Battery Storage Study for Peak Demand Reduction and Emergency Back-up

Public Report

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THE NEW YORK CITY
SCHOOL CONSTRUCTION AUTHORITY
Long Island City, NY

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1 Executive Summary

OLA Consulting Engineers was requested by the New York City School Construction Authority (SCA) to perform studies to research and determine the feasibility of installing battery storage technologies at New York City schools. The Department of Citywide Administrative Services (DCAS) and NYC Department of Education (NYC DOE) have also reviewed this report and provided their feedback, with this feedback incorporated into the report. The current study focuses on reducing the peak electrical demand while a previous study focused on providing power for generator back up. At the time of this study, battery storage appears to be trending to be more viable and may play a role in resiliency strategies. While a battery system can offer peak electrical demand reduction as well as resiliency, it is typically more expensive to design for both strategies. Although it may be more financially viable in the future, battery storage both for reducing peak electric demand and as a backup energy source should continue to be considered by SCA, as costs continue to drive down and the technology continues to improve.

For this study, a "Current Energy Storage (CES)" (formerly Switch) ELM Battery Storage (lithium ion) System[1] was used as the basis for system sizing, layout, and cost estimating. The main objective of this study is to determine the potential energy and carbon savings after performing an assessment including optimal sizing calculations, order of magnitude cost, energy savings and potential carbon offset of installing a battery storage system. It was determined that, at this time, a system size of approximately 125 kW / 880 kWh appears optimal and repeatable across many SCA schools and could become the design standard for new schools to reduce peak electrical demand and to provide energy and carbon savings. Details about this system sizing, layout, cost estimating, and carbon savings are included in this report.

The focus of the current study in this report is on peak electrical demand reduction. A previous study, performed in March 2020, focused on the battery storage system options for replacement of a school's emergency generator. A summary of the findings from that study are also included in this report in Section 12 for reference. Our findings from that study indicate that utilizing battery storage systems as emergency back-up in place of a fuel source emergency generator appears to be a technologically viable option. The battery storage system may be able to replace the emergency generator. However, with some challenges of increased installation costs and early application in the industry of this technology for emergency power, this application may warrant further review and consideration. The resiliency benefits along with the opportunity to remove fossil fuel from the site do make consideration of battery storage systems inviting to the SCA and other entities.

The efforts of the current study helped determine that battery storage appears to be trending to be more viable and may play a role in resiliency strategies. The City's goals of making a utility grid more reliable in conjunction with increased intermittent renewables, makes battery storage attractive on public school buildings despite the upfront financial costs and code/FDNY regulations. With lower costs of products and higher utility costs anticipated, the potential for return on investment is likely in the future.

1. *https://www.elmmicrogrid.com/*
   https://www.currentess.com/

1 Battery Storage System Sizing

There are two main sizing/capacity metrics when selecting a battery storage system: kilowatt (kW) and kilowatt hour (kWh). The first metric, kW, is defined as a measure of electrical power. In this study, a kW is determined by the desired peak electric demand reduction each month. The second metric, kWh is defined as the same measure of electrical power but sustained over a period of one hour. In this study, this is determined by the duration of electrical discharge and charge time needed or desired by the battery storage system. To size a battery storage system, you must determine the required amount of energy storage your building needs. This is accomplished by analyzing the monthly peak electric demand profiles for various school buildings.

1.1 Daily Electric Demand Profiles for NYC Schools

Electric Demand is defined as a measure of the average rate at which a building consumes electricity in a defined time interval (15-minute utility interval). For the purposes of this report, we reviewed the actual daily electrical demand profiles for monthly peak days at 3 different SCA schools; one in the Bronx, Brooklyn and Queens. It should be noted that these schools have fossil fuel heating. In Figures 1 through 4 below, the demand profiles for these 3 NYC public schools are shown for typical months. The dotted red line in these profile graphs shows the approximate point above which the battery storage system would discharge during the day and below which the system would charge at night (this is further illustrated in Section 2.2). For the Brooklyn school, two graphs are shown to illustrate the variation in electric demand between two (2) months of the year (March and September). Peak months were also reviewed (these being summer months) but to ensure proper sizing more typical months were analyzed for battery storage sizing. These graphs show a bell curve type daily demand profile, which is typical for schools. The electric demand appears to increase above the base load for a period of 8 to 12 hours in the schools that were reviewed. A quick peak type or "spiky" demand profile for a building is most favorable for a battery storage system because there would be less hours of peak demand reduction required, resulting in a smaller (kWh) battery storage system – this however is not the case for NYC schools (or typically for schools) so the battery storage system will need to be sized (kWh) to account for this long discharge period duration.

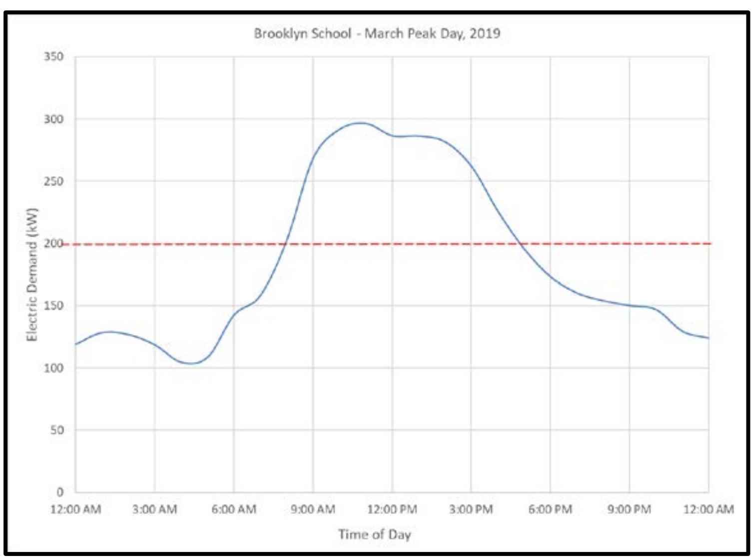


Figure 1: Brooklyn School March Demand

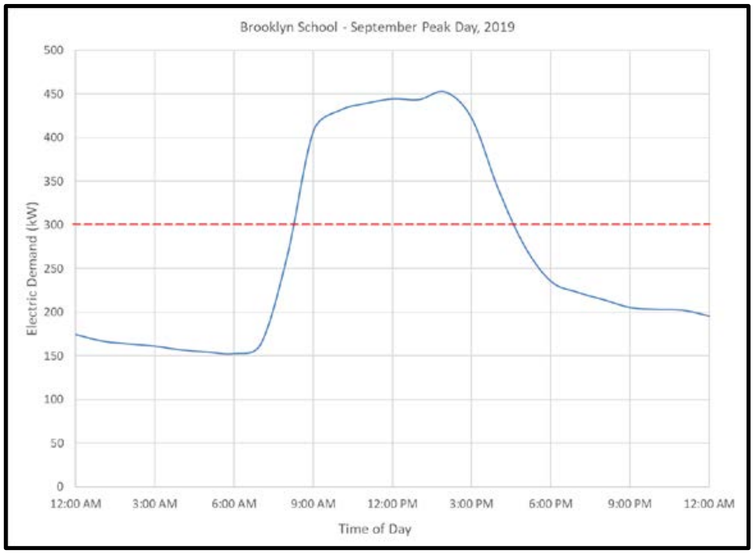


Figure 2: Brooklyn School September Demand

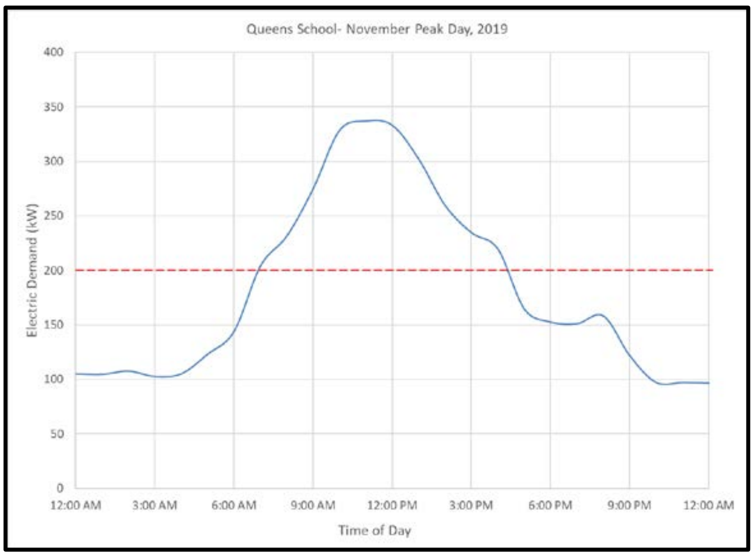


Figure 3: Queens School November Demand

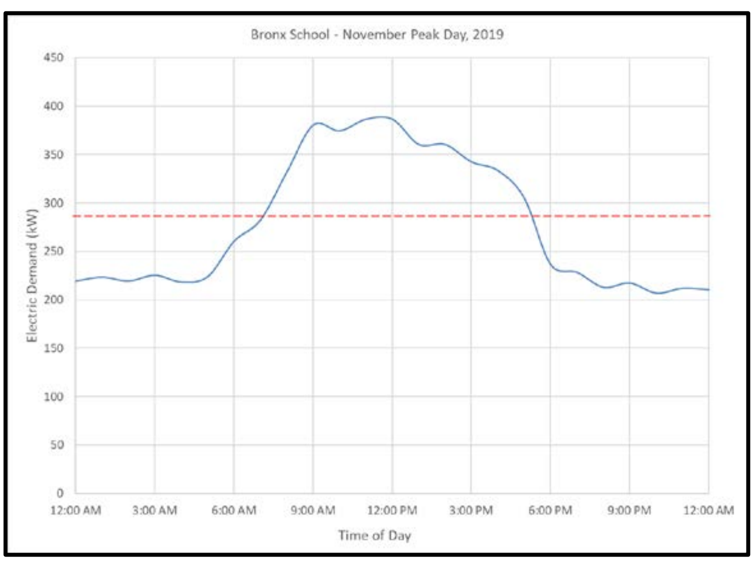


Figure 4: Bronx School November Demand

The electric demand for the NYC public school in Queens, which is an all-electric school, was also analyzed based on energy modeling hourly data. It was found that in the winter months, compared to the summer months, the demand peak is higher in the mornings likely due to the warm-up mode on the electrical heating systems. This creates a need for electricity for a longer period. This is shown in Figure 5 and 6 below.

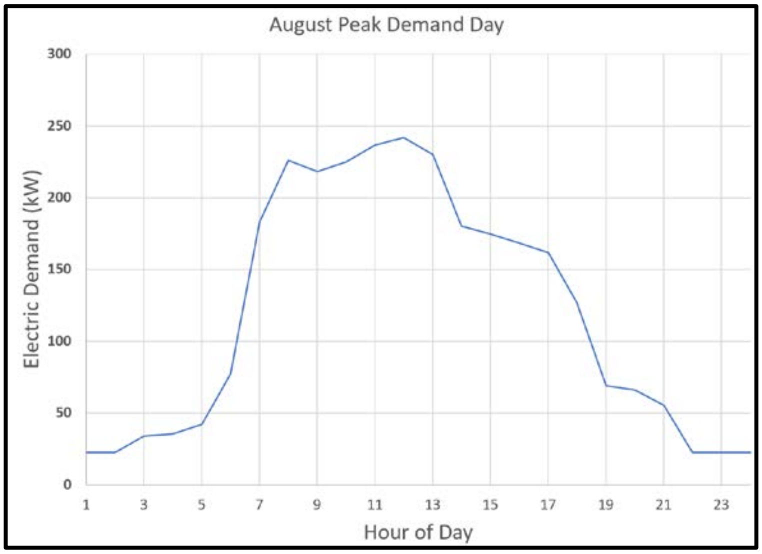


Figure 5: Staten Island School August Demand

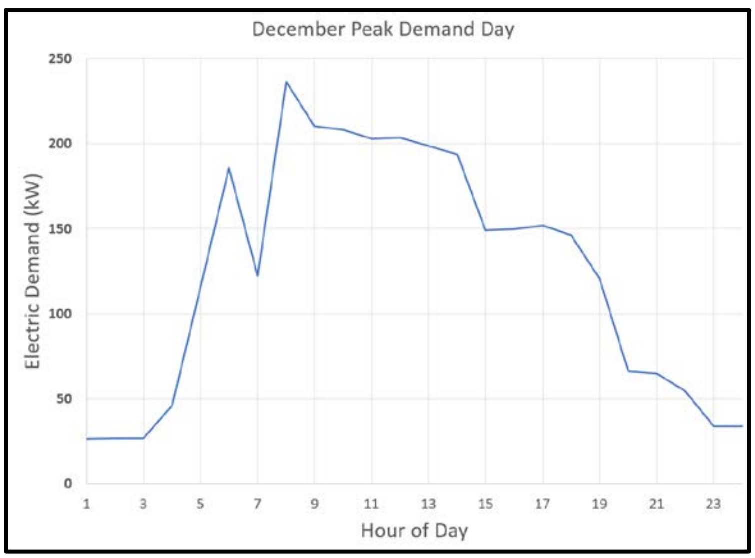


Figure 6: Staten Island School December Demand

In Figure 7 below, the actual electric demand by month is shown for an all-electric school. This curve is essentially flat throughout the year. This is primarily due to a large solar system which is sized to offset the total building's electrical consumption. Therefore, it is notable that the demand would also be reduced. The green line in the Figure represents the buildings electric demand if site solar was not provided (based on energy modeling results). The school was designed as a high efficiency, all electric (i.e. no fossil fuels) school and the peak demand is similar in shape to other fossil fuel plants. However, the peak is shifted to the winter.

Battery storage for peak demand reduction goals would not be as applicable in the case of the Staten Island school as the actual electric demand is somewhat level and therefore would have reduced overall benefits to the grid, carbon reduction and financial savings.

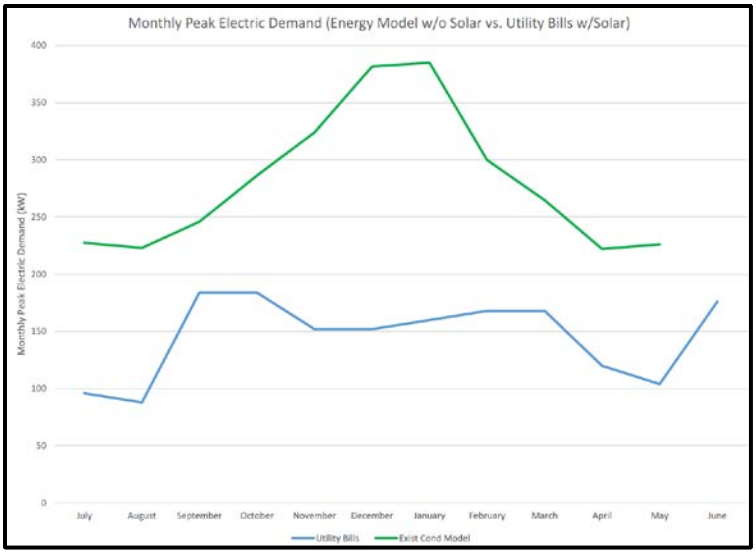


Figure 7: Staten Island Monthly Demand Profile

1.2 Battery System Sizing

From an analysis of the three (3) NYC public schools in Section 2.1 above and their respective demand profiles, a 100 to 150 kW system (peak reduction range) ranging from 600 to 900 kWh (peak reduction range for 6 to 9 hours – area under the curve in Figure 8) appears to be the most appropriate. The March demand profile for the Brooklyn School from Section 2.1 above is annotated in Figure 8 below, indicating the basis of the peak demand reduction battery system sizing, with charging of the battery system at night and discharging during the day.

Two other factors that affect the battery storage sizing are the “depth of discharge” and battery efficiency. Typically, battery storage systems cannot discharge below 10% of full charge. For the purposes of this study, this 10% safety factor was used in battery storage sizing to account for this “depth of discharge” efficiency.

The battery storage system will discharge as needed over time to support the loads for a maximum rate of 100 to 150 kW. The battery efficiency stays the same throughout its lifespan but there are fewer kWh available as the battery ages. If the system discharges every day, it will produce about 82% of the initial kWh at 10 years and about 75% at 15 years. This was taken into consideration with the battery storage system sizing review.

An SCA goal is to determine an appropriate battery storage system capacity that would be applicable to a range of schools. This typical sizing would help with implementation by standardizing the design, obtaining regulatory (FDNY, DOB) approval, and having an impact on the market, thus improving the economics. Based on the above analysis of NYC public school demand profiles and taking into consideration discharge and lifespan efficiencies, the battery storage system size selected and reviewed further in this study report is a 125 kW / 880 kWh system.

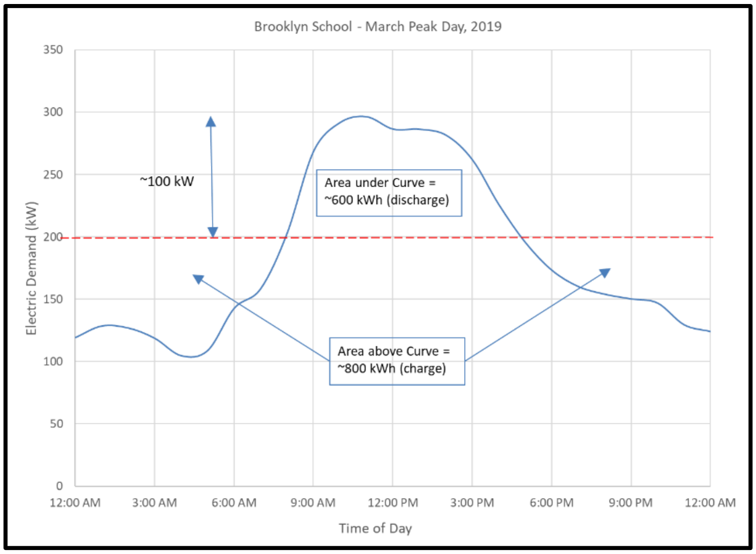


Figure 8: Brooklyn School March Electric Demand (Annotated)

3 Battery Storage System Initial Cost

One potential obstacle to installing battery storage systems is the significant initial costs associated with the procurement and installation. However, due to technological advancements and the ability to manufacture the materials for installation, the feasibility of a storage system continues to improve. The Energy Information Administration's (EIA) U.S Battery Storage Market Trends study from August 2021 shows that the cost of installation per kWh from 2015 to 2019 has decreased 72% and is expected to continue. This decrease in cost is primarily due to product advancements that increase the ability to store more energy within each system. The cost of individual components, as well as the battery storage system itself, are described below and are included in Table 1.

- Equipment / Site Installation – Includes site electrical tie-in of battery storage system including extended switchgear, electrical conduit and feeder material and labor, ancillary devices, excavation and backfill for underground conduits (feeders from battery system to distribution equipment, may be required depending on location of battery system vs. main building distribution system).
- Monitoring – Material and labor costs for the monitoring (possibly low voltage), cabling required for remote monitoring capabilities and what is assumed to be a yearly renewed cost. This is required for battery storage systems per rule 3-RCNY-608-1.
- Fire Alarm – Material/labor for new devices (assumed 3 total devices: pull station, smoke detector, and some horn/strobe combination to alarm) and fire alarm wiring back to FACP, and programming of devices. These devices are required for battery storage systems per rule 3-RCNY-608-1.
- Fire Protection/Suppression – Material/labor for a dry-pipe system to be located a certain distance from the battery storage system enclosure. This cost includes Fire Alarm tie-ins required for a typical dry-pipe system.
- Mechanical Ventilation – Fan and associated material/labor costs required, including electrical and control components. Fan is required for battery storage systems per rule 3-RCNY-608-1.
- Structural – Included below is an initial cost for material/labor for a concrete pad for the battery storage system (assuming a ground mounted system). The assumption is that a concrete pad and standard structural components are required (rebar, etc.) to keep equipment off the ground and protected from some of the elements. The structural cost for a roof mounted installation will be higher than ground mounted installation in order to account for dunnage, roof integration, etc. A comparison of ground versus roof mounted installation is provided in Section 6.

Table 1: Battery Storage System Components for Cost Estimate		
Battery Storage Component	**125 kW/880 kWh (nominal) System**	**Notes / Assumptions**
Battery Storage Equipment	[redacted]	Provided by CES [redacted]
Equipment Installation	[redacted]	35% of Battery Equipment Cost
Site Installation	[redacted]	
Monitoring	[redacted]	
Fire Alarm	[redacted]	
Fire Protection / Suppression	[redacted]	
Mech Ventilation		Included with Equipment
Structural (Concrete) Allowance*	[redacted]	
Subtotal	[redacted]	
OHP/Contingency/Design	[redacted]	20% Assumption
Total	[redacted]	
Total Installed Cost per kWh	[redacted]	
*Assumes ground mount. See Table 8 in report for detailed breakdown of estimated cost.		

4 Energy, Carbon, and Cost Assessment

4.1 Battery Storage Electricity and Cost Savings

To determine the energy savings and resulting energy cost savings associated with the installation of a battery storage system for peak demand reduction, utility rate costs are needed. Figure 9 below shows the demand cost for NYC schools at $32.30/kW (which includes both the "production" and "delivery" demand costs). It should be noted that there is no change in demand rate based on the time of day or the time of year. This rate was confirmed by reviewing a NYPA utility bill for an SCA all electric school.

Table 2 below shows the estimated annual electricity savings, based on the utility rates above and the system sizing and cost in Sections 2 and 3.

Table 2: Battery Storage System Electricity Savings – Base Case	
Cost Item	125 kW/880 kWh (nominal) System
Total Installed Cost per kWh	
Total Installed Cost	
NYPA Rate ($ per monthly peak KW)	$32.30
Demand Reduction (kW)	125
Annual Electricity Savings	$48,000 - $50,000

Table 3 below shows the potential additional electricity savings for demand curtailment. Demand curtailment refers to changes in electric usage by consumers in response to high-use periods to decrease demand on the grid. This strategy helps maintain electric grid reliability. For this analysis a demand curtailment rate of $18/kW/month was used. This value was based on a range provided by the DOE Office of sustainability ($6 to $30/kW depending on program, Tier 1 or 2 network and borough). NYC Schools currently enroll in two Con Ed programs (CSRP and DLRP) and one NYISO program (SCR) for the summer season.

Table 3: Battery Storage Electricity Savings with Demand Curtailment	
Cost Item	Cost
Annual Electricity Cost Savings from Demand Curtailment.	$26,000 - $28,000
Total Annual Electricity Savings with Demand Curtailment Included.	$74,000 - $78,000

4.2 Carbon Emissions Reduction

Table 4 below summarizes potential CO_2 emissions savings based on peak versus base load CO_2e emissions data. The information provided is from eGRID (Emissions and Generation Resource Integrated Database). This resource indicates a 335 lb/MWh reduction from peak to base load CO_2e. For this analysis, it was assumed that the battery storage system functioned as intended for 70% of the year. This metric considers that there are days and time periods that the system does not charge or discharge based on need, and anticipates some downtime from periodic maintenance, resulting in the 30% downtime in battery system operation that is assumed. As a result of this analysis, the battery storage system provides approximately 27 $MTCO_2e$ savings.

Table 4: CO_2 Emissions Savings	
Cost Item	Item
NYC Peak Load CO2e (lb.MWh per eGRID)	971
NYC Base Load CO2e (lb/MWh per eGRID)	636
NYC Reduction in Peak-Base Load CO_2e (lb/MWh)	335
Battery Storage System lbs CO_2 Savings (assume operates 70% of year).	59,500 – 61,000
Battery Storage System Metric Tons CO_2e Savings (assume operates 70% of year).	27-28
Battery Storage System Cost per metric tons CO_2e	

There is also an economic cost or damages associated with emitting one additional ton of carbon dioxide into the atmosphere. This is defined as the “social cost of carbon”. The social cost of carbon puts the effects of climate change into economic terms to help policy and decisionmakers understand the economic impacts of decisions that would either increase or decrease emissions. This metric is used by local, state, and federal governments to inform policy and investment decisions. Per NYC Local Law 6, the social cost of carbon in 2021 is $142 per metric ton of CO_2e.

Table 5: Social Cost of Carbon Savings

Cost Item	Cost
Social Cost per metric tons of CO_2e (LL6, 2021).	142
Annual Electricity Savings from Social Cost of Carbon	$3,800 - $4,000
Total Annual Electricity Cost Savings with Social Cost of Carbon included	$78,000 - $80,000

5 Battery Storage System Selection

Battery storage systems have experienced technological advancements in the last five to ten years, resulting in various options to choose from. The most common form of battery storage is a lithium-ion system. These systems combine ease of installation and integration with code compliance and provide a wide variety of options that can be specialized for different building's needs. OLA reached out to multiple battery storage system suppliers in the New York City area to determine which system to use for this study.

5.1 Battery Storage System Selection

For this study, a CES / ELM Battery Storage System was analyzed as a basis for the study's sizing, layout, energy savings, and cost. The specific unit studied was a MG250 Model sized at 125 kW and 880kWh. This battery storage system is equipped with an inverter, batteries, transformer, controller, monitoring and CTs, disconnects, HVAC and a grid disconnect relay. These components are all factory assembled and wired together in a climate-controlled enclosure with a fire suppression system. Furthermore, before being shipped to the field, the system is pre-engineered and pre-tested. The unit also has on/off grid capability and is equipped with smart controls.

The CES / ELM Battery Storage System has been approved by the FDNY for installation in New York City. Currently, the system is being installed in 2 projects: a hotel and a convention center.

Photo 1: CES / ELM Battery Storage System

5.2 Layout and Installation Requirements

The footprint of the CES / ELM Battery Storage System is 124" x 75" x 106". The mechanical equipment for the unit is mounted on the exterior of the enclosure. With clearances, the required overall footprint of the battery storage system is 20'-9" x 11'-9" or 245 square feet. A plan view of the battery storage system is shown in Figure 12 below. Furthermore, for ground mounted installations, per NYC Fire Department Rule 3 RCNY 608-01, seven (7) foot tall fencing must be installed five (5) feet away from the battery storage system enclosure.

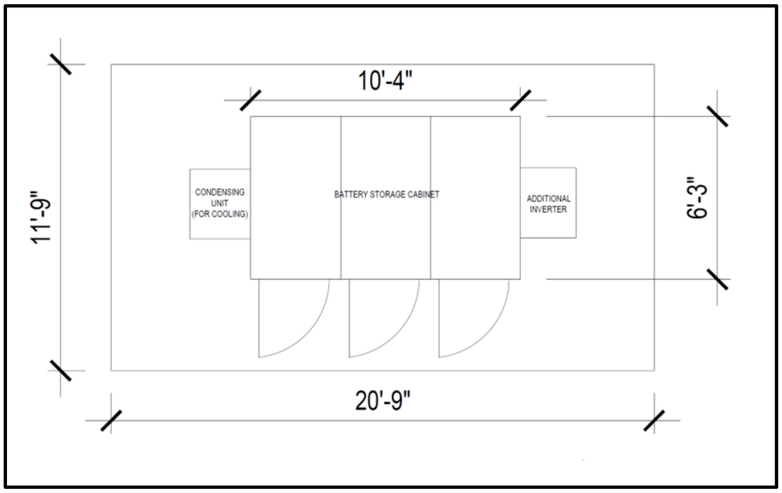


Figure 12: Battery Storage System Plan View

6 Rooftop vs Ground Installation

A rough scope and cost comparison has been provided in this section for rooftop versus ground mounted installation of a battery storage system.

6.1 Rooftop Installation Requirements

For a battery storage system to be allowed to be installed on a rooftop in NYC, it must meet all the clearance requirements listed in Rule 608-01 of NYC: Outdoor Stationary Storage Battery Systems. These include being a minimum of 10 feet from any windows or ventilation intakes, public utility or transportation infrastructure, and any overhead power lines or other aboveground electrical installation measured from the boundary of the utility easement.

If a battery storage system meets all the clearance criteria required in Rule 608-01, it would require:

- Rooftop access and a clear path in accordance with FC 912
- A minimum of two (2) standpipe hose outlets within a bulkhead at an approved distance
- Steel dunnage that is either of the following:
  - One (1) hour fire rated, for small/medium battery systems
  - Two (2) hour fire rated, for large battery systems (the battery system size in this study)

A structural analysis would have to be performed for the existing roof to determine the dunnage required based on weight and weight distribution, with existing rooftop structures or items taken into consideration. A 6 ft wide clear path for FDNY access would have to be coordinated. If there is no bulkhead, one must be included in the design. A rooftop installation would also require fire protection work if standpipe hose outlets do not exist at the roof level.

During construction, the battery storage system would need to be rigged/craned onto the roof. All steel required for the dunnage would also need to be rigged/craned as well, and welding would be needed to finish the steel dunnage. Should a bulkhead be required, that would be additional required steel work. There may be additional work on the roof required to remove/rearrange any existing obstructions to help clear the path required by FDNY. There may be extra safety training required for work on the roof, which may require more staff and therefore more cost. Also, the larger the system becomes, the more complicated/intricate the steel structure supporting it does as well, which may will likely increase associated costs. As a result, ground mount installation of larger battery storage systems becomes more cost effective.

6.2 Ground Installation Requirements

A battery storage system can also be mounted outdoors on a concrete pad. Provided that it meets all the clearance criteria put forth in Rule 608-01, it would require:

- To be within 250 ft of a fire hydrant
- To be safeguarded by a chain link fence or other approved barrier

A site analysis of the soil may be needed to see if the area is suitable for supporting a concrete pad. A structural analysis may be needed to choose a concrete mix based on weight and weight distribution of the battery storage system. If there is no existing fire hydrant within 250 feet of the proposed battery storage system, one would need to be designed/provided.

During construction, excavation would be required for space to pour the concrete, followed by the unloading of the battery storage system. The required barrier, either a chain link fence or other approved design, would need to be installed. The electrical feeders that tie in the battery storage system to the electrical infrastructure would need to be trenched.

6.3 Rooftop vs. Ground Cost Comparison (Order of Magnitude)

Considering the difference in requirements listed in the above sections, in terms of both construction and design scope, a rooftop (or steel) installation would likely increase costs due to the added complexity of the scope. Please note that for the cost analysis in Section 3, a ground installation was assumed.

7 Code Requirements and Incentives

7.1 NYC Code Requirements

There are numerous code and general requirements from both NYC DOB and from the FDNY that affect battery storage system installations. The NYC DOB requires a permit and application (References section 14.8) be submitted to install a battery storage system. This permit contains all requirements including construction, electrical, and plumbing. Furthermore, the FDNY outlines requirements in the NYC Fire Department Rule 3 RCNY 608-01: “Outdoor Stationary Storage Battery Systems”. These requirements differ based on the size of the system. FDNY defines small systems being below 20 kWh, medium systems between 20 and 250 kWh, and large systems being above 250 kWh. The battery storage system size in this study (880 kWh) is therefore considered a large category system.

Large systems require installation approval, a fire extinguishing and explosion mitigation system and a ventilation and gas purge system as compared to the medium and small systems, which do not have these requirements. The FDNY rule requires that all large storage battery systems be required to be installed outdoors and include a remote, 24/7 monitoring system, emergency shut down control (e-stop), an approved dry pipe water fire extinguishing system (installed an approved distance away from a battery storage system), an approved fire detection system, explosion mitigation, and a mechanical ventilation system for battery system enclosures.

All outdoor systems shall be a minimum of 10 feet away from the following exposures: lot lines, public streets, fire apparatus access roads, public walkways, and other public ways, vehicle parking, building entrances, operable windows, ventilation intakes, exit discharges, hazardous outdoor materials, combustible storage facilities, overhead power lines, above-ground electrical installations, and public utility or transportation infrastructure. If installed on a rooftop, the building roof covering, or roofing system shall be made of an approved noncombustible material. If installed on a concrete pad at ground level, the battery system shall be protected from vehicle impact and be securely locked, safeguarded by a chain link fence or other approved barrier.

There are numerous location requirements for battery storage system installations within New York City. One requirement is that any part of the battery storage system cannot obstruct rooftop access and clear path for buildings 100 feet or less in height. Another requirement is that the system must have an unobstructed path from the bulkhead access or rooftop door to battery system enclosure or to the access panel (if any). Also, the system cannot be less than 10 feet from the bulkhead entrance door. Lastly, the system must adhere to proper fire ratings for any structural support and the roofing system must be noncombustible for 5 feet from the installation.

The *New York State Standardized Interconnection Requirements and Application Process for New Distributed Generators and Energy Storage Systems 5 MV or Less Connected in Parallel with Utility Distribution Systems* outlines the process for permitting and interconnection for battery storage system requirements (References section 14.3).

7.2 Battery Storage System Incentives

There are various incentive opportunities that are available for battery storage system installation. Economic incentives such as NYSERDA's Retail Energy Storage Incentive in the link below provide additional pathways for funding of battery storage in commercial projects. However, the last funding opportunity was in June 2021 for $20 million at $100/kWh, which was closed within a day. These incentives are not applicable to SCA without third party ownership. This can be achieved by entering into a power purchase agreement (PPA) with a renewable energy provider. Essentially, SCA would buy the renewable energy from the producer and store it for use during high demand times. This approach is used because government entities such as SCA cannot use the investment tax credit (ITC) themselves.

https://www.nyserda.ny.gov/All-Programs/Energy-Storage/Developers-Contractors-and-Vendors/Retail-Incentive-Offer

Other potential incentive opportunities are the federal investment tax credit (ITC) status. Under the current law, this Federal ITC is applicable for energy storage only when integrated with ITC-eligible solar. However, an incentive program for stand-alone energy storage systems approval is in progress. This may include a direct pay option that would allow municipalities to participate. The program would be for approximately 30% of the battery system cost.

7.3 Future of Battery Storage Systems in NYC

In January 2022, New York State Governor Kathy Hochul expressed plans to double the state's energy storage deployment target from the previous 3 GW target (set in 2018) to at least 6 GW by 2030 which includes 1,500 MW of storage in NYC by 2025 and 3,000 MW by 2030. This coincides with New York's mandated goal of a zero-emission electricity sector by 2040. The doubling of energy storage is important because New York's 3 GW target already led the country for the last decade. To meet this goal, there will be a need for cost-effective procurement mechanisms and added incentives for customers to participate in installation of storage. Furthermore, during this announcement, Governor Hochul announced that the state would create a battery technology development and manufacturing center.

In 2019, New York City passed Local Law 97 which requires buildings over 25,000 square feet to lower their carbon emissions in 2024 and reaching a reduction of 40% in 2030 and 80% in 2050. Building owners who fail to comply with this standard will face penalties based on how much their building's emissions exceed the city's benchmarks. Battery storage systems will help with these carbon reduction goals.

8 Operation and Maintenance Procedures

Operation and Maintenance (O&M) procedures are essential to prolonging the useful life of the battery storage system and to maintaining the maximum efficiency. Furthermore, these procedures allow the operator to ensure that the proper safety techniques are being followed when interacting with any part of the system. Without proper procedures, there will be additional cost associated with replacement materials and safety risks while working on the system. The below sections outline both code-required and manufacturer-required O&M procedures. As part of these battery storage system projects at NYC schools, SCA and NYC DOE will need to consider a detailed maintenance plan to manage these battery storage systems post-installation, with qualified personnel provided to perform inspections and ongoing maintenance. This will need to be an important aspect to consider at the early stages of the project to ensure there is a plan in place for the O&M requirements over the life of these systems.

8.1 3-RCNY-608-01 Operation & Maintenance Requirements

Rule 608-01 of NYC lists the following operational and maintenance requirements which apply to all stationary storage battery systems.

- Remote monitoring of battery management system and reporting – Owner of said system shall arrange for data transmissions from the battery system's battery management system to be continuously monitored (on a 24/7 basis) by a remote monitoring facility staffed by trained and knowledgeable persons retained by the manufacturer or installer of battery system. The remote monitoring facility shall, without delay, make the following notifications in the event a battery system installed in New York City exceeds or appears likely to exceed thresholds at which fire, explosion, or other serious adverse consequences may result:
    - Notify FDNY by calling the Communications Office in the borough in which the battery system is installed.
    - Notify the certificate of fitness holder responsible for the battery system.
    - Notify the manufacturer of the battery system.
- Central station monitoring of fire protection systems – All fire protection systems protecting the battery system installation, including any fire extinguishing system, and fire and gas detection or other emergency alarm system required by this section, shall be monitored by an approved central station.
- Constantly attended on-site locations – Battery systems and fire protection systems may be monitored at a constantly attended on-site location, but such monitoring may not substitute for the remote monitoring facility and/or central station required above, unless such approval is in writing by the Technology Management Unit of the Bureau of Fire Prevention.
- Technical assistance – Upon request of FDNY, both the certificate of fitness holder and battery system manufacturer shall make available to FDNY a representative with technical knowledge of the battery system and its operation.
- Emergency management – Upon request of FDNY, the certificate of fitness holder and an authorized representative of the owner of the premises upon which battery system is installed shall respond to the location of battery installation, within two (2) hours, to assist FDNY in addressing a fire or other emergency involving or affecting battery system.

- Signage – The following signs (or equivalent markings) shall be durable posted for each stationary battery storage battery system, at the locations indicated:
    - Warning signs – On the exterior of medium and large battery systems/enclosure:
        - "Danger: High Voltage", or equivalent.
        - Hazard Identification Sign complying with NFPA Standard 704 (2007).
    - Identification, emergency contact, and emergency shut-down signs:
        - Permit – the permit for the installation
        - Equipment specifications – manufacturer's model number of system and electrical rating (voltage and current)
        - Installation identification – the number or other unique identifier used by the battery management system remote monitoring facility to identify the installation
        - Monitoring facility contact information – the telephone number of the battery management system remote monitoring facility
        - Certificate of fitness contact information – name and telephone number of the certificate of fitness holder responsible for the battery system
        - Emergency shutdown procedures – Emergency shutdown procedures for battery storage system shall be posted at battery system emergency shut down (e-stop) control and at any attended on-site location.
- Maintenance – Owner shall insure that stationary storage battery systems are periodically inspected, tested, serviced, and otherwise maintained in accordance with manufacturer's specifications and requirements of 3-RCNY-608-01.
    - Periodic inspection – The battery system shall be inspected by the certificate of fitness holder on not less than an annual basis to confirm compliance with applicable code, rule and permit requirements.
    - Restoration to service after serious failure – Any battery system that undergoes a serious failure, including one that results in a fire, release of flammable or toxic gas, and/or physical damage to system components, shall be removed from service forthwith. The battery system shall not be restored to service until it has been evaluated by a trained and qualified person, repaired, and tested, and re-commissioned by a person holding a certificate of fitness.
    - Combustible waste – Stationary storage battery system installations shall be kept free from the accumulation of combustible waste and combustible vegetation.
    - Storage of combustible materials - Combustible materials not required for battery system operation shall not be stored in battery system enclosures.
- Recordkeeping Requirements – A written record of the following information shall be maintained at the premises or other approved location by the certification of fitness holder, and, for medium and large battery systems, by the owner or operator of the battery system:
    - Battery system installation and commissioning
    - Battery system maintenance, including all inspections, servicing, and repair
    - Battery system decommissioning and removal
    - Installation and maintenance of battery system fire protection systems, including all inspection, testing, servicing, and repair
    - Fire or other incidents involving or affecting the battery system

8.2 Typical Manufacturer Operation & Maintenance Requirements

Below are operation and maintenance (O&M) recommended procedures for the CES/ELM battery storage system. These procedures range from monthly to 5-year maintenance requirements. Figure 13 below also shows a summary of the various O&M procedures and the frequency in which the maintenance is to be performed.

The monthly maintenance procedures consist of the following:

- Environmental inspection – Operator to check the average ambient temperatures and humidity inside the storage systems container. The average temperature should be 25 degrees +/- 5 degrees and the average relative humidity should be less than 80%.
- Battery Visual Inspection – Operator to check if the form or the color of the communication & power cable has changed. Operator must also check if the contact areas and battery exterior have rusted and if the battery room environment is well- managed.
- DC Protection Inspection – Operator to check the surge protection device indicator.

The maintenance procedures that should be completed every 6 months are the following:

- Operator to visually inspect the container for noticeable intrusion of dust, rodents, pests, and water. Dust should be removed from all surfaces.
- Ensure door latches are not loose.
- Operator to check fire suppression gauge to ensure the system is nominal. Operator should perform a visual inspection of the fire suppression system and confirm the gauges are still in the "green" zone.
- Container should be washed down if located in a corrosive environment.
- Operator to inspect and re-torque any loose connections inside of the container.
- HVAC air filters should be cleaned, and all heat exchanger coolant lines, fittings and seals should be inspected.

The maintenance procedures that should be completed yearly are the following:

- Battery Function – Operator should perform a discharge capacity measurement and state of health update. Verify 48V and 24V auxiliary voltage is within +/- 5%V. Operator should also perform an insulation resistance and fan operation check.

Lastly, a replacement of the storage inverter coolant, fan and pump should be replaced every five years. The UPS battery should also be replaced at the end of five years.

Frequency	Operation	Subsystem
Monthly	Environmental Inspection	Battery
	Visual Inspection	Battery
	DC Protection Inspection	Battery
6 Month	Internal/External Visual Inspection	All
	Dust Removal	All
	Inspect Fire Suppression Gauges	Fire Suppression
	Clean HVAC air filter	HVAC
	Loose Connections Check	All
	Semiannual Inspection and Cleaning	All
12 Month	Annual Inspection and Cleaning	All
	Battery Function	Battery
60 Month	UPS Replacement	APC UPS

Figure 13: O&M Summary Table

9 Battery Storage Sizing for Various NYC Schools

SCA requested that electric demand profiles be reviewed for additional schools, including new construction schools, larger schools, all electric schools, and annex style schools. Five additional SCA schools that have recently completed construction or are still in the design phase were reviewed. OLA has been involved in each of the school's energy model or design review and the energy model data from these studies was used to develop the electric demand graphs below. Two schools (a new Queens School and a new Brooklyn School) were chosen because they are recent new construction schools as compared to the existing Staten Island School and Brooklyn School mentioned in section 1 of this report, while another school (referred to as Large HS New Construction School) is much larger than those two schools. Another school (Electrification School) was chosen due to its recent completed electrification study and the last was chosen because it is an Annex style school. The method used in sizing each system is similar to the one described in Section 2. To reduce the risk of oversizing the storage system, the lowest demand month was used for each profile shown below. Inefficiencies due to depth of discharge limits and battery lifespan efficiencies were also accounted for. In all schools outside of the Electrification school, the summer months had the highest peak electric demand based on energy model simulations.

9.1 Large HS New Construction School

The first school analyzed was a new construction. This school is larger than both the Staten Island school and the Brooklyn school as it was designed as a 6 story, 308,000 ft^2 building located in Queens, NY. Based on the data shown in Figure 14 below, it appears that a larger battery storage system would be required for this new construction school compared with the Staten Island school. For this school, a more appropriate sizing would be 150 kW and 1,200 kWh.

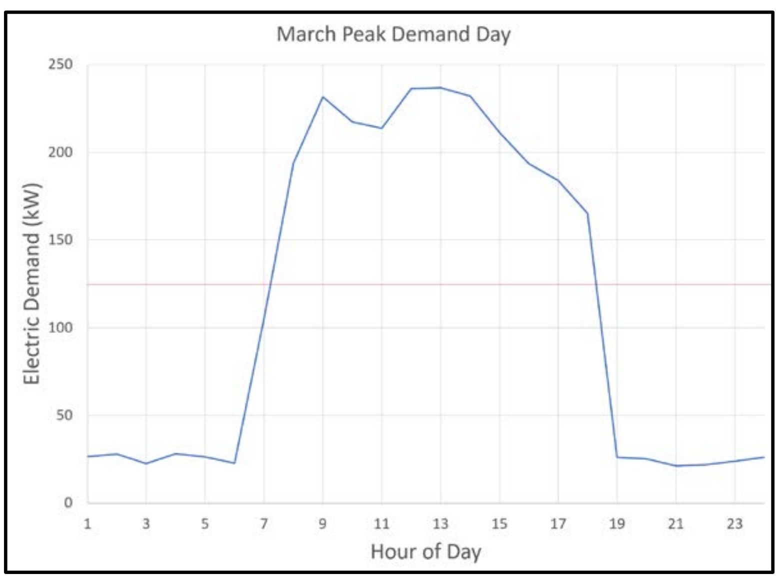


Figure 14: New Construction School March Demand

9.2 New Brooklyn School

Another new school that was analyzed was a new school located in Brooklyn NY. This school is a four (4) story, 91,000 ft^2 school with an air-cooled chiller, gas fired condensing boiler and VAV air handling units. The demand profile for the new Brooklyn school is shown in Figure 15 below. This school battery storage system sizing appears to be approximately 120 kW and 800 kWh.

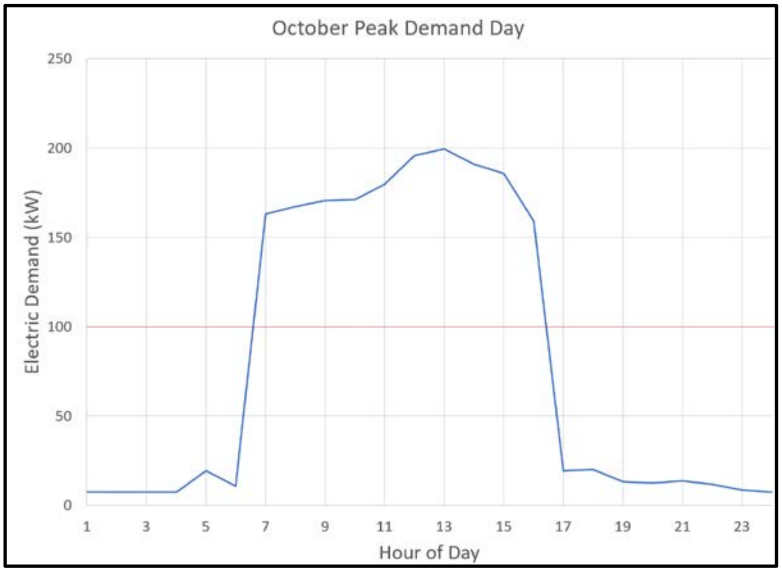


Figure 15: New Brooklyn School October Demand

9.3 New Queens School

This new school is 87,000 square foot and five (5) stories, including a cellar and mechanical penthouses. This school is served by an air-cooled chiller, gas-fired condensing boiler and VAV air handling units. The demand profile for the new Queens school is shown in Figure 16 below. This school battery storage system sizing appears to be approximately 100 kW and 750 kWh.

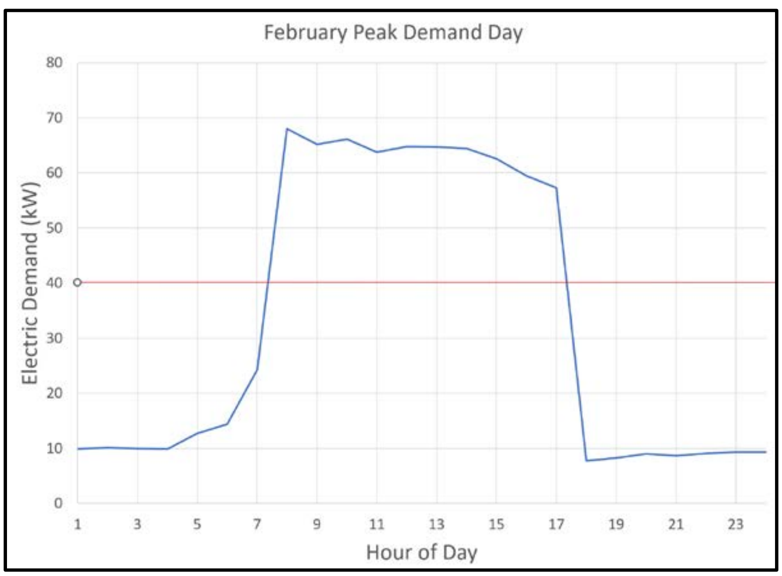


Figure 16: New Queens School February Demand

9.4 Electrification School

Another school that was analyzed as part of this study was a new middle school in Queens, NY. This school was later used for a prototype Electrification School Study. The actual school is approximately 120,000 square feet. Similar to the new Brooklyn school and the new Queens school, this school was originally designed a gas fired boiler and air-cooled chiller. Per the demand profile below in Figure 17, the Electrification school should be sized for a 125 kW and 925 kWh battery storage system.

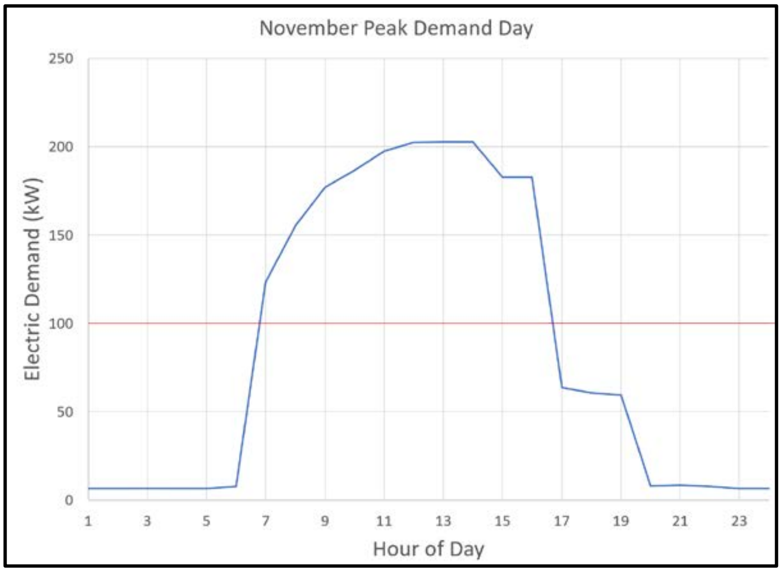


Figure 17: Electrification school November Demand

As stated above, this school was used as a prototype for an electrification study to assess replacing the gas fired boiler with heat pump units that utilize electricity instead of natural gas. Per the demand profile in Figure 18, the winter months tend to have the highest electrical demand as compared to the schools with fossil fuel heating. Furthermore, the graphs show a high demand at the start of the school day. This is likely due to the need for system warm-up when the school becomes occupied. This all-electric school battery storage system sizing appears to be approximately 270 kW and 1,600 kWh.

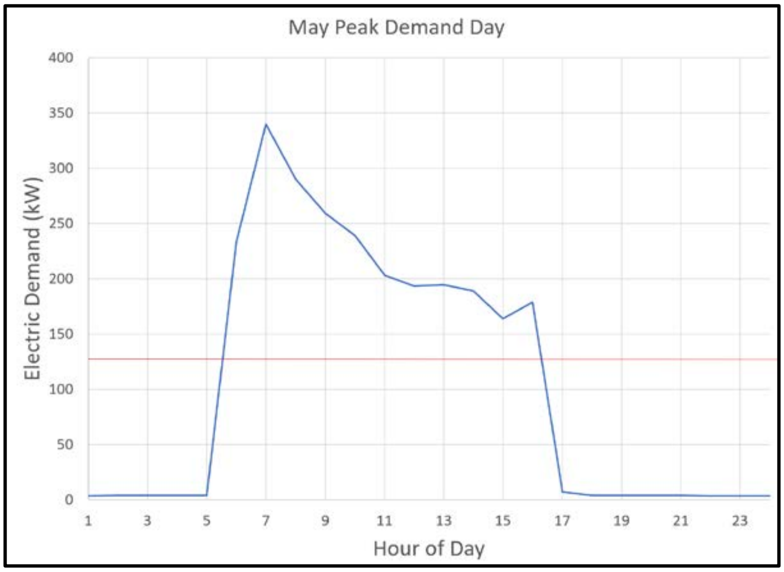


Figure 18: Electrification School May Demand

9.5 Annex Style School

The last school that was analyzed as part of this study was the Annex Style School. This school is in Queens NY and is a three (3) story, 42,359 ft^2 annex style school. As shown in the demand profiles in Figure 19 this school battery storage system sizing appears to be approximately 35 kW and 200 kWh.

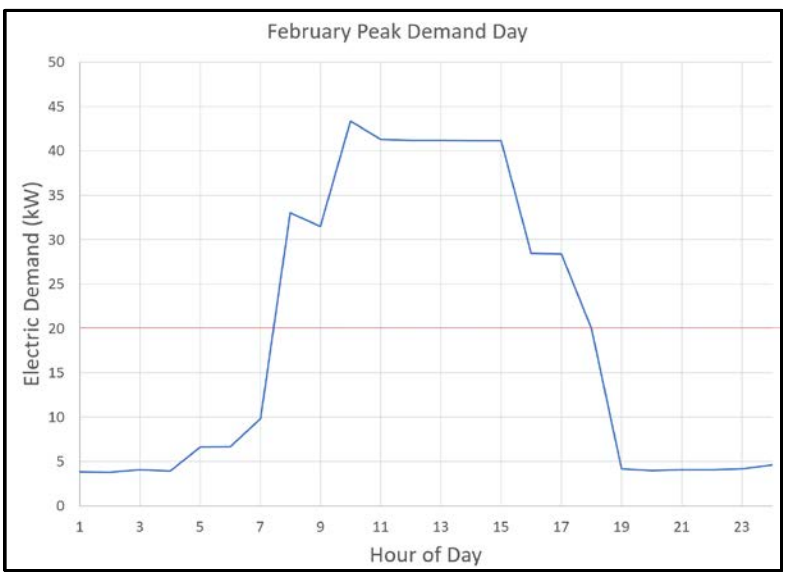


Figure 19: Annex Style School February Demand

10 DCAS, FDNY & DOE Case Study Programs

In April of 2020, a roundtable discussion on city project implementation of battery storage systems was held. At this time research and development and implementation by city agencies had already occurred and served as guidance for piloting future battery storage systems at SCA project.

DCAS first began energy storage implementation through the IDEA (Innovative Demonstrations for Energy Adaptability) program, allowing the city to work with manufacturers to install and commission systems, to demonstrate the technology and carefully vet through its effectiveness and sustainability for City portfolio projects. DCAS continues to assess these projects.

FDNY has also evaluated lead acid battery storage systems for firehouse projects, creating case studies that can also be used as reference for future SCA projects.

In January 2022, SCA and OLA had a call with the NYC DOE (Department of Education) Office of Sustainability in which they presented on their recent/current battery storage system project designs as part of NYC Solar Schools Program. Each of these projects also had a solar PV system component to it. Below is a summary of the proposed battery storage systems for these projects:

- School A – Ground installation by playground
- School B – Ground installation in parking lot
- School C – Ground installation in parking lot
- School D –Ground installation
- School E – Ground installation
- School F – Ground installation in parking lot

Following this call, an initial design report was provided for one of their schools, School C, which is summarized below.

10.1 School C DOE Report Summary

A design study report for a proposed solar Photovoltaic (PV) system with battery back-up paired together to provide a resilient system was completed. The battery storage section of this previous design study is of interest in this report.

School C is a three (3) story, L shaped building with multiple roof sections and is approximately 133,000 gross square feet, located in Brooklyn, NY. The PV system proposed in the study consists of 349 high efficiency panels totaling 151.8 kW in size and producing 203 MWh of electricity annually. The installation of the PV system alone was estimated to save $32,000 annually.

The battery storage systems analyzed in the study included two different sizes. The first option was a Full Load (250kW) system whereby the system provides eight hours of backup power for all building systems except the second and third floor plug loads. The second option was a Reduced Load (125 kW) system where the system provides eight hours of backup for the building plant and assorted systems, building ventilation and lighting for the basement and first floor. If this second option was chosen, it would result in needing to rework the electrical circuitry and create a potential need for supplemental HVAC. Both options are lithium-Ion battery energy storage systems that have built in heating and cooling systems. Other options were considered within the study (Nickel Cadmium and Zinc-Manganese Dioxide batteries). However, due to the physical constraints and capacity requirements, Lithium-Ion batteries were chosen. The proposed location for the battery storage system was the existing concrete padding located adjacent to the building entrance, which would need to be extended for the Full Load option.

The study considered the battery storage system operation also for both load shifting and demand response to maximize the value of this energy storage system and achieve additional savings above that of the PV system. Load shifting is the condition where, based on the on-site load profile and price of the electricity during the day, the energy storage may be operated to lower the energy cost by shifting the load to low-price period of the day. In other words, the storage systems would charge energy from PV systems or the grid during off-peak hours and discharge the stored energy during peak hours to support the building load. Conversely, demand response refers to when the system would be operated in a way to offer demand response service when it is required by Con Edison.

The consultant concluded that the services described above would yield an additional $18,000 per year in savings by participating in Con Edison's "21 Hour Notification Program (CSRP)" demand response option. Specific cost and energy savings associated with the battery storage system were not defined within the study report.

11 NYC Battery Storage Projects

With New York City's desire to increase the amount of renewable energy and energy storage, there have been various projects of different sizes and applications that have been completed throughout the last few years. Below are a few projects that describe the different applications in which battery storage has been used.

11.1 NYC 100-MW Battery Storage Facility

In mid-2021, the New York State Public Service Commission granted the construction and operation of a battery-based energy storage facility, located in Astoria, Queens. This facility is expected to cost $132 million to build, have a capacity of up to 100 MW and be fully operational by the end of 2022. The goal of this facility is to utilize the offshore wind power projects that are ongoing in NY and displace fossil fuel generation when the demand for power is at its highest. This 100 MW capacity can power more than 1,600 average sized homes for several hours or power the World Trade Center for an entire day. Once complete, this facility will be the largest energy storage facility New York City has created.

11.2 Marcus Garvey Village

Marcus Garvey Village is a 625-unit apartment complex in Brownsville, Brooklyn. In 2017 they installed a 300 KW battery storage system to accompany their 400 kW of solar energy and 400 kW fuel cell system. The intent of this system was to reduce the electrical demand costs and provide backup power for critical loads within the complex if an outage was to occur. The costs of installation of the solar and the storage system were $1.3 million with incentives through federal investment tax credit allocations, grant funding from NY Energy Efficiency Corporation and shared savings through a third-party ownership contract. This project received the 2017 building Brooklyn award and was nominated for the 2017 energy storage north American innovation award. Estimated savings from this installation were not included in the study.

11.3 Gateway Center

In 2019, real estate development firm Related Companies launched the largest battery storage system in New York City for its time. This system was a 4.8 MW storage center located in Related's Gateway Center in Brooklyn, NY. This center was able to use its available space to install both PV panels and a battery storage system. Its intent is to support Con Edison's electrical grid during periods of high peak demand periods, rather than provide solar energy for its facility. This provided Related Companies with financial incentives while relieving strain on the Con Edison grid.

12 Battery Storage System for Generator Back-up

OLA had been requested in March 2020 to provide services to study the potential for battery storage coupled with Photovoltaic (PV) power as an alternative to the emergency fuel oil generator installed in the building. This study was completed using the Staten Island school in March 2020. This school is an existing 70,000 square foot 2-story building constructed in 2015 that includes classrooms, gymnasium, cafeteria, kitchen, offices, lounges, restrooms, storage rooms, and mechanical/electrical rooms. There are approximately 2,100 PV panels installed on the school's main roof and parking structure roof, totaling a peak generation capacity of 678 kW. Below is a summary of the findings from this study.

12.1 Existing Conditions

The current existing emergency generator system at the Staten Island school is 250 kW in size and is located on the lower roof of the building in an outdoor enclosure. This generator serves emergency power loads in the building, including emergency lighting, exit signs, elevators, fire alarm system, electric fire pump, ITC/telecom room equipment and emergency circuits throughout the building.

Photo 1. Generator Enclosure at Lower Roof

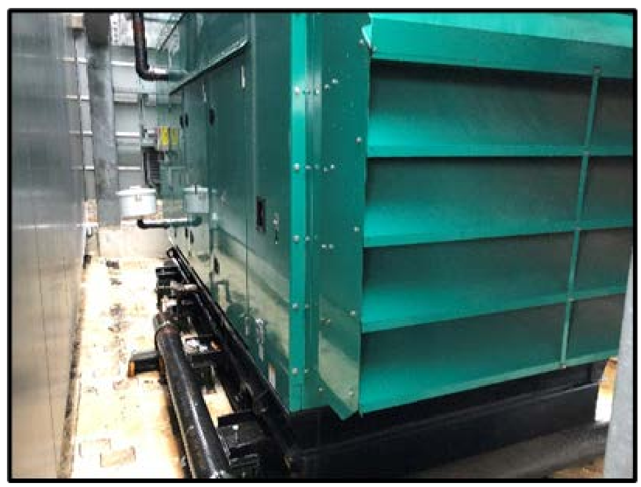


Photo 2. Inside Existing Generator Enclosure

The NYC Electrical Code section 700.12 (A) states that storage batteries used as a source of power for emergency systems shall be of suitable rating and capacity to supply and maintain the total load for a minimum period of 1.5 hours, without the voltage applied to the load falling below 87.5% of normal. Currently, storage batteries for emergency use are allowed by the NEC. It was determined during this study that the DOB interprets the NYC amendments to the NEC code section to require special permission be granted to use storage batteries for emergency uses other than lighting. As battery storage systems are a relatively new technology, our expectation is that the code language will be more receptive in the future to allow these systems to be used and reach greater acceptance.

One potential obstacle or consideration for accomplishing this goal involves emergency generator systems serving fire pumps, such as the system at the school. For non-high-rise buildings such as the Staten Island school, Section 695.3 of the NYC Electrical Code only requires the electrical fire pump to be connected to a reliable power supply, usually taken as a tap ahead of the main service disconnect switch. For a high-rise building, defined in NYC as having an occupiable floor more than 75 ft above fire department access, an electrical fire pump would classify as a standby, legally required system, and thus would require a second, independent source of power. The battery storage system at the school if allowed by DOB, would have to be approved by the FDNY before implementation per NFPA 1.

For the purposes of this study in March 2020, the Tesla Powerpack system was used. This system was sized two different ways. The first was to use the existing generator enclosure. This results in utilizing a 250 kW / 500 kWh battery storage system, which provides a 2-hour running operation that meets electrical code requirements. The Tesla Powerpack system for this option consists of 3 powerpack battery cabinets and 1 inverter, forming a system with a maximum rating of 334.5kW/669kWh. The second was to size the system based on fuel consumption for six (6) hours of running capacity. This results in needing a 250 kW / 1500 kWh system. This system contains a 7 powerpack battery cabinets and 1 inverter, forming a system with a maximum rating of 406kW/1624kWh.

For this school, the battery storage system would replace the diesel generator, but the emergency electrical infrastructure would remain the same; the system would start as soon as a loss of power of the electrical service is detected. The trickle charge could be from either the PV panel system or the electrical service; there is no significant difference in cost to run the charging cable from one or the other.

12.2 Battery Storage Cost Impact for Generator replacement

Table 9 below displays the costs associated with a feasible battery storage system for replacing the school's 250 kW generator with a 250kW/500kWh battery storage system (2-hour rating) or a 250kW/1500kWh battery storage system (6-hour rating). The installed cost of the generator is provided as well in this table for comparison. It should be noted that the following estimates do not include any portion of the emergency electrical system; that cost is considered the same between the two systems. The following estimates for the battery storage systems also include provisions that need to be added to the battery storage system to account for NYC Fire Department regulations (see Section 3.06).

Table 9: Battery Storage System Cost for Generator Back-up

Battery Storage System	Units Required	Estimated battery storage system installed cost*	Estimated Emergency Generator system installed cost**
Tesla Powerpack 250kW/500kWh	1		
Tesla Powerpack 250kW/1500kWh	1		

*Estimated costs to install battery storage system equipment and provisions, including rough order of magnitude cost of FDNY required items listed in Section 3.06, an allowance for potential structural support required, contractor OHP, design costs, and contingency.

** Estimated costs to install new 250kW emergency generator system, which includes 250kW generator, fuel oil tanks, fuel oil pumps, and necessary appurtenances such as wiring, piping, and steel work required to support generator. We are awaiting confirmation from SCA on actual contractor installed cost of 250 kW generator system at the school.

12.3 Battery Storage Energy Impact for Generator replacement

The energy that would be saved each year by replacing the existing stand-by diesel generator with a battery storage system would be from offsetting the weekly run of the generator (and any power outage generator needs, which is not included), which is minimal. If a battery storage system was able to replace the existing generator, the generator would no longer need to be run weekly for 30 minutes for preventative maintenance and testing. The generator consumes 17.8 gallons per hour, which totals 462.8 gallons of diesel fuel per year if the generator is run for 30 minutes per week. At an assumed diesel fuel cost of about $3.15 per gallon, replacing the existing generator would save about $4,600 per year.

13 References

13.1 CUNY Permitting and Interconnection Guide

CUNY has developed a permitting and interconnection guide useful for NYC lithium-ion outdoor systems.
https://nysolarmap.com/media/2101/li-ion-permitting-guide-2020-updated_11320.pdf

13.2 ELM O&M Manual

The Operation and Maintenance (O&M) manual for the ELM Microgrid Battery Storage System in this study has been provided in the appendix.

13.3 New York City Fire Department Rule 3 RCNY 608-01

NYC Fire Department Rule 3 RCNY 608-01: "Outdoor Stationary Storage Battery Systems" (referenced in this study report) states all FDNY requirement for installation of a battery storage system within New York City.
3-rcny-608-01.pdf (nyc.gov)

13.4 NYC 100-MW Battery Storage Facility

Case study for a $132 million dollar project to construct a 100 MW battery storage facility in Astoria Queens.
NYC 100-MW Battery Storage Facility

13.5 Marcus Garvey Village

Case study for the first battery storage system located at a New York City affordable housing complex.
Marcus Garvey Apartments - Clean Energy Group (cleanegroup.org)

13.6 Gateway Center

Case study for a 4.8 MW battery storage system launched in 2019 by The Related Companies at the Gateway Center in Brooklyn, NY.
Enel X Installs NYC's Largest Battery Storage System | Enel X

13.7 FDNY Approval Documents and Guides

FDNY application document (link below), site plan approval guide (included in appendix), FDNY rules and regulations (link below), and standardized interconnection requirements for application process (link below), referenced in the report. This has been provided in the appendix.
https://www1.nyc.gov/assets/fdny/downloads/pdf/business/tm-1-application-for-plan-examination-doc-review.pdf
https://www1.nyc.gov/assets/fdny/downloads/pdf/business/cof-b28-w28-study-material.pdf
May 2022 SIR - FInal - DMM.pdf (ny.gov)

Appendix 13.2:

ELM O&M Manual

MicroGrid Energy Storage System

MGC125

BESS Operation and Maintenance Manual

(KORE POWER M1)

December 10, 2021, Rev. 4

2701 E. State Highway 121, Ste 701
Lewisville, TX 75056

support@elm-fieldsight.com
www.elmmicrogrid.com

Table of Contents

General Information

Limited Warranty Information

ELM FieldSight, LLC warrants, subject to the exclusions contained herein, that the Product shall be free of defects in material and workmanship for the warranty period of twenty-four (24) months from the date the Product is delivered to the Buyer. This warranty excludes any issues and defects caused by abuse, neglect, or improper maintenance of the system, or equipment, as specified in all owner's and operation manuals or any other written information from Seller.

Accessories or other parts, including internal parts, of the Product furnished by Seller, but manufactured by others, shall carry whatever warranty, if any, the manufacturers thereof have given to Seller and which can be passed on to Purchaser. Purchaser agrees to look solely to Seller's products and other such manufacturers or suppliers of such accessories or parts for any warranty, repair or product liability claims arising out of the performance, condition or use of such accessories or parts. Seller agrees to cooperate in furnishing assignments of its rights thereto to Purchaser from such manufacturers and suppliers. Seller shall not be liable for any repairs, replacements or adjustment to the Product, or any costs of labor performed by Purchaser without Seller's prior written approval. The effects of corrosion, erosion and normal wear and tear are specifically excluded from Seller's warranty.

Purchaser shall, within warranty period, notify Seller in writing of any defect(s) and fully cooperate with Seller in pursuing the remedy thereof. The sole remedy for breach of the foregoing warranty shall be repair and or replacement of any defective product, as determined by ELM FieldSight, LLC, based on its evaluation and reasonable discretion. In no event shall ELM FieldSight, LLC be liable for special, indirect or consequential damages including but not limited to lost profits, non-compliance penalties, down time related costs or damages to the premises. In no event shall the aggregate liabilities of ELM FieldSight, LLC arising out of these transactions exceed the price for the goods in respect to which such claim is made. Except as stated herein, Seller makes no performance warranty of any kind respecting the Product.

Safety Information

- This manual contains important instructions that must be followed during installation and maintenance. The product is designed and tested in accordance with international safety requirements, however as with all electrical and electronic equipment, certain precautions must be observed when installing and/or operating this product.
- To reduce the risk of personal injury and to ensure the safe installation and operation of this product, carefully read and follow all instructions, caution statements, and warnings in this manual.
- The equipment described in this manual is powered by potentially lethal electrical voltages. It is vitally important to follow all safety precautions described in this manual. Failure to follow these precautions can result in injury or possibly death. The following paragraphs describe the safety information contained in the manual.

Symbols Used in This Manual

	WARNING The WARNING icon indicates a potentially hazardous situation which, if not avoided, can result in death or serious injury, and/or substantial property damage.
	CAUTION The CAUTION icon indicates a potentially hazardous situation which, if not avoided, can result in minor or moderate injury and/or property damage.

Battery Disposal

Lithium-Ion batteries are not to be discarded or disposed in common landfills or trash disposal facilities. Federal law states that certain batteries must be recycled, and lithium-ion batteries fits these criteria. The "Battery Act" (The Mercury-Containing and Rechargeable Battery Management Act of 1996) was set out to ensure that batteries such as Li-ion batteries in equipment can be recycled for reuse, instead of being released into the environment. For more information on local battery recycling centers see www.batterycouncil.org for information on state and local laws for recycling Lithium-Ion batteries.

General Safety Precautions

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO REDUCE THE RISK OF ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT SPECIFIED IN THE INSTALLATION AND OPERATING INSTRUCTIONS UNLESS QUALIFIED TO DO SO.

All electrical installations must be done in accordance with local and National Electric Code (NEC) ANSI/NFPA 70 or the Canadian Electrical Code CSA C22.1.

All installations must conform to the laws, regulations, codes, and standards applicable in the jurisdiction of installation. Connections should only be made in accordance with the approved connection drawings and must comply with all applicable local codes and standards. Make certain all ground connections, and connections are completed and tightened before energizing the unit.

Personal Protective Equipment (PPE) is required when working on the ESS. Service personnel must wear safety glasses and gloves with a minimum voltage rating of 1500 VDC, Class 0 per ASTM D120 and IEC EN60903 standards.

Shutting off power to the ESS does not de-energize the battery modules. Therefore, a shock hazard will still be present even with external power disconnected. Batteries are not serviceable. Only ELM approved personnel can remove, replace, or dispose of batteries.

Before Any Maintenance Actions!

WARNING

The equipment described in this manual is powered by potentially lethal electrical voltages. It is vitally important to follow all safety precautions described in this manual. Failure to follow these precautions can result in injury or possibly death.

- Disconnect all power before working inside the enclosure.
- Follow all lockout/tag out procedures before any maintenance is performed on the system.
- Use appropriate PPE in accordance with the requirements of NFPA 70.
- Follow the installation and mounting instructions listed in this O&M Manual and any other documentation provided by ELM FieldSight.
- Do not lift or move the unit without proper equipment and properly trained personnel. Lifting provisions are provided on the bottom of the enclosure only. Always use lifting provisions provided by the manufacturer. DO NOT LIFT THE UNIT BY THE ENCLOSURE. Rolling and skidding are NOT recommended.
- Do not off-load the system until it has been fully inspected for any damage that may have occurred during shipment. If any damage is identified, the unit should not be installed until ELM FieldSight, LLC has been contacted and consulted on the damage.
- Connections should only be made in accordance with the approved connection drawings and must comply with all applicable local codes and standards.
- Make certain all connections are completed and tightened before energizing the unit.
- Before operating the MicroGrid system, refer to all subsystem operating manuals for their safety instructions.

Battery Module Precautions

WARNING

Before installing or maintaining battery modules, review and comply with the following requirements. Failure to comply can result in equipment damage, serious injury, or exposure to potentially lethal voltages.

- When working on and installing battery modules the installer must follow standard safety precautions associated with battery installation and operation.
- Follow NFPA 70E Table 130.7 for Personal Protective Equipment requirements when working on batteries. Use appropriate PPE and only use insulated tools when working with battery modules.

- Based on NFPA 70E Table 130.7 (C) (15)(b) Arc-Flash PPE Categories for Direct Current (DC) Systems; It is recommended that the authorized personnel installing and interconnecting the battery modules should wear Category 2 Arc-Flash PPE while installing battery modules. See table 130.7 (C)(15)(c) Personal Protective Equipment (PPE)
- Remove all jewelry and any clothing item which could provide a short circuit source while installing and wiring battery modules.
- Follow proper installation protocols as listed in the manual for connecting and disconnecting battery modules.
- Installation and maintenance of the battery system must be performed by authorized personnel.

Fire Suppression Considerations

Fire suppression systems for energy storage systems are based upon a fire risk assessment as provided by the authority having jurisdiction (AHJ) where the energy storage system will be installed. ELM can provide factory-installed fire suppression systems based on the fire risk assessment by the local AHJ. Please contact ELM for more information on fire suppression.

The level and type of fire detection and suppression required for an energy storage system is dependent upon the size, technology, and location of installation as well as the local building and fire codes or utility requirements. The fire detection and suppression system shall be built into the energy storage system's enclosure as determined from the fire risk analysis as required by the local AHJ.

To determine the level and type of fire detection and fire suppression systems required a fire risk assessment analysis with consideration to the applicable building and fire code requirements for the installation site, and other appropriate design and installation standards, shall be conducted for energy storage system installations to ensure that suitable fire prevention and fire protection requirements for protecting persons and property are met. Guidance on fire risk analysis can be found in the Guide for the Evaluation of Fire Risk Assessments, NFPA 551, and the Guide to the Fire Safety Concepts Tree, NFPA 550.

Energy storage system installations required to be provided with fire suppression shall be provided with a means for fire detection and suppression in accordance with the siting of the system (i.e. indoors, etc.), the energy storage technology and the applicable installation, building and fire safety codes. If not provided as part of the energy storage system, guidance based on scientific data shall be provided for choosing, installing, operating and maintaining suitable fire detection and suppression systems in the installation, operation and maintenance instructions for the energy storage system.

Introduction

Model Identification

There following models are covered by this manual:

Part Number	Max Output (kVA)	AC Breaker Rating	Phase	Voltage	Racks
MGC125-5-480-250-KPM110-4	125	250A	3 **Φ**	480VAC/600VAC	4
MGC125-5-480-250-KPM110-3	125	250A	3 **Φ**	480VAC/600VAC	3
MGC125-5-480-250-KPM110-2	125	250A	3 **Φ**	480VAC/600VAC	2
MGC125-5-480-250-KPM110-1	125	250A	3 **Φ**	480VAC/600VAC	1

System Specifications

MGC125-5-xxx-xxx-xxxxxxx-x

Item	Specification
Cabinet Dimensions	60” x 37” x 104”
Storage Inverter	Dynapower MPS125
Inverter Output Voltage	480 VAC/600VAC
System Weight	5,510 lbs. @ 2 rack capacity

Design Specifications

ELM FieldSight's Energy Storage Solution (ESS) uses top of the line equipment in combination with sophisticated backend architecture and communication interfaces that allow for a customizable, turnkey energy system. The system is designed and ready for operation after the final onsite lines are landed in the enclosure and the system has been commissioned by the ELM team.

Pre-Installation Requirements

Location Considerations

Item	Description
Proximity	Proximity to the structure and convenient proximity to the AC power disconnect will be major factors in locating the system.
Clearance	It is recommended that the system be located a minimum of 5 feet from any doors or windows. Ensure that there is sufficient clearance for any maintenance required. Do not locate the system where bushes, trees, or other vegetation may grow up and obstruct access. Do not locate the system under any decks or other structures. Ensure there is adequate overhead clearance from any structure, overhang, or projections from the wall. Ensure the concrete pad will not interfere with any easements or any underground services such as phone, water, sewage, fuel, or irrigation.
Drainage and Flooding	Do not locate the system where excessive water may accumulate or in locations subject to flooding. Ensure that gutter downspouts, roof runoff, landscape irrigation, water sprinklers, or sump pump discharge will not cause water to accumulate near the system.
Security	It is recommended that the system be located such that it will not be easily accessible to unauthorized individuals.

Concrete Pad Preparation

The ELM ESS must be installed on a foundation or base strong enough to support the weight of the equipment listed in the "System Specifications" section.

1. Provisions must be made for electrical conduit to connect the system to the AC disconnect panel.
2. The foundation and anchoring design must be performed by a civil or structural engineer registered in the state where the system is being installed in accordance with local building codes. Consult the site geotechnical report for the geotechnical design requirements.
3. The concrete pad for the system shall have a minimum strength of 4,000 psi and minimum slab thickness of 8". The reinforcement for the concrete pad shall be in accordance with all local building codes and regulations.
4. The top of the pad shall be a minimum of 6 inches above expected flood elevations.
5. The pad or base shall slope a minimum of 1% and a maximum of 2% to allow positive drainage from the pad/ base or towards a drain.
6. Concrete finishing is required to produce smooth, even surfaces of uniform texture and appearance, free from bulges, depressions, and other imperfections that would impact equipment anchorage or foundation/base drainage.

Mechanical Assembly MGC125–5

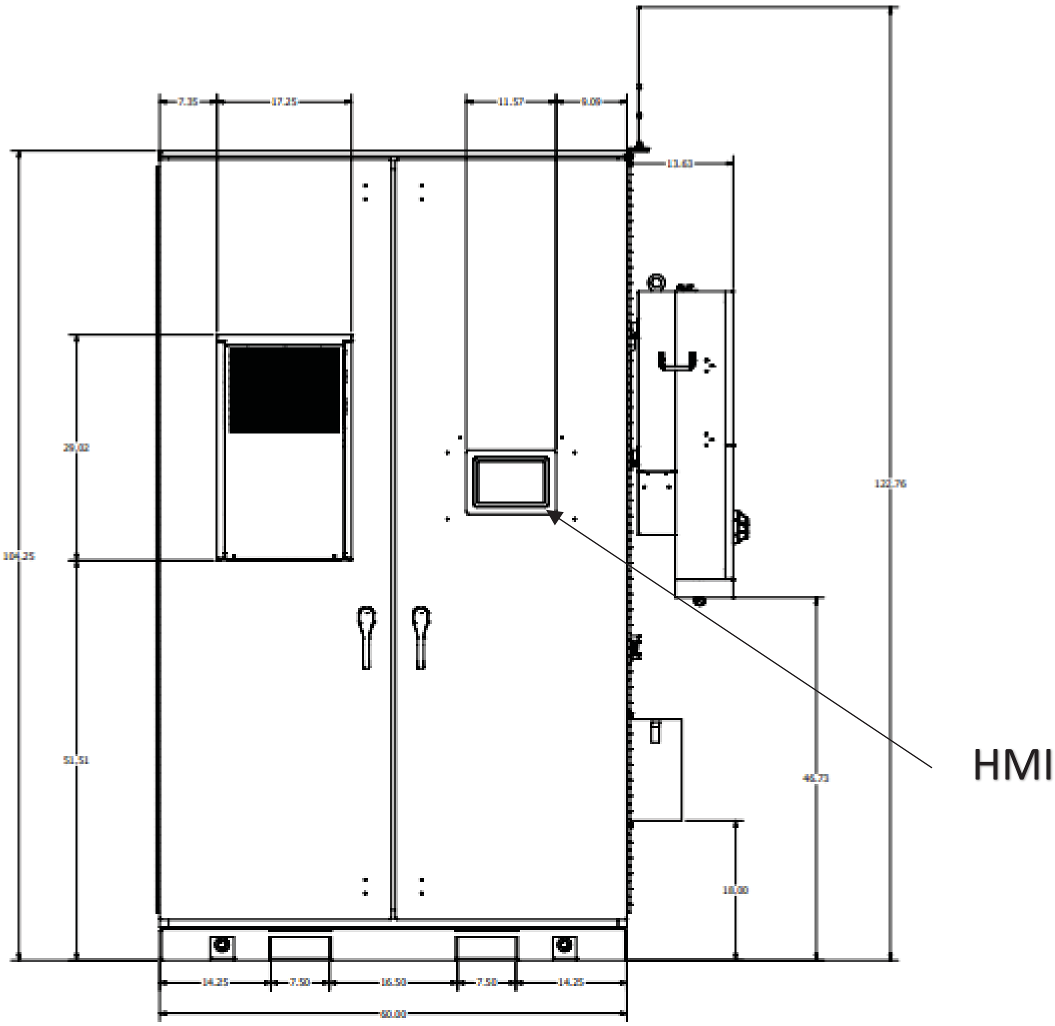


Figure 1. Battery Container HMI

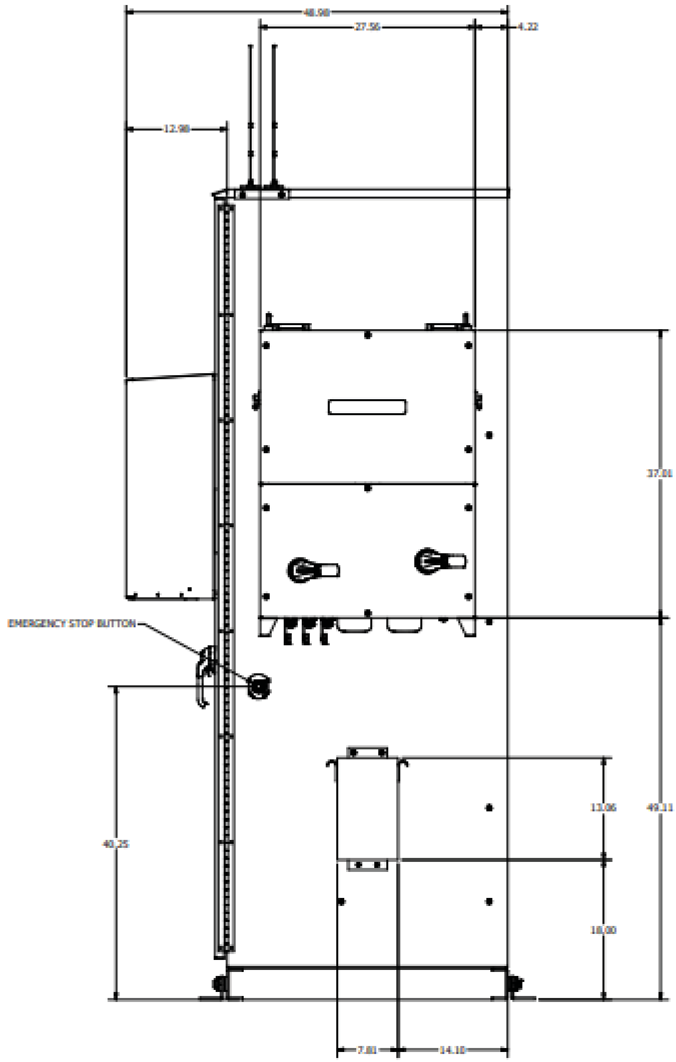


Figure 2. Battery Container E-Stop

Mechanical Properties – MGC125–5

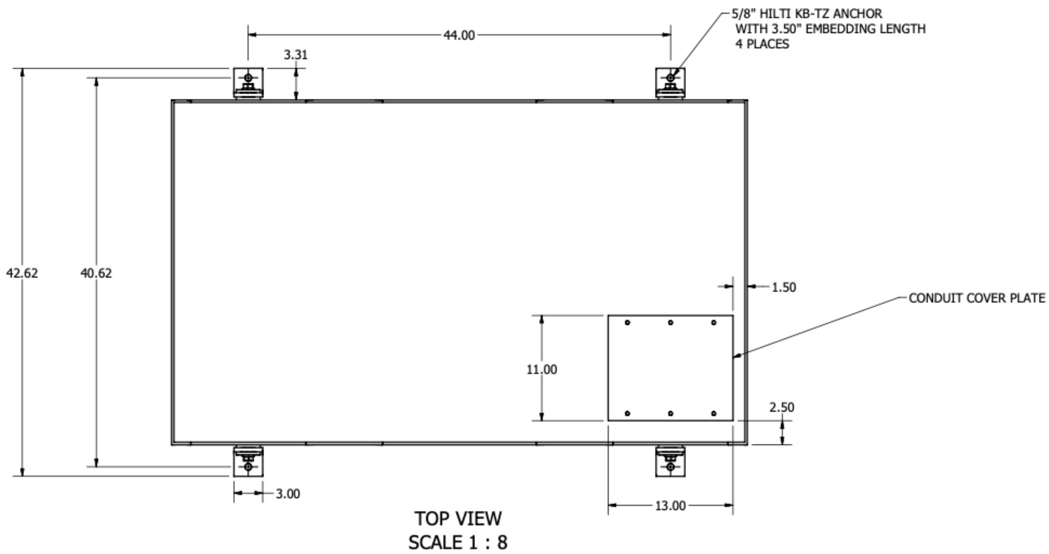


Figure 3. Battery Container Dimensions - Top View

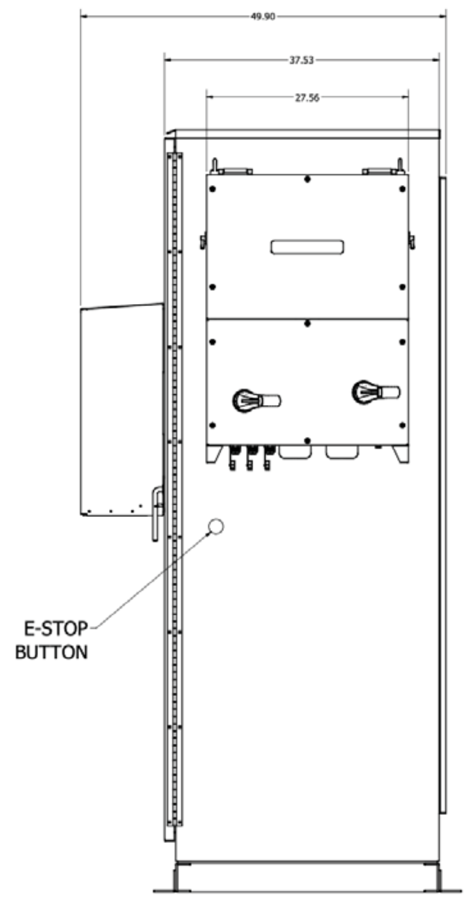


Figure 4. Battery Container Dimensions - Side View

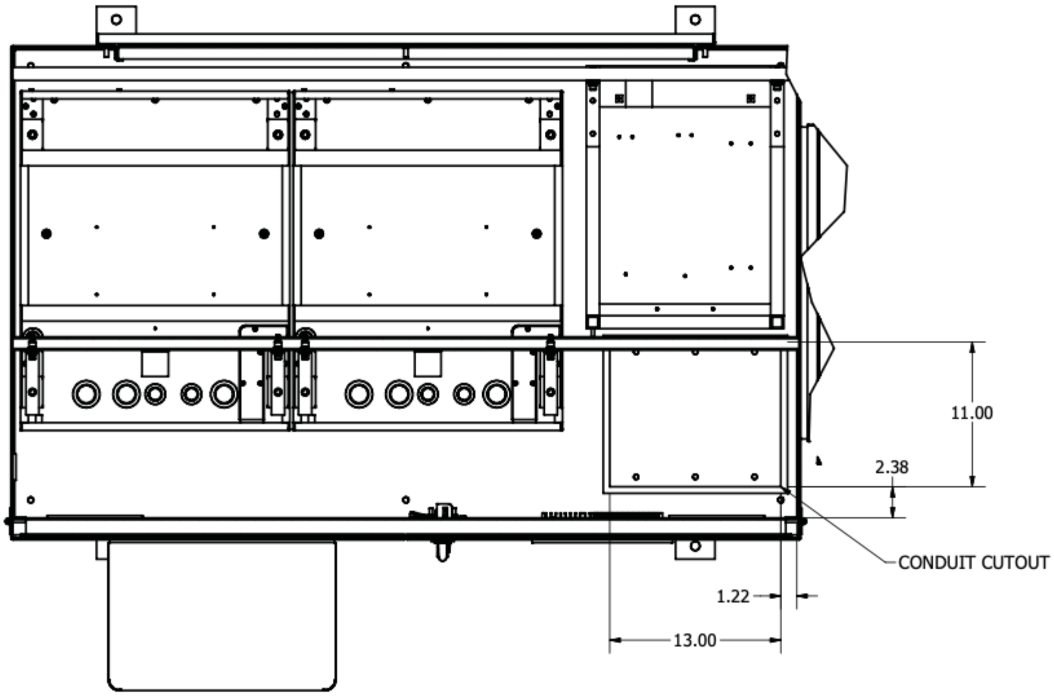


Figure 5. Battery Container Conduit Cutout

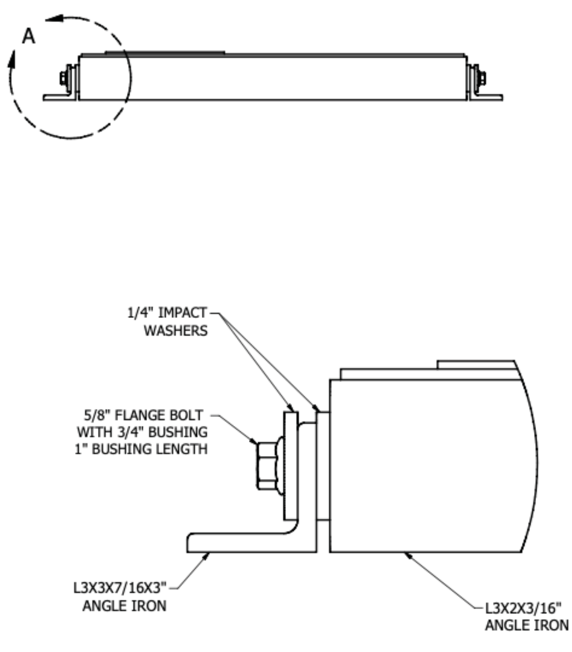


Figure 6. Battery Container Seismic Tiedown Detail

Electronic Components Properties

Power Meter

WattNode series power meters are used to measure voltage and current data collected from current transformers. These meters are flexible, secure, electric meters capable of measuring up to 3 circuits on up to 3-phases (120V – 480V). Important device specifications are listed below. The meter configuration may be found in the Communication Diagram.

Voltage:	(3 channels) 120Vrms (Line to neutral) 240Vrms (Line to Line)
Current:	3 channels, up to 6000A
Power:	Any voltage/current combination
Frequency:	50 or 60 Hz
Operating Temp:	-30 °C to 55 °C

Gateway Computer/HMI

Data collected from the ELM FieldSight Controller is relayed through an industrial gateway computer. Important device specifications for this gateway are listed below.

Operating Temp:	0 °C to 50 °C
Nominal Power Input:	24V AC/DC (9-36V), 4.0 Amps

Network Switch

A 16-port unmanaged network switch is used to facilitate communication between the Site Controller and all other components in the MicroGrid.

Power Requirement:	12-48 VDC
Frequency:	50 or 60 Hz
Operating Temp:	-10 °C to 65 °C
Humidity:	5~95% RH

Modbus Relay

An ADAM-6060 Relay Modbus TCP Module is used for control monitoring between the Site Controller and system components. Important device specifications for this device are listed below.

Power Requirement:	10~30 VDC
Operating Temp:	-20 °C ~ 70 °C
Humidity:	20~95% RH

$48V_{DC}$ Power Supply

One (1) MeanWell UHP-200-48 AC/DC converter is used to supply 48V power to the HVAC system. Important device specifications for this device are listed below.

Input Voltage:	115/230 VAC
Output Current:	21 A
Output Wattage:	1000 W
Output Voltage:	48 VDC
Operating Temp:	-20 °C to 60 °C
Humidity:	20~90% non-condensing

$24V_{DC}$ Power Supply

Two (2) MeanWell RSP-1500-24 AC/DC converters are used to supply 24V power to the Dynapower inverter and battery management system (BMS). Important device specifications for this device are listed below.

Input Voltage:	115/230 VAC
Output Current:	63 A
Output Wattage:	1500 W
Output Voltage:	24 VDC
Operating Temp:	-25 °C to 60 °C
Humidity:	20~90% non-condensing

UPS (Uninterruptible Power Supply)

One (1) APC by Schneider Electric SMT1500C Smart-UPS is mounted in the control cabinet to provide backup power to the controller, inverters, combiners, and BMS should there be a power outage. Important device specifications for this device are listed below.

Input Voltage:	120VAC
Operating Temp:	0 °C to 40 °C
Output Capacity:	1KWatts / 1.5 kVA
Output Voltage:	120VAC
Expected Battery Life:	3-5 years

System Mounting & Installation

Make sure to place container onto properly sized concrete pad with conduit locations in the appropriate cutout window. Attach seismic hold-downs based on local codes.

Pre-Installation

Before Installing batteries or external conductors to the system make sure the following circuit breakers and disconnects are in the Off/Open position:

- Make sure E-Stop button is Engaged (See Figure 2)
- B1 Dedicated ESS AC Circuit Breaker (located in Combiner Enclosure)
- B2 Dedicated Grid AC Circuit Breaker (located in Combiner Enclosure)
- B3 Dedicated Load AC Circuit Breaker (located in Combiner Enclosure)
- B4 Dedicated PV AC Circuit Breaker (located in Combiner Enclosure)

Battery Installation:

- Inspect battery modules to make sure nothing was damaged during transportation.
    - If any damage is noticed, notify ELM FieldSight before installation.
- Install battery modules and cables per Kore’s Installation Manual M1 modules.
    - Adhere to all safety precautions outlined in Kore’s Installation Manual.

External Conductor Installation

- Install external conductors from the site on the provided Circuit Breaker or power distribution blocks per the supplied electrical three-line drawing in the Appendix. Site specific three-line drawings are provided separately.
- The Circuit Breaker or Power Distribution Blocks are labeled indicating where to Land L1, L2, L3 and Grounding connections.

Fire Suppression Activation

Complete the following steps to enable the fire suppression system:

a. Make sure pressure indicator on the gauge located above the transformer (not on the fire suppression bottle) is in the green area.

NOTE: If the indicator is NOT on the green area, contact ELM before proceeding with the next steps.

b. Remove yellow safety pin that locks the valve in the Off position.

c. Change the valve position from OFF to ON.

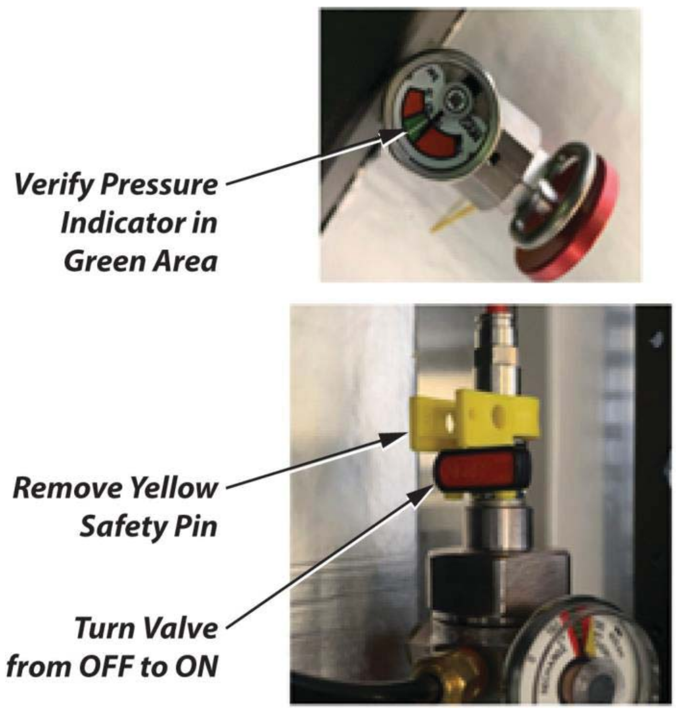


Figure 7. Arming Fire Suppression System

External Communication Wiring

Site Controller is designed to communicate via MODBUS TCP/RTU, CANBUS, and DNP3 as required by individual components. All communication wiring and protocols between components can be found in the Communication Diagram located in the Appendix. Install external communication wiring per Communication Diagram located in Appendix onto the ELM FieldSight Microgrid Controller.

Commissioning

Once all batteries have been installed, all external conductors landed, and all communication wiring landed you may contact ELM FieldSight for Commissioning Test Plan Procedure. Review Dyanpower MPS125 Storage Inverter Manual for information on enabling the inverter. Close breakers and switchgear one by one while measuring voltages. Only proceed if the voltage readings are correct for each stage. Work through the system in the following order, using the provided Three Line Diagram and Mechanical Assembly callouts for reference:

1. (B1) Circuit Breaker (located in Combiner Enclosure)
2. (B2) Circuit Breaker (located in Combiner Enclosure)
3. (B3) Load Center Main and AC Circuit Breakers (located in Combiner Enclosure)
4. (B4) PV AC Circuit Breaker (located in Combiner Enclosure)
5. Turn on UPS
6. 48V and 24V Shelf Power Circuit Breakers
7. Turn On ELM Site Controller (located on rear side of the hinge panel inside the container)

Completing Installation

After all connections have been made and system is ready to be powered on. Contact ELM FieldSight for Commissioning Test Plan Procedure.

User Interface

Main

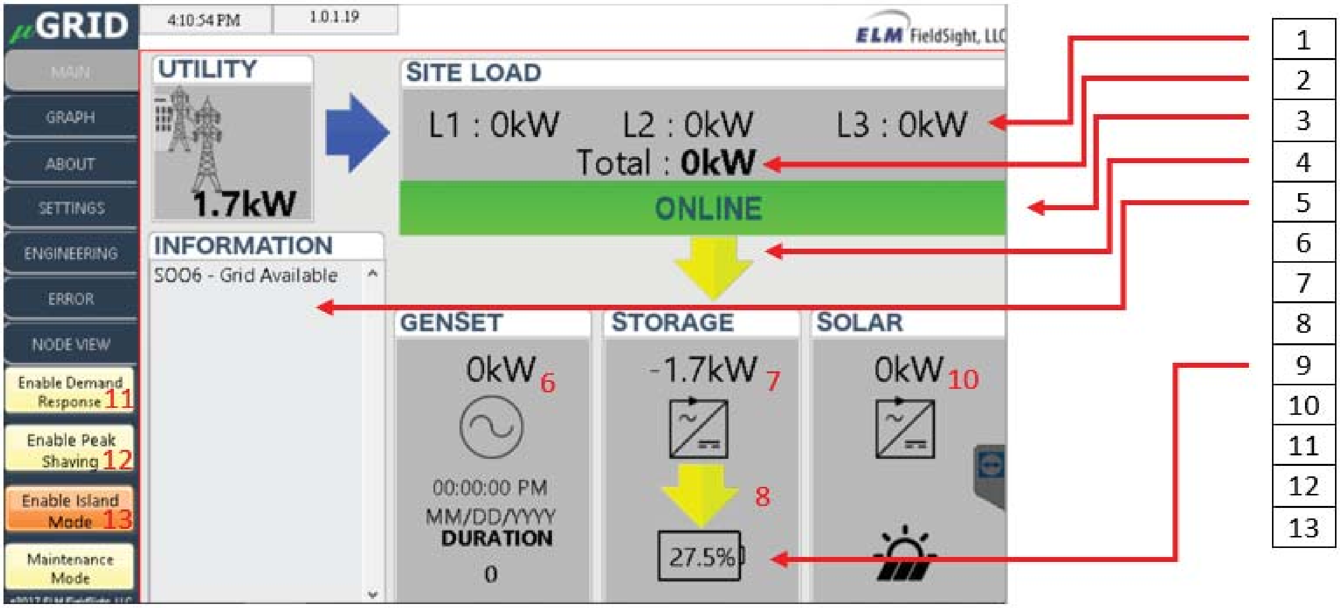


Figure 8. Program GUI Overview

1. This displays power of each phase (L1, L2 and L3) that the site is consuming.
2. This displays the total load of the site (i.e., current power consumption).
3. A green status bar indicates that system is online and operating properly. If there is no load this will turn red and say “OFFLINE”.
4. Arrows will appear showing the direction of power to/from each component of the MicroGrid.
5. Any operational information, alerts, errors, or faults will be displayed here.
6. This displays power (kilowatts) coming from the generator. It also shows the time stamp for the last time the generator ran and for how long it ran.
7. This displays total power (kilowatts) to/from the storage inverter.
8. This displays the flow between the battery system and the inverter. A yellow arrow indicates power is being charged to the batteries; a green arrow indicates the batteries are being discharged.
9. This displays the current state of charge of the battery system (percent of total).
10. This displays power (kilowatts) coming from the solar panels to the solar inverters.
11. Demand Response button: If button is green, the function is enabled. If button is yellow, the function is disabled (for on-grid mode only)
12. Peak Shaving button: If button is green, the function is enabled. If button is yellow, the function is disabled (for on-grid mode only)
13. Island Mode button: If button is green, the function is enabled. If button is orange, the function is disabled (not available in all systems)

Maintenance Mode Button

When this button is pressed, the system will be put into Maintenance Mode. This will put the storage inverter in idle mode and open the PV inverter's contactors (if connected). It also opens the contactors for the battery system and commands the genset to turn OFF (if connected). It is recommended that all disconnects are opened immediately and prior to any maintenance. This system CANNOT shut off incoming power from the utility. Proceed with extreme caution as equipment may remain energized. To come out of Maintenance Mode, close all disconnects, push the Maintenance Mode button again, and respond to HMI on-screen prompt.

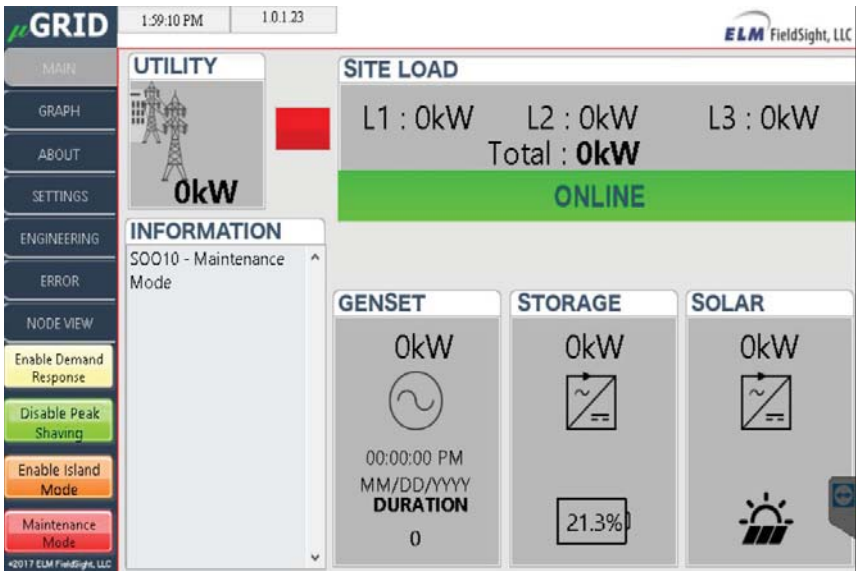


Figure 9. Program Maintenance Mode

Emergency Stop

When the external emergency stop button is enabled or the fire suppression system is activated in the container, the system will be put into Emergency Stop mode. The storage inverter will be put into E-Stop mode which will disable its outputs. The battery system will open its contactors. The controller will command the generator to turn off (if connected). The PV inverters will open its contactors (if connected). To come out of E-Stop mode, release the external system E-Stop button and push the Emergency Stop button on the HMI screen. Respond to on-screen prompts as needed.

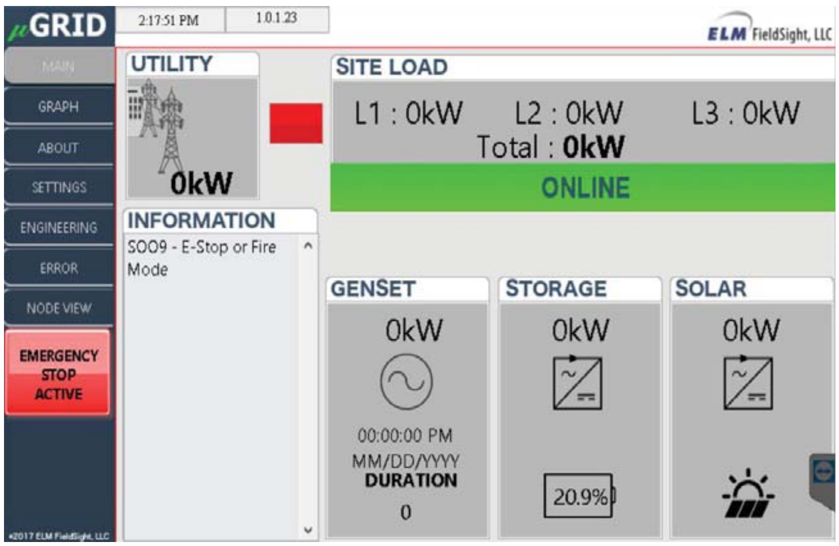


Figure 10. Program Emergency Stop

Graphs

The graphs page compares current power production of the microgrid against the current load of the system. The red bar displays load; the green bar displays grid power; and the blue line displays battery SOC. This graph displays data for the past 30 minutes.

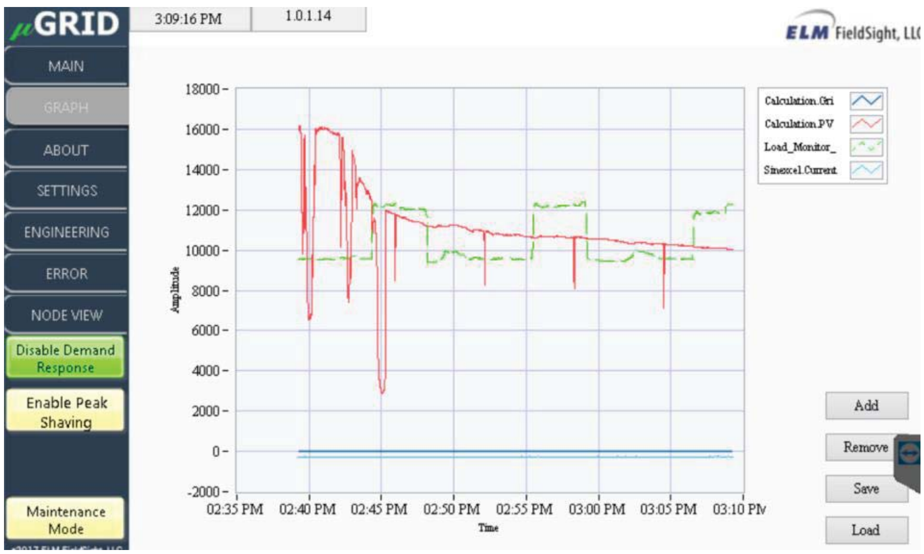


Figure 11. Program Graph Tab

About Screen

This page displays information on the components of the MicroGrid system including make and model of each component and contact information for service/warranty questions. It can be used to access the Engineering Screen for a detailed look at how all the components are currently functioning. It can also be used to download the last 30 days' worth of data and fault history.

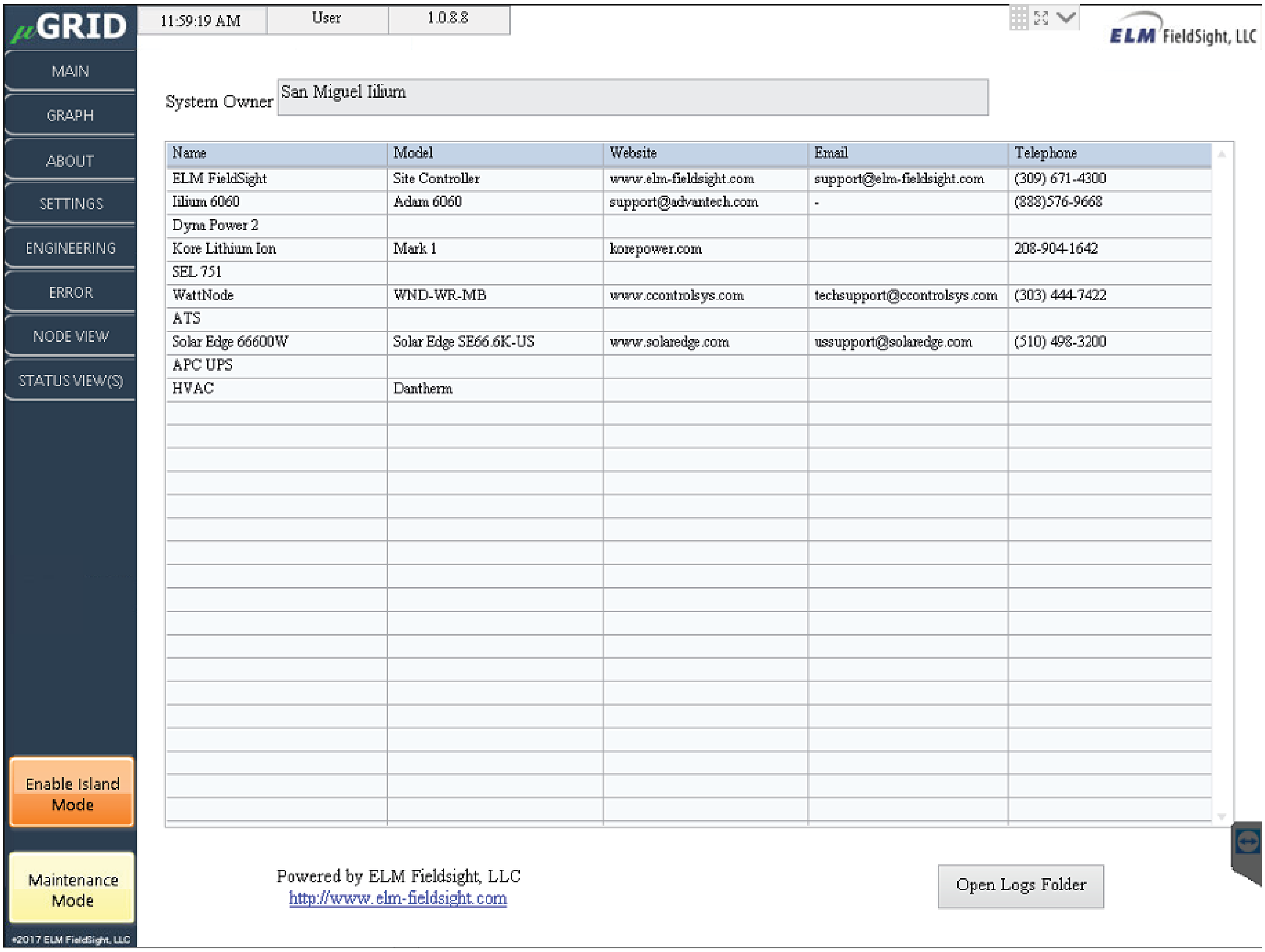


Figure 12. Program About Tab

Settings

This Settings screen allows the user to adjust parameters for the operation of the system in Peak Shaving, Demand Response, and Island Mode. Additionally, there are password protected component and system parameters that can be adjusted to aid in the testing of the system and to allow further optimization of the system as historical data is gathered. See Configurable Setpoints section for more information on setting changes.

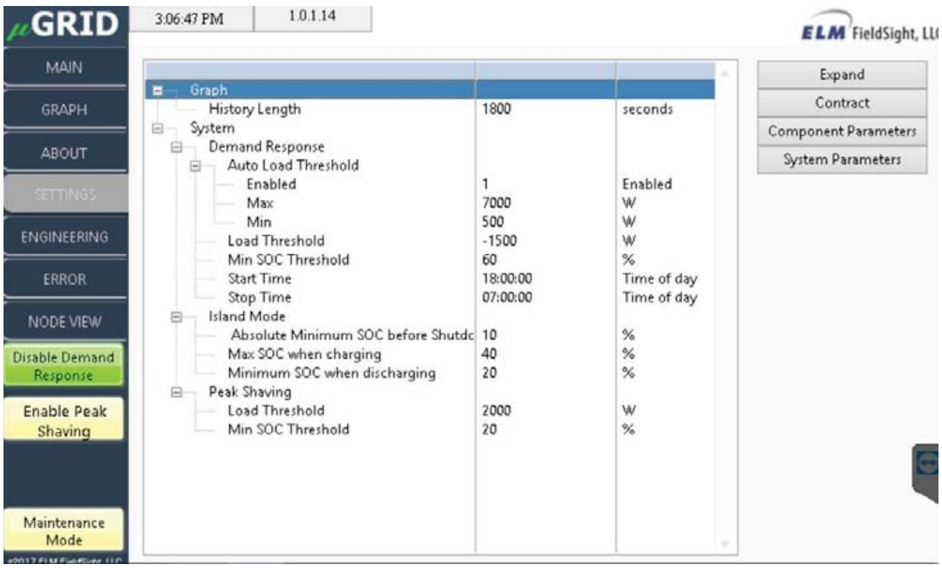


Figure 13. Program Settings Tab

System Operations

Sequence of Operations

The ELM FieldSight BESS control system is custom designed to work specifically for customer project demands and is designed to operate in different Sequence of Operations defined by the following table:

Mode	Operating State	Description
	Initialize	Determine what mode and state the system needs to start in
Island Mode	SOO1	**System Stop Mode:** The system will close battery contactors but remain with the inverter disabled until the system receives a command to start/enable.
	SOO2	**V/F Droop Mode:** The storage inverter will form the grid and act as the Microgrid master. It will respond to V and F commands.
	SOO3	**UPS Mode:** The storage inverter will form the grid and act as the Microgrid master. It will set voltage and frequency to its default values of 480V and 60 Hz respectively.
	SOO4	**Fault Mode:** Should the storage inverter fault while in Island Mode, the system will shut down and attempt to clear faults on the storage inverter. It will remain in this mode until all faults have been cleared. After faults have cleared, it will transition to SOO2 or SOO3 as required.
Grid Mode	SOO5	**Fault Mode:** Should the storage inverter fault while in Grid-tied Mode, the system will remain connected to the grid, but will attempt to clear faults on the storage inverter. It will remain in this mode until all faults have been cleared. It will re-start and transition to SOO6 or SOO7 as required.
	SOO6	Current Source Mode: the Microgrid will operate in parallel with the utility grid. The inverter will be enabled and operate in one of the 2 following modes: **Idle Mode:** The inverter will stay enabled with real and reactive power commands set to 0. **P/Q Mode**: The inverter will respond to both real and reactive power commands. **PF Mode:** The inverter will respond to both real power and power factor commands. **Autonomous Mode:** The BESS will manage its own P/Q setpoints in an effort to balance out the site containers SOC
	SOO7	Voltage Source Mode: The Microgrid will operate in parallel with the utility grid. The inverter will be enabled and operate in the following mode: **V/F Mode:** The inverter will respond to V and F commands

Low SOC	SOO8	The System enters this mode when in Island Mode and the batteries reach an absolute minimum SOC threshold (configurable). At this time, the system will shut down to protect the batteries.
E-Stop / Fire	SOO9	The System enters this mode when the user pushes the physical E-Stop button or the fire suppression system has activated. In this mode, battery controller opens the battery contactor and disables the storage inverter. Site controller maintains the system in this mode until the user resumes system operation on the touch screen (and removes the E-Stop activation).
Maintenance Mode	SOO10	The System enters this mode when the user presses the Maintenance Mode button on the Site Controller touch screen. In this mode, battery controller opens the battery contactor and disables the storage inverter. Site controller maintains the system in this mode until the user resumes system operation on the touch screen.

If at any time a container ESS has a fault on the inverter, battery, or communications issues, it will transition to its respective fault mode (SOO5 or SOO4) and attempt to clear the fault. Once the fault is cleared, if the ESS is still enabled, it will automatically restart in its current mode (SOO6 or SOO3)

System Operation

The communication architecture and system controls has been designed such that the ESS controller will receive control commands from the master controller (RTU). The ESS container controller will then send the proper R/W commands to the battery system, storage inverters, and other auxiliary pieces of hardware to control their operations. The ESS control system is designed to be autonomous, with no user interaction required except from the master controller (RTU) or in the event of maintenance needs or an emergency.

The primary control functions that will need to be sent between the master controller (RTU) and each ESS site controller are outlined in the ELM BESS Points List.

Enable / Disable: This command will start or stop the ESS. If the system is disabled, it will sit in SOO1 until it receives further commands. When it is Enabled, it will look at the Island State register to see if it needs to transition to SOO3 or SOO6.

Island State: This command determines if the ESS needs to operate in Grid Mode (Utility source present) or Island Mode (No Utility source present). If the system is enabled and Island State is set to Grid Mode, the ESS will look to the Grid Control Mode for next state. If the system is enabled and the Island State is set to Island Mode, the ESS will look to the Island Control Mode for next state.

Watchdog Heartbeat: This command is used as a safety protocol for a loss of communications. The watchdog heartbeat needs to be written to continuously by the RTU. The watchdog acts as a countdown timer and if it is being written to, it stays at its max timer value. When the watchdog stops being written to, it will start to countdown from the time it was sent, until it reaches zero. Once it reaches zero, it will automatically disable the system and send it to SOO1 to await further commands.

Real Power Command: While in Grid Mode, the ESS will use this command to charge or discharge batteries as required. *Real power commands need to be limited to the values read on registers 212 and 214 for the ESS Power Charging Limit and ESS Power Discharging Limit. These registers will display the maximum power the ESS can charge/discharge at that point in time based on battery voltage, SOC, and temperature.* Default value is 0.

Reactive Power Command: While in Grid Mode, the ESS will use this command to inject or absorb VARS from the system. Default value is 0.

Voltage Command: While in Grid Mode or Island Mode, the ESS will use this command to adjust its output voltage. Default value is 480.

Frequency Command: While in Grid Mode or Island Mode, the ESS will use this command to adjust its output frequency. Default value is 60.

Power Factor Setpoint: While in Grid Mode, the ESS will use this command to control the PF output of the system in coordination with its real power setpoint. Default value is 1.

Operation Summary

The ELM FieldSight BESS Controller along with its Modbus register list is designed to operate based on the following sequence of commands:

BESS Operations

- Stop BESS at any time
    - Set register 900 to 0 (Enable / Disable)
- To start BESS in Grid Mode
    - Set register 901 to 0 (Island State)
    - Set register 913 to correct operating mode (Grid Control Mode)
    - Set register 900 to 1 (Enable / Disable)
    - Grid Control Modes:
        - For Idle Mode: no additional commands are needed
        - For P/Q Mode:
            - To set Real and Reactive Power commands
                - For Real Power Command, send values to register 903 (real power command)
                    - Power is in watts
                    - Positive number is to discharge the battery
                    - Negative number is to charge the battery
                - For reactive power command, send values to register 905 (reactive power command)
        - For PF Mode:

        - To set Real and Power Factor Commands
            - For Real Power Command, send values to register 903 (real power command)
                - Power is in watts
                - Positive number is to discharge the battery
                - Negative number is to charge the battery
            - For Power Factor command, send values to register 911 (reactive power command)
    - For V/F Mode:
        - To change Voltage and Frequency commands
            - For Voltage Command, send values to register 907 (Voltage command)
            - For Frequency Command, send values to register 909 (frequency command)
    - For Autonomous Mode: no additional commands are needed
- **Note: To transition between different Grid Control Modes, send a new Grid Control Mode setting**

- To start BESS in Island Mode
    - Set register 901 to 1 (Island State)
    - Set register 914 to correct operating mode (Island Control Mode)
    - Set register 900 to 1 (Enable / Disable)
    - Island Control Modes:
        - For Idle Mode: No additional commands are needed
        - For UPS Mode: No additional commands are needed
        - For V/F Droop Mode:
            - For Voltage Command, send values to register 907 (Voltage command)
            - For Frequency Command, send values to register 909 (frequency command)
    - **Note: To transition between different Island Control Modes, send a new Island Control Mode setting**
- Transition from Island Mode to Grid Mode
    - Set register 901 to 0 (Island State)
    - Set register 913 to correct operating mode (Grid Control Mode)
- Transition from Grid Mode to Island Mode
    - Set register 901 to 1 (Island State)
    - Set register 914 to correct operating mode (Island Control Mode)

BESS Side Cases

- If e-stop button is pushed, the system will shut down and change system status to “e-stop” (SOO9)
    - The system will stay in this state until the e-stop button has been pulled out and the “resume from e-stop mode” button on the BESS HMI has been pushed

- If a fire has been detected in the BESS, the system will shut down and change system status to "Fire Suppression (SOO9):
    - The system will stay in this state until the fire suppression detection has changed state and the "resume from e-stop mode" button on the BESS HMI has been pushed
- If the Maintenance Mode button on the BESS HMI has been pushed, the system will shut down (SOO10)
    - The system will stay in this state until the "resume from maintenance mode" button on the BESS HMI has been pushed
- While in Island Mode, if the battery drops below a user defined SOC threshold, the system will shut down (SOO8).
    - The system will stay in this state until Island State changes to Grid Mode or if the SOC threshold is lowered below the current SOC
- The MGMS can not override the cases above. Once the conditions above have been removed, the system will resume operation based on the last received parameters from the MGMS Controller

Configurable Setpoints

Configurable setpoints can be adjusted by the user when logged into the program as an Admin. These parameters can be accessed by the "Settings" tab on the left hand side of the screen. Before changing any setpoints, consult with Support@ELM-FieldSight.com as some setpoints can impact the performance of the system.

System Parameters			
Parameter Name	**Default**	**Units**	**Description**
Graph			
History Length	1800	Seconds	How much time is displayed on the graph
System			
Alert			
Enable	0		1: enable, 0: disable; For e-mail and text alerts
Microgrid Not Started Timer	5	min	Not Used
Debug			
Auto Start	Enabled		When the program is restarted, if auto start is disabled, it will require the user to push a "start" button before the program will start executing
Comm Logging	Disabled		Not used
Controller Logging	Enabled		Not used
Global Message Logging	Enabled		Enable to log control messages received by instrument controller state machine, including state changes and power setpoint commands.
Info Log			
Maintenance Steps	Disabled		If enabled, Information window displays step actions being executed in current SOO.

Transition Steps	Disabled		If enabled, Information window displays step actions taken on transition to current SOO.
Node Logging	Disabled		Enable to log control messages received by instrument node state machine, including state changes and power setpoint commands.
File Retention			
Data Logs	30	days	How long the data logs are stored locally on the controller hard drive
Error Logs	30	days	How long the error logs are stored locally on the controller hard drive
Message Logs	30	days	How long the message logs are stored locally on the controller hard drive
Island Mode	Disabled		Not used
Absolute Min SOC Before Shutdown	5	%	Minimum battery SOC before the system shuts down to protect the battery
Local Data Logging	1		0: disabled, 1: enabled; Logs component data locally on the computer
Maintenance Mode	Disabled		Displays the current state of Maintenance mode
Max System Fault Count	5		How many times a BESS can fault in a consecutive 5 minute period before it becomes a permanent fault
Override Severe Fault Mode	0		0: disabled, 1: enabled; Enable this register to clear the max system fault count
SOO6			
Real Power Percent	2.5	%	Real Power adjustment for storage inverter commanded power
Timer			
SOO1	0.5	minutes	The minimum amount of time the BESS must be in this SOO before the program will allow it to transition to another SOO
SOO2	0.25	minutes	The minimum amount of time the BESS must be in this SOO before the program will allow it to transition to another SOO
SOO3	0.25	minutes	The minimum amount of time the BESS must be in this SOO before the program will allow it to transition to another SOO
SOO4	1	minutes	The minimum amount of time the BESS must be in this SOO before the program will allow it to transition to another SOO
SOO5	1	minutes	The minimum amount of time the BESS must be in this SOO before the program will allow it to transition to another SOO
SOO6	0.25	minutes	The minimum amount of time the BESS must be in this SOO before the program will allow it to transition to another SOO
SOO7	0.25	minutes	The minimum amount of time the BESS must be in this SOO before the program will allow it to transition to another SOO
User Authentication			
Auto Logout Timer	30	minutes	Amount of time between logins before a user must reinput their password

Enable	1		0:disable, 1:enable; This enables or disables the need for a user to use a password for system.
Watchdog Timer			
Battery	30	seconds	Amount of time after communication is lost with this component before the system will fault
Storage Inverter	30	seconds	Amount of time after communication is lost with this component before the system will fault
Web Update Enable	0		0: disable, 1:enable; Ability of system to push data to the web database
Web Update Interval	5	minutes	How frequently data can get pushed to the web database
Component Parameters			
Parameter Name	**Default**	**Units**	**Description**
Battery			
Max Operating Temperature	50	C	The maximum battery cell temperature before a system will fault
Max Operating Voltage	992	VDC	The maximum battery rack voltage before a system will fault
Min Operating Temperature	15	C	The minimum battery cell temperature before a system will fault
Storage Inverter			
Max Power	500,000	W	The maximum power the storage inverter can output
System			
Battery			
Battery Rack Energy	69,800	Wh	The rated battery energy for each battery rack
Max System Power	500,000	W	The maximum power the battery system can output
Storage Inverter			
System Frequency	60	Hz	The rated frequency for the storage inverter
System Voltage	480	VAC	The rated AC voltage for the storage inverter

Alerts and Faults

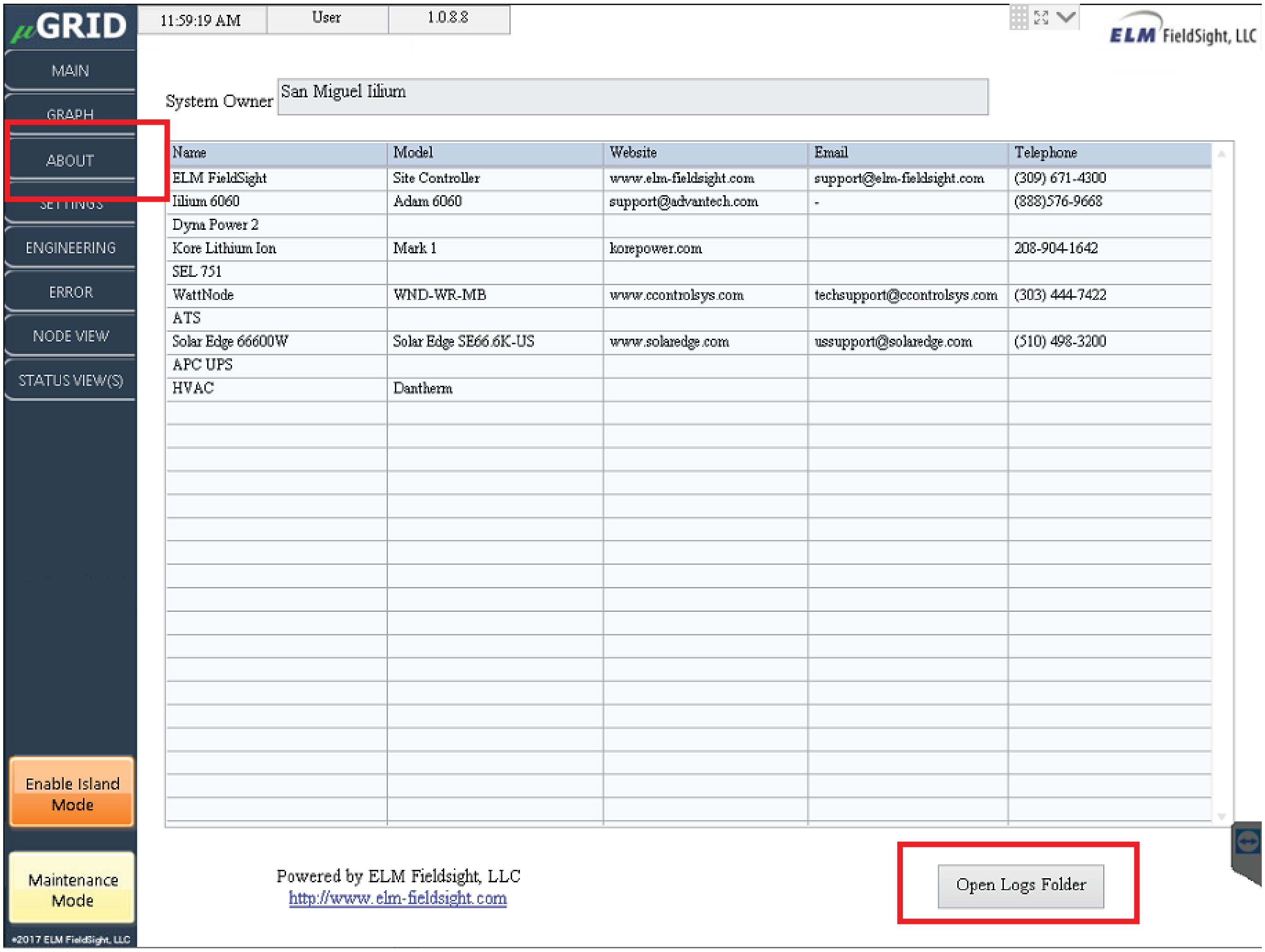
System Status, Alerts and Faults on the system are available to be read through the ELM FieldSight BESS controller Modbus register list.

Element	Description
System Status	0: Disabled; 1: Grid P/Q Mode 2. Grid PF Mode 3: Grid V/F Mode 4: Grid Autonomous Mode 5: Grid Idle Mode 6: Island UPS Mode 7: Island V/F Mode 8: Island Idle Mode 9: System Faulted 10: e-stop Mode 11: Maintenance Mode 12: Fire Suppression Mode 13: Low Battery Fault Mode
Inverter Faults	Bit 0: E-Stop shutdown Bit 1: AC Overcurrent Bit 2: DC Overcurrent Bit 3: DC Overvoltage Bit 4: Device Overtemp Bit 5: Inverter Overtemp Bit 6: Invalid command message Bit 7: DC Undervoltage Bit 8: AC Overvoltage Bit 9: Illegal transition Bit 10: Bad EE header Bit 11: Bad EE section Bit 12: Cooling system Bit 13: AC Timed overload Bit 14: DC Timed overload Bit 15: Timed Circ Current Bit 16: Control Board Voltage Bit 17: Pwr Channel Imbalance Bit 18: Current rise Bit 19: Cooling Flow Bit 20: Thermal Overload Bit 21: Fan Circuit Bit 22: POR Timeout Bit 23: Condensation Bit 24: I2C Comms Bit 25: External Inhibit Bit 26: Ground Fault Bit 27: Fuse or TVS Bit 28: Baseplate Overtemperature Bit 29: AC Disconnect Switch Bit 30: Internal Overtemperature Bit 31: Under-temperature modifier

Battery System Alarms	Bit 0: Communication Error Bit 1: Over Temperature Alarm Bit 2: Over Temperature Warning Bit 3: Under Temperature Alarm Bit 4: Under Temperature Warning Bit 5: Over Charge Current Alarm Bit 6: Over Charge Current Warning Bit 7: Over Discharge Current Alarm Bit 8: Over Discharge Current Warning Bit 9: Over Voltage Alarm Bit 10: Over Voltage Warning Bit 11: Under Voltage Alarm Bit 12: Under Voltage Warning Bit 13: Under State of Charge Min Alarm Bit 14: Under State of Charge Min Warning Bit 15: Over State of Charge Max Alarm Bit 16: Over State of Charge Max Warning Bit 17: Voltage Imbalance Warning Bit 18: Temperature Imbalance Alarm Bit 19: Temperature Imbalance Warning Bit 20: Contactor Error Bit 21: Fan Error Bit 22: Ground Fault Error Bit 23: Open Door Error Bit 24: Current Imbalance Warning Bit 25: Other Battery Alarm Bit 26: Other Battery Warning Bit 27: Reserved Bit 28: Configuation Alarm Bit 29: Configuation Warning
Fire Alarms	Bit 0: ELM Controller Temp Alarm Bit 1: Battery BMS Temp Alarm Bit 2: Reserved Bit 3: Clean Gas Fire Suppression Activated Bit 4: Reserved

Data Log Recovery

To access the data logs for a battery system, the user can navigate to the ‘About’ tab on the system touchscreen. Once on the about screen, the user can click on “Open Logs Folder” in the bottom right of the screen. This will open a File Explorer window where all the log files can be found. All data logs on the system are stored locally for 30 days.



Once the user in the "logs" folder, they will find the following folder structure.

Config	3/24/2021 6:33 PM	File folder
Data	3/26/2021 11:28 AM	File folder
Error	3/25/2021 8:00 PM	File folder
Message Logs	3/26/2021 11:27 AM	File folder
Projects	3/12/2021 10:30 AM	File folder
Web Logs	3/22/2021 5:10 PM	File folder

The 'Data' folder contains the following files that may be useful to the user:

MicroGrid Transition Log: This records when different transitions between SOO's occur and what constraint caused the system to transition to the new SOO

Microgrid Fault Log: This records the time and type of any faults that are logged on the batteries or the storage inverters.

Microgrid Settings Log: This records any settings that are changed in the program and logs the old and new parameter value along with a time stamp.
Microgrid "date" QuarterDay.tdms: This is a raw data file that can be used for troubleshooting a system if needed. These files do require an ELM FieldSight Proprietary software tool to view the files.

The 'Error' folder contains any communication errors that occur between components along.

The 'Message Logs' folder records all commands that are sent to the different components in the system.

HVAC System Operation

ELM's MGC125 uses Dantherm HVAC units to maintain the proper temperature levels inside the battery enclosure, in accordance with the specifications of the battery manufacturer. Depending on the installation of the site, your unit may or may not have an internal heater. ELM monitors the HVAC system via an ethernet connection through the ELM FieldSight Controller. The system has the capability to remotely monitor and manage the following items:

- Read current alarm status
- Read the inlet and outlet temperatures of the HVAC system
- Read and change high and low temperature alarm setpoints
- Manage TCP/IP communication parameters such as gateway IP address, device IP address, and subnet mask

NOTE: In humid conditions, the cooling system will create a significant amount of moisture through condensation. The moisture that the enclosure air can contain is limited. If moisture flows from the condensation drain tube continuously, ambient air is entering the enclosure. Be aware that frequent opening of the enclosure doors, or improperly or incompletely closed doors allow humid ambient air to enter the enclosure. This can cause excessive condensation and potentially damage the equipment. Ensure all doors are fully closed and tightly sealed to prevent this.

- **Please refer to the attached HVAC Operating Manual for maintenance, operating specifics and troubleshooting guides.**

Surge Suppressor Operation

The CITEL DS50VGPVS-1500G/51 Series Surge Protection Device (SPD) is a high-quality transient diversion system designed to protect sensitive equipment from damaging transient voltage surges resulting from load switching, lighting strikes, and sources. The surge protection device is used in the MGC125 to protect the Kore Power M1 batteries. If the SPD is tripped, it will send a signal to the battery system to open its contactors. The battery system can not be used again until the Surge Suppression device or fuses have been replaced.

Figure 14. Surge Suppressor

Maintenance

The following table outlines the basic service requirements for the ESS. More detailed information for performing the tasks can be found in the manufacturer owner's manual. The schedule shown is a recommended schedule and systems in harsh environments or where uptime is critical may want to increase the frequency of the maintenance. Carefully review the Lock-Out Tag-Out procedure below before performing any installation or maintenance work.

Lock-Out and Tag-Out Procedure

Review the following steps before performing any installation or maintenance work:

1. **Work must be performed by qualified personnel only.**
2. **Clearly identify work locations and get familiarized with site interconnection drawings.**
3. **Engage E-Stop on system to prevent remote control operations. (See Figure 2 for Location)**
4. **Ensure that all sources of power have been disconnected by turning to the OFF/Open position the followings in order:**
    a. **B1 ESS Connection Circuit Breaker (located in Combiner Enclosure)**
    b. **20A Load Center (LC) Circuit Breaker (located on hinge panel)**
    c. **Turn off DC and AC disconnects (located on Dynapower Inverter)**
    d. **Verify with customer or Authority Having Jurisdiction (AHJ) for the main service entrance disconnect to be turned to the OFF/Open position and LOTO.**
5. **Verify that Line Side of CB1 (located in Combiner Enclosure) voltages are at or near 0V by measuring with a voltmeter.**
6. **Inverters contain capacitors which require several minutes to discharge after removing power. Verify that system and component voltages are at or near 0V by measuring with a voltmeter.**
7. **Batteries will continue to hold energy, refer to battery O&M manual for safety instructions.**
8. **All electrical installations must comply with the electrical standards applicable on-site.**
9. **Refer to manufacturer's manual for more information.**
    a. **Dynapower MPS125 Storage Inverter Operation and Maintenance Manual**

b. Fire Suppression – SEVO Flex Manual
c. HVAC - Dantherm PrecisionAir-Manual
d. Battery – Kore Power Mark 1 Operation and Maintenance Manual - KORE-M1-MAN-0002
e. UPS - APC SMT1500RM2U 2U 1500VA Smart-UPS Operation Manual

Frequency	Operation	Subsystem
Monthly	Environmental Inspection	Battery
	Visual Inspection	Battery
	DC Protection Inspection	Battery
6 Month	Internal/External Visual Inspection	All
	Dust Removal	All
	Inspect Fire Suppression Gauges	Fire Suppression
	Clean HVAC air filter	HVAC
	Loose Connections Check	All
	Semiannual Inspection and Cleaning	All
12 Month	Annual Inspection and Cleaning	All
	Battery Function	Battery
60 Month	UPS Replacement	APC UPS

Periodic Maintenance Procedures

Monthly:

- Environmental Inspection: Check monthly average ambient temperatures and humidity inside BESS container. Average temperature should be between 25C +\- 5C. Average relative humidity should be less than 80%
- Battery Visual Inspection: Check if the form or the color of the communication & power cable has changed. Check if the contact areas and battery exterior have rusted. Check if the battery room environment is well-managed (dust). Check if you smell chemicals.
- DC Protection Inspection: SPD normal status check. (check LED at the front of the SPD, Normal: grey, Replacement required: red)

6 Month:

- Visually inspect container for noticeable intrusion of dust, rodents & pests, and water. Remove dust from all surfaces.
- Ensure door latches are not loose.
- Check fire suppression gauge to ensure system is nominal. Perform fire suppression visual inspection per SevoSystems operation manual. Inspect fire suppression pressure gauges to make sure they are still being maintained in the green zone of the gauge. Contact ELM FieldSight if the pressure is no longer in the green zone.
- For corrosive environments, wash down container to remove accumulated salt and grime.
- Inspect and re-torque any loose connections inside of container.

- **Clean HVAC air filter and reinstall. Inspect all heat exchanger coolant lines, fittings, and seals. Retighten or replace any lines that are visibly damaged.**

12 Month:

- **Annual inspection and cleaning. Perform all monthly and 6 month inspections.**
- **Battery Function: Perform a discharge capacity measurement and State of Health update. Perform a DC contactor operation inspection. Verify 48 V and 24V auxiliary voltage is within +/-5%V. Perform an insulation resistance check. Perform a FAN operation check.**

60 Month:

- **Perform replacement of storage inverter coolant, fan, and pump.**
- **Perform replacement of UPS battery.**

BESS Labeling

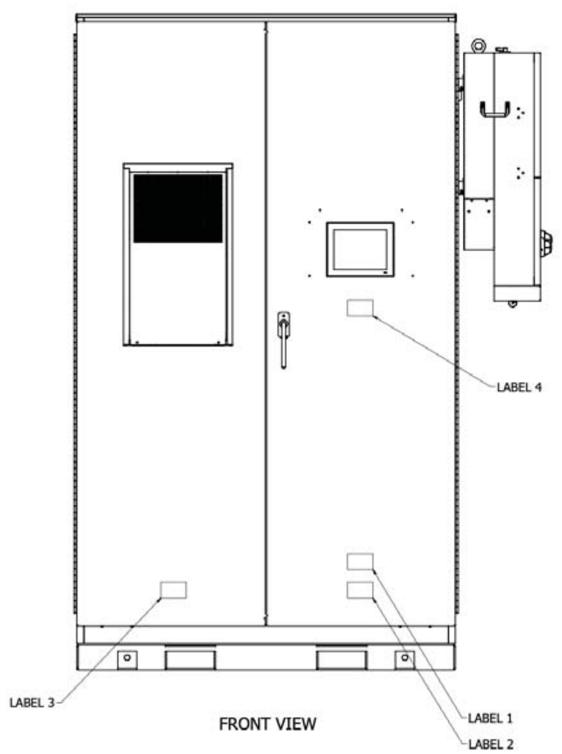


Figure 15. Front View Labels

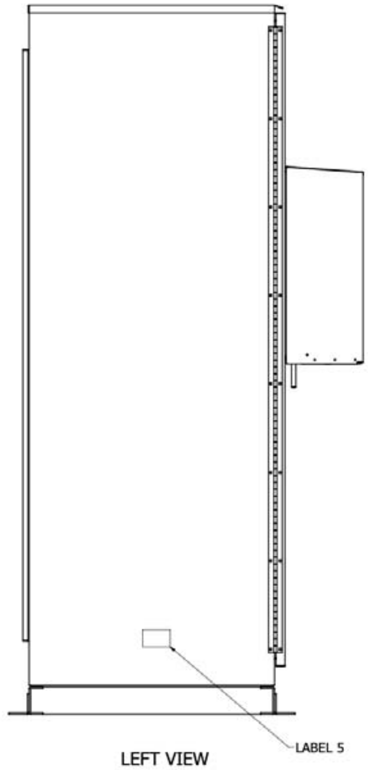


Figure 16. Side View Labels

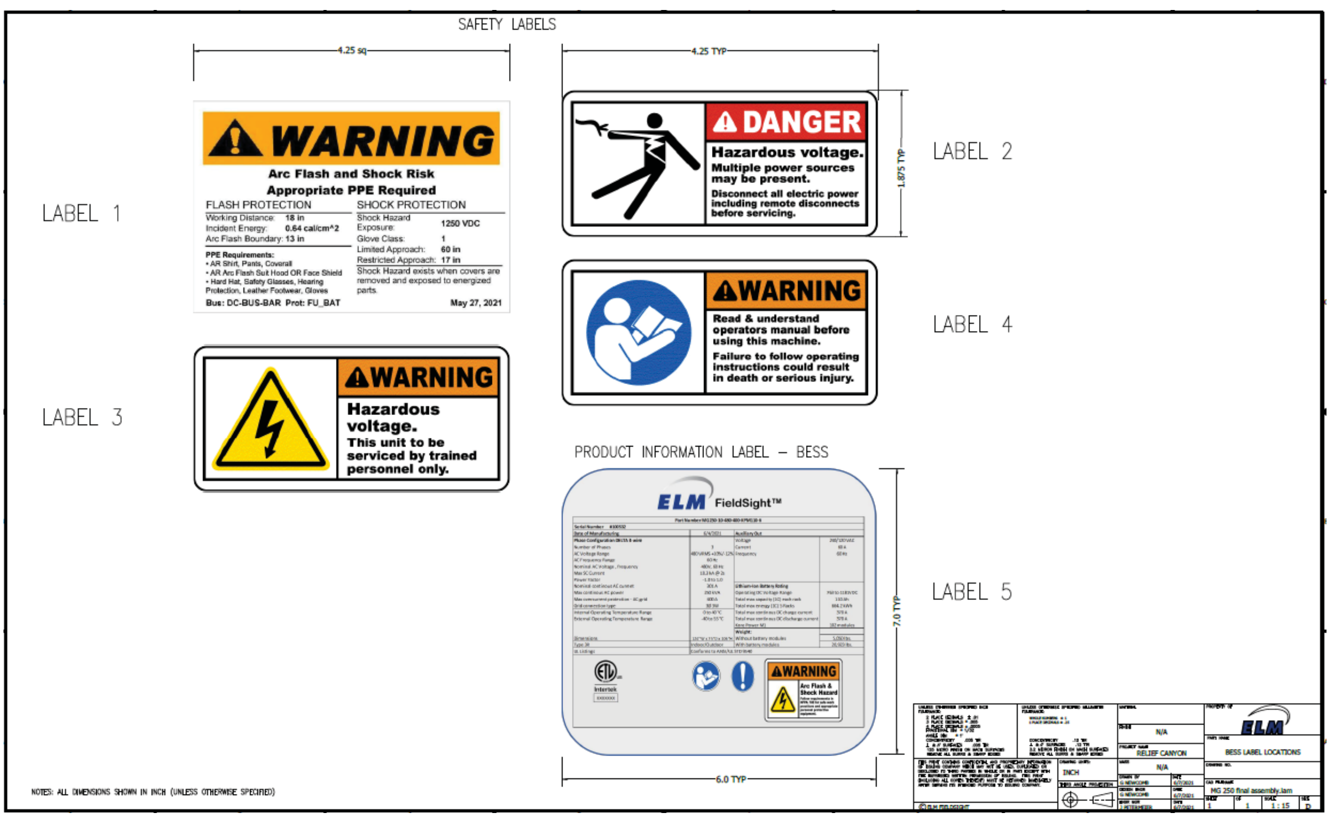


Figure 17. Labels

Troubleshooting

If a component of the MicroGrid system is not operating properly, please refer to the ELM BESS Troubleshooting guide or the individual component manufacturer owner's manual.

In case a component in the system faults, ELM has provided ways for the end user to compile Error and Data Logs. These faults can be found in the 'Data' Folder as described in the data log recovery section.

If the MicroGrid controller is not operating properly or has locked up, try to reboot the system by cycling the power on the controller. Please note: if the system is currently in Island Mode, a reboot will reset the system causing a brief power outage.

If that does not fix the issue, contact ELM FieldSight customer support at support@elm-fieldsight.com

Parts Lists

Figure 18. ESS Inverter

Item	Qty.	Part No.	Manufacturer	Description
1	1	MPS-125	Dynapower	Energy Storage Inverter

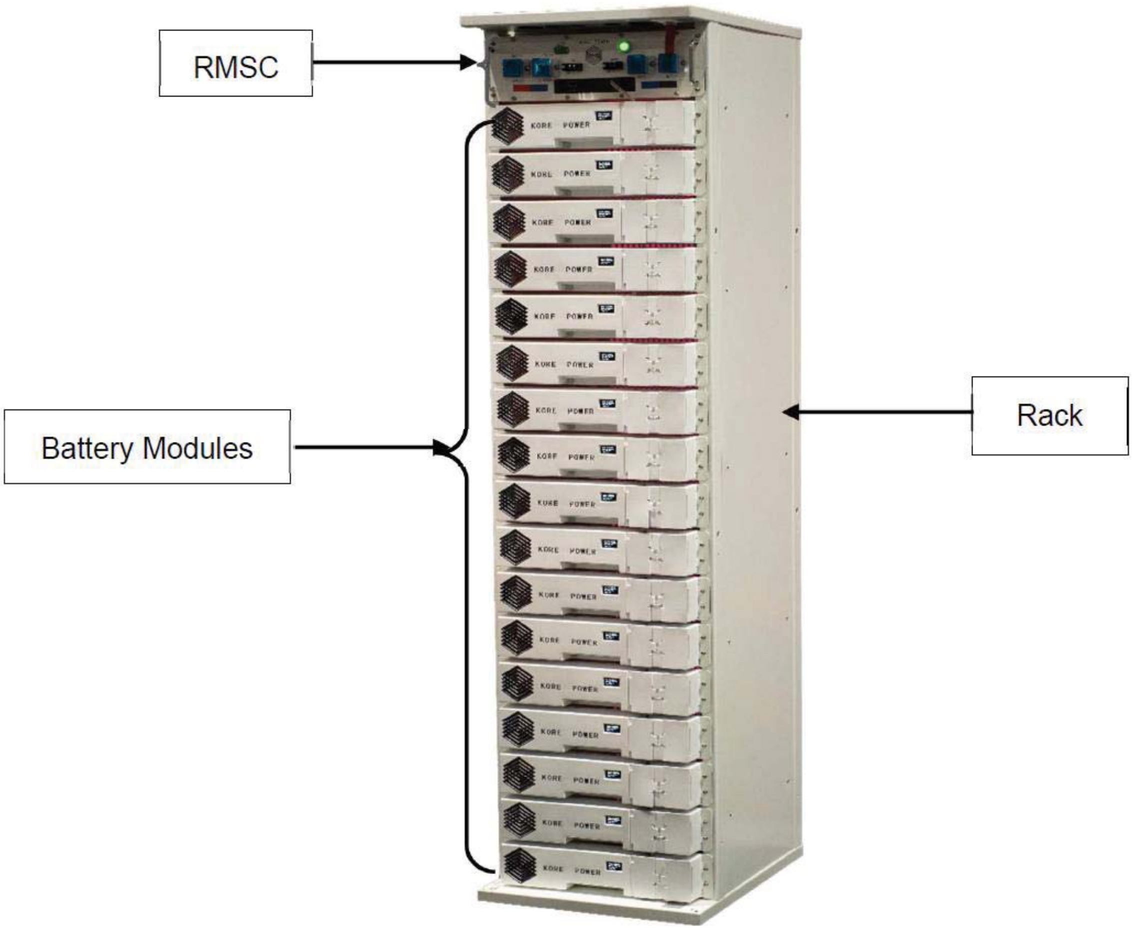


Figure 19. Battery Rack Configuration

Item	Qty.*	Part No.	Manufacturer	Description
1	1	M1-RMSC150	Kore	(RMSC) Battery Switchgear
2	17	M1-M2P16S	Kore	Battery Modules
3	1	3000007721	Kore	Battery Racks

*Note: Quantities are per one (1) Rack. Each system varied from 6 each to 4 each racks total.

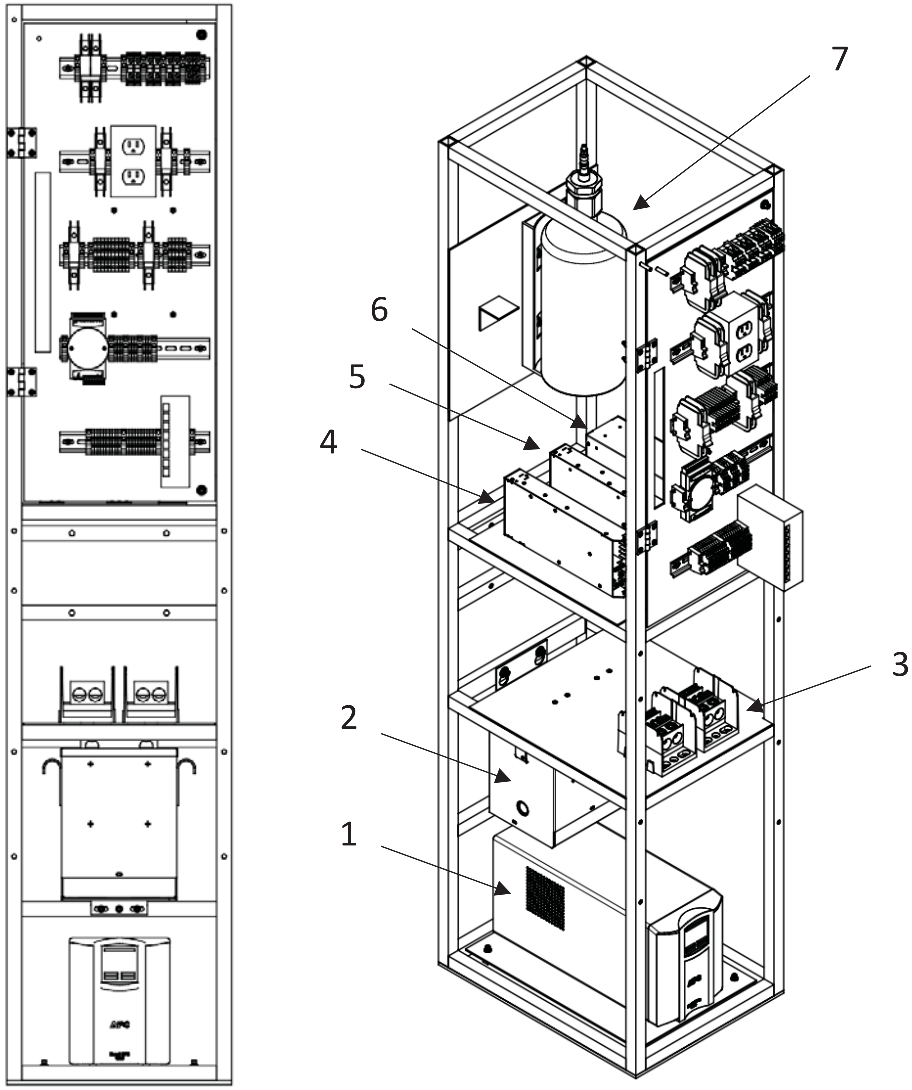


Figure 20. Internal Component Rack

Item	Qty.*	Part No.	Manufacturer	Description
1	1	SMT1500C	APC	UPS
2	1	TF2498735	ACME Electric	Transformer
3	2	HVPB211	Marathon	Power Distribution Block
4	1	RSP-2000-24	Meanwell	Power Supply
5	1	RSP-1000-48	Meanwell	Power Supply
6	1	RSP-1500-24	Meanwell	Power Supply
7	1	Flex-L1400	SEVO	Fire Suppression System

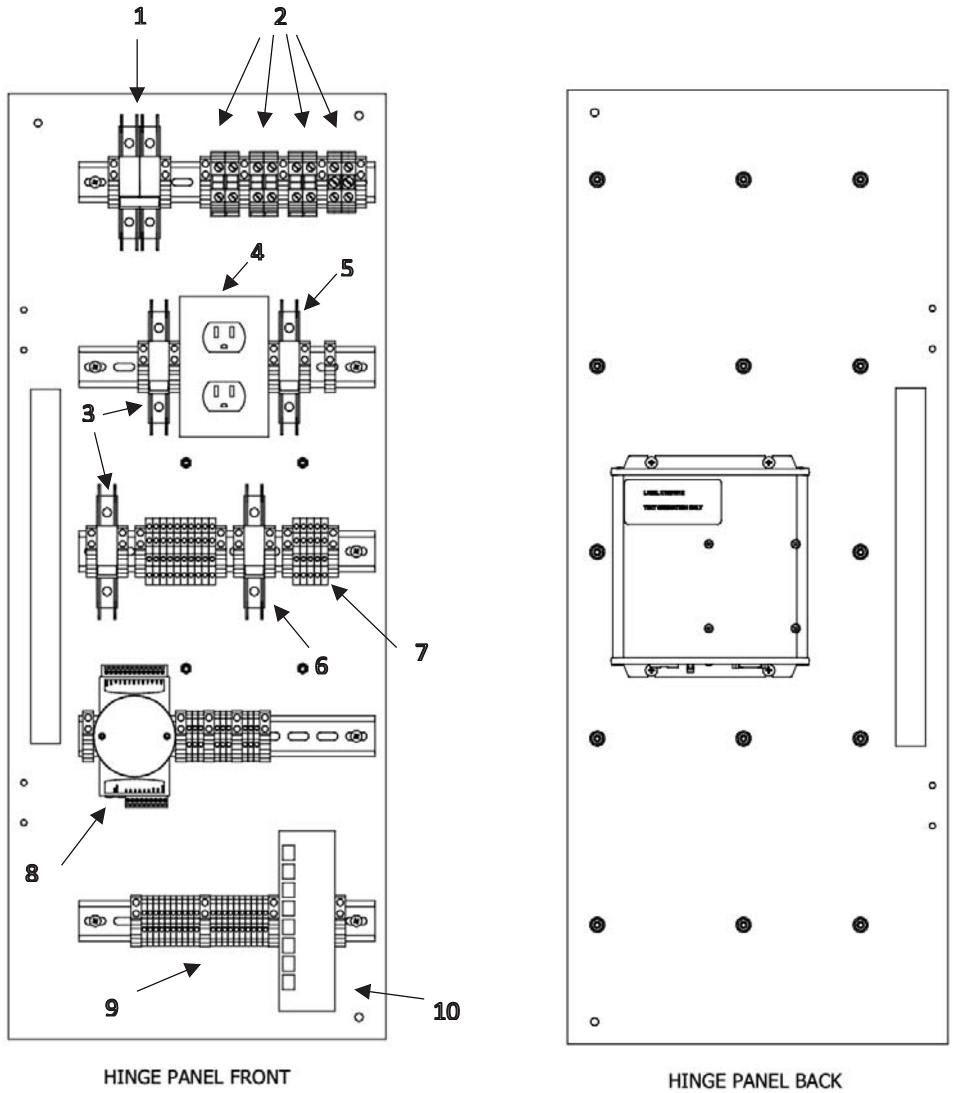


Figure 21. Hinge Panel

Item	Qty.*	Part No.	Manufacturer	Description
1	1	2907662	Phoenix Contact	Circuit Breaker – 2 pole, 15A
2	15	CDL4UN	Altech	Double Deck Terminal Block
3	2	2907573	Phoenix Contact	Circuit Breaker – 1 pole, 20A
4	1	CR20GRY	Hubbell	2 Pole Outlet
5	1	2907571	Phoenix Contact	Circuit Breaker – 1 pole, 15A
6	1	2907641	Phoenix Contact	Circuit Breaker – 1 pole, 25A
7	2	3044199	Phoenix Contact	Terminal Block – UT 16
8	1	ADAM-6060	Adam	Modbus Module – 6 channel
9	29	CTS2.5U-N	Altech	Single Deck Terminal Block
10	1	TI-PG102	TRENDnet	10 port switch

Appendix

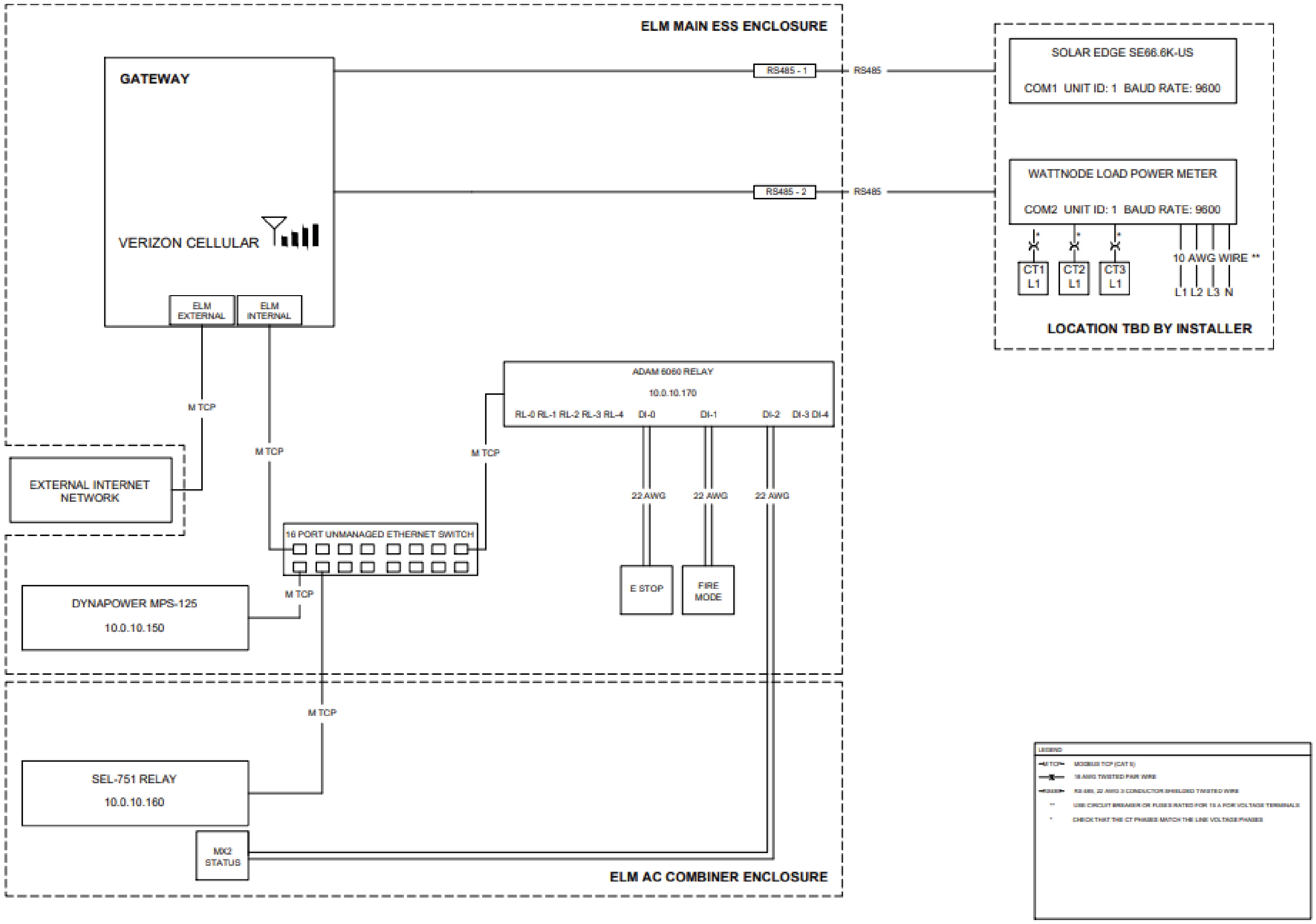


Figure 22. Communications Drawing

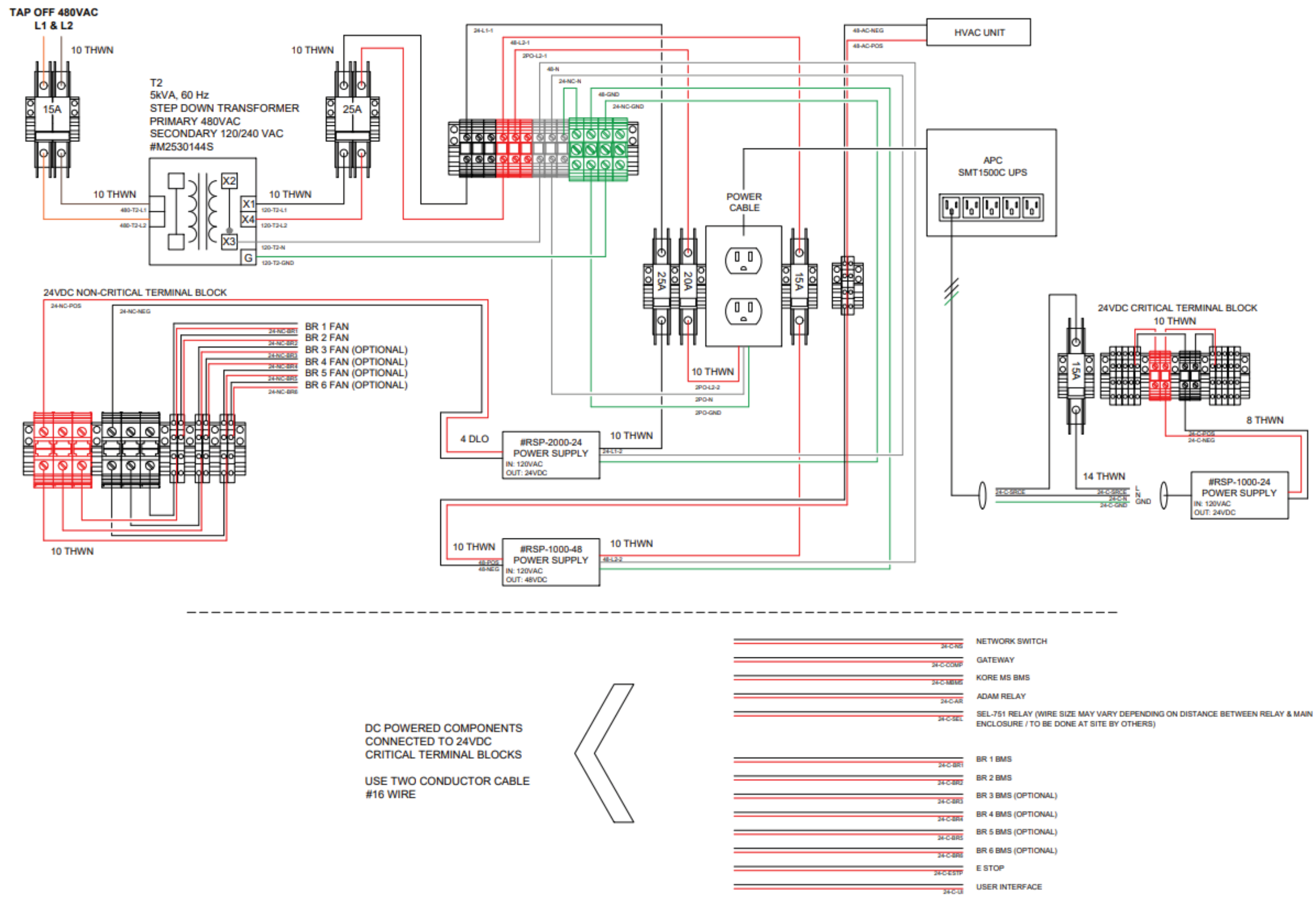


Figure 23. Low Voltage Drawing

Appendix 13. 7

FDNY Approval Documents and Guides

PERMITTING OUTDOOR ENERGY STORAGE SYSTEMS IN NYC

FDNY INSTALLATION APPROVAL SITE PLAN FOR LARGE SYSTEMS

December 2021

NEW YORK STATE OF OPPORTUNITY. | NYSERDA
CUNY SMART DG HUB
NYC Mayor's Office of Climate and Sustainability

Overview

The Smart Distributed Generation (DG) Hub, established by Sustainable CUNY of the City University of New York in 2013, is a comprehensive effort to develop a strategic pathway to safe and effective solar and storage installations in New York City. This document was created in collaboration with the NYC Fire Department (FDNY) and is intended to provide guidance regarding the development of an energy storage installation Site Plan, a key component of the site-specific Installation Approval, which is a requirement for permitting large energy storage systems (ESS) in NYC.

As detailed in 3RCNY Rule 608-01, site-specific Installation Approval is a required part of the FDNY's permitting process for all Large ESS (defined as per section (c)(2) of the Rule as >250kWh for Li-ion based battery types and >500kWh for all other battery chemistry types). The submittal package for the Installation Approval must include:

- a detailed Site Plan which must be prepared by a NYS registered design professional with knowledge of ESS failure modes/analysis and should include the information outlined in the following pages.
- official architectural drawings (Construction, Fire Protection, Electrical, etc.) signed and stamped by the Registered Design Professional.
- other elements as described in section (e) of the Rule.

Table of Contents

Site Plan Checklist

Each Site Plan should include a written description of all items listed in Table 1 below (adapted and expanded from section (e) of 3RCNY Rule 608-01). In addition, the Site Plan should also include visual aids – photographs, and/or map images, and/or site drawings – and these visual aids should show the locations of certain elements as indicated below, using labels or symbols.

Table 1: Universal Site Elements

Site Plan Item/Element	Indicate on Visual Aids
Exact location of the stationary storage battery system installation; including location of access panel or enclosure entrance(s)	✓
Surrounding public streets, fire apparatus access roads and pedestrian walkways	✓
All buildings and structures on or adjoining the premises (or within 100 feet of the perimeter of the system), identified by occupancy group and construction type.	✓
➢ Especially note buildings with sensitive occupancies (e.g. schools) or complicated egress (e.g. hospitals)	
➢ Impact on surrounding exposures due to: explosion, heat flux, toxic fumes.	
Any walls or fencing enclosing the installation or the premises on which it is located.	✓
All transportation and utility infrastructure, including electrical power lines, within 250 feet of the installation.	✓ (as image(s) allow)
Location and content of signage.	✓
Location and type of other stationary storage battery systems located on the premises or within 50 feet of the proposed installation (if 50 feet extends to other premises, as determined by visual inspection of the outdoor space or reasonable inquiry of the owner).	✓
E-Stop and emergency shutdown procedures:	
➢ E-stops should be designed as per the requirements of RCNY 608-01(g)(3)(D).	
➢ Specify what is shut down when e-stop is activated	

Additional Site Plan Information

Table 2 lists additional elements that should also be included in Site Plans if they are applicable to a project (many, but potentially not all, elements below will be applicable for most projects). As with the items in Table 1, these items should also be described both in written form as well as denoted on visual aids where relevant.

Table 2: As-Applicable Site Elements

Site Plan Element	Indicate on Visual Aids
Hydrant locations, hydrant main sizes, and hydrant distance(s) to FDC or ESS (whichever is applicable)	✓
Suppression system – number of sprinkler zones, activation of zones (manual or automatic), suppression agent (water-based or other)	
Responder access area(s):	
➢ Fire Department Connection (FDC) locations, distance from ESS, and identifications of which zone each FDC feeds (signage). Ensure FDC is not located within the deflagration hazard zones or high heat flux areas.	✓
➢ E-stop location & distance from ESS. Ensure e-stop is not located within the deflagration hazard zones or high heat flux areas.	✓
➢ Manual smoke/gas purge system controls & distance from ESS. Ensure purge switch is not located within the deflagration hazard zones or high heat flux areas.	✓
Building openings – on building if ESS is located on rooftop, otherwise on buildings in close proximity	
Vehicle Parking	✓
HVAC intakes – on building if ESS is located on rooftop, otherwise on buildings in close proximity	
Rooftop applications should include clear path/landing zones as per FC 504.4	✓
Enclosure/container manual smoke/gas purge exit points	✓
Enclosure/container déflagration vent locations & hazard zone	✓
Flood zone information (FEMA Flood Map Service Center: https://msc.fema.gov/portal/home)	✓ (if applicable)
Any other potential hazard (exposed natural gas piping, co-generation plant, fuel cell, flammables/combustibles, hazardous materials storage, etc.).	✓
Any other measures or additional lines of protection (e.g. blast wall, etc.) to mitigate the impact of battery system failure on the adjoining buildings or structures, or other site-specific hazard mitigations, including those required by a UL Standard 9540 hazard mitigation analysis or conditions of the product's Equipment Approval/Certificate of Approval (COA).	✓ (if applicable)

Visual Aids

Visual aids are an important component of the Site Plan and should support thorough communication about the proposed project site and its surroundings to the FDNY plan reviewers. Suggested formats and instructions for visual aids are provided below. However, Site Plans may include any type and number of visual aids that would be helpful in imparting a thorough understanding of the project to FDNY plan reviewers.

The following types of visual aids are suggested:

- Satellite map images of proposed site – aerial, broad-scope view that shows the project site in relation to its surroundings. Basic satellite-based mapping tools such as Google Maps are acceptable.
- Drawings/illustrations of proposed project – more focalized, site-level view that shows a more detailed layout of the ESS and its key fire safety elements.
- Photographs that show key areas of the site, and/or any special or unique elements that should be discussed or highlighted with the plan reviewers.

Be sure to denote items clearly using a legend and/or labels.

Examples of site map screenshots and illustrations are provided on pages 4-7. These are intended as examples only; visual aids should be tailored to an individual site's unique features, layout, requirements, and site elements.

In addition, each visual aid example includes an accompanying legend. A *Legend Template Library* is available in Appendix A (page 9) which contains ready-to-use legend symbols, if desired (note that use of this legend format/structure is optional and provided as a helpful tool, but is not required).

Example Visual Aids With Key Item Labels

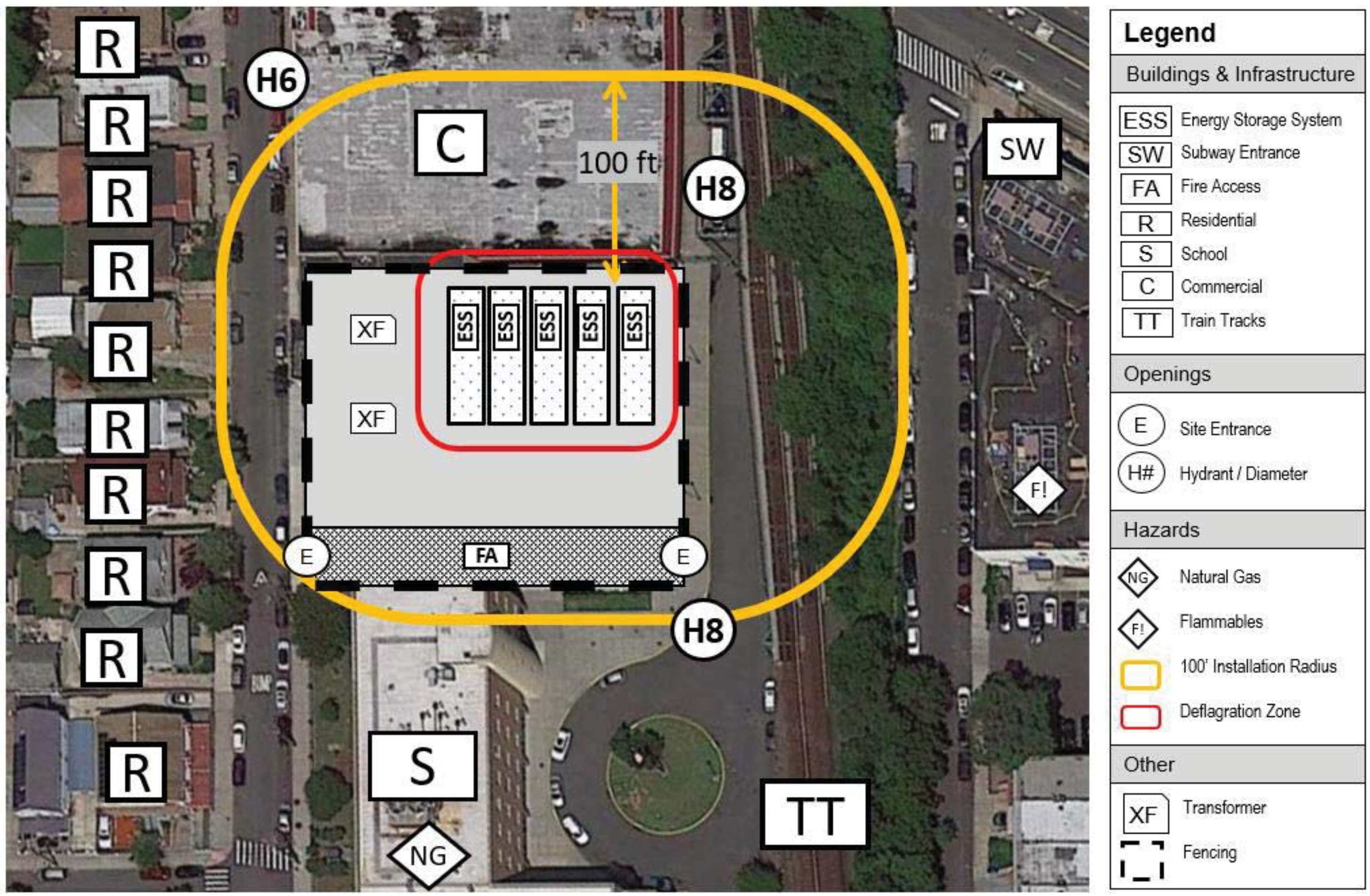
The following four examples illustrate what the visual aids in a site plan could look like, with examples of both a proposed ground-mount and a rooftop installation, as follows:

<u>Example Visual Aid Contents:</u>

1. Ground Mount, Aerial View
2. Ground Mount, Site-Level View
3. Rooftop Mount, Aerial View
4. Rooftop Mount, Site-Level View

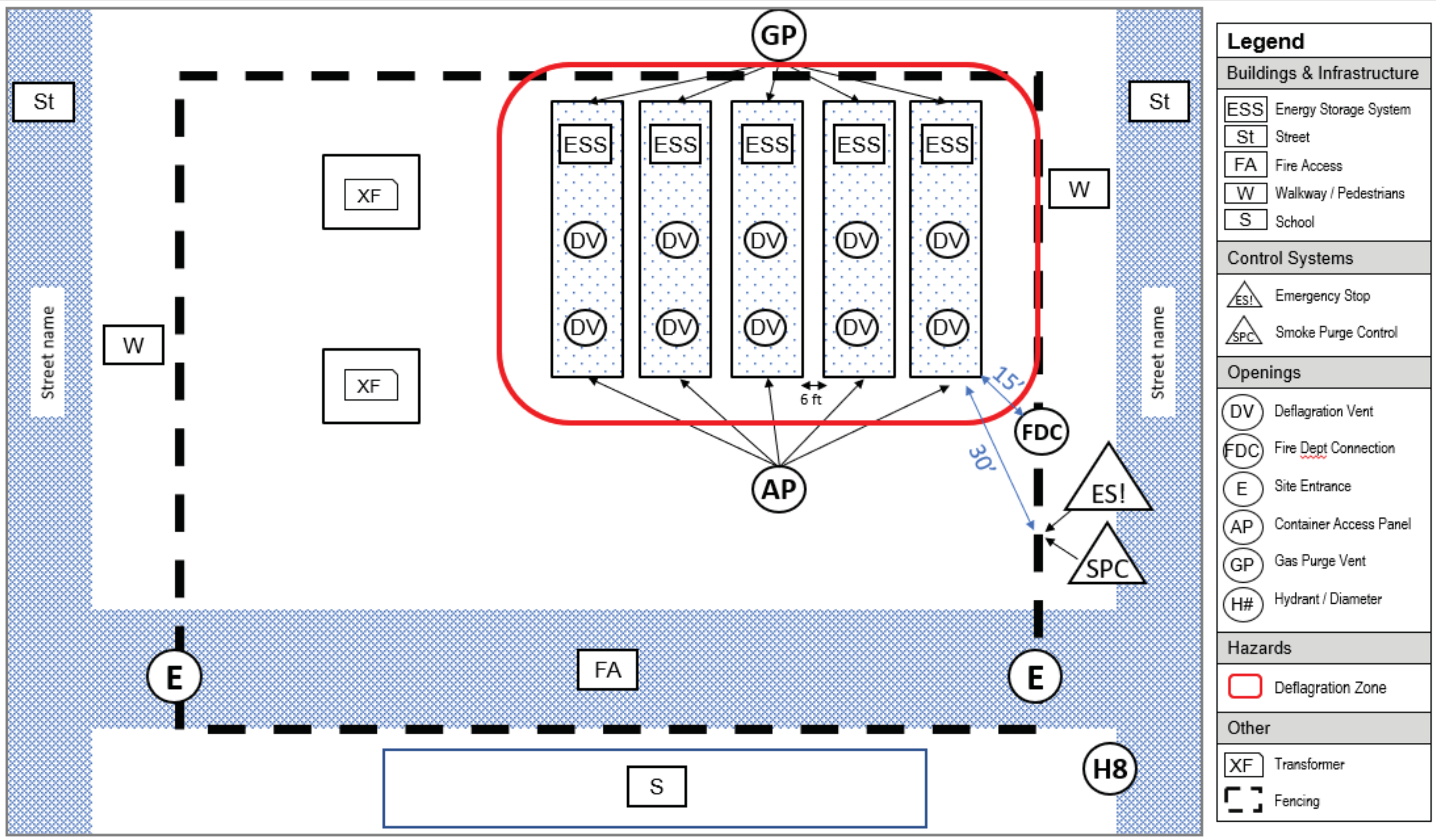
1. Ground Mount Installation, Aerial View

This is an example image taken from Google's online satellite map. Key site as well as surrounding elements are labeled on the map. Note that the items listed in the legend pertain to elements that are specific to this particular site (e.g. School **S**, Train Tracks, **TT** etc.). Legend labels are to be modified to meet your needs, for example a Hospital building denoted by **H**, or a Nursing Home denoted by **N**.



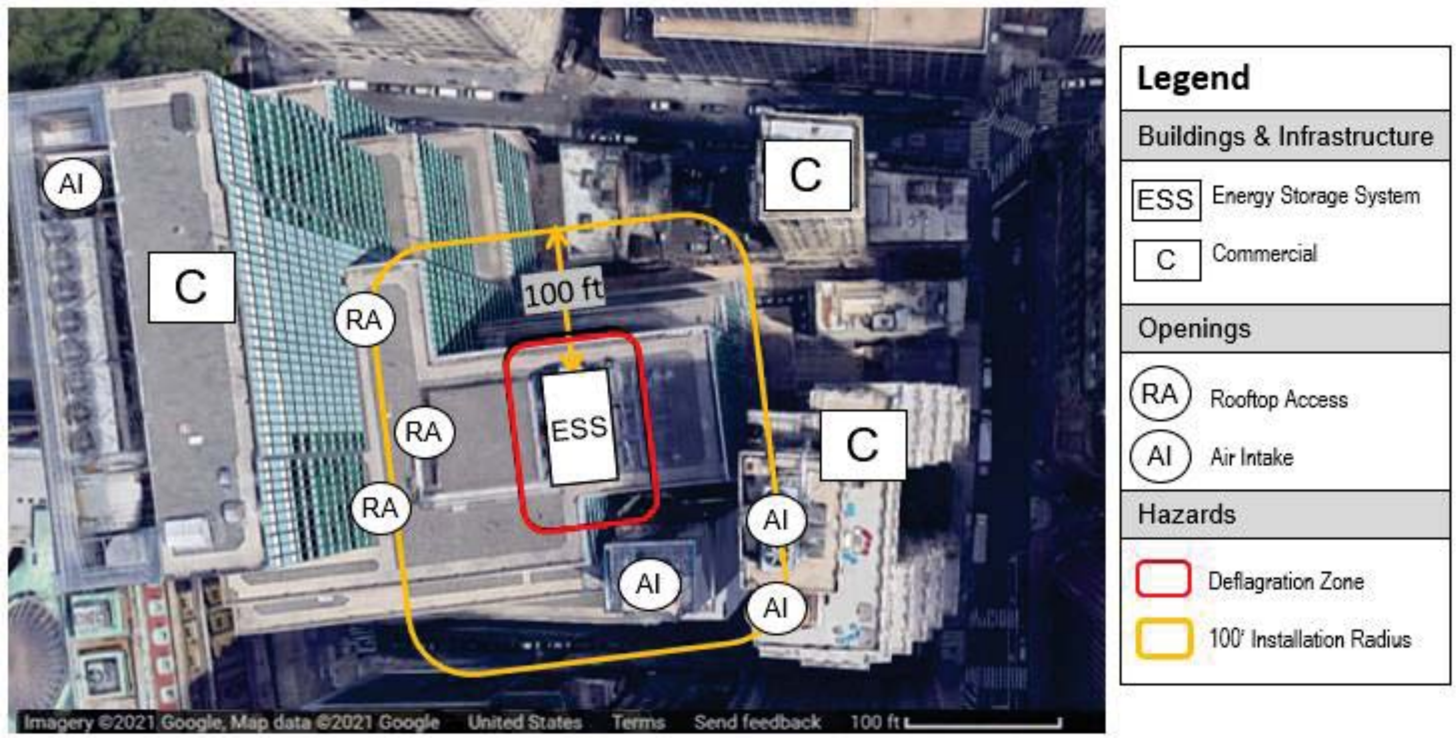
2. Ground Mount Installation, Site-Level View

This is an example of a drawing of the proposed project at site-level view. Details pertaining to the location of equipment-specific elements (e.g. fire safeties, controls) are denoted. Likewise, any legend labels should be modified to meet the needs of your project. Additional layout details, such as the 6 foot spacing shown between containers in the example below, provide helpful context for plan reviewers.



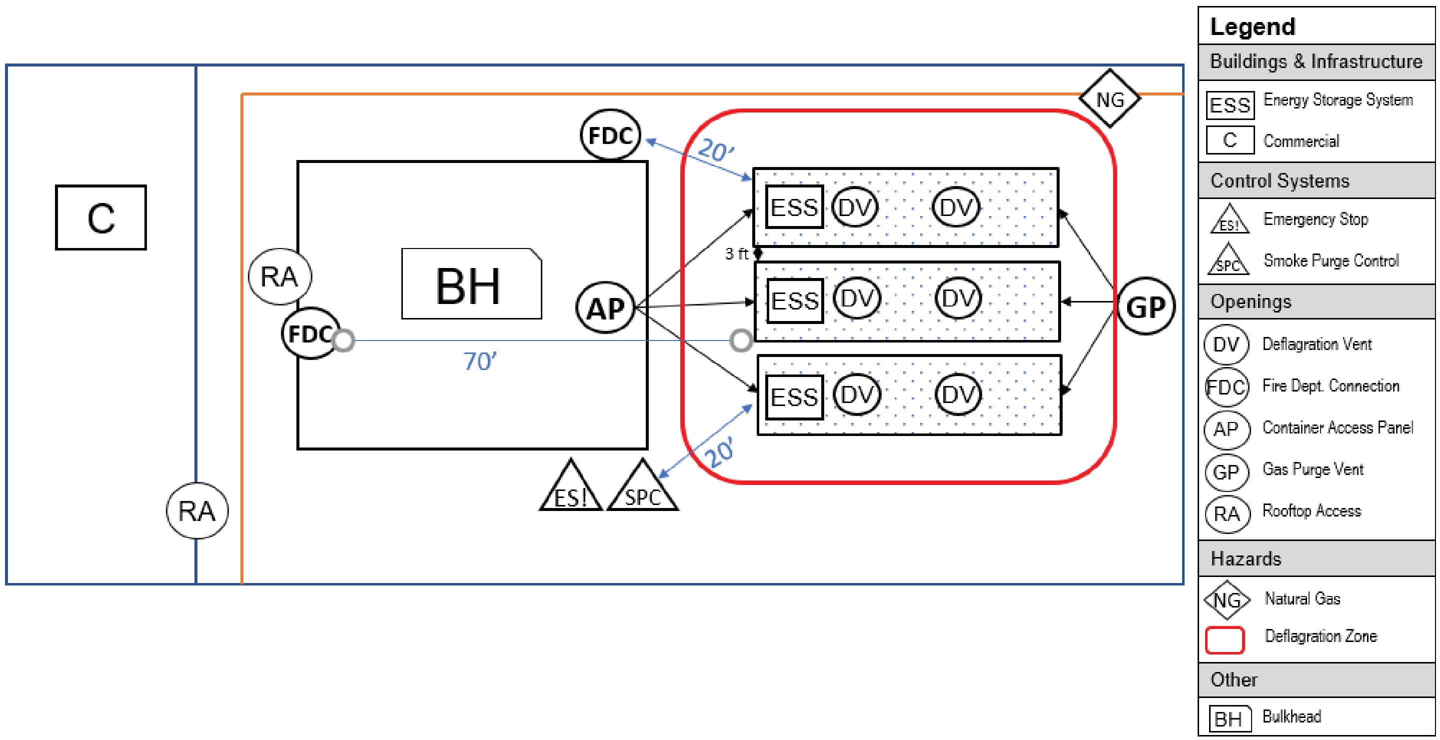
3. Rooftop Installation, Aerial View

This is an example map image of a proposed rooftop installation. Note that this contains several of the same elements that are shown in Example 1 above (Aerial view, Ground-Mount installation), but some key elements are different due to the nature of the rooftop setting – for example, there are no hydrants to be denoted on the image, while Rooftop Access (RA) points are a key item for rooftop installations. Again, all elements must be adapted/modified to meet the unique needs and features of your project.



4. Rooftop Installation, Site-Level View

The drawing below provides an example of the site-level view of the same proposed rooftop installation as shown in example 3 above.



Appendix A: Legend Template Library

Buildings & Infrastructure		Openings		Control Systems		Hazards		Other	
ESS	Energy Storage System	AP	Access Panel	ES!	Emergency Stop	CG	Co-Gen Plant	BH	Bulkhead
FA	Fire Access	AI	Air Intake	SPC	Smoke Purge Control	F!	Flammables	XF	Transformer
St	Street	DV	Deflagration Vent			FC	Fuel Cell		Fencing
SW	Subway Entrance	E	Site Entrance			HM	Hazardous Materials		
TT	Train Tracks	FDC	Fire Dept Connection			NG	Natural Gas		
W	Walkway / Pedestrians	GP	Gas Purge Vent				100' Installation Radius		
C	Commercial	H#	Hydrant / Diameter				Deflagration Zone		
R	Residential	RA	Rooftop Access						
S	School								
RC	Rooftop Clear Path								