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San Francisco Local Agency Formation Commission (LAFCo)

LAFCo Study for CleanPowerSF on Battery Energy Storage Systems

LAFCo BESS Policy Research

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Contents

Tables

Figures

Appendices

1. Executive Summary

The City and County of San Francisco's (CCSF) 2021 Climate Action Plan identified battery energy storage systems (BESS) as important technologies to support the electrification of buildings and transportation, support the reliable operation of the electric grid, and provide emissions-free back-up power supply for energy reliance.[1] This study was commissioned by the San Francisco Local Agency Formation Commission (LAFCo), in collaboration and with funding from CleanPowerSF, San Francisco's Community Choice Aggregation program, operated by the San Francisco Public Utilities Commission (SFPUC). The goal of this study is to improve the experience of residents and businesses seeking to install BESS systems. While multiple factors related to solar and battery markets, costs, and regulations influence customer adoption of BESS, this report focuses on the experience of residential customers seeking to install BESS in San Francisco.

The San Francisco Department of Building Inspection (SFDBI) and Fire Department (SFFD) regulations and policies play a significant role in the BESS installation process. While review of the regulations and codes promulgated by comparable major cities suggests San Francisco is neither an outlier nor creator of significant barriers to BESS installations in terms of code language, review of how that code language is interpreted and enforced by SFFD raises important permitting barriers for BESS implementation in R-2 and R-3 occupancies. The most notable is inadvertent confusion on definitions for "system" and "unit", and how the conflation of the two impacts BESS permitting process. The impact is primarily materialized in inconsistent permitting pathways across online permitting platforms and the departments' (DBI and SFFD), branching permitting processes, and additional BESS installation and permitting requirements for "systems", rather than "units".

In 2023, CCSF adopted National Renewable Energy Laboratory's (NREL) online Solar permitting program, SolarAPP+, allowing applicants to receive automated permits for their Solar+BESS if individual BESS units do not exceed 20 kWh. SolarAPP+ conflicts with the SFFD's permitting policy which requires applicants to submit for a building permit if aggregate capacity of BESS units exceed 20 kWh. This permitting confusing on similar, but different, language and colloquial usage thereof is likely not the primary contributor to BESS implementation challenges. Despite having a more "streamlined" automated permitting option that has saved approximately one (1) hour per application for initial permit review, there have been only 54 SolarAPP+ submittals since October of 2023, suggesting other factors are influencing the low number of BESS associated with solar installations.

While the use of SolarAPP+ does not affect the initial public application process, it does create unintended and unaccounted inefficiencies for CCSF staff in processing the applications. The SolarAPP+ platform limits the information that may be submitted to a simplified checklist, which can be insufficient to convey critical information needed for complete design reviews. Though meant to minimize the initial review period, SolarAPP+ does not allow for detailed information such as plans, single line diagrams, or UL9540A information to be uploaded. This limitation ultimately leaves critical design information out of permit application and pushes design corrections to resubmittals or field inspections. The permitting platform also does not allow for particular use cases like those where solar is already installed at the building, and the applicant is applying for permit to add a BESS. SolarAPP+ platform usage questions are also directed to City staff, which incurs additional time and costs for both residents and the City. A maximum of $450 can be recouped for this additional effort due to the fee cap imposed by California Assembly Bill 1414, which in effect created another unfunded mandate by the State onto local government. Currently, the CCSF's obsolete permitting fee system automatically calculates permit fees based on valuation as opposed to this legislated fee limit. To meet this permit fee limitation in lieu of updating permitting systems, DBI allows contractors to request refunds for the amount the contractor was charged in excess of the fee cap.

[1] For more information see: https://www.sfclimateplan.org/

Some aspects of San Francisco's BESS permitting process (including those mentioned above) that could be improved are:

- Interagency alignment and individually consistent usage of the BESS terms, specifically "unit" and "system"
- SolarAPP+ limitations
- Branching review process (between DBI and SFFD)
- Unspecified review deadlines
- Staff rotation that negatively impacts the process through loss of familiarity and expertise
- Updated IT systems to ensure compliance with state permit fee regulations.

Strengthening the coordination between the SFFD and SFDBI ensures alignment across departments and minimizes the use of resources while expediting the process. Additionally, the permitting process could be clarified by incorporating permit expediters, already commonly used in San Francisco, to field SolarAPP+ questions from applicants rather than City staff. Furthermore, coordination with SFFD to explore embedding inspection requirements into the SolarAPP+ platform to allow first-time BESS installers to have a more streamlined experience would contribute to strengthening SFFD and SFDBI coordination. Consideration for pre-inspection activities, such as an installer uploading photos and additional site information prior to a scheduled inspection, may also expedite the process.

Beyond the permitting process, other factors that may influence BESS uptake, such as equipment and installation costs, represent significant costs for those looking to implement BESS. While there are a variety of state and federal incentive programs dedicated to supporting BESS and solar installations through tax credits, deductions, rebates, technical assistance, and other types of incentives, these can be difficult for applicants to track, navigate, and understand to utilize their potential. This report does not address utility interconnection requirements, though utility interconnection application and permission to operate is also required from the electric utility of all BESS installations. This utility interconnection process can result in additional costs and delays. The complex, costly process of obtaining a permit and installing a BESS or solar system indicates that consumers may need more financial, technical, or communication support throughout the process.

From a workforce development standpoint, the industry is still calibrating to the needs of solar and BESS installations. This means that it can be difficult for contractors to navigate different licensure paths and gain the experience needed to advance their careers. Furthermore, the incentive-based nature of BESS and solar installations means that there is not a steady demand for this type of work. More coordination is needed within the industry to establish congruence between workforce development and BESS and solar installation to meet the respective needs and goals of all involved entities.

2. Introduction

The demand for residential battery BESS in California is increasing each year.[2] According to the California Energy Commission, the total capacity of BESS in residential occupancies was 843 MW in 2023, a substantial increase from just 264 megawatts (MW) in 2020.[2] Drivers of such growth include declining BESS cost, increasing energy costs, new Net Billing Tariff (NBT) compensation rates, concerns regarding grid reliability, and disaster resilience. However, the installation and permitting process can pose challenges. To better align the public experience with policy priorities, LAFCo, in collaboration with the SFPUC and the San Francisco Environment Department, has commissioned this report, funded by CleanPowerSF, with the goal of streamlining the BESS permitting and installation process, focusing on greater cost-effectiveness, policy efficacy, and safety.

[2] California Sees Unprecedented Growth in Energy Storage, A Key Component in the State's Clean Energy Transition

3. Summary

This memo summarizes opportunities and barriers to BESS in Group R-3 and Group R-2 occupancies and provides discussion regarding a comparison to similar high-density municipalities. Group R-3 occupancies are single-family houses and duplexes, while Group R-2 occupancies contain more than two dwelling units. Opportunities and barriers are presented through a summary and qualitative analysis of current BESS regulations for residential buildings in six U.S. cities. These regulations include permitting, installation, operation, and maintenance. The cities selected for this study were chosen for their similarity to San Francisco due to housing type, density, or similar BESS installation maturity. Austin, TX, Chicago, IL, Fremont, CA, New York, NY, and San Jose, CA were selected. The report highlights the similarities and differences amongst regulations and discusses the implications.

Specifically, this report covers the following topics:

- CCSF goals and objectives for BESS in Group R-3 and R-2 residential applications
- Commercially viable battery technologies for BESS with a comparison of applications, safety, performance, price, and other factors
- State and local codes and policies for Group R-3 BESS. This occupancy is the most common for residential buildings in San Francisco. The report focuses on the San Francisco Fire Code (SFFC), San Francisco Electrical Code (SFEC), and SFFD Administrative Bulletin 5.12 "Energy Storage Systems in R-3 Occupancies" (AB 5.12).
- Review of the codes and policies for Group R-3 BESS installations from a sample of municipalities to identify best practices and lessons learned from other jurisdictions
- State and local codes and policies for Group R-2 BESS. This includes relevant information from SFFC and SFEC, but it does not include details from SFFD since this does not apply to R-2 occupancies.
- Review of the permitting processes for BESS by occupancy and capacity, including compliance with SB379 for real-time permitting and the use of NREL SolarAPP+
- Review and mapping of available data related to existing BESS storage and Solar installations in San Francisco
- Financial resources for BESS implementation, including state and federal financial incentives and low-income incentives.
- Educational resources for BESS implementation, including BESS installation workforce and training and consumer navigation and installation
- Opportunities to utilize BESS as a virtual power plant
- Possible areas of improvement to existing San Francisco BESS regulations, and, where applicable, policy recommendations which promote safe and effective residential BESS installations

4. Project Goals and Objectives

The purpose of this study is to identify areas of improvement to existing local BESS policies and regulations in San Francisco to support the City's goals of decarbonization, resilience, and economic development. Increasing BESS implementation could benefit individual residential customers, electric utilities, and the California Independent State Operator (CAISO), not just in energy resiliency but also in reduced energy costs over time despite the high upfront cost of these systems. Individual customers would benefit from lower time-of-use (TOU) rates, electric utilities can gain the benefit of increased distribution of locally generated resources amongst customers whilst still controlling the distribution network, and CAISO would benefit from flexibility and lower peak demands through offsetting demand locally without introducing additional outside electricity resources into the grid.

This study considers three use scenarios: Solar, BESS, and Solar+BESS. Solar installations are those in which there is no associated BESS system and the energy generated is first used to power the building, with any excess sent directly to the grid through a net energy metering (NEM) program. Such installations are not optimized for time-of-use based metering or reliance. BESS installations without Solar can be used to arbitrage price peaks or provide resilience during outage events but are reliant on the grid to be recharged. Solar+BESS installations have the greatest potential benefit as the configuration can generate, store, and use energy, which reduce reliance on the grid.

End users that would benefit the most from BESS deployment are those with existing Solar systems without NEM 1.0/2.0 and Solar users with NEM 3.0. NEM is a California metering policy that allows Solar system owners to earn credit for excess energy production, thereby reducing their monthly energy bill. NEM 1.0 and 2.0 guarantees participants 20 years of net metering after receiving authorization from Pacific Gas & Electric (PGE) through a Permission to Operate (PTO) resulting in bill credits equivalent to their full retail rate for excess Solar generation. Upon expiration of NEM 1.0 and 2.0, participants will no longer be eligible for excess Solar generation bill credits. As such, BESS deployment will ensure excess solar generation is not sent to the grid, but rather stored away for use when solar energy is not being generated. Similarly, Solar users that typically generate excess power and are currently enrolled in NEM 3.0 would also benefit more if paired with a BESS. This is because NEM 3.0 solar export rates are calculated as avoided costs which refers to the price that PG&E pays for solar energy sent to the grid. This new rate is approximately 75% less than NEM 1.0 and 2.0 export rates, meaning that there is less financial incentive to sell excess energy back to the grid. Instead, excess energy generated from Solar can be stored in BESS and used during peak demand when the cost of electricity is highest or when solar energy is not being generated. Older PV systems that are smaller and do not generate excess demand to sell back through the grid through NEM can still benefit from a BESS by engaging in energy arbitrage, but the upfront capital cost of the BESS is likely cost prohibitive for this use case.

Other specific end users that would benefit the most from BESS deployment include electric vehicle (EV) owners, residents planning to electrify their homes, and those who require uninterrupted power for medical reasons. EVs have become increasingly popular with San Francisco having the second highest EV adoption rate (about 34%) among major U.S. metropolitan areas in 2023[3]. California EV incentive programs, such as the Clean Cars for All program run by the Bay Area Air and Quality Management District, offer cash redemption for low-income residents who retire and replace certain vehicles with an EV. Additional incentives are available for installing a Level 2 home charging station attempting to make both EVs and home charging stations more affordable. As the number of residences electrifying and installing at home EV charging increases, BESS can be used to store excess energy that can be discharged during peak demand times, reducing the demand on the grid during peak charging times and saving the BESS user money on electric utility bills.

For medically vulnerable populations who are dependent on refrigerated medication or electricity-powered life sustaining equipment, a BESS can ensure a consistent power supply. Many common medications require refrigeration or run the risk of reduced potency, such as insulin and TNF inhibitors for inflammatory conditions. Without these medications, users can experience a decrease in quality of life or even death. BESS deployment in such residencies reduces the risk of ineffective medication or equipment failure during power outages. These use cases may still be subject to high capital costs associated with BESS implementation, but likely have access to rebates, incentives, and other financing structures that significantly reduce or eliminate costs.

[3] The Bay Area Leads the National Shift to Electric Vehicles - The New York Times (nytimes.com)

5. Commercially Available Battery Technology

The most common battery types found in residential BESS are lithium iron phosphate (LFP), lithium nickel manganese cobalt oxide (NMC), both of which are a type of lithium-ion battery, and lead-acid. Historically, lead-acid was the standard battery chemistry until supplanted by NMC batteries. In recent years, LFP has become the industry standard for residential BESS by providing a more favorable combination of safety, cost, and performance compared to NMC batteries. Table 1 provides an overview of the main differences between lithium iron phosphate, lithium nickel manganese cobalt oxide, and lead-acid batteries. Table 2 provides a list of currently commercially available batteries.

Table 1: Commercially Available Battery Type Comparison

Criteria	Lithium Iron Phosphate (LFP)	Lithium Nickel Manganese Cobalt Oxide (NMC)	Lead-Acid
Efficiency	Has the highest total charge-discharge cycle efficiency.	Has a high total charge-discharge cycle efficiency.	Has a slightly lower total charge-discharge cycle efficiency than lithium-ion battery technologies.
Storage capacity	Systems available in a variety of energy capacities.	Systems available in a variety of energy capacities.	Systems available in a variety of energy capacities but has a lower capacity per battery module than LFP and NMC batteries.
Usable capacity	Has a high usable capacity.	Has a high usable capacity.	Has a lower usable capacity than LFP and NMC batteries.
Energy Density	Has a high energy density.	Has the highest energy density.	Has a low energy density.
Durability	Has the highest durability with a large total life cycle.	Highly durable with a large total life cycle.	Less durable with a lower total life cycle.
Safety	Safest battery technology.	Safe battery technology.	Safer battery technology.
Maintenance	Requires basic annual maintenance.	Requires basic annual maintenance.	Requires basic annual maintenance.
Cost*	More affordable than NMC.	More expensive than LFP.	Cost per cycle is typically higher than NMC and LFP

* Cost per cycle is highly dependent on operation, maintenance, and environment.

Table 2: Examples of Commercially Available Batteries

Battery Type	Name	Storage Capacity
Lithium Iron Phosphate	sonnenCore	10 kWh
Lithium Iron Phosphate	Enphase IQ 10	10.08 kWh
Lithium Iron Phosphate	BYD Battery Box HVS	10.24 kWh
Lithium Nickel Manganese Cobalt Oxide	Tesla Powerwall	13.5 kWh
Lithium Nickel Manganese Cobalt Oxide	LG RESU10H Prime	9.6 kWh
Lithium Nickel Manganese Cobalt Oxide	Generac PWRCell	9 kWh
Lead-Acid	UNBOUND Crown Battery Bank	2.58 kWh per battery pack 20.64 kWh per bank of 8 batteries

5.1 Efficiency

Battery efficiency is a measure of how effectively a battery can convert stored energy into usable power. Most lithium-ion batteries are 95% efficient or more, whereas most lead-acid batteries are 80% to 85% efficient. LFPs are slightly more efficient than NMCs[4], especially at lower temperatures. This matters little when the BESS is installed indoors or in mild climates like San Francisco. Overall, lithium-ion batteries both offer longer usage times between charges and reduce energy waste compared to lead-acid batteries.

5.2 Storage Capacity

A higher storage capacity can be achieved with fewer lithium-ion batteries when compared to lead-acid batteries. Additionally, the lead-acid battery packs have a larger footprint when compared to lithium-ion for the same storage capacity. Thus lithium-ion based battery technology is considered preferable for residential installations as greater capacity in less area is achieved.

5.3 Usable Capacity

The usable capacity of a BESS refers to the amount of electricity stored that is available for use compared to the total capacity, as batteries require a degree of charge to be retained to remain functional. A battery's usable capacity is determined by the depth (e.g., %) that the battery can be discharged before negatively affecting the lifespan.

Lithium-ion batteries can handle discharges of 80% or more, whereas typical lead-acid batteries can accommodate a 50% discharge. Although both battery types can be fully discharged safely, lithium-ion batteries can handle a deeper discharge before risking damage. Lithium-ion batteries can provide more usable energy before needing to be recharged.

5.4 Energy Density

The energy density of a battery system relates to the amount of energy that the battery can store per kilogram (kg) of battery mass. Lead-acid batteries typically have 30–40 Wh/kg compared to 90–120 Wh/kg for LFP batteries and 150–220 Wh/kg for NMC batteries. This means a lead-acid based BESS will weigh more than lithium-ion system and may require additional infrastructure to support the increased weight.

5.5 Durability

The durability of a battery refers to the amount of charge-discharge cycles a battery can withstand before reaching the end of its useful life. Each charge-discharge cycle decreases a battery's useful life and batteries that have reach ~80% of the original capacity are considered to have reached end-of-life. A typical lithium-ion battery can withstand the equivalent of a few thousand charge-discharge cycles to 100% depth of discharge, whereas a typical lead-acid battery can withstand only a few hundred charge-discharge cycles at 100% depth of discharge. Since batteries are never intentionally discharged to 100%, it is important to understand that the charge-discharge cycle is cumulative. For example, a battery that was discharged to 40%, recharged, discharged to 60% and then recharge would have the rough equivalent of a single 100% charge-discharge cycle. The cycle life of LFPs and NMCs are similar, but degradation occurs at a slower rate with LFPs. This means that LFP batteries can store and release more electricity than NMC and lead-acid battery types over time.

From a cost perspective, LFPs are more cost effective. For example, a 10 kWh sonnenCore LFP BESS has an approximate first cost of $9,500 but will output 58,000 kWh of energy over the expected lifetime. Whereas an LG Chem Prime NMC BESS has an approximate first cost of $7,000 but will only output 32,000 kWh of energy.

5.6 Safety

In terms of lithium-ion batteries, LFPs are considered safer than NMCs as lithium iron phosphate is more stable than lithium nickel manganese cobalt at high temperatures. Stability can be benchmarked by the temperature at which the battery enters thermal runaway. Thermal runaway is a fault process where the rate of heat generation in a battery exceeds the battery's ability to dissipate the heat, leading to a rapid increase in temperature that can result in fire or an explosion. Thermal runaway occurs in LFP batteries ~518°F, whereas NMC batteries enter

[4] Degradation of Commercial Lithium-Ion Cells as a Function of Chemistry and Cycling Conditions - IOPscience

thermal runaway at ~410°F. Having a higher temperature tolerance means LFP batteries can handle larger draws of power due to the heat generation from internal resistance.

Due to the higher thermal runaway, LFP batteries are less likely to catch fire than NMC batteries. On the other hand, a fire involving any lithium-ion chemistry may be more severe than that of a lead-acid battery since the only combustible component of a lead-acid battery is the casing, which is usually made of fire-retardant polypropylene.

Battery management systems (BMS), which monitor parameters such as voltage, current, and temperature, allow the BESS to stop the charging or discharging process in case of abnormal conditions. This greatly reduces the chance a battery will enter a state of thermal runaway. A BMS is required as part of a BESS UL 9540 listing. The UL 9540 listing aims to ensure a baseline level of safety and compatibility for a BESS. UL 9540A testing, which is referenced in UL 9540, also covers BMS that are part of a BESS and evaluates the fire safety hazards associated with propagating thermal runaway within a BESS. To pass UL 9540A testing, which is needed for the UL 9540 listing, a residential BESS must meet specific fire safety performance criteria without any external fire suppression or intervention.

5.7 Maintenance

Both LFP and NMC batteries require only basic annual maintenance which includes conducting full maintenance cycles (e.g., a full discharge and full charge) every 3-6 months. Unlike lithium-ion batteries, some lead-acid batteries are recommended to undergo regular maintenance at three-month intervals and certain types, such as flooded lead-acid batteries, must have electrolyte levels monitored and replenished in addition to regular visual inspection to spot sulfation. Failure to regularly maintain a lead-acid battery could result in abnormal operation, more rapid degradation, and other safety concerns.

5.8 Cost

LFP batteries have lower upfront costs than NMC batteries. This is mostly because the elements, iron and phosphate, incorporated into LFP batteries are more abundant and less expensive than the nickel, manganese, and cobalt required to produce NMC batteries. A 2020 report published by the Department of Energy found that LPF batteries cost 6% less per kWh than NMC batteries.[5]

5.9 Key Takeaways

When compared to lead-acid batteries, lithium-ion battery types are generally more efficient, have a higher energy capacity, higher usable capacity, and a higher energy density. This means that a lithium-ion battery can provide more efficient usable energy while taking up less space than a lead-acid battery. Lithium-ion batteries are also more durable and have a longer life cycle and require less maintenance than comparable lead-acid batteries.

While LFP and NMC lithium-ion batteries perform very similarly, it is worth noting that LFP batteries are slightly more efficient and degrade slower than NMC batteries, meaning LFP batteries waste less energy and have a higher total energy output during their life cycle. LFP batteries are also more stable than NMC batteries and hit thermal runaway at higher temperatures, making LFP the safer lithium-ion battery technology. NMC batteries do have a higher energy density, resulting in an overall smaller battery when compared to LFP batteries. LFP, which has greater safety and cost-effectiveness, has become the industry standard for residential BESS.

[5] Final - ESGC Cost Performance Report 12-11-2020.pdf (pnnl.gov)

6. State and San Francisco Local BESS Codes and Policies for Group R-3 Occupancies

6.1 Introduction

In this section, codes and policies affecting BESS in Group R-3 occupancy buildings, including SFFC, SFEC, and SFFD Admin Bulletin 5.12, are presented. A few key limitations on installing BESS in Group R-3 occupancies in San Francisco include:

- Energy capacity limits
- Physical system size
- Additional requirements for systems greater than 20 kWh
- 3ft separation from doors, windows, and other BESS units
- Specific safety requirements such as monitoring, ventilation, explosion mitigation, thermal runaway mitigation, spill control, and fire sprinklers

6.2 San Francisco BESS Requirements

The CCSF has set forth goals towards make the city a cleaner energy consumer by the year 2040.[6] As part of this there has been a focus on transitioning the city's residents towards residential Solar and BESS systems. The SFFD released AB 5.12 to attempt to clarify the Department's interpretation, and how to meet SFFC requirements related to energy storage systems (ESS). This section reviews some of the codes and policies that place restrictions on installing BESS in Group R-3 buildings.

6.2.1 Energy Capacity

The maximum aggregate capacities per installation within Group R-3 occupancies are:

1. 40 kWh within utility closets and storage or utility spaces
2. 80 kWh outdoors on the ground
3. 80 kWh on exterior walls
4. 80 kWh in attached or detached garages and detached accessory structures

AB 5.12 limits the maximum capacity of individual BESS to 20 kWh, and the maximum total energy rating permitted is 280 kWh if all four installation options noted above are implemented. BESS that exceed the individual capacity or aggregate capacity listed above are required to comply with the CFC §1207.1 through §1207.9. The SFFD has interpreted this portion of the code to apply to aggregate BESS and individual BESS units exceeding the 20-kWh threshold.

This is an interpretation of the code language that, in conflating BESS "system" and "unit", aggregate systems exceeding the 20-kWh threshold are subject to additional installation and permitting requirements and processes per the SFFD. The 2022 California Fire Code, SFFD Admin Bulletin 5.12, and 2022 California Residential Code language is written in a way that delineates individual BESS unit requirements from aggregate BESS requirements. Individual battery modules are combined to create a BESS with the desired storage capacity. The capacity can be varied by increasing or decreasing the number of modules used. The aggregate storage capacity

[6] San Francisco Adopts New Climate Action Goals | Office of the Mayor (sfmayor.org)

of any residential BESS is generally limited to 40 kWh or 80 kWh, depending on the location of the system within an R-3 occupancy (reference Appendix A).

An illustrative home in San Francisco using 8,760 kWh of electricity per year, would average 24 kWh of electricity per day. For single family homes under R-3 occupancies, this 20-kWh limitation is typically sufficient, as a 13.5 kWh BESS can power the critical electrical systems, excluding electric heat and air conditioning, in an average house for 24 hours. However, this size of BESS may become increasingly strained as single-family home residents begin to electrify their space heating, water heating, and cooking equipment, add at home EV charging stations, and growing interest in energy resilience and self-reliance like those looking to meet San Francisco's goal of 72-hour disaster recovery (SF72). This is exacerbated when applying this size of BESS to more dense residences like duplexes. Furthermore, if applicants are aiming to achieve whole home backup for even short periods of time, under all R-3 occupancy types, multiple BESS units would need to be combined. Under SFFD's interpretation of BESS "system" and "unit", these latter scenarios would be subjected to the additional installation and permitting requirements for aggregate BESS over 20 kWh.

6.2.2 Ventilation

Indoor BESS that produce hydrogen or other flammable gases during charging shall be provided with mechanical ventilation in accordance with the San Francisco Mechanical Code. Of the three battery chemistries under consideration, this requirement would apply to lead-acid based BESS. BESS that have the potential to release toxic or highly toxic gas during charging, discharging, and normal use conditions shall not be installed within Group R-3. None of the battery chemistries considered fall under this restriction.

6.2.3 Permitting Requirements

A construction permit is required for BESS at 20 kWh or greater or for any BESS with liquid capacities exceeding 50 gallons in Group R-3 occupancies. DBI requires an electrical permit for construction, and additional building permits may be necessary depending on the scope of work. SFFD requires a construction permit for systems of 20 kWh or greater, as well as operational permits of systems with 50 gallons or more of electrolyte.[7,8] Compared to SolarAPP+ permits that can be automated for individual BESS units less than 20 kWh, larger systems where individual BESS units exceed 20 kWh can incur permitting fees of $6,000 or more. While individual BESS in residential applications are unlikely to exceed this limit based on typical market sizing of residential BESS, the SFFD interpretation detailed in Section 6.2.1, forces BESS that, either in aggregate or individually, exceed the 20 kWh threshold to obtain a construction permit.

6.2.4 Listings

BESS shall be listed and labeled in accordance with UL 9540.[9] BESS less than 1 kWh are not required to be listed and labeled in accordance with UL 9540.

The UL 9540 listing provides the confidence that a baseline level of safety has been met. The UL 9540 listing references UL 9540A *"Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems"* which is a testing methodology to determine how components within the BESS act in thermal-runaway failure scenario from the cell level to the unit level of the system.[10]

6.2.5 Vehicle Impacts

BESS must comply with applicable requirements of CFC §1207.11.7.1. Where a BESS is installed in the normal driving path of vehicle travel within a garage, impact protection complying with §1207.11.7.3 shall be provided.

[7] Get a permit for a Solar photovoltaic system | San Francisco (sf.gov)

[8] 2022 San Francisco Fire Code T-107-A

[9] UL 9540 Energy Storage System (ESS) Requirements - Evolving to Meet Industry and Regulatory Needs | UL Solutions

[10] UL 9540A Test Method | UL Solutions

Where clear height of vehicle garage opening is 7 feet 6 inches or less, ESS installed not less than 36 inches above finished floor are not subject to vehicle impact protection requirements. Impact protection must be implemented per §1207.11.7.3 and either include bollards at least 6 inches from the BESS or wheel barriers not less than 54 inches from the BESS.

Vehicle impact protection protects the BESS from vehicular damage since such damage could result in thermal runaway or fire from abnormal conditions. This results in an increased level of safety for BESS that is installed in areas with a higher-than-normal risk of damage.

6.2.6 Space Requirements for Outdoor Specific Installation

SFFC allows BESS to be installed outdoors not less than 3 feet from doors and windows. The purpose of the 3-foot separation from doors and windows is because, such openings create a pathway for fire to spread into the home more easily than an exterior wall. Where the exterior walls of homes are located closely adjacent to property lines or other homes, the exterior installation of BESS may be challenging.

Separation using fire-rated assemblies is not required unless the aggregate rating of the BESS exceeds 200 kWh, which is not typical of BESS used in R-3 occupancies. The SFFC does not outline egress or public way requirements for BESS of 20 kWh or less, but notes egress requirements for BESS larger than 20 kWh are as required by the fire code official, but not less than 10 feet.

6.2.7 Space Requirements for Interior Installation

The SFFC requires that BESS shall be installed only in the following locations:

1. Detached garages and detached accessory structures.
2. Attached garages separated from the dwelling unit living space and sleeping units as follows:
   a. For attached garages located below habitable rooms, the separation shall be constructed of a minimum 5/8-inch Type X gypsum board or equivalent.
   b. From the residence and attics, the wall separation shall be not less than a ½-inch gypsum board or equivalent on the garage side.
3. Outdoors or on the exterior side of the exterior walls located not less than 3 feet from doors and windows directly entering the dwelling unit.
4. Enclosed utility closets, basements, storage or utility spaces within dwelling units with finished or noncombustible walls and ceilings. Walls and ceilings of unfinished wood-framed construction shall be provided with not less than a 5/8-inch Type X gypsum wallboard.

Individual BESS units shall be separated by at least 3 feet of spacing. Clearance of 3 feet shall be provided in front of electrical equipment for maintenance purposes and kept clear of combustible storage. Any eaves, structures, decking, or other such construction protruding more than 2 feet from the exterior wall upon which the BESS is installed shall be located at least 3 feet from the BESS unless exterior walls and eaves are constructed with noncombustible surfaces.

SFFD AB 5.12 allows spacing requirements to be reduced from 3 feet upon review and approval by the AHJ when complying with CFC §1207.1.5 and §104.8.2. For approval, the applicant is required to submit copies of both UL 9540A testing report and installation instructions showing recommended reduced spacing between the ESS unit(s) being installed. If minimum spacing varies between the two documents, the more restrictive separation distance will be approved.

6.2.8 Additional Installation Requirements per SFFD Bulletin 5.12

For exterior installations of BESS, the AB 5.12 requires the following:

- Property lines and means of egress: minimum separations of 3 feet may be reduced to 12 inches where a 1-hour free-standing fire barrier and extending 3 feet above and 3 feet beyond the physical boundary of the BESS installation is provided to protect the exposure.
- The exterior wall upon which the BESS is installed shall be located at least 12 inches from other exterior walls of the same building in either direction.
- The BESS shall be installed at a minimum of 3-feet from the public way, unless protected by a 1-hour fire barrier.

This language changes the SFFC code requirements which requires that BESS installed outdoors or on the exterior side of exterior walls be located at least 3 feet from doors and windows that open directly into the dwelling unit. This interpretation has additional implications for permitting BESS as it may require the Planning Department review.

For interior installations of BESS that are installed within 3 feet from the property line, AB 5.12 requires the following: the BESS shall be installed on not less than on a layer of 5/8 inch Type X gypsum board that extends not less than 4 feet in vertical directions, which is installed from the floor to the ceiling and not less than 4 feet across the ceiling from the wall on which the BESS is mounted.

Installing BESS in the permitted locations is intended to help compartmentalize fire away from normally occupied areas of the home for enough time to ensure safe egress. Locating individual BESS units away from each other will help prevent the spread of fire from one unit to another. Locating BESS systems away from a means of egress will ensure safe egress from any fire that originates from the BESS. These spacing requirements may reduce the flexibility of BESS installations in smaller occupancies, but ultimately ensure the safe egress of occupants during a fire and mitigate fire size by containing fire to a single BESS unit.

The additional language surrounding the additional Type X gypsum installation does pose a significant barrier when applied to San Francisco. The city contains a significant portion of R-3 occupancy buildings that share walls with buildings on either side, surpassing the 3-foot minimum property line requirement and ultimately requiring the Type X gypsum installation. This means each of these individual residences will need to install not less than one layer of 5/8 inch Type X gypsum board that extends not less than 4 feet in vertical directions, installed from the floor to the ceiling and not less than 4 feet across the ceiling from the wall on which the BESS is mounted. These are considerable design additions for CCSF applicants to account for. When this scenario is paired with raising demand for at-home energy storage systems, and a workforce not yet equipped to handle that demand, this barrier can grow into a significant deterrent for BESS uptake.

6.2.9 Fire and Gas Detection

2019 California Residential Code §R327.7 required rooms and areas within dwelling units, sleeping units, basements, and attached garages in which ESS are installed to be protected with a listed heat detector interconnected to a smoke alarm when smoke alarms cannot be installed based on their listing. 2019 California Fire Code §1206.11.6 contained this language as well. When the codes were written, and currently, listed heat detectors do not exist. Therefore the 2022 California Fire and Residential codes were changed to "a listed heat alarm." There are not commercially available heat alarms listed for installation in unconditioned spaces where the temperature can exceed 100°F and installation of existing listed heat alarms in those conditions could create nuisance alarms.[11] [12]

[11] Information Bulletin - 2019 California Residential Code section R327.7

[12] https://34c031f8-c9fd-4018-8c5a-4159cdff6b0d-cdn-endpoint.azureedge.net/-/media/osfm-website/resources/information-bulletins/ib_ess_heat_detector_residential_code_final.pdf

This led to confusion on how the code can be met and was a driving factor for the California State Fire Marshal Bulletin 21-004 and the subsequent interpretation from SFFD via AB 5.12. The State Fire Marshal has suggested local jurisdictions consider alternates to the use of heat alarms until clearer guidance and listed devices are available. Unconditioned garages are typical locations within Group R-3 occupancies of San Francisco where BESS would be installed, and therefore interim solutions are needed and should consider if the garage has fire sprinkler protection and expected ambient temperatures based on location and exposure.[11]

AB 5.12 provided additional language requiring areas containing BESS to be protected by one of the following:

- Existing fire alarm system shall be expanded to provide heat detection and notification. This requires a Fire-Only Permit.
- Install UL 539/CFSM listed interconnected heat alarm above the BESS area for applications where there is an existing UL 539/CSFM listed interconnected heat alarm and the garage/unconditioned BESS area does not exceed 100 degrees Fahrenheit. This requires a DBI permit since the interconnected heat alarm is hard-wired with battery backup.
- Install UL 539/CFSM listed interconnected heat alarm above the BESS area and heat alarm inside each dwelling unit in an approved location near the door leading to the garage/BESS space for applications where there is no existing system and the garage/BESS area does not exceed 100 degrees Fahrenheit. This requires a DBI permit since the interconnected heat alarm is hard-wired with battery backup.
- Install a dedicated function UL 864/CFSM listed Fire Alarm Control Unit in an approved location at the dwelling unit. UL 521/CSFM listed heat detectors shall be installed at the BESS areas and compatible horns/audible appliance at the BESS and inside the dwelling unit for applications where there is no existing system and the garage/BESS area does exceed 100 degrees Fahrenheit. This requires a Fire-Only Permit.

7. Comparable Municipalities ESS Codes and Policies for R-3 Occupancies

7.1 Summary

Five cities' state, local, electrical, and fire codes and policies for BESS in Group R-3 occupancies were compared to San Francisco. Those five cities were: Austin, Texas, Chicago, Illinois, Fremont, California, New York City, New York, and San Jose, California.

The key takeaways regarding requirements and limitations to installing BESS are:

- New York City has more stringent allowable maximum battery size standards, explosion mitigation standards, sprinkler system standards, and monitoring and detection standards.
- Austin, Chicago, Fremont, and San Jose codes are similar to San Francisco's requirements. However, San Francisco's interpretation of the SFFC in AB 5.12 provides clarifications and additional requirements for installations of BESS in Group R-3 occupancies. More in-depth comparisons are shown in Sections 7.2, 7.3, 7.4, 7.5, and 7.6, and in Appendix A.

7.2 Austin, Texas

Austin and San Francisco's BESS codes and restrictions for Group R-3 occupancies are almost identical with no noteworthy differences.

7.3 Chicago, Illinois

Chicago and San Francisco's BESS codes and restrictions for Group R-3 occupancies differ slightly in the following ways:

- Chicago's energy storage capacities are less stringent and have a 600 kWh per fire area maximum allowable quantity (MAQ) for lithium-ion batteries. For all other battery types, refer to International Fire Code Table 1206.2.9.
- Chicago's has not specifically listed fire rated walls and enclosure requirements. San Francisco requires 20 kWh or greater BESS to be separated from other rooms in a building by 2-hour fire barriers. San Francisco also allows 1-hour fire barrier protection around a BESS to reduce the required clearance from property lines, means of egress, and the public way by 3 feet.

7.4 Fremont, California

Fremont and San Francisco's BESS codes and restrictions for Group R-3 occupancies are similar besides the following exception: Fremont has not created a local interpretation of Section 6.2.8's California Fire Code installation requirements.[13]

7.5 New York City, New York

New York City (NYC) and San Francisco's BESS codes and restrictions for Group R-3 occupancies differ in the following ways:

1. NYC has more stringent energy storage capacities regulations. BESS' maximum rated energy capacity should not exceed 20 kWh, and BESS' maximum aggregate should not exceed 20 kWh/dwelling unit, 40 kWh for a 2-hour fire barrier wall when in attached garages, or 40 kWh in attached garages.
2. NYC has more stringent permitting requirements. NYC requires permits for outdoor BESS only if the installation is larger than 20 kWh for lithium-ion chemistries or 70 kWh for lead-acid chemistries. Only a supervisor with a Certificate of Fitness can maintained and operate outdoor BESS.
3. NYC has more stringent monitoring and detection requirements. NYC requires an approved automatic smoke detection system or radiant energy sensing fire detection system in indoor areas that contain BESS. Remote monitoring is required for all outdoor BESS.
4. NYC has more stringent outdoor-specific requirements. Outdoor lithium-ion BESS greater than 250 kWh and lead-acid BESS greater than 500 kWh cannot be installed in enclosed areas without direct access from a public street or fire access road unless full testing occurs.
5. NYC has more stringent space requirements. Indoor BESS cannot be installed below grade in a dwelling unit or garage.
6. NYC has more stringent sprinkler and fire extinguishing requirements. NYC requires fire extinguishing for outdoor lithium-ion BESS greater than 250 kWh and outdoor lead-acid BESS greater than 500 kWh.
7. NYC has less stringent explosion mitigation requirements. San Francisco has a blanket explosion mitigation requirement for all lead-acid, Ni-Cd, Ni-MH, and lithium-ion BESS. NYC only requires explosion mitigation for outdoor lithium-ion BESS greater than 250 kWh and outdoor lead-acid BESS greater than 500 kWh.
8. NYC has more stringent fire rated wall and enclosure requirements. NYC requires that all indoor BESS are protected by a 1-hour fire barrier when the clearances prescribed in sections 6.2.6 and 6.2.7 are reduced.

[13] Due to existing building conditions in Fremont, including setbacks from buildings on adjacent parcels and from the public right of way, the addition of a local ordinance similar to SFFD Bulletin 5.12 would likely not impact BESS installation.

7.6 San Jose, California

San Jose and San Francisco's BESS codes and restrictions for Group R-3 occupancies are similar; however, San Jose has not created a local interpretation of Section 6.2.8's California Fire Code installation requirements. San Jose's existing building stock was constructed recently. As a result, due to differences in building form and age, there are significant setbacks from buildings on adjoining parcels and from the public right of way. As a result, if San Jose adopted AB 5.12's interpretations, BESS installation could likely proceed unhindered.

8. State and SF Local BESS Codes and Policies for R-2 Occupancies

8.1 Introduction

In this section, we will examine state and local codes and policies for BESS in R-2 occupancies. Key requirements and limitations are energy capacity limits on BESS size, indoor and outdoor BESS separation distance requirements, indoor BESS installation sprinkler system standards, explosion mitigation requirements, spill control requirements, and upgraded enclosure construction requirements.

8.2 San Francisco

In San Francisco, for R-2 occupancies, the SFFC and SFEC regulations apply.

8.2.1 Energy Capacity

The MAQ of a lithium-ion BESS is 600 kWh per fire area. San Francisco requires that electrochemical BESS must be segregated into groups less than 50 kWh. Each BESS group must be separated a minimum of 3 feet from other BESS groups and walls unless a fire code official permits otherwise.

According to the U.S. Energy Information Administration, apartment buildings in the West use an average of 5,365 kWh per unit in 2020, which is about 15 kWh per unit per day. In R-2 occupancies, 600 kWh could supply 24 hours of uninterrupted energy to about 40 units in the case of a power outage.

8.2.2 Ventilation

San Francisco requires exhaust ventilation in areas containing lead-acid, Ni-Cd, Ni-MH, and flow battery technologies. Lithium-ion batteries do not produce toxic gas under normal operating conditions and do not require exhaust ventilation.

Ventilation systems must limit flammable gas concentrations to 25% of the lower flammability limit (LFL) in the area containing the BESS. Otherwise, mechanical ventilation is required at a minimum rate of 1 $ft^3/min/ft^2$.

8.2.3 Permitting Requirements

BESS installations require construction and operational permits, which can be obtained online.

8.2.4 Listings

BESS must be listed in accordance with UL 9540. A UL 9540 listing ensures a baseline level of safety and compatibility for a BESS' integrated components. The UL 9540 listing references UL 9540A, which is the "Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems." This testing methodology examines how components within a BESS act in a worst-case scenario. UL 9540A tests BESS from the cell level to the unit level. UL 9540A models how thermal runaway may propagate through the system and to adjacent systems and areas. This test is used to reduce spacing between units.

8.2.5 Monitoring and Detection

San Francisco requires that lead-acid, Ni-Cd, Ni-MH, and lithium-ion BESS installations have a device that prevents, detects, and contains thermal runaway events. Many commercially available BESS come equipped with a battery management system (BMS) designed to monitor and control the charging, discharging, and overall performance of a battery while maintaining its health and capacity. The BMS is covered by the battery's required UL 9540 listing. The BMS system must disconnect electrical connections to the BESS or otherwise place it in a safe condition if potentially hazardous temperatures or conditions arise (e.g., short circuits, over voltage, or under voltage).

8.2.6 Vehicle Impacts

Vehicle impact protection must be installed in areas where motor vehicles may come in contact with BESS. BESS subject to impact by a motor vehicle, including forklifts, shall be provided in accordance with CFC Section 312. Vehicle impact protection includes guard posts that comply with the following requirements:

1. Constructed of steel not less than 4 inches in diameter and concrete filled
2. Spaced not more than 4 feet between posts on center
3. Set not less than 3 feet deep in a concrete footing of not less than a 15-inch diameter
4. Set with the top of the posts not less than 3 feet above ground
5. Located not less than 3 feet from the protected object

Vehicle impact protection protects BESS from vehicular damage, and such damage could result in thermal runaway or fire from abnormal conditions. This results in an increased level of safety for BESS that are installed in areas that pose a higher-than-normal risk of damage.

8.2.7 Space Requirements for Outdoor Installations

BESS located outdoors are required to be separated by a minimum of 10 feet from any means of egress, lots lines, public ways, buildings, stored combustible materials, and other exposures. This separation distance is permitted to be reduced by providing free-standing fire barrier around the BESS, or by providing upgrades to the exterior wall of an adjacent building. Additionally, areas within 10 feet of outdoor BESS are required to be cleared of combustible vegetation.

BESS is permitted to be installed outdoors on exterior walls where the maximum energy capacity of individual units does not exceed 20 kWh and individual units are separated from each other by 3 feet and doors, windows, HVAC inlets and other openings by 5 feet.

Doors and windows, which are generally unprotected openings in residential occupancies, create a pathway for fire to spread into the home more easily than an exterior wall would, giving reason to the mentioned spacing requirement. The exterior installation of BESS may be challenging where the exterior walls of homes are located close to property lines or other homes.

8.2.8 Space Requirements for Indoor Installation

Each electrochemical BESS group must be separated a minimum of 3 feet from other groups and from walls in the storage room or area. This is to prevent flame propagation between individual BESS groups or between a BESS and an adjacent wall.

Electrochemical BESS may not be installed in areas where the floor is located more than 75 feet above the lowest level of fire department vehicle access or below the lowest level of exit discharge.

8.2.9 Sprinkler Requirements and Fire Extinguishing Systems

Areas containing BESS are required to be protected by one of the following:

1. Automatic sprinkler coverage with minimum density of 0.3 gpm/ft^2 based on the fire area or 2,500 ft^2 design area; whichever is smaller
2. Automatic sprinkler coverage with a hazard classification based on large-scale fire testing
3. An approved alternative automatic fire-extinguishing system

A sprinkler system with a design density of 0.3 gpm/ft^2 over 2,500 ft^2 is sufficient to protect an Extra Hazard Group 1 occupancy, which is defined as an occupancy where the quantity and combustibility of contents are very high and dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release but with little or no combustible or flammable liquids.[14] This is a more demanding system than what is typically required in common areas of R-2 occupancies, including guest rooms, restrooms, parking garages, and mechanical, electrical, and storage rooms.

8.2.10 Fire and Gas Detection

An automatic smoke detection system or radiant energy-sensing fire detection system is required to be provided in rooms, indoor areas, and walk-ins containing electrochemical BESS. An approved radiant energy-sensing fire detection system is required to be provided in open parking garages and rooftops where BESS is installed. Alarm signals from detection systems are required to be transmitted to a central station, proprietary or remote station service.

This requirement is not overly burdensome or costly as many R-2 occupancies are provided with smoke detection regardless of any BESS installations.

8.2.11 Explosion Mitigation

Explosion control complying with CFC §911 is required for Lithium-ion, Ni-Cd, and Ni-MH ESS battery types. Explosion control will be achieved by providing deflagration venting, deflagration prevention systems, or barricades.

Usually, deflagration vents are the least costly solution, although they introduce additional requirements and constraints, and can still be expensive. Firstly, walls, ceilings, and roofs exposing surrounding areas are required to be designed to resist a minimum internal pressure of 100 lb./ft^2, which is a costly and difficult upgrade from a typical gypsum stud wall. Secondly, deflagration vents are only permitted to be provided on exterior walls and roofs and may only discharge directly to the exterior of the building where an unoccupied space not less than 50 feet in width is provided between the exterior walls of the building and the lot line. Considering the proximity of neighboring buildings in San Francisco, this may be a difficult constraint to navigate.

8.2.12 Spill Control

Areas containing free-flowing liquid electrolyte or hazardous materials with Lead-acid, Ni-Cd, Ni-MH, and Flow ESS battery technologies are required to be provided with spill control. As such, lithium-ion batteries are not required to be provided with spill control.

Where required, spill control is relatively inexpensive and can be as simple as providing a spill berm capable of containing a spill from the single largest battery.

8.2.13 Fire Rated Wall and Enclosure Requirements

Enclosures of ESS shall be of noncombustible construction. In dedicated-use buildings, areas containing ESS shall be separated from areas in which administrative and support personnel are located by 2-hour fire barriers. In nondedicated-use buildings, areas containing ESS shall be separated by other areas in the building by 2-hour fire barriers.

[14] 2019 NFPA 13 §3.3.134.1

A fire barrier having a 2-hour fire resistance rating means that the fire barrier assembly can withstand an ASTM E119 test furnace on one side of the assembly for 2 hours without any flame penetration through the wall, ttemperature rise on the unexposed side of the wall beyond prescribed limits, and structural failure or collapse of the assembly. This fire resistance rating provides a baseline level of safety for the enclosure housing the BESS.

9. Review of City Permitting by Building/Zoning Type and Storage Size

In September 2022, Chapter 356 of Senate Bill 379 (SB 379) was approved by the State of California and aims to streamline the permitting process for Solar energy systems and related energy storage systems serving residential properties. This bill targets single-family homes and buildings with no more than two units, also referred to as Group R-3 occupancy buildings. Cities and counties complying with SB 379 will have implemented an online, automated permitting system to verify code compliance and issue permits in real time.

San Francisco has complied with SB 379 and has established an online Solar permitting program using SolarAPP+, an online software facilitating the permitting process covering the energy systems of interest in SB 379 and is administered by NREL. To qualify for use of SolarAPP+, projects shall meet all the following criteria:[15]

1. Existing single- or two-family home (R-3 occupancy)
2. Photovoltaic and energy storage system are onsite
3. Does not include a ballasted or ground-mounted PV system
4. Is not a new service or panel upgrade
5. Meets the technical specifications listed by the City
6. Complies with the SFFD AB 5.12

The no-cost process of using SolarAPP+ issues an approval ID, inspection checklist, and specification sheet which is required for submission for the electrical permit. Users are then permitted to install their energy system, which is then subjected to inspection and approval by the SFFD and DBI.

For residential Solar energy permits, residential permits shall not exceed $450 plus $15 for every additional kilowatt above 15 kW. Only under reasonable and documented evidence shall this limit be exceeded.[16] This cap applies to the entire jurisdiction and does not consider whether one department is providing a review, or multiple departments are (e.g., DBI and SFFD). For field inspections administered by the SFFD, the hourly fee begins at $144, which can increase application costs, particularly if additional inspections are required. Inspections by DBI start at $181.82 per hour. This is a financial burden for San Francisco since the departments are limited in recouping the costs of time spent on additional processing and reviews. Even when the additional building permit is not triggered by the BESS being over the 20 kWh threshold, it is still subject to structural review to screen whether the application must be put on hold until a building permit is secured, and the new system can be appropriately supported structurally. If it is determined that the structural work and additional strengthening is not needed and the additional building permit is not pulled, then the structural review cost is absorbed by the department. Similarly, costs for the electrical plan check and administration of an electrical trade permit for systems under 20 kWh are also absorbed by the DBI.

[15] Get a permit for a Solar photovoltaic system | San Francisco (sf.gov)

[16] Section 66015 - [Effective until 1/1/2034] Residential and commercial Solar energy systems, Cal. Gov. Code § 66015 | Casetext Search + Citator

As of September 30th, 2023, NREL has reported the CCSF have issued 54 permits for photovoltaic systems (without energy storage systems) and 15 permits for photovoltaics with storage systems for a total capacity of 491 kWh approved.[17] Since its adoption, the use of SolarAPP+ for this jurisdiction has saved an estimated 71 hours for first time permit reviews.[17] For context, there are approximately 149,000 single- and two-family homes in San Francisco, indicating that there are likely multiple factors contributing to a low rate of BESS implementation in San Francisco rather than permitting. At the time of this memo's writing, DBI and the SFFD were not experiencing high volumes of BESS applications. The SFFD reported an estimate of 1-2 SolarAPP+ applications per week, and 1-2 applications per month that warrant more thorough reviews and permitting due to exceeding BESS threshold sizes or deviating from SFFD installation requirements. The review of applications through the SolarAPP+ take the SFFD approximately 5 hours to complete which they are currently able to manage with an unregulated two-week turnaround. Current resourcing at SFFD would be limited to five SolarAPP+ applications per week before they are unable to manage turnaround within that same period, at which time the timeline becomes unknown.

10. Existing Storage and Rooftop Solar Data

To supplement findings from the technology, municipal code, and permitting reviews, Arup conducted a review of publicly available data containing existing energy storage and Solar installations in California. This aspect of the project was intended to allow us to visualize where the state has seen significant uptake in different types of energy storage systems (ESS). This visualization would identify the municipalities with more uptake in this realm as well as areas that may be at risk of missing an opportunity to benefit from this technology. Findings from this work can be used to inform future research, partnerships, and data collection efforts in this space.

Finding reliable storage and rooftop data that is publicly available proved difficult due to a lack of data collection standardization. Additionally, because the most granular spatial unit associated with the available datasets is the ZIP code, there is no reliable way to distinguish between R-2 and R-3 residential types across all datasets. After reviewing a variety of datasets sourced from utility companies and public agencies, the project team was not able to secure sufficiently robust data that could reliably illustrate existing installations isolated by residential occupancy type. Without comprehensive storage and rooftop solar data that allows distinction between R-2 and R-3 occupancy types, findings using the publicly available data would not provide an accurate representation of the total number of installations throughout San Francisco; any additional analysis like those to assess opportunities for solar and storage in disadvantaged communities (DACs) would be misguided.

One of the most promising datasets that provided some distinction between residential occupancies was application data from state incentive programs such as Multi-family Affordable Solar Housing (MASH), Solar on Multi-family Affordable Housing (SOMAH), and Single-family Affordable Solar Homes (SASH). Arup found that the datasets were reporting unexpectedly low installation amounts across CCSF, and even zero installations for single family affordable homes. While not meant to represent the entire stock of rooftop solar installations on multi-family and single-family housing, the reliability of this data was called into question when compared to GoSolarSF Program data that was available to the client team. GoSolarSF offers financial incentives to support the installation of rooftop solar panels across the City and keeps complete records from the program's history. Because there was overlap in the incentive programs represented by the publicly available data and the GoSolarSF data, the client team was able to identify that the publicly available data was missing records. According to SFPUC GoSolar program data, since 2008 the GoSolar program provided over 1,000 systems with rebates for low-income applicants. Between 2008 and 2019, there were a total of 165 disadvantaged community SASH rebates. Arup was not able to access this dataset from SFPUC to verify, but the disconnect between reported GoSolar data from the SFPUC and the SASH dataset should be investigated further for proper alignment. The data sources, process, and visualizations of this data exercise are detailed further in Appendix A.1.1.

[17] SolarAPP+™ | SolarAPP+ Adoption at a Glance (nrel.gov)

The current landscape of BESS installation data is complicated by the many different technologies, many of which can be combined in a single installation. When data is reported from different sources, in this case utilities, there is some discrepancy in the categorization, and it becomes difficult to isolate BESS systems from general ESS. This is sure to improve over time as agencies innovate better ways to collect and publish data efficiently and effectively. Though the data needs to be investigated further for accuracy, the ESS data demonstrated that San Francisco installations largely pair BESS with Solar PV installations. The available data does not show which Solar installations are not yet bolstered with BESS. This category of installations would be the best candidates for BESS technology, but there is no way to isolate it with publicly available data. Finding this information would likely require outreach to Solar installation owners.

11. Financial Resources for BESS Implementation

11.1 State and Federal Financial Incentives

Table 3 below shows a list of applicable BESS financial incentives, rebates, and tax credits currently available, that can be used to spur growth in residential BESS installations. Since funding, grants, and financial incentives come in waves, and that funding is targeted differently each time with different eligibility requirements, securing funding is always a moving target. Therefore, this table represents a snapshot of funding available now, and is likely to change in the future as some funds become exhausted and others become available.

There is a wide array of State and Federal incentives for clean energy and energy efficiency, which include a mixture of tax credits, grants, rebates, and financing options for residential, business, and community projects. Tax credits are available for 30% of the cost of battery storage and solar energy systems for homes and businesses with the Residential Clean Energy Tax Credit. Total grant availabilities range from $3 million for rural energy improvements (USDA High Energy Cost Grant Program) to $14 billion for national clean technology financing (via the National Clean Investment Fund), with targeted funds for low-income and disadvantaged communities. Property tax exclusions can cover 75% of solar and BESS system costs, and upfront incentives are offered for self-generated electricity. Additional programs provide affordable financing (R-PACE), accelerated depreciation for solar and storage systems (MACRS), and $101.5 million for low-income multi-family energy efficiency upgrades.

To keep up to date on the newest and most relevant funding opportunities, agencies seeking to tap into those opportunities to support initiatives and programs for BESS implementation must be vigilant in their incentives research, continuously stay informed on new opportunities, and employ staff that are equipped to interpret funding language, requirements, and processes. To help agencies better track these clean energy state and federal financial opportunities, websites have been developed to consolidate financial opportunities. One such aggregator website is https://www.dsireusa.org/ (Database of State Incentives for Renewables & Efficiency) which can be leveraged to identify applicable grants, rebates, and tax credits as they are made available to fuel the transition to a cleaner more resilient economy.

Table 3: State and Federal Financial Incentives

1	Residential Clean Energy Tax Credit - Battery Storage Technology Tax Credit	Tax credit for battery installation for existing homes or new construction	Tax credit for 30% of system cost
2	Residential Clean Energy Tax Credit - Solar Energy Systems Tax Credit	Tax credit for solar installation for existing homes or new construction	Tax credit for 30% of system cost

3	Business Energy Investment Tax Credit (ITC)	Tax credit for solar and battery installation for existing homes or new construction	Tax credit for 30% of system cost
4	USDA - High Energy Cost Grant Program	Grant program for the improvement of energy generation, transmission, and distribution facilities in rural communities	$3 million grant
5	Property Tax Exclusion for Solar Energy Systems and Solar Plus Storage Systems	Property tax exclusion for certain types of solar energy systems installed between January 1, 1999, and December 31, 2024	Tax credit for 75% of system cost (on property taxes)
6	Self-Generation Incentive Program (SGIP)	Incentives to customers of SDG&E, PG&E, SCE, or SoCal Gas who produce electricity with wind turbines, fuel cells, PV, various forms of combined heat and power and advanced energy storage	Upfront incentive (or half of this figure if the system is 30 kW or larger): • Solar Generation: $2.00/W • Small Residential Storage: $0.15/Wh - $0.20/Wh
7	Net Metering/Net Billing	Net Billing Tariff (often referred to as "NEM 3.0"). Credited to customer's next bill at the utility's avoided cost, to receive payment for the surplus power generated.	NBT. Credited to customer's next bill at the utility's avoided cost. Customer to receive payment for the surplus power generated. It should be noted that NBT provides much lower rate in the middle of the day during solar hours than the older NEM 2.0.
8	R-PACE Residential Property Assessed Clean Energy	Affordable financing that expands access for homeowners to make critical energy efficiency, renewable energy, environmental conservation, and disaster resiliency improvements to their properties	Examples of property-based underwriting standards may include the following: • The PACE assessment does not exceed 20% of the fair market value of the property. • The combined mortgage related debt and the PACE assessment do not exceed the value of the property
9	MACRS (Modified Accelerated Cost Recovery System) for Solar + BESS	A special accelerated depreciation schedule to reduce year end taxes for PV + BESS systems	7-year MACRS (without solar) or 5-year MACRS (with solar)
10	Low-Income Weatherization Program's (LIWP) Multi-Family Energy Efficiency and Renewables Component	Technical assistance and incentives for the installation of energy efficiency measures and solar photovoltaic systems in low-income multi-family dwellings	$101.5 million available
11	National Clean Investment Fund [Part of the Greenhouse Gas Reduction Fund (GGRF)]	Provides grants to 2–3 national nonprofit clean financing institutions capable of partnering with the private sector to provide accessible, affordable financing for tens of thousands of clean technology projects across the country. These national nonprofit financing entities will enable families, small businesses, communities and many others to access the capital they need to install cost-saving and air pollution reducing	$14 billion available

		clean technology projects—with at least 40% of capital flowing into low-income and disadvantaged communities.	
12	Clean Communities Investment Accelerator [Part of the Greenhouse Gas Reduction Fund (GGRF)]	Provides grants to 2–7 hub nonprofits that will, in turn, deliver funding and technical assistance to build the clean financing capacity of local community lenders working in low-income and disadvantaged communities—so that underinvested communities have the capital they need to deploy clean technology projects. These hub nonprofits will enable hundreds of public, quasi-public, not-for-profit, and non-profit community lenders—such as community development financial institutions, credit unions, green banks, housing finance agencies, minority depository institutions, and many others—to finance clean technology projects in low-income and disadvantaged communities, with 100% of funds dedicated to these communities.	$6 billion available
13	Disadvantaged Communities – Single-Family Solar Homes program	California's DAC-SASH program (approved by the CPUC) provides solar incentives for low-income customers in disadvantaged communities. Administered by GRID Alternatives, the program offers Californians $8.5 million in incentives annually. The California Public Utilities Commission says that eligible customers can receive up to $3 per watt in incentives for solar installations. The current cost per watt of solar panels in California is $3.93, so DAC-SASH participants could save about 75% on solar installations.	$8.5 million annually available

11.2 Low Income Incentives

Energy poverty disproportionately affects low-income and disadvantaged communities (LIDACs) because they spend a larger percentage of their income on energy bills, often live in inefficient housing exacerbated by deferred maintenance, and have limited access to capital for energy-efficient upgrades. Financial strain further burdened by high energy costs from inefficient buildings and equipment can lead to health and safety risks when families are forced to cut back on essential heating or cooling. These risks underscore the need for targeted support to alleviate energy insecurity in disadvantaged communities and promote equity by engaging all socio-economic groups in the transition to renewable energy and ensuring they have access to the benefits of clean energy. BESS access for DACs can enable historically underserved communities to reduce monthly utility bills, enhance community resilience to energy price volatility, mitigate impacts of power outages, and enhance energy resilience. The accessibility of these systems relies on external structures of support to ensure first costs, implementation processes, technical assistance, and operational and maintenance costs are not an additional burden to DACs.

External structures that can be leveraged to support DACs in accessing renewable energy and BESS incentives are listed in Table 4 below. Many of these incentives and programs promote or even require that a certain percentage of funds go directly towards supporting disadvantaged communities. One example includes the National Clean Investment Fund, funded by the Greenhouse Gas Reduction Fund (GGRF), which has a requirement that at least 40% of capital from the fund is allocated for low-income and disadvantaged communities.

BESS have often prohibitively high first costs that create significant barriers to DACs that are resource strained. To maximize financial and technical support for BESS implementation in DACs, stacking incentives is an essential way to obtain the largest amount of financial support for solar and BESS projects and critical for implementing BESS in DACs despite the system's high capital cost. Stacking incentives typically involves leveraging various financial incentives, such as tax credits, grants, rebates, or low-interest loans, to reduce the upfront costs and improve the return on investment.

Table 4 below shows a list of applicable low-income financial incentives that can be used to spur growth in residential BESS installations.

Table 4: Low Income Incentives

	Incentive/Program Name	Incentive Summary
1	Disadvantaged Communities – Single-Family Solar Homes program	California's DAC-SASH program provides solar incentives for low-income customers in disadvantaged communities. Administered by GRID Alternatives, the program offers Californians $8.5 million in incentives annually. To qualify for DAC-SASH, homeowners must live in one of the top 25 percent most disadvantaged communities statewide using the CalEnviroScreen and be a billing customer of Pacific Gas & Electric (PG&E), Southern California Edison (SCE), or San Diego Gas & Electric (SDG&E). Homeowners must also meet income qualifications as denoted by annual CARE and FERA guidelines. See the CPUC website for more information about income limits. The California Public Utilities Commission says that eligible customers can receive up to $3 per watt in incentives for solar installations. The current cost per watt of solar panels in California is $3.93, so DAC-SASH participants could save about 75% on solar installations.
2	Low-Income Weatherization Program's (LIWP) Multi-Family Energy Efficiency and Renewables Component	Technical assistance and incentives for the installation of energy efficiency measures and solar photovoltaic systems in low-income multi-Property must contain 5 units or more in addition to: • At least 1 building must have 5 units. If not, the property must have 20 total units. • At least 66% of tenants with incomes < 80% area median income (AMI). • Able to achieve modeled energy savings > 15%-family dwellings. • $101.5 million available
3	National Clean Investment Fund [Part of the Greenhouse Gas Reduction Fund (GGRF)]	Provides grants to 2–3 national nonprofit clean financing institutions capable of partnering with the private sector to provide accessible, affordable financing for tens of thousands of clean technology projects across the country. These national nonprofit financing entities will enable families, small businesses, communities and many others to access the capital they need to install cost-saving and air pollution reducing clean technology projects—with at least 40% of capital flowing into low-income and disadvantaged communities.
4	Clean Communities Investment Accelerator [Part of the Greenhouse Gas Reduction Fund (GGRF)]	Provides grants to 2–7 hub nonprofits that will, in turn, deliver funding and technical assistance to build the clean financing capacity of local community lenders working in low-income and disadvantaged communities—so that underinvested communities have the capital they need to deploy clean technology projects. These hub nonprofits will enable hundreds of public, quasi-public, not-for-profit, and non-profit community lenders—such as community development financial institutions, credit unions, green banks, housing finance agencies, minority depository institutions, and many others—to finance clean technology projects in low-income and disadvantaged communities, with 100% of funds dedicated to these communities.

	Incentive/Program Name	Incentive Summary
5	Self-Generation Incentive Program (SGIP)	The “Equity” and “Equity Resiliency” SGIP rebates lower the cost of energy storage technology to almost, if not completely, free of cost. Depending on which category a customer is eligible for, they can receive $850 per kilowatt hour under the “Equity” Category or $1,000 per kilowatt-hour under the “Equity Resilience” Category. Both of these amounts would mean an energy storage system for the home or facility would be almost, to potentially completely, free of cost. Household income must be 80% or less of area median income (AMI). Incentives to customers of SDG&E, PG&E, SCE, or SoCal Gas who produce electricity with wind turbines, fuel cells, PV, various forms of combined heat and power and advanced energy storage.
6	GoSolarSF	The GoSolarSF solar rebate program provided by the SFPUC began in 2008 and has provided solar rebates to over 5000 solar installations in San Francisco, including 1200 low-income residential systems. All incentive categories have become fully subscribed, except for its Low-income DAC-SASH category which continues to provide substantial rebates in cooperation with the States DAC-SASH program administered by Grid Alternatives delivering no-cost solar systems to DAC located low-income homeowners.

12. BESS Consumer Navigation and Installation

As a relatively new residential technology, CCSF residents must first be made aware of the opportunities to deploy this technology in their homes, and then be properly assisted to evolve from awareness and interest through permitting, installation, and maintenance. Residential battery systems are a significant investment, and navigating the installation, design, and permitting phases is crucial for ensuring minimized costs and timelines, safety, compliance, optimal performance, and longevity. Proper guidance helps customers make informed decisions, avoid common pitfalls, increase access to residential batteries, reduce time to install batteries, and maximize the benefits of their energy storage solutions.

A few resources to help consumers navigate the installation design, permitting, and rebates for BESS include the following:

Step by Step Permit Guidance for SF PV + BESS:[18] The Step-by-Step Permit Guidance Tool provided by CCSF can be used to help prospective solar customers walk through the PV + battery permitting process. This tool walks a resident through how they can apply for a PV + battery permit by providing the following information:

1. Whether the prospective customer meets the requirements to apply for a PV system permit
2. Whether building permit, electrical permit, or SolarAPP+ can be used for permit
3. The process the prospective customer needs to follow based on the type of permit they need
4. The process the prospective customer needs to follow to get their installed system inspected

This resource does not include guidance in electrical-interconnection application processes which is a critical component to safely installing BESS. Interconnection applications are complex, require time, and are routinely managed by licensed contractors installing solar and BESS systems.

[18] Get a permit for a solar photovoltaic system | San Francisco (sf.gov)

Solar Access Act and SolarAPP+:[19] [20] [21] In 2022, California passed the Solar Access Act, Senate Bill 379 (Wiener), which requires cities and counties to adopt an online instant permitting system to allow residents to instantly obtain a permit for simple residential solar and solar-plus storage systems in real time. This will help to reduce permitting time and costs to streamline the installation of PV + BESS systems.

In response to this requirement, San Francisco adopted the use of the SolarAPP+ platform. SolarAPP+ is an online platform developed by the National Renewable Energy Laboratory (NREL) in collaboration with the US Department of Energy (DOE). The primary purpose of SolarAPP+ is to streamline and expedite the permitting process for residential solar energy systems.

The SolarAPP+ has the following benefits:

1. Instant Permitting: SolarAPP+ allows for instant approval of simple residential solar and solar-plus-storage system permits.
2. Automated Review: The platform uses automated algorithms to assess system designs and ensure compliance with safety and code requirements.
3. Reduced Wait Times: By eliminating manual reviews, it significantly reduces the time required for permitting by approximately 71 hours for first time permit reviews per applicant.
4. Standardized Process: SolarAPP+ attempts to establish consistent standards across jurisdictions, making it easier for homeowners and installers.

However, SolarAPP+ has the following disadvantages:

1. Low Usership: Since October of 2023, there have only been approximately 54 SolarAPP+ applications, indicating other factors may be influencing the low rate in PV and BESS installations or that this platform is not streamlining the process consistently for applicants.
2. Lack of Granularity: Even though this SolarAPP+ process has minimized time expended for applicant's first review, the simple platform does not allow for detailed plans, single line diagrams, or 9540A information to be uploaded to allow for more comprehensive and proactive reviews. This limitation ultimately leaves critical design information out of permits and pushes design corrections to the field inspection incurring additional time and costs.
3. Maximum Allowable BESS Size: For BESS permitting of 20 kWh or larger, additional requirements and inspection are needed to meet the permitting standards. CalSSA has flagged that the average desired system size is over 20 kWh.
4. 'Not-So-Standardized' Standardized-Process: While the SolarAPP+ attempts to establish confident standards across jurisdictions, the various jurisdictions still have a different understanding and interpretation of the code. The process across jurisdiction differs, which means contractors are never properly in the loop since they are constantly evolving to the jurisdiction they are installing in. One example of how different interpretations of the code impact this process is the use of the terms "panel," "system," and "unit," interchangeably, sometimes to mean the same thing, and when referring to different things. This lack of standardization can cause issues in the permitting process.
5. Excludes Existing PV-Only Systems: SolarAPP+ does not currently support users who already have a PV system and want to add a BESS, even if the BESS complies with the threshold requirements to use the permitting platform.

[19] https://www.energy.ca.gov/programs-and-topics/programs/residential-solar-permit-reporting-sb-379

[20] SolarAPP+™ | SolarAPP Adoption at a Glance (nrel.gov)

[21] SolarAPP+™ | Solar TRACE (nrel.gov)

Energy Storage Permitting Guidebook:[22] [23] The Center for Sustainable Energy, is creating an Electronic Energy Storage Guidebook (Guidebook) to help Authorities Having Jurisdiction (AHJs) standardize and streamline their energy storage permitting process. The goal for the guidebook (which is not yet complete) is to increase the adoption of behind-the-meter (BTM) energy storage technologies in all market sectors, by reducing the barriers and soft costs associated with permitting. The guidebook will contain lessons learned and best practices based on input from local governments, AHJs, industry representatives, state agencies and end-use customers. Furthermore, the guidebook will document and simplify the patchwork of permitting requirements into one authoritative best practices manual. It will build upon NREL's SolarAPP+ by developing a software module that will integrate the Guidebook recommendations into the SolarAPP+ platform. The guidebook will also attempt to integrate the following topics into its recommendations:

1. CA Title 24 Standards Codes
2. SolarAPP+
3. National Simplified Residential PV and Energy Storage Permit Guideline[24]
4. NFPA 855 Standard for the Installation of Stationary Energy Storage Systems
5. Safety Best practices for the Installation of Energy Storage

Symbium:[25] Symbium is a free software which automatically checks for code compliance and issues permits instantly for residential rooftop solar and battery storage systems. The platform helps to simplify the complex legal landscape of property development and management by translating intricate laws and regulations into straightforward workflows, effectively automating the regulatory review process for city planning. This innovation aims to empower individuals by enabling them to easily understand, visualize, and manage what is possible on their property, including the submission and management of permits, related rebates, and inspections. Currently, the software is limited to 10 jurisdictions and two unincorporated counties within California and is not yet approved to be used in CCSF territory. The software is planning to add more jurisdictions to their remit, so this resource should be revisited in the future for application to the CCSF.

DSIRE USA Clean Energy Programs Finder:[26] The Database of State Incentives for Renewables and Efficiency (DSIRE), operated by the North Carolina Clean Energy Technology Center (NCCETC), is a comprehensive source of information on clean energy-related policies and incentives in the United States. DSIRE provides detailed summary maps and data on financial incentives, regulatory policies, and other initiatives that promote renewable energy and energy efficiency. The database is updated regularly and serves as a valuable resource for individuals, businesses, policymakers, and researchers interested in clean energy development.

NODE Collective:[27] Formally known as the National Open Data for Electrification (NODE) Collective, is a nonprofit alliance that focuses on creating and maintaining a comprehensive database of electrification incentives available across the country. By structuring and sourcing data on various incentive programs, Node Collective supports consumers in making informed decisions and encourages market actors to align with an electric-oriented future. Their efforts are instrumental in overcoming the fragmentation and confusion that often accompany the landscape of electrification rebates and incentives. This tool works with NCCETC's DSIRE and

[22] Developing the Energy Storage Permitting Guidebook | Energy Storage (energystorageca.com)

[23] Resources | Energy Storage (energystorageca.com)

[24] National Simplified Residential PV and Energy Storage Permit Guidelines (PDF) | SolSmart

[25] Symbium - Property and Permit Information Portal

[26] DSIRE (dsireusa.org)

[27] NODE Collective - Powering Electrification through Open Data

expands upon its impact by enabling the development of more consumer-facing tools with a standardized underlying dataset to navigate incentive data holistically.

EnergySage Marketplace:[28] [29] EnergySage's marketplace platform empowers consumers by providing a platform to request and compare quotes from vetted local installers and providers, facilitating informed decisions and potential savings on energy solutions, including clean energy products such as solar, energy storage, and heat pumps. EnergySage partners with manufacturers of solar and battery equipment to provide promotions and rebates and can help identify those opportunities for prospective BESS owners.

13. BESS Installation Workforce and Training

The residential battery storage installation sector is a burgeoning field in the US, reflecting the growing demand for energy solutions to support solar adoption, electrification, reduce energy costs, and enhance energy resilience in the face of increasing power disruptions from aging infrastructure and intensifying weather conditions brought on by climate change. In 2019, 83% of all reported small-scale (less than 1 MW) storage power capacity in the US was in California, 31% of which was specific to the residential sector.[30] However, there has been a slowdown of residential BESS installations in California, and more notably, in San Francisco over the last couple years.[31] This volatility in demand for BESS has impacted the workforce trained to do this work and the supportive workforce pipelines to fuel this work's development and implementation.

As this industry demand has ebbed and flowed over the past 5-10 years, specialized training and upskilling opportunities for workers have become available, but most lack BESS specific training, and over time some of those resources that have been made available have also been closed, like the International Brotherhood of Electrical Workers (IBEW) in San Francisco ("local 6") who has halted their union apprenticeship classes the last several years. After reviewing currently available BESS installation and workforce trainings in San Francisco, few residential battery focused programs were found. And while there are multiple online focused BESS and microgrid trainings available, they are usually focused on larger systems rather than residential BESS.

Opportunities for San Francisco workforce development in the BESS space include:

The Energy Storage and Microgrid Training and Certification (ESAMTAC): Led by Penn State University, ESAMTAC is an online (and/or in person) education/training program and credential that prepares electrical contractors and workers for the safe and effective assembly, testing, commissioning, maintenance, repair, retrofitting, and decommissioning of energy storage and microgrid (ESM) systems. This training mostly focuses on systems larger than those used in residential applications. The course includes instruction, testing and credentialing based on skills attainment. This course is for electricians and electrical contractors.[32]

Department of Industrial Relations (DIR) Electrician Certification Program: This program is to obtain certification required for persons who perform work as electricians for contractors licensed as class C-10 electrical contractors.[33] This program requires the individual to complete a state-approved electrical apprenticeship, or a predetermined number of equivalent work experience hours based on certification type. At the time of this writing, the program was not accepting online applications due to a high volume of applications

[28] Compare and save on clean home energy solutions | EnergySage

[29] Promotions | EnergySage

[30] https://www.eia.gov/analysis/studies/electricity/batterystorage/pdf/battery_storage_2021.pdf

[31] CaliforniaDGStats

[32] ESAMTAC

[33] Division of Labor Standards Enforcement - Electrician certification program

and limited staffing. By-mail applications currently are being accepted but all applications are taking approximately 12 weeks to review and process.

Western Electrical Contractors Association (WECA) Apprenticeships:[34] A Sacramento-based apprenticeship open to individuals who are 18 years of age or older and have a high school diploma or GED. The program consists of full-time classroom training and hands-on labs for two consecutive weeks every five to seven months. This apprenticeship focuses on building commercial and residential wiremen, and though it builds out critical baseline training for future BESS workforce it lacks specific content on BESS.

Eden Area Regional Occupation Program (ROP):[35] This program provides career pathways for high school students and adults that are aspiring electricians across the mid-Alameda County region. There are 6-month accelerated electrician training, 5-year journey-level hybrid training, and certified electrician continuing education programs. This training is not specific to BESS, but education on BESS may be embedded into the electrician training.

Community College Degree/Certificate Programs: Several local community colleges offer class and hands-on experience-based curriculums that, if completed, give individuals training to support future careers as general electricians. Local colleges with these offerings include Hayward, Contra Costa, and Foothill College among many others.[36] [37] [38] [39] [40] There are no BESS-specific curriculums available, though education on BESS may be embedded into the inside wireman and residential wireman associate degrees and certificates.

Joint Apprenticeship and Training Committee (JATC): There are several JATCs across California, including in Alameda, Contra Costa, and San Francisco Counties, that are sponsored by the National Electrical Contractors Association (NECA) and the IBEW to create apprenticeship training programs. These programs are 3-5 years long and allow individuals to "learn while you earn" by providing wages and benefits while program individuals learn hands-on experience. There are no BESS specialties available in the apprenticeships, though training regarding BESS may be embedded in the inside wireman and residential wiremen specialties.

There is a distinct gap in BESS specific programs available for the San Francisco workforce and future workforce to get involved in. While the general electrician and electrical contractor training currently offered is critical to serve as a baseline for more specialized work, it is clear BESS specializations are lacking in the CCSF region and needed to upskill the workforce. Even though the opportunities locally are sparse, CCSF can look to other programs available to inspire future possibilities of creating their own programs, like the below program:

Los Angeles Cleantech Incubator (LACI) Microgrid Maintenance Training Program: The Advanced Prototyping Center at the LACI and Clean Power Alliance (CPA) have a combined microgrid (solar + storage) maintenance workforce training program. This program includes a specialized microgrid curriculum, hands-on training for tools and equipment, certifications, and extended internship stipends. [41]

To supplement Arup's review of local training and educational resources to support BESS implementation, Arup gleaned insights from the local solar and battery design build firms of Luminalt, the California Solar & Storage Association (CALSSA), and the San Francisco Electrical Construction Industry (SFECI). These conversations confirmed that the best way to break into the industry is to complete a community college program or an

[34] Apply for Apprenticeship (goweca.com)

[35] Home - Eden Area ROP (edenropadultprograms.org)

[36] Apprenticeship Programs (foothill.edu)

[37] Apprentices | Alameda County JATC (595jatc.org)

[38] Electrician Apprenticeship School San Francisco (sfeca.org)

[39] electrical training ALLIANCE || About Us

[40] Electrician Schools in San Francisco, CA: Top Programs (2024 Updated) (electricianclasses.com)

[41] Workforce Training and Development - Clean Power Alliance

apprenticeship, but even then, there are limitations. Installing solar and BESS systems is a multi-craft trade and there are currently no registered solar apprentice programs in San Francisco. Currently, the C-10 electrical contractors license is required to install BESS projects, with an exception that C-46 contractors are permitted to install BESS when they are installed at the same time as a solar PV system, leading to a discrepancy between the workforce capable of doing the work and the workforce that is allowed to do the work.[42]

Another recent development within the workforce for BESS installation is the passing of Assembly Bill (AB) 2143, which requires 'large customer-cited renewable electrical generation (solar) facilities, and any associated battery storage, that enroll in tariffs designed for these projects to provide prevailing wages to all construction workers and apprentices.'[43] There are three exception categories outlined in the bill:

1. Residential facilities that have a maximum generating capacity of 15 kW or less, or that will be installed on a single-family home
2. Projects that are already a public work under existing law
3. Facilities that serve only a modular home, a modular home community, or multi-unit housing that has 2 or fewer stories

A consequence of this bill from a workforce development standpoint is that employees looking to train specifically on solar and BESS installation projects will be excluded from opportunities on prevailing wage jobs. Since BESS installations must be performed by a C-10 electrical contractor, and there are only special cases where a C-46 license is acceptable, it may be difficult for some members of the workforce to gain the necessary experience and licenses required to work on these projects. This difficulty may be exacerbated by ramifications of AB 2143. IBEW expressed that there is not a huge demand for installing these systems, and incentive-based programs tend to be unpredictable in terms of workforce demand. Without intervention, these factors may make it difficult for the solar and BESS installation subset of the workforce to grow.

14. BESS as a Virtual Power Plant

An additional method of enhancing BESS installations across CCSF, is to identify opportunities for San Francisco residents to participate in Virtual Power Plant (VPP) programs. VPPs represent an innovative and sustainable approach to managing energy resources, and they are gaining traction in California, creating pathways for CCSF to follow suit. These systems integrate multiple distributed energy resources (DERs) like solar panels and BESS into a single, flexible network that can be managed and optimized in real time. Given there are no VPP programs available for San Francisco residents to partake in, the opportunities to integrate VPPs are substantial, both in terms of economic benefits and sustainability goals. VPPs could provide several advantages, including:

1. Grid Reliability: By aggregating multiple small-scale energy producers and storers, VPPs can offer a more reliable and resilient power supply, which is crucial during peak demand periods or emergencies. By offering greater demand flexibility, VPPs also protect the grid as customers increasingly electrify their heating, cooking, and transportation.
2. Cost Savings: Participants in VPPs can reduce their energy bills through demand response programs and by selling excess power back to the grid. These cost savings are particularly salient when VPPs are used to lower the demand for expensive power during peak energy demand periods.

[42] https://web.cslb.ca.gov/Resources/BoardPackets/BESS_report.pdf

[43] Prevailing Wage for Qualified Renewable Energy Facilities (ca.gov)

3. Environmental Impact: VPPs help decrease reliance on fossil fuels by optimizing the use of renewable energy sources and minimize the use of high polluting peaker plants during times of high energy demand.

Currently, there are promising developments in the broader California region that San Francisco residents can look to for inspiration. Marin Clean Energy (MCE) has unveiled a VPP program, launching in 2025, which can serve as a model for future VPP aspirations in CCSF. MCE's VPP program leverages financing from California Energy Commission (CEC) grants to specifically rehabilitate abandoned homes with energy efficiency updates as well as establish a VPP.[44] MCE's program relies on a partnership that will assist in financing the acquisition of the abandoned homes, rehabilitating the homes, and subsequently reselling the homes as affordable properties. Part of the rehabilitation includes upgrades that will be included in the VPP program like smart thermostats, heat pump space and water heating, and EV charging. MCE's program encourages residents to install solar and BESS through upfront incentives and ongoing payments to participants who contribute their energy storage systems to the aggregated network. This aggregate network can then provide grid services and enhance energy security. Residents can sign up for this program through MCE's website, where they can find detailed information on the benefits and the installation process.

Additional initiatives San Francisco can look towards include SunRun's CalReady VPP program that has been successfully developing VPPs across California. Their partnerships with investor-owned utilities (IOUs) like Pacific Gas & Electric (PG&E) and Southern California Edison (SCE) as well as community choice aggregators (CCAs) like Ava Community Energy, Silicon Valley Clean Energy (SVCE), and Peninsula Clean Energy (PCE) have allowed SunRun to aggregate residential solar and battery systems for grid services. SunRun has heavily leveraged the CEC's Demand Side Grid Support Program and is responsible for monitoring and dispatching all enrolled customer's batteries. Similar to MCE's program, customers are incentivized to enroll in the, CalReady program by receiving compensation for sharing their stored solar energy with the grid while SunRun manages the battery dispatching.[45]

While there is currently no VPP program for San Francisco residents, opportunities exist through broader regional initiatives and the potential for new programs inspired by successful models in other areas. By addressing access gaps through policy support, public-private partnerships, and community engagement, San Francisco has an opportunity to create a robust and inclusive VPP network, enhancing its energy resilience and sustainability.

15. Discussion and Key Takeaways

15.1 External Deterrents Impacting BESS Implementation in CCSF

When assessing how various factors may impact the safety of BESS implementation, there is a qualitative consensus that the number of fires caused by battery malfunction is very low compared to the number of installed systems. Arup has not been able to find any data that specifically tracks the incidence of fires due to BESS in residential or commercial buildings. SFFD is working to develop a database to track how fires were started when a BESS was present (not necessarily that cause) but does not anticipate this effort will conclude for another few years, with an additional 5-10 years to properly interpret the data. Thus, Arup has no evidence to support the assumption that the current installation process in San Francisco is unsafe or needs additional regulation.

Due to fear surrounding battery fires in devices such as electric scooters, electric bikes, and handheld devices, it is worth noting that building battery systems are different from smaller and less regulated micromobility and replacement batteries. Micromobility batteries, such as those used in electric bikes and scooters, have different characteristics and risks than residential BESS, especially in terms quality control and BMS features.

[44] California Community Choice Aggregator Unveils Virtual Power Plant Program | American Public Power Association

[45] Sunrun sets a record in California with the US's largest virtual power plant (electrek.co)

Micromobility batteries are often smaller, lighter, and more portable than residential batteries, which means they are more likely to be exposed to physical damage, environmental factors, and improper handling. There is little regulation of micromobility batteries and no formal permitting process, meaning micromobility batteries are not held to the same safety standards as a listed BESS system. As of March 7th, 2024, San Francisco has begun requiring all Powered Mobility Devices (PMDs) to be UL 2849 or UL 2272 listed, though there is no clear means to enforce this requirement. Unregulated micromobility battery fires prior to this date have helped form a negative public opinion regarding lithium-ion battery safety.

Residential battery storage systems, on the other hand, are larger, heavier, and stationary, which means they are less prone to physical damage and more protected from varying environmental conditions. BESS also have more sophisticated safety features and monitoring systems that can prevent or mitigate thermal runaway from abnormal conditions. Residential BESS, unlike micromobility battery systems, are required be listed and labeled in accordance with UL 9540, the Standard for Energy Storage Systems and Equipment, which provides a safety baseline that must be met before a BESS is permitted to be installed in a residential occupancy. Overall, BESS intended for residential use does not pose the same level of risk as a less regulated micromobility battery.

15.2 Challenges to BESS Implementation in CCSF

Arup found that the construction regulations and code language are generally similar across the analyzed cities as they typically use the current edition of UL 9540 which limits the maximum energy capacity of individual BESS units for residential use to 20 kWh for their BESS code requirements. The rationale behind this limit is not relevant for the purposes of this report, as it is based on the NFPA standards that are developed through government, industry, and consumer input apart from the additional requirements included in the SFFD AB 5.12 code interpretation. New York City has slightly more stringent requirements than San Francisco, while the other four municipalities reviewed have only slight code variations compared to San Francisco. These differences between local BESS codes are primarily due to cities outside California adopting different editions of the *International Fire Code* with few to no amendments. Due to the nature of how cities are legally incorporated in California, many can create and apply local amendments leading to lack of consistency residential and fire codes, especially in larger cities.

However, CCSF is distinct from the other municipalities reviewed in terms of review procedures and interpretations and has formalized additional code language through the SFFD AB 5.12. For example, a separate fire department permit is required to install an aggregate or individual BESS larger than 20 kWh in CCSF. Due to SFFD's interpretation of "system" and "unit" in the code, BESS aggregate systems exceeding 20 kWh are required to obtain a building fire department permit even though the system's individual BESS units do not exceed the 20-kWh threshold. This incurs additional installation and permitting requirements and impacts to CCSF and applicant resources that would otherwise be avoided if the BESS was not subject to this unique SFFD code interpretation. On the CCSF side, the resources spent on additional reviews is not able to be recouped due to the Assembly Bill 1414 fee cap mandate.

SFFD's additional installation requirements delivered through their AB 5.12, means that San Francisco also does not permit BESS to be installed within 3 feet from property lines, means of egress, and the public way unless protected by a 1-hour fire barrier; a reduction from the 10-foot clearance required by the California Building Code. For interior installations of BESS that are installed within 3 feet from the property line, AB 5.12 requires the following: the BESS shall be installed on not less than on a layer of 5/8 inch Type X gypsum board that extends not less than 4 feet in vertical directions, installed from the floor to the ceiling and not less than 4 feet across the ceiling from the wall on which the BESS is mounted. This additional installation language poses a significant barrier when applied to CCSF. San Francisco contains a significant portion of R-3 occupancy buildings that share walls with buildings on either side, surpassing the 3-foot minimum property line requirement and ultimately requiring the Type X gypsum installation.

From a review perspective, there is a branching permitting process across different departments that creates inconsistency across the building department and an additional financial and procedural burden for CCSF and those looking to install BESS. Currently, SolarAPP+ allows aggregate BESS over 20 kWh to receive an automated permit if individual BESS units do not exceed 20 kWh, conflicting with the SFFD code interpretation.

If that same application did not go through the SolarAPP+ platform, and instead was sent to DBI for review, that application would be returned to the applicant and require the applicant to submit for a building permit which includes a SFFD review. In addition to inconsistency across permitting pathways, SolarAPP+ has its own limitations and unintended consequences.

- SolarAPP+ does not allow for detailed information to be uploaded for review, leaving critical design information out of automated permits and pushing design corrections to resubmittals or field inspections.
- SolarAPP+ does not allow for particular use cases, limiting its applicability.
- SolarAPP+ platform usage questions are directed to City staff which incurs additional time and unrecoverable costs due to the Assembly Bill 1414 fee cap mandate.

To complement optimized permitting and installation processes and cultivate BESS implementation, applicants need to be well-informed on and guided through those processes, the workforce needs to be comprehensively equipped to deliver code compliant and effective systems efficiently, and VPP programs could be leveraged to improve the energy cost savings of BESS implementation. Recent federal funding opportunities through the Inflation Reduction Act has created a variety of financial resources to implement Solar+BESS and BESS, though targeted resources to guide applicants through accessing these ever-evolving resources is lacking. On the workforce side, there are currently few programs that are designed to develop the workforce specifically for BESS and solar installations. Some programs created for this purpose have paused or cancelled due to a lack of consistent work in the field. Additionally, because BESS installations must be performed by a C-10 electrical contractor and there are only special cases where a C-46 license is acceptable, it may be difficult for some members of the workforce to gain the necessary experience and licenses required to work on these projects. This difficulty may be exacerbated by ramifications of AB 2143, prevailing wage requirements may make it more difficult for apprentices to gain the needed training hours under new prevailing wage requirements. VPP programs could enhance the value San Francisco residents could obtain from their BESS installations, and there are regional examples that CCSF can look to and model future programs after.

15.3 Opportunities for Improvement for BESS Implementation in CCSF

The following are notable observations areas of recommendations resulting from this study:

15.3.1 Observations

- The upfront cost of installing battery energy storage systems may be a bigger deterrence to consumers than other factors. Even though there are a variety of state and federal financial incentives available to support the investment, these resources are evolving and difficult to navigate, and installations likely do not offer an attractive enough ROI to outweigh high upfront costs. BESS may become more financially attractive as costs of electricity continue to rise, NEM export rates lower, and the importance of energy resilience grows.
- Users that may benefit most from BESS include current Solar users that participate in NEM 3.0 or do not participate in a NEM program at all, people with home EV charging stations, residents that will be electrifying their homes, and medically dependent people that cannot risk power interruptions.
- The typical battery size offered on the market for R-3 occupancies is 13.5 kWh. If two or more batteries are needed for installation, this immediately exceeds SFFD's interpretation of the 20-kWh threshold for R-3 occupancies and shall comply with more stringent requirements as well as a lengthier and more costly permitting process.
- AB 2143 requires most large electrical generation (solar) facilities that are above 15 kW or 3+ story multi-unit housing facilities to provide prevailing wages to all construction workers and apprentices. While this strengthens wages for certified, licensed installers, it may impact workforce development efforts as apprentices will not be able to train on projects that fall under this bill. There should be strategic efforts to ensure workforce development opportunities across various levels of experience grow alongside the desired growth of BESS and solar installations throughout San Francisco.

- There are currently no opportunities in CCSF to participate in a VPP program, though there are nearby programs that can be used to model future programs in CCSF.

15.3.2 Opportunities for Improvement

- *Defined code-related BESS terms*: The lack of clarity around the terms "system" and "unit" as they relate to BESS in applicable codes is causing confusion for installation and permitting requirement expectations for BESS in residential (primarily R-3) occupancies. Developing a shared language around these terms will put applicants, installation stakeholders, and permitting stakeholders in alignment. This alignment can sow stronger interagency coordination at CCSF to safeguard BESS implementation delays and wasted resources associated with unclear policies and procedures. Consider not using the terms 'system' or 'unit' as modifiers when describing a BESS. If multiple BESS are installed state it as such and continue to use the terms 'aggregate' or 'aggregate capacity'.

- *Streamline permitting process*:

  1. Investigate and pursue opportunities to treat BESS permit applications that exceed the 20-kWh threshold similar to a Solar permit application. The permitting process for these systems can be expedited if the applications were able to be sent via email to DBI for electrical review directly, and then routed to the SFFD for detailed review of the BESS. This would bypass unnecessary reviews that accompany full building permits, while directing the application to staff at the SFFD who hold the expertise necessary to perform targeted reviews of BESS.

  2. Utilize dedicated plan expediters to clarify the permitting process and field SolarAPP+ questions from applicants to minimize resources spent by other City technical review staff.

  3. Update SolarAPP+ platform capabilities to allow for more detailed plans to be reviewed across different departments. Allowing first time permit applicants to complete SFFD inspection through the SolarAPP+ and allowing higher and more detailed functionality within SolarAPP+ for plan review may streamline the permitting process, which currently requires separate inspections by SFFD and DBI and incurs unrecoverable costs. SolarAPP+ would be more efficient if plans could be submitted via email to the DBI electrical reviewers and additional disciplines required for complete reviews were added on as needed (as noted in item 1 in this list).

  4. Update permitting department IT system to have capabilities of complying directly with state fee cap regulations. Currently, CCSF's obsolete permitting systems automatically calculate permit fees based on valuation as opposed to this mandated fee cap. To meet this permit fee regulation DBI allows contractors request refunds in the amount the contractor was charged that exceeded this fee cap. However, refunds must be requested to be given, meaning that contractors may not always be charged appropriately, and extra CCSF resources are used to handle and administer the refunds.

- *Create a BESS implementation one-stop shop*: Efficient navigation of the application, installation, design and permitting processes is crucial for minimizing timelines, costs, safety, compliance, optimal performance, and longevity of BESS and solar installations. There are several different resources available for consumers to consult while making decisions during this process, but this web of information may be overwhelming to some prospective consumers and may contribute to lower uptake. Applicants could benefit from a consolidated and organized list of resources to serve as a BESS implementation hub to guide them from BESS consideration through installation, operation, and maintenance.

- *Provide financial assistance for BESS installations:* Reduce the initial investment barrier for installing solar panels and battery systems through targeted financial incentive programs. Low-interest loans could enable middle-income households to use energy savings to gradually pay off the upfront costs of solar and BESS. Low-income households who do not have the financial resources to take on loan payments will require additional subsidies to be able to install solar and BESS.

- *Facilitate opportunities for VPP*: To unlock VPP as an opportunity for BESS owners to increase the value of their systems; there are several strategies that can be considered:

    1. Public-Private Partnerships: evaluate opportunities to collaborate with companies like SunRun and local utilities to develop and promote VPP programs. For example, SunRun's partnerships with IOUs and other CCAs could serve as a model for similar collaborations in San Francisco.

    2. Community Engagement: educating residents about VPPs and providing easy access to participation through streamlined processes and financial incentives. Outreach programs can specifically target low-income and underserved communities to ensure equitable access.

    3. Simplify Enrollment: once a VPP is established, develop user-friendly online platforms where residents can easily sign up and access information about VPP programs.

Appendix A

A.1 Data Sources

The following data sources were used to compile and map the existing energy storage and Solar installations across California with a particular focus on the San Francisco Bay Area.

Table 5: Data Sources

Source	California Energy Storage System Survey	California Distributed Generation Statistics	U.S. Zip Code Areas
Author	**California Energy Commission**	**California Solar Initiative (CSI), GRID Alternatives, California IOUs, and CPUC**	**United States Postal Service (USPS) / ESRI**
Description	This contains information about ESS installations throughout the state of California. It is the first of its kind, combining data from all utility providers into one dataset.	This contains data from the CSI program which includes Solar installation data sourced from various incentive program applications. The data sets highlighted in this memo include the CSI program data and the Single-family Affordable Solar Homes (SASH) program data.	This is geospatial data for each ZIP code in the US.
File Type	CSV	CSV	ESRI Shapefile
Link	Workbook: Energy Storage Dashboard (ca.gov)	CaliforniaDGStats	USA ZIP Code Areas - (arcgis.com)

A.1.1 Data Processing

A.1.1.1 California Distributed Generation Statistics

The two datasets within this resource used were the CSI Working Data set, which was last updated in 2020, and the Low-Income Applications set which includes the SASH incentive program dedicated to single-family homes. The CSI data was queried to include only non-SASH and non-MASH (multi-family equivalent of SASH) residential installations that were listed as of May 28, 2020, within the nine Bay Area Counties. The Low-Income Applications data was queried to include completed installations that received funding through single-family incentive programs. Both sets of queried data were summarized by calculating the total amount of installations and the sum of the nameplate capacity per each ZIP code.

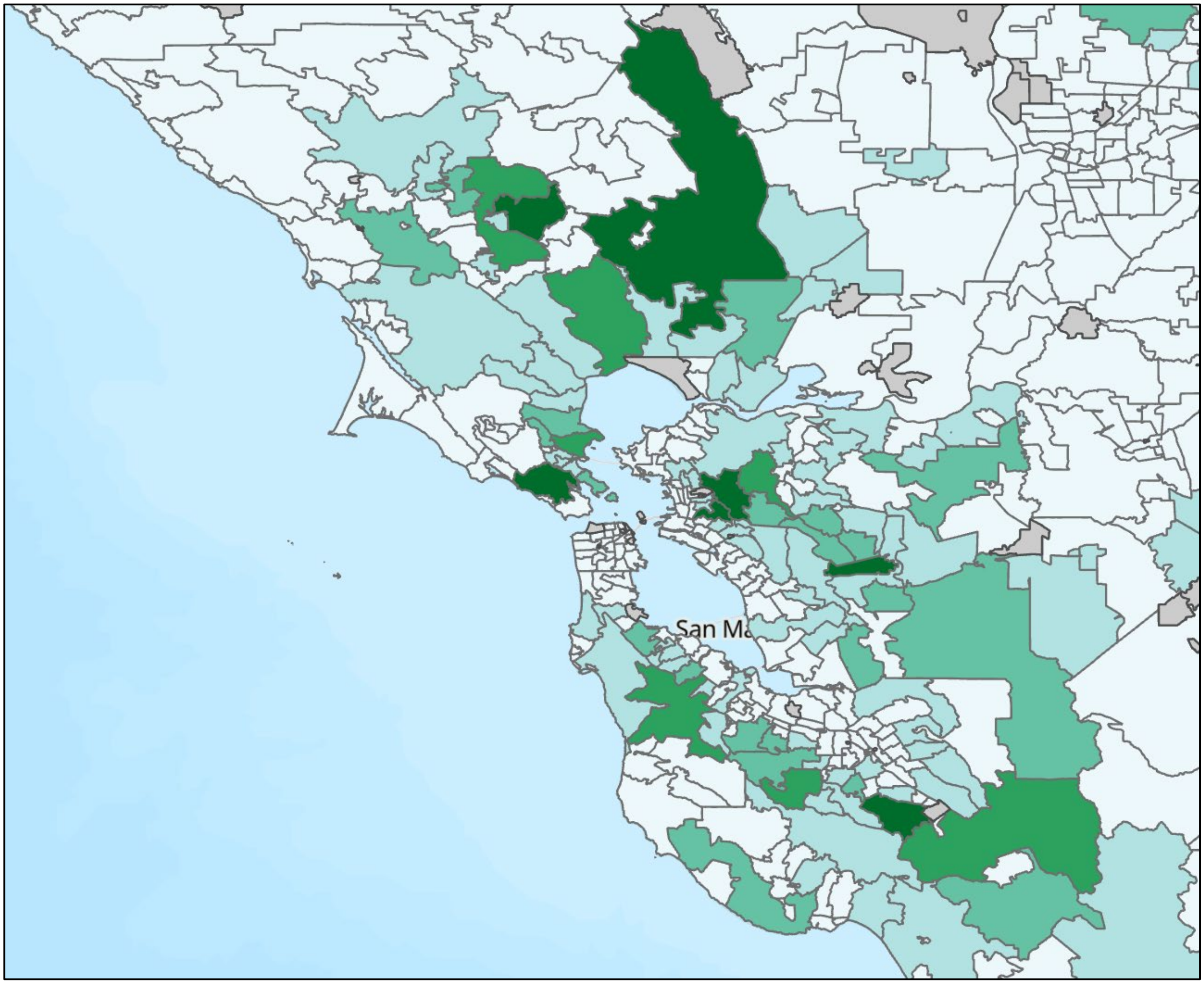
A.1.1.2 U.S. Zip Code Areas – United States Postal Service (USPS) / ESRI

The ZIP code data was processed by reprojecting the shapefile from its original coordinate system into the NAD83 California State Plane projected coordinate system to maintain the highest level of accuracy. Zone III was the state plane zone used due to this project’s focus on the San Francisco Bay Area. Then, a new layer containing only California ZIP codes was created from the original shapefile to shadow the energy storage system data.

A.1.1.3 Preliminary Results

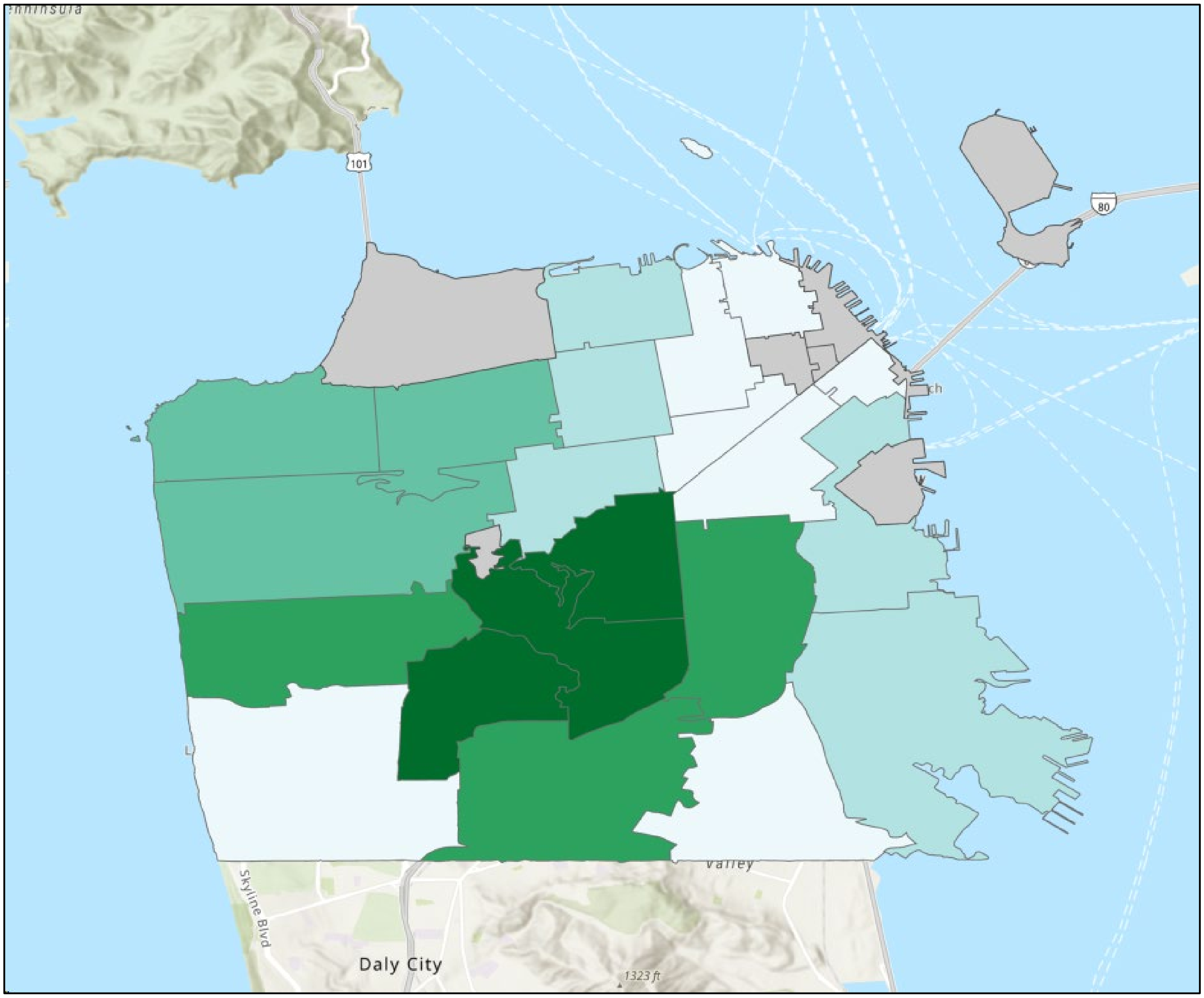
Finalized maps with legends, scale bars, etc. will be included in the final report. For reference, grey indicates a ZIP code where there are 0 installations while light to dark green indicates the least to most installations per number of housing units in each ZIP code. For each dataset, there is one map for the entire Bay Area and one map for San Francisco. The ranges were recalculated at the San Francisco scale; the images are not merely zoomed in.

Figure 1: California Energy Storage System Survey – Bay Area



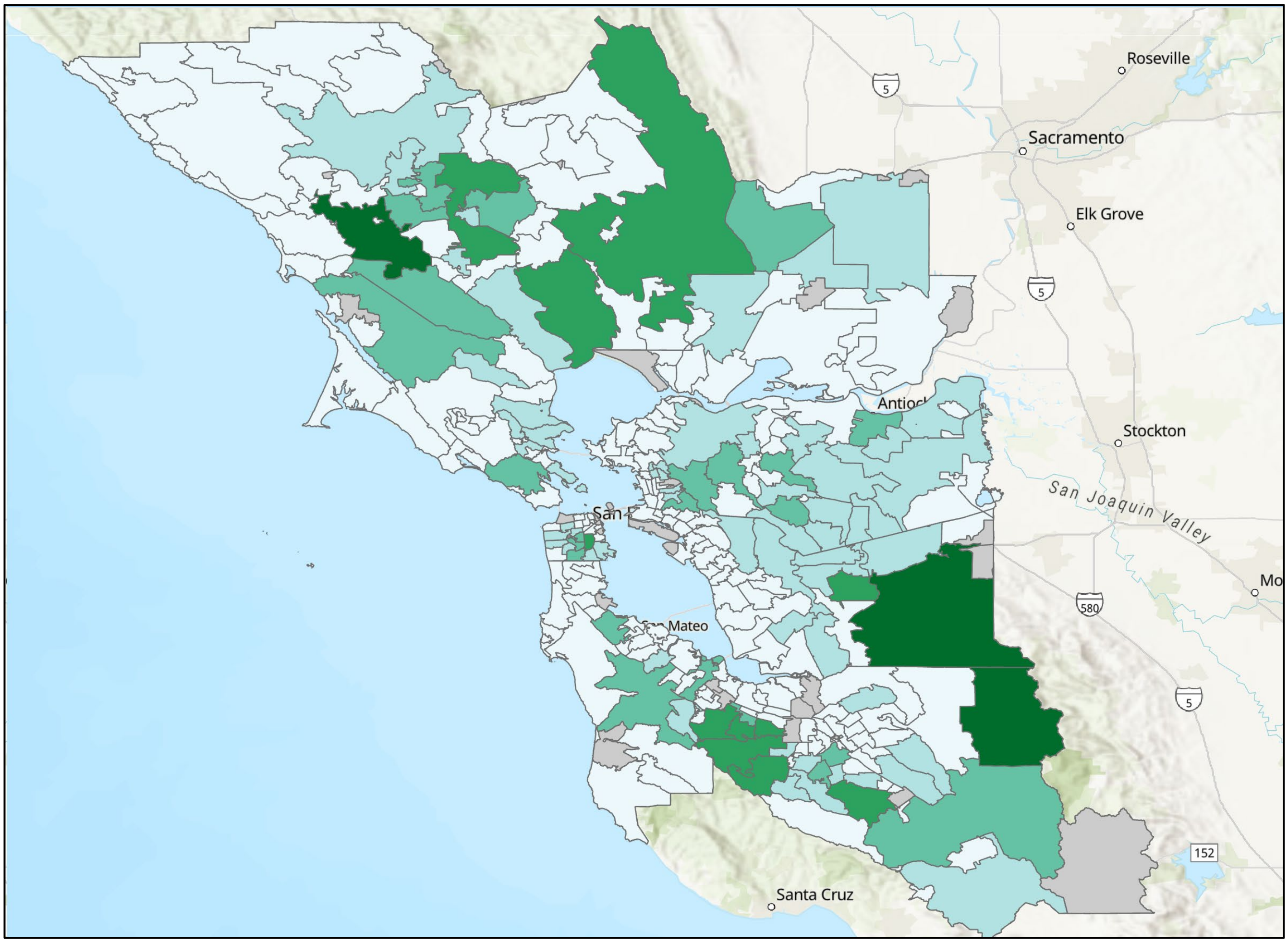
This map shows that there are BESS installations of some form throughout the Bay Area, with higher frequencies of installations outside of the downtown areas of San Francisco, Oakland, and San Jose. The lightest green indicates a ZIP code with anywhere between 1 and ~150 installations, while the darkest green indicates a ZIP code with anywhere between ~600-750 installations. From this map, it is clear that San Francisco has a relatively low uptake in ESS compared to the rest of the Bay Area. This is a very high-level observation as there are other factors that influence ESS adoption, and the size and density of the ZIP codes are not incorporated within this map.

Figure 2: California Energy Storage System Survey – San Francisco



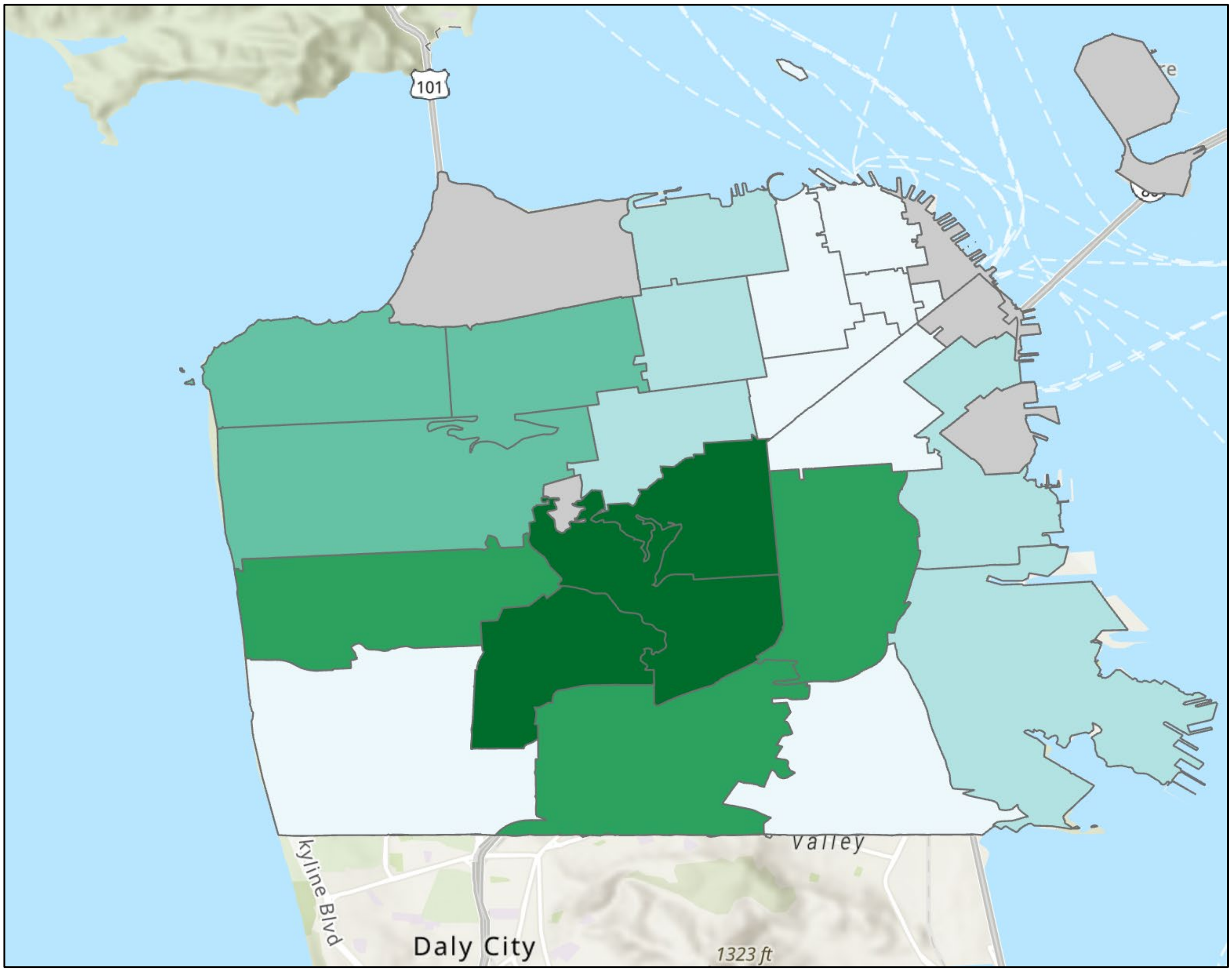
Taking a closer look at San Francisco, we see that there are BESS installations in most ZIP codes aside from a few. This map shows where ESS is more prominent within San Francisco. The three ZIP codes that are the darkest green contain between 80 and 100 installations each, while the lightest shaded ZIP codes may contain up to 20 installations. Per CalEnviroScreen The lighter regions roughly correspond to areas experiencing increased poverty rates, housing burden, and typically include census tracts identified as low-income.

Figure 3: CSI Working Data – Bay Area



This map shows Solar installations current as of May 2020 that were funded in some part through the now-exhausted CSI program. It does not include incentive applications from more directed incentive programs such as SASH and MASH. The darkest green ZIP codes contain between ~360-460 installations each. The map shows that the installations are spread across almost the entire Bay Area, with some ZIP codes in San Francisco hosting the similar amounts of installations as less dense areas of the region.

Figure 4: CSI Working Data – San Francisco



Recalculating for San Francisco can show more clearly which ZIP codes have the most and least installations. This map is nearly identical to the ESS map shown previously, with the same ranges for the colors. As was the case in the ESS map, the darkest green ZIP codes contain between 80-100 installations each. It is not possible to say how much overlap there is between these datasets without having more information about the ESS data and any incentive programs that a given installation utilized. Because the BESS data in San Francisco was heavily skewed towards Solar PV technology, this map with CSI data confirms that the same ZIP codes are showing much higher adoption rates than other parts of the city.

A.1.1.4 Data Scoring

This subsection serves to demonstrate an evaluation of each dataset used for the purposes of this project. Each dataset was scored based on how much qualifying information could be readily found from 1-3. For a dataset to receive a score of 3, it needs to have each column of the below table completed. The ZIP code data and incentives application data from CA Distributed Generation Statistics received a score of 3 because both had complete methodologies, and the latter included data keys that defined each column of the exported CSVs. The CA ESS Survey data received a score of 2 because although it was published by a reputable source, the California Energy Commission (CEC), we were not able to find detailed information about how the data was compiled from utility surveys.

Figure 5: Data Scoring

Source - Title	Description	Methodology	Updated	Scoring; Metadata
CEC - CA Energy Storage System Survey	Statewide dataset including residential, commercial, and utility-scale installations as obtained through a semi-annual survey of all utilities in California. Note: Data may not be available for all zip codes as some utilities do not report ESS as separately identifiable from a co-located Solar photovoltaic system.	Data in this dashboard is obtained through a survey of all utilities in California and is current as of October 24, 2023. The dataset will be updated semi-annually upon completion of each survey. Note: Utility data on installations of energy storage systems may not be available for all zip codes. Due to variations in local permitting regulations, not all utilities reported energy storage systems as separately identifiable from a co-located Solar photovoltaic system.	10/24/23	2; Incomplete
USPS, Esri - U.S. Zip Code Areas	This shapefile contains the ZIP Code, postal district name, population, and area for the ZIP Code areas in the United States.	U.S. ZIP Code Areas represents five-digit ZIP Code areas used by the U.S. Postal Service to deliver mail more effectively. The first digit of a five-digit ZIP Code divides the United States into 10 large groups of states (or equivalent areas) numbered from 0 in the Northeast to 9 in the far West. Within these areas, each state is divided into an average of 10 smaller geographical areas, identified by the second and third digits. These digits, in conjunction with the first digit, represent a Sectional Center Facility (SCF) or a mail processing facility area. The fourth and fifth digits identify a post office, station, branch, or local delivery area.	8/20/23	3; Complete
CPUC, et al – CSI Working Data; Low-Income Solar PV Data	This contains data from the CSI program which includes Solar installation data sourced from various incentive program applications. The data sets highlighted in this memo include the CSI program data and the Single-family Affordable Solar Homes (SASH) program data that is found in the Low-Income Solar PV Data Set.	The California Solar Initiative (CSI) Working Data Set represents the CSI incentive application data from PG&E, SCE and SDG&E service territories for the now-closed CSI Program, except for applications removed due to erroneous data. The Low-Income Solar PV Data Set contains all applications received through the Single-family Affordable Solar Homes (SASH) programs, the Multi-family Affordable Solar Housing (MASH) programs and the Disadvantaged Communities - Single-family Affordable Solar Homes (DAC-SASH) program. This data set includes incentive applications from PG&E, SCE and SDG&E territories and is updated weekly. Please note that SASH 1.0 and MASH 1.0 incentive applications are also included in the CSI Working Data Set.	5/28/20; 4/18/24	3; Complete

A.2 BESS Codes and Policies for R-3 Occupancies

Table 6: BESS Codes and Policies for R-3 Occupancies

Comparison Item	SF	Austin	NYC	Chicago	San Jose	Fremont
Energy Capacity	Maximum capacity per individual ESS unit shall not exceed 20 kWh. Maximum aggregate capacities per installation location within R-3 occupancy are: 1. 40 kWh within utility closets and storage or utility spaces 2. 80 kWh outdoors on the ground 3. 80 kWh on exterior walls 4. 80 kWh in attached or detached garages and detached accessory structure Maximum energy rating permitted is 280 kWh. ESS installations exceeding the individual ESS rating of 20 kWh or the aggregate capacities shall be installed in accordance with CFC §1207.1-§1207.9.[1]	Individual ESS units shall have a maximum rating of 20 kWh. The aggregate rating structure shall not exceed:[2] 1. 40 kWh within utility closets and storage or utility spaces. 2. 80 kWh in attached or detached garages and detached accessory structures. 3. 80 kWh on exterior walls. 4. 80 kWh outdoors on the ground.	For NYC, the maximum rated energy capacity of any ESS shall not exceed 20 kWh, and the maximum aggregate should not exceed 20 kWh/dwelling unit or 40 kWh for a 2 hr fire barrier wall when in attached garages, or 40 kWh in attached garages3 For New York State, individual ESS units shall have a maximum rating of 20 kWh. The aggregate rating structure shall not exceed: [4] 1. 40 kWh within utility closets and storage or utility spaces. 2. 80 kWh in attached or detached garages and detached accessory structures. 3. 80 kWh on exterior walls. 4. 80 kWh outdoors on the ground.	The maximum allowable quantity (MAQ) of a lithium-ion battery is 600 kWh per fire area. For all other battery types, refer to IFC Table 1206.2.9.[5] Electrochemical ESS shall be segregated into groups not exceeding 50 kWh. Each group shall be separated a minimum of 3 feet from other groups and walls within the area.[6]	Individual ESS units shall have a maximum rating of 20 kWh. The aggregate rating structure shall not exceed:[7] 1. 40 kWh within utility closets and storage or utility spaces. 2. 80 kWh in attached and detached garages and detached accessory structures. 3. 80 kWh on exterior walls. 4. 80 kWh outdoors on the ground.	Maximum capacity per individual ESS unit shall not exceed 20 kWh. Maximum aggregate capacities per installation location within R-3 occupancy are:[8] 1. 40 kWh within utility closets and storage or utility spaces 2. 80 kWh outdoors on the ground 3. 80 kWh on exterior walls 4. 80 kWh in attached or detached garages and detached accessory structure
Ventilation	Indoor installations of ESS that produce hydrogen or other flammable gases during charging shall be provided with mechanical ventilation in accordance with the CMC.[9] ESS that have the potential to release toxic or highly toxic gas during charging, discharging, and normal use conditions shall not be installed within Group R-3.[10]	Indoor installations of ESS that include batteries that produce hydrogen or other flammable gases during charging shall be provided with exhaust ventilation in accordance with Section 1207.6.1.[11] Exhaust ventilation required for areas containing Lead-acid, Ni-Cd, Ni-MH, and flow battery ESS technologies. Not required for Lithium-ion ESS. Ventilation shall be designed to limit the maximum concentration of gases to 25% of the LFL or to provide an exhaust rate of not less than 1 $ft^3/min/ft^2$ of floor area of the area.[12]	Indoor installations of ESS that include batteries that produce hydrogen or other flammable gases during charging shall be provided with exhaust ventilation in accordance with Section 1206.13.1.[13] ESS that have the potential to release toxic or highly toxic gas during charging, discharging, and normal conditions shall not be installed with one and two family dwellings and townhouses[14]	Exhaust ventilation required for areas containing Lead-acid, Ni-Cd, Ni-MH, and flow battery ESS technologies. Not required for Lithium-ion ESS. Ventilation shall be designed to limit the maximum concentration of gases to 25% of the LFL or to provide an exhaust rate of not less than 1 $ft^3/min/ft^2$ of floor area of the area.[15]	Indoor installations of ESS that include batteries that produce hydrogen or other flammable gases during charging shall be provided with exhaust ventilation.[16]	Indoor installations of ESS that produce hydrogen or other flammable gases during charging shall be provided with mechanical ventilation in accordance with the CMC.[17] ESS that have the potential to release toxic or highly toxic gas during charging, discharging, and normal use conditions shall not be installed within Group R-3.[18]
Permitting Requirements (operational building permits, FD reviews)	A construction permit is required for ESS at 20 kWh or greater.[19] Operational permits are required for ESS and lithium batteries.[20]	Construction permits are required for stationary ESS installations in accordance with AFC Section 105.5.22.[21] Operational permits are required for stationary ESS that exceed the energy capacities listed in AFC Table 1207.1.1 and employ Capacitor ESS, Lithium-ion batteries, Ni-MH, or other electrochemical ESS technologies in accordance with AFC Section 105.5.22.[22] Operational permits are required for stationary ESS installations utilizing fifteen or more gallons of corrosive electrolyte in flooded lead-acid, valve regulated lead-acid batteries or Ni-Cd batteries in accordance with AFC Section 105.5.22 based on Health Hazard Category 3 liquids.[23]	Construction permits are required including the following specifications listed below. Location and layout diagram of the room or area in which the ESS is to be installed. Details on the fire-resistance rating of assemblies enclosing the ESS. Manufacturer's specifications. Ratings and listings of each ESS. Description of energy storage management systems and their operation. Location and content of required signage. Details on fire suppression, smoke or fire detection, thermal management, ventilation, exhaust and deflagration venting systems. Seismic restraint[24] Permits only required for outdoor BESS larger than 20 kWh for Li-ion and 70 kWh for lead-acid batteries[25] Outdoor BESS of all sizes need to be maintained and operated under the general supervision of someone holding a Certificate of Fitness[26,27].	Construction permits are required for stationary ESS installations in accordance with IFC Section 105.7.2. Construction documents are required with the permit application[28]	Construction and operational permits shall be obtained for stationary ESS installations.[29] Construction documents are required to be provided with the permit application.[30]	Construction and operational permits shall be obtained for stationary ESS installations. Construction documents are required to be provided with the permit application[31]

Comparison Item	SF	Austin	NYC	Chicago	San Jose	Fremont
Listings	ESS shall be listed and labeled in accordance with UL 9540.[32] Where approved, repurposed unlisted battery system from electric vehicles are allowed to be installed outdoors or in detached sheds located not less than 5 feet from exterior walls, property lines, and public ways.[33]	ESS shall be listed and labeled in accordance with UL 9540. ESS listed and labeled solely for utility or commercial use shall not be used for residential applications[34] Where approved, repurposed unlisted battery systems from electric vehicles are allowed to be installed outdoors or in detached dedicated cabinets located not less than 5 feet from exterior walls, property lines and public ways.[35] ESS less than 1 kWh is not required to be listed and labeled in accordance with UL 9540.[36]	ESS shall be installed in accordance with NFPA 70 and UL 9540[37]	(in IFC 2018 same as R-2)	ESS shall be listed in accordance with UL 9540.[38] Inverters shall be listed and labeled in accordance with UL 1741 or provided as part of the UL 9540 listing.[39]	ESS shall be listed and labeled in accordance with UL 9540.[40]
Monitoring and Detection	For BESS over 20 kWH, where required by the ESS listing, an approved energy storage management system that monitors and balances cell voltages, currents and temperatures within the manufacturer's specifications shall be provided.	Where required by the ESS listing, an approved energy storage management system that monitors and balances cell voltages, currents and temperatures within the manufacturer's specifications shall be provided. The system shall place the ESS system in a safe condition if hazardous conditions are detected.[41]	Where required by the ESS listing, an approved energy storage management system that monitors and balances cell voltages, currents and temperatures within the manufacturer's specifications shall be provided. The system shall place the ESS system in a safe condition if hazardous conditions are detected.[42] An approved automatic smoke detection system or radiant energy sensing fire detection system shall be installed in rooms indoor areas and walk in ESS units containing ESS.[43] Remote monitoring required for outdoor battery systems of all sizes[44] Indoor and outdoor systems shall be designed to address the hazards identified by full scale testing including fire barriers, fire alarms, explosion mitigation, gas detection, fire extinguishing, and ventilation systems[45]	Where required by the ESS listing, an approved energy storage management system that monitors and balances cell voltages, currents and temperatures within the manufacturer's specifications shall be provided. The system shall place the ESS system in a safe condition if hazardous conditions are detected.[46] Fire detection, smoke detection, and gas detection systems shall be provided in accordance with Sections IFC 1206.2.11-1206.2.11.5, IFC 907.2, And IFC 916 respectively[47]	Where required by the ESS listing, an approved energy storage management system that monitors and balances cell voltages, currents and temperatures within the manufacturer's specifications shall be provided. The system shall place the ESS system in a safe condition if hazardous conditions are detected.[48]	Required if energy capacity is exceeded. Where required by the ESS listing, an approved energy storage management system that monitors and balances cell voltages, currents and temperatures within the manufacturer's specifications shall be provided. The system shall place the ESS system in a safe condition if hazardous conditions are detected.[49]
Vehicle Impacts	Comply with applicable requirements of 2022 CFC §1207.11.7.1. Equivalencies or requests for smaller separation distance may be proposed via a pre-application meeting with the San Francisco Fire Department by submitting a pre-application meeting request form. Where an ESS is installed in the normal driving path of vehicle travel within a garage, impact protection complying with Section 1207.11.7.3 shall be provided. Normal driving path is a space between garage vehicle opening and interior face of the back wall to a height of 48 inches above the finished floor. Impact protection shall also be provided for ESS installed at either of the following locations: On interior face of back wall and located within 36 inches to the left or to the right of the normal driving path. On interior face of a side wall and located within 24 inches from the back wall and within 36 inches of the normal driving path. Where clear height of vehicle garage opening is 7 feet 6 inches or less, ESS installed not less than 36 inches above finished floor are not subject to vehicle impact protection requirements.	ESS installed in a location subject to vehicle damage shall be protected by approved barriers. Appliances in garages shall also be installed in accordance with Section 304.3 of the *International Mechanical Code.*	ESS installed in a location subject to vehicle damage or other impact shall be protected by approved barriers[50]	Where ESS are subject to impact by a motor vehicle, including forklifts, vehicle impact protection shall be provided in accordance with CFC Section 312.[51]	ESS installed in a location subject to vehicle damage shall be provided with impact protection. In garages, ESS shall be provided with impact protection when installed in the normal driving path of vehicle travel within a garage as defined by SJFC §1207.11.7.1.[52] Acceptable forms of impact protection include bollards or wheel barriers constructed in accordance with SJFC §1207.11.7.3.	ESS installed in a location subject to vehicle damage shall be provided with impact protection. In garages, ESS shall be provided with impact protection when installed in the normal driving path of vehicle travel within a garage as defined by CFC §1207.11.7.1. Acceptable forms of impact protection include bollards or wheel barriers constructed in accordance with CFC §1207.11.7.3.

Comparison Item	SF	Austin	NYC	Chicago	San Jose	Fremont
Outdoor Specific	ESS shall be permitted to be installed outdoors or on the exterior side of exterior walls located not less than 3 feet from doors and windows directly entering the dwelling unit.[53] For exterior installations of ESS:[54] 1. Property lines and means of egress: minimum separations of 3 feet may be reduced to 12 inches where a 1 hour free-standing fire barrier and extending 3 feet above and 3 feet beyond the physical boundary of the ESS installation is provided to protect the exposure. 2. The exterior wall upon which the ESS is installed shall be located at least 12 inches from other exterior walls of the same building in either direction.	Outdoor walk-in units housing ESS shall not exceed 53 feet by 8 feet by 9.5 feet high. Outdoor walk-in units exceeding these limitations shall be considered indoor installations.[55] ESS located outdoors shall be a minimum of 10 feet from lot lines, public ways, buildings, stored combustible materials, hazardous materials, high-piled stock, an other exposure hazards.[56] This distance is permitted to be reduced to 3 feet for the following: 1. A 1-hour free standing fire barrier exceeding 5 feet above and 5 feet beyond the physical boundary of the ESS is provided to protect the exposure. 2. Clearances to buildings are permitted to be reduced to 3 feet where noncombustible exterior walls with no openings or combustible overhangs are provided on the wall adjacent to the ESS. Wall must be rated for 2-hours. 3. Clearances to buildings are permitted to be reduced to 3 feet where a weatherproof enclosure constructed of noncombustible materials that has gone through large-scale fire testing is provided over the ESS. ESS is permitted to be installed outdoors on exterior walls where the maximum energy capacity of individual units does not exceed 20 kWh and individual units are separated from each other by 3 feet and doors, windows, HVAC inlets and other openings by 5 feet.[57]	Outdoor walk-in units housing ESS shall not exceed 53 feet by 8 feet by 9.5 feet high. Outdoor walk-in units exceeding these limitations shall be considered indoor installations.[58] Outdoor walk in ESS shall not exceed 4,028 cu ft in size[59] (same as requirement listed above but NY State reworded it) Areas within 10 ft on each side of an outdoor ESS shall be cleared of combustible vegetation[60] BESS systems must be a minimum of 10 ft from any of the following exposures: lot lines, public streets, vehicle parking, building entrances, windows, or ventilation intakes, building egress, hazardous materials storage, overhead power lines, public utility or transportation infrastructure[61] Outdoor lithium ion greater than 250 kWh and lead-acid greater than 500 kWh shall not be installed in enclosed areas without direct access from a public street or fire access road unless full testing is undergone. [62]	ESS located outdoors and in open parking garages shall be separated from any means of egress as required by the fire code official by no less than 10 feet. Reduced separation shall be subject to approval by fire code official upon review of large-scale fire testing.[63] ESS located outdoors shall be a minimum of 5 feet from lot lines, public ways, buildings, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards.[64] This distance is permitted to be reduced to 3 feet for the following:	Outdoor walk-in units housing ESS that exceeds 53 feet by 8 feet by 9.5 feet high shall be considered indoor installations and must comply with the applicable requirements.[65] ESS located outdoors and in open parking garages shall be separated from any means of egress by a minimum of 10 feet.[66] ESS located outdoors shall be separated by a minimum of 10 feet from lot lines, public ways, buildings, stored combustible materials, hazardous materials, high-piled stock, and other exposure hazards. The distance is permitted to be reduced to 3 feet if the requirements of SJFC §1207.8.3 Exceptions 1 through 3 are met.[67] ESS shall be permitted to be installed outdoors on exterior walls of buildings when all of the following conditions are met:[68] 1. Individual ESS units shall not exceed 20 kWh. 2. The ESS shall comply with SJFC Section 1207. 3. The ESS shall be installed in accordance with the manufacturer's instructions and their listing. 4. Individual ESS units shall be separated from each other by at least 3 feet. 5. The ESS shall be separated from doors, windows, operable openings into buildings or HVAC inlets by at least 5 feet. ESS and associated equipment that are located on rooftops and not enclosed by building construction shall comply with the following:[69] 1. Stairway access to the roof shall be provided either through a bulkhead from the interior of the building or a stairway on the exterior of the building. 2. Service walkways at least 5 feet in width shall be provided from the point of access to the roof to the system. 3. ESS and associated equipment shall be located from the edge of the roof a distance equal to at least the height of the system, equipment, or component but not less than 5 feet. 4. The roofing materials under and within 5 feet horizontally from an ESS or associated equipment shall be noncombustible or shall have a Class A rating in accordance with ASTM E108 or UL 790. 5. A class I standpipe outlet shall be installed at an approved location on the roof level of the building or in the stairway bulkhead at the top level. The ESS shall be a minimum of 10 feet from the fire service access point on the rooftop.	Where approved, repurposed unlisted battery system from electric vehicles are allowed to be installed outdoors or in detached sheds located not less than 5 feet from exterior walls, property lines, and public ways.[70]

Comparison Item	SF	Austin	NYC	Chicago	San Jose	Fremont
Space requirements for installation	ESS shall be installed only in the following locations:[71] 1. Detached garages and detached accessory structures. 2. Attached garages separated from the dwelling unit living space and sleeping units in accordance with Section R302.6. 3. Outdoors or on the exterior side of the exterior walls located not less than 3 feet from doors and windows directly entering the dwelling unit. 4. Enclosed utility closets, basements, storage or utility spaces within dwelling units with finished or noncombustible walls and ceilings. Walls and ceilings of unfinished wood-framed construction shall be provided with not less than 5/8-inch Type X gypsum wallboard. Individual ESS units shall be separated by at least 3-ft of spacing. Spacing requirement may be reduced upon review and approval by AHJ when complying with CFC §1207.1.5 and §104.8.2. Applicant shall submit copies of both UL 9540A testing report and installation instructions showing recommended reduced spacing between the ESS unit(s) being installed. If minimum spacing varies between the two documents, the more restrictive separation distance will be approved. ESS shall be installed minimum of 3 feet from property lines, unless protected by a 1-hour fire barrier. ESS shall be installed at a minimum of 3 feet from the dedicated 36 inch wide means of egress pathway unless protected by a 1 hour fire barrier. ESS shall be installed at a minimum of 3 feet from the public way, unless protected by a 1 hour fire barrier. Clearance of 3 feet shall be provided in front of electrical equipment for maintenance purposes in accordance with CEC and CMC and kept clear of all combustible storage. Any eaves, structures, decking, or other such construction protruding more than 2 feet from exterior wall upon which the ESS is installed shall be located at least 3 feet from the ESS.72	ESS shall only be installed in the following locations:[73] 1. Detached garages and detached accessory structures. 2. Attached garages separated from the *dwelling unit* living space and *sleeping units* in accordance with Section 406.3.2 of the *International Building Code.* 3. Outdoors on exterior walls located a minimum of 3 feet from doors and windows. 4. Utility closets and storage or utility spaces within *dwelling units* and *sleeping units.* Combustible materials shall not be stored in ESS rooms, areas or walk-in units.[74] Groups of ESS are required to be separated a minimum of 3 feet from other groups and from walls in the storage room or area.[75] Electrochemical ESS shall not be located in areas where the floor is located more than 20 feet above the lowest level of fire department vehicle access or below the lowest level of exit discharge.[76]	No indoor system shall be installed below grade in a dwelling unit or garage.[77] ESS shall only be installed in the following locations: [78] 1. Detached garages and detached accessory structures. 2. Attached garages separated from the *dwelling unit* living space and *sleeping units* in accordance with Section 406.3.2 of the *International Building Code.* 3. Outdoors on exterior walls located a minimum of 3 feet from doors and windows. 4. Utility closets and storage or utility spaces within *dwelling units* and *sleeping units.*	ESS shall only be installed in the following locations: 1. Detached garages and detached accessory structures. 2. Attached garages separated from the *dwelling unit* living space and *sleeping units* in accordance with Section 406.3.2 of the *International Building Code.* 3. Outdoors on exterior walls located a minimum of 3 feet from doors and windows. 4. Utility closets and storage or utility spaces within *dwelling units* and *sleeping units.* Combustible materials shall not be stored in ESS rooms, areas or walk-in units. Groups of ESS are required to be separated a minimum of 3 feet from other groups and from walls in the storage room or area. Electrochemical ESS shall not be located in areas where the floor is located more than 20 feet above the lowest level of fire department vehicle access or below the lowest level of exit discharge.	Individual units shall be separated from each other by at least 3 feet of spacing.[79] ESS shall only be installed in the following locations:[80] 1. Detached garages and detached accessory structures. 2. Attached garages separated from the dwelling unit living space and sleeping units. 3. Outdoors or on the exterior side of the exterior walls located not less than 3 feet from doors and windows directly entering the dwelling unit. Enclosed utility closets, basements, storage or utility spaces within dwelling units with finish or noncombustible walls and ceilings.	Individual units shall be separated from each other by at least 3 feet of spacing.[81] ESS shall be installed only in the following locations:[82] 1. Detached garages and detached accessory structures. 2. Attached garages separated from the dwelling unit living space and sleeping units in accordance with Section R302.6. 3. Outdoors or on the exterior side of the exterior walls located not less than 3 feet from doors and windows directly entering the dwelling unit. 4. Enclosed utility closets, basements, storage or utility spaces within dwelling units with finished or noncombustible walls and ceilings. Walls and ceilings of unfinished wood-framed construction shall be provided with not less than 5/8-inch Type X gypsum wallboard.
Sprinkler requirements and fire extinguishing systems	For BESS over 20 kWh, areas containing ESS are required to be protected by one of the following: 1. Automatic sprinkler coverage 2. Automatic sprinkler coverage with a hazard classification based on large-scale fire testing An approved alternative automatic fire-extinguishing system	Areas containing ESS are required to be protected by one of the following: 1. Automatic sprinkler coverage with a minimum density of 0.3 gpm/ft^2 over 2,500 ft^2 2. Automatic sprinkler coverage with a hazard classification based on large-scale fire testing 3. An approved alternative automatic fire-extinguishing system (e.g. CO_2, water spray, water mist, clean agent, fixed aerosol)	Fire suppressions system is required with automatic sprinklers or following NFPA 12, 15, 750, 2001, and 2010.[83] Fire extinguishing for outdoor BESS is needed for lithium ion greater than 250 kWh and lead-acid greater than 500 kWh[84] Indoor and outdoor systems shall be designed to address the hazards identified by full scale testing including fire barriers, fire alarms, explosion mitigation, gas detection, fire extinguishing, and ventilation systems[85]	Areas containing ESS are required to be protected by automatic sprinkler coverage in accordance with IFC Section 903.3.1.1. [86]	Rooms and areas within buildings and walk-in units containing electrochemical ESS shall be protected by an automatic sprinkler system designed with a minimum density of 0.3 gpm/ft^2 over the fire area or 2,500 ft^2, whichever is smaller.[87] ESS located in walk-in units on rooftops shall be provided with automatic fire suppression systems within the ESS enclosure.[88]	Required if energy ratings are exceeded. Rooms and areas within buildings and walk-in units containing electrochemical ESS shall be protected by an automatic sprinkler system designed with a minimum density of 0.3 gpm/ft^2 over the fire area or 2,500 ft^2, whichever is smaller.[89] ESS located in walk-in units on rooftops shall be provided with m automatic fire suppression systems within the ESS enclosure.[90]

Comparison Item	SF	Austin	NYC	Chicago	San Jose	Fremont
Fire and gas detection	Rooms and areas within dwelling units, basements, and attached garages in which ESS are installed shall be protected by smoke alarms in accordance with Section R314. A heat detector, listed and interconnected to the smoke alarms, shall be installed in locations within dwelling units and attached garages where smoke alarms cannot be installed based on either listing.[91] ESS that have the potential to release toxic or highly toxic gas during charging, discharging, and normal use conditions shall not be installed within Group R-3.[92]	Rooms and areas within *dwelling units*, *sleeping units* and *attached garages* in which ESS are installed shall be protected by smoke alarms in accordance with Section 907.2.11. A heat detector listed and interconnected to the smoke alarms shall be installed in locations within swelling units, sleeping units and attached garages where smoke alarms cannot be installed based on their listing. [93]	Rooms and areas within dwellings units, sleeping units and attached garages in which ESS are installed shall be protected by smoke alarms in accordance with Section 907. A heat detector or heat alarm listed and interconnected to the smoke alarms shall be installed in locations within dwelling units, sleeping units and attached garages where smoke alarms cannot be installed based on their listing.[94] ESS that have the potential to release toxic or highly toxic gas during charging, discharging and normal use conditions shall not be installed within Group R-3 and R-4 occupancies.[95]	Automatic smoke detection shall be installed in rooms containing ESS in accordance with IFC Section 907.2.[96]	Rooms and areas within dwelling units, sleeping units, basements and attached garages in which ESS are installed shall be protected by smoke alarms. A listed heat alarm interconnected to the smoke alarms shall be installed in locations within dwelling units, sleeping units, and attached garages where smoke alarms cannot be installed based on their listing.[97]	Rooms and areas within dwelling units, sleeping units, basements and attached garages in which ESS are installed shall be protected by smoke alarms. A listed heat alarm interconnected to the smoke alarms shall be installed in locations within dwelling units, sleeping units, and attached garages where smoke alarms cannot be installed based on their listing.[98]
Explosion mitigation	For BESS over 20 kWh, explosion control is required to be provided for Lead-acid, Ni-Cd, Ni-MH, Lithium-ion, and flow battery technologies	Explosion control complying with AFC Section 911 is required for Lithium-ion, Ni-Cd and Ni-MH ESS battery types.[99]	Explosion mitigation for outdoor BESS is needed for li-ion greater than 250 kWh and lead-acid greater than 500 kWh [100] Indoor and outdoor systems shall be designed to address the hazards identified by full scale testing including fire barriers, fire alarms, explosion mitigation, gas detection, fire extinguishing, and ventilation systems[101]	Explosions will be contained within unoccupied battery storage rooms for the minimum duration of fire resistance rated walls. [102]	Explosion control is required to be provided for Lead-acid, Ni-Cd, Ni-MH, Lithium-ion, and flow battery technologies.[103] Explosion control shall consist of explosion (deflagration) venting, explosion (deflagration) prevention, or barricades.[104]	Required if energy ratings are exceeded. Explosion control is required to be provided for Lead-acid, Ni-Cd, Ni-MH, Lithium-ion, and flow battery technologies.[105]
Spill control	For BESS over 20 kWh, areas containing free-flowing liquid electrolyte or hazardous materials with Lead-acid, Ni-Cd, Ni-MH, and Flow ESS battery technologies are required to be provided with spill control.	Areas containing free-flowing liquid electrolyte or hazardous materials with Lead-acid, Ni-Cd, Ni-MH, and Flow ESS battery technologies are required to be provided with spill control.[106]	Areas containing free-flowing liquid electrolyte or hazardous materials with Lead-acid, Ni-Cd, Ni-MH, and Flow ESS battery technologies are required to be provided with spill control.	Areas containing free-flowing liquid electrolyte or hazardous materials with Lead-acid, Ni-Cd, Ni-MH, and Flow ESS battery technologies are required to be provided with spill control and neutralization.[107]	Areas containing free-flowing liquid electrolyte or hazardous materials with Lead-acid, Ni-Cd, Ni-MH, and Flow ESS battery technologies are required to be provided with spill control and neutralization.[108]	Required if energy ratings are exceeded. Areas containing free-flowing liquid electrolyte or hazardous materials with Lead-acid, Ni-Cd, Ni-MH, and Flow ESS battery technologies are required to be provided with spill control and neutralization.[109]
Thermal runaway	For BESS over 20 kWh, lead-acid, Ni-Cd, Ni-MH, and Lithium-ion battery ESS types are required to be provided with a listed or approved method to prevent, detect, and minimize the impact of thermal runaway	Lead-acid, Ni-Cd, Ni-MH, and Lithium-ion battery ESS types are required to be provided with a listed or approved method to prevent, detect, and minimize the impact of thermal runaway.[110]	Lead-acid, Ni-Cd, Ni-MH, and Lithium-ion battery ESS types are required to be provided with a listed or approved method to prevent, detect, and minimize the impact of thermal runaway.	Lead-acid, Ni-Cd, Ni-MH, and Lithium-ion battery ESS types are required to be provided with a listed or approved method to prevent, detect, and minimize the impact of thermal runaway.[111]	Lead-acid, Ni-Cd, Ni-MH, and Lithium-ion battery ESS types are required to be provided with a listed or approved method to prevent, detect, and minimize the impact of thermal runaway.[112]	Required if energy ratings are exceeded. Lead-acid, Ni-Cd, Ni-MH, and Lithium-ion battery ESS types are required to be provided with a listed or approved method to prevent, detect, and minimize the impact of thermal runaway.[113]
Fire rated wall and enclosure requirements	For BESS over 20 kWh, enclosures of ESS shall be of noncombustible construction. Rooms and areas containing ESS shall be separated from other areas in the building by 2-hour fire barriers.	Enclosures of ESS shall be of noncombustible construction.[114] In dedicated-use buildings, areas containing ESS shall be separated from areas in which administrative and support personnel are located by 2-hour fire barriers. In nondedicated-use buildings, areas containing ESS shall be separated by other areas in the building by 2-hour fire barriers.[115]	Indoor systems shall be protected by a 1 hr fire barrier: NYC[116] Rooms and areas containing ESS shall be protected on the system side by 2-hour rated fire barriers (NY State) constructed in accordance with Section 707 of the Building Code of New York State and 2-hour rated horizontal assemblies constructed in accordance with Section 711 of the Building Code of New York State[117]	Not mentioned for ESS technology but 2 hour fire resistance rated construction required for capacity type energy storage systems. [118]	Enclosures of ESS shall be of noncombustible construction.[119] Rooms and areas containing ESS shall be separated from other areas in the building by 2-hour fire barriers.[120]	Required if energy ratings are exceeded. Enclosures of ESS shall be of noncombustible construction. Rooms and areas containing ESS shall be separated from other areas in the building by 2-hour fire barriers.[121]

[1] San Francisco Fire Department Administrative Bulletin 5.12 Energy Storage Systems in R-3 Occupancies

[2] 2021 AFC §1207.11.4

[3] 2022 New York City Fire Code Chapter 6 section 608.1 Stationary ESS

[4] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[5] 2018 IFC Table 1206.2.9

[6] 2018 IFC §1206.2.8.3

[7] 2022 SJFC §1207.11.4

[8] 2022 CFC §1207.11.4

[9] 2022 CRC §328.9

[10] 2022 CFC §1207.11.9

[11] 2021 AFC §1207.11.8

[12] 2021 AFC Table 1207.6, §1207.6.1

[13] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[14] 2020 Residential Code of NY State Chapter 3 Section R327 ESS

[15] 2018 IFC 1206.2.11.3

[16] 2022 SJFC §1207.11.8

[17] 2022 CFC §1207.11.8

[18] 2022 CFC §1207.11.9

[19] San Francisco Fire Department Bulletin 5.12 ESS in R-3 Occupancies

[20] 2022 SFFC Table 107-A

[21] 2021 AFC §1207.1.2 Item 1

[22] 2021 AFC §1207.1.2 Item 2

[23] 2021 AFC §1207.1.2 Item 3

[24] 2020 Fire Code of NY State Ch 12 Section 1206.4

[25] New York City Fire Department: New Fire Department Rule 3 RCNY 608-01: "Outdoor Stationary Battery Systems"

[26] New York City Fire Department: New Fire Department Rule 3 RCNY 608-01: "Outdoor Stationary Battery Systems"

[27] 2022 New York City Fire Code Chapter 6 section 608.1 Stationary ESS

[28] 2018 IFC §1206.2.1 and 1206.2.2

[29] 2022 SJFC §1207.1.2

[30] 2022 SJFC §1207.1.3

[31] 2022 CFC §1207.1.2, §1207.1.3

[32] 2022 CRC §R328.2

[33] 2022 CRC §R328.2 Exception

[34] AFC §1207.11.1

[35] AFC §1207.11.1 Exception 1

[36] AFC §1207.11.1 Exception 2-

[37] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[38] 2022 SJFC §1207.11.1

[39] 2022 SJFC §1207.11.5

[40] 2022 CFC §1207.11.1

[41] AFC §1207.3.4

[42] AFC §1207.3.4

[43] 2020 Fire Code of NY State Ch 12 Section 1206.12.4

[44] New York City Fire Department: New Fire Department Rule 3 RCNY 608-01: "Outdoor Stationary Battery Systems"

[45] 2022 New York City Fire Code Chapter 6 section 608.1 Stationary ESS

[46] 2018 IFC §1206.2.10.3

[47] 2018 IFC §1206.2.11

[48] 2022 SJFC §1207.3.4

[49] 2022 CFC §1207.3.4

[50] 2020 Residential Code of NY State Chapter 3 Section R327 ESS

[51] 2018 IFC §1206.2.5

[52] 2022 SJFC §1207.11.7

[53] 2022 CRC §328.4

[54] San Francisco Fire Department Bulletin 5.12 ESS in R-3 Occupancies

[55] 2021 AFC §1207.5.6

[56] 2021 AFC §1207.8.3

[57] 2021 AFC §1207.8.4

[58] 2021 AFC §1207.5.6

[59] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[60] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[61] New York City Fire Department: New Fire Department Rule 3 RCNY 608-01: "Outdoor Stationary Battery Systems"

[62] New York City Fire Department: New Fire Department Rule 3 RCNY 608-01: "Outdoor Stationary Battery Systems"

[63] 2018 IFC §1206.2.8.7.2

[64] 2018 IFC §1206.2.8.7.1

[65] 2022 SJFC §1207.5.6

[66] 2022 SJFC §1207.5.8

[67] 2022 SJFC §1207.8.3

[68] 2022 SJFC §1207.8.4

[69] 2022 SJFC §1207.9.5

[70] 2022 CFC §1207.11.1 Exception

[71] 2022 CRC §R328.4

[72] San Francisco Fire Department Bulletin 5.12 ESS in R-3 Occupancies

[73] AFC §1207.11.3

[74] 2021 AFC §1207.4.6

[75] 2021 AFC §1207.5.1

[76] 2021 AFC §1207.5.3

[77] 2022 New York City Fire Code Chapter 6 section 608.1 Stationary ESS

[78] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[79] 2022 SJFC §1207.11.2.1

[80] 2022 SJFC §1207.11.3

[81] 2022 CFC §1207.11.2.1

[82] 2022 CFC §1207.11.3

[83] 2020 Fire Code of NY State Ch 12 Section 1206.12.5

[84] New York City Fire Department: New Fire Department Rule 3 RCNY 608-01: "Outdoor Stationary Battery Systems"

[85] 2022 New York City Fire Code Chapter 6 section 608.1 Stationary ESS

[86] 2018 IFC §1206.2.11.1

[87] 2022 SJFC §1207.5.5

[88] 2022 SJFC §1207.9.4

[89] 2022 CFC §1207.5.5

[90] 2022 CFC §1207.9.4

[91] 2022 CRC §R328.7

[92] 2022 CFC §1207.11.9

[93] AFC §1207.11.6

[94] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[95] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[96] 2018 IFC §1206.2.11.2

[97] 2022 SJFC §1207.11.6

[98] 2022 CFC §1207.11.6

[99] 2021 AFC Table 1207.6, §1207.6.3

[100] New York City Fire Department: New Fire Department Rule 3 RCNY 608-01: "Outdoor Stationary Battery Systems"

[101] 2022 New York City Fire Code Chapter 6 section 608.1 Stationary ESS

[102] 2018 IFC §1206.2.3.2

[103] 2022 SJFC Table 1207.6

[104] 2022 SJFC §1207.6.3, §911.1

[105] 2022 CFC Table 1207.6

[106] 2021 AFC Table 1207.6, §1207.6.2

[107] 2018 IFC §1206.2.11.5

[108] 2022 SJFC Table 1207.6, §1207.6.2

[109] 2022 CFC Table 1207.6

[110] 2021 AFC Table 1207.6, §1207.6.5

[111] 2018 IFC 1206.2.10.7

[112] 2022 SJFC Table 1207.6, §1207.6.5

[113] 2022 CFC Table 1207.6

[114] 2021 AFC §1207.3.5

[115] 2021 AFC §1207.7.4

[116] 2022 New York City Fire Code Chapter 6 section 608.13 Stationary ESS

[117] 2020 Fire Code of NY State Chapter 12 Section 1206: Electrical ESS

[118] 2018 IFC 1206.3.2.2

[119] 2022 SJFC §1207.3.5

[120] 2022 SJFC §1207.7.4

[121] 2022 CFC §1207.3.5, §1207.7.4