RESILIENT SOLAR CASE STUDY: SUNY New Paltz – NYPA Integrated Grid Pilot

PROJECTS UNDER DEVELOPMENT

PROJECT SNAPSHOTS

Location: SUNY New Paltz, NYS

System Owners: Direct Purchase – SUNY New Paltz Campus

Project Goal: Resilience, energy savings, grid services, and research

System Components: 217 kW Solar PV total, 200 kWh battery storage, 30 kW gas genset

Initiative Timeline: 2016 - Present

Resilience Benefits: Shelter during grid outages

Total Cost: $1.3 million

Performance Data: EPRI is capturing data and testing the microgrid's resilience and grid services performance

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INTRODUCTION/BACKGROUND

The State University of New York (SUNY) New Paltz, the New York Power Authority (NYPA), the Electric Power Research Institute (EPRI), New York State Energy Research & Development Authority (NYSERDA), and Central Hudson Gas & Electric (CHG&E) have partnered together to develop two demonstration projects on the SUNY New Paltz campus under an "Integrated Grid Pilot" initiative. These projects will provide the research partners with an opportunity to study the impacts of solar PV on the campus' distribution feeder, assess the feasibility of a PV+battery microgrid, and evaluate the economic costs and benefits of the projects, in order to learn more about the gaps between theory and practical implementation.

The first project consists of a solar PV array connected to smart inverters installed on the campus' Sojourner Truth Library. The second project is a microgrid comprising a PV array connected to a battery and backup generator installed on the campus' Elting Gymnasium, which will enable the Gymnasium to operate as a shelter during a grid outage.

The objectives for the project include:

1. **Supporting SUNY New Paltz goal of reducing campus energy use intensity (EUI) by 20% per EO-88**
   Executive Order 88 requires NYS entities to reduce energy use intensity by 20% by 2020, relative to 2010-11 levels.
2. **Serve as a Red Cross emergency shelter during grid outages**
   The Elting Gymnasium will serve as an emergency shelter, with the microgrid powering electrical loads.
3. **Enhance and increase renewable integration in the area through the use of smart inverters and battery storage**
   Analysis gained from the research will be used to optimize configurations for the battery and smart inverters to mitigate issues related to intermittent generation, enabling increased penetration of renewables onto the grid.
4. **Test the smart inverters' ability to provide ancillary services**
   Verify advanced inverter functionality such as reactive power support, power limiting, and voltage & frequency ride-through.

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[1] The Smart DG Hub was formed by Sustainable CUNY of the City University of New York (CUNY). The DG Hub's Resilient Solar Project is a collaboration between CUNY, the National Renewable Energy Laboratory and Meister Consultants Group, funded by the U.S. Department of Energy and the State of New York.

Multiple parties have collaborated to develop the microgrid project; their roles are outlined in the table below:

Team Member	Project Role
New York Power Authority (NYPA)	Project Manager from design phase to commissioning
EPRI	Data collection, research and reporting
NYSERDA	Funding and technology support
Central Hudson Gas and Electric (CHG&E)	Grid integration research support
SUNY New Paltz	Host-site and education and outreach lead

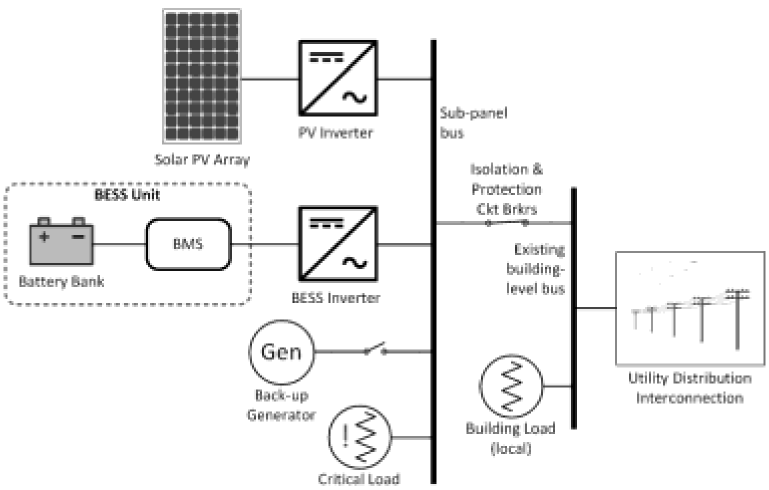
The project costs totaled $1.36 million dollars, however funding from NYSERDA, CHG&E, and NYPA reduced this amount to just over $300,000. Utility cost savings are anticipated to be approximately $25,000 annually, from a combination of consumption, demand, and capacity charge reductions. NYSERDA, EPRI, and NYPA are providing over $600,000 in funding and in-kind services to support additional research.

The research component is being led by EPRI, focused around three primary areas:

- Determining how PV, smart inverters, and batteries can be used to mitigate technical impacts of high penetration of renewables on specific feeders and maximize the economic benefits of distributed energy resources.
- Ensuring distributed energy resources are available during grid outages and determining the level to which services can be provided to the larger grid during grid-connected mode.
- Pinpointing gaps between the theories and practical implementation of DERs used for grid services.

HARDWARE COMPONENTS

***Figure 1**. Overview of Elting Gymnasium Microgrid Design*



The Sojourner Truth Library has a 117 kW solar PV array installed on the rooftop consisting of 305-watt poly-crystalline CSUN modules, and utilizes five 20 kW SMA Sunny Tri-power string inverters with smart functions.

The Elting Gymnasium has 101 kW of solar PV installed on the rooftop, made up of the same 305-watt CSUN modules, along with a 200 kWh Samsung SDI lithium-ion battery installed at ground level. The battery is expected to have 80% capacity after 6,000 cycles and last 10 years before replacement.

The PV and battery each utilize a Princeton Power 100 kW/107 kVA bi-directional hybrid smart inverter with a 96.5% CEC efficiency rating. The battery and PV system is an AC-coupled system. A 30 kW three-phase Kohler gas generator is also interconnected to the microgrid system for supplemental power.

MICROGRID SOFTWARE DETAILS

The microgrid system will be managed and controlled using Princeton Power's *EMOS Hub* energy management software. This software system will enable peak power limiting as well as reactive power support and can be controlled remotely using an online web-based dashboard. EMOS Hub primarily communicates with the system's control and metering devices utilizing Modbus communications protocols via a wired (ethernet) connection and externally the system communicates with the web dashboard via a hardwired LAN connection. The microgrid system will enable peak shaving via on-site monitoring of the campus load. The microgrid equipment analyses the data and outputs power according to the peak shaving algorithm and user-programmable setpoints.

During the testing and certification process, EPRI will control the EMOS Hub software remotely. SUNY New Paltz will assume control once the research process is complete and may continue collaboration with NYPA and CHG&E.

USE CASES & GRID SERVICES

As outlined in the table below, many functions are currently operational while some are still under development.

Function	Definition	Status
Solar time shifting	Excess electricity produced from the PV during the day can be stored in the battery for later use for economic benefit.	Available
Peak shaving	The battery will supply power to meet the campus' peak loads during periods of high demand, reducing the demand charge portion of the campus' electricity bill.	Available
Voltage regulation (Volt-VAR)	Transmission and distribution lines must maintain voltages, typically to within ±5% of the normal voltage, to provide stable electricity to customers. The smart inverters will have the capacity push the voltage up or pull the voltage down to help utilities maintain the voltage within acceptable bounds.	Available
Frequency regulation (frequency-watt)	Transmission and distribution lines must maintain certain frequencies, typically within 1% of 60 Hz in the U.S., which can be disrupted by changes in supply and demand. The smart inverters will use PV and battery power to provide frequency regulation services to the electrical grid.	Available
Fixed, real and/or reactive power control	Another voltage control method is to adjust the amount of reactive power delivered to the grid. Reactive and active power must work in conjunction to maintain voltage and power factor of the grid. Smart inverters can dynamically adjust reactive power delivery to maintain high power factor. Batteries can also supplement this capability.	Available
Microgrid Islanding	The microgrid system is configured to automatically disconnect (island) from the central grid during an outage and continue to provide electricity to the Elting Gymnasium. The backup generator connection is currently manual, with plans to automate generator connection in the future.	Available
Solar Smoothing	The level of production from solar PV varies throughout the day due to sun position, shading, clouds, and dust, among other factors. The battery system will charge or discharge accordingly to reduce the variability of power generation output, to limit the impacts on nearby feeders.	Testing of this function underway
Power Factor Correction	The system will utilize the smart inverters' capabilities to dynamically adjust power factor and improve grid stability.	Testing of this function underway

RESILIENCY & SUSTAINABILITY BENEFITS

As with many solar + storage installations, the system is designed to provide resiliency functions. During weather-related or other emergencies, the Elting Gymnasium will operate as a Red Cross emergency shelter for the local community (the library system will not operate in the event of a power outage). SUNY staff will monitor and control the microgrid's operation during a grid outage, and the system will be used to power lighting and outlets. The backup generator will be dispatched manually for supplemental power during long duration outages when the solar output alone cannot support the shelter load and will also supply loads during periods of high demand and charge the battery when extra generator capacity is available.

A key sustainability benefit is provided by the research effort which aims to explore the deployment of distributed energy resources in a variety of scenarios to gain insights and help to inform future deployments of similar technologies. This opportunity will allow the team to study the impacts and performance of the solar PV and microgrid on the campus' distribution feeder. The energy storage system and smart inverters are intended to enhance the functionality of the photovoltaic system by enabling it to endure voltage sag, spikes, and other power quality problems. This will allow it to remain connected to the grid for longer periods during grid disturbances, giving the grid the potential to correct disturbances rather than exacerbating problems from the buildings disconnecting themselves from the grid.

INTERCONNECTION AND TIMELINE

The microgrid and the SUNY New Paltz campus is located on a 13.2 kV radial grid distribution feeder. Due to the microgrid's minimal generation when compared to the University's loads, no transformer or other electrical infrastructure upgrades were required by CHG&E. However, additional protective equipment was needed to ensure the microgrid system could properly detect 3-phase and single-phase power loss and disconnect from the utility grid before entering microgrid mode. The Sojourner Truth Library interconnection process began in August 2016 with the submission of an initial application and was interconnected in March 2017. The Elting Gymnasium also submitted its initial application in August 2016; construction is still underway and interconnection will be complete by March 31, 2018.

LESSONS LEARNED

In regard to the procurement and design of the system, the development team has identified the following lessons for projects going forward:

- **Factory testing of equipment**. Confirm access to the proper equipment to perform required factory acceptance testing. In order to fully test the functionality of the whole system before shipping to the project site, a 200kW grid simulator was required. This inverter manufacturer did not own this equipment.
- **System-wide technical certification**. The gym microgrid system is highly customized, with many components added externally to the UL listed inverters and batteries. This caused many challenges throughout the course of the project in the form of utility approvals. For example, one inverter utilized was UL listed, but when placed in a series with the transformer, it did not meet UL standards. It is highly advisable for contract language to require that the fully integrated system meet certification requirements and not just its constituent parts, to avoid these challenges.
- **Technology readiness assurance.** Confirm the readiness of smart functions before signing contract by asking for documentation of test results, user manuals, or results from previous installations (if available). It was known that some of the smart inverter functionality to be employed for this project was still in development phases, causing difficulty in receiving acceptable test reports for the "in development" functionality prior to field deployment. It is

advisable for future microgrid projects that all smart functions are tested and the developer checks the testing documentation prior to purchasing the microgrid system. This eliminates uncertainty in operational abilities at the time of installation.

- **Battery site selection.** Seeking a location with the appropriate safety, environmental, and weather characteristics is critical when choosing a site for the battery storage. Naturally occurring temperature ranges may impact performance, particularly during cold weather seasons. The battery, which was sited outside due to indoor space constraints, had to be installed in an environmentally sealed container to maintain the appropriate conditions.

SOURCES

- *Initial Customer Installation Commitment.* New York Power Authority in cooperation with SUNY New Paltz.
- Magerko, Alex*. State University of New York – New Paltz: NYPA Integrated Grid Pilot*. Electric Power Research Institute. 2017
- Hermann, Charles. *Executive Summary Slides: SUNY New Paltz Solar Microgrid*. New York Power Authority. December 2015.
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