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Stewart Airport-New Windsor Community Microgrid

August 30, 2016

Microgrid Feasibility Study

NY Prize Community Grid Competition
Stage 1: Feasibility Assessment
NYSERDA RFP 3044

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Section 1 – Project Summary and Description of Microgrid Capabilities

Executive Summary

Stewart International Airport ("SWF" or the "Airport"), operated by the Port Authority of New York and New Jersey (the "Port Authority or "PANYNJ") and located in Orange County, New York, plays a critical role to the community, region, and state and has been designated a state strategic asset by Governor Cuomo. In addition to the Airport's day-to-day general aviation services, it serves as a diversion airport, as well as an emergency operations center and emergency preparedness staging area for New York City. For days after Superstorm Sandy, the Airport facilitated the transport of electrical crews and heavy equipment from outside the region to affected areas. Hourly flights of C-17 military aircraft streamed in, delivering relief workers and equipment from outside the region to assist in restoring power to New York City. Furthermore, the proposed project also includes Town of New Windsor sewer pumping and water booster station assets, a NY State Police Crime Lab, a NY State Police Aviation unit (law enforcement support, search & rescue, and medical evacuation), Department of Defense (DOD) tenants, two private aviation services companies, and numerous other entities that provide critical services to the community, region, and state and rely on the Airport's infrastructure.

The critical role of Stewart International Airport to the community, region, and state and the need for enhanced resilience to disaster events will only increase. According to an FAA-NYSDOT sponsored study published in May 2011, investments in NY State's aviation sector have "the potential to help improve the health of local economies and the state as a whole." This study quantified the economic impacts of NY State's public-use airports for the year of 2009.

Commercial Service Airport	Total Jobs	Annual Earnings	Annual Economic Activity
Stewart International	5,579	$333,621,900	$750,722,800

The proposed project has been designed to address the objectives of the PANYNJ, the Town of New Windsor, and their respective tenants in the project footprint. These include providing highly reliable service and disaster resistance in a sustainable, cost-effective way and promoting clean and efficient local generation. As illustrated below, the microgrid will address the following for customer participants at Stewart International Airport in the Town of New Windsor:

Current Status of Stewart Airport	Proposed Project Results
Reliance on diesel generators with significant air emissions	Deploy an optimized mix of clean, reliable, resilient, and efficient on-site generation
Insufficient backup power to meet the needs of the main Terminal building	Support full backup power needs of Terminal building as well as expansion project; ensure continuity of critical services during power outages or other emergencies
Separated, unlinked, individual backup generating assets	Airport-wide distributed energy resources management system to control, coordinate, and optimize new & existing assets in both "grid-tied" and "island" modes

Significant issues could arise if the primary operations center, emergency operations center, passenger terminal, runway lights, and/or other safety equipment are unavailable to continue critical services during a power outage due to severe weather or other events. For example, Stewart International Airport does not currently have sufficient back-up generation capabilities to meet the full needs of the main terminal building and its critical loads. This is primarily due to PANYNJ budgetary constraints, as the generator would not have recoverable cost savings associated with it. It is a high priority for SWF, and the Airport has put forth a project in the 2016 budget to start the design of a full back-up solution. The proposed microgrid has been designed to address this vulnerability by fully supporting the main passenger terminal and other critical loads for the PANYNJ and Town of New Windsor at the Airport and in its immediately surrounding area. Improved reliability and resilience could result in minimizing the frequency and economic impact of power outages, maintaining power to essential customer needs and operations in the event of emergencies, and protecting critical infrastructure in the Town of New Windsor.

In addition, Stewart International Airport currently has separate, un-linked backup generators that produce significant air emissions when in operation but sit idle for the majority of the time. The project team sees an opportunity to deploy a mix of cleaner, more efficient distributed energy resources ("DER") not only to provide more reliable emergency power but also to serve customer needs and provide grid support services under normal grid-tied conditions. The project will aggregate and coordinate new and existing DER at the Airport and in New Windsor under an integrated control and management platform, which will leverage the technologies to capture as many benefit streams as possible in day-to-day operating conditions, while maintaining the system's reliability and resiliency attributes.

A microgrid solution that addresses the issues described above would also serve to advance the objectives of the PANYNJ's Sustainability Policy and the Airport's site-specific Sustainability Plan. The PANYNJ has an agency-wide focus on advancing the development of strategies for climate change resilience and the use of clean/renewable energy sources.

Project Background

NRG Energy, Inc. ("NRG"), Central Hudson Gas & Electric Corp. ("Central Hudson"), the Port Authority of New York and New Jersey (the "Port Authority or "PANYNJ"), and the Town of New Windsor have partnered to develop a resilient, multi-customer microgrid in New Windsor, New York, at Stewart International Airport ("SWF" or the "Airport") and adjacent property owned by the Town of New Windsor. The project is expected to significantly enhance the efficient operations and resiliency of critical facilities in New Windsor, including town water pumping facilities and those at Stewart International Airport. As currently envisioned, the project will deploy an optimized mix of clean, reliable, resilient, and efficient on-site generation, coupled with distributed energy storage and an integrated control system and management technology platform. The project team consists of the following members:

NRG is a Fortune 200 company, the largest competitive power producer in the U.S., and one of the nation's largest developers and owners of renewable generation. NRG is a competitive energy solutions provider with a proven track record of developing and implementing microgrids incorporating multiple generation and storage technologies using integrated control and optimization platforms, at locations such as Princeton HealthCare System's University Medical Center of Princeton at Plainsboro.

Central Hudson is the local gas and electric distribution company, serving 302,000 electric customers and 79,000 natural gas customers in the Hudson Valley, including the PANYNJ and its tenants at Stewart International Airport and customers in the Town of New Windsor. Central Hudson is part of Fortis, Inc., which has $26 billion in assets and more than 3 million customers in North America and the Caribbean.

The PANYNJ is a financially self-supporting entity that builds, operates, and maintains infrastructure critical to the New York/New Jersey region's trade and transportation network. The PANYNJ became the leasehold owner and assumed management and operational control of Stewart International Airport in 2007.

New Windsor is a town in Orange County, New York and the location of Stewart International Airport, with Town-owned water pumping assets and Public Works maintenance facility at the Airport as well as other commercial, industrial, retail, and residential facilities and developments in the immediate vicinity.

Task 1 – Description of Microgrid Capabilities

The one-line and layout drawings for the proposed microgrid for Stewart International Airport-Town of New Windsor Community Microgrid project are shown in Appendix C and included as separate drawings in the submittal package. The microgrid uses a portion of the Central Hudson 13.2 kV distribution circuit in the vicinity of the Airport. This circuit would feed loads on Airport property and in the Town of New Windsor.

A new, remotely operated recloser will be added at the tap point and will sense loss of utility voltage and initiate microgrid islanding and operation.

The Airport's main terminal facility will have a new combined heat and power ("CHP") natural gas reciprocating generator rated at 200 kW and operating during normal conditions when there is demand for the heat. Similarly, Atlantic Aviation's Hangar G (Building 118) will have a 100 kW CHP to supplement existing boilers.

The SWF main terminal and Atlantic Aviation buildings will also have 500 kW and 300 kW, respectively, of rooftop solar photovoltaic ("PV") installations. The main terminal will also have a 1 MW solar PV carport installation in the parking lot across First St. from the main terminal.

There will be a new 2 MW natural gas reciprocating generator in a noise suppressing outdoor enclosure also in the parking area across First St. from the main terminal. The generator is sized to provide make-up capacity for the solar PV source and will provide black start capability.

When loss of utility power occurs, the recloser would open after a programmed delay, and the microgrid controller would shut down the CHP generators (if running) and the PV inverters. Critical facilities with existing backup generators would exercise their normal backup generator transfer sequence. Once the microgrid is established, the automatic transfer switches at these locations would perceive the microgrid voltage and frequency reference as a return of electrical service and transfer the facility to the microgrid.

The 2 MW generator would be started and connected to the islanded microgrid, then the solar PV and CHP sources would be added. The solar PV and CHP generators would be operated at maximum output for conditions by the microgrid controller. The 2 MW generator would provide load not supported by the solar PV generation. The microgrid controller will adjust the operating point when major changes are required.

When utility power is restored and after a delay, all of the microgrid sources would be shut down, and the recloser would close to connect the utility to the distribution circuit. The solar PV and CHP generators, if available, would be added by the microgrid controller.

From the Central Hudson load data, the peak demand when islanded is estimated to be 2.2 MW. By utilizing CHP generator waste heat, the boiler energy consumption is estimated to be reduced by 2,167 MMBtu/year.

A distributed microgrid controller system will operate the microgrid. This controller consists of two components: the PowerLogic™ Microgrid Controller ("PMC"), a real-time controller that is operating on the millisecond and second time scale, and StruxureWare™ Demand Side Operation ("SW DSO") software, a predictive controller that provides optimized DER schedules in 15-minute windows for the day ahead. While the PMC maintains responsibility for balancing of generation with loads and islanding/reconnection events, SW DSO utilizes outside information in the form of weather and load forecasts, energy tariff data (such as Time-of-Use rates), Demand Response commands, and user-imposed system constraints to optimize system performance.

The PMC will be capable of interfacing with the local controllers provided by the DER vendors and the utility. These local DER controllers will be responsible for the most basic level operation of the DER, i.e. maintaining the required voltage and frequency output for system stability. The PMC will provide a level of coordination above these local controllers such that the site load is shared between DER and the utility grid (when connected) at an optimal level.

Below are the Task 1.1 and 1.2 descriptions, as originally submitted to and approved by NYSERDA for completion of Milestone 1. Language has been updated to reflect the current conceptual design where applicable, but in the event of any discrepancy, these two subtasks are superseded by the descriptions above and elsewhere in this final study.

Task 1.1 – Minimum Required Capabilities

Per the facilities list in Appendix A, the proposed microgrid is intended to serve numerous and diverse critical airport facilities, municipal infrastructure, such as water pumping stations, and commercial entities. 27 metered facilities will be supported by the proposed microgrid during an extended outage.

Generation asset size and mix will include sustainable natural gas thermal-based generation, with combined heat and power utilization, as well as renewable assets in the form of solar PV generation. The incorporation of up to ~1.1 MW-DC of PV generation at the parking lot across from the main terminal building (Parking Lot A) has already been explored by the Port Authority, and an 82 kW rooftop PV system has already been installed at SWF's main terminal (Building 128).

Presently, net metering policy under NY State law does not include non-residential, gas-fired generation other than biogas and fuel cells as eligible technologies.[1] Fuel cells do not load follow well and would need to be base loaded. Fuel cell thermal output could be used for building heating at the SWF main terminal. Natural gas fueled reciprocating generators could provide load following in support of a base-loaded fuel cell. Waste heat could provide absorption cooling in the summer. Fuel cell technology and its financial feasibility may be further evaluated during the detailed design phase.

The current design incorporates new CHP natural gas reciprocating generators connected to the electrical distribution system at the SWF main terminal and Atlantic Aviation buildings and operating during normal conditions when there is demand for the heat. The thermal output of the engines could supplement building heating and possibly cooling. They would also be connected to the building electrical distribution at the utility interface so as to enable support of the islanded electrical load infrastructure. However, these generating sources would not be configured for export of electrical energy, as they do not qualify for any potential net metering programs at this time.

Fixed-Base Operators ("FBO") in the project footprint include Atlantic Aviation FBO Holdings LLC (Buildings 112 & 118) and Airborne Aviation Services (Buildings 136 & 140). These two FBOs have been granted the right by the PANYNJ to operate at SWF and provide air-side services such as fueling, hangaring, tie-down and parking, aircraft rental, aircraft maintenance, etc.

The microgrid control system would provide optimum resource allocation to maximize reliability and economic dispatch in the grid-connected mode. All microgrid generation would be in paralleling mode. As described above, the reciprocating generators would operate during normal conditions when there is demand for the heat and would be dispatched as needed to optimize

[1] Net Metering eligibility summary based on NY State law - http://www.centralhudson.com/dg/netmetering.aspx

the mix of production and consumption of energy within the optimum operating parameters of the equipment.

If utility power is lost in grid-connected mode, utility loss will be detected by the IEEE 1547 protective relaying at the isolation point of the circuit. A Viper solid dielectric re-closer from G&W Electric, Inc. will replace the fuses presently on the pole top at the tap off the circuit running along Route 207 at the southern end of the Airport. The re-closer has a full complement of protection and communication functions. It is also the device Central Hudson has standardized on for their system. It monitors voltage on both sides of the switch. The switch would open and the generation resources would be electrically isolated. The large loads at the terminal and FBO facilities would need to be isolated to allow cold pickup by the reciprocating generators. The operation will be open transition.

The synchronous generators would be switched to voltage control mode and simultaneously closed onto the microgrid. The existing load without the SWF main terminal and Atlantic Aviation facilities would be small enough to allow the generator to pick up. The other generation assets would be added, and the SWF main terminal and Atlantic Aviation loads sequenced on.

An additional non-CHP natural gas powered generator would provide N+1 capability as backup for loss of microgrid generation or scheduled maintenance of the sources. This unit has been sized and located in support of a percentage of the primary island mode operation, but not less than that needed to support all functions of the SWF main terminal.

The microgrid control system would manage generation to assure optimum voltage and frequency control. The loads were evaluated for real and reactive requirements as part of sizing the synchronous generators, plus a generous margin. The PV inverters can be capable of providing reactive power if needed. These measures will help assure the requirements of ANSI C84.1 are met.

Other than for the SWF main terminal and Atlantic Aviation facilities, there is no load shed scheme. Load shedding would be implemented at each building's main electrical panel. These are high priority loads that should not be intentionally shed except during transition.

Most of the other loads are small and would have to be shed either at the utility feed (13.2 kV) or at the building electrical equipment. Isolation at the building electrical equipment has two problems. First, it would have to be custom engineered and installed for each building and could cost about $20k to $30k each. Second, the owners/tenants may not consent to have equipment installed that would isolate them from backup power in the event of a utility outage.

An alternative is to have a remotely controlled switch on the utility riser pole or transformer pole for each customer for shedding. Due to price, this is not considered viable for a large number of buildings. The preferred alternative is to use utility switches to segment parts of the distribution circuit. This is intended to try to isolate the low priority loads while retaining the high priority loads. The cost difference between adding individual isolation and the incremental cost of adding low priority loads to the generation will be further evaluated during the detailed design phase.

Inclusion of high priority loads in outlying areas may not be economically viable. This refers to facilities on the other leg of the Central Hudson feeder as shown in Appendix B and delineated by the dashed line (to the southwest of Breunig Rd. and International Blvd.), as well as facilities on the airport leg of the feeder but more removed distance-wise (for example, in the vicinity of Perimeter Rd.) from the core airport buildings along First St.

To switch back to grid-connected operation, stable voltage and frequency must be detected for at least five minutes at the utility side of the isolation switch. The operation is open transition. The current source devices (inverters) and synchronous generators are switched off simultaneously. After a two second time delay, the utility isolation switch is closed. After a time delay, any other isolation switches in the circuit are closed.

Black start is similar to the loss of islanding sequence. The utility isolation switch would be opened. After that, the islanding sequence would be followed. The 2 MW microgrid generator would have black start capability.

Most of the microgrid portion of the utility distribution circuit construction is overhead except for a portion along First St. near the main terminal. Generally, microgrid construction is underground to improve resiliency by protecting from the effects of the wind damage associated with storms. Other than the PV arrays, all other equipment would be outdoor rated for moderate to severe wind. Added conductors would be underground.

The project team believes there is potential to leverage existing and planned DER for Demand Response participation, specifically in the New York Independent System Operator's ("NYISO") voluntary response Emergency Demand Response Program ("EDRP") or mandatory response ICAP Special Case Resources ("SCR") Program. Existing back-up generators at SWF were previously enrolled for demand response, and the PANYNJ is currently coordinating between SWF and the Office of Environmental & Energy Programs to develop a game plan for re-enrollment. NYISO's SCR Program involves a 100 kW minimum reduction in aggregate, mandatory response during reliability events for a minimum of four hours, and payments for capacity (monthly based on sales made through ICAP auctions or bilateral contracts) and energy (based on performance in capability tests & reliability events). In addition, the NY PSC has recently approved Central Hudson's proposed demand response program (in a rate plan order issued June 17, 2015), but the SWF microgrid project area in New Windsor does not fall into one of the three congested areas initially targeted for Central Hudson's "non-wires alternative" program.

During detailed design, the project team will also consider the potential for SWF microgrid resources to participate in the ancillary services market (providing real-time operating reserves and/or regulation services) through NYISO's Demand Side Ancillary Service Program ("DSASP"). The DSASP involves a 1 MW minimum reduction in aggregate, mandatory participation when scheduled, and reductions from Curtailable Load and/or Local Generators that may participate as non-synchronized reserve suppliers.

Microgrid System Communication and interoperability with the local utility (Central Hudson), as well as the primary operator of the microgrid system will be incorporated into the final design of the project. It is anticipated that such communication will be based on standard protocols such as OpenADR, et al. Existing communication infrastructure for operational technology (OT) systems is non-existent. Existing Information Technology (IT) systems and infrastructure are limited to specific areas of activity and operation, and will not be leveraged for the microgrid control and optimization system. Separation of OT and IT systems will enable site and activity specific cyber security controls and levels to be applied as appropriate for those systems. Hard wired (copper and/or fiber) as well as remote (cloud based) access will be required and incorporated into the design as part of the application design study.

As stated above, primary generation will be fueled by natural gas using established distribution infrastructure, which greatly exceeds this supply requirement. Any existing liquid fueled standby generation assets available will be incorporated for demand response program participation and peak load management only, and will not be utilized for continuous or primary island mode support. The use of these existing standby generation assets is not anticipated to require more than 24 hours of continuous use; however, SWF currently stores and distributes fuel to these assets from large (~5,000 gallon capacity) diesel storage tanks, which would enable the existing diesel standby generators to run for more than 5 days.

Task 1.2 – Preferable Microgrid Capabilities

The essential and desired functionality of the microgrid is based on a primary optimization and control scheme. Monitoring and/or control of all system assets and conditions will be continuous, and primary control will be through a master microgrid controller, as well as distributed control systems.

Schneider Electric's microgrid control solution is comprised of two complementary levels of control that both (1) coordinate the microgrid assets in real-time for maintaining and monitoring power quality and reliability and (2) optimize the scheduled functioning of the microgrid with historical and predictive algorithms and cloud based information.

These include the *PowerLogic™ Microgrid Controller* ("PMC"), a reactive, real-time controller that operates on the millisecond and second time scale, and *StruxureWare™ Demand Side Operation* ("SW DSO"), a predictive controller that optimizes DER schedules updated on a rolling 15-minute increment for the next 24 hours of operation. While the PMC is responsible for balancing generation with loads, maintaining the user control interactions, and islanding/reconnection events, SW DSO utilizes outside information in the form of weather and load forecasts, energy tariff data (such as Time-of-Use rates), Demand Response commands, and user-imposed system constraints to optimize system performance.

PowerLogic™ Microgrid Controller

The PowerLogic™ Microgrid Control System is built from the same standard, rugged, and reliable hardware platform used in thousands of critical applications in the industrial automation and process industries. A modular architecture provides an optimized solution today and can be easily expanded to control additional equipment in the future. Its flexible I/O and communications architecture easily adapts to a wide range of DER and microgrid equipment. Key advantages include:

- Pre-wired, pre-tested, and ready to install to speed installation and reduce site labor
- Ethernet I/O architecture eliminates the limitations of proprietary network topologies, while providing a high level of performance
- Dual ports provide communications and cable redundancy for high reliability operation
- Compatible with standard network infrastructure devices, tools, and network analyzers to simplify maintenance and training
- Microgrid software applications built using non-proprietary standard tool sets, easily modified and maintained

M580 Automation Platform

At the heart of the PowerLogic™ Microgrid Controller is the compact Modicon M580 offered with small box flexibility and integrated functions. The Modicon M580 is the world's first ePAC – with Ethernet built right into its core. It gives you the power to design your automation architecture without constraint. In the heart of your process, it provides Plug&Work solutions with both Schneider Electric and third party devices for:

- Substation Automation, control of distributed energy resources
- Industrial harden, conformal coding
- Process industries
- Renewable energy resources, such as Solar and Wind power
- 7 Kinst/ms
- Multitasking system for guaranteed reflex time
- USB port for programming and HMI
- 3 additional ports as required: Ethernet, CANopen, Modbus
- Programming code up to 70 Kinst
- Application back-up in supplied memory card
- Additional file storage up to 4 GB expandable memory w SFTP access
- Process control (Integrated Process Control library)
- High density analog I/O modules
- Extended temperature (-25°C +70°C)

Advanced Metering

Advanced power quality metering assets will be utilized for all critical generation and storage assets, as well as for critical facility load monitoring and load management. Schneider Electric's advanced ION metering systems are anticipated to be incorporated into any distribution equipment. For example:

ION7650 advanced revenue metering and power quality analysis

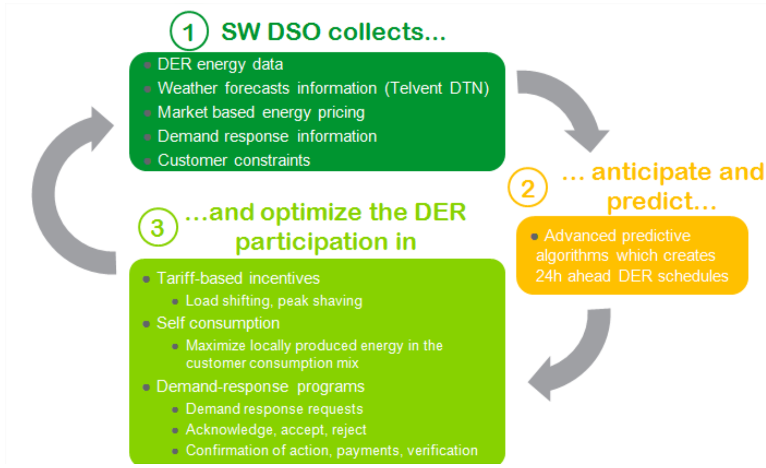
Ideal for both energy suppliers and consumers, and loaded with advanced functionality for monitoring key distribution points and sensitive loads, the PowerLogic™ ION7650 power and energy meter offers an unmatched feature set including advanced power quality analysis coupled with revenue accuracy, multiple communications options, web compatibility, and control capabilities.

An active network control system that optimizes demand, supply and other network operation functions within the microgrid is the basis for the primary optimization and control scheme. Monitoring and/or control of all system assets and conditions will be continuous, and primary control will be through a master microgrid controller and other hardware as described, as well as distributed control systems. Inter-operability with the primary and variable renewable generation, as well as demand, will be optimized through cloud-based optimization algorithms. Predictive modeling and historical reference through the life of the system will enhance the optimization of the microgrid assets in both grid-connected as well as island modes. Input from the local utility with respect to substation automation and isolation functions will be required. Communication infrastructure will be required, and fully addressed during the detailed design phase of the project.

Energy conservation measures (ECM) will be addressed during the detailed design phase. However, given the mix and type of facilities that are intended to form the microgrid at the Airport, the anticipated reduction in generation requirements are expected to be limited. ECM have already been undertaken at the Airport, and additional improvements and upgrades to external and internal lighting are already planned or underway. The use of advanced, cloud based optimization software will enhance overall efficiency of the microgrid as a system, beyond the limitation of the existing load constraints.

StruxureWare™ Demand Side Operation

SW DSO software optimizes the operation of microgrid and distributed energy assets. Using real-time pricing data feeds and weather conditions in conjunction with predicted load profiles, the software uses advanced algorithms to coordinate communications with the smart grid and optimize microgrid operation. By tracking, forecasting, and visualizing all microgrid parameters, it controls energy assets to maximize financial benefits while maintaining optimal operation.



SW DSO automatically predicts energy flexibility for the upcoming time period and proposes it to the system for evaluation (with manual override capability). The system will then coordinate actions at scheduled times (for example by curtailing non-critical loads) and will manage all payment transactions. SW DSO is hosted in the cloud, and provides the following advantages:

- Direct access to dynamic information through web services (more precise weather forecast information with a subscription to DTN WeatherSentry), electricity tariff data, demand response requests through Open ADR protocol
- The system is always up to date
- Possible to leverage best practices and benchmarking versus other facilities
- Access via a remote HMI through a secured connection

The Prosumer Solution operates in three steps, as shown below. The Prosumer Solution automatically manages DER to the extent these options are available, without any operator action required.

1 – StruxureWare™ Demand Side Operation collects...

DER Energy Data

How much energy is produced/consumed/stored? (Power, time, etc. for each DER connected to SW DSO through the DER Box).

Weather Forecast Information

Weather forecast information is provided for the coming hours and days. Weather conditions and forecast data are collected through web services from DTN WeatherSentry or can be deduced through predictive algorithms. The weather forecast used in our platform realizes not only energy consumption (for Heating & cooling systems in conjunction with thermal modeling), but also the integration of Telvent irradiance forecast used to realize PV production forecast.

Electricity Tariff

Electricity tariff for the next hours and days is obtained through web services or entered manually.

Demand Response Requests

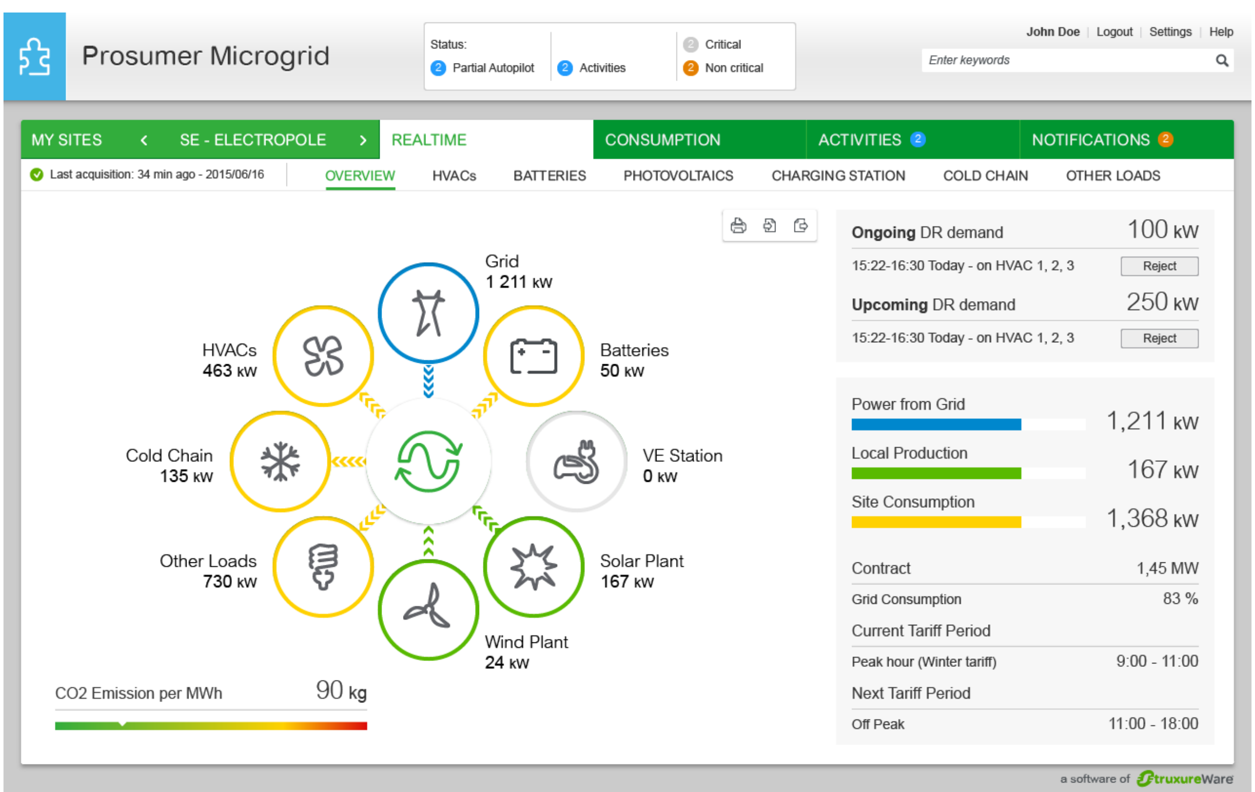
Demand Response requests for the next 24 hours can be collected through an Open ADR communication protocol, if available within the Utility service area.

2 – Anticipates & predicts…

Algorithms hosted in SW DSO then create the DER schedule for the next 24 hours. A schedule is defined by a time period and a set of control actions to achieve the desired energy generation and load modulation. Those schedules are updated every 15 minutes, and are then sent to the DER box.

3 – Optimizes the DER…

The DER schedules received by the DER box are then applied to the different DER. The Microgrid Control System will be customized for the specified use cases. A sample view of the DER asset utilization found within the SW DSO application is below:



Coordinating with Reforming the Energy Vision ("REV") Work

As described in Central Hudson's Report from the REV Collaborative Recommending Demonstration Projects, which was filed with the New York Public Service Commission ("PSC") on May 1, 2015 under Case 14-E-0318, the proposed microgrid project will be expected to advance innovative energy solutions, including market-based technologies, products, services, and business models, in the State of New York.

The project will explore the market opportunity and a technical, regulatory, and contractual framework for Central Hudson, its customers, and competitive solutions providers to establish public-private partnerships and develop efficient and resilient microgrids. The project will test the demand for enhanced reliability/resiliency services, promote clean and distributed generation, and determine value steams that can be quantified and captured by the parties as well as commercial structures that may be replicated and used to engage additional customers. The project team will use its best efforts to build a flexible and scalable platform that can support future growth at the Airport and in its surrounding community as well as can be leveraged in similar projects across New York State.

Leveraging Private Investment

The proposed commercial structure described in Section 3 is primarily based on the use of private capital from a third party. NRG is one such party that can provide a design-build-own-operate-maintain solution that includes project financing. No upfront capital requirements would be expected from customer participants (or minimal if a desire to invest and take minority interest in the project company) under the proposed third-party ownership structure. The project team believes in keeping the burgeoning microgrid industry competitive and engaging solutions providers that can bring their innovation and private capital to bear on meeting customer and community objectives.

Involving Clean Power Supply Sources

This project incorporates clean power for support of primary generation sources. Proposed generation sources include sustainable natural gas thermal-based generation, with CHP utilization, as well as renewable assets in the form of solar PV generation -- 1.8 MW in aggregate, or 44% of the new nameplate capacity in the proposed microgrid. As shown in the table in Task 4.2, 76% of average annual production is expected to come from renewable resources under normal conditions.

Demonstrating Tangible Community Benefits

The microgrid project at Stewart International Airport will be expected to result in valuable experience and tangible benefits related to the effective integration of clean and efficient DER and development of new business models with customer, local utility, community, and competitive solutions provider engagement. According to an FAANYS DOT sponsored study published in May 2011, investments in New York State's aviation sector have "the potential to help improve the health of local economies and the state as a whole." The microgrid project will serve 27 diverse facilities during an extended outage, including water pumping assets that are critical for the provision of drinking water to the local community. Stewart International Airport has been designated a state strategic asset by Governor Cuomo and plays a significant role in supporting regional economic growth and jobs in New York. Non-participating customers in the community, region, and state will benefit from the enhanced reliability and resiliency of the Airport and the vital services and facilities that rely on its infrastructure.

Strengthening the Surrounding Power Grid

The microgrid project will relieve the local grid transmission and distribution infrastructure, as well as remote generation infrastructure, of a significant load that is comprised of the primary critical facilities and infrastructure at the Airport and in the Town of New Windsor. The system will be expandable and modularized to the extent feasible to account for future growth and ensuing power needs of the Airport, thereby further relieving the surrounding power grid of future stress. Capacity Impacts and Ancillary Services are briefly described in Task 4.3.

Section 2 – Preliminary Technical Design Costs and Configuration

Task 2.1 – Proposed Microgrid Infrastructure and Operations
Task 2.2 – Load Characterization
Task 2.3 – Distributed Energy Resources Characterization
Task 2.4 – Electrical and Thermal Infrastructure Characterization

A preliminary one-line diagram along with conceptual equipment layout plans for the Stewart International Airport-Town of New Windsor Community Microgrid project are shown in Appendix C and included as separate drawings in the submittal package. The microgrid uses a portion of the Central Hudson 13.2 kV distribution circuit in the vicinity of the Airport. This circuit is tapped off the line along Route 207, which runs along the southern end of the Airport. The circuit feeds loads roughly east and west of Breunig Road, with loads to the east for the most part associated with customers on the Airport's property and those to the west with customers on Town of New Windsor property.

A new, remotely operated recloser will be added at the tap point and will sense loss of utility voltage and initiate microgrid islanding and operation. The pole top G&W Viper recloser will provide IEEE 1547 protective functions such as under/over frequency, under/over voltage, and loss of phase protection, through internal voltage and current sensing. Also, it will provide over current protection and will sense when the utility circuit is restored. All information will be communicated to the microgrid controller that is anticipated to be installed in the main airport terminal building (Building 128).

The main airport terminal facility will have a new CHP natural gas reciprocating generator rated at 200 kW, located outside near the mechanical room, and operating during normal conditions when there is demand for the heat. The terminal has two boilers for facility heating. Likewise, the FBO Atlantic Aviation's Hangar G (Building 118) will have a 100 kW CHP reciprocating generator located outdoors near the mechanical room and operated as needed to supplement existing boilers. Absorption cooling has higher capital costs than conventional cooling and would not be cost competitive at these small-sized systems. Both CHP generators were sized based on 60% of the estimated base electrical building loads. The intent is to meet the requirements for NYSERDA's PON 2568 CHP Acceleration Program incentive.

A CHP generator is a relatively straightforward mechanical addition. The engine has a heat exchanger in parallel with the engine radiator. Coolant is diverted from the radiator to the heat exchanger depending on the building heating requirements. The heat exchanger is piped in series with the boiler inlet heating the incoming feed water. This reduces the heating burden of the boiler without having to make complex modifications to the existing boiler controls.

The SWF main terminal and Atlantic Aviation buildings will have 500 kW and 300 kW, respectively, of solar PV installations on the roof of each building. The main terminal will also have a 1 MW solar PV carport installation in the parking lot across First St. from the main terminal.

There will be a new 2 MW natural gas reciprocating generator in a noise suppressing outdoor enclosure also in the parking area across First St. from the main terminal. The generator governor, exciter, and engine will be selected to provide good load following capability.

This 2 MW generator would primarily operate only as a standby source when in islanded microgrid mode. It could have limited run hours when operating for NYISO demand response program participation or on an opportunistic basis when economic in the NYISO markets.

Table of DER Characteristics

DER	Type	Rating	Fuel	Thermal
Terminal CHP	CHP	0.2 MW	Natural Gas	1,076 kBTU/hr
Atlantic CHP	CHP	0.1 MW	Natural Gas	538 kBTU/hr
Terminal PV1 (carport)	PV	1.0 MW	Solar	-
Terminal PV2 (rooftop)	PV	0.5 MW	Solar	-
Atlantic PV (rooftop)	PV	0.3 MW	Solar	-
Microgrid Generator	Recip Gen	2.0 MW	Natural Gas	-

Under normal conditions, the recloser at Route 207 would be closed and the airport area facilities' load would be fed by the utility, less the solar and CHP output. The CHP generators at the main terminal and Atlantic Aviation would be operating if the thermal demand existed. The rooftop and carport solar PV installations would also be operating as solar conditions allow.

Upon loss of utility power, the recloser would sense the loss of power and open after a programmed delay. The microgrid controller would shut down the CHP generators (if running), and the PV inverters would shut down. Critical facilities with existing backup generators will exercise their normal backup generator transfer sequence. Once the microgrid is established, the automatic transfer switches at these locations will perceive the microgrid voltage and frequency reference as a return of electrical service and transfer the facility to the microgrid. If the pre-trip load was more than the pickup capability of the 2 MW generator, the SWF terminal and Atlantic building loads could be temporally shed. Alternatively, a pole top sectionalizer could isolate part of the distribution circuit and add it after generation is stabilized.

The 2 MW generator would be started and connected to the islanded microgrid, then the solar PV and CHP sources would be added. The solar PV and CHP generators would be operated at maximum output for conditions by the microgrid controller. The 2 MW generator would provide load following as the load varied. The 2 MW generator requires a minimum output in order to load follow. If the load approaches the PV output, the PV output will be reduced to provide sufficient margin for the natural gas generator to be able to load follow. The 2 MW generator governor and exciter will define the generation and voltage for the islanded microgrid. The microgrid controller will adjust the operating point when major changes are required.

When utility power is restored and after a delay, all of the microgrid sources would be shut down, and the recloser would close to connect the utility to the distribution circuit. The solar PV and CHP sources, if available, would be added by the microgrid controller.

A closed transient transfer to the utility was evaluated, where the islanded microgrid is switched to the utility without shutting power off. However, the problem is that the recloser would not be suitable as the synchronizing device to connect the operating island to the utility. The recloser closing time would most likely be too slow, and the voltage phase information of the two systems would not be communicated fast enough to support synchronizing.

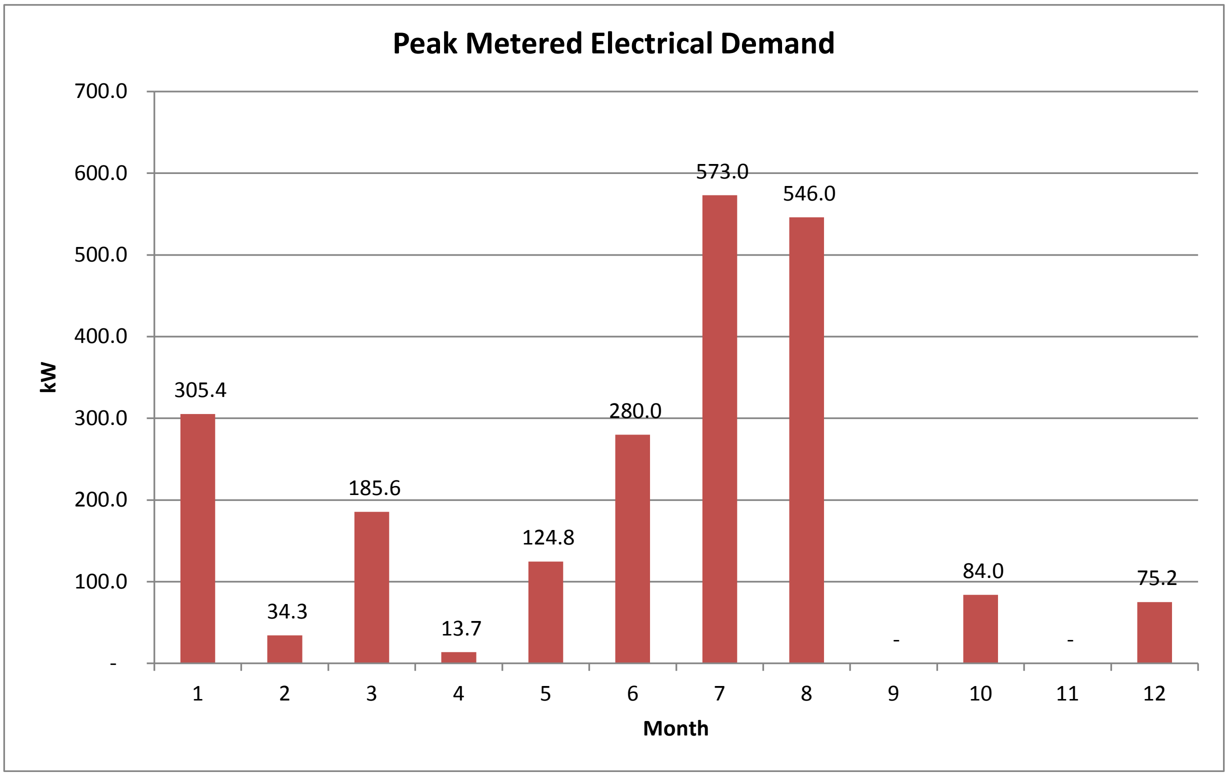
Electrical consumption data for the microgrid is shown in the table below. Some small and/or vacant facilities do not any have consumption information. By utilizing CHP generator waste heat, the boiler energy consumption is estimated to be reduced by 2,167 MMBtu/year. Facility gas consumption data is from Central Hudson billing data.

Hourly electrical data was not available from the existing meters at these buildings, except for two of the Port Authority of NY&NJ's accounts at SWF (main airport terminal, Bldg. 128 and field lighting vault, Bldg. 144). For the other buildings, demand was estimated as a fraction of monthly consumption. The graph below shows monthly peak demand data for the subset facilities where demand is part of the billing. This data is from Central Hudson. Note that since demand data is only available for a subset of the facilities, the monthly peak demands shown in the graph are much less than the estimated aggregate demand in the table below. The graph shows a very strong summer peak.

Paralleled and Islanded Electrical Consumption

Mode	Annual Energy	Peak Demand	Average Demand
Paralleled	9.2 MWh	3.1 MW	980 kW
Islanded	6.5 MWh	2.2 MW	800 kW

Peak Monthly Demands for Project Facilities with Demand Data



The islanded peak electrical demand of ~2-2.5 MW in aggregate from the supplied information is the basis for sizing the DER. Temporary power monitoring will be required to further refine the demand estimate. The total natural gas reciprocating generation is 2.3 MW. This ensures that the entire islanded peak demand can be met by these generators; in addition, it is more economical to purchase and install at this size than a smaller unit. The 1.8 MW of solar PV will provide an additional margin when available.

If generation is short for whatever reason, there is approximately 2,500 kW of standby diesel generation spread over several facilities. Some of these could be set up as load shed resources, where the microgrid controller would force the facility load to disconnect from the microgrid and switch to the standby generator for that facility alone. Another option is to add a wirelessly controlled utility circuit pole top sectionalizer that would shed part of the distribution circuit. If the 2 MW microgrid generator is out of service, the standby generator load shed, CHP generators, and solar PV production would be the means to manage the load. Scheduled maintenance would be planned for late fall with much lower demand and good probability of sunshine.

The major threat to the operation of the microgrid is wind and ice damage to overhead lines. A separate underground distribution circuit could be provided to harden the microgrid against these threats. However, it is estimated that the additional cost would be $8-10 million at a minimum, with a substantial disruption of local activity to accomplish the installation. The proposed overhead line microgrid segment is short (just over a mile), and as such the microgrid would not depend on miles of overhead distribution or transmission line to be functional. Falling trees and limbs are typically the leading cause of overhead line interruptions, and there are very few trees on the microgrid circuit segment. Ice storm damage to overhead lines is largely due to drooping or falling ice covered tree branches. Power lines are normally designed to support one inch of ice buildup. While not the most ideal configuration, leveraging the existing overhead distribution infrastructure is a very practical solution.

There is significant solar PV generation that could be vulnerable to snow cover. From the load demand graph, the loads are summer peaking, and it is expected that the natural gas reciprocating generation would be able to accommodate the microgrid load during a snow event. The PV panels could be blown away in a serious wind storm, but the 2 MW generator would be available to handle almost all the load. The natural gas generator and CHP units are outdoor units housed in enclosures that would survive far more serious winds than the buildings that these units are serving.

Central Hudson is the natural gas provider in the area and has confirmed that adequate capacity and pressure are available in the airport area to fuel the microgrid reciprocating generators. Furthermore, the gas supply is not dependent on the electrical grid and can, for all intents and purposes, be considered indefinite.

The system would perform as black start every time it switches to microgrid islanded mode. The 2 MW microgrid generator would start first, and other DER would then be added. In the event of a grid outage, the microgrid would aid in Central Hudson's system restoration efforts by isolating a significant pocket of critical loads, allowing Central Hudson to focus on other priority customers.

Overcurrent protection of the microgrid would be the standard protective practices of the Central Hudson distribution circuit when connect to the utility. In fact, the new recloser would provide a far greater selection of protective functions compared to the existing fuse protection. When operating as a microgrid, the available fault currents would be far less than when grid connected. Consequently, selectivity would be lost, and a fault anywhere on the system would probably trip the DER overcurrent protection. This has not been investigated in detail. In some cases, multi-function relays could be added and separate setting groups could be selected depending on the mode of the microgrid. However, if no tripping devices are available, this option would be costly.

While grid-connected, the large 1 MW PV inverter could help with voltage control and reactive power support. Frequency control would not be as practical since utility frequency variations are so small. Frequency could be indirectly supported by dispatching the sources to a particular power output. The other solar PV and CHP sources may be available for dispatch but may not have the capability in smaller-sized units. The 2 MW microgrid generator would be available for these functions, too.

While in grid-connected mode, the utility system dominates electrical performance. However, the local paralleled sources would help maintain voltage and power quality in the immediate area. The ability depends on the impedance of the distribution circuit at the load (short circuit capability). If it is low, the local generation will have a significant effect on voltage sags. If it is high, it will have much less effect. With the solar PV sources operating, there will be appreciable improvement of voltage sag ride through capability. Since the most sensitive equipment can be disrupted by voltage suddenly dropping to less than 80% to 85% and most voltage sags are above 60%, the solar PV may reduce the severity of many disruptive voltage sags locally.

Task 2.5 – Microgrid and Building Controls Characterization

A distributed microgrid controller system will be provided to govern the operation of the microgrid. This controller consists of two components: the PowerLogic™ Microgrid Controller ("PMC"), a real-time controller that is operating on the millisecond and second time scale, and StruxureWare™ Demand Side Operation ("SW DSO") software, a predictive controller that provides optimized DER schedules in 15-minute windows for the day ahead. While the PMC maintains responsibility for balancing of generation with loads and islanding/reconnection events, SW DSO utilizes outside information in the form of weather and load forecasts, energy tariff data (such as Time-of-Use rates), Demand Response commands, and user-imposed system constraints to optimize system performance.

The PMC will be capable of interfacing with the local controllers provided by the DER vendors. These local DER controllers will be responsible for the most basic level operation of the DER, i.e. maintaining the required voltage and frequency output for system stability. The PMC will provide a level of coordination above these local controllers such that the site load is shared between DER and the utility grid (when connected) at an optimal level.

A free standing master PMC enclosure will be provided at the microgrid distribution switchboard. Wall-mounted distributed remote PMC enclosures will be located at each DER to enable secure and dedicated control of each resource. Remote PMC enclosures will also be located at each microgrid participant building, and at the utility recloser. The majority of the participant buildings do not currently have a building management controller. The main terminal has some building controls capability. Depending on feasibility, the microgrid building controller may be integrated with any existing building management controllers.

A modular architecture provides an optimized solution today and can be easily expanded to control additional equipment in the future. The flexibility of the I/O and communications architecture allows it to be easily adapted to a wide range of distributed energy resources and microgrid equipment.

When operating in normal grid-connected (parallel) mode, all utility voltage and frequency reference will be from the new utility recloser added to the circuit at Route 207. If there is an outage, the recloser will open and all DER sources will isolate from the grid at their connection points. The PMC will then initiate black start of the anchor generator bringing it on line and creating a microgrid voltage and frequency reference for the other DER sources.

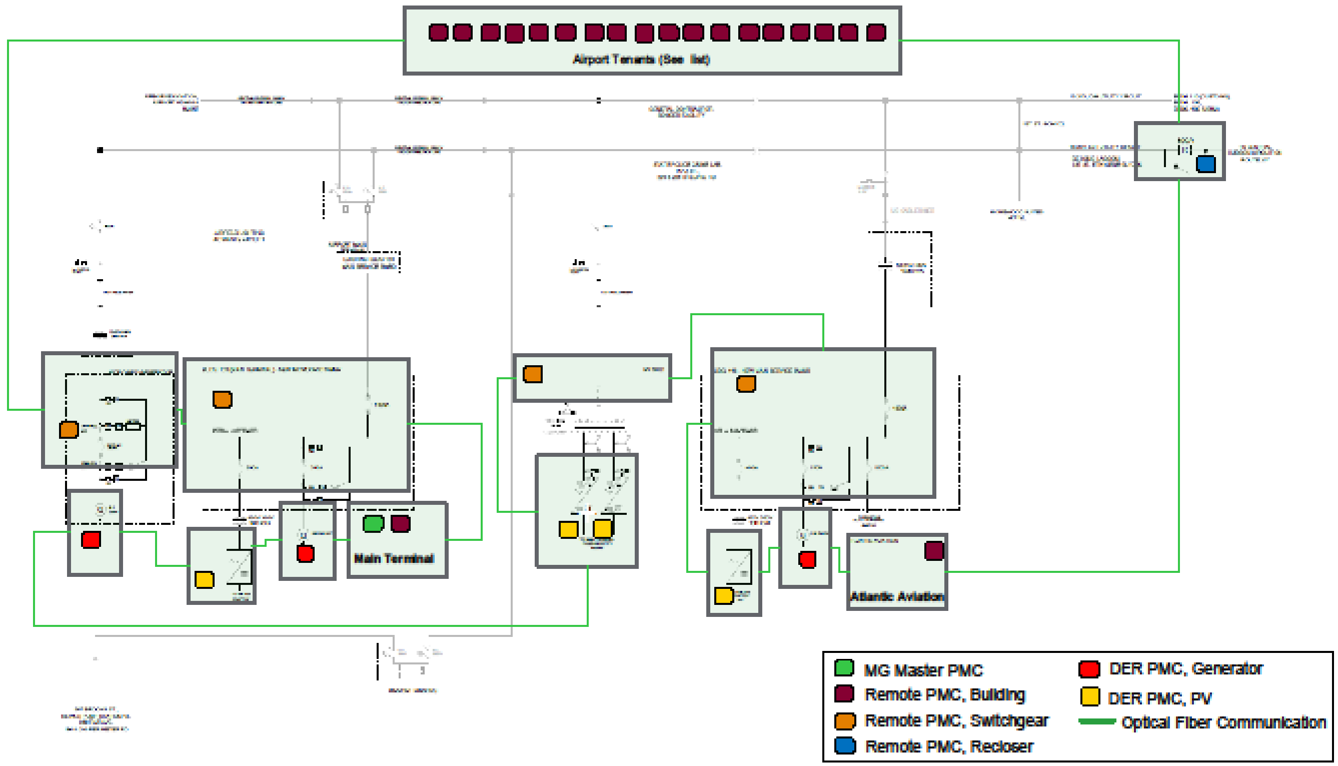
Through a predetermined sequence, the DER sources will be made available to the microgrid, and the buildings will be brought back on line. During the transition to microgrid islanded operation following an outage, critical facilities with existing backup generators will exercise their normal backup generator transfer sequence. Once the microgrid is established, the automatic transfer switches at these locations will perceive the microgrid voltage and frequency reference as a return of electrical service and transfer the facility to the microgrid. Load meters, which will be located in each building, will allow the PMC to manage building loads in conjunction with available DER.

Should any DER source drop off line, the PMC will work via the remote PMC controllers located at the buildings to shed appropriate loads or facilities in order to maintain a stable microgrid.

The PMC will constantly monitor for utility availability. Once utility service is restored, it will initiate a reverse sequence by shedding all loads and interrupting islanded operation. The utility recloser will be closed, and the buildings brought back on line. DER sources will be restarted in grid-tied operation compliance mode and synchronize to the utility.

The PMC system is built from the same standard, rugged, and reliable hardware platform used in thousands of critical applications in the industrial automation and process industries. To ensure resilience against severe weather conditions, control system components will be housed in protective indoor or outdoor-rated enclosures, and control points will be linked via an overhead self-healing optical fiber ring. All control panels will be equipped with a battery-based, uninterruptible power supply.

Proposed Control System Layout



Task 2.6 – Information Technology (IT)/ Telecommunications Infrastructure Characterization

A closed self-healing overhead and underground optical fiber ring will form the physical communication medium between control components within the microgrid. The master PMC will communicate with local controllers and utility interfaces using Modbus TCP, DNP3, and proprietary remote I/O protocols. The PMC will interface with the SW DSO hardware via Modbus TCP. If facilities participate in any ISO and/or utility demand response programs, external communications between the microgrid and the utility will be in accordance to the specifications of the ISO and/or utility to be further determined.

If communications with the utility is lost during normal grid-tied operation, the PMC will be able to access whether there is also a loss of the utility voltage and frequency reference. If the determination is that utility voltage is present and within requirements, but communication to the utility has been lost, the microgrid will continue to operate and be seen as a load center on the utility system. If the utility stipulates that a loss of communication under any circumstance should direct islanded operation of the microgrid, then the PMC will act accordingly. If the loss of communications with the utility can also be associated with a loss of utility voltage and frequency reference, the microgrid will disconnect from the utility and commence the islanded operation sequence. Once the microgrid is islanded from the utility, the microgrid can operate in the absence of communications with the utility.

Section 3 – Assessment of Commercial and Financial Feasibility

Task 3.1 – Commercial Viability – Customers

Stewart International Airport is a diversion airport for New York City airports, and it played a critical role in Superstorm Sandy response efforts as it was the landing point for hourly deliveries of key personnel and equipment needed to support the rebuilding of the region. In addition to establishing itself as a critical operation center during times of crisis, SWF plays a vital role to the local economy and state as a whole by providing jobs to 2,700 airport employees while also directly contributing $450M to the local economy and an additional $160M in wages and salaries to 3,300 more individuals. In an effort to further support the local economy, more than 50% of capital projects completed at SWF have been carried out by local companies.[2] The image to the right illustrates the number of individuals that would be affected by a loss of critical power to SWF.[3]

Thus, a major power outage at SWF will impact a combined 30K+ local employees and travelers, disrupt $1.5M+ in economic activity, and displace over 42 tons of cargo.[3] These numbers are exponentially higher in the event of an extreme weather event like Superstorm Sandy given the support role that the Airport plays for New York City, its associated 8M residents and the 13th largest economy in the world.[4] In addition to the specific items mentioned thus far, a microgrid at SWF airport introduces an innovative paradigm to daily energy operations with the following advantages:[5]

- **Fast-paced improvements.** Mindfulness of energy usage combined with local generation results in a tailored system that meets specific local needs, resulting in long-term cost savings.
- **Elevated reliability.** The proposed microgrid implementation includes control and automation upgrades to enable SWF to anticipate and quickly respond to macrogrid disturbances, saving users from surprise blackouts.

[2] Stewart International Airport: Facts & Information – http://www.panynj.gov/airports/swf-facts-info.html
[3] The Times Herald-Record – http://www.recordonline.com/article/20151118/NEWS/151119384
[4] The Atlantic – http://www.theatlantic.com/business/archive/2011/07/if-us-cities-were-countries-how-would-they-rank/241977/
[5] Galvin Electricity Initiative – http://www.galvinpower.org/resources/microgrid-hub/smart-microgrids-faq/benfits

- Scalability. The proposed microgrid will function as an energy platform from which SWF can grow incrementally to meet specific local energy needs. Distributed generation removes a capital burden from the local utility, while providing flexibility for SWF to update the system quickly when needed. SWF has realized growth in cargo shipments since 2010; a microgrid provides the needed platform to deftly scale generation to support future growth and development of the area.

Although the proposed microgrid at SWF will have the ability to provide frequency/real power, voltage/reactive, and system restoration support, there are no current programs in place at the local utility level that could utilize this capability. It is possible that such programs could be added in the future. In return for the services rendered in support of the macrogrid and utility system, the microgrid project owner may be compensated at a rate to be determined in the future as the project progresses.

Facilities that support and/or provide critical functions for SWF and the Town of New Windsor will be customers of the proposed microgrid: the Port Authority and its tenants at the Airport, as well as the Town of New Windsor with Water Dept. and Highway Dept. facilities on site. The facilities list is shown in Task 4.1. The resilience, efficiency, and reliability offered to customers will be paid directly by those customers via a pricing structure to be agreed upon in the future, e.g. time-of-use pricing, critical peak pricing, and/or a combination of fixed and variable pricing components, and may include a resiliency fee and/or subscription fee.

At the heart of this initiative is the desire to increase the operational efficiency, sustainability profile, and reliability and resilience of a profoundly critical facility that has supported the recovery of the Hudson Valley region and NYC downstate areas after devastating storm events; as the frequency and severity of storms increase, it is likely that SWF will continue to play a key role into the future for the safety and economies of the Hudson Valley and the greater NYC region. Therefore, indirectly affected stakeholders include residents of nearby towns and municipalities as far reaching as New York City, with its 8 million residents.

The Airport is the location of critical infrastructure and functions related to emergency operations and services for New York State, the Hudson Valley, and NYC. Significant issues could arise if the emergency operations center, passenger terminal, runway lights, and/or other safety equipment are unavailable during a power outage. The Airport hosts a multitude of aviation and non-aviation tenants and a significant military presence in the form of the NYANG, U.S. Marine Corps, and U.S. Army, which all rely on the Airport's services and infrastructure to a certain degree. Also, Governor Cuomo has indicated that Stewart International Airport is a state strategic asset and has proposed the creation of a tax-free START-UP NY Zone, including the establishment of a regional cargo distribution hub that will complement the $20 million Federal Inspection Station ("FIS") terminal expansion project at the Airport and further support regional economic growth and job creation in New York. As an example of how improved system resiliency at the Airport would have regional benefits, after Superstorm Sandy, the Airport was able to facilitate the transport of electrical crews and heavy equipment from outside the region to affected areas. For days after the storm, hourly flights of C-17 military aircraft streamed in, delivering relief workers and equipment from California and Georgia to assist Con Edison in restoring power to New York City.

The proposed microgrid project is designed to achieve the following objectives and provide the associated benefits to customer participants: increase the Airport's ability to maintain full terminal operations and aviation services in the event of the loss of grid power, promote the use of clean and renewable energy sources at the Airport, and deploy a management and control system to integrate and coordinate DER to meet facility energy needs as cost-effectively as possible in normal and emergency conditions. The proposed solution will greatly enhance the efficient operations and resiliency of critical facilities at the Airport and for the nearby Town of New Windsor facilities by providing a high percentage of energy needs from on-site sources, while allowing the facilities to island from the grid if necessary during an emergency event. The flexibility of the management and control system shall provide a platform to support future development and growth at the Airport and in its immediate vicinity. Both the Town of New Windsor and the PANYNJ are actively promoting additional development of this area.

In 2007 upon taking over operations, the PANYNJ pledged $500 million as part of a 10-year capital improvement plan for Stewart International Airport. Capital spending by the PANYNJ at the SWF site has been in excess of $200 million since November 1, 2007, with an additional $262 million planned for the 2014-2023 period.[6] This investment, including the FIS terminal expansion that provides a permanent international arrivals facility, demonstrates the agency's commitment to the site. The PANYNJ continues to be proactive in attracting and maintaining air service at SWF. According to an April 2012 Long Range Forecast, the PANYNJ anticipates that SWF will handle approximately 2.2 million passengers by 2032, representing a 2012-2032 average annual growth rate of 8.9 percent.[7]

Details of the commercial arrangement between the microgrid project owner and/or operator and the microgrid customer participants (or power purchasers) will be confirmed in the future, but under current consideration are Energy Service Agreements ("ESA") between the microgrid project owner/operator and the PANYNJ, its tenants (most notably the Fixed-Base Operators), and the Town of New Windsor. NRG has the means to own, operate, and maintain the microgrid to serve the PANYNJ and its tenants, including the Fixed-Base Operators, and the Town of New Windsor. The commercial structure may involve third-party ownership by NRG, or ownership by the PANYNJ with a long-term contract for dispatch/operational control of the DER assets and on-going Operations & Maintenance ("O&M") services with a company such as NRG. The specific

[6] The Port Authority of New York & New Jersey, Capital Plan Summary 2014-2023. February 19, 2014. Reprinted: October 1, 2015. < https://www.panynj.gov/corporate-information/pdf/2014-public-capital-plan.pdf>.
[7] The Port Authority of New York & New Jersey, Long Range Forecast for the Port Authority Airports. April 2012.

ESA terms and commercial relationships will be negotiated at a later time and could contain payment structures with fixed and/or variable pricing components. Additional information regarding the ESA follows:

- Governs sales of electricity, heating, cooling, and related services, such as provision of back-up power, securing supply and delivery of power from the local utility and/or competitive suppliers, purchasing natural gas and other fuel, and the billing and/or metering mechanism
- Establishes appropriate standards and benchmarks for operations and maintenance
- May authorize or require the payment of management fees, resiliency fees, and/or customer subscription fees
- May be separate Solar and/or Fuel Cell Power Purchase Agreements ("PPA") between the system owner and off-takers

There are no executed contractual agreements with critical and non-critical load purchasers currently in place. Planned contractual agreements may include Engineering, Procurement and Construction Agreements, Power Purchase/Energy Service Agreements, Site Lease/Ownership Agreements, Site Improvement Agreements, etc.

NRG, Central Hudson, the Port Authority of NY & NJ, and the Town of New Windsor have previously executed a Letter of Intent to work together to develop a microgrid demonstration project at Stewart International Airport in New Windsor, NY. Upon establishing the technical and economic feasibility of the SWF microgrid project, the parties expect to commence discussion of commercial terms for further phases of work on the project. Project team members may enter into subsequent definitive agreements as necessary to proceed with future phases of work, including detailed design and structuring. Unless otherwise exempted, procurement of future services by the customer participants will be subject to all applicable procurement and contracting laws and policies.

As part of ongoing discussions with stakeholders, all key parties are aware of the potential microgrid development and implementation. It is anticipated that the customers will not change as the microgrid shifts between grid-connected (paralleled) and islanded mode. The specifics of microgrid customer participant solicitation have not been developed yet, but it is expected that a third party firm, such as NRG, would be responsible for soliciting and registering the microgrid participants/customers in the agreed-upon commercial structure.

There is 300 kW of CHP in aggregate that will offset heating needs for the main airport terminal and Atlantic Aviation buildings. Details are discussed in Section 2.

Task 3.2 – Commercial Viability – Value Proposition

The benefits to the local economy and beyond will be acutely apparent during times when inclement weather renders the utility grid inoperative. The SWF microgrid will power critical aviation/transportation facilities and Town of Windsor water/sewer pumping stations, a police aviation unit, and a host of other necessary services. Bolstering the local system with DER will help the local area keep moving forward in difficult times and continue to support neighboring regions as it did during Superstorm Sandy.

Beyond added resilience and reliability, the SWF microgrid proposed adds long-term commercial value. Within approximately eleven years of commercial operation, initial financial modeling indicates that the solar PV will pay for itself and continue to generate inexpensive renewable energy for another 15 years. In light of the scalable system design and the pace of technology improvements and price reductions, SWF will be positioned to expand generation at a lower cost in the future to keep pace with expected growth and development. The CHP systems will reduce utility demand and cover capital costs within approximately seven years of implementation and continue to deliver high-quality inexpensive power for years to follow.

The primary business model involves PPA and/or ESA contracts signed between the microgrid owner and customer participants. Planned contracts may also include Engineering, Procurement and Construction Agreements, O&M Service Agreements, Site Lease/Ownership Agreements, and Site Improvement Agreements. There are secondary revenue streams that may be utilized by the microgrid owner, such as ancillary services, demand response, and/or utility infrastructure investment deferrals.

Microgrid business models are constantly changing and a source of innovation. The project team will propose a more detailed business model at a later phase, based on customer preferences and all available value streams and cost saving measures. Upon establishing the technical and economic feasibility of the Stewart Airport-New Windsor microgrid project, the parties expect to commence discussion of commercial terms for further phases of work on the project.

End-users will have high quality, reliable and resilient power. The community will see critical functions (e.g. water/sewer pumping stations) continue to operate during inclement weather disruptions. New York State will continue to experience the benefit of a thriving community that will be a significant catalyst for economic development in the region and that can lend a helping hand to millions of others in times of need.

Customer participants (i.e. the power purchasers) will realize the benefits of reduced risk to operations. Specific arrangements will be further discussed and agreed upon by all parties; resilience, reliability, and efficiency offered to customers will be paid directly by the customers realizing those benefits via a pricing structure to be agreed upon in the future, e.g. time-of-use, critical peak, and/or a combination of other fixed and variable pricing components; costs will be charged to the customer associated with the meter where the DER asset is tied. The addition of distributed generation assets across the Stewart Airport-FBO-Town of New Windsor locations can alleviate loading on existing transmission and distribution infrastructure. NRG's strong balance sheet, relationships with banks and other capital providers, and experience on past microgrid projects will ensure that the local utility will not need to incur additional cost as a result of this project.

NRG is a Fortune 200 company, the largest competitive power producer in the U.S., and owns and operates nearly 50,000 MW of net generation capacity nationwide, representing a diversified mix of fuel sources, generation technologies, output configurations, and geographical locations. NRG is also one of the nation's largest renewable generation owners and developers -- both at the utility and distribution scale -- with 3,000+ MW of wind generation assets and 2,000+ MW of solar in operation, construction, and development. NRG has demonstrated the ability to provide energy solutions and add value to countless stakeholders; no two projects are alike, so NRG will continue to tailor the approach to best meet the needs of all stakeholders involved with the SWF/New Windsor microgrid project. It is likely that NRG's tried-and-true turnkey approach will be utilized because a single master developer could best manage the economic risk that the assets will perform as expected and also contract with the various OEMs/sub-contractors. NRG has significant expertise in the structuring, negotiation, execution, and management of EPC arrangements for power generation projects. NRG's procurement and construction personnel are skilled at negotiating contracts with vendors and suppliers to maximize quality, limit cost, and ensure adherence to schedules.

NRG has replicated this third-party ownership and operations business model with customers. Orange County's employment growth has exceeded that of the rest of the state; as this trend continues into the future, the Port Authority and Town of New Windsor will be positioned to grow alongside the county with a nimble microgrid infrastructure in place; this can be accomplished by increasing the generation asset sizes or adding new generation assets. The PMC system seamlessly supports growth in the project area from the controls perspective, and NRG will be able to rapidly develop designs and implement further generation assets utilizing the unified turnkey model discussed above.

Strengths	For an efficient integrated microgrid, the coordination and optimization of DER enhances the functionality of the microgrid. The primary strength of this proposed endeavor is that a single, capable entity will own and operate the assets as a system to optimize performance and reduce risk and costs to participants. Secondly, the intellectual and technological capital on the project team, including NRG and Schneider Electric, ensures an effective design executed

	with best-in-class equipment. Furthermore, the project has received strong support from the PANYNJ and Central Hudson. Continued support from the project partners will be critical to the success of the project.
Weaknesses	A potential weakness of the turnkey approach is the inability of any one organization to be the expert in the myriad aspects of DER project execution, but NRG has mitigated this risk by carefully selecting subject matter experts, such as Schneider Electric, in needed areas to augment NRG's in-house expertise.
Opportunities	Opportunities abound for NRG and its partners in this space as distributed generation continues to grow in popularity to meet customer needs for resilient, high-quality power. Additionally, this project aligns with NY REV 2030 targets to generate 50% of energy from renewable sources by 2030, as the solar PV of this project will contribute to this renewable generation target. As described in Central Hudson's Report from the REV Collaborative Recommending Demonstration Projects, which was filed with the PSC on May 1, 2015 under Case 14-E-0318, Central Hudson and the other project team members believe that the proposed microgrid project will advance innovative energy solutions, including market-based technologies, products, services, and business models, in the State of New York. Also, this proposed microgrid project significantly supports and advances the PANYNJ's vision and the Airport's sustainability goal "to develop Stewart International Airport into a vibrant regional Airport that serves the needs of residents and businesses, promotes economic growth in the Hudson Valley region, and operates in a sustainable manner that conserves natural resources and protects the environment, consistent with the Port Authority's mission of the Airport." The proposed microgrid project, employing clean energy and distributed generation, shall enhance resiliency at Stewart Airport and advance goals set forth in the PANYNJ's Sustainability Policy, including the development of strategies for climate change resilience and the use of clean/renewable energy sources, and the Airport's Sustainability Plan.
Threats	DER experts will have to continually monitor and attempt to shape the legal, regulatory, and technological frameworks at the federal, state, and local levels in order to continue to deliver distributed energy solutions to

	customers and empower these customers with competitive choice and control to meet their energy needs. Numerous stakeholders representing private companies, federal agencies, and local/state agencies bring differing business and operational execution styles to the table. Moreover, each entity has unique needs and desires for the microgrid. These stakeholders will most likely require an industry expert to successfully partner with them to understand their differences, unite their common goals, and meet their distinct needs.

Tasks 3.3 and 3.4 – Commercial Viability – Project Team and Creating & Delivering Value

NRG, on behalf of the Stewart Airport-New Windsor project team members, is the NY Prize Stage 1 applicant. It is expected that a third party, such as the NRG and Schneider Electric team, would be engaged to oversee the further assessment and follow-on engineering and design of the microgrid as part of Stage 2. Looking forward to Stage 3, NRG is interested in offering a design-build-own-operate-maintain solution that includes project financing. Schneider Electric is interested in continuing to provide technical engineering and analysis services. If the project moves forward, the solicitation and award of future design, engineering, construction, or other services for the customer participants will be subject to applicable contract procurement requirements, unless otherwise exempted.

This microgrid project will impact local residents and community groups, but the primary customers will be business and government entities. Accordingly, NRG has engaged potential customer participants, including the PANYNJ, two FBOs, and Town of New Windsor Water Dept., through discussions on their needs and the potential benefits to be achieved with the project. This is an ongoing process that will develop further as the project progresses through the design and structuring phases. An elemental aspect of the message is the strength of the NRG and Schneider Electric team and its ability to deliver the project and the subsequent long-term benefits.

NRG's ability to provide a turn-key, single point of responsibility for design, engineering, permitting, construction, financing, commissioning, and long-term operations and maintenance minimizes risk and effort for customers. A single master developer could best manage the economic risk that the assets will perform as expected and also contract with the various OEMs/sub-contractors. NRG has significant expertise in the structuring, negotiation, execution, and management of EPC arrangements for power generation projects. NRG's procurement and construction personnel are skilled at negotiating contracts with vendors and suppliers to maximize quality, limit cost, and ensure adherence to schedules.

Engineering and Construction: NRG's engineering and construction team has extensive experience across a wide array of conventional and renewable energy generation technologies, and a track record for on-time and on-budget performance. The typical project execution approach is for NRG to directly manage and oversee project engineering and on-site construction, as performed by NRG-qualified contractors and suppliers. To ensure cost-effective execution in-line with requirements, NRG typically selects contractors and suppliers via competitive solicitations from among a pool of pre-qualified and well-proven contractors. NRG engages the contractors via EPC contracts with built-in risk management techniques, including, for example, date certain fixed price contracts, with appropriate retainage, liquidated damages and warranties. During the execution phase, internal NRG experts would manage construction, actively overseeing the contractors' activities to ensure on-time and on-budget delivery consistent with the project specifications.

One such partner that NRG has engaged is Schneider Electric for both engineering support and equipment needs. Schneider Electric has experience as a critical team member on 250 microgrid projects globally, with a team of technical experts as well as staff experienced in some regulatory and legal issues, and Schneider Electric equipment has been used on countless more projects. Schneider Electric is a global company ranking 206 on the Forbes global 2000 list with a market capitalization of $47.5B. Today, 170,000 Schneider Electric employees apply their expertise in energy management and automation, delivering innovative solutions for customers in more than 100 countries.

Operations: Consistent with NRG's normal practice and if selected in the future as the project's O&M services provider, NRG would manage and operate the microgrid project utilizing a team of highly experienced internal experts, supplemented by qualified subcontractors where beneficial. NRG has a strong record for safety and high reliability. NRG's operations and technical staff would develop and implement a strategy to deliver long-term reliable performance, utilizing tools such as 24x7 equipment monitoring, regular preventive maintenance, spare parts inventory and supply management, and performance reporting and assessment. In addition, NRG would maintain appropriate levels of insurance, and where available, obtain long-term warranties from original equipment manufacturers and construction contractors to ensure high levels of equipment performance.

Behind the operational excellence of NRG is a solid balance sheet. With $693 million of unrestricted cash and $2.1 billion in liquidity at the NRG Corporate level as of December 31, 2015, as well as $14.7 billion in annual operating revenues in 2015, NRG has sufficient liquidity to fund and deliver the proposed microgrid development and construction project on balance sheet. If financing is deemed appropriate as project execution nears, NRG would strive to finance the energy system in the most optimal, cost-effective manner, which could involve a combination of NRG and third-party funds. NRG would also take steps to increase the attractiveness of the project to sources of potential financing, as well as other project participants, such as EPC contractors. This would include efforts to structure financeable, long-term power purchase and/or energy services agreement(s) with microgrid customer participants. NRG has ample balance sheet liquidity, NRG Yield (NYSE: NYLD) as a potential financing vehicle and long-term owner upon commercial operation, deep relationships with third-party capital providers, including lenders, tax equity investors and institutional investors, and experience with government grants and incentive funds, including for innovative renewable energy projects.

NRG has successfully raised financing for construction projects in the last several years that range in size from large and small utility scale to distributed and residential scale. NRG has financed 3,700+ net MW of development projects on a non-recourse basis, resulting in over $7 billion of project debt financing at competitive terms. NRG has experience structuring and closing various types of financial arrangements that optimize the economic viability of projects with unique or complex features.

NRG's ability to successfully finance, build, own, operate, and maintain DER and microgrids for host customers is demonstrated by the following examples of operational systems:

- NRG Energy Center Princeton – State-of-the-art and self-sufficient, with the lowest net energy consumption and highest reliability available for a healthcare facility, this CHP-based microgrid supplies the total energy needs of the University Medical Center of Princeton at Plainsboro – under a long-term full requirements contract to provide steam, chilled water, electricity from a gas turbine generator and solar, back-up generation, and thermal storage. NRG was selected to finance, design, build, own, operate, and maintain the sustainable energy system. The project commenced commercial operations in January 2012 ahead of schedule and on budget, and NRG's solution dramatically cuts energy bills and emissions while increasing reliability.
- Arizona State University – NRG entered into an agreement with ASU to design, construct, and operate the Sun Devil Energy Center, a CHP plant and emergency back-up assets connected to on-campus laboratories and research facilities that require reliable and resilient energy supplies on a 24/7 basis. In addition, NRG has provided significant solar generation for the ASU campus, with over 12 MW of solar currently installed. Applications include rooftop, elevated parking arrays, and single axis ground mount solar solutions.

Commercial viability of the proposed Stewart Airport-New Windsor microgrid is sustained by a balanced generation approach that meets historical baseload requirements while maintaining an economical natural gas generator contingency to ensure resilience in the event of a macrogrid outage. The calculated design and selected technology results in a measured mix of new generation that balances cost and output needs to deliver cost-effective power when it is needed.

The main airport terminal facility will have a new CHP natural gas reciprocating generator rated at 200 kW, located outside near the mechanical room, and operating during normal conditions when there is demand for the heat. The terminal has two boilers for facility heating. Likewise, the FBO Atlantic Aviation's Hangar G (Bldg. 118) will have a 100 kW reciprocating generator CHP located outdoors near the mechanical room and operated as needed to supplement existing boilers. Absorption cooling has higher capital costs than conventional cooling and would not be cost competitive at these small-sized systems. Both CHP generators were sized based on 60% of the estimated base electrical building loads. The intent is to meet the requirements for NYSERDA's PON 2568 CHP Acceleration Program incentive.

The two CHP generators supply only a fraction of what the islanded microgrid would need. Additional solar PV is also included with a 1 MW carport installation and two rooftop installations at the main terminal and Atlantic Aviation facilities of 500 kW and 300 kW, respectively. The sizes were constrained by physical layout and economics. Combined capacity is close to the expected peak during Island Mode. However, solar PV generation is an intermittent resource and therefore cannot typically be used to satisfy the facility Island Mode requirements on its own.

Some type of engine powered generation can serve as a standby source and as a means to handle the solar PV variability. A 2 MW natural gas fueled internal combustion generator has been selected as the most economical and reliable choice. Natural gas would be continuously available even during extended outages. The natural gas generator would operate to make up the differences between the other microgrid sources and the load. It would generally not be expected to operate when the microgrid is connected to the utility.

An alternative means to handle the solar PV variability is a battery energy storage system (BESS). These have relatively high capital cost and would need to be very large capacity to accommodate even the night time load, let alone extended periods of overcast. BESS can also make the microgrid more robust by providing back-up power during islanded operation or by assisting with peak shaving during normal operation. Schneider Electric's EcoBlade solution or other BESS may be further evaluated during the detailed design phase.

The location of electrical meters and load requirements dictate that generation assets will be placed at both the SWF main terminal and Atlantic Aviation (Hangar G), one of the two fixed-base operators on site. The main terminal used 2.2M kWh of energy according to twelve months of data from October 2014 to September 2015; the peak power demand was 573 kW in February, and the total natural gas consumption was 45,500 CC. Atlantic Aviation (Hangar G) used 1M kWh of electricity with a peak demand of 320 kW; total natural gas consumption for the period was 79,660 CCF. Implementing a 200 kW CHP generator at the main terminal will account for approximately 1.6MWh and meet or exceed heating needs for eight of 12 months of the year. Although a larger CHP system would meet more energy needs, it leads to an overall reduction in efficiency given the heating load. Hence, the addition of 500 kW of solar PV generates 694MWh to meet the entire annual energy need.

Atlantic Aviation would implement a 100 kW CHP generator to account for 788MWh of energy and meet 100% of heating needs for seven of 12 months each year. Combining 300 kW of solar PV to the 100 kW of CHP adds another 417MWh of energy to meet the annual need. An increase in CHP size will increase energy generation but decrease efficiency. The proposed CHP sizes meet a considerable percentage base load, and the proposed 2 MW natural gas generator will step in during critical periods or emergencies to offset shortfalls (e.g. when cloud cover reduces solar PV generation).

In addition, the benefit-cost analysis of the SWF microgrid project in Section 4 is based on an assumption that the full capability of the back-up generation within the microgrid footprint (2.0 MW and 2.3 MW) will be able to participate in the NYISO capacity market. This will require a change in NYISO rules to allow multiple resources to aggregate behind a consolidated metering point, whereas current rules limit the capacity value of such resources to the demand located at the same retail electric meter where the back-up generator is connected. NRG believes such a rule change is warranted and achievable, to support the implementation of microgrids and other distributed energy resources, consistent with NY State policies, and to support the use of the full capability of these resources in NYISO planning and operations. During detailed design, the economic evaluation will also consider a sensitivity case in which the back-up generation within the project's footprint is valued based on current rules, which limit participation to the value of the load drop, which is the lesser of the generator size behind a given meter and the customer's 'baseline' load level (the Average Coincident Load or "ACL").

Taking a broader look at the market and microgrid projects, there are significant technological and intellectual capital barriers to entry. NRG has been successful in the distributed generation market and has experience overcoming challenges and barriers to entry, such as the following:

- Changing and evolving regulatory environment between different states and different utility service territories;
- Recovering costs for the different entities involved in the project;
- Microgrid design engineers and developers face challenges when dealing with a built environment and existing infrastructure, as compared to a new building or campus that can be more easily and economically set up for islanding operation;
- Interdisciplinary nature of microgrid design involving electrical, mechanical, financial, legal, and regulatory domains;
- Difficulty in many markets to deliver value at a competitively priced rate; and
- High capital costs for new/updated infrastructure

Utilizing a combination of in-house expertise and external subject matter experts, a single entity with a proven track record and adequate financial strength can finance, build, own, operate, and maintain the assets as a system to optimize performance and reduce risk and costs to microgrid customer participants. The Stewart Airport-New Windsor microgrid design team has working experience with third-party ownership/operations structures for energy projects. NRG has successfully completed operational microgrids for host customers, and Schneider Electric has experience as a critical team member on 250 microgrid projects globally.

The details of the commercial structure will need to be worked out within the legal and regulatory environment. Responsibility for operations and maintenance of the microgrid system and its components up to the point of common coupling could reside with the system/equipment owner, a third party operator, or the customers depending upon the ultimate ownership structure as well as technical expertise. NRG is one such party that can successfully fulfill a design-build-own-operate-maintain role on a "turn-key" basis. Central Hudson shall continue to own and operate the distribution system components incorporated in the microgrid and certain additional switchgear components on the distribution network required for islanding capability. New generation will be installed behind the customer meters, so that the DER can be used to offset retail electric rates and Central Hudson's existing interconnection processes can be used. The project team does not expect that special permits will be required.

The microgrid design team will work with the local utility (Central Hudson) on technical and commercial tasks to successfully develop the proposed project. The tasks will include review and approval of design documents, relay settings, and coordinating the integration of the intertie switchgear for each generating package and switchgear. Establishing communication with each distributed generator and resolving the metering issues will also be required.

The project team will use its best efforts to address technical, regulatory, and contractual challenges and develop a framework that paves the way for future microgrids in the Hudson Valley and across New York State. Although all scenarios are different, the basic need for resilience and the combination of multiple DER – CHP and solar PV in this case – are realities for municipalities and businesses across the state. Long-term power purchase and/or energy service agreements between a third party and public/private customer entities are a proven and widely-used deal structure to implement large energy infrastructure projects.

Task 3.5 – Financial Viability

As discussed in the commercial viability tasks above, the proposed microgrid design balances performance and cost to meet customer needs. For example, the CHP generators are sized to meet baseload requirements and maximize utilization. Larger generators could be purchased for CHP, but they would remain unused for much of the time and only be utilized during rare emergencies; to meet this less frequent need, a more cost effective natural gas generator was selected. This 2 MW microgrid generator can also offset its capital cost in time by generating revenues as a NYISO demand response resource. Based on NYCA (ROS) average capacity prices for Summer 2015 ($3.46/kw-m) and Winter 2015-2016 ($1.14/kw-m), a 2 MW generator may receive revenues of ~$55K annually in this scenario. This is a more conservative estimate on the capacity prices since the project is located in the Hudson Valley capacity zone, which may produce revenues of up to ~$155K annually based on historical average prices for the past two seasons and under the assumption that the zone continues to command a premium to NYCA (ROS). Also, the site currently maintains diesel generation assets for power backup; these assets are not used for demand response at this time.

Preliminary economic modeling for the Stewart Airport-New Windsor Microgrid System, i.e. the proposed DER in aggregate, indicates a payback period of approximately twelve to thirteen years excluding additional NY Prize funding. Projected savings and net cash flow estimates for the DER in aggregate are shown in the table at the end of Task 3.5. In terms of the estimated Annual Utility Savings in aggregate over the life of the microgrid system's useful life, the relative contributions by individual DER are estimated to be the following: Main Terminal PV (41%); Atlantic Aviation PV (10%); Main Terminal CHP (30%); and Atlantic Aviation CHP (19%). The relative contributions of estimated total Net Cash Flows by individual DER are the following: Main Terminal PV (17%); Atlantic Aviation PV (11%); Main Terminal CHP (40%); and Atlantic Aviation CHP (32%).

As described later in this section, preliminary economic results include the Federal Investment Tax Credit, NY-SUN Commercial / Industrial Performance-Based Incentive, and NYSERDA CHP Program Incentive. Note that it does not include additional incentive funds from NY Prize or any other program, or estimated revenues from potential participation in NYISO markets for energy, capacity, and/or ancillary services, such as demand response programs. For the solar PV behind the Main Terminal's meter, the payback period would improve if the resource can take advantage of remote net metering and offset energy usage across other facility meters.

In addition, the preliminary modeling results in this section do not account for the 2 MW natural gas microgrid generator, which would primarily operate only as a standby source when in islanded microgrid mode. The preliminary modeling has been done for each individual DER and thus does not include full microgrid implementation costs for Initial Planning & Design, Utility Modifications, and Microgrid Controls (as shown in Task 4.4).

The table below, also shown in Task 4.0 as Table 3 – Detailed BCA Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate), presents an overview of the costs and benefits of the entire project. Approximately 60% of the overall cost is due to the upfront capital expenditures.

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$2,000,000	$176,000
Capital Investments	$9,010,000	$753,000
Fixed O&M	$2,150,000	$190,000
Variable O&M (Grid-Connected Mode)	$0	$0
Fuel (Grid-Connected Mode)	$667,000	$58,800
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$1,610,000	$105,000
Total Costs	**$15,400,000**	
Benefits		
Reduction in Generating Costs	$2,490,000	$220,000
Fuel Savings from CHP	$51,900	$4,580
Generation Capacity Cost Savings	$5,670,000	$500,000
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,330,000	$118,000
Power Quality Improvements	$933,000	$82,300
Avoided Emissions Allowance Costs	$1,240	$110
Avoided Emissions Damages	$1,890,000	$123,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$12,400,000**	

The fixed and variable costs (2014$) from above consist of the following:

FIXED COSTS	
Design, Planning, Permitting, Commissioning (upfront)	~$2,000,000
PV Arrays, CHP, Gas-Fired Generator, Utility Modifications (upfront)	~$9,000,000
VARIABLE COSTS	
Fuel (PV of 20-year operating period)	~$667,000
Emissions Damages (PV of 20-year operating period)	~$1,600,000

A number of federal and state-level incentives, subject to funding availability and eligibility and changes in incentive levels and structures, will contribute to the overall financial viability of this project. Note that the preliminary modeling does not include additional incentive funds from NY

Prize or any program other than those listed below, or estimated revenues from potential participation in NYISO markets for energy, capacity, and/or ancillary services, such as demand response programs.

In general, with the potential enactment of new policies and market rule changes to allow "behind-the-meter net generation" or "BTM-NG" to participate in the NYISO wholesale markets by the end of 2016, it is hoped that the microgrid will sell power, capacity, and/or ancillary services to the grid and receive new on-going revenues as a result. NYISO's current proposal for BTM-NG would apply to a generator (or interconnected group of generators) that serves load behind the meter and has excess generation capability (at least 1 MW of energy to export) after serving its retail load. The intent is to allow for routine "exports" into the NYISO markets for over-sized BTM capacity, while smaller DER will be considered in the future, perhaps under a different set of rules. The magnitude of these potential revenues is difficult to predict at this stage given the emerging nature of these grid services and markets. Many of the market rules would have to be changed in order to fully support selling into *both* the DSP (or Distribution System Platform envisioned under REV) and the NYISO.

Incentives to deploy solar PV and CHP would buy down the initial cost of these technologies. Other incentives required or preferred will depend in part on the magnitude of the NY Prize funding received in future stages. The project team believes that the NY Prize Stage 2 funding will be particularly important for communities and their partners to move forward with the microgrid development process. Absent this funding from NYSERDA, communities will most likely be challenged to secure additional funds and proceed to a final, buildable project design.

The incentives listed below are currently reflected in the preliminary economic modeling of the Stewart Airport-New Windsor microgrid generation resources.

- Federal Investment Tax Credit ("ITC")
    - 30% - Solar PV (extended at 30% through 12/31/2019 and gradually stepping down each year thereafter)
    - 10% - CHP (currently set to expire on 12/31/2016)
- NY-SUN Commercial / Industrial Performance-Based Incentive – NY PON 3082
    - $0.114/kWh-AC for 4 years (not to exceed - $400K)
- NYSERDA CHP Program – NY PON 2568

It is important to note that the previous NYSERDA CHP offerings were merged as of March 1, 2016 under the Clean Energy Fund structure. The maximum incentive available is $2,500,000 per eligible project, and incentives for systems 50 kW - 3 MW will periodically be reduced along a declining glide path with applications for projects up to 3 MW accepted until December 31, 2018.[8]

[8] NYSERDA PON 2568 CHP Program (Updated March 2016) - http://www.nyserda.ny.gov/PON2568.

Please see Task 4.4 – Project Costs for a breakdown of anticipated capital costs and operating expenses.

Preliminary Economic Modeling – Main Terminal PV

The following image illustrates key elements, as summarized below, from the financial model for 1,500 kW of solar PV (500 kW rooftop and 1,000 kW carport) at the Main Terminal:

- $2.70/Watt capital cost
  - o Plus an additional cost estimate of $500,000 for parking structure
- $0.02/Watt operations and maintenance annually
- $0.30/Watt repair and replacement every 10 years
- Base energy costs of $0.13/kWh; escalation 4% annually[9]
- 30% Federal Investment Tax Credit; and approximately $50k/year for 4 years as part of NYSERDA PON 3082 (NY-SUN Commercial / Industrial Performance-Based Incentive)
- No value for Renewable Energy Credits (RECs), as NY State is only now moving to an RPS that would have a tradable value for RECs in the future

Energy Model Details

Solar Resource

Parameter	Value	Units
Location	NY, Newburgh	
Longitude	74.10	degrees
Latitude	41.50	degrees
Daily Average Irradiance	1,596	Btu/ft2/day
Daily Total Generation	50	Wh/ft2/day
Annual Power Density	1,389	kWh/kW
Estimated Production	2,083,814	kWh

Electricity

Parameter		Value	Units
Fuel Units		kWh	
Energy Content		3,413	Btu per kWh
Baseline Energy Cost		0.129	$/kWh
Post Retrofit Energy Cost		0.144	$/kWh
What type of net metering?		12 Month	
Credits for Net Export	$	0.0500	$/kWh
Energy Escalation Rates		4.00%	

Net Metering Math

Parameter	Value	Units
Total Facility Usage	620,872	kWh
Total PV Generation	2,083,814	kWh
Avoided Grid Usage	620,872	kWh
Net Excess	1,462,942	kWh
Grid Buy-Back	0	kWh

Technology Estimate Assumptions

Installed Cost Estimate

Parameter	Value	Units	Year 1		Include?	
Solar PV System, Installed	2.70	$/Watt	$	4,050,000	Y	1
Parking Structure	500,000	$	$	500,000	Y	1
Batteries	$0	$	$	-	Y	1
Battery Install	$0	$	$	-	Y	1
Metering and Utility	0.00	$/Watt	$	-	Y	1
Labor	0.00	$/Watt	$	-	Y	1

On-Going Costs

Parameter	Value	Units	Year 1		Frequency	Escalation
Operation and Maintenance	0.02	$/Watt	$	30,000	1	3.0%
Repair and Replacement	0.30	$/Watt	$	450,000	10	3.0%
M+V	0.00	$/Watt	$	-	1	3.0%
Other	0.00	$/Watt	$	-	1	
Other	0.00	$	$	-	1	
Other	0.00	$	$	-	1	

Based on these assumptions, the initial cash flow modeling illustrates a payback in approximately twenty two years for 1,500 kW of solar PV at the Main Terminal. If the project can take advantage of *remote* net metering and offset energy usage across a number of PANYNJ facility meters at the SWF site, the economic payback would be more attractive than what is shown below.

Clean Energy Fund Investment Plant: Resource Acquisition Transition Chapter (Revised 2/22/16) - http://www.nyserda.ny.gov/About/Clean-Energy-Fund

[9] 1999-2003 CAGR for Industrial customers – http://www.nyserda.ny.gov/Cleantech-and-Innovation/Energy-Prices/Electricity

	Energy			Technology Cost					Total	
Year	Baseline Utility Cost	Future Utility Cost	Utility Savings	Technology Cost	Financing	O+M	Incentive	Scheduled Principal Payment	Net Cashflow	Cummulative Cashflow
0	$ 80,092	$ 80,092	$ -	$ (3,134,818)		$ -	$ 50,182	$ -	$ (3,084,637)	$ (3,084,637)
1	$ 83,296	$ (9,686)	$ 92,982		$ -	$ (30,000)	$ 50,182	$ -	$ 113,164	$ (2,971,473)
2	$ 86,628	$ (78,758)	$ 165,386		$ -	$ (30,900)	$ 50,182	$ -	$ 184,668	$ (2,786,805)
3	$ 90,093	$ (81,377)	$ 171,470		$ -	$ (31,827)	$ 50,182	$ -	$ 189,825	$ (2,596,980)
4	$ 93,697	$ (84,081)	$ 177,778		$ -	$ (32,782)	$ -	$ -	$ 144,997	$ (2,451,984)
5	$ 97,445	$ (86,875)	$ 184,320		$ -	$ (33,765)	$ -	$ -	$ 150,555	$ (2,301,429)
6	$ 101,343	$ (89,761)	$ 191,104		$ -	$ (34,778)	$ -	$ -	$ 156,325	$ (2,145,104)
7	$ 105,396	$ (92,742)	$ 198,138		$ -	$ (35,822)	$ -	$ -	$ 162,316	$ (1,982,787)
8	$ 109,612	$ (95,821)	$ 205,433		$ -	$ (36,896)	$ -	$ -	$ 168,536	$ (1,814,251)
9	$ 113,997	$ (99,000)	$ 212,997		$ -	$ (38,003)	$ -	$ -	$ 174,994	$ (1,639,257)
10	$ 118,556	$ (102,285)	$ 220,841		$ -	$ (626,291)	$ -	$ -	$ (405,450)	$ (2,044,707)
11	$ 123,299	$ (105,677)	$ 228,976		$ -	$ (40,317)	$ -	$ -	$ 188,658	$ (1,856,048)
12	$ 128,231	$ (109,181)	$ 237,411		$ -	$ (41,527)	$ -	$ -	$ 195,884	$ (1,660,164)
13	$ 133,360	$ (112,799)	$ 246,159		$ -	$ (42,773)	$ -	$ -	$ 203,386	$ (1,456,778)
14	$ 138,694	$ (116,537)	$ 255,231		$ -	$ (44,056)	$ -	$ -	$ 211,175	$ (1,245,603)
15	$ 144,242	$ (120,396)	$ 264,638		$ -	$ (45,378)	$ -	$ -	$ 219,261	$ (1,026,342)
16	$ 150,012	$ (124,383)	$ 274,394		$ -	$ (46,739)	$ -	$ -	$ 227,655	$ (798,687)
17	$ 156,012	$ (128,499)	$ 284,512		$ -	$ (48,141)	$ -	$ -	$ 236,370	$ (562,317)
18	$ 162,253	$ (132,751)	$ 295,004		$ -	$ (49,585)	$ -	$ -	$ 245,418	$ (316,898)
19	$ 168,743	$ (137,142)	$ 305,885		$ -	$ (51,073)	$ -	$ -	$ 254,812	$ (62,087)
20	$ 175,493	$ (141,676)	$ 317,169		$ -	$ (841,683)	$ -	$ -	$ (524,514)	$ (586,600)
21	$ 182,512	$ (146,359)	$ 328,871		$ -	$ (54,183)	$ -	$ -	$ 274,688	$ (311,912)
22	$ 189,813	$ (151,195)	$ 341,008		$ -	$ (55,809)	$ -	$ -	$ 285,199	$ (26,714)
23	$ 197,405	$ (156,189)	$ 353,594		$ -	$ (57,483)	$ -	$ -	$ 296,111	$ 269,397
24	$ 205,301	$ (161,346)	$ 366,647		$ -	$ (59,208)	$ -	$ -	$ 307,439	$ 576,837
25	$ 213,513	$ (166,671)	$ 380,184		$ -	$ (60,984)	$ -	$ -	$ 319,200	$ 896,037

The current modeling illustrated above assumes that the solar PV is located behind the meter of the SWF Main Terminal building. When other loads from the project footprint (PANYNJ, FBO-Atlantic Aviation, and Town of New Windsor electric accounts) are combined and remotely net metered with the Main Terminal load above, the estimated payback/breakeven point is reduced from twenty two years to just under twelve years.

	Energy			Technology Cost					Total	
Year	Baseline Utility Cost	Future Utility Cost	Utility Savings	Technology Cost	Financing	O+M	Incentive	Scheduled Principal Payment	Net Cashflow	Cummulative Cashflow
0	$ 414,845	$ 414,845	$ -	$ (3,134,818)		$ -	$ 50,182	$ -	$(3,084,637)	$(3,084,637)
1	$ 431,439	$ 146,830	$ 284,610		$ -	$ (30,000)	$ 50,182	$ -	$ 304,791	$(2,779,845)
2	$ 448,697	$ 154,183	$ 294,514		$ -	$ (30,900)	$ 50,182	$ -	$ 313,796	$(2,466,049)
3	$ 466,645	$ 161,881	$ 304,763		$ -	$ (31,827)	$ 50,182	$ -	$ 323,118	$ (2,142,931)
4	$ 485,310	$ 169,941	$ 315,369		$ -	$ (32,782)	$ -	$ -	$ 282,587	$ (1,860,344)
5	$ 504,723	$ 178,379	$ 326,344		$ -	$ (33,765)	$ -	$ -	$ 292,579	$ (1,567,766)
6	$ 524,912	$ 187,211	$ 337,701		$ -	$ (34,778)	$ -	$ -	$ 302,922	$ (1,264,843)
7	$ 545,908	$ 196,456	$ 349,453		$ -	$ (35,822)	$ -	$ -	$ 313,631	$ (951,212)
8	$ 567,745	$ 206,131	$ 361,614		$ -	$ (36,896)	$ -	$ -	$ 324,717	$ (626,495)
9	$ 590,454	$ 216,257	$ 374,198		$ -	$ (38,003)	$ -	$ -	$ 336,195	$ (290,300)
10	$ 614,073	$ 226,853	$ 387,220		$ -	$ (626,291)	$ -	$ -	$ (239,071)	$ (529,372)
11	$ 638,635	$ 237,940	$ 400,695		$ -	$ (40,317)	$ -	$ -	$ 360,377	$ (168,994)
12	$ 664,181	$ 249,542	$ 414,639		$ -	$ (41,527)	$ -	$ -	$ 373,112	$ 204,118
13	$ 690,748	$ 261,680	$ 429,069		$ -	$ (42,773)	$ -	$ -	$ 386,296	$ 590,414
14	$ 718,378	$ 274,378	$ 444,000		$ -	$ (44,056)	$ -	$ -	$ 399,944	$ 990,358
15	$ 747,113	$ 287,662	$ 459,451		$ -	$ (45,378)	$ -	$ -	$ 414,074	$ 1,404,432
16	$ 776,998	$ 301,557	$ 475,440		$ -	$ (46,739)	$ -	$ -	$ 428,701	$ 1,833,133
17	$ 808,078	$ 316,092	$ 491,986		$ -	$ (48,141)	$ -	$ -	$ 443,844	$ 2,276,977
18	$ 840,401	$ 331,294	$ 509,107		$ -	$ (49,585)	$ -	$ -	$ 459,521	$ 2,736,499
19	$ 874,017	$ 347,193	$ 526,824		$ -	$ (51,073)	$ -	$ -	$ 475,751	$ 3,212,249
20	$ 908,977	$ 363,820	$ 545,157		$ -	$ (841,683)	$ -	$ -	$ (296,526)	$ 2,915,724
21	$ 945,337	$ 381,208	$ 564,129		$ -	$ (54,183)	$ -	$ -	$ 509,945	$ 3,425,669
22	$ 983,150	$ 399,390	$ 583,760		$ -	$ (55,809)	$ -	$ -	$ 527,951	$ 3,953,620
23	$ 1,022,476	$ 418,401	$ 604,075		$ -	$ (57,483)	$ -	$ -	$ 546,592	$ 4,500,212
24	$ 1,063,375	$ 438,278	$ 625,097		$ -	$ (59,208)	$ -	$ -	$ 565,889	$ 5,066,102
25	$ 1,105,910	$ 459,060	$ 646,850		$ -	$ (60,984)	$ -	$ -	$ 585,866	$ 5,651,968

Alternatively, if a solar PV system is sized more in line with the Main Terminal facility's annual electricity usage (i.e. 500 kW of rooftop PV behind the Main Terminal's meter as shown below), the 500 kW solar PV project would pay for itself in approximately eight years.

	Energy			Technology Cost					Total	
Year	Baseline Utility Cost	Future Utility Cost	Utility Savings	Technology Cost	Financing	O+M	Incentive	Scheduled Principal Payment	Net Cashflow	Cummulative Cashflow
0	$ 80,092	$ 80,092	$ -	$ (894,818)		$ -	$ 50,182	$ -	$ (844,637)	$ (844,637)
1	$ 83,296	$ (9,686)	$ 92,982		$ -	$ (10,000)	$ 50,182	$ -	$ 133,164	$ (711,473)
2	$ 86,628	$ (10,584)	$ 97,212		$ -	$ (10,300)	$ 50,182	$ -	$ 137,093	$ (574,380)
3	$ 90,093	$ (10,830)	$ 100,923		$ -	$ (10,609)	$ 50,182	$ -	$ 140,496	$ (433,884)
4	$ 93,697	$ (11,079)	$ 104,776		$ -	$ (10,927)	$ -	$ -	$ 93,849	$ (340,035)
5	$ 97,445	$ (11,333)	$ 108,778		$ -	$ (11,255)	$ -	$ -	$ 97,522	$ (242,513)
6	$ 101,343	$ (11,224)	$ 112,567		$ -	$ (11,593)	$ -	$ -	$ 100,974	$ (141,538)
7	$ 105,396	$ (11,088)	$ 116,484		$ -	$ (11,941)	$ -	$ -	$ 104,544	$ (36,995)
8	$ 109,612	$ (10,926)	$ 120,538		$ -	$ (12,299)	$ -	$ -	$ 108,239	$ 71,244
9	$ 113,997	$ (10,736)	$ 124,733		$ -	$ (12,668)	$ -	$ -	$ 112,065	$ 183,309
10	$ 118,556	$ (10,517)	$ 129,073		$ -	$ (208,764)	$ -	$ -	$ (79,690)	$ 103,619
11	$ 123,299	$ (10,266)	$ 133,565		$ -	$ (13,439)	$ -	$ -	$ 120,126	$ 223,744
12	$ 128,231	$ (9,982)	$ 138,213		$ -	$ (13,842)	$ -	$ -	$ 124,371	$ 348,115
13	$ 133,360	$ (9,663)	$ 143,023		$ -	$ (14,258)	$ -	$ -	$ 128,765	$ 476,880
14	$ 138,694	$ (9,306)	$ 148,000		$ -	$ (14,685)	$ -	$ -	$ 133,315	$ 610,195
15	$ 144,242	$ (8,908)	$ 153,150		$ -	$ (15,126)	$ -	$ -	$ 138,025	$ 748,220
16	$ 150,012	$ (8,468)	$ 158,480		$ -	$ (15,580)	$ -	$ -	$ 142,900	$ 891,120
17	$ 156,012	$ (7,983)	$ 163,995		$ -	$ (16,047)	$ -	$ -	$ 147,948	$ 1,039,068
18	$ 162,253	$ (7,450)	$ 169,702		$ -	$ (16,528)	$ -	$ -	$ 153,174	$ 1,192,242
19	$ 168,743	$ (6,865)	$ 175,608		$ -	$ (17,024)	$ -	$ -	$ 158,584	$ 1,350,826
20	$ 175,493	$ (6,227)	$ 181,719		$ -	$ (280,561)	$ -	$ -	$ (98,842)	$ 1,251,984
21	$ 182,512	$ (5,531)	$ 188,043		$ -	$ (18,061)	$ -	$ -	$ 169,982	$ 1,421,965
22	$ 189,813	$ (4,774)	$ 194,587		$ -	$ (18,603)	$ -	$ -	$ 175,984	$ 1,597,949
23	$ 197,405	$ (3,953)	$ 201,358		$ -	$ (19,161)	$ -	$ -	$ 182,197	$ 1,780,147
24	$ 205,301	$ (3,064)	$ 208,366		$ -	$ (19,736)	$ -	$ -	$ 188,630	$ 1,968,776
25	$ 213,513	$ (2,103)	$ 215,617		$ -	$ (20,328)	$ -	$ -	$ 195,289	$ 2,164,065

Preliminary Economic Modeling – Atlantic Aviation PV

The following image illustrates key elements, as summarized below, from the financial model for 300 kW of rooftop solar PV at Atlantic Aviation:

- $2.70/Watt capital cost
- $0.02/Watt operations and maintenance annually
- $0.30/Watt repair and replacement every 10 years
- Base energy costs of $0.13/kWh; escalation 4% annually
- 30% Federal Investment Tax Credit; and approximately $30k/year for 4 years as part of NYSERDA PON 3082 (NY-SUN Commercial / Industrial Performance-Based Incentive)
- No value for RECs, as NY State is only now moving to an RPS that would have a tradable value for RECs in the future

Energy Model Details

Solar Resource

Parameter	Value	Units
Location	NY, Newburgh	
Longitude	74.10	degrees
Latitude	41.50	degrees
Daily Average Irradiance	1,596	Btu/ft2/day
Daily Total Generation	50	Wh/ft2/day
Annual Power Density	1,389	kWh/kW
Estimated Production	416,763	kWh

Electricity

Parameter	Value	Units
Fuel Units	kWh	
Energy Content	3,413	Btu per kWh
Baseline Energy Cost	0.129	$/kWh
Post Retrofit Energy Cost	0.144	$/kWh
What type of net metering?	12 Month	
Credits for Net Export	$ -	$/kWh
Energy Escalation Rates	4.00%	

Net Metering Math

Parameter	Value	Units
Total Facility Usage	239,040	kWh
Total PV Generation	416,763	kWh
Avoided Grid Usage	239,040	kWh
Net Excess	177,723	kWh
Grid Buy-Back	0	kWh

Technology Estimate Assumptions

Installed Cost Estimate

Parameter	Value	Units	Year 1	Include?	
Solar PV System, Installed	2.70	$/Watt	$ 810,000	Y	1
	0	$	$ -	Y	1
Batteries	$0	$	$ -	Y	1
Battery Install	$0	$	$ -	Y	1
Metering and Utility	0.00	$/Watt	$ -	Y	1
Labor	0.00	$/Watt	$ -	Y	1

On-Going Costs

Parameter	Value	Units	Year 1	Frequency	Escalation
Operation and Maintenance	0.02	$/Watt	$ 6,000	1	3.0%
Repair and Replacement	0.30	$/Watt	$ 90,000	10	3.0%
M+V	0.00	$/Watt	$ -	1	3.0%
Other	0.00	$/Watt	$ -	1	
Other	0.00	$	$ -	1	
Other	0.00	$	$ -	1	

Based on these assumptions, the initial cash flow modeling illustrates a breakeven point in approximately fourteen years for 300 kW of solar PV at Atlantic Aviation.

	Energy			Technology Cost					Total	
Year	Baseline Utility Cost ($)	Future Utility Cost ($)	Utility Savings ($)	Technology Cost ($)	Financing ($)	O+M ($)	Incentive ($)	Scheduled Principal Payment ($)	Net Cashflow	Cummulative Cashflow
0	$ 30,836	$ 30,836	$ -	$ (536,891)		$ -	$ 30,109	$ -	$ (506,782)	$ (506,782)
1	$ 32,070	$ (3,729)	$ 35,799		$ -	$ (6,000)	$ 30,109	$ -	$ 59,908	$ (446,874)
2	$ 33,352	$ (3,878)	$ 37,231		$ -	$ (6,180)	$ 30,109	$ -	$ 61,160	$ (385,715)
3	$ 34,686	$ (4,033)	$ 38,720		$ -	$ (6,365)	$ 30,109	$ -	$ 62,463	$ (323,251)
4	$ 36,074	$ (4,195)	$ 40,269		$ -	$ (6,556)	$ -	$ -	$ 33,712	$ (289,539)
5	$ 37,517	$ (4,362)	$ 41,879		$ -	$ (6,753)	$ -	$ -	$ 35,126	$ (254,413)
6	$ 39,018	$ (4,537)	$ 43,555		$ -	$ (6,956)	$ -	$ -	$ 36,599	$ (217,814)
7	$ 40,578	$ (4,718)	$ 45,297		$ -	$ (7,164)	$ -	$ -	$ 38,132	$ (179,682)
8	$ 42,201	$ (4,907)	$ 47,109		$ -	$ (7,379)	$ -	$ -	$ 39,729	$ (139,952)
9	$ 43,889	$ (5,103)	$ 48,993		$ -	$ (7,601)	$ -	$ -	$ 41,392	$ (98,560)
10	$ 45,645	$ (5,308)	$ 50,953		$ -	$ (125,258)	$ -	$ -	$ (74,306)	$ (172,866)
11	$ 47,471	$ (5,520)	$ 52,991		$ -	$ (8,063)	$ -	$ -	$ 44,927	$ (127,938)
12	$ 49,370	$ (5,741)	$ 55,110		$ -	$ (8,305)	$ -	$ -	$ 46,805	$ (81,134)
13	$ 51,344	$ (5,970)	$ 57,315		$ -	$ (8,555)	$ -	$ -	$ 48,760	$ (32,373)
14	$ 53,398	$ (6,209)	$ 59,607		$ -	$ (8,811)	$ -	$ -	$ 50,796	$ 18,423
15	$ 55,534	$ (6,457)	$ 61,992		$ -	$ (9,076)	$ -	$ -	$ 52,916	$ 71,339
16	$ 57,756	$ (6,716)	$ 64,471		$ -	$ (9,348)	$ -	$ -	$ 55,124	$ 126,462
17	$ 60,066	$ (6,984)	$ 67,050		$ -	$ (9,628)	$ -	$ -	$ 57,422	$ 183,884
18	$ 62,468	$ (7,264)	$ 69,732		$ -	$ (9,917)	$ -	$ -	$ 59,815	$ 243,699
19	$ 64,967	$ (7,554)	$ 72,521		$ -	$ (10,215)	$ -	$ -	$ 62,307	$ 306,006
20	$ 67,566	$ (7,856)	$ 75,422		$ -	$ (168,337)	$ -	$ -	$ (92,914)	$ 213,092
21	$ 70,268	$ (8,171)	$ 78,439		$ -	$ (10,837)	$ -	$ -	$ 67,603	$ 280,695
22	$ 73,079	$ (8,498)	$ 81,577		$ -	$ (11,162)	$ -	$ -	$ 70,415	$ 351,110
23	$ 76,002	$ (8,837)	$ 84,840		$ -	$ (11,497)	$ -	$ -	$ 73,343	$ 424,453
24	$ 79,042	$ (9,191)	$ 88,233		$ -	$ (11,842)	$ -	$ -	$ 76,392	$ 500,845
25	$ 82,204	$ (9,559)	$ 91,763		$ -	$ (12,197)	$ -	$ -	$ 79,566	$ 580,411

Preliminary Economic Modeling – Main Terminal CHP

The financial model for 200 kW of CHP at the Main Terminal assumes base energy costs of $0.13/kWh (4% annual escalation) and the following related to plant availability and costs:

- Plant availability: 90%
- Heating fuel cost: $8.50/MMBtu; CHP fuel cost: $6/MMBtu
- Heating fuel system efficiency: 85%
- CHP gross installed cost: $3.50/Watt

CHP System Assumptions

General Cogen Performance Data

Parameter	Value	Units
Nameplate Electrical Power Output	200	kW
Electrical Efficiency (HHV)	33%	%
Fuel Input Capacity (HHV)	2,068.48	kBtu/hr
Fuel Input Capacity (HHV)	2.07	Therm/hr
Overall Efficiency (HHV)	85%	%
Recoverable Heat	1,075.61	kBtu/hr
Unrecoverable Heat	310.27	kBtu/hr

Plant Operation Inputs

Parameter	Value	Units
Total Number of Generators	1	Qty
Plant Nameplate Electrical Capacity	200	kW
Plant Electrical Output Capacity	200	kW
Plant Availability	90%	%
Load Matching	Electric Follow	
Plant Useful Life	20	Years

Energy Model Details

Electricity

Parameter	Value	Units
Fuel Units	kWh	
Energy Content	3,413	Btu per kWh
Baseline Energy Cost	$ 0.129	$/kWh
Post Retrofit Energy Cost	$ 0.144	$/kWh
What type of net metering?	None	
Credits for Net Export	$ -	$/kWh
Escalation Rates	4.00%	

Firing Fuel

Parameter	Value	Units
Fuel Units	MMBtu	
Energy Content, HHV	1,000,000	Btu per MMBtu
Baseline Energy Cost	$ 8.5000	per MMBtu
Post Retrofit Energy Cost	$ 6.0000	per MMBtu
Heating Fuel System Efficiency	85.0%	
Escalation Rates	2.0%	

In terms of fuel savings, the baseload CHP generator at the Main Terminal is estimated to offset the need for 3,837 MMBtu/year of heating, as shown below by month. These are rough estimates based on fuel usage. Actual heat recovery will depend on site-specific factors, such as existing equipment configuration and operating temperatures.

Existing Utility Usage		Existing Loads		Operation	Electric			Heat			Fuel	
Electricity	Total Heating Fuel	Addressable Heating Load	Addressable Cooling Load	Run Hours	Electric Generation	Avoided Electric Usage	Excess Electric Generatio	Adjusted Max Heat Recovery	Avoided Addressable Heat	Excess Addressable Heat	Fuel Usage	Avoided Fuel
kWh	MMBtu	kBtu	Ton-Hrs	Hours	kWh	kWh	kWh	kBtu	kBtu	kBtu	MMBtu	MMBtu
177,083	34	33,924		670	133,920	133,920	0	720,230	33,924	686,306	1,385	40
172,365	1	1,028		648	129,600	129,600	0	696,997	1,028	695,969	1,340	1
182,934	0	0		670	133,920	133,920	0	720,230	0	720,230	1,385	0
176,816	0	0		670	133,920	133,920	0	720,230	0	720,230	1,385	0
164,290	4	4,112		605	120,960	120,960	0	650,530	4,112	646,418	1,251	5
175,416	109	108,968		670	133,920	133,920	0	720,230	108,968	611,262	1,385	128
163,905	507	506,804		648	129,600	129,600	0	696,997	506,804	190,193	1,340	596
185,635	921	921,088		670	133,920	133,920	0	720,230	720,230	0	1,385	847
190,039	1,106	1,106,128		648	129,600	129,600	0	696,997	696,997	0	1,340	820
210,369	941	940,620		670	133,920	133,920	0	720,230	720,230	0	1,385	847
210,214	730	729,880		670	133,920	133,920	0	720,230	720,230	0	1,385	847
188,606	325	324,848		648	129,600	129,600	0	696,997	324,848	372,149	1,340	382
2,197,672	**4,677**	**4,677,400**	**0**	**7,884**	**1,576,800**	**1,576,800**	**0**	**8,480,126**	**3,837,370**	**4,642,756**	**16,308**	**4,515**

The projected cash flow estimates below show that the Main Terminal CHP generator (200 kW) is expected to pay for itself in approximately seven years; the modeling results below do not account for the 2 MW natural gas microgrid generator.

	Energy			Technology Cost					Total	
Year	Baseline Utility Cost	Future Utility Cost	Utility Savings	Technology Cost	Financing	O+M	Incentive	Scheduled Principal Payment	Net Cashflow	Cummulative Cashflow
0	$ 323,258	$ 188,230	$ -	$ (700,000)		$ -	$ 140,000	$ -	$ (560,000)	$ (560,000)
1	$ 335,393	$ 193,783	$ 141,610		$ -	$ (63,072)	$ -	$ -	$ 78,538	$ (481,462)
2	$ 347,997	$ 199,518	$ 148,479		$ -	$ (64,964)	$ -	$ -	$ 83,515	$ (397,947)
3	$ 361,090	$ 205,443	$ 155,647		$ -	$ (66,913)	$ -	$ -	$ 88,734	$ (309,213)
4	$ 374,690	$ 211,563	$ 163,127		$ -	$ (68,920)	$ -	$ -	$ 94,206	$ (215,007)
5	$ 388,817	$ 217,886	$ 170,931		$ -	$ (70,988)	$ -	$ -	$ 99,943	$ (115,064)
6	$ 403,491	$ 224,419	$ 179,072		$ -	$ (73,118)	$ -	$ -	$ 105,954	$ (9,110)
7	$ 418,736	$ 231,170	$ 187,565		$ -	$ (75,311)	$ -	$ -	$ 112,254	$ 103,145
8	$ 434,572	$ 238,147	$ 196,425		$ -	$ (139,064)	$ -	$ -	$ 57,361	$ 160,505
9	$ 451,023	$ 245,357	$ 205,666		$ -	$ (79,898)	$ -	$ -	$ 125,768	$ 286,274
10	$ 468,113	$ 252,809	$ 215,305		$ -	$ (82,295)	$ -	$ -	$ 133,010	$ 419,284
11	$ 485,869	$ 260,512	$ 225,357		$ -	$ (84,763)	$ -	$ -	$ 140,593	$ 559,877
12	$ 504,315	$ 268,475	$ 235,840		$ -	$ (87,306)	$ -	$ -	$ 148,534	$ 708,411
13	$ 523,479	$ 276,707	$ 246,772		$ -	$ (89,926)	$ -	$ -	$ 156,846	$ 865,257
14	$ 543,389	$ 285,219	$ 258,171		$ -	$ (92,623)	$ -	$ -	$ 165,547	$ 1,030,804
15	$ 564,076	$ 294,019	$ 270,056		$ -	$ (95,402)	$ -	$ -	$ 174,654	$ 1,205,459
16	$ 585,569	$ 303,120	$ 282,449		$ -	$ (176,162)	$ -	$ -	$ 106,286	$ 1,311,745
17	$ 607,900	$ 312,532	$ 295,368		$ -	$ (101,212)	$ -	$ -	$ 194,156	$ 1,505,901
18	$ 631,102	$ 322,265	$ 308,837		$ -	$ (104,248)	$ -	$ -	$ 204,589	$ 1,710,490
19	$ 655,211	$ 332,333	$ 322,878		$ -	$ (107,376)	$ -	$ -	$ 215,502	$ 1,925,992
20	$ 680,261	$ 342,747	$ 337,514		$ -	$ (110,597)	$ -	$ -	$ 226,917	$ 2,152,909

Preliminary Economic Modeling – Atlantic Aviation CHP

Similarly, the financial model for 100 kW of CHP at Atlantic Aviation assumes the same energy prices and the following related to plant availability and costs:

- Plant availability: 90%
- Heating fuel cost: $8.50/MMBtu; CHP fuel cost: $6/MMBtu
- Heating fuel system efficiency: 85%
- CHP gross installed cost: $3.10/Watt

CHP System Assumptions

General Cogen Performance Data

Parameter	Value	Units
Nameplate Electrical Power Output	100	kW
Electrical Efficiency (HHV)	33%	%
Fuel Input Capacity (HHV)	1,034.24	kBtu/hr
Fuel Input Capacity (HHV)	1.03	Therm/hr
Overall Efficiency (HHV)	85%	%
Recoverable Heat	537.81	kBtu/hr
Unrecoverable Heat	155.14	kBtu/hr

Plant Operation Inputs

Parameter	Value	Units
Total Number of Generators	1	Qty
Plant Nameplate Electrical Capacity	100	kW
Plant Electrical Output Capacity	100	kW
Plant Availability	90%	%
Load Matching	Electric Follow	
Plant Useful Life	20	Years

Energy Model Details

Electricity

Parameter	Value	Units
Fuel Units	kWh	
Energy Content	3,413	Btu per kWh
Baseline Energy Cost	$ 0.129	$/kWh
Post Retrofit Energy Cost	$ 0.144	$/kWh
What type of net metering?	None	
Credits for Net Export	$ -	$/kWh
Escalation Rates	4.00%	

Firing Fuel

Parameter	Value	Units
Fuel Units	MMBtu	
Energy Content, HHV	1,000,000	Btu per MMBtu
Baseline Energy Cost	$ 8.5000	per MMBtu
Post Retrofit Energy Cost	$ 6.0000	per MMBtu
Heating Fuel System Efficiency	85.0%	
Escalation Rates	3.0%	

In terms of fuel savings, the baseload CHP generator at Atlantic Aviation is estimated to offset the need for 2,167 MMBtu/year of heating, as shown below by month. Again, these are rough estimates based on fuel usage. Actual heat recovery will depend on site-specific factors, such as existing equipment configuration and operating temperatures.

Existing Utility Usage		Existing Loads		Operation	Electric			Heat			Fuel	
Electricity kWh	Total Heating Fuel MMBtu	Addressable Heating Load kBtu	Addressable Cooling Load Ton-Hrs	Run Hours Hours	Electric Generation kWh	Avoided Electric Usage kWh	Excess Electric Generatio kWh	Adjusted Max Heat Recovery kBtu	Avoided Addressable Heat kBtu	Excess Addressable Heat kBtu	Fuel Usage MMBtu	Avoided Fuel MMBtu
68,960	1	617		670	66,960	66,960	0	360,115	617	359,498	693	1
67,040	550	275,093		648	64,800	64,800	0	348,498	275,093	73,406	670	324
85,520	1,909	954,498		670	66,960	66,960	0	360,115	360,115	0	693	424
103,120	2,482	1,240,899		670	66,960	66,960	0	360,115	360,115	0	693	424
117,840	3,037	1,518,253		605	60,480	60,480	0	325,265	325,265	0	626	383
110,240	2,986	1,492,964		670	66,960	66,960	0	360,115	360,115	0	693	424
83,840	1,368	684,083		648	64,800	64,800	0	348,498	348,498	0	670	410
90,640	265	132,458		670	66,960	66,960	0	360,115	132,458	227,657	693	156
81,840	4	2,210		648	64,800	64,800	0	348,498	2,210	346,288	670	3
92,240	2	925		670	66,960	66,960	0	360,115	925	359,190	693	1
105,040	2	771		670	66,960	66,960	0	360,115	771	359,344	693	1
121,920	2	1,028		648	64,800	64,800	0	348,498	1,028	347,470	670	1
1,128,240	**12,608**	**6,303,799**	**0**	**7,884**	**788,400**	**788,400**	**0**	**4,240,063**	**2,167,210**	**2,072,853**	**8,154**	**2,550**

The projected cash flow estimates below show that the Atlantic Aviation CHP generator (100 kW) is expected to pay for itself in approximately four years.

	Energy			Technology Cost					Total	
Year	Baseline Utility Cost $	Future Utility Cost $	Utility Savings $	Technology Cost $	Financing $	O+M $	Incentive $	Scheduled Principal Payment $	Net Cashflow	Cummulative Cashflow
0	$ 252,708	$ 158,208	$ -	$ (310,000)		$ -	$ 62,000	$ -	$ (248,000)	$ (248,000)
1	$ 261,744	$ 163,444	$ 98,300		$ -	$ (31,536)	$ -	$ -	$ 66,764	$ (181,236)
2	$ 271,110	$ 168,856	$ 102,254		$ -	$ (32,482)	$ -	$ -	$ 69,772	$ (111,464)
3	$ 280,818	$ 174,451	$ 106,366		$ -	$ (33,457)	$ -	$ -	$ 72,910	$ (38,554)
4	$ 290,879	$ 180,235	$ 110,644		$ -	$ (34,460)	$ -	$ -	$ 76,184	$ 37,630
5	$ 301,308	$ 186,215	$ 115,094		$ -	$ (35,494)	$ -	$ -	$ 79,600	$ 117,229
6	$ 312,118	$ 192,397	$ 119,722		$ -	$ (36,559)	$ -	$ -	$ 83,163	$ 200,392
7	$ 323,324	$ 198,788	$ 124,536		$ -	$ (37,656)	$ -	$ -	$ 86,880	$ 287,272
8	$ 334,938	$ 205,395	$ 129,543		$ -	$ (100,279)	$ -	$ -	$ 29,264	$ 316,536
9	$ 346,978	$ 212,227	$ 134,751		$ -	$ (39,949)	$ -	$ -	$ 94,803	$ 411,339
10	$ 359,459	$ 219,290	$ 140,169		$ -	$ (41,147)	$ -	$ -	$ 99,022	$ 510,361
11	$ 372,398	$ 226,593	$ 145,804		$ -	$ (42,382)	$ -	$ -	$ 103,422	$ 613,783
12	$ 385,810	$ 234,145	$ 151,665		$ -	$ (43,653)	$ -	$ -	$ 108,012	$ 721,795
13	$ 399,715	$ 241,952	$ 157,762		$ -	$ (44,963)	$ -	$ -	$ 112,799	$ 834,594
14	$ 414,129	$ 250,026	$ 164,104		$ -	$ (46,312)	$ -	$ -	$ 117,792	$ 952,386
15	$ 429,074	$ 258,374	$ 170,700		$ -	$ (47,701)	$ -	$ -	$ 122,999	$ 1,075,385
16	$ 444,567	$ 267,007	$ 177,560		$ -	$ (127,030)	$ -	$ -	$ 50,530	$ 1,125,915
17	$ 460,630	$ 275,933	$ 184,697		$ -	$ (50,606)	$ -	$ -	$ 134,091	$ 1,260,005
18	$ 477,284	$ 285,165	$ 192,119		$ -	$ (52,124)	$ -	$ -	$ 139,995	$ 1,400,000
19	$ 494,551	$ 294,711	$ 199,840		$ -	$ (53,688)	$ -	$ -	$ 146,152	$ 1,546,152
20	$ 512,454	$ 304,583	$ 207,870		$ -	$ (55,299)	$ -	$ -	$ 152,572	$ 1,698,724

Preliminary Economic Modeling – Stewart Airport-New Windsor Microgrid System

Projected cash flow estimates are shown below for the Stewart Airport-New Windsor microgrid DER in aggregate.[10] Based on preliminary modeling presented in this section, the microgrid resources in aggregate have a payback period of approximately twelve to thirteen years excluding additional NY Prize funding.

[10] Excludes the 2 MW microgrid generator. Based on individual DER costs in aggregate and thus does not include full microgrid implementation costs for Initial Planning & Design, Utility Modifications, and Microgrid Controls (as shown in Task 4.4).

	Energy			Technology Cost					Total	
Year	Baseline Utility Cost	Future Utility Cost	Utility Savings	Technology Cost	Financing	O+M	Incentive	Scheduled Principal Payment	Net Cashflow	Cummulative Cashflow
0	$ 699,897	$ 463,713	$ -	$ (4,751,818)		$ -	$ 260,182	$ -	$ (4,491,637)	$ (4,491,637)
1	$ 724,954	$ 334,356	$ 390,598		$ -	$ (130,608)	$ 50,182	$ -	$ 310,172	$ (4,181,465)
2	$ 750,955	$ 272,862	$ 478,093		$ -	$ (134,526)	$ 50,182	$ -	$ 393,749	$ (3,787,716)
3	$ 777,936	$ 280,223	$ 497,713		$ -	$ (138,562)	$ 50,182	$ -	$ 409,333	$ (3,378,383)
4	$ 805,936	$ 287,817	$ 518,118		$ -	$ (142,719)	$ -	$ -	$ 375,399	$ (3,002,984)
5	$ 834,992	$ 295,652	$ 539,340		$ -	$ (147,000)	$ -	$ -	$ 392,339	$ (2,610,645)
6	$ 865,148	$ 303,738	$ 561,410		$ -	$ (151,410)	$ -	$ -	$ 410,000	$ (2,200,645)
7	$ 896,444	$ 312,082	$ 584,363		$ -	$ (155,953)	$ -	$ -	$ 428,410	$ (1,772,235)
8	$ 928,927	$ 320,694	$ 608,233		$ -	$ (222,125)	$ -	$ -	$ 386,108	$ (1,386,127)
9	$ 962,641	$ 329,585	$ 633,056		$ -	$ (165,450)	$ -	$ -	$ 467,606	$ (918,522)
10	$ 997,635	$ 338,765	$ 658,870		$ -	$ (874,991)	$ -	$ -	$ (216,121)	$ (1,134,643)
11	$ 1,033,958	$ 348,243	$ 685,715		$ -	$ (175,526)	$ -	$ -	$ 510,189	$ (624,454)
12	$ 1,071,663	$ 358,032	$ 713,631		$ -	$ (180,792)	$ -	$ -	$ 532,839	$ (91,614)
13	$ 1,110,803	$ 368,142	$ 742,661		$ -	$ (186,216)	$ -	$ -	$ 556,445	$ 464,831
14	$ 1,151,434	$ 378,586	$ 772,848		$ -	$ (191,802)	$ -	$ -	$ 581,046	$ 1,045,877
15	$ 1,193,614	$ 389,375	$ 804,239		$ -	$ (197,556)	$ -	$ -	$ 606,683	$ 1,652,560
16	$ 1,237,404	$ 400,524	$ 836,880		$ -	$ (281,381)	$ -	$ -	$ 555,499	$ 2,208,059
17	$ 1,282,866	$ 412,044	$ 870,822		$ -	$ (209,587)	$ -	$ -	$ 661,235	$ 2,869,294
18	$ 1,330,066	$ 423,950	$ 906,116		$ -	$ (215,875)	$ -	$ -	$ 690,241	$ 3,559,534
19	$ 1,379,072	$ 436,257	$ 942,815		$ -	$ (222,351)	$ -	$ -	$ 720,463	$ 4,279,998
20	$ 1,429,954	$ 448,980	$ 980,974		$ -	$ (1,175,915)	$ -	$ -	$ (194,941)	$ 4,085,057

The financing structure is expected to be similar to other power generation projects wherein a construction loan and/or equity is used to fund construction costs that are then recovered along with a reasonable return on investment under long-term energy off-take/services agreements. A third party is expected to serve as long-term owner and operator of the proposed microgrid, subject to competitive procurement requirements of customer participants. NRG is one such company that can provide a design-build-own-operate-maintain solution with project financing. NRG has sufficient liquidity on balance sheet to deliver the proposed microgrid development and construction project, assuming that it meets corporate investment criteria and receives required approvals for the allocation of funds. Alternatively, customer participants may elect to take a sole or majority ownership interest in the microgrid project company and then, as may be needed, solicit additional investors as well as a third party to operate the system and provide on-going O&M services.

Task 3.6 – Legal Viability

The development and implementation of "first-of-a-kind" community-based microgrids that are both reliable and economic will involve complexity and challenges. For example, state legislatures and public utility commissions may need to act to resolve legal issues related to local distribution utility exclusive franchise rights and whether microgrids serving multiple, unaffiliated end users fall under public utility regulations.

The project team believes robust deployment of microgrids in New York State can be best accomplished through competitive development driven by customer engagement and value, and that microgrids can and should be financed by customers or by third parties. Based on "NRG's Response to Notice Soliciting Comments on Microgrids" (filed with the PSC on May 1, 2015), NRG offers the following three recommendations to help enable microgrid development:

1) Just as the PSC has directed that utility ownership of DER should be very limited, the PSC should restrict utilities (and DSPs) in their ownership of microgrids in order to ensure that market-based solutions drive microgrid adoption. Keeping the burgeoning microgrid industry competitive will enable the robust deployment of microgrids and create a business environment in which competitive providers of microgrids can bring their innovation and private capital to bear on meeting customer and community objectives. Regulated utility ownership and control of microgrids would delay and constrain deployment, add to utility costs, and thus expose ratepayers and utility investors to excessive risk.
2) Properly valuing and accounting for the multiple benefits a microgrid offers – to its individual customers, the community, the wholesale market, as well as to the distribution system – is a crucial element in ensuring their widespread adoption. Microgrids become more cost-effective if they are operated more frequently than just as a back-up solution, but this requires the development of markets and revenue generation opportunities that appropriately compensate microgrids for the services they provide. As envisioned under REV, an important role of the DSP will be to pay DER for the "value they provide to the grid… in fair and open markets." The DSP will serve as a means of providing a price signal for enhanced resiliency, delayed distribution upgrades, and other values that currently are not expressly valued in our energy infrastructure. Likewise, NYISO rules must enable participation by microgrids in the wholesale markets.
3) PSC precedent allowing microgrid developers to connect adjoining or related facilities is well-established, but it would be helpful for developers if the PSC clarifies that related facilities are those that may cross a right of way as of right, without seeking an additional PSC ruling and running afoul of utility franchise laws. The ability to connect two or more related sites is extremely important in reducing customer costs, because spreading the fixed costs of a microgrid development across a wider array of customers and/or facilities can allow additional economies of scale and reduce costs for each participating customer.

As an owner and operator of power generation assets and on-site energy systems nationwide, NRG is familiar with navigating the regulatory landscape, including working to identify and overcome regulatory barriers at the municipal, state, and federal levels. NRG has an experienced team in Market & Regulatory Affairs, as well as Government Affairs and Legal professionals dedicated to these issues. NRG actively comments on regulatory proceedings and has effectively helped to shape the legal and regulatory landscape within which third-party generators compete at the utility and distribution scale, both behind and in front of the meter. NRG is participating in NY State's REV proceeding, supporting the REV objectives of competitive markets, customer choice and participation, renewable deployment and integration, enhanced system efficiency, reliability, and resiliency. The NY Prize microgrid projects will present new challenges for regulators as well as for the parties implementing the projects, and NRG is well-positioned to work cooperatively and constructively with state regulators, utilities, customers, and other stakeholders to craft workable business models and market rules within which microgrids and distributed energy resources can operate efficiently and profitably.

NRG has had a strong operating presence in New York State since 1999, with energy customers and generation assets across the state. NRG owns and operates more than 4,100 net MW of wholesale generation in New York State and has hundreds of additional MWs of demand response (through NRG Curtailment Solutions f/k/a Energy Curtailment Specialists) and retail load (through brands such as NRG Home, Green Mountain Energy, and Energy Plus), giving NRG extensive experience with the NYISO markets and the permitting, regulatory, and legal environment in the state.

Through its wholesale generation, demand response, and retail businesses in New York, NRG is fully compliant and conversant with NYISO's interconnection requirements, including metering, ancillary service provisions, operating policies, criteria, rules, guidelines and tariffs, and employs Good Utility Practice in all markets in which it operates and conducts business.

A third party is expected to serve as long-term owner and operator of the proposed microgrid, subject to procurement policy requirements of the customer participants and future competitive solicitations for services as may be required under law. NRG is capable of and interested in serving in such as role for the Stewart Airport-New Windsor microgrid customer participants. NRG would establish a single purpose, project-specific limited liability company that would hold and own project contracts, assets, and property. This special purpose entity would most likely be a wholly-owned project subsidiary of NRG, or it could be majority-owned by NRG with minority ownership encouraged from customer participants or other strategic partners or investors.

The sites where the microgrid equipment and systems are to be installed are owned (or leased) by the customer participants. A third-party owner would have to enter into site access and lease agreements with the owners. Upon establishing technical and commercial feasibility, the parties expect to commence discussion of commercial terms for further phases of work on the project, including a conversation on the potential for future site control through lease, purchase and/or option agreements.

NRG and its partners are well-positioned to work cooperatively and constructively with state regulators, utilities, communities, customers, and other stakeholders to lead and support the project team through the NY Prize Competition process, craft workable business models and structures within which DER and microgrids can operate, and increase the likelihood of successful development and implementation of a Stewart Airport-New Windsor microgrid, thus advancing the objectives of NY Prize and NY State's REV policy initiative.

In addition, the expected use of capital from a third party, such as NRG, and/or other sources, which may include customer participants, will prove out the commercial viability of the project and minimize the risk of cost assignment to Central Hudson's rate base customers. However, where non-participating customers will benefit from community facilities, emergency services, and/or essential retail or commercial services served by a public purpose microgrid, it may be appropriate to socialize a portion of the project's costs through Central Hudson's rates or other form of cost recovery under REV, as determined by the PSC.

Given the complexities involved in the design, engineering, development, and implementation of reliable and economical microgrid systems, communities and other customer participants are encouraged to partner with energy service companies that have a proven track record and the necessary financial, technical, and regulatory expertise. In addition, private firms that use the proposed third-party business model and implement these distributed projects are accustomed to ensuring the privacy of their public and private host customers. As a competitive services provider and long-term owner/operator of distributed generation, NRG is one such company that is leading the transition to a clean renewables-driven, increasingly distributed, and grid-resilient future.

Section 4 – Microgrid Benefit-Cost Analysis

Task 4.0 – Benefit-Cost Analysis Summary Report

PROJECT OVERVIEW

As part of NYSERDA's NY Prize Community Grid Competition, NRG on behalf of its partners in the Town of New Windsor has proposed development of a microgrid serving numerous facilities in and around Stewart International Airport. The microgrid would focus on maintaining service to facilities at the airport as well as several other facilities in the surrounding area. The airport is currently served by four airlines and provides a national and international connection for travelers accessing locations in the Hudson River Valley.[11] Table 1 identifies the specific facilities that the proposed microgrid would serve. As shown, the facilities include a variety of airport operations (terminal, hangars, etc.); police facilities; Town of New Windsor Water and Highway Department facilities; a hotel; a preschool; etc.

The microgrid would combine five distributed energy resources (DER): a 2 MW natural gas-fired generator; two natural gas-fired combined heat and power (CHP) systems with a combined capacity of 0.3 MW; and two photovoltaic (PV) solar arrays with a combined capacity of 1.8 MW. Of these, the two CHP systems and the two PV arrays would be used under normal operating conditions, while the gas-fired generator would supplement production primarily during major power outages.

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

[11] http://www.panynj.gov/airports/swf-airlines.html, accessed on March 31, 2016.

Table 1 – Facilities Served by the Proposed Microgrid

Facility Name	Facility Description
PANYNJ - SWF Main Terminal	Airport's main passenger terminal
PANYNJ - SWF Admin Office	Airport's administration office
PANYNJ - SWF Operations/Customs	Normal and emergency operations, and customs
PANYNJ - SWF Maintenance Shop	Airport's maintenance shop
PANYNJ - SWF Field Lighting Vault	Airport's field lighting vault
PANYNJ - SWF Main Terminal Parking	Terminal parking - Lot A
PANYNJ - SWF Southwest Fuel Farm	Airport's main fuel farm
PANYNJ - SWF De-Icing Lagoon	Airport's de-icing glycol lagoons
PANYNJ - Office	Office building (currently vacant)
PANYNJ - Office	Office building (currently vacant)
FBO - Airborne Aviation Office	Fixed-Base Operator facility
FBO - Airborne Aviation Hangar "A"	Fixed-Base Operator facility
FBO - Atlantic Aviation Hangar "G"	Fixed-Base Operator facility
FBO - Atlantic Aviation Hangar "I"	Fixed-Base Operator facility
Town of NW - Sewer Pumping Station	Town of New Windsor Water Department facility
Town of NW - Water Booster Station	Town of New Windsor Water Department facility
Town of NW - New Highway Garage	Town of New Windsor Highway Department facility
Town of NW - Service Garage	Town of New Windsor Highway Department facility
U.S. Military Academy	USMA-West Point facilities, houses NYS Police Aviation unit
NY State Police Crime Lab (New)	New crime lab
NY State Police Crime Lab (Old)	Old crime lab
NY State Dept. of Corrections	Dormitory
Homewood Suites by Hilton	Extended stay hotel
Tutor Perini Corp.	General contractor office
The Arc of Orange County	Preschool learning center
Pet Central Station	Pet daycare, grooming, boarding, training
Far Post Soccer Club	Indoor soccer facility

METHODOLOGY AND ASSUMPTIONS

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

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

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

The BCA model is structured to analyze a project's costs and benefits over a 20-year operating period. The model applies conventional discounting techniques to calculate the present value of costs and benefits, employing an annual discount rate that the user specifies – in this case, seven percent.[12] It also calculates an annualized estimate of costs and benefits based on the anticipated engineering lifespan of the system's equipment. Once a project's cumulative benefits and costs have been adjusted to present values, the model calculates both the project's net benefits and the ratio of project benefits to project costs. The model also calculates the project's internal rate of return, which indicates the discount rate at which the present value of the

[12] The seven percent discount rate is consistent with the U.S. Office of Management and Budget's current estimate of the opportunity cost of capital for private investments. One exception to the use of this rate is the calculation of environmental damages. Following the New York Public Service Commission's (PSC) guidance for benefit-cost analysis, the model relies on temporal projections of the social cost of carbon (SCC), which were developed by the U.S. Environmental Protection Agency (EPA) using a three percent discount rate, to value CO2 emissions. As the PSC notes, "The SCC is distinguishable from other measures because it operates over a very long time frame, justifying use of a low discount rate specific to its long term effects." The model also uses EPA's temporal projections of social damage values for SO2, NOx, and PM2.5, 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.]

project's costs and benefits would be equal. All monetized results are adjusted for inflation and expressed in 2014 dollars.

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

The BCA considers costs and benefits for two scenarios:

- Scenario 1: No major power outages over the assumed 20-year operating period (i.e., normal operating conditions only).
- Scenario 2: The average annual duration of major power outages required for project benefits to equal costs, if benefits do not exceed costs under Scenario 1.[13]

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

RESULTS

Table 2 summarizes the estimated net benefits, benefit-cost ratios, and internal rates of return for the scenarios described above. The results suggest that if no major power outages occur over the microgrid's assumed 20-year operating life, the present value of the project's costs would exceed its benefits. In order for the present value of the project's benefits to outweigh its costs, the average duration of major outages would need to exceed approximately 0.4 days per year (Scenario 2). The discussion that follows provides additional detail on the findings for these two scenarios.

Table 2 – BCA Results (Assuming 7 Percent Discount Rate)

ECONOMIC MEASURE	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES	
	SCENARIO 1: 0 DAYS/YEAR	SCENARIO 2: 0.4 DAYS/YEAR
Net Benefits - Present Value	-$3,070,000	$147,000
Benefit-Cost Ratio	0.8	1.0
Internal Rate of Return	2.8%	7.1%

Scenario 1

Figure 1 and Table 3 present the detailed results of the Scenario 1 analysis.

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

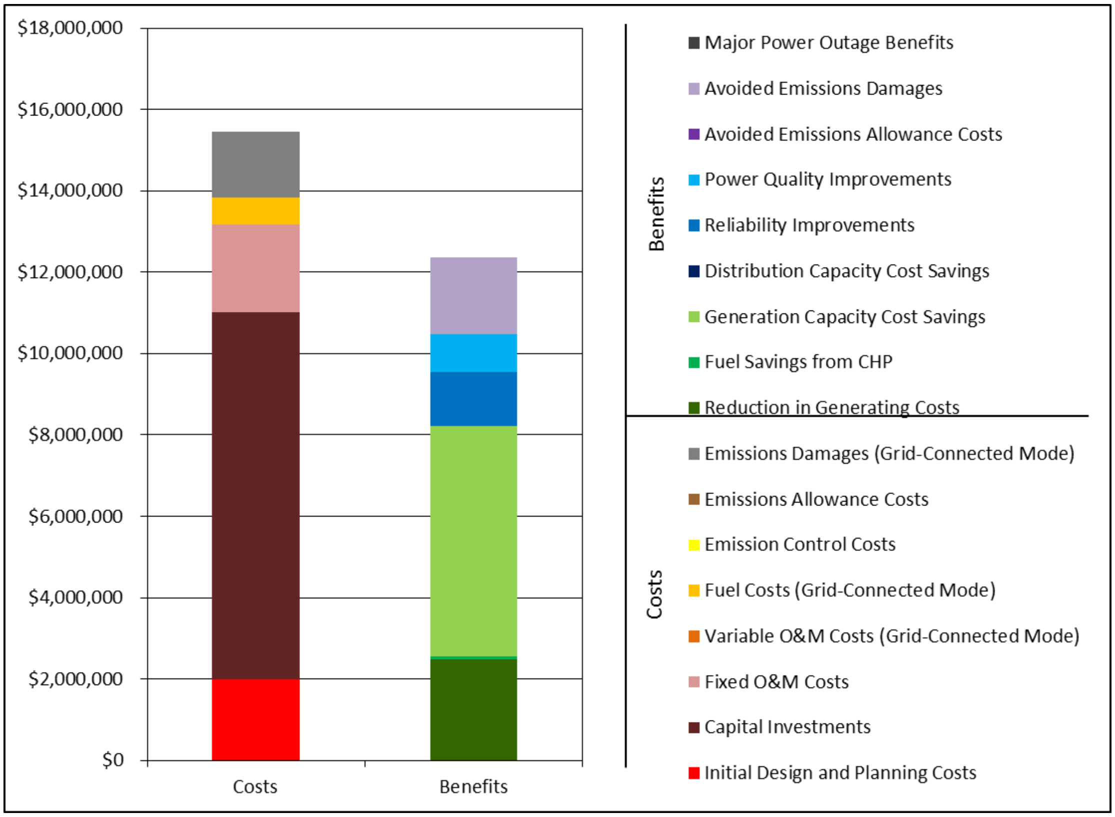


Table 3 – Detailed BCA Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$2,000,000	$176,000
Capital Investments	$9,010,000	$753,000
Fixed O&M	$2,150,000	$190,000
Variable O&M (Grid-Connected Mode)	$0	$0
Fuel (Grid-Connected Mode)	$667,000	$58,800
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$1,610,000	$105,000
Total Costs	**$15,400,000**	
Benefits		
Reduction in Generating Costs	$2,490,000	$220,000
Fuel Savings from CHP	$51,900	$4,580
Generation Capacity Cost Savings	$5,670,000	$500,000
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,330,000	$118,000
Power Quality Improvements	$933,000	$82,300
Avoided Emissions Allowance Costs	$1,240	$110
Avoided Emissions Damages	$1,890,000	$123,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$12,400,000**	
Net Benefits	**-$3,070,000**	
Benefit/Cost Ratio	**0.8**	
Internal Rate of Return	**2.8%**	

Fixed Costs

The BCA relies on information provided by the project team to estimate the fixed costs of developing the proposed microgrid. The project team's best estimate of initial design and planning costs is approximately $2.0 million, including costs of design, permitting, project front-end support, and commissioning. The present value of the project's capital costs is estimated at approximately $9.0 million, including the costs of the PV arrays (about $4.9 million), the CHP systems (about $1.0 million), the gas-fired generator (about $1.4 million), and utility modifications and control improvements (about $1.7 million).

The present value of the microgrid's fixed operations and maintenance (O&M) costs (i.e., O&M costs that do not vary with the amount of energy produced) is estimated at $2.2 million, or about $190,000 annually.

Variable Costs

One variable cost associated with the proposed project is the cost of fuel, primarily natural gas, for the CHP units and the gas-fired generator. To characterize these costs, the BCA relies on estimates of fuel consumption provided by the project team and projections of fuel costs from New York's 2015 State Energy Plan (SEP), adjusted to reflect recent market prices.[14] The present value of the project's fuel costs over a 20-year operating period is estimated to be approximately $667,000.

In addition, the analysis of variable costs considers the environmental damages associated with pollutant emissions from the DER that serve the microgrid, based on the operating scenario and emissions rates provided by the project team and the understanding that none of the system's generators would be subject to emissions allowance requirements. In this case, the damages attributable to emissions from the microgrid's fuel-based generators are estimated at approximately $105,000 annually. These damages are primarily attributable to the emission of NOx. Over a 20-year operating period, the present value of emissions damages is estimated at approximately $1.6 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 $2.5 million. The new CHP units would also conserve about 670 MMBtu of fuel per year, providing additional savings relative to current heating systems. The BCA estimates the present value of fuel savings over the 20-year

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

operating period to be approximately $52,000. These reductions in demand for electricity from bulk energy suppliers and heating fuel would also cut emissions of CO2, SO2, NOx, and particulate matter, yielding avoided emission allowance costs with a present value of $1,200 and avoided emissions damages with a present value of approximately $1.9 million.[15]

In addition to the savings noted above, development of a microgrid could yield cost savings by avoiding or deferring the need to invest in expansion of the conventional grid's energy generation or distribution capacity.[16] The analysis estimates the impact of the new DER on peak generating capacity requirements to be about 2.66 MW per year. In addition, the project team expects development of the microgrid to affect the conventional grid's demand for generating capacity by an additional 2.3 MW as a result of new demand response capabilities. The project team notes that the inclusion of demand response capabilities in this analysis rests on the assumption that the full capability of existing diesel backup generators at Stewart International Airport will be able to participate in the NYISO capacity market.[17] Based on these figures, the BCA estimates the present value of the project's generating capacity benefits to be approximately $5.7 million over a 20-year operating period.

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

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[15] Following the New York Public Service Commission's (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 NOx 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.

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

[17] The project team further notes that this full participation will require a change in NYISO rules to allow multiple resources to aggregate behind a consolidated metering point. Current rules limit the capacity value of such resources to the demand located at the same retail electric meter where the backup generator is connected.

Reliability Benefits

An additional benefit of the proposed microgrid would be to reduce customers' susceptibility to power outages by enabling a seamless transition from grid-connected mode to islanded mode. The analysis estimates that development of a microgrid would yield reliability benefits of approximately $118,000 per year, with a present value of $1.3 million over a 20-year operating period. This estimate is calculated using the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator, and is based on the following indicators of the likelihood and average duration of outages in the service area:[18]

- System Average Interruption Frequency Index (SAIFI) – 1.24 events per year.
- Customer Average Interruption Duration Index (CAIDI) – 136.2 minutes.[19]

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

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

Power Quality Benefits

The power quality benefits of a microgrid may include reductions in the frequency of voltage sags and swells or reductions in the frequency of momentary outages (i.e., outages of less than five minutes, which are not captured in the reliability indices described above). The analysis of power quality benefits relies on the project team's best estimate of the number of power quality events that development of the microgrid would avoid each year. The Stewart Airport-New Windsor project team estimates that the microgrid would help the facilities it serves avoid between three and six power quality events per year; the analysis assumes an average of 4.5 events avoided

[18] www.icecalculator.com.

[19] The analysis is based on DPS's reported 2014 SAIFI and CAIDI values, excluding major storm events, for Central Hudson Gas & Electric.

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

each year. The model estimates the present value of this benefit to be approximately $933,000 over a 20-year operating period.

Summary

The analysis of Scenario 1 yields a benefit/cost ratio of 0.8; i.e., the estimate of project benefits is about 80 percent of project costs. Accordingly, the analysis moves to Scenario 2, taking into account the potential benefits of a microgrid in mitigating the impact of major power outages.

Scenario 2

Benefits in the Event of a Major Power Outage

As previously noted, the estimate of reliability benefits presented in Scenario 1 does not include the benefits of maintaining service during outages caused by major storm events or other factors generally considered beyond the control of the local utility. These types of outages can affect a broad area and may require an extended period of time to rectify. To estimate the benefits of a microgrid in the event of such outages, the BCA methodology is designed to assess the impact of a total loss of power – including plausible assumptions about the failure of backup generation – on the facilities the microgrid would serve. It calculates the economic damages that development of a microgrid would avoid based on (1) the incremental cost of potential emergency measures that would be required in the event of a prolonged outage, and (2) the value of the services that would be lost.[21,22]

The proposed microgrid project would serve 27 facilities during an extended outage. In the BCA model, several factors influence the costs that facilities would incur during an outage, including the following:

- Whether or not backup generation currently exists at the facility;
- Whether the facility would rent a backup generator to supply power during an outage;
- The ability of the facility to operate when using backup power;
- The ability of the facility to operate during a complete loss of power;
- The cost of operating existing or rental generators;

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

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

- The extent to which the facility incurs one-time and/or on-going costs for emergency measures (e.g., evacuating personnel); and

- The economic value of the services that the facility would cease to provide during an outage.

Table 4 summarizes these parameters for six sets of facilities.

- **Airport Facilities:** This facility group includes several buildings at Stewart International Airport, as listed in Table 4. Using the ICE Calculator, the analysis estimates the value provided by these PANYNJ and FBO Atlantic Aviation facilities to be about $593,000 per day. In addition, the analysis assumes that all personnel would be evacuated from the airport's main terminal in the event of a power outage (as the backup generator for that facility only supplies power to emergency egress lighting), at an estimated cost of $2,000. The project team also indicates that maintaining electric power at Stewart International Airport would preserve emergency medical services for the surrounding area, with a population of 140,000 people. The analysis estimates the value of these services to be about $139,000 per day.[23]

- **New Windsor Water Department Facilities:** This facility group includes the Town of New Windsor's sewer pumping station and water booster station. Based on the population served by these facilities (2,700 people), the analysis estimates that the value of the service they provide is about $395,000 per day.

- **Commercial Facilities with Backup Power:** This category includes the Town of New Windsor's new highway garage and service garage, as well as the new NY State Police Crime Lab. These three facilities are equipped with backup generators and would lose 100% of their service capabilities if backup power were to fail. Using the ICE Calculator, the analysis estimates the value of the service provided by these facilities to be about $124,000 per day.

- **Commercial Facilities without Backup Power and High Service Losses:** This category includes Homewood Suites, The Arc of Orange County, the old NY State police crime lab, two vacant airport office buildings, Tutor Perini Corp. office, Pet Central Station, and Far Post Soccer Club. These facilities do not have backup generators to the project team's knowledge, and the analysis assumes that they would lose 100% of their service capabilities in the event of a major power outage. The collective value of service for these facilities, as estimated by the ICE Calculator, is about $342,000 per day.

[23] The project team also stated that the airport supports services provided by the NY State Police Aviation Unit, but since the model's valuation methodology only accounts for crime prevention services, and the NY State Police Aviation Unit does not directly contribute to crime prevention, these services are not included in the analysis.

- Commercial Facilities without Backup Power and Moderate Service Losses: This category includes the U.S. Military Academy hangars and the NY State Dept. of Corrections dormitory building. These facilities do not have backup generators to the project team's knowledge, and the analysis assumes that they would lose 50% of their service capabilities in the event of a major power outage. The collective value of service for these facilities, as estimated by the ICE Calculator, is about $103,000 per day.

- Facilities with No Service Losses: A final category of facilities includes those for which a complete loss of power is not expected to have any impact on the facilities' ability to provide service, as prior experience has shown that these facilities are able to provide major services in the absence of electric power. This category includes the PANYNJ de-icing lagoon, the FBO Airborne Aviation Office, and the FBO Airborne Aviation Hangar "A." For these facilities, the analysis does not estimate any impact associated with major power outages.

In all cases, backup generators are assumed to run 24 hours per day, and each has a 15 percent chance of failing.

Table 4 – Summary of Major Power Outage Parameters for Six Sets of Facilities, Scenario 2

CATEGORY	FACILITIES INCLUDED	VALUE OF SERVICE ($/DAY)	PERCENT LOSS IN SERVICE CAPABILITIES DURING AN OUTAGE		GENERATOR COSTS		OTHER EMERGENCY COSTS	
			WITH BACKUP POWER	WITHOUT BACKUP POWER	ONE-TIME	DAILY	ONE-TIME	DAILY
Airport Facilities (including emergency medical services)	SWF Main Terminal; SWF Admin Office; SWF Field Lighting Vault; SWF Operations/Customs; SWF Southwest Fuel Farm; SWF Maintenance Shop; SWF Main Terminal Parking; FBO Atlantic Aviation Hangar "G" and Hangar "I"	$593,000 (airport); $139,000 (EMS)	0%	100%	$2,600	$3,542	$2,000	$0
New Windsor Water Department Facilities	Town of NW - Sewer Pumping Station and Water Booster Station	$395,000	50%	100%	$1,000	$1,143	$0	$0
Commercial Facilities with Backup Power	Town of NW - New Highway Garage and Service Garage; NYS Police Crime Lab (new)	$124,000	0%	100%	$750	$1,536	$0	$0
Commercial Facilities without Backup Power and High Service Losses	Homewood Suites; The Arc of Orange County; NYS Police Crime Lab (old), PANYNJ - Offices (vacant); Tutor Perini Corp. Office; Pet Central Station; Far Post Soccer Club	$342,000	N/A	100%	$0	$0	$0	$0
Commercial Facilities without Backup Power and Moderate Service Losses	U.S. Military Academy hangars and NYS Dept. of Corrections - dormitory	$103,000	N/A	50%	$0	$0	$0	$0
Facilities with No Service Losses	PANYNJ De-Icing Lagoon; FBO Airborne Aviation Office and Hangar “A”	$0	N/A	0%	$0	$0	$0	$0

Summary

Figure 2 and Table 5 present the results of the BCA for Scenario 2. The results indicate that the benefits of the proposed project would equal or exceed its costs if the project enabled the facilities it would serve to avoid an average of 0.4 days per year without power. If the average annual duration of the outages the microgrid prevents is less than this figure, its costs are projected to exceed its benefits.

Figure 2 – Present Value Results, Scenario 2 (Major Power Outages Averaging 0.4 Days/Year; 7 Percent Discount Rate)

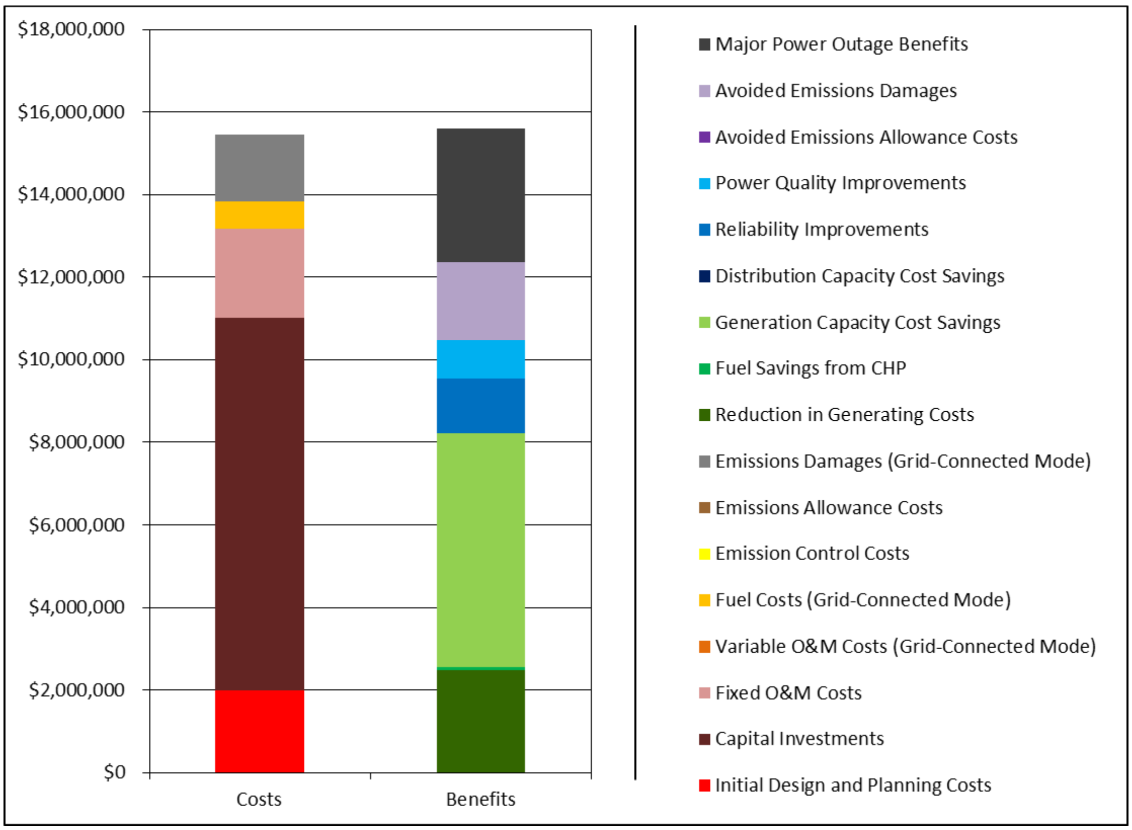


Table 5 – Detailed BCA Results, Scenario 2 (Major Power Outages Averaging 0.4 Days/Year; 7 Percent Discount Rate)

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$2,000,000	$176,000
Capital Investments	$9,010,000	$753,000
Fixed O&M	$2,150,000	$190,000
Variable O&M (Grid-Connected Mode)	$0	$0
Fuel (Grid-Connected Mode)	$667,000	$58,800
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$1,610,000	$105,000
Total Costs	**$15,400,000**	
Benefits		
Reduction in Generating Costs	$2,490,000	$220,000
Fuel Savings from CHP	$51,900	$4,580
Generation Capacity Cost Savings	$5,670,000	$500,000
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,330,000	$118,000
Power Quality Improvements	$933,000	$82,300
Avoided Emissions Allowance Costs	$1,240	$110
Avoided Emissions Damages	$1,890,000	$123,000
Major Power Outage Benefits	$3,220,000	$284,000
Total Benefits	**$15,600,000**	
Net Benefits	**$147,000**	
Benefit/Cost Ratio	**1.0**	
Internal Rate of Return	**7.1%**	

Task 4.1 – Facility and Customer Description

The table below has the 27 utility accounts and corresponding facilities that would be supported by the proposed microgrid during an extended outage. These facilities are also listed in Task 4.0 (Table 1 and Table 4) and Appendix A. Appendix A shows annual electricity usage and peak electric demand for three different tiers or clusters of facilities. The aggregate data for the 27 metered facilities is approximately 7.5 MWh in annual electricity usage and 2.5 MW in peak electric demand.

Facility Name	Rate Class	Facility / Customer Description (Specify Number of Customers if More Than One)	Economic Sector Code	Percent of Average Usage Microgrid Could Support During Major Power Outage	Hours of Electricity Supply Required Per Day During Major Power Outage
PANYNJ - SWF Main Terminal Building	Large Commercial	Airport's main passenger terminal (Bldg 128)	All other industries	100%	24
FBO - Atlantic Aviation Hangar "G"	Large Commercial	Fixed-Base Operator facility (Bldg 118)	All other industries	100%	24
PANYNJ - SWF Field Lighting Vault	Large Commercial	Airport's field lighting vault (Bldg 144). Power critical to all field lighting & NAV aids	All other industries	100%	24
Town of NW - Sewer Pumping Station	Large Commercial	Town of NW Water Dept.	All other industries	100%	24
FBO - Atlantic Aviation Hangar "I"	Large Commercial	Fixed-Base Operator facility (Bldg 112)	All other industries	100%	24
The Arc of Orange County - preschool	Large Commercial	Preschool learning center	All other industries	100%	24
PANYNJ - SWF Main Terminal Parking	Large Commercial	Terminal parking - Lot A	All other industries	100%	24
PANYNJ - SWF Admin Office	Large Commercial	Airport administration office (Bldg 138)	All other industries	100%	24
Town of NW - New Highway Garage	Large Commercial	Town of NW Highway Dept. (Bldg 2220)	All other industries	100%	24
PANYNJ - SWF Operations/Customs	Large Commercial	Normal and emergency operations, and customs (Bldg 110)	All other industries	100%	24
FBO - Airborne Aviation Office	Large Commercial	Fixed-Base Operator facility (Bldg 140)	All other industries	100%	24
PANYNJ - SWF Maintenance Shop	Large Commercial	Airport maintenance shop (Bldg 142)	All other industries	100%	24

Facility Name	Rate Class	Facility/Customer Description (Specify Number of Customers if More Than One)	Economic Sector Code	Percent of Average Usage Microgrid Could Support During Major Power Outage	Hours of Electricity Supply Required Per Day During Major Power Outage
FBO - Airborne Aviation Hangar "A"	Small Commercial	Fixed-Base Operator facility (Bldg 136)	All other industries	100%	24
Town of NW account - Water Booster Station	Small Commercial	Town of NW (887 Brooks St)	All other industries	100%	24
PANYNJ - Southwest Fuel Farm	Small Commercial	Airport's main fuel farm (Bldgs 650/651)	All other industries	100%	24
Town of NW - Service Garage	Small Commercial	Town of NW Highway Dept.	All other industries	100%	24
PANYNJ - SWF De-Icing Lagoon	Small Commercial	Airport's de-icing glycol lagoons (Bldg 653)	All other industries	100%	24
U.S. Military Academy	Large Commercial	USMA-West Point facilities (Bldgs 108-109) – NYS Police Aviation unit located here (Bldg 108)	All other industries	100%	24
NYS Police Crime Lab	Large Commercial	New crime lab (Bldg 801) Critical Police Services. Temperature sensitive materials, power must be provided 24/7	All other industries	100%	24
NYS Police Crime Lab	Large Commercial	Old crime lab (Bldg 804)	All other industries	100%	24
NY State Dept. of Corrections	Large Commercial	Dormitory (563 Reed St)	All other industries	100%	24
Homewood Suites by Hilton*	Large Commercial	Extended stay hotel (180 Breunig Rd)	All other industries	100%	24
PANYNJ - Office	Large Commercial	Vacant-Office (226 Breunig Rd)	All other industries	100%	24
PANYNJ - Office	Large Commercial	Vacant-Office (Bldg 105)	All other industries	100%	24
Tutor Perini Corp.	Large Commercial	General Contractor (Bldg 808)	All other industries	100%	24
Pet Central Station	Small Commercial	Pet daycare, grooming, boarding, training (Bldg 806)	All other industries	100%	24
Farpost Soccer Club	Small Commercial	Indoor soccer facility (Bldg 810)	All other industries	100%	24

**Electricity usage and peak demand values used for Homewood Suites are estimates for the facility as a whole. Hotel has 125 suites with fully equipped kitchens and also 3,000 sq. ft. of meeting space, a heated indoor pool, and a fitness center*

Task 4.2 – Characterization of Proposed Distributed Energy Resources

Distributed Energy Resource Name	Facility Name	Energy Source	Nameplate Capacity (MW)	Average Annual Production Under Normal Conditions (MWh)	Average Daily Production During Major Power Outage (MWh)	Fuel Consumption per MWh	
						Quantity	Unit
Terminal CHP	Main Terminal	Natural Gas	0.2	573	4.8	10	MMBtu/MWh
Atlantic CHP	Atlantic Aviation	Natural Gas	0.1	288	2.4	10	MMBtu/MWh
Terminal PV1	Main Terminal	Solar	1.0	1400	3.8	0	None
Terminal PV2	Main Terminal	Solar	0.5	700	1.9	0	None
Atlantic PV	Atlantic Aviation	Solar	0.3	700	1.9	0	None
Microgrid Generator	First Street	Natural Gas	2.0	0	48	8.2	MMBtu/MWh

Task 4.3 – Capacity Impacts and Ancillary Services

The following resources would available for peak load support, if such programs are added in the future at the distribution-level and the DER meet eligibility requirements.

Distributed Energy Resource Name	Facility Name	Available Capacity (MW / year)	Does distributed energy resource currently provide peak load support?
Terminal CHP	Main Terminal	0.2	☐ Yes
Atlantic CHP	Atlantic Aviation	0.1	☐ Yes
Terminal PV*	Main Terminal	0.3	☐ Yes
Atlantic PV*	Atlantic Aviation	0.06	☐ Yes
Microgrid Generator	First Street	2.0	☐ Yes

**Based on guidance from IEc, project team used 20% of nameplate capacity as availability factor for solar PV*

Facility Name	Capacity Participating in Demand Response Program (MW / year)	
	Following Development of Microgrid	Currently
Microgrid Generator	2.0	0
Port Authority of NY & NJ and Atlantic Aviation Services (existing diesel backup at Stewart Int'l Airport in aggregate)	2.3	0

The benefit-cost analysis of the SWF microgrid project is based on an assumption that the full capability of the back-up generation within the microgrid footprint (2.0 MW and 2.3 MW) will be able to participate in the NYISO capacity market. This will require a change in NYISO rules to allow multiple resources to aggregate behind a consolidated metering point, whereas current rules limit the capacity value of such resources to the demand located at the same retail electric meter where the back-up generator is connected. NRG believes such a rule change is warranted and achievable, to support the implementation of microgrids and other distributed energy resources, consistent with NY State policies, and to support the use of the full capability of these resources in NYISO planning and operations. During detailed design, the economic evaluation will also consider a sensitivity case in which the back-up generation within the project's footprint is valued based on current rules, which limit participation to the value of the load drop, which is the lesser of the generator size behind a given meter and the customer's 'baseline' load level (the Average Coincident Load or "ACL").

The location of the Stewart Airport Microgrid does not fall within one of the NY Prize opportunity zones where there are loading constraints on the transmission and/or distribution systems.

According to Central Hudson, no growth related capital expenses would be deferred because of development of the microgrid.

Furthermore, transmission capacity requirements in the area of the Stewart Airport Microgrid do not fall within opportunity zones set forth by NY Prize, and distribution capacity in the area of the Stewart Airport Microgrid is not a concern. The microgrid project is not expected to impact Central Hudson's transmission or distribution capacity requirements in the area.

Although no current need in the area, potential utility transmission and distribution capacity relief from the project would be 2.3 MW. The microgrid project is anticipated to alleviate capacity loading on existing transmission and distribution infrastructure. It may result in reduced losses on the system.

The microgrid DER would be available for real (power) and reactive (voltage) local utility support.

Combined heat and power resources are planned for the Main Terminal and Atlantic Aviation facilities. The annual energy savings, as compared to the existing system, are projected to be 670 MMBtu.

No emission allowances will be purchased for the operation of the DER. For regulated NOx and Particulate Matter emissions, the generator engines meet the required limit. Estimated emission rates for the equipment are in the following table. These rates are weighted averages for only the natural gas-based generators, rather than all DER in the microgrid.

Emissions Type	Emissions per MWh	Unit
CO_2	337	lb
SO_2	0.002	lb
NO_x	5.9	lb
PM	0.012	lb

Task 4.4 – Project Costs

The fully installed cost (+/-30% estimates) and engineering life span for all the capital equipment is shown in the below table:

Capital Component	Installed Cost ($)	Component Lifespan (round to nearest year)	Description of Component
Terminal CHP	$0.70M	20	CHP Generator Complete
Atlantic CHP	$0.35M	20	CHP Generator Complete
Terminal PV	$4.05M	25	PV System Complete
Microgrid Generator	$1.40M	20	Remote NG Generator
Atlantic PV	$0.81M	25	PV System Complete
Utility Modifications	$0.40M	25	Addition of reclosures & misc. work
Microgrid Controls	$1.30M	20	Control panels, Software, Comms
Subtotal - Capital Costs	**$9.01M**		
Initial Planning & Design	$2.00M		Design, permitting, project front-end support, commissioning
Total	**$11.01M**		

Initial planning and design cost are estimated at $2.0 million. Fixed O&M costs are projected to be $190,000 per year. There are no anticipated non-fuel variable O&M costs.

All of the proposed fuel based DER will use natural gas. According to Central Hudson, the gas distribution company, the supply will be unlimited for the expected design basis events. The gas service at the main terminal and Atlantic Aviation may need to be enlarged to accommodate the generators. Fuel consumption is listed in the below table.

Distributed Energy Resource Name	Facility Name	Duration of Design Event (Days)	Quantity of Fuel Needed to Operate in Islanded Mode for Duration of Design Event	Unit
Terminal CHP	Terminal	Indefinitely	10	MMBtu/MWh
Atlantic CHP	Atlantic Aviation	Indefinitely	10	MMBtu/MWh
Microgrid Gen	Parking Lot	Indefinitely	8.2	MMBtu/MWh

Task 4.5 – Costs to Maintain Service during a Power Outage

Existing Backup Generation Capabilities:

Facility Name	Generator ID	Energy Source	Nameplate Capacity (MW)	Standard Operating Capacity (%)	Avg. Daily Production During Power Outage (MWh/Day)	Fuel Consumption per Day		One-Time Operating Costs ($)	Ongoing Operating Costs ($/Day)
						Quantity	Unit		
SWF Main Terminal (Bldg 128)	Bldg 128	Diesel	0.080	95	1.8	152	gal	0	100
SWF Airport Admin Office (Bldg 138)	Bldg 138	Diesel	0.125	70	1.1	168	gal	0	100
SWF Maintenance Shop (Bldg 142)	Bldg 142	Diesel	0.040	50	0.4	96	gal	0	100
SWF Field Lighting Vault (Bldg 144)	Bldg 144	Diesel	0.750	95	7.2	500	gal	0	100
SWF Main Terminal Parking - Lot A	Lot A	Diesel	0.100	65	0.7	176	gal	0	100
SWF Operations/Customs (Bldg 110)	Bldg 110	Diesel	0.050	95	1.1	120	gal	0	100
SWF Southwest Fuel Farm (Bldg 650/651)	SWFF	Diesel	0.150	50	0.8	72	gal	0	120
FBO-Atlantic Aviation Hangars (Bldg 118/112)	Bldg 118	Diesel	0.450	100	10.8	480	gal	100	120
New Windsor Water Dept. - Sewer Pump Station	NWWD Sewer	Diesel	0.150	100	3.6	260	gal	500	250
New Windsor Water Dept. - Water Booster Station	NWWD Water	Diesel	0.150	50	1.8	160	gal	500	250
New Windsor Highway Dept. - New Highway Garage (Bldg 2220) and Service Garage	NWHD Garage	Diesel	0.075	100	1.8	130	gal	250	165
NYS Police Crime Lab - new (Bldg 801)	NYSP CL	Diesel	0.400	95	4.5	700	gal	0	100

Cost of Maintaining Service while Operating on Backup Power:

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
SWF Main Terminal (Bldg 128)	One-Time Measures	Evacuate all personnel	2,000	$	Generator only supplies power to emergency egress lighting
SWF Airport Admin Office (Bldg 138)	One-Time Measures	Monitor Generator system/usage	500	$	During any power outage. Building is 100% covered by backup power

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
SWF Maintenance Shop (Bldg 142)	One-Time Measures	Monitor Generator system/usage	500	$	During any power outage. Minimal backup circuits. Enough lighting to perform all maintenance duties
SWF Field Lighting Vault (Bldg 144)	One-Time Measures	Monitor Generator system/usage	500	$	During any power outage
SWF Main Terminal Parking - Lot A	One-Time Measures	Monitor Generator system/usage	500	$	During any power outage
SWF Operations/Customs (Bldg 110)	One-Time Measures	Monitor Generator system/usage	500	$	During any power outage
SWF Southwest Fuel Farm (Bldg 650/651)	Choose an item.	N/A	N/A	N/A	N/A
FBO-Atlantic Aviation Hangars (Bldg 118/112)	Choose an item.	N/A	N/A	N/A	N/A
NYS Police Crime Lab - new (Bldg 801)	One-Time Measures	Monitor Generator system/usage	500	$	During any power outage

Cost of Maintaining Service while Backup Power is Not Available:

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
SWF Main Terminal (Bldg 128)	One-Time Measures	Emergency Egress Lighting Only. Winter time, additional generation will be needed for Heating Systems	500	$	Year-round
SWF Main Terminal (Bldg 128)	Ongoing Measures	Renting a generator	390	$/day	Year-round
SWF Airport Admin Office (Bldg 138)	One-Time Measures	Monitor all systems	500	$	Year-round
SWF Airport Admin Office (Bldg 138)	Ongoing Measures	Renting a generator	560	$/day	Year-round
SWF Maintenance Shop (Bldg 142)	One-Time Measures	Monitor all systems	500	$	Year-round
SWF Maintenance Shop (Bldg 142)	Ongoing Measures	Renting a generator	240	$/day	Year-round
SWF Field Lighting Vault (Bldg 144)	Ongoing Measures	Monitor all systems	500	$	Year-round. Power critical to all field lighting and NAV aids
SWF Field Lighting Vault (Bldg 144)	Ongoing Measures	Renting a generator	2,050	$/day	Year-round. Power critical to all field lighting and NAV aids
SWF Main Terminal Parking - Lot A	One-Time Measures	Monitor all systems	500	$	Year-round
SWF Main Terminal Parking - Lot A	Ongoing Measures	Renting a generator	525	$/day	Year-round
SWF Operations/Customs (Bldg 110)	One-Time Measures	Monitor all systems	500	$	Year-round
SWF Operations/Customs (Bldg 110)	Ongoing Measures	Renting a generator	390	$/day	Year-round
SWF Southwest Fuel Farm (Bldg 650/651)	One-Time Measures	Hooking up additional portable generator	500	$	24/7

Facility Name	Type of Measure (One-Time or Ongoing)	Description	Costs	Units	When would these measures be required?
SWF Southwest Fuel Farm (Bldg 650/651)	Ongoing Measures	Renting additional portable generator	650	$/day	24/7
FBO-Atlantic Aviation Hangars (Bldg 118/112)	One-Time Measures	Hooking up additional portable generator	500	$	24/7
FBO-Atlantic Aviation Hangars (Bldg 118/112)	Ongoing Measures	Renting additional portable generator	750	$/day	24/7
New Windsor Water Dept. - Sewer Pump Station	Ongoing Measures	Genset Rental	650	$/day	Utility interruption
New Windsor Water Dept. - Water Booster Station	Ongoing Measures	Genset Rental	650	$/day	Utility interruption
New Windsor Highway Dept. - New Highway Garage (Bldg 2220) and Service Garage	Ongoing Measures	Genset Rental	400	$/day	Utility interruption
NYS Police Crime Lab - new (Bldg 801)	One-Time Measures	Monitor all systems	500	$	Year-round
NYS Police Crime Lab - new (Bldg 801)	Ongoing Measures	Renting a generator	880	$/day	Year-round

SWF airport maintenance is performed by a third-party provider (AvPORTS, an AFCO company). The $500/generator estimated costs for monitoring, as shown above, would represent added maintenance charges from AvPORTS to cover a more thorough monitoring of each backup generator (including checking all equipment and the control panel at each location) during an emergency event, such as a major power outage.

During non-emergency events, the generators are programmed to run on a pre-scheduled basis, and Maintenance staff visit each generator once a week to ensure that everything is working properly. During an emergency event, the cost indicated is for time to perform a more thorough check of all generators, since they would be actually in use and Maintenance staff would want to ensure that they are all working as required.

Task 4.6 – Critical Facilities Supported by the Microgrid

Estimated percent loss in the facility's ability to provide services during a power outage:

Facility Name	Percent Loss in Services When Using Backup Gen.
SWF Main Terminal (Bldg 128)	100%
SWF Airport Admin Office (Bldg 138)	0%
SWF Maintenance Shop (Bldg 142)	0%
SWF Field Lighting Vault (Bldg 144)	0%
SWF Main Terminal Parking - Lot A	0%
SWF Operations/Customs (Bldg 110)	0%

Facility Name	Percent Loss in Services When Using Backup Gen.
SWF Southwest Fuel Farm (Bldg 650/651)	0%
FBO-Atlantic Aviation Hangar "G" (Bldg 118)	0%
FBO-Atlantic Aviation Hangar "I" (Bldg 112)	0%
FBO-Airborne Aviation Office (Bldg 140)	0%
FBO-Airborne Aviation Hangar "A" (Bldg 136)	0%
New Windsor Water Dept. - Sewer Pump Station	0%
New Windsor Water Dept. - Water Booster Station	50%
New Windsor Highway Dept. - New Highway Garage (Bldg 2220) and Service Garage	0%
NYS Police Crime Lab - new (Bldg 801)	0%

Facility Name	Percent Loss in Services When Backup Gen. is Not Available
SWF Main Terminal (Bldg 128)	100%
SWF Airport Admin Office (Bldg 138)	100%
SWF Maintenance Shop (Bldg 142)	50%
SWF Field Lighting Vault (Bldg 144)	100%
SWF Main Terminal Parking - Lot A	100%
SWF Operations/Customs (Bldg 110)	100%
SWF Southwest Fuel Farm (Bldg 650/651)	100%
SWF De-Icing Lagoon (Bldg 653)	0%
U.S. Military Academy (Bldg 108)	50%
U.S. Military Academy (Bldg 109)	50%
FBO-Atlantic Aviation Hangar "G" (Bldg 118)	60%
FBO-Atlantic Aviation Hangar "I" (Bldg 112)	60%
FBO-Airborne Aviation Office (Bldg 140)	0%
FBO-Airborne Aviation Hangar "A" (Bldg 136)	0%
New Windsor Water Dept. - Sewer Pump Station	100%
New Windsor Water Dept. - Water Booster Station	100%
New Windsor Highway Dept. - New Highway Garage (Bldg 2220) and Service Garage	100%

Facility Name	Percent Loss in Services When Backup Gen. is Not Available
NYS Police Crime Lab - new (Bldg 801)	100%
Homewood Suites - 180 Breunig Rd (Bldg 602)	100%
NYS Dept. of Corrections - dormitory (563 Reed St)	50%
The Arc of Orange County - preschool (930 Raz Ave)	100%

Emergency Medical Services (EMS) and Police Services (NYS Police Aviation Unit):

The population served by EMS is approximately 140,000 within ~5 miles in the eastern part of Orange County (Newburgh, New Windsor, Cornwall, Montgomery). EMS services are handled through the Orange County 911 system through a mix of volunteer ambulance corps and Mobile Life Support Services, Inc. (MLSS). MLSS is privately owned with 50+ ambulances and serves the Hudson Valley Region. The closest hospital is St. Luke's Cornwall Hospital in Newburgh, approx. 6 miles away. An alternative facility is Orange Regional Medical Center in Middletown, approx. 20 miles away.

Based on conversations with Orange County Emergency Services personnel, the percent increase in average response time during a power outage is estimated at 25%.

In terms of distance to the next nearest alternative EMS provider, two volunteer ambulance corps are within 5 miles of SWF, and MLSS is 6 miles away. Additional volunteer corps are in surrounding municipalities.

The NY State Police ("NYSP") Aviation Unit and Medical Response Team ("MRT") are based at SWF, specifically at the USMA's 2nd Aviation Detachment hangar. The NYSP Aviation Unit and MRT have responsibility for the whole Hudson Valley region (the SWF catchment area for aviation services is 1.3M people) and do not act as direct support of SWF unless needed in a major emergency.

The NYSP Aviation Unit has several helicopters and one plane at the DOD/USMA Hangar (Building 108) that provide law enforcement support, search & rescue, and medical evacuation services. The unit and its aircraft rely on airport infrastructure to remain operational in an emergency. For example, power would need to be available to the airfield for the unit's plane to take off & land and to the Southwest Fuel Farm for aircraft fueling. In a worst case scenario (if a major power outage and backup generation is not available), the NYSP Aviation Unit could likely experience logistical issues with supplying and fueling its operations and an overall reduction in service effectiveness.

Under normal conditions, the NY State Police have 10 troopers + 1 supervisor assigned to SWF to cover everything 24/7/365 (utilizing 2 troopers plus a supervisor per shift), plus 25 troopers are on site everyday as part of the Aviation & MRT units. During an emergency event, these numbers would increase dramatically (at least doubling, if not tripling). NYSP would supplement with staff from other stations (closest is Troop F HQ in Montgomery, 4 miles away) and/or troops if needed. No reduction in effectiveness from a staffing perspective for the NY State Police would be expected during a major power outage, as the troopers would still have radios/phones, vehicles, etc. and be expected to be able to serve & protect the area.

Water/Wastewater Services (Town of New Windsor Water Dept. facilities):

The total population served by the Town of New Windsor Water Dept. facilities in the microgrid project area is 2,700, and the facilities support both residential customers and businesses.

Airports and Aviation Services (PANYNJ Stewart International Airport, Atlantic Aviation Services, and Airborne Aviation):

The Port Authority of NY & NJ at Stewart International Airport serves approximately 1,000 passengers per day on average, and 150 to 200 flights per day would be impacted by a major power outage. The SWF catchment area for aviation services (based on a 60-90 mile drive time) is 1.3M people. The nearest alternative airfield would be approx. 5-10 miles away for smaller aircraft and 75-100 miles away for larger aircraft that would have to divert to a major facility, such as JFK, EWR, or Dover AFB.

Atlantic Aviation Services serves approx. 20 individuals per day on average, and 5 flights per day on average would be impacted by a major power outage. The nearest alternative airfield for typical flights serviced by Atlantic is 60 miles away.

Airborne Aviation serves 15 travelers per day on average, as a conservative estimate. The number fluctuates between 1 and 20 per day and is likely on the lower side in winter months. Similarly, the average number of flights per day that would be impacted by a major power outage fluctuates between 1 and 5-10, with an average of 5 per day as a conservative estimate including commercial aircraft. The nearest alternative airfields are Dutchess County Airport (22 miles) for larger or mid-sized aircraft and Orange County Airport (12 miles) for smaller aircraft.

Additional Information on Size/Scope of Operations at SWF:

Based on discussion related to the 9/11 event, SWF handled close to 200 aircraft of various sizes and for various lengths of time. If SWF could handle 1,000 passengers a day now on 8 flights, at 5% utilization of space, it can then be assumed that SWF can handle up to 160 flights & 20,000 passengers per day – given proper spacing out of arrivals over a 24 hour period.

The NY Air National Guard ("NYANG") takes up roughly a third of the airport's land and runs independently of the PANYNJ for security reasons. Based on a recent presentation by the NYANG at an Orange County Chamber meeting, the NYANG has approx. 2,000 full-time employees with another 2,500 reservists on part-time/weekends. During a major emergency event impacting NYC, the NYANG base could easily swell to 10,000 people or more.

The NY State Police ("NYSP") have 10 troopers + 1 supervisor assigned to SWF to cover everything 24/7/365 (utilizing 2 troopers plus a supervisor per shift on a normal basis). In addition, NYSP has 25 troopers on site everyday as part of the Aviation & Medical Response Team (MRT) units and the entire staff of the NYS Police Crime Lab (approx. 25-30 per day). FBI has 150 personnel on site daily, Immigration and Customs Enforcement (ICE) has 100 daily, U.S. Customs and Border Protection (CBP) has 1 daily, and the Orange County Sheriff's Academy has 25 daily. During an emergency event, these numbers would increase dramatically on the NYSP & Orange County Sheriff sides – at least doubling, if not tripling. NYANG has 300 Security Force personnel as well.

Stewart International Airport sustained damage during Superstorm Sandy, but due to its elevation remained open in order to serve as an emergency operations center and emergency preparedness staging area for New York City. After Superstorm Sandy, Stewart Airport was able to facilitate the transport of electrical crews and heavy equipment from outside the region to affected areas. Resources, such as utility line trucks, were flown into Stewart Airport to support restoration services in the downstate area. For days after the storm, hourly flights of C-17 military aircraft streamed in, delivering relief workers and equipment from California and Georgia to assist Con Edison in restoring power to New York City.

Section 5 – Feasibility Study Results

Stewart International Airport plays a critical role to the community, region, and state and has been designated a state strategic asset by Governor Cuomo. In addition to the Airport's day-to-day general aviation services, it serves as a diversion airport, as well as an emergency operations center and emergency preparedness staging area for New York City. For days after Superstorm Sandy, the Airport facilitated the transport of electrical crews and heavy equipment from outside the region to affected areas. Hourly flights of C-17 military aircraft streamed in, delivering relief workers and equipment from outside the region to assist in restoring power to New York City. Furthermore, the proposed project also includes Town of New Windsor sewer pumping and water booster station assets, a NY State Police Crime Lab, a NY State Police Aviation unit (law enforcement support, search & rescue, and medical evacuation), Department of Defense (DOD) tenants, two private aviation services companies, and numerous other entities that provide critical services to the community, region, and state and rely on the Airport's infrastructure.

The critical role of Stewart International Airport to the community, region, and state and the need for enhanced resilience to disaster events will only increase. According to an FAA-NYSDOT sponsored study published in May 2011, investments in NY State's aviation sector have "the potential to help improve the health of local economies and the state as a whole." This study quantified the economic impacts of NY State's public-use airports for the year of 2009. In order to improve the resilience of this vital asset and ensure its availability in the future, it needs to have DER added along with the ability to island as a microgrid.

Commercial Service Airport	Total Jobs	Annual Earnings	Annual Economic Activity
Stewart International	5,579	$333,621,900	$750,722,800

As illustrated below, the proposed microgrid project is designed to achieve the following objectives and provide the associated benefits to customer participants: increase the Airport's ability to maintain full terminal operations and aviation services in the event of the loss of grid power, promote the use of clean and efficient energy sources at the Airport, and deploy a management and control system to integrate and coordinate DER to meet facility energy needs as cost-effectively as possible in normal and emergency conditions. The proposed solution will greatly enhance the efficient operations and resiliency of critical facilities at the Airport and for the nearby Town of New Windsor facilities by providing a high percentage of energy needs from on-site sources, while allowing the facilities to island from the grid if necessary during an emergency event. The flexibility of the management and control system shall provide a platform to support future development and growth at the Airport and in its immediate vicinity.

Current Status of Stewart Airport	Proposed Project Results
Reliance on diesel generators with significant air emissions	Deploy an optimized mix of clean, reliable, resilient, and efficient on-site generation
Insufficient backup power to meet the needs of the main Terminal building	Support full backup power needs of Terminal building as well as expansion project; ensure continuity of critical services during power outages or other emergencies
Separated, unlinked, individual backup generating assets	Airport-wide distributed energy resources management system to control, coordinate, and optimize new & existing assets in both "grid-tied" and "island" modes

At the heart of this initiative is the desire to increase the operational efficiency, sustainability profile, and reliability and resilience of a profoundly critical facility that has supported the recovery of the Hudson Valley region and NYC downstate areas after devastating storm events; as the frequency and severity of storms increase, it is likely that SWF will continue to play a key role into the future for the safety and economies of the Hudson Valley and the greater NYC region. Therefore, indirectly affected stakeholders include residents of nearby towns and municipalities as far reaching as New York City, with its 8 million residents. Non-participating customers in the community, region, and state will benefit from the enhanced reliability and resiliency of the Airport and the vital services and facilities that rely on its infrastructure.

The microgrid project at Stewart International Airport will be expected to result in valuable experience and tangible benefits related to the effective integration of clean and efficient DER and development of new business models with customer, local utility, community, and competitive solutions provider engagement. Furthermore, a microgrid solution will serve to advance the objectives of the PANYNJ's Sustainability Policy and the Airport's site-specific Sustainability Plan. The PANYNJ has an agency-wide focus on advancing the development of strategies for climate change resilience and the use of clean/renewable energy sources.

The proposed microgrid uses a portion of the Central Hudson 13.2 kV distribution circuit in the vicinity of Stewart International Airport. A circuit will be tapped off the line along Route 207 at the south end of the Airport. The circuit will feed facility loads roughly east and west of Breunig Road, with loads to the east associated with customers on the Airport's property and those to the west with customers on Town of New Windsor property.

A new, remotely operated recloser will be added at the tap point that will sense loss of utility voltage and initiate microgrid island operation. The pole top G&W Viper recloser will provide IEEE 1547 protective functions such as under/over frequency, under/over voltage, and loss of phase protection, through internal voltage and current sensing. Also, it will provide over current protection and sense when the utility circuit is restored. All information will be communicated to the microgrid controller that is anticipated to be installed in the main terminal building.

The main airport terminal facility will have a new combined heat and power (CHP) natural gas reciprocating generator rated at 200 kW, located outside near the mechanical room, and operating during normal conditions when there is demand for heat. The terminal has two boilers for facility heating. Likewise, the Fixed Base Operator (FBO) Atlantic Aviation's hangar will have a 100 kW CHP reciprocating generator located outdoors near the mechanical room and operated as needed to supplement existing boilers. Both CHP generators were sized based on 60% of the estimated base electrical building loads.

A CHP generator is a relatively straightforward mechanical addition. The engine has a heat exchanger in parallel with the engine radiator. Coolant is diverted from the radiator to the heat exchanger depending on the building heating requirements. The heat exchanger is piped in series with the boiler inlet heating the incoming feed water. This reduces the heating burden of the boiler without having to make complex modifications to the existing boiler controls.

The SWF main terminal and Atlantic Aviation buildings will have 500 kW and 300 kW, respectively, of solar PV installations on the roof of each building. The main terminal will also have a 1 MW solar PV carport installation in the parking lot across First Street from the main terminal.

There will be a new 2 MW natural gas reciprocating generator in a noise suppressing outdoor enclosure also in the parking area across First Street from the main terminal. The generator governor, exciter, and engine will be selected to provide good load following capability.

This 2 MW generator would primarily operate only as a standby source when in islanded microgrid mode. It could have limited run hours when operating for NYISO demand response program participation or on an opportunistic basis when economic in both the NYISO and DSP (or Distribution System Platform envisioned under REV) markets, subject to current and/or future market rules.

The Stewart Airport-New Windsor community microgrid is technically feasible but will most likely require additional incentives to attract private funding for full build-out in its proposed form. Incentives could include NYSERDA or other grants, favorable gas tariffs, and/or credits for DER generation or capacity. Preliminary economic modeling for the microgrid DER in aggregate indicates a payback period of approximately twelve to thirteen years excluding any additional NY Prize funding. These preliminary results include the Federal ITC, NY-SUN Commercial / Industrial Performance-Based Incentive, and NYSERDA CHP Program Incentive. An additional level of incentive funding would serve to reduce the payback period for full microgrid implementation, including the 2 MW natural gas generator and microgrid-specific costs (Initial Planning & Design, Utility Modifications, and Microgrid Controls).and to attract private or other sources of capital, thus improving the financial and commercial feasibility of the microgrid. Financial feasibility is covered in detail in Task 3.5.

The table below, also shown in Task 4.0 as Table 3 – Detailed BCA Results, Scenario 1 (No Major Power Outages; 7 Percent Discount Rate), presents an overview of the costs and benefits of the entire project. The results suggest that if no major power outages occur over the microgrid's assumed 20-year operating life, the present value of the proposed project's costs would exceed its estimated benefits. Therefore, the Benefit-Cost Analysis performed by IEc indicates the need for a capital injection to ensure the success of this project, i.e. full microgrid implementation in its proposed form.

COST OR BENEFIT CATEGORY	PRESENT VALUE OVER 20 YEARS (2014$)	ANNUALIZED VALUE (2014$)
Costs		
Initial Design and Planning	$2,000,000	$176,000
Capital Investments	$9,010,000	$753,000
Fixed O&M	$2,150,000	$190,000
Variable O&M (Grid-Connected Mode)	$0	$0
Fuel (Grid-Connected Mode)	$667,000	$58,800
Emission Control	$0	$0
Emissions Allowances	$0	$0
Emissions Damages (Grid-Connected Mode)	$1,610,000	$105,000
Total Costs	**$15,400,000**	
Benefits		
Reduction in Generating Costs	$2,490,000	$220,000
Fuel Savings from CHP	$51,900	$4,580
Generation Capacity Cost Savings	$5,670,000	$500,000
Distribution Capacity Cost Savings	$0	$0
Reliability Improvements	$1,330,000	$118,000
Power Quality Improvements	$933,000	$82,300
Avoided Emissions Allowance Costs	$1,240	$110
Avoided Emissions Damages	$1,890,000	$123,000
Major Power Outage Benefits	$0	$0
Total Benefits	**$12,400,000**	

The table below summarizes the estimated net benefits (present value assuming a 7% discount rate), benefit-cost ratios, and internal rates of return for the two scenarios performed by IEc in the Benefit-Cost Analysis and described in Task 4.0. In order for the present value of the project's benefits to outweigh its costs, the average duration of major outages would need to exceed approximately 0.4 days per year.

ECONOMIC MEASURE	ASSUMED AVERAGE DURATION OF MAJOR POWER OUTAGES	
	SCENARIO 1: 0 DAYS/YEAR	SCENARIO 2: 0.4 DAYS/YEAR
Net Benefits - Present Value	-$3,070,000	$147,000
Benefit-Cost Ratio	0.8	1.0
Internal Rate of Return	2.8%	7.1%

Absent full microgrid implementation in its proposed form, an attractive path forward could also involve implementing some combination of additional ECM measures, economically favorable and efficient DER (base load CHP for the SWF Main Terminal and Atlantic Aviation), clean and renewable generation resources (1.8 MW of carport and rooftop solar PV). These components may be pursued on a more accelerated timeline with or without additional funding from the NY Prize program, if agreed upon by the customer participants. As shown in Task 3.5, preliminary economic modeling for individual DER indicates attractive payback periods of approximately twelve years for the Main Terminal PV (1.5 MW) with remote net metering, fourteen years for the Atlantic Aviation PV (300 kW), seven years for the Main Terminal CHP (200 kW), and four years for the Atlantic Aviation CHP (100 kW).

Listed below are some of the lessons learned during the Stage 1 feasibility assessment from the perspective of the microgrid's design engineers. In addition, legal/regulatory recommendations are presented in Task 3.6.

- Working with many public and private energy customers, as well as other stakeholders, such as the local distribution company, has required significant communication to validate customer needs and preferences pertaining to a microgrid and the proposed technical configuration.
- As customer needs were learned more fully over time, proposed configuration changes had to be communicated to the design team for validation, such that any of the individual entity's needs would not be compromised.
- Energy providers and customers were hesitant to divulge energy consumption/demand data and security sensitive infrastructure documents; multiple protective documents were required to obtain useful and necessary information for the development of an applicable conceptual microgrid design.
- Many skills and subject matter experts were required for a complete conceptual microgrid design, i.e. power systems design engineers, energy management process control design engineers, financial/commercial consultants, distributed energy resource consultants, energy efficiency consultants, etc.
- This project is a case where the proposed microgrid employs a portion of an existing utility distribution circuit. The project team, including Central Hudson, has worked well together, and the feasibility study process has moved smoothly.

- Accurate load profiles for the microgrid continue to be a challenge. Assumptions usually lead to over design and less accurate financial projections. To reduce project risk and promote the long-term success, an initial data collection and analysis project should be included as part of the overall microgrid program for SWF. Prior to finalizing designs, detailed load data needs to be collected and analyzed to specify the exact sizes of the DER assets.

The proposed microgrid design addresses the objectives of the Stewart Airport-New Windsor customer participants, including promoting the use of cleaner and more efficient generation and improving reliability and resiliency for facilities in New Windsor, including facilities that are critical for airport operations and local water/wastewater services. It is an actionable and feasible design that meets the technical needs of the microgrid, while also providing for adequate generation to the area during islanded operation.

The proposed microgrid system is also scalable and flexible, with a control solution that serves as a platform for future growth at the Airport and in the surrounding area and a design that can accommodate additional DER and/or a phased build-out. The system will be expandable and modularized to the extent feasible to account for future growth and ensuing power needs of the buildings, further relieving the surrounding grid of future stress.

The real-time microgrid controller will balance generation with loads, maintain and monitor power quality and reliability, and take on responsibility for islanding/reconnection events. The advanced software technology will utilize historical/predictive algorithms and cloud-based information to optimize system dispatch and performance. As a result, the microgrid will reduce susceptibility to power outages by enabling a seamless transition from grid-connected to islanded mode, and while in normal grid-connected operation, the management technology platform will coordinate and optimize the microgrid assets.

As demonstrated in the days following Superstorm Sandy, Stewart International Airport plays a critical role to the community, region, and state. This study proposes and assesses a reliable, resilient, and efficient microgrid that would help minimize the impact of major power outages and ensure continued and efficient operation of the Airport and 27 facilities in the project area in the Town of New Windsor. This would advance the objectives of the NY Prize program and NY REV policy initiative, as well as the PANYNJ's Sustainability Policy and Stewart Airport's site-specific Sustainability Plan. In addition to addressing immediate needs, such as full reliable power for the main passenger terminal, the proposed microgrid project aligns with the overall sustainability goal for SWF: "to develop SWF into a vibrant regional Airport that serves the needs of residents and businesses, promotes economic growth in the Hudson Valley region, and operates in a sustainable manner that conserves natural resources and protects the environment, consistent with the Port Authority's mission for the Airport."

Section 6 – Appendices

Appendix A – List of Critical & Emergency Facilities

TIER 1 – Critical Port Authority Airport Facilities (to include main terminal, operations/customs, admin/maintenance, field lighting vault, southwest fuel farm, etc.), Fixed-Base Operators (Atlantic Aviation & Airborne Aviation), U.S. Military Academy apron (including NYS Police Aviation unit), and Town of New Windsor Assets (Water Dept. sewer pumping / water booster stations, Highway Dept. maintenance garage)

Customer Name	Address	Notes
PORT AUTHORITY OF NY & NJ	1130 FIRST ST BLDG 128	Main Passenger Terminal Building
ATLANTIC AVIATION (FBO)	1070 FIRST ST BLDG 118	HANGAR “G”
PORT AUTHORITY OF NY & NJ	1180 FIRST ST BLDG 144	Field lighting vault
USMA-U.S. MILITARY ACADEMY	1005 FIRST ST BLDG 108-109	Bldg 108 houses the NYS Police Aviation unit (Law Enforcement Support, Search and Rescue, MEDEVAC)
TOWN OF NEW WINDSOR	840 BROOKS ST BLDG 2210	Sewer pump station - electric
ATLANTIC AVIATION (FBO)	1044 FIRST ST BLDG 112	HANGAR “I”
The Arc of Orange County (formerly Orange AHRC)	930 RAZ AVENUE *southwest corner of Raz Ave and Reed (“B”) St*	Preschool Learning Experience (PLE) program - New Windsor center. Leased from the Town of New Windsor
PORT AUTHORITY OF NY & NJ	1010 BREUNIG RD LOT A	Main terminal parking lot - Lot A
PORT AUTHORITY OF NY & NJ	1180 FIRST ST BLDG 138	Airport administration office
TOWN OF NEW WINDSOR	196 PERIMETER ROAD BLDG 2220	New Highway Garage
PORT AUTHORITY OF NY & NJ	1038 FIRST ST BLDG 110	OPERATIONS/CUSTOMS
AIRBORNE AVIATION (FBO)	1188 FIRST ST BLDG 140	FBO - Office
PORT AUTHORITY OF NY & NJ	1192 FIRST ST BLDG 142	Airport maintenance shop
AIRBORNE AVIATION (FBO)	1170 FIRST ST BLDG 136	HANGAR “A”
TOWN OF NEW WINDSOR	887 BROOKS STREET	*Assumed to be Water Booster Station*
PORT AUTHORITY OF NY & NJ	FIRST ST-ETHYLENE GLYCO BLDG 650-651	Southwest Fuel Farm
TOWN OF NEW WINDSOR	206 PERIMETER ROAD	Service Garage
PORT AUTHORITY OF NY & NJ	RECREATION RD GLYCOLE BLDG 653	De-Icing Lagoon

TIER 2 – Port Authority or Town of New Windsor Tenants (NYS Police Crime Lab, NYS Dept. of Corrections, Homewood Suites)

Customer Name	Address	Notes
NYS POLICE CRIME LAB (new)	224 BREUNIG RD BLDG 801	400 kW backup generator [PANYNJ tenant]
NYS POLICE CRIME LAB (old)	BREUNIG RD BLDG 804	
NYS DEPT. OF CORRECTIONS	563 READ ST DORMITORY	Dormitory [Town of New Windsor tenant]
HOMEWOOD SUITES	180 BREUNIG RD BLDG 602	Hotel - important facility for airlines and their staff, and also serves as emergency relief center [PANYNJ tenant]

TIER 3 – Non-Critical Port Authority Facilities (Vacant Offices-Bldgs. 802 & 105) and Other Tenants (Pet Central, Soccer Club)

Customer Name	Address	Notes
PORT AUTHORITY OF NY & NJ	226 BREUNIG RD BLDG 802	Vacant-Office
PORT AUTHORITY OF NY & NJ	1001 FIRST ST BLDG 105	Vacant-School/Office
TUTOR PERINI CORP	2057 SECOND ST BLDG 808	General Contractor
PET CENTRAL	236 BREUNIG RD BLDG 806	Pet daycare, grooming, etc.
FARPOST SOCCER CLUB	306 Y ST BLDG 810	Indoor soccer facility

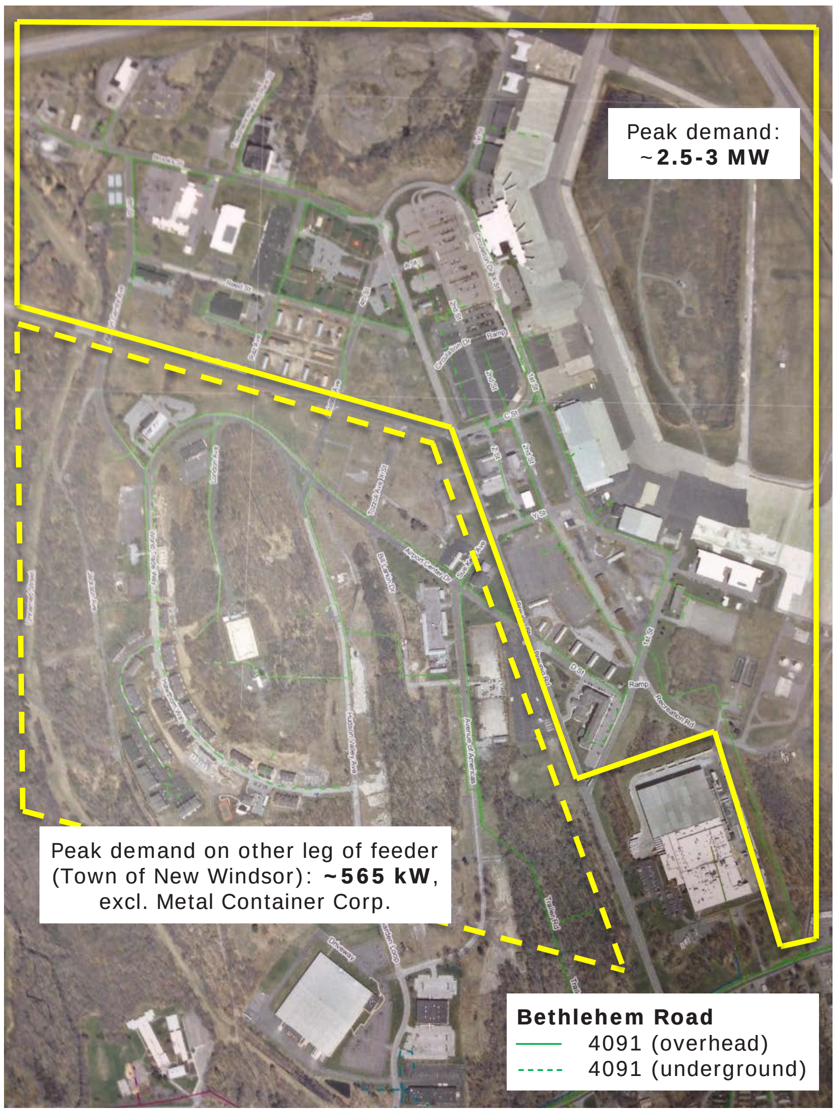
SUMMARY OF IN-SCOPE METERED FACILITIES

Tier	12 Months Electric Usage (kWh)	Peak Electric Demand (kW)	Description
Tier 1	5,604,823	1,796.6	Critical Port Authority Airport Facilities, including Fixed-Base Operators (FBO) and U.S. Military Academy apron (NYS Police Aviation unit), and Critical Town of New Windsor Assets
Tier 2	1,689,400	635.6	Port Authority or Town of New Windsor Tenants
Tier 3	229,167	89.8	Non-Critical Port Authority Facilities and Other Tenants
Total In-Scope	**7,523,390**	**2,522.0**	
Total Footprint	*9,561,008*	*3.210.2*	*Includes Town of New Windsor Water Dept. assets on other leg of CH feeder (London Ave, Hudson Valley Ave, World Trade Way) and other Federal DOD facilities (U.S. Army Reserve, U.S. Marine Corps)*

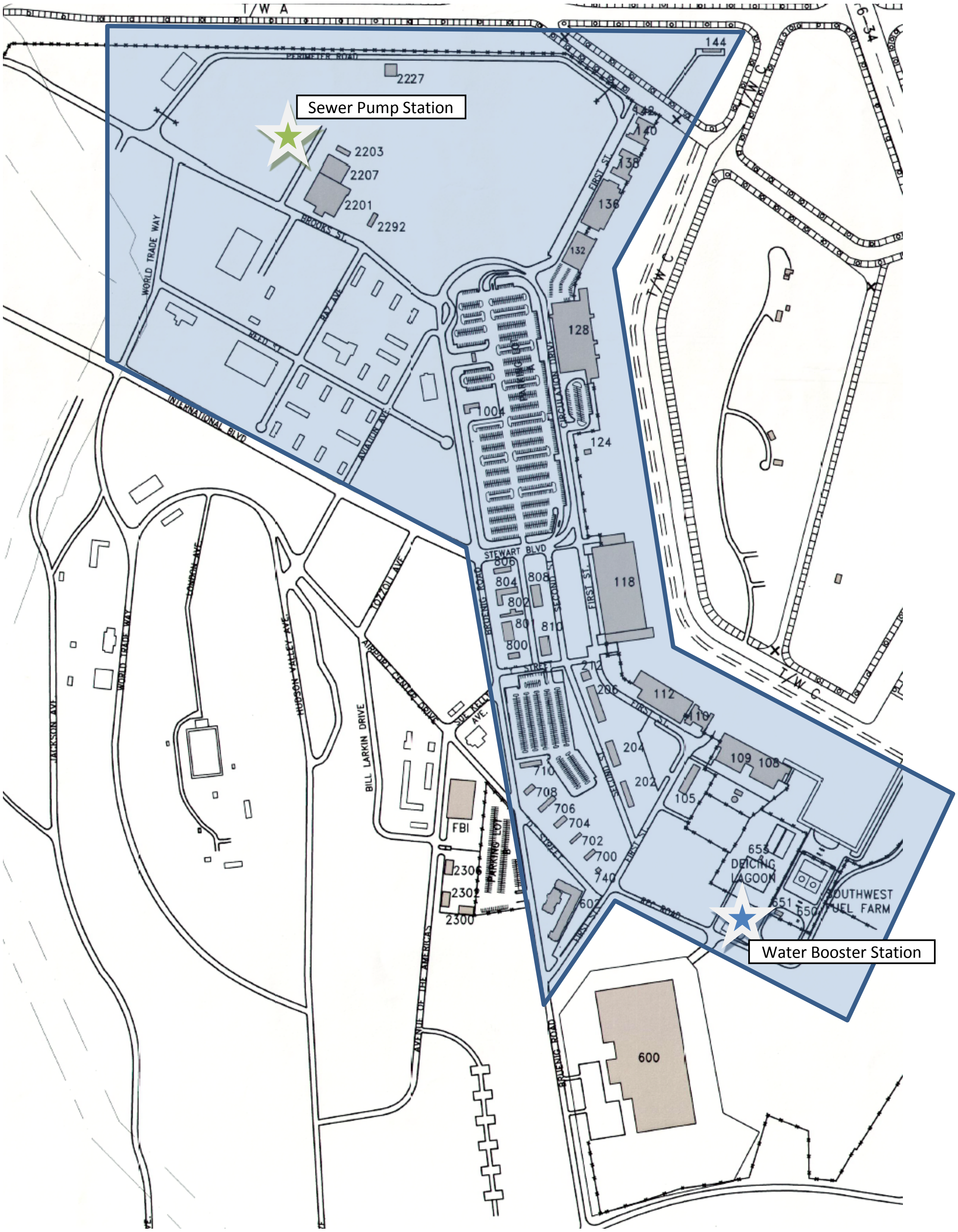
Appendix B – Microgrid Maps with Critical Facilities

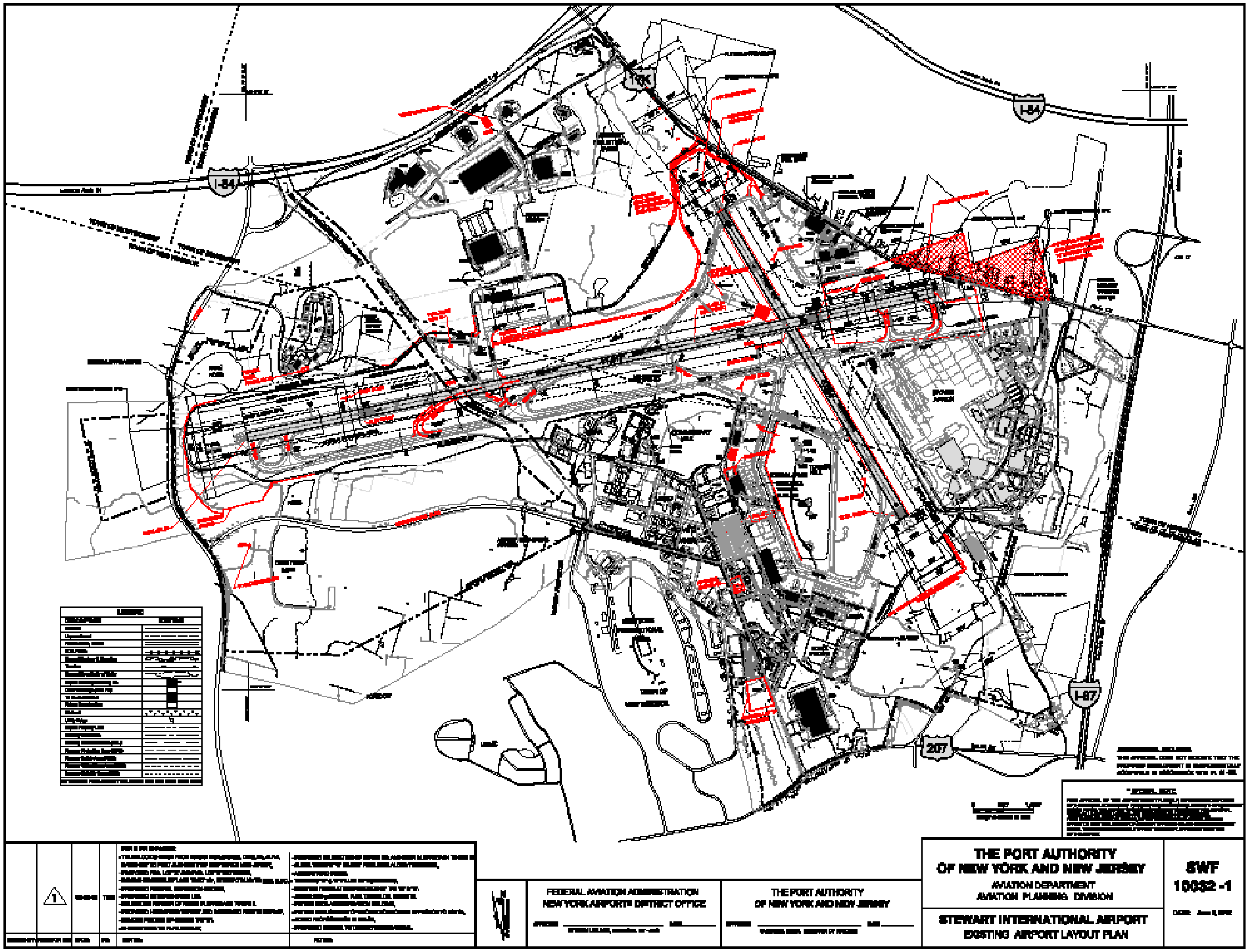
Microgrid Project Focus Area

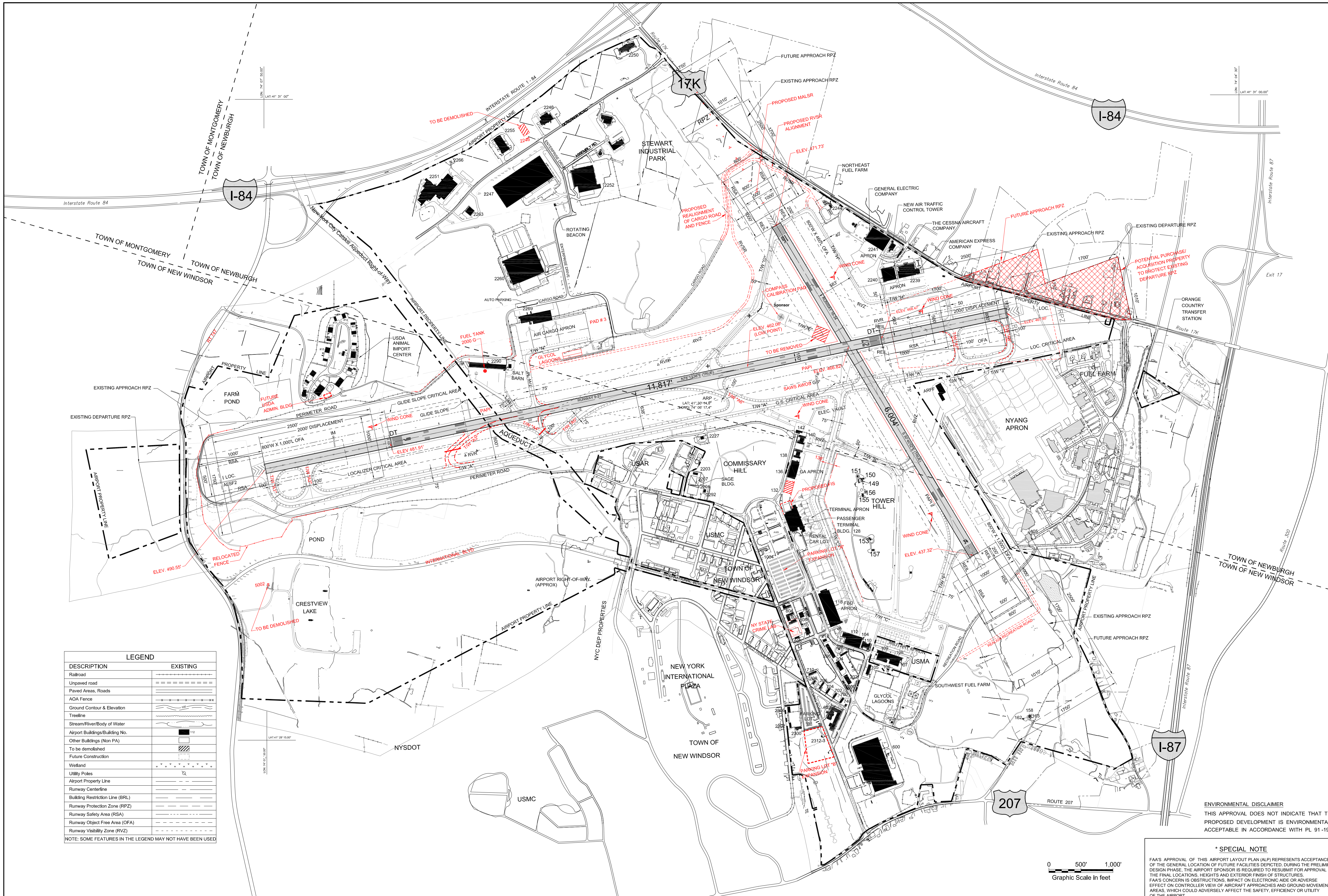
Below is a map of the proposed microgrid focus area, including Stewart International Airport and its immediate vicinity in the Town of New Windsor. It depicts areas served by separate legs of a feeder divided Breunig Road and International Boulevard. Subject to further evaluation at future stages, these may be connected by installation of switching and other equipment such that additional facilities in the Town of New Windsor can be supported by a microgrid system.



In-Scope Facilities based on the Existing Underlying Distribution Network




I-84
I-87
207
FEDERAL AVIATION ADMINISTRATION
NEW YORK AIRPORTS DISTRICT OFFICE
THE PORT AUTHORITY
OF NEW YORK AND NEW JERSEY
THE PORT AUTHORITY
OF NEW YORK AND NEW JERSEY
AVIATION DEPARTMENT
AVIATION PLANNING DIVISION
SWF
10032 -1
STEWART INTERNATIONAL AIRPORT
EXISTING AIRPORT LAYOUT PLAN



LEGEND	
DESCRIPTION	EXISTING
Railroad	
Unpaved road	
Paved Areas, Roads	
AOA Fence	
Ground Contour & Elevation	100
Treeline	
Stream/River/Body of Water	
Airport Buildings/Building No.	112
Other Buildings (Non PA)	
To be demolished	
Future Construction	
Wetland	
Utility Poles	
Airport Property Line	
Runway Centerline	
Building Restriction Line (BRL)	
Runway Protection Zone (RPZ)	
Runway Safety Area (RSA)	
Runway Object Free Area (OFA)	
Runway Visibility Zone (RVZ)	

NOTE: SOME FEATURES IN THE LEGEND MAY NOT HAVE BEEN USED

ENVIRONMENTAL DISCLAIMER

THIS APPROVAL DOES NOT INDICATE THAT THE PROPOSED DEVELOPMENT IS ENVIRONMENTALLY ACCEPTABLE IN ACCORDANCE WITH PL 91 -190.

* SPECIAL NOTE

FAA'S APPROVAL OF THIS AIRPORT LAYOUT PLAN (ALP) REPRESENTS ACCEPTANCE OF THE GENERAL LOCATION OF FUTURE FACILITIES DEPICTED. DURING THE PRELIMINARY DESIGN PHASE, THE AIRPORT SPONSOR IS REQUIRED TO RESUBMIT FOR APPROVAL THE FINAL LOCATIONS, HEIGHTS AND EXTERIOR FINISH OF STRUCTURES. FAA'S CONCERN IS OBSTRUCTIONS, IMPACT ON ELECTRONIC AIDE OR ADVERSE EFFECT ON CONTROLLER VIEW OF AIRCRAFT APPROACHES AND GROUND MOVEMENT AREAS, WHICH COULD ADVERSELY AFFECT THE SAFETY, EFFICIENCY OR UTILITY OF THE AIRPORT.

SIGNED BY:	REVISION NO.	DATE:	BY:	NOTES:	NOTES:
	1	06-09-12	TSM	PEN & INK CHANGES: - TITLE BLOCK CHANGE FROM National Express Group, DWG. No. ALP-2, DATED 3/07 TO PORT AUTHORITY OF NEW YORK & NEW JERSEY, - PROPOSED PKG. LOT "A" AND PKG. LOT "B" EXTENSION, - NAME CHANGE DRURY LANE TO RT 747, STEWART BLVD TO INT'L BLVD, - PROPOSED FEDERAL INSPECTION STATION, - PROPOSED NY STATE CRIME LAB, - RELOCATED PORTION OF FENCE IN APPROACH TO R/W 9, - PROPOSED HIGH SPEED T/W EXIT AND INCREASED FILLETS R/W 9-27, - REMOVE PORTION OF CLOSED T/W "E", - CHANGE VASIs TO PAPIs R/W 9-27,	- PROPOSED RELOCATION OF CARGO RD. AND RSVR IN APPROACH TO R/W 16, - CLEAR TAXIWAY "C" OBJECT FREE AREA ALONG TOWER HILL, - ADDED 5 WIND CONES, - TAXIWAYS "M" & "N" FILLET IMPROVEMENTS, - MODIFIED FENCE AT INTERSECTION OF T/W "M" & "N", - ADDED 2000 gal DIESEL FUEL TANK BLDG. 2290 SITE, - FUTURE USDA ADMINISTRATION BUILDING, - FUTURE REALIGNMENT OF RECREATION ROAD IN APPROACH TO R/W 34, - ADDED PROPOSED R/W 16 MALSR, - PROPOSED CHANGE TO TAXIWAY DESIGNATIONS.

FEDERAL AVIATION ADMINISTRATION
NEW YORK AIRPORTS DISTRICT OFFICE

APPROVED ____________ DATE ________
STEVEN URLASS, MANAGER NY - ADO

THE PORT AUTHORITY
OF NEW YORK AND NEW JERSEY

APPROVED ____________ DATE ________
SUSAN M. BAER, DIRECTOR OF AVIATION

THE PORT AUTHORITY OF NEW YORK AND NEW JERSEY

AVIATION DEPARTMENT
AVIATION PLANNING DIVISION

STEWART INTERNATIONAL AIRPORT

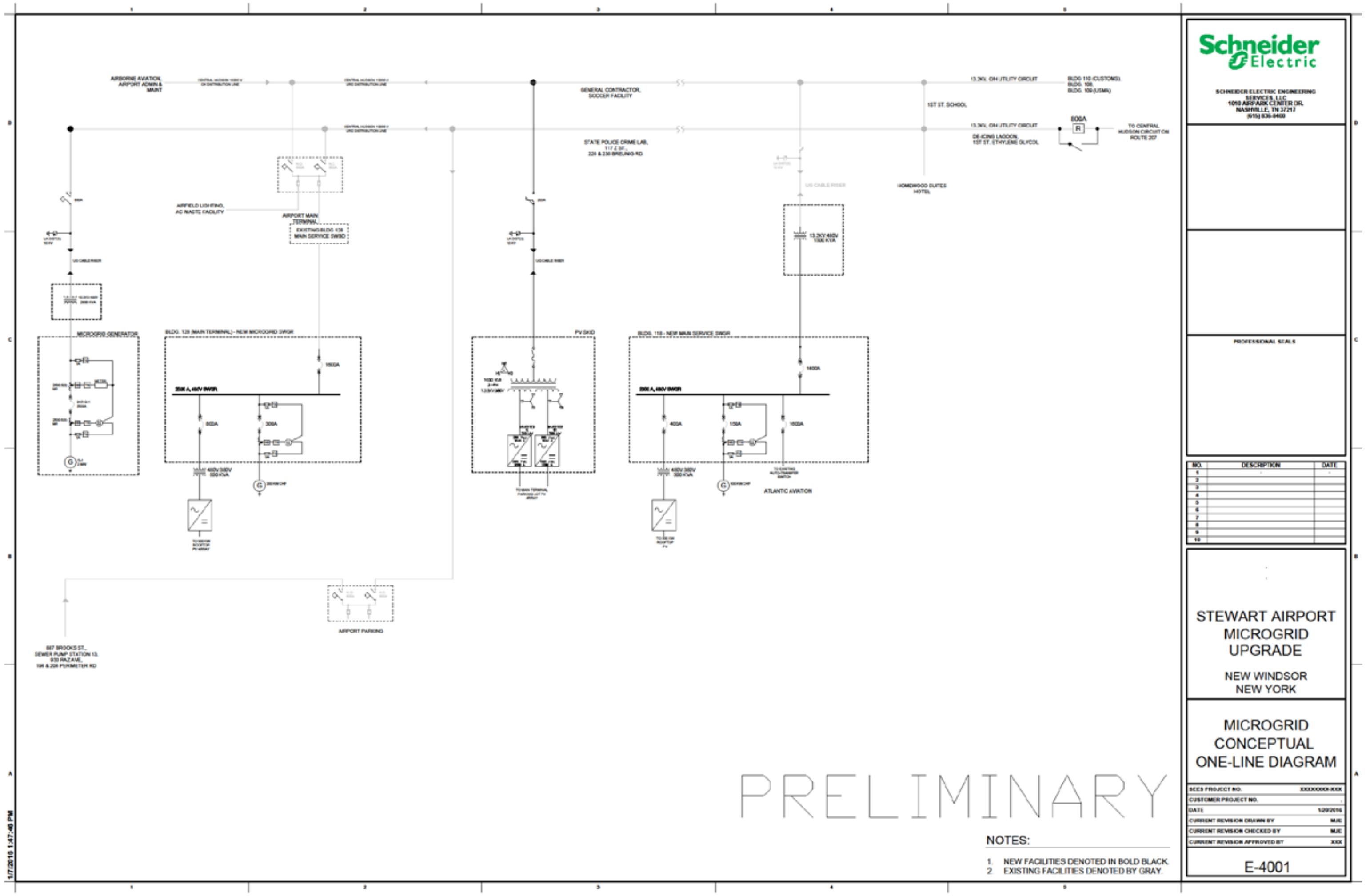
EXISTING AIRPORT LAYOUT PLAN

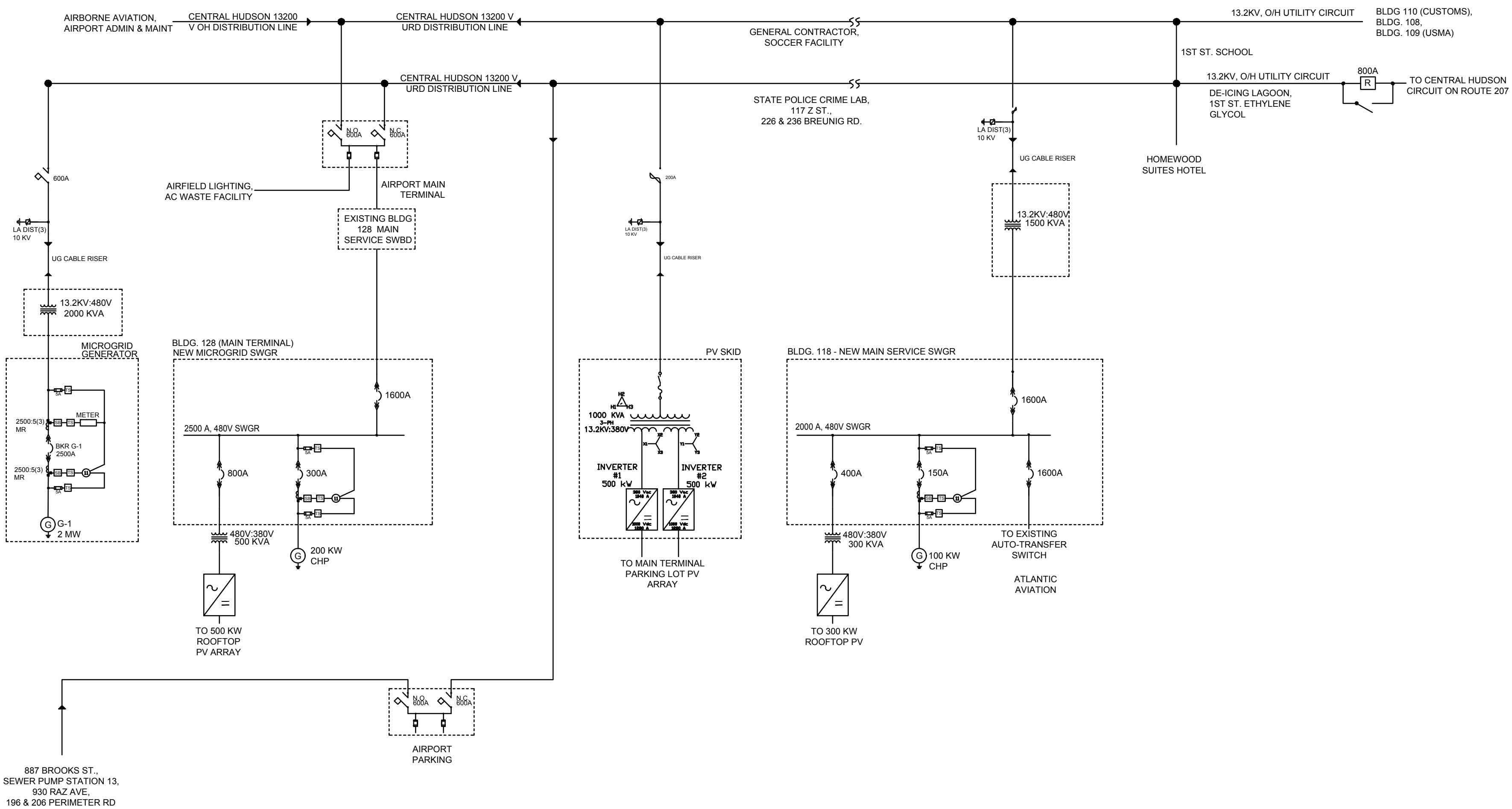
SWF 10032 -1

DATE: June 9, 2012

Appendix C – Preliminary One-Line Diagrams

Preliminary One-Line Diagram for Proposed Microgrid





PRELIMINARY

NOTES:

1. NEW FACILITIES DENOTED IN BOLD BLACK.
2. EXISTING FACILITIES DENOTED BY GRAY.

Schneider Electric

SCHNEIDER ELECTRIC ENGINEERING SERVICES, LLC
1010 AIRPARK CENTER DR.
NASHVILLE, TN 37217
(615) 836-8400

PROFESSIONAL SEALS

NO.	DESCRIPTION	DATE
1	-	-
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3		
4		
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6		
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STEWART AIRPORT MICROGRID UPGRADE

NEW WINDSOR
NEW YORK

MICROGRID CONCEPTUAL ONE-LINE DIAGRAM

SEES PROJECT NO.	XXXXXXXX-XXX
CUSTOMER PROJECT NO.	-
DATE	1/20/2016
CURRENT REVISION DRAWN BY	MJE
CURRENT REVISION CHECKED BY	MJE
CURRENT REVISION APPROVED BY	XXX

E-4001

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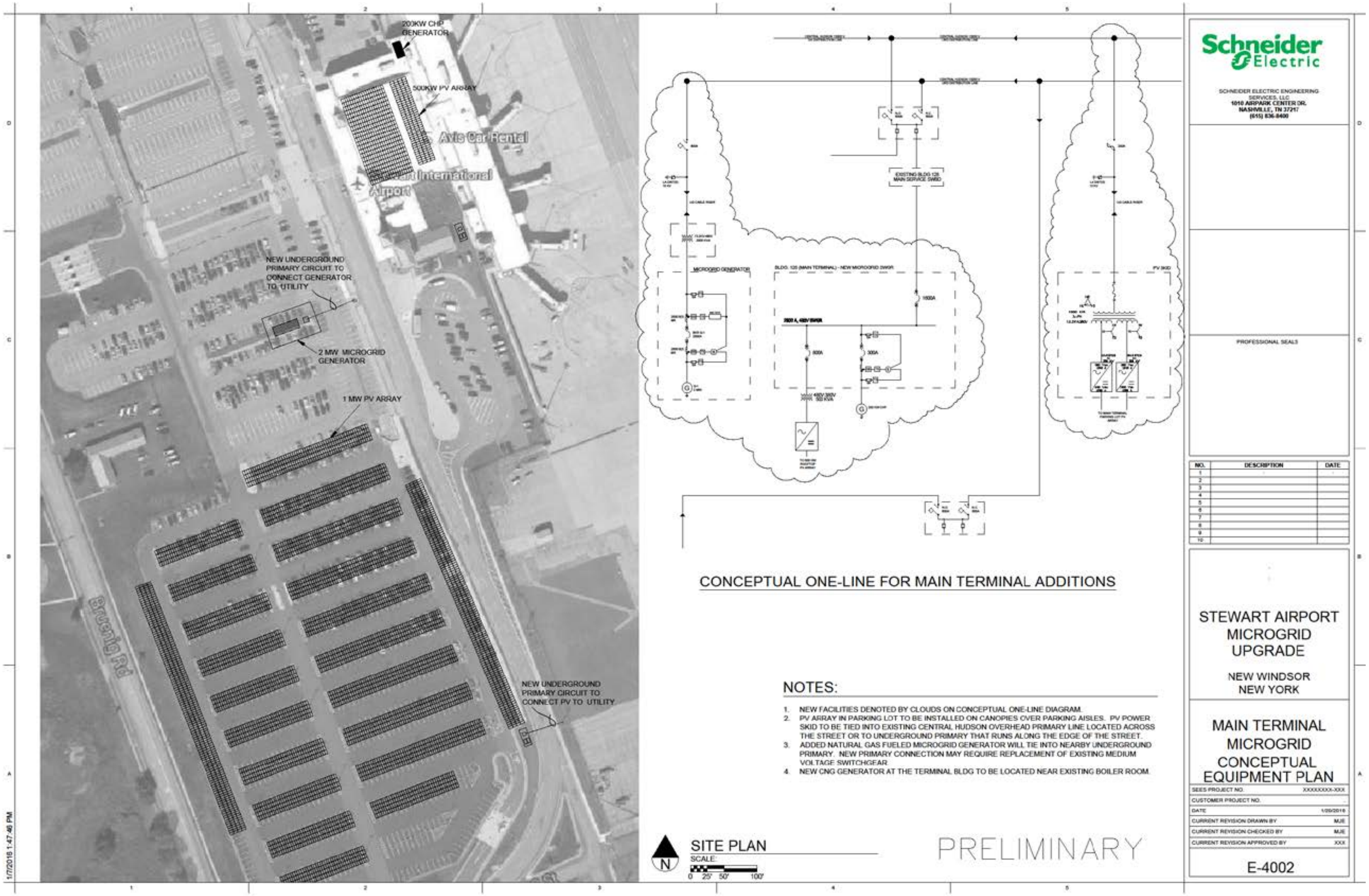
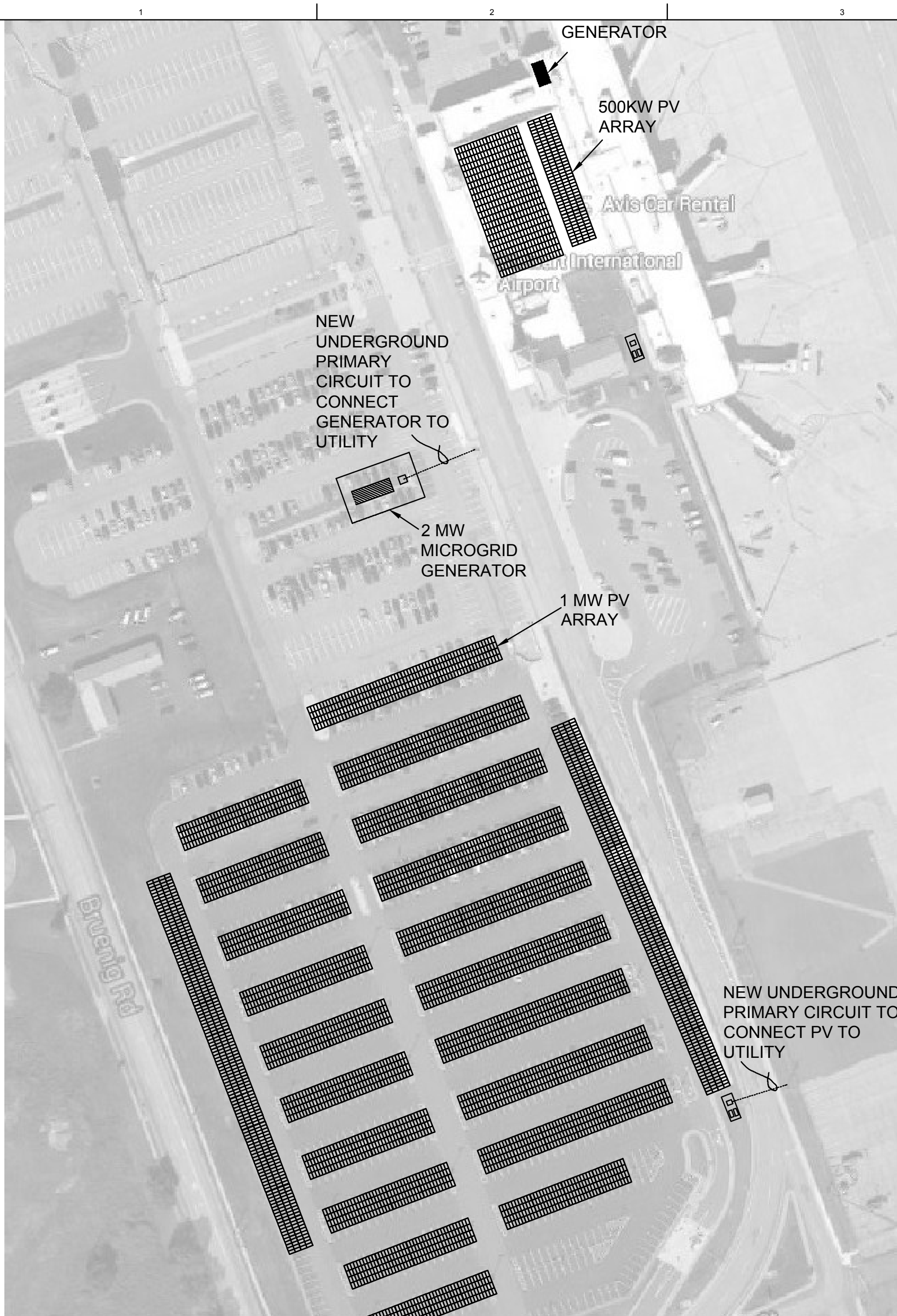
Conceptual One-Line and Equipment Site Plan for Main Terminal Additions

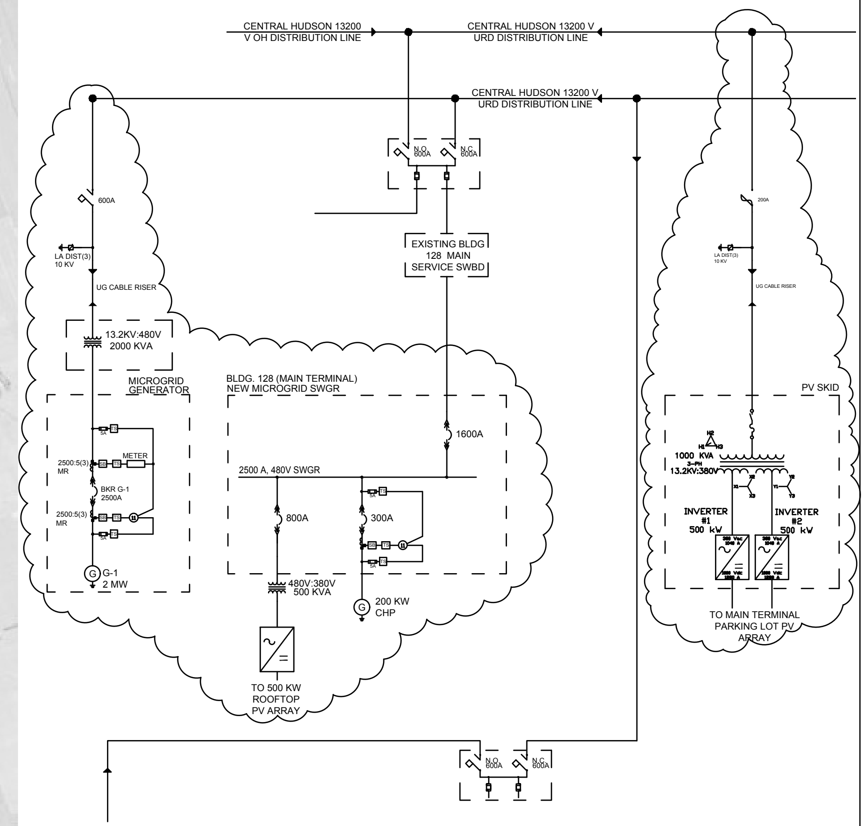




SITE PLAN

SCALE:

0 25' 50' 100'



CONCEPTUAL ONE-LINE FOR MAIN TERMINAL ADDITIONS

NOTES:

1. NEW FACILITIES DENOTED BY CLOUDS ON CONCEPTUAL ONE-LINE DIAGRAM.
2. PV ARRAY IN PARKING LOT TO BE INSTALLED ON CANOPIES OVER PARKING AISLES. PV POWER SKID TO BE TIED INTO EXISTING CENTRAL HUDSON OVERHEAD PRIMARY LINE LOCATED ACROSS THE STREET OR TO UNDERGROUND PRIMARY THAT RUNS ALONG THE EDGE OF THE STREET.
3. ADDED NATURAL GAS FUELED MICROGRID GENERATOR WILL TIE INTO NEARBY UNDERGROUND PRIMARY. NEW PRIMARY CONNECTION MAY REQUIRE REPLACEMENT OF EXISTING MEDIUM VOLTAGE SWITCHGEAR.
4. NEW CNG GENERATOR AT THE TERMINAL BLDG TO BE LOCATED NEAR EXISTING BOILER ROOM.

PRELIMINARY

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(615) 836-8400

PROFESSIONAL SEALS

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STEWART AIRPORT MICROGRID UPGRADE

NEW WINDSOR
NEW YORK

MAIN TERMINAL MICROGRID CONCEPTUAL EQUIPMENT PLAN

SEES PROJECT NO.	XXXXXXXX-XXX
CUSTOMER PROJECT NO.	-
DATE	1/20/2016
CURRENT REVISION DRAWN BY	MJE
CURRENT REVISION CHECKED BY	MJE
CURRENT REVISION APPROVED BY	XXX

E-4002

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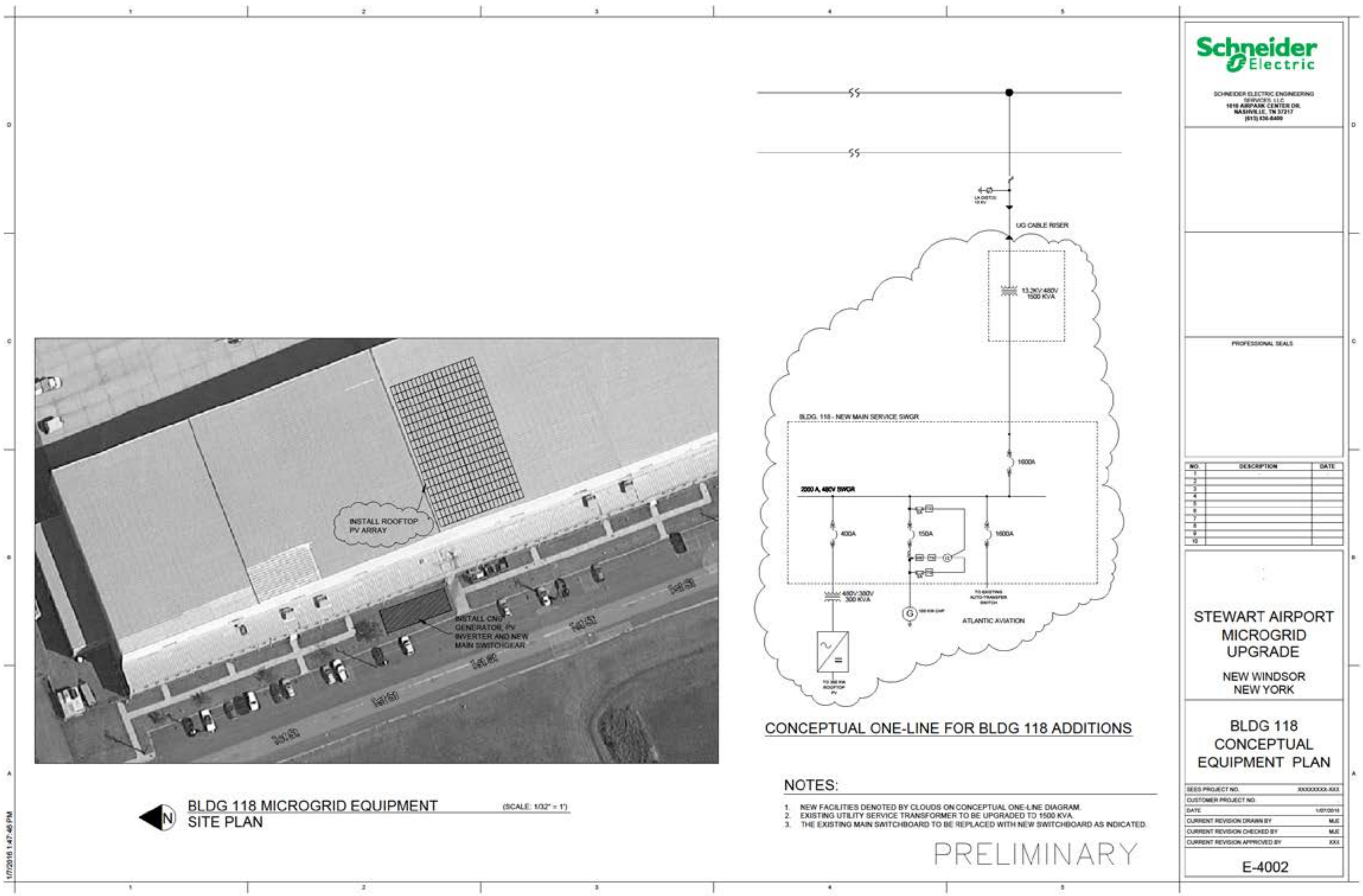
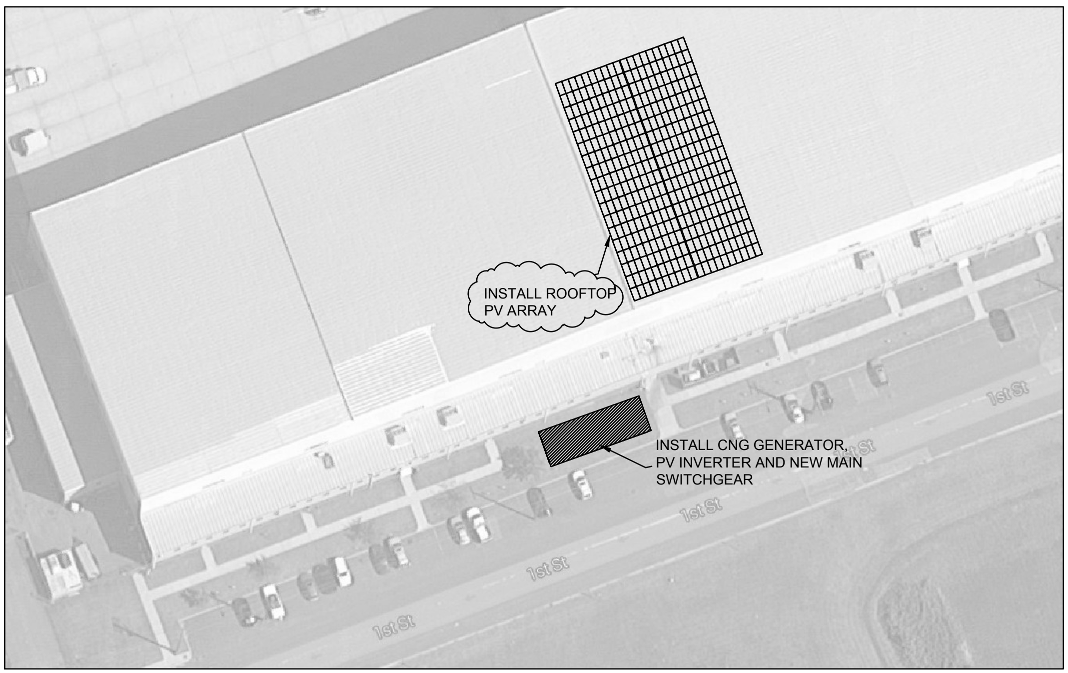
Conceptual One-Line and Equipment Site Plan for Atlantic Aviation Additions

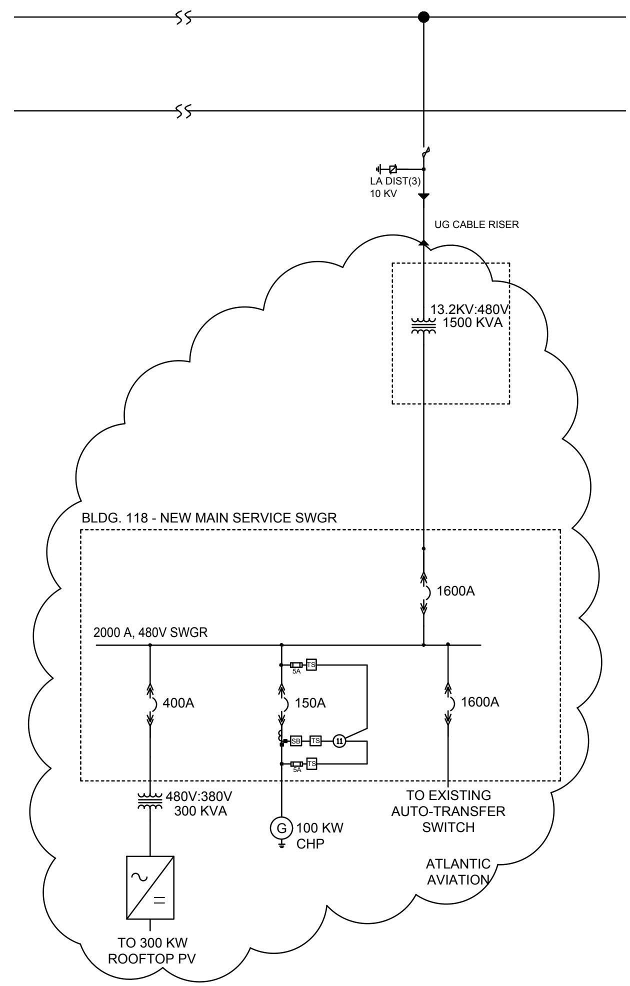


nrg



N

BLDG 118 MICROGRID EQUIPMENT SITE PLAN (SCALE: 1/32" = 1')



CONCEPTUAL ONE-LINE FOR BLDG 118 ADDITIONS

NOTES:

1. NEW FACILITIES DENOTED BY CLOUDS ON CONCEPTUAL ONE-LINE DIAGRAM.
2. EXISTING UTILITY SERVICE TRANSFORMER TO BE UPGRADED TO 1500 KVA.
3. THE EXISTING MAIN SWITCHBOARD TO BE REPLACED WITH NEW SWITCHBOARD AS INDICATED.

PRELIMINARY

Schneider Electric

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NASHVILLE, TN 37217
(615) 836-8400

PROFESSIONAL SEALS

NO.	DESCRIPTION	DATE
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STEWART AIRPORT MICROGRID UPGRADE

NEW WINDSOR
NEW YORK

BLDG 118 CONCEPTUAL EQUIPMENT PLAN

SEES PROJECT NO.	XXXXXXXX-XXX
CUSTOMER PROJECT NO.	-
DATE	1/07/2016
CURRENT REVISION DRAWN BY	MJE
CURRENT REVISION CHECKED BY	MJE
CURRENT REVISION APPROVED BY	XXX

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