85% of the plant output, the 15% of power will be consumed by the remaining customers and therefore none of the additional customers are considered critical to this project.

Our plan for gaining customer acceptance of this project is to work with OGS to meet with of each of the customers to review the 1) potential savings, 2) reliability benefits, 3) environmental benefits, and 4) societal and community benefits which can be had from this project. It is the expectation that the savings brought forth will be enough to warrant customers to join the microgrid, however the additional customers be motivated to gain the additional reliability and community benefits as well. Preliminary discussions with the additional customers have already begun and the project has been well received.

The microgrid will provide steam and chilled water to the ESP and provide chilled water to the AE Smith, NYS Capitol and NYS Education facilities. This is the current configuration for these series of buildings.

SUBTASK 3.2 COMMERCIAL VIABILITY – VALUE PROPOSITION

There are a variety of benefits that this project will bring to the downtown Albany community. The proposed microgrid will generate electricity for state, county and city owned buildings during normal operation and utility outages.

As stated previously, the population of Albany, NY is estimated to be almost 100,000² people. In the event that there was a natural disaster or super storm to affect the area, the Times Union Center, Empire State Plaza, and Albany Capital Center could provide shelter at a minimum of 30,500 people, approximately 30% of the New York State Capital **c** population. Additionally, the Times Union Center



is a Red Cross recognized center for mass inoculations. This means that if there was ever an epidemic of disease or illness to succumb the area, civilians could go to the TUC to receive proper care and vaccinations.

Currently, the emergency generation system which feeds the Empire State Plaza, New York State Capitol and the Alfred E. Smith Building is in need of an upgrade. The system is maintained to provide life-safety measures to the occupants at a minimum. Located within the buildings of the Empire State Plaza are a series of agencies which maintain critical functions for the community, state, and country. A list below has been provided by a Director of Utilities at OGS:

- **Dept. of Health** . Occupies approximately 21 floors of the Corning Tower. OGS is often asked to provide off hours utilities, i.e. lighting, HVAC, etc. for them during times of statewide health emergencies or response, like hepatitis outbreaks, etc. as they mobilize staff to man call centers, etc.
- **Dept. of Health Wadsworth Center's Biggs Laboratory** is housed at the Empire State Plaza . This lab is a key facility in meeting the departments mission related to:
 - o Research
 - Newborn Screening
 - Infectious Disease
 - Environmental Health
 - Regulatory Programs
 - o Education



- NYS Museum. Houses the states library in addition to the State Museum. Both contain priceless artifacts and rare books and documents requiring around the clock environmental controls to preserve their condition.
- **NYS Public Service Commission** is occupies the entire Agency 3 Building (20 floors):
 - Manage Public Utility oversight
 - Utility help lines for customers (Call Center)
 - Customer Hotline for utility terminations (gas or electric) (Call Center)
 - o Statewide energy curtailments managed on-site
- States Legislative Offices & Hearing Rooms on-site
 - Computer Center
- NYS Capitol Building:
 - NYS Senate & Assembly Chambers
 - NYS Division of Budget
 - NYS Executive & staff offices
 - Museum Quality artifacts
- Alfred E. Smith Building:
 - NYS Department of Criminal Justice
 - i. Call Centers
 - ii. Computer Center
 - iii. Crime Victim programs
 - iv. Support Agency for local law enforcement
 - v. Sex Offender Registry
 - vi. Missing Person/Child Information
 - NYS Department of Civil Service
 - i. Manages NYS government employee benefits programs
 - ii. Manages and administers NYS employment & recruitment
 - iii. Testing/exam management
 - iv. State and local municipality Human Resource Management
- NYS Media Services Center The Media Services Center (MSC), an OGS shared services enterprise, provides media solutions for executive agencies across the entire communications spectrum, including:
 - o public service announcement
 - location-based press event

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- o webcast
- o satellite broadcasting

There has been no feedback received from the utility on any benefits that would be recognized by National Grid with installation of this project. However, it is evident that there must be some system benefit. The microgrid is anticipated to produce 118,850,000 kWh or 81.38% of total electricity annually for these ten facilities. With an electric reduction of this magnitude on the distribution system, the utility will be able to distribute the power that is now not being consumed by the microgrid customers, to other customers on the National Grid utility system. In addition, total demand for this system will be reduced by approximately 14 MW in this location.

The electrical interconnection process has not been identified yet; however the cost of interconnection would be expected to be within \$100,000-\$400,000 for the base CHP project, not the microgrid. The additional electrical interconnection for the microgrid component of this project is estimated to be \$100,000. This is not firm, nor provided by the utility, only an estimate based on experience at other projects (Albany Medical Center, St. Joseph& Hospital, Union College, etc.).

There is an opportunity for the utility to obtain additional revenue from this project by selling the existing customer transformers and vaults at fair market value. Since the utility did not outline any costs that would be associated with this project, further investigations will be uncovered in Stage 2.

The proposed business model for this microgrid would be for OGS to finance the project through NYPA for the construction of the project. After construction of the system, OGS would enter into a Power Purchase Agreement (PPA) with each of the microgrid customers. It would be anticipated that the PPA would be contracted for a 15-20 year term. The term is typically determined by the amount of infrastructure costs that will have to be paid back by the customers over time. Although the customers will need to enter into the PPA, it is important to recognize the customers will still save money each year.

SWOT ANALYSIS

Strengths

• State, county and city agencies are all included in the customer mix of the microgrid. These agencies are long term customers and will not be closing their business/operations during the 15-20 year PPA term.



- The most facilities included in the microgrid have typical operational hours of 9-5; therefore electricity consumption will not significantly increase/decrease over time.
- OGS is a not for profit agency, therefore their thresholds for Simple Payback are higher than traditional companies. OGS also will not have to make a profit on the power they sell, just enough for any additional administrative and maintenance fees.
- The microgrid customers receive power from the utility at a lower voltage than the microgrid will provide. Therefore, by being electrically connected behind the Empire State Plaza 34.5kV utility meter, the customers will be favored under better utility rates.
- The Empire State Plaza is already a large thermal and electric consumer of energy that the additional customers are not needed to make the project realistic. However, the additional customers will increase savings for the ESP and microgrid customers, while meeting the goals set forth by New York State.

Weaknesses

• Due to various state, county and city agencies there may be various bureaucratic delays to work through.

Opportunities

- The development of pilot tariffs to lower the delivery costs of natural gas and electricity to microgrid customers, lower the state taxes associated with the energy consumed, and allow net metering for any excess power sold back to the utility.
- For the utility to recognize there is a system benefit of 118,850,000 kWh taken off of the existing system and this benefit to be financially reimbursed to the microgrid customers.
- To increase the number of construction jobs in the Capital Region during the construction period.

Threats

- The potential (but rare) threat of customers withdrawing from the microgrid.
- The inversion of natural gas and electricity prices. However, with the abundance of shale gas in the region and natural gas storage levels being at an all-time high, this should not be a viable concern for microgrid customers.
- The threat of the utility deciding not to support the project and try to halt the project due to the rights of way the utility owns.


There are several characteristics to the proposed microgrid which have been identified below:

- 1) Aggregation of Multiple Customer Services onto the OGS system behind the utility meter
- 2) Purchase of existing National Grid assets
- 3) Robust Load Management System which will monitor and shed loads as necessary during normal and emergency situation. There are 16 different load centers within just the ESP that can be shed to maintain turbines in addition to each of the microgrid customers will be able to shed load at their facilities to keep the system running through a power outage.
- Existing Backup No. 2 Fuel Storage at the SASP that without any refills or daily deliveries has enough storage on site to run the CHP system for a week.
- 5) The Refused Derived Fuel (RDF) existing building that can be taken advantage of to house the plant with minimal construction and building costs.
- 6) The microgrid will provide power to state agencies, capital and governor¢ office but other critical infrastructure as outlined earlier in Section 3.2

The CHP science and microgrid technologies have been tried and are true to success. A project like this will not only work due to geographical location, since this proposed project has already been in the marketplace for decades. The proposed project is a similar yet larger project than the existing Burrstone Energy Center located in Utica, NY.

This project is scalable because the base project includes a solid thermal host, and adding the other microgrid customers to consume electricity only increases efficiency, savings, and reliability. A microgrid as such will continue to remain scalable as long as the right mix of businesses participates within a scalable proximity.

The need for this project comes from the congested utility infrastructure located in downtown Albany. In addition, a project of this magnitude serves many energy, policy, and societal benefits. As the capital of New York State, reliability and resiliency are critical to the community and state. Various state agencies are stationed within the ESP and the full operation of these facilities is imperative for the state. Please refer to the list on in Section 3.2.

The microgrid will be designed to withstand any weather disruptions that are typical to the area. The CHP Plant will be installed indoors and above sea level, resilient to any flooding or additional weather disruptions. All of the electrical



cables will be installed underground, in concrete encased duct back which will provide full resiliency against any weather phenomenon. If a severe weather event was to impact the area, the microgrid would be able to operate fully for a minimum of one week. This is due to the existing No. 2 Fuel Oil storage on site. The CHP Plant has the ability to operate for a longer duration if refueling trucks were able to access the site and provide additional oil.

The overall value proposition can be outlined below:

- 1) Each of the customers will save money, have more reliable power and have power available to their facilities during a prolonged utility outage.
- 2) The installation of the CHP Plant will help OGS and New York State meet Executive Order 88, which requires 20% reduction in site energy by 2020
- 3) Additional savings for OGS will be recognized by adding the microgrid customers. Increased savings is a result of a) the gas turbines are operating much closer to full load and therefore are generating electricity at a more efficient rate, b) total electric consumption from each facility remains the same however the cogenerated power costs less per unit to generate versus National Grid supplied power being purchased, c) power for all customers is being purchased at the SC-7 Rate for cogenerated power which is more favorable than the existing tariffs of most customers.
- 4) All of the various command centers stated in Section 3.2 will be able to operate during prolonged utility outages to be better able to help communities throughout the state not just the Capital Region
- 5) The center of New York State Government remains viable and valuable
- 6) An annual utility reduction in 118,500,000 kWh on their system
- 7) An estimated 30,500 community members or 31% of the Albany population would be able to be housed in three out of ten facilities in the event of a natural disaster
- 8) Bette & Cring Construction, CHA Consulting, and Cogen Power Technologies . the three companies that comprise the Design-Build team are all Upstate New York companies with headquarters in NYS to promote their standing in the state and the northeast for developing the complex microgrids
- 9) Multiple construction jobs will be created throughout the installation and construction of this project.

At current commodity pricing, the savings that can be realized by this project can be as high as \$4.1M for the total of the microgrid customers. OGS would realize a small increase in savings over the base CHP project due to the gas turbines operating much closer to full load and therefore generating electricity at a more



efficient rate. Analyses of the potential savings for various cases of the microgrid have been provided in Appendix K.

There are a variety of potential revenue streams that can be developed due to the installation of this microgrid. It is dependent on the participation of NYSERDA, the utility and Public Service Commission to move forward with the development of these opportunities. Various revenue streams have been identified in a report issued by Pace Climate and Energy Center, included as Appendix L. The potential revenue streams are identified in Section 11.4 % Rotential Future Revenue Streams+.

REV Goa		Advancement of that Goal				
(Cutting greenhouse gas emissions 80% by 2050	^{<i>x</i>} Large scale combined heat and power (CHP) is core to the project providing significant efficiency benefits ^{<i>x</i>} 16MW CHP Plant will save 25,642 tons per year of CO2equivalent				
Ŷ	Making energy more afforable for all New Yorkers	["] This NY Prize project may be one of the most cost effective developments available to the State ["] If an important NY prize selection metric is ‱ost effective+resiliency, the ESP project is likely to score well. ["] Large CHP installation reduces energy spending for 10 customers, most of them government buildings including Empire State Plaza and the Capitol Building. Lower government spending means more efficient use of taxpayer dollars ["] Reduced local demand has the potential to defer local utility capital spending, saving money for all ratepayers in the National Grid territory				

This project supports each of the REV goals as outlined in the table below:



		NY PRIZE STAGE 1 FEASIBILITY ASSESSMENT AGREEMENT NO. 65038 CITY OF ALBANY
24	Improving our existing initiatives and infrastructure	["] Project will be one of the largest district energy systems in the state ["] Located in Albany, proximity allows for easy evaluation by, and collaboration with, NYSERDA, PSC, and Governor Office ["] An ideal location for setting up a market testbed+in collaboration with National Grid a potential showcase model
<u>↓</u>	Helping clean energy innovation grow	"Innovative business model provides a template for others to follow by incorporating building owners from city government, state government, and county agencies
Enst €	Building a more resilient energy system	" Dual fuel CHP systems will be able to completely island from utility in cases of grid outage or gas curtailment " Provides backup electrical power to numerous state and city buildings allowing for continuity of government services during extended grid outages, including comptrollercs offices (state government payments) and capitol building " Connected buildings could provide shelter for over 30,500 people during outages of extended duration
ŝ	Creating new jobs and business opportunities	"Empire State Plaza CHP plant is cost effective without NY Prize award. Prize funding enables a significant expansion, at a very modest incremental cost to an innovative, world class community microgrid system serving the center of New York State government

A robust Load Management System (LMS) would be installed to promote new technology. The LMS works by recognizing within 80 milliseconds that utility



power has been lost, and isolating the CHP system from the utility to create and island and provide power to the microgrid customers. The LMS will also detect and shed load where necessary on the microgrid loads to prevent the turbine from tripping offline.

SUBTASK 3.3 COMMERCIAL VIABILITY – PROJECT TEAM

The approach to gaining support from local government, community groups and residents would be similar to the approach that will be used to gain microgrid customer support. An overview of the project would be had with the appropriate groups, outlining the proposed scheme, environmental benefits and societal benefits that would be a result of installation of this project.

The Design-Build team would consist of the following firms:

- Bette & Cring Construction Group (B&C) as the General Contractor. Roles would include construction management, holding contracts with the client and subcontractors, cost estimating, project scope and budget, field management, subcontractor selection, self-performing construction work, providing the Payment and Performance Bond, and providing the Guaranteed Maximum Price (GMP) Guarantee.
- 2) Cogen Power Technologies (CPT) as the CHP Program Manager. Roles would include Development of GMP, manage interfaces with the client, design team, major equipment suppliers and utility; manage financial, technical, and scheduling aspects of major equipment contracts, testing and commissioning of the microgrid. CPT would support OGS facilities personnel for the first year of operations.
- 3) CHA Consulting, Inc. (CHA) as the Design Engineer of Record. Roles would include being the responsible design engineer of the microgrid system, interconnection with the utility and all necessary permits.

The New York Power Authority (NYPA) would be the financing partner used for deployment of this project. Additionally, NYPA will be the project manager for OGS.

The Office of General Services (OGS) would be the Owner of the CHP Plant and microgrid assets. OGS would act as an integral part of this project through development and construction, and be responsible for operations and maintenance of the system after final commissioning. It is anticipated that CPT will assist OGS with the first year of operations.

OGS, NYPA, and NYSERDA are all public entities. The private entity included in this project is Bette & Cring as the General Contractor.



It is difficult to assess the financial strength of a state agency. It can be assumed that the state is in stable financial strength. Any further information required for this item can be addressed in Stage 2 of NY Prize.

Cogen Power Technologies (Cogen) has joined with CHA Consulting, Inc. (CHA), and Bette & Cring Construction (B&C) to form a proven team to has worked together for over 7 years and forged a strong complementary bond to deliver design-build CHP solutions across the Northeast as a team.

Cogen Power Technologies (Cogen). Our business is cogeneration - plain and simple. As a CHP program manager, integrator, and operator, Cogen provides client-focused comprehensive cogeneration solutions. Cogen has worked with a number of institutions - including Albany Medical Center and Utica College- to deliver successful CHP projects from feasibility studies to design through build-out and operation. Since 2007, we developed and now own and operate a cogeneration microgrid. Burrstone Energy Center that serves Utica College, Faxton-St. Luke¢ Hospital, and St. Luke¢ Nursing Home, that has produced over 100 Million kilowatt hours of electricity. John Moynihan, Managing Partner of Cogen was the recipient of the 2014 North East Combined Heat and Power Initiative (NECHPI) Champion of the Year award.

CHA Consulting, Inc. (CHA) - With over 1400 employees and 50 offices, CHA is a highly diversified, full service engineering firm providing a wide range of planning and design services to clients for over 60 years. A licensed Mechanical, Electrical, and Structural Engineering firm headquartered in Albany, CHA has designed more than 20 different CHP plants, from 1 MW to over 110 MW, over the past 15 years in the US and Canada. CHA¢ signature projects include Albany Medical Center CHP Plant and the 30 MW CHP plant installed at Cornell University. CHA has extensive experience with permitting coordination for gas supply and electrical system interconnection, and has been complimented by National Grid for its detailed, high quality application packages.

Bette & Cring (B&C) - Since 1999, Bette & Cring has been one of the region argest General Contractors with offices in Latham and Watertown, NY. B&C has managed the design-build construction of six (6) CHP Plants including Burrstone Energy Center Microgrid, and Albany Medical Center CHP. B&C offers extensive experience in all phases of design, planning, and construction, and have constructed numerous commercial, institutional, and related capital projects over the past fifteen years. Our annual business volume was \$133 Million in 2014.



Summary of Key Combined Heat & Power Projects - PROPOSER TEAM									
		TEAM		PRIME MOVERS			FEATURES		
PROJECT	COGEN	СНА	B&C	CHP PLANT CAPACITY	STEAM CAPACITY	STEAM PRESSURE	CAMPUS MICROGRID	COMMUNITY MICROGRID	CRITICAL FACILITIES
Burrstone Energy Center CHP Microgrid Utica, NY	*		*	3.6 MW Gas Engine	7,000 pph	85 psig	*	*	*
Albany Medical Center CHP Plant Albany, NY	*	*	*	4.6 MW Gas Turbine	60,000 pph	85 psig	*		*
St. Joseph's Hospital CHP Plant Syracuse, NY	*	*	*	4.6 MW Gas Turbine	45,000 pph	85 psig	*		*
Cornell University CHP Plant Ithaca, NY		*		30 MW Gas Turbine	300,000 pph	400 psig	*		*
Kingston General Hospital/Queen's University CHP Microgrid Kingston, ON		*		15 MW Gas Turbine	150,000 pph	275 psig	*	*	*
Union College CHP Plant Schenectady, NY	*	*	*	1.75 MW Gas Turbine	45,000 pph	90 psig	*		*
GUSC Energy Biomass Plant Rome, NY	*	*	*	1 MW	40,000 pph	\$16 Million			
CHP FEASIBILITY STUDIES (BY COGEN/CHA/B&C TEAM)									
4.6 MW – St. Joseph's Hospital Cogeneration Plant, Syracuse, NY • 4.6 MW - Bay State Hospital Cogeneration Plant, Springfield, MA • 1.8 MW - Union College Cogeneration Plant, Schenectady, NY • 1 MW - Skidmore College Cogeneration Plant, Saratoga Springs, NY • 1 MW - Williams College Cogeneration Plant, Williamstown, MA • 555 kW Opeida Healthcare									

Facility, Oneida, NY • 10 MW - Central Pennsylvania Manufacturer

The General Contractor for this project would be Bette & Cring, LLC. Services provided would be construction management, holding contracts with the client and subcontractors, cost estimating, project scope and budget, field management, subcontractor selection, self-performing construction work, providing the Payment and Performance Bond, and providing the Guaranteed Maximum Price (GMP) Guarantee.

NYPA will serve as the financing entity for the project. The financing will be under the OGS Energy Service Agreement between NYPA and OGS.

Included on the team is Thomas G. Bourgeois, Deputy Director and his team at the Pace Energy and Climate Center (Pace) who will aid in the regulatory advisement of the project. For more than 25 years, Pace has worked in New York and across the Northeast region engaging government, communities, businesses, and key stakeholders in action that leads to better energy and climate policy. Paces diverse staff conducts research and analysis, finding solutions to meet todays complex energy and climate change challenges.¹²

¹² Cited per Pace Climate and Energy Center proposal to CPT dated November 5, 2015.



Legal advisement for the project team will include Robert Loughney at Couch White, LLP. Couch White, LLP is a full-service business law firm with nationally-recognized leadership in the practice of energy and construction law. Their business law practice areas include banking, commercial and corporate law, environmental, renewable energy, land use, zoning and real estate development, government contracts, labor and employment, litigation, real estate and trusts, estates and business succession planning.¹³ Couch White was the attorney used for the development of Burrstone Energy Center and was instrumental in helping to navigate through the same microgrid issues that face this project.

SUBTASK 3.4 COMMERCIAL VIABILITY – CREATING AND DELIVERING VALUE

The technologies chosen for this microgrid include electricity generation in the form of gas turbine generators (GTGs) installed as part of a Combined Heat and Power (CHP) plant and controls for electric load shedding. It had previously been determined that a GTG powered CHP sized to supply the average electrical load of the Empire State Plaza (ESP) complex as well as the average thermal energy load with some extra capacity would make a feasible project. The large steam demand of the ESP makes this CHP technology a perfect candidate for installation of this size unit. This CHP technology is well proven as a reliable electricity supply system from previous similar installations. The addition of electrical loads from microgrid customers would improve the utilization of the GTGs.

The main benefit of the CHP is that it can remain in operation during loss of utility supplied electricity and/or the loss of the natural gas fuel supply. Under normal conditions, the microgrid is connected to the utility system and can import electricity, as needed, when the system demand exceeds the generation capacity of the CHP. The GTGs can fire natural gas or No. 2 fuel oil to power the microgrid while in islanded mode. This allows the microgrid to continue operation during loss of utility power, even if the natural gas supply is interrupted. Fuel oil is stored on site in sufficient quantities to operate the CHP for at least 7 days. Each facility will have its own emergency power supply system to handle life safety electrical loads and a black start generator will be available to restart the CHP in case of a trip during a utility power outage. The CHP will also supply steam for heating and cooling of facilities in the ESP and the adjacent State government buildings. An additional benefit of the CHP is that it will potentially result in cost savings to the ESP and the microgrid customers during normal operation due to improved efficiency of the combined generation of electricity and thermal energy resulting in lower cost energy being supplied to these facilities.



The challenges of employing the CHP technology will be to ensure that adequate electricity and steam can be supplied to all users during loss of the utility electrical supply. Although the installed generation capacity will meet a significant part of the microgrid electrical load, load shedding will be required to ensure that GTG capacity is not exceeded during high load periods. The challenge will be to effectively implement the load shedding in order to balance the needs of all facilities connected to the microgrid. Steam demand may at times exceed the steam output capacity of the CHP. During these periods, additional steam can be generated by the existing dual fuel boilers in the Sheridan Avenue Steam Plant firing natural gas when available and fuel oil when the gas supply is interrupted. To ensure reliability of the CHP, a comprehensive maintenance schedule will be implemented requiring periodic shutdowns to conduct inspections and service the equipment. One of the challenges will be to schedule these shutdowns to avoid periods when forces of nature events are most likely to occur. The maintenance schedule will also aim to ensure that only one of the two GTG/HRSG combinations is unavailable for any period.

The existing RDF building is a critical component of infrastructure that can be leveraged to house the CHP Plant and save a significant amount of construction costs. Natural gas, fuel oil, and steam tie in points are available for use for the CHP Plant. The existing steam tunnel which runs from the SASP to the ESP is another significant asset which can be leveraged, since the cost of running thermal distribution systems over long distances can often be uneconomical. The No. 2 Fuel Oil tanks are existing assets of the SASP site which has substantial benefit and cost savings towards the project.

As discussed, the CHP will be operated by OGS whom also operates the ESP and the adjacent state buildings. To ensure that electrical generation capacity of the CHP is not exceeded during an outage of the utility electrical supply, load shedding will be implemented, as necessary, affecting only the ESP and some of the adjacent state government facilities. Other microgrid customers would not be affected.

OGS will have full control of the steam generation at the CHP and Sheridan Avenue Steam Plant as well as consumption at the ESP and connected adjacent state buildings. If necessary, to conserve fuel oil during an extended natural gas interruption, non-critical steam loads can be shut down or reduced.

During the construction of the project, standard construction building permits would be required. In addition, the team will work with the New York State



Department of Environmental Conservation (DEC) to modify the Air Permit for inclusion of this project.

A comprehensive electrical interconnection with the utility will have to be successfully navigated to ensure the proper requirements are met.

Special permissions for this project will need to come from the utility regarding the following items:

- 1) Rights of Way for crossing a public road
- 2) Aggregation of multiple electrical customers down to one through the Empire State Plaza
- 3) Leasing or buying existing utility infrastructure

The proposed approach for development and construction of this project will be a Design-Build method. Through this method, project costs can be minimized due to less engineering fees and this method significantly reduces the project duration for design and construction so that the microgrid customers may realize the benefits and savings sooner.

It is expected that CPT will assist OGS in the first year of operations to ensure proper procedures and maintenance of the microgrid system.

The community will recognize two major benefits from the deployment of this project. First being that in the event of a natural disaster, the microgrid facilities will be available to provide shelter to community members for a prolonged duration. Second, there will be more energy available to community members from the utility since the microgrid will be producing its own. It is not expected that the community should incur any costs due to implementation of this project.

In order the utility to ensure that this project can benefit the microgrid customers and the community, the utility will need to provide cooperation with the following items:

1) Rights of Way for crossing a public road

- 2) Aggregation of multiple electrical customers down to one through the Empire State Plaza
- 3) Leasing or buying existing utility infrastructure

Each of the microgrid technologies that will be used as a part of this project have been previously implemented elsewhere. The Solar Turbines Taurus 70 has over 800 units worldwide, generating electricity and recovering the exhaust heat in a



thermal application. The Load Management System (LMS) has been employed at a variety of sites, including Albany Medical Center specifically.

It is anticipated that the CHP Plant will operate at a minimum of 95% of the year, only unavailable during times of scheduled maintenance outages. Given the availability of the system, the system will be operating almost all year round to ensure that all of the goals of the system are being met.

OGS will act as the energy provider and issue monthly bills to the microgrid customers. The CHP Plant will generate power and distribute to the microgrid customers at the cost of generating power. An additional fixed monthly fee to recover the capital investment in the microgrid infrastructure will be applied. A small administrative fee may be included as well for the overall management and development of the monthly bills. CPT will assist OGS in the development of their charging strategy to customers. Usage of the microgrid customers will be metered by the installation of standard revenue grade meters at each location.

This project is a slight variation of the successful microgrid implementation at Burrstone Energy Center in Utica, NY. This approach is scalable and portable to any city or community in the country with an appropriate energy profile.

The barriers to market entry for this project lie solely with participation of the utility.

Based on past success at the Burrstone Energy Center, CPT feels very optimistic that this project is similar and on a grander scale and fully capable to step through the barriers of this project.

SUBTASK 3.5 FINANCIAL VIABILITY

At current commodity pricing, the annual savings that can flow to the microgrid owner can be as high as \$2.73M. OGS would realize a small increase in savings over the base CHP project due to the gas turbines operating much closer to full load and therefore generating electricity at a more efficient rate.

In order for the microgrid customers to save money, the issues outlined in the SWOT Analysis in Section 3.2 regarding delivery charges of commodities, state taxes, etc. will need to come to fruition to enhance the economics to the customers and microgrid owner. Without these types of changes in the microgrid landscape, it will be difficult (if not impossible) for other projects that are not as robust as this project to materialize. The major incentive that will be required for this project to be deployed and successful is the \$5M-\$7M NYSERDA subsidy available through NY Prize.



A summary of the anticipated capital and operating costs of this microgrid have been included in Appendix M. It is important to be noted that the capital and operating costs outlined include the microgrid components **only**, not the installation and maintenance of the CHP Plant.

The business model for this project will be profitable because all of the microgrid customers will save money. OGS already provides thermal energy to some of the microgrid customers, enhancing their ability to be an energy provider for additional customers.

There are several models that can be employed, but traditional NYPA Financing is anticipated. NYPA would be responsible for paying the contractors for preestablished milestones. Near completion, NYPA would develop a substantial construction milestone re-payment plan and bill OGS for these efforts. Payments would be modified at conclusion of project for reconciled costs.

SUBTASK 3.6 LEGAL VIABILITY

The proposed ownership of the CHP Plant and microgrid assets will fall under the Office of General Services. OGS will act as an energy provider to the microgrid customers and have full ownership.

The project owner will be the Office of General Services and the applicant is Cogen Power Technologies (CPT). CPT completed the Level III Feasibility Assessment for the ESP/SASP for the base project of the CHP Plant.

OGS owns the RDF, all equipment and associated land necessary for the CHP Plant.

The approach to protecting the privacy rights of the microgrid customers would be to engage each customer individually to discuss if they would want their name associated with the project. The approach would be to explain that the customer would become a part of the ESP electrical infrastructure and no longer be a customer of National Grid. All energy consumption would be monitored and measured by the OGS measurement and verification (M&V) systems, not by National Grid. Eliminating National Grid and keeping the M&V more centralized within the OGS system provides an additional level of privacy. Additionally, any contractual agreements between customers and OGS would be confidential.

The major regulatory hurdles that could implicate this project are:

1) Crossing public roads



- 2) The aggregation of multiple electric services
- 3) Buying or leasing existing utility equipment

The plan to address these issues is to follow the same path that was used at Burrstone Energy Center. Robert Loughney at Couch White, LLP will be hired to help navigate a waiver to cross public roads with the PSC and National Grid support. The Burrstone Energy Centerc waiver number through the PSC for this project is Case 07-E-0802 and included in Appendix N. Thomas G. Bourgeois of the Pace Energy and Climate Center has been included on the project team to navigate the aggregation of multiple electric services and the buying/leasing of existing utility equipment.



SECTION IV DEVELOP INFORMATION FOR BENEFIT COST ANALYSIS

Each of the Facility Questionnaires and the Microgrid Questionnaire were submitted to IEC for proper analyzing for the Benefit Cost Analysis (BCA). The BCA result for this microgrid study is 1.1 without any days of power outages, with a Net Benefits . Present Value of \$28,200,000 and an Internal Rate of Return at 25.4%. A second case for a BCA of 1.0 or greater was not necessary since the microgrid BCA reached the 1.0 goal without any power outages needed. The information provided by IEC for the BCA has been included in Appendix O.



SECTION V FINAL WRITTEN DOCUMENTATION

E)

The final presentation was held on March 23, 2015 at the Albany office of NYPA. In attendance were members from OGS, NYPA, NYSERDA, CHA, and CPT. A copy of the final presentation has been included in Appendix P.



SECTION VI APPENDICES

- A. GEOGRAPHICAL LOCATION OF PROPOSED MICROGRID
- B. EMPIRE STATE PLAZA RESOURCE SHEET
- C. TIMES UNION CENTER RESOURCE SHEET
- D. ALBANY CAPITAL CENTER RESOURCE SHEET
- E. HISTORICAL AND RECENT CRESTS FOR ALBANY, NY
- F. ELECTRICAL CABLE LAYOUT DIAGRAM
- G. CHP PLANT EQUIPMENT LAYOUT DIAGRAMS
- H. ELECTRICAL SINGLE LINE DIAGRAMS
- I. MONTHLY ENERGY LOADS
- J. LOAD PROFILES
- K. SAVINGS ANALYSIS BY CASE
- L. PACE CLIMATE AND ENERGY CENTER . NY PRIZE REPORT
- M. CAPITAL AND OPERATING COSTS
- N. BURRSTONE ENERGY CENTER PSC WAIVER
- O. BENEFIT COST ANALYSIS
- P. FINAL PRESENTATION
- Q. REFERENCES



APPENDIX A

GEOGRAPHICAL LOCATION OF PROPOSED MICROGRID

Microgrid Customers







APPENDIX B

EMPIRE STATE PLAZA RESOURCE SHEET

E)



ABOUT THE CAPITAL CENTER + PLAN YOUR EVENT + WHAT IS THE CAPITAL COMPLEX? PLAN YOUR VISIT + NEWS & EVENTS FREQUENTLY ASKED QUESTIONS CONTACT US +

Home > Plan Your Event > Empire State Plaza Convention Center

EMPIRE STATE PLAZA CONVENTION CENTER





The flexible Convention Center space can accommodate groups from 10 to 10,000. It is ideally situated to enjoy the unique amenities of the government seat of New York. Visitors can enjoy touring the Plaza and its Memorials, the Capitol Building, Executive Mansion, the Plaza Art Collection and the New York State Museum. Furthermore, just a short walk away, you'll find world-class museums, unique galleries, stunning architecture, gourmet restaurants, and all the welcoming accommodations of the capital city.



APPENDIX C

TIMES UNION CENTER RESOURCE SHEET



ABOUT THE CAPITAL CENTER - PLAN YOUR EVENT - WHAT IS THE CAPITAL COMPLEX? PLAN YOUR VISIT - NEWS & EVENTS FREQUENTLY ASKED QUESTIONS CONTACT US -

TIMES UNION CENTER



Albany's Times Union Center, formerly Pepsi Arena, continues to have great success. Renamed in January 2007, the The Times Union Center is "Upstate New York's Premier Sports and Entertainment Facility."



Owned by Albany County and operated by SMG, the world's largest private management firm for public assembly facilities, the Times Union Center has an adaptable seating capacity between 6,000 and 17,500. Since Frank Sinatra christened the building on January 30, 1990, more than seven million patrons have walked through the turnstiles. As a multi-purpose facility, the **Times Union Center has hosted a variety of events, including concerts, family shows and sporting events, averaging 165 events each year**.

Times Union Center has developed a rich history of events over the past eleven years. Albany County, SMG and the Capital Region look forward to a future filled with the biggest names in sports and entertainment.



APPENDIX D

ALBANY CAPITAL CENTER RESOURCE SHEET





Contact Information:

Shannon Licygiewicz, Director of Sales (518) 487-2009 shannon.licygiewicz@albanycapitalcenter.com

ALBANYCAPITALCENTER.COM



Located in the historic downtown of New York's Capital City, the Albany Capital Center will provide state of the art convention, ballroom, and meeting space. The facility will have direct connections to the Empire State Plaza Convention Center, The Egg Performing Arts Center, and the Times Union Center arena, creating the Capital Complex, the largest meeting space in Upstate New York.



Facility Address (Under Construction): Albany Capital Center, 55 Eagle Street, Albany NY 12207 Mailing Address: Albany Capital Center c/o Times Union Center, 51 South Pearl Street, Albany NY 12207



OPENING EARLY 2017! AlbanyCapitalCenter.com



Room	Est. Useable Space (LxW)	Sq. Feet*	Theatre	Classroom	Banquet
Capital Room**	40' × 25'	1,000	100	51	50
MR 1-A	55' × 30'	1,650	192	96	100
MR 1-B	55' × 30'	1,650	192	96	100
Combined	55' x 60'	3,300	400	192	220
MR 2-A	55' × 30'	1,650	182	96	100
MR 2-B	55' × 30'	1,650	182	96	100
MR 2-C	55' × 30'	1,650	182	96	100
Combined	55' x 89'	4,900	600	288	320
PRE-FUNCTION	Varies	10,500			

Level 1

- Pre-function space 10,500 sq. ft.
- Meeting Room 1 3,300 sq. ft. divisible into two 1,650 sq. ft. rooms
- Meeting Room 2 4,900 sq. ft. divisible into three 1,650 sq. ft. rooms
- Capital Room 1,000 sq. ft.

Room	Est. Useable Space (LxW)	Sq. Feet*	Theatre	Classroom	Banquet	10' x 10' Booths		
Multi-Purpose Room	109' x 200'	22,500	2,700	1,224	1,420	110		
PRE-FUNCTION	Varies	3,100						
Combined		25,600						
with Airwall								
Multi-Purpose Room	109՝ x 142՝	15,600	1,900	882	940	75		
PRE-FUNCTION	Varies	10,000				25		

Level 2 (without air wall)

- Pre-function space 3,100 sq. ft.
- Multipurpose space 22,500 sq. ft.

Level 2 (with air wall)

- Pre-function space 10,000 sq. ft.
- Multipurpose space 15,600 sq. ft.



Parking

- 130 vehicles within 3 underground levels
- Connected to Times Union Center garage (950 spaces) and Empire State Plaza Convention Center parking garage (450 spaces)
- Additional downtown parking lots/garages

Pedestrian Walkway

- Connected to Empire State Plaza, Convention Center, and the Times Union Center
- Connected to Renaissance Albany

Nearby Hotels

Renaissance Albany, 204 rooms Hilton Albany, 385 rooms Hampton Inn & Suites, Albany Downtown, 165 rooms Fairfield Inn & Suites (formerly 74 State), 74 rooms Holiday Inn Express, Albany Downtown, 135 rooms





APPENDIX E

HISTORICAL AND RECENT CRESTS FOR ALBANY, NY

Historic Crests

(1) 21.71 ft on 02/09/1857 (2) 21.45 ft on 03/28/1913 (3) 20.42 ft on 02/14/1900 (4) 18.98 ft on 10/05/1869 (5) 17.86 ft on 03/19/1936 (6) 17.50 ft on 01/01/1949 (7) 17.40 ft on 03/02/1910 (8) 17.00 ft on 02/21/1909 (9) 16.50 ft on 09/22/1938 (10) 15.96 ft on 11/05/1927 (11) 15.50 ft on 01/20/1996 (12) 15.40 ft on 08/29/2011 (13) 15.40 ft on 10/10/1903 (14) 15.30 ft on 03/13/1936 (15) 14.47 ft on 03/15/1977 (16) 12.69 ft on 04/05/1960 (17) 11.46 ft on 01/09/1998 (18) 11.33 ft on 10/30/2012 (19) 11.32 ft on 09/09/2011 (20) 11.10 ft on 08/28/2011 (21) 10.90 ft on 10/17/1955 (22) 10.14 ft on 03/30/1993 (23) 10.05 ft on 05/31/1984 (24) 9.78 ft on 03/22/1980 (25) 9.51 ft on 04/26/1983 (26) 9.45 ft on 04/05/1987 (27) 9.31 ft on 02/25/1975 (28) 8.77 ft on 04/05/1973 (29) 8.58 ft on 12/02/1996 (30) 8.57 ft on 03/16/1986 (31) 8.39 ft on 05/22/1990 (32) 8.21 ft on 11/09/1996 (33) 8.06 ft on 05/07/1989 (34) 7.92 ft on 04/17/1994 (35) 7.56 ft on 12/11/1992 (36) 7.33 ft on 12/28/1973 (37) 7.22 ft on 04/07/1997 (38) 6.87 ft on 04/22/1991 (39) 6.71 ft on 07/04/1974 (40) 6.62 ft on 09/27/1985 (41) 6.45 ft on 03/04/1999 (42) 6.24 ft on 04/07/1988 (43) 6.14 ft on 01/21/1995

(P): Preliminary values subject to further review.

Recent Crests

(1) 11.33 ft on 10/30/2012 (2) 11.32 ft on 09/09/2011 (3) 15.40 ft on 08/29/2011 (4) 11.10 ft on 08/28/2011 (5) 6.45 ft on 03/04/1999 (6) 11.46 ft on 01/09/1998 (7) 7.22 ft on 04/07/1997 (8) 8.58 ft on 12/02/1996 (9) 8.21 ft on 11/09/1996 (10) 15.50 ft on 01/20/1996 (11) 6.14 ft on 01/21/1995 (12) 7.92 ft on 04/17/1994 (13) 10.14 ft on 03/30/1993 (14) 7.56 ft on 12/11/1992 (15) 6.87 ft on 04/22/1991 (16) 8.39 ft on 05/22/1990 (17) 8.06 ft on 05/07/1989 (18) 6.24 ft on 04/07/1988 (19) 9.45 ft on 04/05/1987 (20) 8.57 ft on 03/16/1986 (21) 6.62 ft on 09/27/1985 (22) 10.05 ft on 05/31/1984 (23) 9.51 ft on 04/26/1983 (24) 9.78 ft on 03/22/1980 (25) 14.47 ft on 03/15/1977 (26) 9.31 ft on 02/25/1975 (27) 6.71 ft on 07/04/1974 (28) 7.33 ft on 12/28/1973 (29) 8.77 ft on 04/05/1973 (30) 12.69 ft on 04/05/1960 (31) 10.90 ft on 10/17/1955 (32) 17.50 ft on 01/01/1949 (33) 16.50 ft on 09/22/1938 (34) 17.86 ft on 03/19/1936 (35) 15.30 ft on 03/13/1936 (36) 15.96 ft on 11/05/1927 (37) 21.45 ft on 03/28/1913 (38) 17.40 ft on 03/02/1910 (39) 17.00 ft on 02/21/1909 (40) 15.40 ft on 10/10/1903 (41) 20.42 ft on 02/14/1900 (42) 18.98 ft on 10/05/1869 (43) 21.71 ft on 02/09/1857

(P): Preliminary values subject to further review.



APPENDIX F

ELECTRICAL CABLE LAYOUT DIAGRAM

E)





APPENDIX G

CHP PLANT EQUIPMENT LAYOUT DIAGRAMS









APPENDIX H

ELECTRICAL SINGLE LINE DIAGRAMS

E)








APPENDIX I

MONTHLY ENERGY LOADS

E)

NY PRIZE- ALBANY NY EMPIRE STATE PLAZA MICROGRID

Project: 30604 Date: Jan 21/16

	TOTAL		Empire State Plaza		AE Smith Building		Capitol			Education Building			Education Building Annex					
	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
January	13,751.8	18,248.2	24,907.5	10,549.4	14,023.0	18,715.2	470.0	723.1	1,138.0	389.0	579.6	951.0	388.6	586.5	824.5	213.6	323.4	499.2
February	13,639.6	17,836.1	25,163.5	10,652.9	13,729.2	19,147.0	537.0	731.6	1,147.0	394.0	553.0	916.0	438.6	592.5	804.7	207.6	288.2	436.8
March	13,759.0	17,669.5	25,019.8	10,298.7	13,559.3	19,086.3	485.0	721.6	1,145.0	403.0	599.6	910.0	435.2	588.2	792.4	213.6	273.3	412.2
April	12,285.7	16,634.8	24,030.2	9,607.4	12,700.6	18,500.4	428.0	655.0	1,065.0	358.0	525.3	888.0	338.5	557.1	795.4	189.0	269.8	422.4
May	12,056.0	16,106.0	24,828.0	9,368.3	12,267.6	19,198.8	439.0	639.7	1,041.0	340.0	529.6	908.0	324.0	507.6	748.4	199.8	272.5	430.2
June	12,592.6	16,649.3	24,877.3	9,612.6	12,517.3	18,771.0	493.0	735.8	1,135.0	376.0	578.5	960.0	322.1	516.0	758.5	199.8	293.7	452.4
July	12,561.6	16,570.0	24,167.8	9,416.3	12,229.1	17,717.6	558.0	769.8	1,123.0	390.0	528.2	802.0	413.0	557.3	751.2	273.0	334.9	473.4
August	12,078.5	15,775.5	23,042.2	9,232.5	11,807.6	17,602.1	491.0	718.4	1,112.0	390.0	511.0	786.0	396.4	544.8	714.4	234.0	328.3	481.8
September	12,195.5	16,138.9	23,596.2	9,252.8	12,115.7	17,788.9	552.0	733.5	1,106.0	147.0	507.2	790.0	331.8	512.6	714.4	207.6	285.9	424.2
October	11,968.6	16,245.6	23,571.3	8,523.3	12,397.7	17,934.6	442.0	643.8	1,027.0	329.0	487.4	790.0	227.8	487.2	712.8	186.6	274.4	420.0
November	12,486.8	15,808.1	23,182.6	9,419.2	12,094.4	17,866.4	472.0	638.3	1,051.0	366.0	474.5	800.0	316.8	485.2	729.0	177.6	250.4	433.8
December	12,895.0	16,453.6	23,173.8	10,108.4	12,645.4	17,635.5	441.0	654.8	1,040.0	368.0	497.8	767.0	343.7	573.9	767.3	194.4	254.6	396.6
Annual	11,968.6	16,672.3	25,163.5	8,523.3	12,668.6	19,198.8	428.0	696.9	1,147.0	147.0	530.9	960.0	227.8	542.3	824.5	177.6	287.6	499.2
	Times Union Center		enter	Alban	y Capital (Center	110 State St		112 State St		County Courthouse			City Hall				
	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
January	231.8	727.7	1,293.6	73.8	231.7	412.0	482.0	749.0	1,259.0	49.6	107.3	211.2	88.8	152.0	247.3	23.6	44.8	94.4
February	415.0	666.3	1,127.3	132.2	212.2	359.0	513.0	771.8	1,245.0	47.2	97.4	204.0	90.8	149.9	246.9	23.6	43.7	94.4
March	396.9	645.0	1,123.9	126.4	205.4	357.9	533.0	789.1	1,271.0	48.0	95.2	199.2	87.3	150.9	243.6	22.0	41.7	88.0
April	353.2	603.5	1,348.2	112.5	192.2	429.4	538.0	834.0	1,853.0	47.2	100.1	318.4	90.2	154.6	246.3	21.6	42.6	86.4

Table 1 - Electrical Load Summary

	Times Union Center		Albany Capital Center		110 State St		112 State St		County Courthouse			City Hall						
	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.
	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
January	231.8	727.7	1,293.6	73.8	231.7	412.0	482.0	749.0	1,259.0	49.6	107.3	211.2	88.8	152.0	247.3	23.6	44.8	94.4
February	415.0	666.3	1,127.3	132.2	212.2	359.0	513.0	771.8	1,245.0	47.2	97.4	204.0	90.8	149.9	246.9	23.6	43.7	94.4
March	396.9	645.0	1,123.9	126.4	205.4	357.9	533.0	789.1	1,271.0	48.0	95.2	199.2	87.3	150.9	243.6	22.0	41.7	88.0
April	353.2	603.5	1,348.2	112.5	192.2	429.4	538.0	834.0	1,853.0	47.2	100.1	318.4	90.2	154.6	246.3	21.6	42.6	86.4
May	301.2	551.1	1,360.4	95.9	175.5	433.3	509.0	842.1	1,518.0	52.8	137.3	384.0	78.2	145.7	242.2	19.2	37.3	76.8
June	389.8	545.7	1,018.1	124.1	173.8	324.2	518.0	902.8	1,653.0	63.2	193.1	432.0	81.1	151.6	247.8	14.3	41.1	105.6
July	416.2	614.8	1,438.1	132.6	195.8	458.0	526.0	918.7	1,900.0	66.4	216.0	472.8	83.5	149.6	236.0	14.3	55.8	140.8
August	189.4	467.5	1,040.3	60.3	148.9	331.3	492.0	868.4	1,476.0	62.4	180.8	380.0	79.6	146.2	227.8	19.0	53.6	140.8
September	335.6	590.5	1,322.2	106.9	188.1	421.1	462.0	846.0	1,709.0	69.6	164.5	377.6	80.8	141.6	233.4	18.4	53.5	136.0
October	303.7	639.7	1,253.7	96.7	203.7	399.3	459.0	796.7	1,531.0	59.2	131.0	352.0	80.6	146.2	234.5	18.4	38.0	78.4
November	360.4	669.4	1,380.6	114.8	213.2	439.7	471.0	701.0	1,327.0	52.8	106.1	199.2	75.7	139.4	236.4	19.2	36.2	76.8
December	417.9	615.6	1,274.7	133.1	196.0	406.0	454.0	719.8	1,185.0	56.8	112.7	203.2	89.4	143.5	230.8	19.2	39.6	80.0
Annual	189.4	611.0	1,438.1	60.3	194.6	458.0	454.0	811.8	1,900.0	47.2	137.1	472.8	75.7	147.6	247.8	14.3	44.0	140.8

CHART 1





NY PRIZE- ALBANY NY EMPIRE STATE PLAZA MICROGRID

Project: 30604 Jan 21/16

Date:

Table 2 - Electrical Consumption Summary

	Total	Empire State Plaza	AE Smith	Capitol	Education	Education Annex	Times Union Center	ACC	110 State	112 State	Courthouse	City Hall
	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh	kWh
January	13,558,441	10,419,116	537,249	430,658	435,787	240,296	540,657	172,189	556,527	79,730	112,936	33,295
February	11,985,830	9,226,034	491,624	371,620	398,181	193,704	447,786	142,611	518,667	65,477	100,759	29,368
March	13,146,090	10,088,154	536,896	446,107	437,629	203,318	479,869	152,829	587,119	70,803	112,306	31,061
April	11,977,059	9,144,468	471,582	378,180	401,132	194,274	434,513	138,384	600,477	72,100	111,285	30,664
May	11,982,901	9,127,117	475,954	394,034	377,623	202,704	410,045	130,591	626,553	102,166	108,394	27,720
June	11,987,495	9,012,451	529,780	416,528	371,509	211,455	392,895	125,129	650,017	139,012	109,123	29,596
July	12,328,090	9,098,446	572,711	392,993	414,654	249,168	457,378	145,666	683,500	160,720	111,334	41,521
August	11,736,996	8,784,821	534,473	380,189	405,335	244,223	347,832	110,778	646,114	134,537	108,786	39,910
September	11,619,998	8,723,339	528,090	365,158	369,047	205,871	425,132	135,396	609,129	118,412	101,938	38,485
October	12,086,705	9,223,887	478,973	362,590	362,450	204,138	475,901	151,565	592,709	97,452	108,746	28,293
November	11,381,806	8,707,936	459,585	341,638	349,350	180,309	481,990	153,504	504,698	76,401	100,360	26,036
December	12,257,951	9,420,808	487,834	370,862	427,535	189,663	458,586	146,050	536,235	83,932	106,919	29,527
Annual	146,049,361	110,976,577	6,104,751	4,650,557	4,750,231	2,519,122	5,352,584	1,704,692	7,111,745	1,200,742	1,292,886	385,476

CHART 2





APPENDIX J

LOAD PROFILES

_____(=)

CHART 3



CHART 4



1/21/2016



APPENDIX K

SAVINGS ANALYSIS BY CASE

E)



COGEN POWER TECHNOLOGIES	Project:	30604
NY PRIZE- EMPIRE STATE PLAZA MICROGRID	Date:	29/1/2016
ESP MICROGRID CUSTOMER SAVINGS SUMMARY	Issue:	05

Electricity is sold to microgrid customers at the cost of electricty							
purchased by ESP unde	er PSC 220 T	Гariff SC-7 (SC-3	A) with no				
d	discount applied						
ESP/SASP CHP Savings	CASE 1	CASE 2	CASE 3				
Total ESP Savings	\$575,370	\$877,562	\$899,267				
Customer Savings	CASE 1	CASE 2	CASE 3				
AE Smith	\$68,755	\$88,464	\$90,410				
Capitol	\$44,606	\$59 <i>,</i> 553	\$61,032				
Education 1	\$261,640	\$276,857	\$278,364				
Education 2	\$28,246	\$36,432	\$37,241				
TUC	\$0	\$115,453	\$117,127				
ACC	\$0	\$36,769	\$37,303				
110 State	\$0	\$156,405	\$158,667				
112 State	\$0	\$54,767	\$55,158				
City Hall	\$0	\$0	\$15,905				
Court House	\$0	\$0	\$28,554				
Total Customer Savings	\$403,247	\$824,700	\$879,761				



APPENDIX L

PACE CLIMATE AND ENERGY CENTER – NY PRIZE REPORT

FD

Business Model Analysis: Albany Empire State Plaza

1 Project Specific Overview

The Albany Empire State Plaza project ("ESP") is an ideal candidate for selection for NY Prize for several reasons. NY Prize seeks to demonstrate the viability of microgrids as an important component of a critical infrastructure resiliency strategy.

Superior microgrid projects at this early stage of market deployment are those that can address and test a variety of technical, legal/regulatory and business model challenges. All else being equal an ideal project is one that tests the multiple aspects of the value proposition to the end-user, the grid, and to society at large and does so at reasonable total cost. We can credibly assert that the Albany project stands out in this regard. The proposed system, including up to 10 end-users, is an ideal test case in purchasing major resiliency benefits, positively affecting thousands of New Yorkers, at a modest incremental cost.

Because there are sizeable end-user benefits that accrue from the Combined Heat and Power (CHP) investment at this site the CHP project will be undertaken by New York State Office of General Services (OGS) regardless of whether or not the multi-party microgrid is ultimately part of the plan. The close proximity of additional customers, who can be served at a modest incremental cost, represent a sizeable resiliency benefit with an atypically small price tag for the size.

Additionally, the cost of financing is a major component of operating costs. When considering the "cost stack", the cost of capital is near the top. In order to lower the total cost of operation, to improve economic viability and return on investment, it's critical to focus on the optimal financing plan. The Albany: ESP project is fortunate to benefit from very attractive financing available from NYPA. The low cost of financing creates for this proposed development is an important advantage that markedly improves the economic viability.

When projects are being ranked, scored and considered for Stage 2, we suggest that an important metric is "per-capita resiliency" benefit, per State dollar invested. This cost effective, Albany:ESP project should rank well on the numbers of people that can be provided with a resiliency benefit, per incremental dollar spent.

1.1 Minimizing Project Development Risk

The single user microgrid at Albany is going forward, with or without the addition of other customers and implementation of a multi-user microgrid that NY Prize would enable. When rating and scoring projects weight should be given to developments with a high probability of occurrence.

State incentive programs, whether in NY or any other jurisdiction, are prone to some degree of project attrition risks. Before the development of its highly successful Market Acceleration Program Historic CHP programs had an attrition rate of greater than 50%, that is, more than half of those earlier generation awarded projects never made it to being operational – typically never even ordered equipment. We suggest that the more complex the project, the greater is the risk that it doesn't proceed to completion. Multi-user microgrids are particularly challenging insofar as they involve organizing the interests of multiple unaffiliated entities, combining a suite of technologies and operating within a current regulatory environment that has not been designed to accommodate microgrids. Given the stand-alone viability of the CHP system and the commitment of OGS and NYPA, the Albany project should rank well when compared to other Stage 2 candidates on the probability of moving to completion.

The Albany ESP project will go forward as a "campus system". For a modest incremental cost, the benefits can be extended to up to 10 buildings, in a multi-party microgrid. Project development risk is small

1.2 Exploring Opportunities for Testing REV Concepts

The projects selected for NY Prize can and will provide information for refining the concepts and the regulatory structures that will be the future foundation for REV. Maximizing the value of DER as dynamic assets serving the grid requires new systems that integrate traditional utility tools such as DMS and SCADA systems, and leveraging existing and emerging utility databases and other systems such as CIS, OMS and AMI.

As this project proceeds, the development team will make a concerted effort to collaborate with National Grid (NG) to identify and test new market concepts. As one example, there has been some discussion of National Grid hosting a pilot that might include collection of detailed information regarding the interaction of a microgrid with the distribution system for the purpose of developing a knowledge base that can optimize distributed energy management, grid operations, and planning.

Empire State Plaza, as home to State Government, is an ideal location to serve as a test bed. Siting a multi-user microgrid at the ESP and embedding in the project design a set of hypothesis for testing offers multiple advantages. DPS staff and the Commission are in close proximity to the site, permitting close engagement with testing protocols that are put in place. Top executive and legislative leaders have ready access facilitating education and outreach and rapid dissemination of lessons learned.

As the owner/operator the State removes many of the constraints to site access that would otherwise be the case with a 3rd party. This offers a much greater degree of flexibility in how tests can be conducted. Should the Albany: ESP project move to Stage 2, we would seek to collaborate with National Grid and perhaps EPRI to conduct empirical analysis on the value that this particular microgrid provides to the network in which it operates.

Should this project be fortunate to NY Prize Stage 2, the team suggests building into the design, to the extent feasible and cost justified, an analysis of the value of "D", that is an empirical analysis of the "value of distributed energy resources", that may provide lessons learned, generalizable to the larger REV process. The following quotes from various Commission orders, demonstrates that establishing a sound rationale and empirical basis for LMP+'D' is integral to the entire REV process

"The Commission has stated that achieving a more precise articulation of the full value of distributed energy resources ("DER") is 'a cornerstone REV issue."¹

"The development of the tools and methodologies required to fully implement an approach [for valuation of DER] on the 'Value of D' is likely a long term effort."²

"[the] 'value of D' can include load reduction, frequency regulation, reactive power, line loss avoidance, resilience and locational values as well as values not directly related to delivery service such as installed capacity and emission avoidance."³

"The "value of D" takes different forms and values depending on the application. For example, the first major application for the "value of D" is valuing alternatives to long term investments such as traditional utility investment, investment in DSP infrastructure and non-wire alternatives. A second application is compensation mechanisms, which includes rate design, LMP+D payments, as the basis for the transition from NEM."⁴

¹ NYS PSC, Case 15-E-0082, Proceeding on a Community Net Metering Program, Order Establishing a Community Distributed Generation Program and Making Other Findings, (July 17, 2015) p. 24 (CDG Order)

² NYS PSC, CASE 15-E-0751, In the Matter of the Value of Distributed Energy Resources, Dec 23, 2015, Attachment A Page 1 ³ NYS PSC, NEM Interim Ceilings Order, p. 9.

⁴ NYS PSC, CASE 15-E-0751, In the Matter of the Value of Distributed Energy Resources, Dec 23, 2015, Attachment A Page 3

1.3 Favorable Financing, Incentives and Future Revenue Streams

The cost of capital is an important factor in the economic viability of a microgrid. After fuel cost, financing costs are the second largest component of cost. As a consequence, the obvious opportunities for a project to bring down costs is to address fuel cost and financing charges.

The Strategic Advantage of NYPA Financing: The Albany ESP project will benefit significantly from access to low cost financing available from NYPA. The cost of capital at today's rates for projects of similar scale and of a similar credit rating would likely be significantly greater, absent the NYPA financing.

Several initiatives are underway that are expected to create new markets and revenue opportunities for microgrids and distributed energy resources generally.

New markets will take some time to develop. They are likely to take shape over a multi-year time frame. However there are some areas where DER's and microgrids can provide demonstrable support and value to the distribution utility.

Targeted Utility/DSP DG Incentives

Strategically sited, appropriately configured and operated microgrids can allow the utility to defer or avoid significant distribution system capital expenditures. An example of one such program, now in existence is Con Edison's Case 14-E-0302 – Order Establishing Brooklyn/Queens Demand Management Program, issued and effective December 12, 2014. The BQDM program, currently in process with ConEd, offers a glimpse into how REV may drive incentives for CHP and DER. Announced on December 8, 2015, qualifying CHP projects were being offered an incentive of \$1,800/Kw. Projects will have to meet Con Ed and NYSERDA terms of performance and be operational by June 1, 2017, the start of the 2017 Summer Capability period.

Distribution utilities are being encouraged to submit "non-wires" pilots. The incentive levels will vary from location to location as the value of avoided marginal distribution capacity costs are highly variable across the State.

The value of Microgrids, operating in the right locations and at the right time of day and season of the year is now being realized in New York State.

Operational Services

REV envisions new markets, at the distribution system level and in concert with the NYISO, to mirror new wholesale markets for DER services. Some of the new services that might be offered by appropriately designed, configured and operated microgrids include:

- Frequency regulation
- Volt-ampere reactive (VARs) compensation
- Demand response services

Princeton University reports that they first implemented FERC 755 Frequency Regulation in January 2013. They initially started by offering a 1 MW grid load change, accomplished by changing gas combustion turbine output (up / down). They report⁵ that payments were averaging \$200,000 per MW/year PLUS a performance multiplier of up to 3X (\$600,000). In addition to utilization of the gas turbine for measured grid load changes, they expect also to be utilizing VFD's for this purpose. Princeton is also providing Synchronous Reserves (FERC 755) in the PJM market. They entered the Synchronous Reserves market in October 2012. They report that potential savings are \$30,000/MW-year⁶

 ⁵ "New Market Opportunities for CHP: Next Steps in Market Participation at Princeton and MIT. Presented at the International District Energy Association's 26th Annual Campus Energy Conference. February 18-22, 2013
 ⁶ Ibid.

2 Microgrids – Overall Value Proposition

2.1 Beneficiaries

Three main groups benefit from the presence of microgrids: owner/users, the utility transmission and distribution grid, and societal at large.



2.2 Total Benefits are Greater than Costs

NY Prize is an innovative, first-in-nation program that will speed the development of successful markets for multi-party microgrids. At this early stage of market development, New York is willing to invest some public funds in order to stimulate the market for projects with significant and demonstrable social benefits.

The ultimate objective is to create an environment where no public subsidies are required. Once REV markets are in place we can expect that high efficiency, environmentally superior, resilient microgrids will attract sufficient private sector investment capital, where they are economically viable.

The sum of total benefits (to the end-user, the utility and society) are greater than the total costs. However, due to the fact that end-users aren't compensated for the utility benefits and societal benefits that they create, meritorious projects will not materialize. The owner will not invest unless the benefits that they receive outweigh the costs that they incur. At the current time, some form of government support is likely to be necessary, in order to stimulate such an investment.



2.3 New Markets Are Needed

The objective should be creation of new markets for microgrid owners to capture a greater share the presently nonmonetized benefits that they create. Self-funded microgrid development will arise over time by making progress on two



The goal is self-funded microgrids that provide more resilient energy for our communities.



fronts. A self-sustaining industry will come about in part as a result of a reduction over time in microgrid costs.

3 Capital Reserves

As with any business, the microgrid will need to maintain an appropriate level of working capital to ensure adequate liquidity. As an example, with the inherent volatility in energy markets the microgrid will need to keep sufficient capital reserves on hand to cope with spikes in the price of natural gas or electricity due to the delay between the utility billing periods and those of the microgrid's customers.

The economic viability of the microgrid necessitates a strategy for continuity of operations of their customers. If the microgrid is offline the customers can't be without electricity or heat. Backup electric and thermal energy costs can be costly and will erode the value proposition for the customer and the economic return to the project. The microgrid must have in place arrangements for continuity of service. Sufficient cash reserves, or lines of credit, allow quick response to emergencies and other service interruptions: malfunctioning equipment, damaged distribution systems, etc. Such situations may be covered in part by insurance policies. Payments from such policies can have long delays; sometimes measured in months. Continuity planning and adequate capital reserves will be needed to bridge such a gap.

4 Metering

All electrical customers within the microgrid will have advanced metering hardware capable of measuring data at least as frequently as the utility (e.g., 15 minute data points). Meters will also measure a number of electricity variables beyond consumption: demand, voltage level, voltage frequency, and reactive power. If measurements are taken more frequently than the utility they will be at round multiple thereof. The microgrid might sample more frequently, particularly if this would facilitate the microgrid's participation in new ISO or distribution level markets that we anticipate are going to be developed as a consequence of the NY PSC REV proceeding.

Distributed Energy Resources (DER) such as auto-DR loads and combined head and power equipment will be metered at least as frequently as the end users (see above). Technical control and administration protocols will likely necessitate real time, or near to real time, monitoring. Participation in future ISO (wholesale) or utility (distribution / retail) markets for services, will require sophisticated and fast response communications, controls, and metering.

5 Billing and Customer Risks

The generation resources will be designed to meet specifically modeled consumption patterns (after accounting for energy efficiency). Absent long-term procurement arrangements, customers may decide to scale back or opt-out of their anticipated consumption shares. Such an occurrence would negatively impact the microgrid's ability to service debt and would reduce returns to equity partners. Financing is a major component of capital cost. The risk of customer defection and revenue erosion must be addressed otherwise it will increase the cost of debt and equity and could severely impact economic viability. There should be a mechanism in place for the microgrid to ensure long-term commitments that reasonably under-gird multi-year revenue projections from the sale of electricity and thermal energy to customers. This obligation needs to be secure several years into the future in order to support repayment of debt and to insure reasonable expectations for return on equity.

The microgrid should secure a contractual minimum billing level from their customers to insure adequate revenue. Additionally, there should be exit fees associated with early withdrawal from the microgrid supply agreement (decreasing over time) perhaps backed through an encumbrance on the real estate or with an agreement from the local municipality to guarantee payment in the event of default.

Ideally, such obligations should be structured to have some degree of transferability. For example, a current customer might wish to scale back their usage. At the same time a current customer (or new one) may be adding capacity and have an increasing energy need. Customers should be allowed to engage in "energy services trading" amongst themselves provided it doesn't mean a reduction in minimum billing thresholds or other negative impact on the microgrids required cash-flow. This type of structure will bring greater liquidity to the contractual obligations that will simultaneously make the long term procurement decisions more palatable to microgrid participants and less risky for debt and equity providers.

Note that the above considerations apply to both the electrical and thermal outputs of the system. Both types of energy should have specific quotas or thresholds set lest the demand of thermal and electrical power output from the CHP resources become mismatched.

6 Thermal Energy

6.1 Combined Heat and Power – Unit Sizing

The microgrid will generate thermal energy from local combined heat and power (CHP) equipment. This thermal energy will be sold to customers to address their thermal loads (space heating, hot water, and/or cooling). Certain customers may opt to contract with the microgrid to provide some or all of their thermal need(s) thereby allowing them to remove or substantially downsize their own local boiler plants, water heaters, and/or air conditioning systems.

Thermal energy generation benefits greatly from economies of scale. By aggregating customer loads together a lower marginal cost per unit can be achieved which provides good earnings potential for the microgrid. Additionally, if customers are able to completely outsource this portion of their operations then their costs are reduced through lower staffing requirements, maintenance expenses, and freed up floor space. Such benefits can be priced into the charges for thermal energy that the microgrid levees on customers, further increasing profitability.

There are several points of risk that the microgrid business plan must thoroughly take account of. First, if decommissioning their own equipment, thermal customers will expect that the microgrid will be able to provide their full peak demand: they expect that their building should be well heated on very cold winter days, and cooled to their desired level of comfort on hot summer days. Failing to do this will not only represent a loss of revenue and reputation for the microgrid but may also subject it to legal liability or fines. This may require the system to be designed with higher than anticipated capacity or redundancy to ensure a safety margin. That increased capacity could mean a higher initial capital expenditure and/or a minor degradation in system efficiency which could erode profitability.

The business plan for the microgrid should thoroughly investigate the building envelopes and heating systems of their customers ahead of time. The microgrid should avoid a situation where they design their thermal system assuming a load based on an old building that is poorly sealed. If that building is later weatherized, or has its distribution system updated, this could result in a much lower thermal requirement from the microgrid. That reduced demand would decrease thermal energy revenues from that customer as well as decrease the efficiency of the system overall because it now runs at a lower overall utilization level. The latter issue can be somewhat guarded against through the use of more prime movers; 6-7 smaller capacity units rather than 3-4 larger ones with the same total output, for example. This would allow units to be cycled on and off with greater efficiency and would help ensure that, when they *are* running, they do so at nearer to 100%.

A minimum threshold of *electricity* consumption is something customers will likely feel comfortable committing to, especially if cooling loads don't figure highly into that minimum threshold. Lighting, equipment, machinery, etc. are used year round. So this is a viable option for that revenue stream. However, this may not be viable for customers for heating charges. Rightly or wrongly they may perceive this as a potential penalty for them in the event of a warm winter; something out of their control. Likewise if the microgrid is providing cooling services. Inspection of buildings to model thermal needs and right-sizing the system is the recommended course of risk mitigation, rather than minimum charges, for thermal revenue.

6.2 Natural Gas Procurement

The microgrid will purchase natural gas for use in CHP systems. New York's Distributed Generation Gas Service Classifications provide for a significant discount for qualifying systems where natural gas is purchased for use in CHP systems. This will allow for input cost savings improving the economic viability of the microgrid.

As fuel costs are the primary factor in the cost structure of the microgrid there may be value to hedging input fuel cost risks. This risk can be somewhat mitigated by long term supply contracts but the longest of these are typically four (4) years. Longer contracts typically charge a much higher premium, to account for the greater uncertainty, and this premium often costs more than the downside risk customers are looking to hedge against. Therefore, on a 15+ year time horizon this risk factor will still be present for the microgrid.

As noted above, New York State's DG gas service classifications do provide preferential natural gas rates which are lower for gas utilized in CHP installations. The microgrid may be able to offer those customers purchasing thermal energy an attractive value proposition while maintaining sufficient margins on electricity and useful thermal energy sales.

One additional factor is that the cost of natural gas in New York State is largely influenced by the price of natural gas. As prices for gas increase, so do those for electricity. So while fuel costs for the CHP system may increase, this is directly correlated to an increase in the cost of the electricity that would otherwise have to be purchased from the utility by the microgrid's customers.

7 Electricity – Microgrid Owned Distribution

This section assumed that most or all microgrid customers will be connected into a common electricity distribution system that is owned and operated by the microgrid. In this instance, individual customers will be aggregated and will appear to the utility as "one large load" at the point of common coupling.

7.1 Electricity Generation

Output from the CHP system will provide a large portion of the microgrid's income. The greater the portion of customer loads accounted for by the microgrid, assuming economically attractive aggregated thermal / electric load profiles, the greater the revenue generation for the microgrid. Realizing economies of scale and high levels of asset utilization by connecting and aggregating loads, is key to maximizing this revenue source. Running at/near full load levels the CHP equipment (with heat recovery), for as many hours per year as possible, increases efficiency and enhances profit margins. The microgrid business model assumes that local generation at one site can be consumed by other customers either through direct connection or, in the case of connection via utility infrastructure, at the "retail rate."⁷

7.2 Demand Charges

Combining all customers into a single aggregated load will, by definition, reduce the level of demand seen at the point of common coupling (PCC). Separate connections result in an *additive* calculation method where each customer's monthly peak is summed together regardless of the day or time it occurred. Aggregation results in a *coincidental* peak demand calculation which, by definition, cannot be higher than the additive method. Since it's highly unlikely that all customers on the microgrid will incur their peak demand at the same time and on the same day, this will result in savings on grid purchased electricity. Energy efficiency investments and on site generation from CHP will further reduce aggregate demand and associated charges.

This reduction in demand charges from supplemental electricity purchases made from the macrogrid will mean a lower cost for electricity purchases from the grid on a per kilowatt hour basis. Consequently customers will save relative to the T&D charges that they would otherwise incur had they remained full service customers purchasing electricity from a competitive supplier and paying T&D charges to the utility.

7.3 Electricity Procurement

For supplemental power demands, over and above that provided by the onsite generation, the microgrid will be able to competitively procure grid purchased electricity for the aggregate load of its customers. This allows for lower per-unit costs from third party suppliers. There should be a net savings between what individual customers would have paid, absent the microgrid, and the group procurement arrangement that the microgrid can negotiate. This margin can be shared with some part accruing to a more attractive price to connected microgrid customers and the remaining share going to profitability of the microgrid.

7.4 Time Variant Pricing

Time Variant Pricing (TVP), also known as hourly pricing and time of day pricing, adds additional complexity to the measurement and verification (M&V) procedures, increases customer billing complexity, and offers an additional source

⁷ Akin to virtual net metering, or passing benefits to customers via an "offset tariff" type of arrangement

of potential revenue for the microgrid. The microgrid would be treated as a single large customer behind the common point of coupling. The microgrid should reserve space for battery storage to be added to the network.

The time difference in electricity prices for grid purchased electricity offers an arbitrage opportunity: charge the batteries up during less expensive time periods (e.g., at night) and discharge them in the grid during peak demand periods (e.g., 2-6 PM). The microgrid may choose to wait until after the system is up and running in order to get a more accurate measurement of specific usage profiles. However, a basis benefit-cost analysis for battery storage should be conducted as part of the phase 2 design.

The NYS REV proceeding is likely to advance the use of time variant pricing throughout the State. Having connectivity and physical space available for batter storage will allow the microgrid to more easily take advantage of new pricing schemes for electricity.

7.5 Customer Billing Procedure

The business model calls for microgrid customers to be billed for electricity from the microgrid at a fixed rate (with yearly escalation factors) while grid purchased electricity will be passed through at retail cost. Customer billing procedures, while not a source of financial risk, are a potential source of reputational risk.

The method by which local power is allocated to customers should be transparent and specifically spelled out in their contract. The cost of microgrid generated power will differ from the retail cost and on average it must be cheaper otherwise the value proposition of providing power at or less than current cost (with resiliency as a bonus) cannot be fulfilled.

At a minimum, retail prices for electricity will vary from month to month. If the microgrid is subject to time variant pricing this will increase the complexity of these calculations. In the latter case, prices vary from day to day and from hour to hour within the day and so microgrid generated power and supplemental power charges will need to take account of this.

The allocation method should take into account several key considerations including:

- When 100% of local microgrid electricity is being consumed, how is the output allocated among the customers? (Proportionally by average monthly load, by peak demand, by proportion on contracted minimum billing, or some other method?)
- How will demand charges (from the grid) be allocated among customers? Or will they be billed based on kWh only? If the former, how will the microgrid communicate the timeframe of the monthly peak demand to customers? In any case, will there be an incentive for customers to shift this demand? If subject to minimum demand billing in shoulder months, how are such charges allocated?

Customers will need key parameters included on their bills so that they can understand the variables that lead to specific costs.

7.6 Resiliency Configuration

The microgrid will not be able to supply peak demand to all customers when in island mode. Therefore the amount of electrical capacity allocated to customers during grid outages of extended duration should be clearly delineated in their contracts. The microgrid must ensure that customer's systems are configured to manage their load and make sure their thresholds are not exceeded. This may involve rewiring buildings and/or reconfiguring existing control systems. Likewise, their ability to join the microgrid must be contingent on installation and successful commissioning of this enabling equipment. It must be determined ahead of time whether the costs of these retrofits are to be embedded in the levelized cost of energy (LCOE) and borne by customers or paid for by them upfront.

As noted prior, the total cost of energy, including the embedded capital and operating cost of energy will be priced at a price per unit energy that gives connected customers a bill for electricity and purchased fuels that is less than or equal to

their "business as usual" costs. The expected savings from an agreed upon baseline, as well as the amount of electric (and thermal where applicable) energy services that would be provided during islanded operations, must be clearly communicated and defined in their contracts.

The microgrid may wish to provide "additional" resiliency as a service. Suppose for example, it's determined that the services provided during an outage of extended duration would be X% of the total site demand and would encompass a specified list of life safety and critical infrastructure functions. It may be the case that a particular site would want additional capacity and more building services available. The microgrid may seek to negotiate a cost of "additional resiliency" and provide the financing of this into the microgrid contract. Furthermore, any additional operating expense that would be incurred by the microgrid to provide a "premium" resiliency service, on the demand of one site, would be an additional cost charged to that site. This would be especially valuable if the costs of capital for the microgrid is lower than the customer's and if the incremental operations cost of resiliency are such that customers seeking "premium resiliency" are willing to pay the marginal cost for capturing this incremental benefit. Both of these options that comprise a "premium resiliency package," and include incremental retrofit, capital financing and marginal operations costs are potential sources of additional revenue.

7.7 Demand Response

Some utilities offer their customers the option of participating in demand response programs. This typically involves the customer curtailing demand at a pre-set period after they've been notified of the time window in advance. The microgrid may be able to participate in this program through several possible methods:

- Microgrid dynamically curtails loads customer load (if they've opted in) scaling back HVAC systems and turning off ancillary equipment such as extra elevators
- Increases local generation to reduce the microgrid's draw from the utility
- Discharges batteries charged at off peak times

Programs typically give compensation for participation in the summer/winter season (paid out regardless of the number of DR events, even if that is zero). Additional payments are made for energy provided in each DR event. Penalties are levied if customers fail to curtail load when dispatched. Enrollment in this program is another source of revenue for the microgrid; possibly with some cost share to specific customers that curtail load (by turning down the intensity of air conditioning, for example).

7.8 Net Metering and Electricity Export

Inherent in the very structure of a microgrid, is the ability to "internally net meter" between various local distributed energy resources and across microgrid connected buildings. This cost offset, from building to building and from customer to customer, is a major factor in the overall value proposition.

The business plan does not identify the export of electricity to the grid as a source of revenue for the microgrid.

8 NY ISO Incentives

There are a variety of revenue streams; existing, proposed and anticipated that may be available to support the economic viability of the microgrid projects. The projects proposed here are not likely to be able to take advantage of the existing NYISO programs. However, at this writing, the NY ISO has authorized a new Behind the Meter: Net Generation program (BTM:NG) This program is expected to be launched for the Winter period of 2016. It will not be available during the summer capability period until the 2017 Summer Capability period, which runs from June 1, 2017 – September 30, 2017.

NY ISO – Day-Ahead Demand Response Program (DADRP)

Program where participants bid into the Day-Ahead Market for load curtailment at a specific rate (i.e., \$X/MWh). Accepted offers are notified by 11:00 a.m. of scheduled commitment for the next day (midnight-midnight) and a response is mandatory when selected (penalties are levied if participants fail to provide scheduled load reduction in real

time). Note that the rules to permit behind-the-meter generation to participate are currently under review by FERC (Docket # EL13-74-000). Participants must provide an aggregate reduction of at least 1 MW. Offer floor price of \$75/MWh.

NY ISO – Emergency Demand Response Program (EDRP)

Voluntary program, similar to DADRP but the ISO offers a specific price (locational based marginal price – LBMP) for electricity. Customers perform load reduction through interruptible loads or loads with a qualified behind-the-meter local generator. Minimum reduction is 100kW. Payment is based on measured energy reduction during an event, with a minimum rate of \$500/MWh or the actual LBMP, if higher.

NY ISO – Installed Capacity (ICAP) Special Case Resources (SCR)

Similar to the EDRP except that customers offer into installed capacity (ICAP) auctions or may sell capacity in bilateral contracts. Customers perform load reduction through interruptible loads or loads with a qualified behind-the-meter local generator. Minimum reduction is 100kW. Note that for CHP this will generally require an "N+1" configuration of prime movers with the "extra" unit being brought online for participation in this program There is a mandatory response during reliability events for a minimum of four hours. Payments are based on sales made through ICAP auctions or bilateral contracts and additional payments are made based on performance in events & tests (LBMP with daily guarantee of strike price recovery).

NY ISO – Behind the Meter: Net Generation (BTM:NG)

This program⁸ will allow participation in the wholesale market for customers that that have on-site generation capability that routinely serves a Host Load (e.g., on site user) and has excess generation capability after serving that Host Load. Resources will be allowed to participate in the energy, capacity, and ancillary services markets.

Generation resources for this program must:

- Be designed and operated to facilitate the business function of the on-site load by providing electricity in the regular course of business
- > Meet NYSDEC requirements to operate under non-emergency conditions
- > Have an effective interconnection agreement
- > Meet minimum net generation requirements (see program details for exact formula)
- Have appropriate metering configurations
- > Be responsive to dispatch instructions as a single entity interfacing with the grid

9 Capex Incentives

New York offers numerous incentives that reduce the initial capital cost for qualifying distributed energy resource investments. Oftentimes the higher initial capital costs are a deterrent to cost effective investments in efficiency, CHP, and renewable energy resources. Distributed energy resources may require higher upfront capital outlays, with recurring savings over time that more than offset this higher initial costs.

NYSERDA CHP Programs

NYSERDA will provide financial incentives of up to \$2.5M for CHP systems. These programs are currently being modified due to updates from the recently passed Clean Energy Fund (CEF). Prior programs include PONs 2568 & 2701. There is currently. There is an incentives and services budget of \$22 Million, set aside for CHP in calendar year 2016.

Modified Accelerated Cost Recovery System (MACRS)

The microgrid will investigate which of the assets comprising the system can take advantage of this portion of the tax

⁸ This program is still in the design phase within the NYISO shared governance process. Currently the timeline for the incorporation of this program into NYISO tariffs is Q4 2016. For more info:

http://www.nyiso.com/public/webdocs/markets_operations/committees/bic/meeting_materials/2015-12-09/agenda 8 BTMNG BIC Presentation.pdf

code,⁹ a system by which entities can modify the way in which tangible assets are depreciated, to decrease their tax liability. For example, CHP systems qualify for the tax benefits accorded by the five year Modified Accelerated Cost Recovery System (MACRS). Accelerated depreciation generates savings to taxpayers by permitting them to take large percentages of their depreciation expense in qualifying physical capital in the early years of the investment. MACRS is only available to tax paying entities. Therefore, the choice of ownership model, for profit or not for profit, will determine the relevance of MACRS

Targeted Utility/DSP DG Incentives

Strategically sited, appropriately configured and operated microgrids can allow the utility to defer or avoid significant distribution system capital expenditures. An example of one such program, now in existence is Con Edison's Case 14-E-0302 – Order Establishing Brooklyn/Queens Demand Management Program, issued and effective December 12, 2014. The BQDM program, currently in process with ConEd, offers a glimpse into how REV may drive incentives for CHP and DER.

Announced on December 8, 2015, qualifying CHP projects were being offered an incentive of \$1,800/Kw. Projects will have to meet Con Ed and NYSERDA terms of performance and be operational by June 1, 2017, the start of the 2017 Summer Capability period.

Business Energy Investment Tax Credit (ITC)

Federal corporate tax credit: 30% for solar and 10% for micro turbines and CHP. If not renewed through legislative action, the ITC will expire in 2016 <u>http://programs.dsireusa.org/system/program/detail/658</u>

- Maximum Incentive Micro turbines: \$200 per kW, all other eligible technologies: no limit
- Eligible System Size Micro turbines: 2 MW or less, CHP: 50 MW or less¹⁰

As noted above, Investment Tax Credits, production tax credits and preferential depreciation treatment are mechanisms that are only available to for profit entities. However, if the legal form of ownership is a non-profit or government entity, then these ownership forms are not eligible for the tax credits reported above.

NYPA Financing

The cost of capital is an important factor in the economic viability of a microgrid. After fuel cost, financing costs are the second largest component of cost. As a consequence, the obvious opportunities for a project to bring down costs is to address fuel cost and financing charges. The Albany ESP project will benefit significantly from access to low cost financing available from NYPA.

The cost of capital at today's rates for projects of similar scale and of a similar credit rating would likely be significantly greater, absent the strategic advantage of NYPA financing. This advantage makes the economics and the project rate of return more favorable than would otherwise be the case.

10 Reforming the Energy Vision (REV)

Reforming the Energy Vision (REV) is New York's comprehensive strategy to align state regulatory policies, clean energy programs and the development of new and expanded retail and wholesale markets to transform the production, consumption and delivery of energy in the State. The New York Department of Public Service declared that "REV is a strategy to build a clean, resilient and affordable energy system for all New Yorkers. REV proposes to achieve several goals that support the mission of a clean, resilient energy system."

⁹ <u>https://www.irs.gov/publications/p946/ch04.html</u>

¹⁰ Combined heat and power systems can only receive the full credit if the system has an electrical capacity of 15 MW or less, and a mechanical energy capacity of 20,000 HP or less, or an equivalent combination of electrical and mechanical energy capacities. Larger combined heat and power systems (up to a maximum of 50 MW and 67,000 HP) can qualify for a reduced tax credit equal to the ratio between the actual system capacity and 15 MW. For example, a 45 MW system can qualify for a tax credit worth 15/45 of the otherwise allowable credit.

In the REV Track 1 Order¹¹ the Commission specified its policy on microgrids under REV, which is focused around five "attributes":

- 1. Ability to optimize system efficiency within the microgrid and advance REV objectives such as integration of clean distributed generation and addressing grid constraint
- 2. Interconnection with the larger utility system, assuming a DSP market that allows mutual benefits and services to be monetized
- 3. Resilience and the ability to island in the event of system outage, particularly where critical customer facilities are involved
- 4. The obligation to provide reliable power at just and reasonable rates within the microgrid
- 5. Consumer protections for residential customers as required by the Home Energy Fair Practices Act (HEFPA).¹²

10.1 REV Track 1 Goals

As identified in the Track 1 Order for Reforming the Energy Vision (REV) there are six main goals. Each of these goals (listed in the below sections) will be achieved through the creation of a community microgrid that adheres to these attributes.

Enhanced customer knowledge and tools that will support effective management of their total energy bill

Most parties committing to joining a community microgrid will be private, government, or non-profit groups, who have analyzed the benefits and costs and decided that the former outweighs the latter, making them highly educated customers. The customers served will be better informed about their energy breakdown because of their participation in the microgrid, and the Special Purpose Entity (SPE) that oversees the microgrid will be managing energy production, distribution, and consumption, to ensure that everything is functioning efficiently.

Market animation and leverage of ratepayer contributions combined with system wide efficiency

(Note that this section addresses two of the six goals)

Under REV, utilities are urged to find innovative ways to put the ratepayers' dollars to work, specifically through contracting with outside sources of ancillary services. In the REV Staff Report and Proposal, the New York State Department of Public Service explains the value of microgrids, stating that they "support the overall utility grid, lightening the burden on congested infrastructure and avoiding investment in traditional system upgrades." By encouraging the implementation of ancillary services, like "frequency regulation, voltage support, and black start capability", the utilities will, as the REV Track 2 White Paper acknowledges, "optimize energy efficient and reliable electricity delivery," benefiting their own employees and business, as well as maximizing their use of revenue.

Another incidental ancillary service that a microgrid provides to the grid is a decrease in risk of total grid failure as a result of special circumstances, like a lapse in system security. As stated in the Track 1 Order, "[a] decentralized system... that is capable of segmentation and contains self-sufficient microgrids or similar configurations with appropriate firewalls, may be more resilient against the impacts of a wide scale cyber-attack." The utility also receives the benefit of having segments of the grid's design and infrastructure upgraded, e.g., with more resilient wiring and advanced methods of monitoring demand-response.

The establishment of a decentralized system featuring the use of community microgrids also improves system efficiency by lightening the load on utilities, especially during peak energy use hours. This is partially due to the use of energy storage, but also because of the addition of new energy sources, like PV arrays and CHP.

Fuel and resource diversity

The new sources of energy installed to power the microgrid improve the diversity of the energy market. While there is an initial installation cost to be accounted for, this can be offset by several incentives that these community microgrids can take advantage of.

 ¹¹ <u>http://energy.pace.edu/sites/default/files/REV%20TRACK%201%20ORDER.pdf</u>, hereafter as "Track 1 Order"
 ¹² Id., at 112.

System reliability and resiliency

Microgrids are especially important when it comes to system reliability and resiliency. Microgrids decentralize the electrical grid, and as stated in the Staff Report & Proposal, "during a utility grid outage, a microgrid can intentionally island itself to maintain critical loads." Subsisting only off of the power produced and stored in its community unit allows critical facilities within the microgrid to continue to have the capacity to serve the public in times of crisis or emergency, when the rest of the grid is down, without any danger of surges. Community microgrids that use underground wiring to create the islanded system are even more protected from outages due to storms or other weather events.

Reduction of carbon emissions

The energy mix consumed in these microgrid projects, partnered with the ancillary services provided, increase the efficiency of the energy consumed and decrease the amount of energy produced from fossil fuels, both of which lead to a reduction in carbon emissions.

If any more proof is needed of the success of a community microgrid partnering public and private stakeholders is needed, the multi-stakeholder microgrid in Utica, overseen by Burrstone Energy Center LLC, has been supporting the community since 2009. The group has even developed an algorithm that helps it make hourly decisions on how to most economically operate the plant, which could be applied in these projects if that is a concern that needs to be addressed.

10.2 Additional REV Initiatives

Several initiatives are underway that are expected to create new markets and revenue opportunities for microgrids and distributed energy resources generally.

New markets will take some time to develop. They are likely to take shape over a multi-year time frame. However there are some areas where DER's and microgrids can provide demonstrable support and value to the distribution utility.

Targeted Utility/DSP DG Incentives

Strategically sited, appropriately configure and operated microgrids can allow the utility to defer or avoid significant distribution system capital expenditures. An example of one such program, now in existence is Con Edison's Case 14-E-0302 – Order Establishing Brooklyn/Queens Demand Management Program, issued and effective December 12, 2014. The BQDM program, currently in process with ConEd, offers a glimpse into how REV may drive incentives for CHP. ConEd is working to reduce peak load demand on their Brownsville substation through energy efficiency and DER initiatives. One current incentive being offered is up to \$1,800/kW for CHP installations. This is in addition to any incentives the customer may receive from NYSERDA or other sources. The incentives received cannot be >100% of the installed cost. A qualifying project must be operational by the start of the 2017 Summer Capability Period (June 1, 2017).

Distribution utilities are being encouraged to submit "non-wires" pilots. The incentive levels will vary from location to location as the value of avoided marginal distribution capacity costs are highly variable across the State.

The value of Microgrids, operating in the right locations and at the right time of day and season of the year is now being realized in New York State.

Operational Services

Microgrids, and the suite of DER resources that comprise them, can serve as dynamic assets supporting the grid. REV envisions new markets, at the distribution system level and in concert with the NYISO, to mirror new wholesale markets for DER services. Some of the new services that might be offered by appropriately designed, configured and operated microgrids include:

- Frequency regulation
- Volt-ampere reactive (VARs) compensation
- Demand response services

There is precedent for distributed energy resources to capture revenue streams for the value that they create in wholesale markets. Princeton University reports that they first implemented FERC 755 Frequency Regulation in January

2013. They initially started by offering a 1 MW grid load change, accomplished by changing gas combustion turbine output (up / down). They report¹³ that payments were averaging \$200,000 per MW/year PLUS a performance multiplier of up to 3X (\$600,000). In addition to utilization of the gas turbine for measured grid load changes, they expect also to be utilizing VFD's for this purpose.

Princeton is also providing Synchronous Reserves (FERC 755) in the PJM market. They entered the Synchronous Reserves market in October 2012. They report that potential savings are \$30,000/MW-year¹⁴

Solar Grid Storage (SGS) business focus is in the PJM Independent System Operator service territory. They are operating 4 storage projects in the PJM fast frequency regulation market. Response to FERC SGS has a pilot project at the Philadelphia Navy Yard, a stand-alone battery system. They have 2 projects in New Jersey co-located with PV projects at a commercial customer's site. What they describe as their flagship project is a solar microgrid at the Konterra Headquarters in Laurel, Maryland. It's a 500kW project providing frequency regulation services to PJM and backup power from the customer's 400kW PV parking lot canopy.¹⁵

Though not publicly released yet, we expect to see one or more new microgrid projects, sited in the PJM footprint, which will be designed to capture revenues from PJM markets for ancillary services.

10.3 Recommendations to Facilitate Microgrid Market Development

There has long been a recognition that Microgrid development is hampered by the absence of formal statutory or regulatory recognition. Microgrids exist in New York but are addressed by PSC on a case-by-case basis. There is no clear set of rules to guide a microgrid developer, thus creating significant uncertainty and market risk.¹⁶

The State of Connecticut addressed this matter, for certain types of customers and for particular public purposes. CT Public Act 13-298, section 39 authorizes that "a municipality, state or federal governmental entity authorized to distribute electricity across a public highway or street pursuant to section 39 of this act."

Sec. 39. (NEW) (Effective July 1, 2013) The Public Utilities Regulatory Authority shall authorize any municipality or state or federal governmental entity that owns, operates or leases any Class I renewable energy source, as defined in section 16-1 of the general statutes, as amended by this act, Class III source, as defined in section 16-1 of the general statutes, or generation source under five megawatts, to independently distribute electricity generated from any such source across a public highway or street, provided (1) any such source is connected to a municipal microgrid, as defined in subdivision (5) of subsection (a) of section 16-243y of the general statutes, as amended by this act, and (2) to ensure the reliability and availability of the microgrid delivery system and the safety of the public, such municipality or state or federal governmental entity shall engage the applicable electric distribution company, as defined in section 16-1 of the general statutes, as amended by this act, to complete the interconnection of such microgrid to the electric grid in accordance with the authority's interconnection standards. For purposes of this section, any such municipality or governmental entity shall not be considered an electric company, as defined in section 16-1 of the general statutes, as amended by this act.¹⁷

 ¹³ "New Market Opportunities for CHP: Next Steps in Market Participation at Princeton and MIT. Presented at the International District Energy Association's 26th Annual Campus Energy Conference. February 18-22, 2013
 ¹⁴ Ibid.

¹⁵ TESTIMONY OF Christopher Cook President, Solar Grid Storage BEFORE THE HOUSE SUBCOMMITTEE ON ENERGY AND POWER LEGISLATIVE HEARING ON DISCUSSION DRAFT ON ACCOUNTABILITY AND DEPARTMENT OF ENERGY PERSPECTIVES ON TITLE IV: ENERGY EFFICIENCY JUNE 4, 2015

¹⁶ Case 13-E-0030, et al. Collaborative Working Group 2 Meeting, Summary of NYC DG Collaborative. Presentation By: Robert Loughney, Couch White LLP and Tom Bourgeois Pace Energy & Climate Center, October 3, 2013

¹⁷ Public Act No. 13-298 AN ACT CONCERNING IMPLEMENTATION OF CONNECTICUT'S COMPREHENSIVE ENERGY STRATEGY AND VARIOUS REVISIONS TO THE ENERGY STATUTES. Page 72 or 110.

10.4 Potential Future Revenue Streams

The PSC has laid out their initial vision for the revenue streams that will be enabled for DER under REV as part of their Benefit-Cost Analysis (BCA) Staff Whitepaper. The REV proceeding is still a work in process and so the exact mechanisms and revenue streams, and the incentive models for them, have not yet been solidified.

While the precise mechanisms are not fully developed the fact that the PSC anticipates that DERs, including microgrids with CHP, will be able to compensated for the measured value that they provide to utility operations and planning is not in doubt.

Below we have summarized numerous expected services that DERs may provide, as they were discussed in the Staff Benefit-Cost Analysis (BCA) Whitepaper. We also note that the Commission has ordered that the utilities file an Initial Distributed System Implementation Plan (DSIP) June 30, 2016 and a Supplemental Plan September 30, 2016¹⁸

The importance of the DSIP is that it is expected that it will provide to market participants information on utility system needs and to identify opportunities for DERs to offer services to assist distribution system operation and distribution system capital investment requirements. The DSIP will also identify the mechanisms to deliver information that will facilitate market participation. It will define specific market mechanisms that will effectively elicit and compensate DER that can satisfy operations needs and capital investment requirements that have always been self-procured by the distribution utility.

The BCA Whitepaper indicates the range of various potential activities that provide value to the system. Historically DERs may have provided some of these values, though they were never measured, monitored, taken account of in utility planning and operations, and as a consequence they went uncompensated. In the future we expect that appropriately designed, configured and operated Microgrids with CHP, those that are in the right locations and operating at the right time of day and season of year, will be paid for the value(s) that it is creating for the utility system.

The precise available revenue streams will become clearer as the DSIP model(s) are fleshed out. However, it is illustrative to examine the categories that have been identified in the paper (and summarized below). Material is from Staff Whitepaper on Benefit-Cost Analysis in the Reforming Energy Vision Proceeding 14-M-0101, July 1, 2015.¹⁹

A key point to note is that a CHP centric microgrid is poised to take advantage of many of these revenue streams; though it would be rare for a project to be able to leverage all of them. Also, it will mean tighter constraints on the design, configuration, and operations of the microgrid. The developer will do their own internal BCA to determine if the costs of these tighter constraints are exceeded by the benefits of the extra revenue that can be brought in.

Avoided Generation Capacity (ICAP) Costs, including Reserve Margin: ICAP costs are driven by system coincident peak demand. Thus, this component of benefits applies to the extent to which the resources under consideration reduce coincident peak demand.

Avoided Energy – Location Based Marginal Pricing (LBMP): This includes costs for a number of other factors: (1) compliance costs of various air pollutant emission regulations including the Regional Greenhouse Gas Initiative and now-defunct SO2 and NOX cap-and-trade markets; (2) transmission-level line loss costs; and (3) transmission capacity infrastructure costs built into the transmission congestion charge.

Avoided Transmission Capacity Infrastructure and O&M: A portion of the Avoided Transmission Capacity Infrastructure and related O&M costs are included in both the Avoided Generation Capacity (ICAP) and Avoided Energy (LBMP) benefit categories. Transmission capacity and O&M costs are reflected in the difference between zonal ICAP clearing prices.

¹⁸ Case 14-M-0101, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Order Adopting Regulatory Policy Framework and Implementation Plan, (issued February 26, 2015) (Track I Order).

¹⁹ <u>http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/c12c0a18f55877e785257e6f005d533e/</u> <u>\$FILE/Staff_BCA_Whitepaper_Final.pdf</u>

Generation assets located in high load and congestion areas, such as New York City, the lower Hudson Valley, and Long Island, clear the ICAP market at a higher price in reflection of the fact that load serving entities in those areas are required to purchase generation from local assets due to restrictions on the transmission system, which precludes the purchase and transport of generation from cheaper assets further away from the load. Transmission congestion charges, related to the availability of transmission infrastructure to carry energy from zone to zone, are included in the LBMP. Both the ICAP prices and transmission congestion charges would be decreased in the event that additional transmission assets are built or load is reduced.

Avoided Transmission Losses: A portion of the Transmission Loss costs are included in the LBMP, and are therefore partially counted already through the Avoided Energy (LBMP) benefit category as part of the costs included in the LBMP. To the extent that there are avoided transmission losses above and beyond what is included in the LBMP, such losses should be considered separately herein.

Avoided Ancillary Services: Required ancillary services, including spinning reserve, frequency regulation, voltage support and VAR support would be reduced if generators could more closely follow load. Certain projects will enable the grid operator to require a lower level of ancillary services or to purchase ancillary services from sources other than conventional generators at a reduced cost without sacrificing reliability.

Avoided Distribution Capacity Infrastructure: A utility's decision of what infrastructure to invest in, and when to make that investment, is generally driven by two factors: first, its need to meet the peak demand placed on its system; and second, the amount of available excess capacity on its system. The importance of these factors can vary depending upon the voltage at which an incremental load is connected to the utility grid.

Avoided O&M Costs: Certain projects could result in lower operation and maintenance costs, due to, for example, lower equipment failure rates, while other measures may increase operation and maintenance expenses due to, for example, increased DER interconnections. These changes in O&M should be determined by using the utility's activity-based costing system or work management system.

Avoided Distribution Losses: The difference in the amount of electricity measured coming into a utility's system from the NYISO or distributed generators and the amount measured by the Company's revenue meters at customer locations is defined as the "Loss" or "Losses" experienced on the Utility's system. Losses can be categorized as technical and non-technical losses, where technical losses are the amount of energy lost on the utility's system as heat and the magnetic energy required to energize various pieces of equipment used by the utility, and non-technical losses represent energy that is delivered but not registered by utility revenue meters. For the purposes of these analyses, the PSC will focus on technical losses. Technical losses can be further categorized into fixed and variable losses, and attributed to various pieces of equipment. While both fixed and variable losses are significant, actions taken by customers and the utility will have a greater impact on variable losses since fixed losses can only be reduced marginally by replacing equipment with lower loss models or removing equipment from service. Variable losses should be considered when a project increases or decreases the load served on a utility's system. The impact of the increased or decreased load should be considered for all levels which will be affected. For example, a self-supplying microgrid connected at a utility's transmission voltage would reduce transmission line losses, but not distribution line losses.

Net Avoided Restoration Costs: Projects such as automated feeder switching or improved diagnosis and notification of equipment conditions could result in reduced restoration times. To calculate this avoided cost, utilities could compare the number of outages and the speed and costs of restoration before and after the project is implemented. Such tracking would need to include the cause of each outage. The change in the restoration costs could then be determined.

Net Avoided Outage Costs: Avoided outage costs could be determined by first determining how a project impacts the number and length of customer outages then multiplying that expected change by an estimated cost of an outage. The estimated cost of an outage will need to be determined by customer class and geographic region. We note that outage mitigation often factors into a utility's decisions to invest in T&D infrastructure, so some portion of outage costs are already included in the Avoided T&D Infrastructure category described above.

Externalities: in addition to pecuniary costs and benefits, utilities need to consider out-of-market public costs and benefits that DER impose or provide. Many of these (such as land, water, and neighborhood impacts) will depend on the specific alternatives considered and will likely need to be weighed in a qualitative and judgmental way. However, the quantitative impact of three damaging gas emissions— SO₂, NO_x, and CO₂—are measured and modeled at the bulk level and can be estimated at the DER level. Both externality "taxes" and C&T programs result in a price being placed on each ton of damaging gas emitted, so both approaches "internalize" some or all of the external damage costs. This is important to keep in mind when valuing the net, or un-monetized, portion of marginal damage costs caused by bulk power generation. If externality prices were set high enough to equal marginal damage costs per ton emitted, wholesale LBMPs would fully reflect the social value of emission-free generation with respect to the pollutants covered by the emission pricing program.

Net Non-Energy Benefits: Non-energy benefits include, but are not necessarily limited to, such things as health impacts, employee productivity, property values, reduction of the effects of termination of service and avoidance of uncollectible bills for utilities. While Staff recognizes the existence of these costs and/or benefits, we propose that such difficult-to-quantify costs and benefits not be monetized at this time. However, when utilities consider specific alternatives, they should recognize any of these impacts when relevant, and weigh their impacts, quantitatively, when possible, and qualitatively, when not. For example, if a DER proposal for low and moderate income customers results in a reduction in the number of utility service terminations, the corresponding resource savings should be reflected in the SCT cost test results.

Wholesale Market Price Impacts: Distributed energy resources reduce the need for wholesale generation. DERs can obviate the need for calling on the next marginal generating unit. The marginal unit sets the price for all infra-marginal generators. That increase in price, that is avoided by DER, provides a benefit to all electricity consumers (reducing the price of energy and the price of demand). This is sometimes referred to as Demand Reduction Induced Price Effect (DRIPE).



APPENDIX M

CAPITAL AND OPERATING COSTS



CAPITAL COST

DESCRIPTION	2016 COST
Electrical Subcontractor & Duct Bank Work	\$7,060,075
Equipment, Permits, CxA, General Conditions, Insurance & Bond	\$1,016,049
National Grid Equipment, Interconnect and Aggregation Costs	\$2,545,950
Soft Costs and Contingency	\$1,849,582
NYPA PM, Administrative & Interest During Construction	\$2,904,294
TOTAL	\$15,375,950



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OPERATING COST

COST PER YEAR	DESCRIPTION
\$20,000	 (-) Oil samples from each customer transformer, labor, and lab testing of oil samples (-) Infrared inspections (-) Minor part replacements



APPENDIX N

BURRSTONE ENERGY CENTER PSC WAIVER

STATE OF NEW YORK PUBLIC SERVICE COMMISSION

At a session of the Public Service Commission held in the City of Albany on August 22, 2007

COMMISSIONERS PRESENT:

Patricia L. Acampora, Chairwoman Maureen F. Harris Robert E. Curry, Jr. Cheryl A. Buley

Case 07-E-0802 - Burrstone Energy Center LLC - Petition For a Declaratory Ruling That the Owner and Operator of a Proposed Cogeneration Facility Will Not Be Subject to Commission Jurisdiction.

DECLARATORY RULING ON EXEMPTION FROM REGULATION

(Issued and Effective August 28, 2007)

BY THE COMMISSION:

BACKGROUND

In a Petition filed on July 9, 2007, Burrstone Energy Center LLC (Burrstone) requests issuance of a Declaratory Ruling finding that the 3.6 MW cogeneration facility it intends to construct in Oneida County will not be regulated under the Public Service Law (PSL). Burrstone reports that it will provide electric and steam service to Faxton-St. Luke's Health Care, Inc. (the Hospital), and electric service to Utica College (the College) and St. Luke's Home Residential Health Care Facility, Inc. (the Home). Burrstone believes its facility, including its appurtenant distribution lines, is a qualifying cogeneration facility (QF) under PSL §2(2-a) and §2(2-d). No responses to the Petition were received within the 21-day period prescribed under the Rules of Procedure, 16 NYCRR §8.2(c). That period expired on July 30, 2007.

THE PETITION

Burrstone begins by describing its cogeneration facility as consisting of four natural gas-fueled engine generators with a total capacity of approximately 3.6 MW that will operate in parallel with the system of the local utility, National Grid (Grid). The thermal output from the engine generators will be consumed by the Hospital in the form of steam and hot water, enabling it, through the installation of absorption chillers, to meet its cooling needs as well as its heating needs. The thermal energy usage, Burrstone asserts, will satisfy the requirements of the Public Utility Regulatory Policies Act of 1978 (PURPA) and PSL §2(2-a), enabling it to obtain QF status under both federal and state law.

Besides distributing electricity to the Hospital, the College, and the Home, Burrstone intends to sell excess electricity to Grid. The Hospital, the College and the Home will remain Grid customers, purchasing from it any electricity they need in excess of the cogeneration facility's production.

Its generators, Burrstone relates, will be installed in a separate building constructed on the Hospital's campus. From the cogeneration building, separate electric distribution systems will lead to the College, the Hospital, and the Home. To reach the College, Burrstone will install approximately 3,800 feet of underground cable that will cross underneath Champlin Avenue, a public street separating the Hospital and College campuses, and extend into the College campus. Thermal energy will be delivered to the Hospital through an approximately 50foot pipeline. Burrstone anticipates commencing construction of

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the project soon, and is aiming to enter service by the first quarter of 2008.

The project, says Burrstone, will benefit the customers and will further important public policies. Burrstone emphasizes that the new cogeneration facility will replace older, less efficient facilities, including the Hospital's boilers that are more than 50 years old. Burrstone also notes that, because its cogeneration project will enable the customers to achieve significant energy savings and enhances service reliability, in conformance with public policies, it was able to obtain a grant of \$1.0 million from the New York State Energy Research and Development Authority.

Asserting that it qualifies for the exemptions from regulation afforded to QFs under the PSL, Burrstone contends that it is a cogeneration facility under PSL §2(2-a), because it is sized at less than 80 MW, it generates electricity, and it produces thermal energy that is useful for commercial purposes. Its electric and steam distribution lines, Burrstone continues, are "related facilities" falling within the scope of the QF exemptions.

Burrstone cites the Nassau District and Nissequogue Rulings for the proposition that cogeneration facilities similar to its configuration have been granted the QF exemptions from regulation.¹ It notes that its electric and steam distribution lines are shorter than the lines that, in those Rulings, were deemed related facilities under PSL §2(2-d) because located "at or near" the cogeneration facilities.

¹ Case 89-E-148, <u>Nassau District Energy Corporation</u>, Declaratory Ruling (issued September 27, 1989); Case 93-M-0564, <u>Nissequogue Cogen Partners, L.P.</u>, Declaratory Ruling (issued November 19, 1993).

The only feature of its project that distinguishes it from the Nassau District and Nissequogue projects, Burrstone explains, is that those cogeneration facilities serve only one user owning property on both sides of a street. Its facility, Burrstone continues, will supply multiple users, with one user, the College, owning property separated from the others by a street. Burrstone asserts, however, that PSL §2(2-d) explicitly contemplates multiple users, in providing for inclusion within the definition of related facilities those needed to transmit electricity or steam to "users," in the plural. That its electric line to the College crosses a street, Burrstone continues, does not remove the line from the scope of the §2(2-d) definition of related facilities. In both the Nassau District and Nissequoque Rulings, Burrstone emphasizes, distribution lines that crossed streets were treated as related facilities.

As a result, Burrstone believes its cogeneration facility, including the electric distribution line to the College, falls within the ambit of the exemptions from regulation granted to QFs, under PSL §2(3), §2(4), §2(13) and §2(22). Therefore, Burrstone concludes it is not, respectively, a corporation, person, electric corporation, or steam corporation for the purposes of the PSL.

DISCUSSION AND CONCLUSION

Under PSL §2(2-a), a cogeneration facility is defined as an electric generating plant sized at up to 80 MW, together with any related facilities located at the same project site, which simultaneously or sequentially produces electricity and thermal energy useful for industrial or commercial purposes. The electric and steam cogeneration facility that Burrstone intends to construct resembles the facilities found to satisfy

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the $\S2(2-a)$ statutory definition in the Nassau District and Nissequogue Rulings. As a result, its cogeneration facility falls within the ambit of the $\S2(2-a)$ criteria.

Under PSL §2(2-d), a cogeneration facility includes, besides the electric and steam cogeneration facility itself, "such transmission or distribution facilities as may be necessary to conduct electricity...or useful thermal energy to users located at or near a project site."² The lines distributing electricity and steam from Burrstone's cogeneration facility to users are similar to lines, including some that cross public streets, that were deemed related facilities in the Nassau District and Nissequogue Rulings, except that Burrstone's lines are shorter and less extensive in scope. Since it was decided in those Rulings that the distribution facilities were located at or near the cogeneration facilities, notwithstanding the street crossings, we find that Burrstone's distribution lines are located at or near its cogeneration facility even though one line crosses a street.

As Burrstone points out, the only distinction between its circumstances and those at issue in the Nassau District and Nissequogue Rulings is that, instead of serving one user owning property on two sides of a public street, it is furnishing electric service to multiple users, with one user owning property separated from the others by a street.³ PSL §2(2-d), however, specifically contemplates multiple users, by providing that electricity may be distributed to "users," in the plural, and does not require that users share property ownership rights.

² <u>See</u> Case 06-E-1203, <u>Steel Winds Project LLC</u>, Declaratory Ruling on Electric Corporation Jurisdiction (issued December 13, 2006).

³ The College qualifies as a user because it consumes the electricity delivered to it for useful purposes.

Therefore, the electric and steam distribution facilities that Burrstone describes, with an electric distribution line extending across a property line and a public street to serve one of a number of multiple users, are related facilities falling within the exemption from regulation granted to cogeneration facilities.

Since Burrstone's proposed project is a cogeneration facility under PSL $\S2(2-a)$, and its electric and steam distribution lines are related facilities that are part of the cogeneration project under PSL $\S2(2-d)$, it qualifies for the exemptions from regulation set forth at PSL $\S2(3)$, 2(4), 2(13) and 2(22). Therefore, Burrstone is not, respectively, a corporation, person, electric corporation or steam corporation for the purposes of the PSL.⁴

The Commission finds and declares:

1. The electric and steam generation and distribution facilities Burrstone Energy Center LLC describes in its Petition filed in this proceeding constitute a cogeneration facility as defined in the Public Service Law, and, accordingly, it is exempt from the provisions of the Public Service Law (except for Article VII).

2. This proceeding is closed.

By the Commission,

(SIGNED)

JACLYN A. BRILLING Secretary

⁴ Burrstone is reminded that, under PSL §2(4), cogeneration facilities remain subject to PSL Article VII, if they build electric or gas transmission lines sized above the thresholds triggering application of that Article.



APPENDIX O

BENEFIT COST ANALYSIS

E)

Benefit-Cost Analysis Summary Report

Site 48 – City of Albany (Empire State Plaza)

PROJECT OVERVIEW

As part of NYSERDA¢ NY Prize community microgrid competition, the City of Albany has proposed development of a microgrid that would enhance the resiliency of electric service for 10 commercial and government facilities located near the Empire State Plaza in downtown Albany. These facilities include:

- Empire State Plaza, a complex of several state government buildings that can be used as an emergency shelter in the event of a widespread power outage;
- The Times Union Center, which is a premier sports and entertainment facility and can also be used as an emergency shelter in the event of a widespread power outage;
- The New York State Capitol;
- The New York State Education Department;
- The office of the New York State Comptroller;
- The Alfred E. Smith building, which houses other offices of the New York State government;
- Albany Capital Center, an event and meeting space;
- The Albany County office building;
- The Albany County Courthouse; and
- Albany City Hall.

The microgrid would be powered by two new 7.9 MW natural gas-fired combined heat and power (CHP) generators, which would be located near the City of Albanys existing steam plant, and seven existing diesel backup generators with a combined capacity of 9.7 MW. The CHP generators would produce electricity during periods of normal operation, as well as in islanded mode during power outages. The existing backup generators would operate during power outages only. The system as designed would be able to meet approximately 81 percent of the facilitys average demand for electricity during a major power outage. The projects consultants also indicate that the system would be capable of providing ancillary services, in the form of black start support, to the grid.

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

METHODOLOGY AND ASSUMPTIONS

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

- Costs represent the value of resources consumed (or benefits forgone) in the production of a good or service.
- Benefits are impacts that have value to a firm, a household, or society in general.
- Net benefits are the difference between a project s benefits and costs.
- Both costs and benefits must be measured relative to a common *baseline* for a microgrid, the %without project+scenario - that describes the conditions that would prevail absent a project 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 users specification of project costs, the projects 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 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 equipment. Once a project costs and benefits and costs have been adjusted to present values, the model calculates both the project net benefits and the ratio of project benefits to project costs. The model also calculates the project internal rate of return, which indicates the discount rate at which the project costs and benefits would be equal. All monetized results are adjusted for inflation and expressed in 2014 dollars.

With respect to public expenditures, the models 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 **%** ocietal 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 Budgets 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 Commissions (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 CO₂ emissions. As the PSC notes, %he 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 EPAs temporal projections of social damage values for SO₂, 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 indicate that even if there were no major power outages over the 20-year period analyzed (Scenario 1), the project¢ benefits would exceed its costs by approximately 10 percent. As a result, the analysis does not evaluate Scenario 2. Consideration of Scenario 2 would further increase the project¢ already positive benefit-cost ratio.

The discussion that follows provides additional detail on these findings.

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

	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES				
ECONOMIC MEASURE	SCENARIO 1: 0 DAYS/YEAR	SCENARIO 2			
Net Benefits - Present Value	\$28,200,000	Not Evaluated			
Benefit-Cost Ratio	1.1	Not Evaluated			
Internal Rate of Return	25.4%	Not Evaluated			

Scenario 1

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

² The New York State Department of Public Service (DPS) requires utilities delivering electricity in New York State to collect and regularly submit information regarding electric service interruptions. The reporting system specifies 10 cause categories: major storms; tree contacts; overloads; operating errors; equipment failures; accidents; prearranged interruptions; customers equipment; lightning; and unknown (there are an additional seven cause codes used exclusively for Consolidated Edisons underground network system). Reliability metrics can be calculated in two ways: including all outages, which indicates the actual experience of a utilitys customers; and excluding outages caused by major storms, which is more indicative of the frequency and duration of outages within the utilitys 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 utilitys control as <code>%major power outages,+and evaluates the benefits of avoiding such outages separately.</code>



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

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

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014\$)	ANNUALIZED VALUE (2014\$)					
Costs							
Initial Design and Planning	\$6,190,000	\$546,000					
Capital Investments	\$9,180,000	\$692,000					
Fixed O&M	\$227,000	\$20,000					
Variable O&M (Grid-Connected Mode)	\$0	\$0					
Fuel (Grid-Connected Mode)	\$112,000,000	\$9,880,000					
Emission Control	\$0	\$0					
Emissions Allowances	\$0	\$0					
Emissions Damages (Grid-Connected Mode)	\$126,000,000	\$8,250,000					
Total Costs	\$254,000,000						
	Benefits						
Reduction in Generating Costs	\$77,600,000	\$6,850,000					
Fuel Savings from CHP	\$70,300,000	\$6,200,000					
Generation Capacity Cost Savings	\$12,500,000	\$1,100,000					
Distribution Capacity Cost Savings	\$0	\$0					
Reliability Improvements	\$2,860,000	\$253,000					
Power Quality Improvements	\$0	\$0					
Avoided Emissions Allowance Costs	\$40,300	\$3,560					
Avoided Emissions Damages	\$119,000,000	\$7,760,000					
Major Power Outage Benefits	\$0	\$0					
Total Benefits	\$282,000,000						
Net Benefits	\$28,200,000						
Benefit/Cost Ratio	1.1						
Internal Rate of Return	25.4%						

Fixed Costs

The BCA relies on information provided by the project team to estimate the fixed costs of developing the microgrid. The project teams best estimate of initial design and planning costs is approximately \$6.19 million, including costs associated with permitting, design, and coordinating interconnection to the local utility, among others. The present value of the projects capital costs is estimated at approximately \$9.18 million; this figure includes costs associated with installing new electrical connections to each customer, communications infrastructure, concrete duct banks for the distribution system, electrical breakers, and transformers. The project team expects that additional costs may be required every five years for selective catalytic reduction, but was not able to estimate the expenditure required at this point. As a result, that potential cost is not accounted for in the BCA. The present value of the microgrids fixed operations and maintenance (O&M) costs (i.e., O&M costs that do not vary with the amount of energy produced) is estimated at approximately \$227,000 or \$20,000 annually.

Variable Costs

The most significant variable cost associated with the proposed project is the cost of natural gas to fuel operation of the system CHP generators. 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 2015 State Energy Plan (SEP), adjusted to reflect recent market prices.³ The present value of the project fuel costs over a 20-year operating period is estimated to be approximately \$112 million. All O&M costs are assumed to be reflected in the project team setimate of fixed annual O&M costs presented above.

In addition, the analysis of variable costs considers the environmental damages associated with pollutant emissions from the distributed energy resources that serve the microgrid, based on the operating scenario and emissions rates provided by the project team and the understanding that none of the system¢ generators would be subject to emissions allowance requirements. In this case, the damages attributable to emissions from the microgrid are estimated at approximately \$8.25 million annually. The majority of these damages are attributable to the emission of CO₂. Over a 20-year operating period, the present value of emissions damages is estimated at approximately \$126 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 \$77.6 million; this estimate assumes the microgrid provides base load power, consistent with the operating profile upon which the analysis is based. Additional benefits would result from fuel savings due to the new CHP system; the BCA estimates the present value of these savings over the 20-year operating period to be approximately \$70.3 million. The reduction in demand for electricity from bulk energy suppliers and for heating fuel would also avoid emissions of CO₂, SO₂, NO_x, and particulate matter, yielding emissions allowance cost savings with a present value of approximately \$40,300 and avoided emissions damages with a present value of approximately \$119 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 grids energy generation or distribution capacity.⁵ The project team expects development of the microgrid to reduce the conventional grids demand for generating capacity by 14.7 MW as a result of new demand response capabilities. Based on this figure, the BCA estimates the present value of the projects generating capacity benefits to be approximately \$12.5 million over a 20-year operating period. The project team does not anticipate any distribution capacity benefits.

³ The model adjusts the State Energy Plans 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.

⁴ Following the New York Public Service Commission**¢** (PSC) guidance for benefit-cost analysis, the model values emissions of CO₂ 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 SO₂ 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 models 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.

The project team has indicated that the proposed microgrid would be designed to provide ancillary services, in the form of black start support, to the New York Independent System Operator (NYISO). Whether NYISO would select the project to provide this service depends on NYISOs requirements and the ability of the project to provide support at a cost lower than that of alternative sources. Based on discussions with NYISO, it is our understanding that the market for black start support is highly competitive, and that projects of this type would have a relatively small chance of being selected to provide support to the grid. In light of this consideration, the analysis does not attempt to quantify the potential benefits of providing this service.

Reliability Benefits

An additional benefit of the proposed microgrid would be to reduce customersqsusceptibility 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 \$253,000 per year, with a present value of \$2.86 million over a 20-year operating period. This estimate is developed using the U.S. Department of Energy& Interruption Cost Estimate (ICE) Calculator, and is based on the following indicators of the likelihood and average duration of outages in the service area:⁶

- System Average Interruption Frequency Index (SAIFI) . 0.96 events per year.
- Customer Average Interruption Duration Index (CAIDI). 116.4 minutes.⁷

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.⁸ It assumes that establishment of a microgrid would reduce the rate of failure to near zero.

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

Power Quality Benefits

The power quality benefits of a microgrid may include reductions in the frequency of voltage sags and swells or reductions in the frequency of momentary outages (i.e., outages of less than five minutes, which are not captured in the reliability indices described above). The analysis of power quality benefits relies on the project teams best estimate of the number of power quality events that development of the microgrid would avoid each year. In the case of the Albany microgrid, the project team expects that the microgrid would improve power quality for the customers it serves but has no information on the frequency of events that would be avoided. As a result, the BCA does not quantify this potential benefit of the microgrid but notes that its consideration would further increase the net benefits of the projects development.

⁶ www.icecalculator.com.

⁷ The analysis is based on DPSos reported 2014 SAIFI and CAIDI values for National Grid.

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

Summary

The analysis of Scenario 1 yields a benefit/cost ratio of 1.1; i.e., the estimate of project benefits is approximately 10 percent greater than that of project costs. Accordingly, the analysis does not consider the potential of the microgrid to mitigate the impact of major power outages in Scenario 2. Consideration of such benefits would further increase the net benefits of the project development.



APPENDIX P

FINAL PRESENTATION

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NY Prize - Stage 1 Feasibility FINAL PRESENTATION

APRIL 12, 2016

Objectives



- 1. Assess technical configurations for providing electricity to select facilities during normal and emergency situations in congested, downtown Albany
- 2. Develop preliminary installation and operating costs for the microgrid

- 3. Determine potential savings scenarios for each customer
- 4. Outline the utility participation necessary to promote a successful project
- 5. Evaluate community benefits
- 6. Enhance opportunity for OGS



The Design-Build-Operate Team





Microgrid Customers





Executive Summary



- The microgrid will provide an average of 81% of each customer's electricity during normal and emergency operations
- The \$15.4 M capital investment is minimized due to the installation of CHP Plant as an independent project.

The \$5-7M NYSERDA incentive can reduce it even further.

- OGS could recognize an increased annual savings of \$500k - \$900k with addition of microgrid customers
- Promotes NY State objectives such as Executive Order 88 and REV
- Provides NYSERDA and PSC a platform for addressing several microgrid issues with National Grid

Simplified Electrical Diagram





Cable Routing Diagram





Changes from Base CHP Project





150412

Energy Analysis



MICROGRID CUSTOMERS ANNUAL ELECTRICITY CONSUMPTION



- Turbines will be operating closer to full load and generating more electricity and steam at a more efficient rate
- CHP plant will provide 81% of each customers power on average
- Portion of electricity purchased from utility will be at a more favorable rate for microgrid customers

Empire State Plaza Microgrid Estimated Savings





150412



Electricity is sold to microgrid customers at the cost of electricity purchased by ESP under PSC 220 Tariff SC-7 (SC-3A) with no discount applied

ESP/SASP CHP Savings ¹	CASE 1	CASE 2	CASE 3
Total ESP Savings	\$575,370	\$877,562	\$899,267

Customer Savings ²	CASE 1	CASE 2	CASE 3	
AE Smith	\$68,755	\$88,464	\$90,410	
Capitol	\$44,606	\$59,553	\$61,032	
Education 1	\$261,640	\$276,857	\$278,364	
Education 2	\$28,246	\$36,432	\$37,241	
TUC	\$0	\$115,453	\$117,127	
ACC	\$0	\$36,769	\$37,303	
110 State	\$0	\$156,405	\$158,667	
112 State	\$0	\$54,767	\$55,158	
City Hall	\$0	\$0	\$15,905	
Court House	\$0	\$0	\$28,554	
Total Customer Savings	\$403,247	\$824,700	\$879,761	

Total Microgrid Savings	\$978,617	\$1,702,262	\$1,779,028
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Marginal Savings

Adding these customers cost \$2.9 M more generating only \$44,459 in annual savings.

NOTES:

1. "Total ESP Savings" is in addition to the \$2.73M CHP Plant Savings. The ESP will save additional money due to the gas turbines operating closer to full load to generate electricity at a more efficient rate.

2. This savings analysis does not represent the recommended 15% reduction to account for additional administrative and maintenance expenses.



\$16.8 M Project Cost with NYSERDA Incentive



Issues With Utility



- Rights of Way for crossing a public road
- Aggregation of multiple electrical customers down to one through the Empire State Plaza
- Buying or leasing existing utility infrastructure
- Addressing tariff changes that improve project financial performance



Schedules



SHERIDAN AVENUE STEAM PLANT	DURATION	2016	2017	2018	2019
CHP PROJECT TRADITIONAL SCHEDULE					
CHP Project Bid	4 Months				
Contract Award Process	6 Months	*			
Project Start			*		
Utility Interconnection	15 Months				
CHP Major Equipment Procurement	11 Months				
CHP Plant Design	10 Months				
Permitting	4 Months				
CHP Plant Construction	10 Months				
Equipment Installation	6 Months				
System Training	11 Months				
Start-up & Testing	3 Months				
Synchronization					
System Commissioning	4 Months				
CHP Plant Project Complete					

NY PRIZE COMMUNITY MICROGRID Anticipated delivery schedule	DURATION	2016	2017	2018	2019
Stage 1 Feasibility Study	8 Months				
Stage 2 Application Due		*			
Stage 2 Detailed Design Award		*			
Stage 2 Detailed Design	9 Months				
Stage 3 Application Due				₩.	
Stage 3 Design-Build Award				*	
Microgrid Design	8 Months				
Microgrid Construct	5 Months				
Microgrid Testing & Commissioning	2 Months				
Microgrid Project Complete					*

Questions?







APPENDIX Q

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