Battery Energy Storage Systems

CSLB Staff Report in Consultation with Expert Consultants

June 3, 2022

Introduction

Battery energy storage systems (BESS), and particularly lithium-ion BESS, developed substantially and expanded rapidly in use in recent years. In response to the changing technology and uses, national and state regulatory bodies and standards authorities adopted (and then amended) health and safety standards that are designed to ensure that BESS are developed and installed safely. The Contractors State License Board (CSLB or Board), for its part, is reviewing the extent to which C-46 solar contractors should be permitted to install BESS in light of recent technological developments and their expanded use.

Fundamentally, the C-46 solar contractor classification was established to enable solar contractors to install, modify, maintain, or repair thermal and photovoltaic solar energy systems, not modern BESS. The C-46 classification regulation does not expressly include BESS within its scope, and there are important reasons why modern BESS should be considered separate electrical systems.

Nonetheless, C-46 contractors undoubtedly perform BESS installations, but the appropriate limit for such installations is the subject of much debate. To clarify the appropriate scope of C-46 BESS installations, CSLB must revise the classification regulations through the regulatory rulemaking process in the Administrative Procedure Act.[1]

To assist in this effort, in March of 2022, the Board directed staff to retain outside consultants or experts to: (1) evaluate information already received and perform additional fact finding, as necessary; and (2) assess whether allowing C-46 contractors to install BESS within a kilowatt-hour (kWh) threshold would be supported by existing building codes, is prevalent among C-46 contractors in the construction business, and is consistent with the Board's public safety mandate.

After consulting with subject matter experts, staff makes the following recommendation:

Recommendation

The Board should consider amending the C-46 solar contractor classification to expressly permit them to install a BESS up to and including 80 kWh when installed at the same time a solar photovoltaic (PV) energy system is installed, as incidental and supplemental to the solar photovoltaic energy system installation.

As discussed below, 80 kWh would be an appropriate threshold to limit C-46 contractor installation, when installed as incidental and supplemental to the installation of a photovoltaic energy system, for the following reasons:

- Establishing an 80 kWh threshold as the point at which BESS installation is no longer incidental and supplemental to a C-46 contractor's installation of a solar photovoltaic energy system, and is instead a separate electrical system, is consistent with and preserves the existing regulatory classification framework.
- Establishing an 80 kWh threshold will preclude C-46 contractors from installing larger systems that are more appropriate for a C-10 contractor.
- C-46 contractors (holding no "A", "B", or "C-10" license) typically perform installations within an 80 kWh threshold commonly found in the residential market, where there is typically no need for BESS in excess of 80 kWh.
- The available evidence does not demonstrate increased incidents of consumer harm within an 80 kWh threshold based on the classification type of the installer.
- Establishing an 80 kWh threshold will aid C-46 licensees in knowing and complying with a clear standard and will aid the Board in enforcing the classification standard.
- Pursuant to the Residential and Fire Codes, 80 kWh is the maximum allowable capacity that can be installed for a residential occupancy within common residential locations. Above 80 kWh, more rigorous safety standards can apply to the installation.
- The codes, standards, and regulations in California are established to ensure public safety at the 80 kWh threshold, and a C-46 contractor following the applicable standards would not create an increased risk of consumer harm.

Report

1. Background.

For several years, CSLB staff has received written and oral testimony on whether and to what extent C-46 contractors should install BESS from the two primary stakeholders with differing views on the issue: the California Solar and Storage Association (CALSSA) representing the C-46 solar contractors and the National Electrical Contractors Association / International Brotherhood of Electrical Workers Labor Management Cooperation Committee (IBEW-NECA) representing the C-10 electrical contractors.

Since 2019, the full Board and its Legislative Committee on several occasions directed staff to research BESS, meet with stakeholders, and/or develop draft regulatory language for inclusion of BESS in CSLB regulations.[2] After CSLB staff received conflicting stakeholder information on the economic, market, and risks or hazards of

limiting BESS by contractor license classification,[3] in December 2020, the Board contracted with the University of California (UC) Berkeley to review and make a recommendation regarding the appropriate classifications to install BESS between C-46 solar contractors and C-10 electrical contractors.

In July of 2021, UC Berkeley released a report (UC Berkeley Report)[4] recommending the Board restrict C-46 contractors from installing BESS in any capacity.[5] The UC Berkeley Report concluded that precluding C-46 solar contractors from installing BESS would have public safety benefits, minimal adverse economic impacts, and benefit the workforce.[6]

In November of 2021, CSLB staff developed a proposal to preclude C-46 contractors from installing BESS consistent with the UC Berkeley recommendation, but it was not approved by the Board. The Board raised concerns about the impact of the proposed rule to small businesses and directed staff to seek more input and possible resolution between the industry stakeholders and develop draft regulatory language that may be acceptable to the electrical and solar stakeholders.[7]

Staff met with stakeholder groups multiple times between December 2021 and March 2022, but was unsuccessful in developing a proposal agreeable to both the solar and electrical industry representatives.

A review of the materials indicates the disputed issues between CALSSA and IBEW-NECA include, but are not limited to, the following:

Whether BESS is incidental and supplemental to the installation of a photovoltaic solar energy system.

Existing law provides that specialty contractors (such as C-10 and C-46 contractors) may take contracts in trades other than those in which they are licensed, if the work is "incidental and supplemental" to the work in the craft for which they are licensed.[8]

- CALSSA states that if a BESS size limit is placed on the C-46 classification, it must be considered part of the authorized work for solar contractors, and not simply incidental and supplemental to it.[9]
- IBEW-NECA states that if a BESS size limit is placed on the C-46 classification, the installation should only be considered incidental and supplemental to a solar energy system installation up to a certain point,[10] after which the BESS should be considered a separate electrical system that cannot be installed by a C-46 contractor.[11]

Whether there are increased risks of hazards or safety concerns in authorizing C-46 contractors to install BESS of a certain size.

- IBEW-NECA states that there is substantial evidence that battery energy storage systems pose significant fire and life safety risks[12] that increase with the size of

the system.[13] They further state that contractors holding a C-10 license performed 89% of solar-paired storage installations in California.[14]

- CALSSA states that C-46 contractors have safely and without incident installed more than 80% of the solar and energy storage systems in California.[15] CALSSA states that risks of larger battery systems are hypothetical and fail to recognize existing product and regulatory protections, installer trainings, and the proven effectiveness of those protections.[16]

The role of certified electricians in solar-paired storage projects.

Existing law provides that persons who engage in the connection of electrical devices for contractors licensed as class C-10 electrical contractors are required to be certified electricians when performing electrical work.[17] This includes all persons who engage in the connection of electrical devices 100 volt-amperes and up.[18]

- CALSSA states that dual license holders (those holding both a C-10 and C-46 license) commonly use solar installers, not certified electricians, to install batteries.[19] CALSSA states that if BESS is removed from the C-46 scope of work, it would require C-46 solar contractors to replace their workers with certified electricians for solar and storage jobs.[20]
- IBEW-NECA states that as dual license holders begin performing more BESS work, they will need to hire more certified electricians; that current workers who are not certified electricians will continue to be able to perform work; and, that there are plenty of installation requirements for BESS that do not involve electrical work and do not require use of a certified electrician.[21]

Whether a C-46 contractor can add BESS to an existing photovoltaic solar energy system or maintain BESS they previously installed.

Existing law provides that a C-46 contractor may not perform work in building or construction trades, crafts, or skills except when "required to install a . . . photovoltaic solar energy system."[22] With this classification limitation in mind, C-46 contractors may take contracts in trades other than those in which they are licensed if the work is "incidental and supplemental" to the work in the craft for which they are licensed.[23]

- CALSSA states there is no justification for allowing the installation of batteries at the same time as solar panels but prohibiting battery installation if it occurs later in time under a separate contract.[24] CALSSA also proposes to allow solar contractors to maintain or repair any BESS the contractor previously installed to fulfill warranty and contractual obligations.[25]
- IBEW-NECA states that CALSSA's proposal to expand the scope of the C-46 license to allow installation of energy storage projects as stand-alone projects that are installed after a solar system is installed is unacceptable (because it would be a standalone electrical contract).[26]

What is an appropriate kWh threshold for a C-46 contractor to install a solar-paired BESS.

CALSSA and IBEW-NECA agree that a regulatory threshold can be based on the capacity of the BESS,[27] and that a capacity limitation would make the most sense from a technical, safety, economic and regulatory perspective.[28] However, they disagree on the appropriate threshold, as follows:

- CALSSA proposes 1 Megawatt-hour (MW) and 600 kWh thresholds.[29] CALSSA believes 1 MW is the most appropriate threshold, but if BESS is to be tied to safety codes, it should set it at 600 kWh, below which an extensive safety analysis is not required.[30] CALSSA states that a 50 kWh threshold would be arbitrary.[31]
- IBEW-NECA states CSLB could use the 10 kWh / 20 kWh / 70 kWh technology-based thresholds set forth in the Fire Code or set a single threshold to ease compliance and enforcement.[32] Or CSLB could set a 20 kWh threshold for lithium-ion batteries, the most prominent in battery in residences.[33]

2. Materials reviewed in preparation of the report.

This report considers the following resources, which are referred to or cited herein as follows:

- California Business and Professions Code (B & P Code), Division 3, Chapter 9, Contractors State License Law
- Title 16, Division 8, Articles 1 through 9 of the California Code of Regulations (CCR)
- 2019 California Building Code, Title 24, Part 2, Volume 1 with July 2021 Supplement (CBC)
- 2019 California Residential Code, Title 24, Part 2.5 with July 2021 Supplement (CRC or Residential Code)
- 2019 California Electrical Code, Title 24, Part 3 (CEC or Electrical Code)
- 2019 California Energy Code, Title 24, Part 6 with Jan 2020 Errata (Ca. Energy Code)
- 2022 California Energy Code (Approved by California Energy Commission August 2021, effective January 2023) (2022 Ca. Energy Code)
- 2019 California Fire Code, Title 24, Part 9 with July 2021 Supplement (CFC or Fire Code)
- C-46 Solar Examination, Occupational Analysis Report. CSLB Examination Development Unit, August 2017 (C-46 Occupational Analysis)
- C-10 Electrical Examination, Occupational Analysis Report. CSLB Examination Development Unit, September 2018 (C-10 Occupational Analysis)
- October 14, 2019, CALSSA letter to CSLB (October 2019 CALSSA Letter)

- Robertson, Tony, Barowy, Adam. Underwriters Laboratories. “UL 9540A Test Method Brings Clarity to Insurance and Fire Mitigation Professionals.” Webinar, July 2018. https://www.ul.com/resources/ul-9540a-test-method-brings-clarity-insurance-and-fire-mitigation-professionals (UL July 2018 Webinar)
- Florence, Laurie, Johnson, Maurice, Trudeau, James. Underwriters Laboratories. “Energy Storage Systems: What you Need to Know about UL 9540 and 9540A.” Webinar, July 7, 2020. https://www.ul.com/resources/energy-storage-systems-what-you-need-know-about-ul-9540-and-9540a (UL July 2020 Webinar)
- Zabin, Carol, Betony Jones and Don Holmstrom. Evaluation of Alternative Contractor License Requirements for Battery Energy Storage Systems. UC Berkeley Labor Center, June 30, 2021. https://laborcenter.berkeley.edu/evaluation-of-alternative-contractor-license-requirements-for-battery-energy-storage-systems/. (UC Berkeley Report)
- November 24, 2021, CALSSA letter to CSLB (November 2021 CALSSA Letter)
- November 30, 2021, California Energy Commission letter to Suzan Granzella (November 2021 CEC Letter)
- January 19, 2022, IBEW-NECA letter to David Fogt (January 2022 IBEW-NECA Letter)
- February 23, 2022, CALSSA letter to David Fogt (February 2022 CALSSA Letter)
- March 4, 2022, IBEW-NECA Response to February 23, 2022, CALSSA Letter (March 2022 IBEW-NECA Letter)
- March 29, 2022, CALSSA letter to David Fogt (March 2022 CALSSA Letter)
- May 3, 2022, meeting of CSLB staff, Board Member Susan Granzella, and four CSLB-licensed C-10 and C-46 contractor subject matter experts (SMEs) with CSLB exam development experience on the topic of BESS. (May 2022 SME Meeting)
- May 9, 2022, meeting of CSLB staff with Assistant Fire Marshal, Assistant Deputy Director, and Chief of Code Development and Analysis, for the Office of the State Fire Marshal. (May 2022 SFM Meeting)

In addition, staff consulted with Joe Barragan, a CSLB licensee holding A, B, C-7, C-10, C-16, and C-46 specialty classifications. He also holds International Code Council certifications as a building official, residential building inspector, commercial electrical inspector, and fire inspector, and he is a National Fire Protection Association certified fire inspector. Mr. Barragan has inspected and reviewed plans for hundreds of solar projects. Mr. Barragan reviewed the staff report and provided input in the drafting, and he concurs in the recommendation.

3. **The Board may reasonably establish in regulation an 80 kWh threshold as the point at which BESS installation is no longer incidental and supplemental to a C-46 contractor’s installation of a solar photovoltaic energy system, and is instead a separate electrical system.**

There are multiple kWh thresholds for BESS installations that Title 24 Codes cite: 1 kWh, 3 kWh, 10 kWh, 20 kWh, 40 kWh, 50 kWh, 70 kWh, 80 kWh, 200 kWh, 280 kWh, or 600 kWh or more. The different thresholds often trigger different safety standards depending on BESS type, chemistry, location, and spacing, building occupancy, listing, and proximity to combustible construction, among other factors.[34]

The cited Residential and Fire Codes set minimum safety standards for the installation of BESS, and do not directly address the electrical complexity required to install BESS, or expressly specify the point at which the installation of BESS is more appropriate for an electrical contractor or solar contractor.

Nonetheless, the Board may reasonably establish in regulation an 80 kWh threshold as the point at which BESS installation is no longer incidental and supplemental to a C-46 contractor's installation of a solar photovoltaic energy system, and is instead a separate electrical system that should not be installed by a C-46 contractor.

This approach would be consistent with the existing contractor classification framework, which limits out-of-classification work to instances where it is incidental and supplemental to the installation of in-classification work.

Also, installations within the 80 kWh threshold are typical among C-46 contractors in the construction business. C-46 contractors (holding no "A," "B," or "C-10" license) installed approximately 1,800 solar-paired BESS systems between 2015 and 2020.[35] The number of solar-paired BESS installed in California increased substantially in recent years and demand for BESS is expected to continue because of utility power outages in California and the need to meet California's clean energy goals.[36] However, the average size of C-46 contractor installations was fairly small, between 5.2 and 6.6 kilowatts (kw),[37] within the 80 kWh threshold recommended in this report.[38]

In addition, the available evidence within this threshold does not demonstrate increased risks of consumer harm based on license classification. On the other hand, installations above 80 kWh can involve electrical knowledge and experience that is beyond the skillset of a C-46 contractor. Finally, setting a clear threshold will assist the Board in ensuring compliance and in enforcement efforts.

a. Within an 80 kWh threshold, the available evidence does not demonstrate increased incidents of consumer harm based on the classification type of the installer.

As it relates to the hazards of BESS, the UC Berkeley report concluded that "BESS is a low frequency, high risk technology; while incidents have been rare, they have serious consequences."[39] The report also stated, "BESS risks are significant for grid-utility, industrial, commercial, and residential applications," and that "[s]erious incidents have occurred in all phases of the BESS lifecycle, including construction, installation, and operation."[40]

On the other hand, the report noted that there were "no identified incidents in California," and that "[l]ithium-ion batteries are a relatively new technology utilized for BESS, so these batteries lack a lengthy track record for evaluation of hazards and risks."[41] And "[s]ince such a small percentage of BESS projects have been installed by C-46 (no C-10, A, or B), . . . the safety record is extremely limited for this group of contractors . . . ."[42]

In addition to the limitations on available information, the hazardous incidents identified in the UC Berkeley Report were criticized as being distinguishable from the types of installations that a C-46 contractor would normally perform.[43] The reported incidents involved defective batteries, manufacturing problems, installations that exceeded 80 kWh, and/or installations outside California and, consequently, not subject to the same regulatory standards.[44]

As the UC Berkeley Report and IBEW-NECA have articulated, thermal runaway is the most significant of BESS hazards.[45] Thermal runaway is the result of a chemical reaction within a cell that releases flammable vapors resulting in a fire or explosion.[46]

At the May 2022 meeting of subject matter experts, they stated that higher capacity BESS may result in a more substantial fire (if a fire occurs at all); however, the kWh total of a BESS or multiple BESS strung together does not, by itself, create more complexity in the electrical installation or create a higher risk of a fire occurring.[47] Mr. Barragan concurs in this conclusion. In fact, as discussed below, the risk of thermal runaway is more a function of the internal circuitry and chemistry of a battery (or possible mishandling), and there are protections in place to prevent or preclude a fire from occurring at all.

As it relates to arc flash and electrical shock from an energized BESS or electrical system, which were also identified by UC Berkeley and IBEW-NECA as significant risks in BESS installations,[48] CALSSA stated, "[i]t is patently false to claim that energy storage systems represent a higher risk of [main service] panel overloads than solar systems alone," and that, "[t]he formulas for wire sizing and breaker sizing are the same."[49] Subject matter experts supported this view generally and indicated that "the electrical theory does not change" when installing a single 20 kWh BESS, or when connecting multiple BESS together to reach a higher threshold.[50]

Furthermore, the kWh thresholds in the Title 24 Codes are already set relatively low for safety. Underwriters Laboratories (UL) is the joint standard for the United States and Canada for which ESS are evaluated for safety.[51] During a discussion of UL 9540A (large scale fire testing for ESS), UL stated that the kWh quantity thresholds set by the International Fire Code (that California has adopted) were set "fairly low" because the systems are still new, and the codes will be updated when more information is learned about what quantities are truly "safe" or "unsafe."[52] For example, NFPA 855, the standard for ESS adopted by the Fire Code, provides that lithium ion BESS over 20 kWh must be certified to UL 9540.[53] This is a manufacturing standard to show that the

product prevents thermal runaway, which, in turn, prevents the battery from being the cause of a fire.[54] To be certified to UL 9540, the product must undergo a compatibility system safety analysis to evaluate hazard, risk, and failure mode, and undergo standard mitigation strategies to ensure no system hazards are introduced due to any BESS components interacting with each other.[55] It appears that the standards were developed in part due to hazardous incidents occurring with much larger systems. Indeed, UL has indicated that the battery incidents "of particular interest in developing 9540A" were in other countries and one state outside of California, at a size between 50 kw and 20 megawatts.[56] (For comparison, a Tesla Powerwall is 5.8 kw). By contrast, from the information available so far, small residential batteries perform well.[57]

Both C-46 and C-10 contractors are required to know the portions of California Electrical Code (based on the National Electrical Code) applicable to their trades: for C-46 contractors, this includes the Electrical Code articles that relate to solar PV systems and the devices that connect to them, including BESS, and for electrical contractors, this includes the entirety of the Electrical Code.[58] The C-46 license examination tests on safety procedures when working with solar system components of low, medium, and high voltage to avoid electrical fire, arc-flash, and shock in accordance with Cal/OSHA requirements.[59] While it is possible through negligence (such as penetrating, crushing, dropping the battery, loose connections) that a contractor can cause thermal runaway[60] or electric shock, negligence is a risk factor in any installation by any contractor.

Based on the foregoing, it is reasonable to infer that if a contractor is licensed to make electrical connections to a solar system through meeting the minimum standards of C-46 or C-10 licensure, such as by taking the CSLB license examination, they have the skill and ability needed to make electrical connections required for smaller BESS installations within an 80 kWh threshold when paired to solar PV system, and that those activities alone would not create greater risk to building occupants or consumers. Mr. Barragan concurs in this conclusion.

b. Establishing an 80 kWh threshold as the point at which BESS installation is no longer incidental and supplemental to a C-46 contractor's installation of a solar photovoltaic energy system, and is instead a separate electrical system, is consistent with the existing regulatory framework.

The CSLB C-46 solar contractor classification regulation provides:

> A solar contractor installs, modifies, maintains, and repairs thermal and photovoltaic solar energy systems. A licensee classified in this section shall not undertake or perform building or construction trades, crafts, or skills, except when required to install a thermal or photovoltaic solar energy system.[61]

The regulation precludes C-46 contractors from engaging trades, crafts or skills outside the scope of the classification, unless required to install a photovoltaic solar energy system. In light of this regulatory limitation, Board staff previously stated that BESS may

be installed concurrently with the installation of a photovoltaic solar energy system, when such installation is incidental and supplemental to the installation of the solar energy system.

Nonetheless, there is some question whether BESS installations should ever be considered incidental and supplemental to the installation of a photovoltaic solar energy system. Photovoltaic systems and battery systems are separately defined systems in the Electrical Code.[62] They are governed by different provisions of the Electrical and Fire Codes.[63] They are "different technologies with different purposes and ways of interacting with the electrical system of a structure."[64] "[A] solar PV system generates and transmits electrical energy, while a BESS utilizes electrical energy, transforms that energy into a storage state, and then transmits back that stored electrical energy when needed for other uses."[65]

Although they are separate systems, they can, however, be complementary—the Electrical Code provides that solar photovoltaic systems "may be interactive with other electrical power production sources or stand-alone or both, and may or may not be connected to energy storage systems such as batteries."[66]

In light of the differences between the two electrical systems, the UC Berkeley Report concluded that BESS should not be considered within the scope of the C-46 classification, or incidental and supplemental to the installation of a solar energy system:

> *BESS is not essential to solar installation. BESS is not included in the C-46 solar contractor regulatory description . . . . BESS is not a thermal or photovoltaic solar energy system.* BESS is listed as a distinct system in a separate Chapter 7 Special Conditions of NFPA 70 (2020) from solar photovoltaic (PV) systems in Chapter 6 Special Equipment. *BESS is not essential or required to be installed with a PV system.* BESS can be installed as a stand-alone system or with other equipment including wind turbines, PV systems, or engine generators.[67]

The UC Berkeley Report recommended that "CSLB limit the scope of the C-46 to its original scope and preclude C-46 license holders from installing BESS even when paired with solar . . . ."[68] But the Board previously considered this regulatory option in November 2021 and did not support it. The C-46 and C-10 participating stakeholders agreed, and the Board encouraged, a kWh threshold should be used to clarify the scope of the work performed by C-46 contractors.

To remove any possible doubt in the regulations about whether BESS installation should be considered incidental and supplemental to the installation of a solar photovoltaic energy system, the Board should consider amending the regulations to state expressly that BESS installations are incidental and supplemental to the installation of photovoltaic solar energy systems, up to 80kWh. This approach preserves the regulatory and practical differences between BESS and photovoltaic solar energy systems by treating BESS installations as out-of-classification work for C-46

contractors, but also recognizes that BESS have become a desirable supplemental system to photovoltaic solar energy system installations, and that C-46 contractors perform BESS installations contemporaneously with the installation of photovoltaic solar energy systems.

c. Electrical system connections required at thresholds above 80 kWh are more appropriate for a C-10 contractor.

The higher the kWh threshold, the more likely the solar-paired BESS installation exceeds what is typically installed for residential or light commercial applications and requires connections to, upgrades to, or changes to, main service panels that require skills and knowledge that are more appropriate to the C-10 electrical contractor than the C-46 solar contractor.

During the May 2022 subject matter expert meeting, the stakeholders agreed that a challenge in identifying a single kWh threshold to distinguish between C-46 and C-10 installations is that the kWh of a BESS does not neatly determine the complexity of the electrical installation.[69] The subject matter experts stated that complexity of the installation changes depending on what the BESS "is tying into," i.e., the electrical system of the structure or distribution network of the grid.[70] The subject matter experts were concerned about whether C-46 contractors would have sufficient knowledge of transformers and voltages needed and skills required if, for example, a BESS is tied into a "three phase system" versus a "single phase system" as it relates to the electrical main service panel system.[71] The subject matter experts noted that tying into a single-phase system is relatively straightforward, but connecting to a three-phase system, in their view, would fall outside of the C-46 classification because it involves knowledge and skill of a more complex electrical system[72] that operates independently of any photovoltaic solar energy system that is installed at the stie. Mr. Barragan concurs that this work would typically exceed the knowledge and skill of a C-46 contractor.

Single-phase systems are used in homes with a smaller power load and in residential buildings where, in Mr. Barragan's opinion, it would be more common to find BESS within an 80 kWh threshold, and three-phase systems are used in factories and commercial buildings with heavy power load.[73] These topics deal with voltages, phases, breakers, terminals and amperage. Indeed, the National Electrical Code provides that the primary BESS function is "providing electrical energy into the premises wiring system or an electric power production and distribution network."[74] The C-10 license examination contains extensive questions on the tools, methods, and procedures to test for voltage, current, resistance, phase rotation, and polarity, the methods for calculating electrical loads, voltages, and currents (e.g., Ohm's Law), protection devices (e.g., overcurrent, overload, fault current, GFCI, GFEP, and shunt-trip devices) for circuits, and equipment in commercial and industrial applications.[75] According to the subject matter experts, such wiring systems and electric power production and distribution networks are more complex than single-phase systems commonly seen in residential applications.[76]

CALSSA previously stated, “the largest risk of improper system installation is incorrectly connecting the solar or storage system to the electrical service.”[77] CALSSA notes that the “Main Service Panel (MSP) is typically the critical component that must be considered when configuring the interconnection method,” and stated that it “is essential that no device ever feeds or draws more current through the service panel than it is designed to handle.”[78] CALSSA has also acknowledged that “commercial properties nearly always have three-phase lines, and multifamily properties are a mix of three-phase lines and single-phase lines,”[79] and has suggested that multifamily housing properties and commercial properties could have power needs as high as 200 kw.[80]

Indeed, the average U.S. home uses about 30 kWh of electricity each day[81] but the kWh usage of the average commercial building in the U.S. appears much higher.[82] The average rated power of nonresidential installations in California was between 91 and 130 kw between 2015-2020.[83] As such, commercial, industrial, or large multifamily structures with heavier power loads more commonly use a BESS with a much higher kWh, which typically require connecting to a complex main service panels that require broader electrical knowledge. BESS installations at these higher thresholds are more appropriate for C-10 contractors than C-46 contractors.

d. C-46 contractors (holding no “A”, “B”, or “C-10” license) typically perform installations within an 80 kWh threshold commonly found in the residential market.

The UC Berkeley Report studied the size of solar-paired BESS installations in California broken down by license classification. The data shows that C-46 solar contractors holding no C-10, A, or B license typically install smaller projects with sizes more commonly found in the residential market, and that establishing a low BESS threshold for C-46 contractors would have minimal impact in the industry.[84] CSLB data similarly shows that C-46 contractors are more likely to work on residential projects than commercial projects.[85] The recommended 80 kWh threshold will continue to permit C-46 contractors to install BESS at a level that is prevalent among C-46 contractors in the construction business.

Even though BESS is a rapidly growing industry in California, the average size of storage systems in California is declining due to a rapid growth of residential installations,[86] which tend to be smaller. An example of the smaller residential BESS systems is the Tesla Powerwall with a 5.8 kw power rating and 13.5 kWh storage capacity, well below the proposed 80 kWh threshold. Likewise, the LG RESU has a 5 kw power rating and 9.8 kWh storage capacity, below the proposed threshold. These two brands comprise approximately 97% of the residential BESS installed from 2015 to present.[87]

The UC Berkeley Report shows that between 2015-2020, the average rated power of residential BESS installations in California was between 6 and 7 kw.[88] The average

rated power of nonresidential installations was between 91 and 130 kw, far greater than for residential installations.[89]

As it relates to license class, of all solar-paired BESS installations in California, the average rated power of a system installed by a C-46 solar contractor (that did not hold a C-10, A or B) was 5.2 kw between 2015 and 2020 and up to 6.6 kw in 2020, which is within the overall 6-7 kw range commonly found for residential projects reported above, and far less than the overall 91-130 kw average for commercial projects.[90] And focusing more specifically on C-46 residential projects, the average size of a residential BESS installed by a C-46 contractor holding no other license class was between 5.1 kw and 6.6 kw, again within the overall 6-7 kw range commonly found in residential projects.[91] For non-residential projects, the average size of a BESS installed by a C-46 contractor that did not hold a C-10, A or B license class was 12.35 kw, also well below the 91-130 kw overall average for non-residential projects.[92]

The UC Berkeley Report presented its data in kilowatts (kw) only. However, the UC Berkeley raw data includes the kilowatt-hour (kWh) totals. The raw data shows that the average kWh installed by C-46 contractors not holding an A, B, or C-10 license was 17.15 kWh between 2015 and 2020.[93] The raw data shows that the average kWh installed by C-46 contractors not holding an A, B, or C-10 was 19.2 kWh in 2020.[94]

This compares with an average conversion rate from kw to kWh. The kw power of a BESS can generally be multiplied by 2.7 to convert to a reasonable correlating kWh capacity.[95] Using this calculation method, the kw data above can be presented in kWh for C-46 contractors that do not hold a C-10, A or B license for all solar-paired BESS projects, as follows:

- The average capacity was 14.04 kWh between 2015 and 2020 and 17.82 kWh in 2020.
- The average capacity for residential projects was 15.79 kWh and for non-residential projects was 33.34 kWh.

By either measure, the data demonstrates that C-46 contractors that hold no A, B, or C-10 license perform BESS installations within an 80 kWh threshold. The raw UC Berkeley data shows capacities between 17 and 19 kWh, and the average shows capacities between 14 and 34 kWh. Both measures support the conclusion that the average kWh capacity of a BESS installed by a C-46 in residential and nonresidential applications in California is well within 80 kWh and that threshold covers the projects prevalent in the C-46 construction business (for a C-46 that does not hold a C-10, A or B).

e. An 80 kWh threshold is supported in the Title 24 Codes because it is the maximum allowable capacity that can be installed at common residential locations, and establishing a uniform threshold does not diminish applicable safety standards and will ease compliance and enforcement.

The Title 24 Codes provide several variations in the type of BESS installations that can be performed at different kHw capacities in compliance with codes, standards and regulations. Generally speaking, 80 kWh is the maximum kWh of a BESS allowed in one location by the Residential Code and in specified residential occupancies in the Fire Code, within attached or detached garages and detached accessory structures, on exterior walls, or outdoors on the ground.[96]

Installations above this standard can be subject to more rigorous safety standards because they present greater risks.[97] Since C-46 contractors that do not hold a C-10, A or B license typically install BESS within an 80 kWh threshold, in sizes more commonly found in residential applications, this report recommends that the Board consider establishing in regulation an 80 kWh standard, beyond which C-46 contractors may not install BESS.

Establishing a uniform 80 kWh standard will also assist licensees with complying with the regulations, and assist the Board in enforcing them.[98] A variable threshold, on the other hand, based on the different variable standards present in the codes, would make it difficult to define in regulation every possible scenario under which a C-46 contractor may install BESS, and could become out-of-date at each code revision cycle.

Here are the examples of some possible installations for a BESS in the Residential Code or Fire Code that would make it difficult to account for all the scenarios in a CSLB regulation:

- An individual BESS unit shall have a maximum energy rating of 20 kWh.[99]
- The 20 kWh requirement applies to battery size in nonresidential[100] and residential occupancies, as follows: every detached one- and two-family dwelling and townhouse three stories or less[101] and to residential R-3 and R-4 occupancies[102] (which include occupancies such as day-care homes, lodging houses, boarding houses, and assisted living facilities).
- Multiple individual BESS units of no more than 20 kWh a piece can be installed up to an aggregate total rating of 80 kWh, by locations that are identified in the codes.[103]
- The maximum for each location type is 40 kWh within utility closets and storage or utility spaces; 80 kWh in attached or detached garages and detached accessory structures; 80 kWh on exterior walls; and 80 kWh outdoors on the ground.[104]
- The individual BESS may be separated throughout different locations, or all in one location, as long as the aggregate total for any of the locations is not exceeded.[105]
- The 80 kWh maximum requirement applies to every detached one- and two-family dwelling and townhouse three stories or less and to residential R-3 and R-4 occupancies.[106] However, the Residential Code and Fire Code provide that if the 20 kWh rating is exceeded for an individual BESS, or if any of the aggregate

capacities in any one location is exceeded, more rigorous provisions of the Fire Code apply to the installation.[107]

- In such scenarios, or if the C-46 is installing a BESS in a nonresidential structure, the BESS must be segregated into groups not exceeding 50 kWh.[108]

This report recommends a single 80 kWh threshold, but without regard to occupancy. Both IBEW-NECA and CALSSA stated that they do not believe the BESS determination should be made by considering occupancy,[109] and depending on how a BESS is deployed, a residential application of BESS may be subject to more rigorous Fire Code rules for commercial systems. For example, the installation of multiple BESS in a utility closet and storage or utility space at a residence could be subject to the more rigorous Fire Code rules for nonresidential large scale fire testing.[110] This includes a fire official approval of a special permit based on a hazard mitigation analysis and large-scale fire testing, based on UL 9540A.[111]

A contractor installing BESS would need to comply with the codes and other related safety standards when installing in a residential or non-residential setting. These requirements cover safety-related aspects of BESS technologies and installations, from development to installation and commissioning and then operation, maintenance, and through to decommissioning and even beyond that to any repurposing for a second use.[112] The Electrical Code provides for the practical safeguarding of persons and property from hazards arising from the use of electricity.[113] And the Fire Code establishes the minimum requirements consistent with nationally recognized good practices to safeguard the public health, safety and general welfare from the hazards of fire, explosion or dangerous conditions in new and existing buildings, structures and premises, and to provide safety and assistance to fire fighters and emergency responders during emergency operations.[114]

Contractors must also comply with applicable state or local laws relating to the issuance of building permits, and they must adhere to accepted trade standards for good and workmanlike construction in accordance with plans and specifications, with limited exceptions.[115]

These requirements apply irrespective of the contractor classification installing BESS. Consequently, establishing a uniform 80 kWh standard above which C-46 contractors cannot install BESS will not diminish the safety standards applicable to the installation or otherwise increase the risks mitigated by the codes. A uniform standard will aid C-46 licensees in knowing and complying with the standard, aid the Board in enforcing the classification standard, and would eliminate the need to regularly revise the classification each time there is a revision to the building codes.

UNRESOLVED ISSUES

Unresolved issue one: BESS "only" contracts. CALSSA states that if there is a new regulation that precludes C-46 contractors from maintaining or repairing a BESS on a PV system they previously installed, that it would unlawfully impair contracts.[116]

CALSSA also states that for each BESS paired solar PV installation, there is a contract that includes a warranty as a requirement of participating in the state's Self Generation Incentive Program, which provides rebates to consumers for installing BESS.[117] Ten-year installation and equipment warranties are also a required condition of interconnection, meaning that any consumer wishing to connect a storage system to the grid must contract with the installing contractor for such a warranty.[118] These issues should be considered further through the regulatory rulemaking process, if specific contractual or warranty provisions are presented through public comments raising the issues.

Unresolved issue two: **Economic Impact of regulatory limitation on BESS.** The UC Berkeley Report concludes that there will be no adverse economic impacts of precluding the C-46 from BESS.[119] The report finds that C-10 contractors and certified electricians are plentiful and can expand as demand for BESS increases, whether commercial or residential, or rural and urban.[120] The report documents significant savings in project costs in installations by C-46 contractors partly because the portions of the work that may require certified electricians is a small portion of the costs.[121]

Most writings provided by CALSSA, as well as the economic impact provided by UC Berkeley, are predicated on the assumption that C-46s would be precluded from installing BESS *entirely*, which is not what this report recommends. However, the potential impact of regulatory action on the labor workforce of C-10 and C-46 contractors will be a factor in any regulatory action taken on this matter and will require an articulation of the economic impact of the rulemaking.

ENDNOTES

[1] Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of the Government Code. See also, generally November 29, 2021, Contractors State License Board meeting packet, p. 23-24
[2] CSLB regulations are codified in Title 16, Division 8, Articles 1 through 9 of the California Code of Regulations (CCR)
[3] See generally, materials and video for November 7, 2019 Legislative Committee meeting
[4] Evaluation of Alternative Contractor License Requirements for Battery Energy Storage Systems. UC Berkeley Labor Center. July 9, 2021
[5] UC Berkeley Report, p. 95
[6] From July 27, 2021 slide show presentation of UC Berkely report authors at July 27, 2021 Board Meeting.
[7] November 29, 2021 Board Meeting Minutes
[8] B & P Code § 7059 (a); CCR § 831
[9] February 2022 CALSSA Letter, p. 6
[10] January 2022 IBEW-NECA Letter, p. 4
[11] January 2022 IBEW-NECA Letter, p. 2
[12] January 2022 IBEW-NECA Letter, p. 7

[13] March 2022 IBEW-NECA Letter, p. 2
[14] January 2022 IBEW-NECA Letter, p. 16
[15] February 2022 CALSSA Letter, p. 5
[16] February 2022 CALSSA Letter, p. 3
[17] Labor Code § 108.2 (a), (b), & (k)
[18] Labor Code § 108 (c)
[19] November 2021 CALSSA Letter, p. 5
[20] November 2021 CALSSA Letter, p. 4
[21] March 2022 IBEW-NECA Letter, p. 4
[22] CCR § 832.46
[23] B & P Code § 7059 (a); CCR § 831
[24] February 2022 CALSSA Letter, p. 6
[25] February 2022 CALSSA Letter, p. 6
[26] March 2022 IBEW-NECA Letter, p. 1
[27] February 2022 CALSSA Letter, p. 6; January 2002 IBEW-NECA Letter, p. 2
[28] January 2022 IBEW-NECA Letter, p. 2
[29] March 2022 CALSSA Letter, p. 2
[30] March 2022 CALSSA Letter, p. 2-3
[31] March 2022 CALSSA Letter, p. 3
[32] January 2022 IBEW-NECA Letter, p. 11
[33] January 2022 IBEW-NECA Letter, p. 11
[34] See generally CRC § R327, *et seq* and CFC § 1206, *et seq*
[35] UC Berkeley Report, p. 25, Tables 1 and 2
[36] UC Berkeley Report, p. 20, 44
[37] UC Berkeley Report, p. 25, Tables 1 and 2.
[38] See Section d of this report.
[39] UC Berkeley Report, p. 7
[40] UC Berkeley Report, p. 7
[41] UC Berkeley Report, p. 7, 44
[42] UC Berkeley Report, p. 11
[43] November 2021 CALSSA Letter, p. 6
[44] UC Berkeley Report, p. 48-54
[45] UC Berkeley Report, p. 45-46
[46] UC Berkeley Report, p. 45-46
[47] May 2022 SME Meeting
[48] See UC Berkeley report p. 47 and January 2022 IBEW-NECA Letter, p. 8-9
[49] October 2019 CALSSA Letter, p. 15
[50] May 2022 SME Meeting
[51] UL July 2020 Webinar
[52] UL July 2018 Webinar
[53] UL July 2020 Webinar; see CFC §§ 1206.3.1, 1206.11.1; CRC § R327.2
[54] May 2022 SFM Meeting
[55] UL July 2020 Webinar
[56] UL July 2018 Webinar
[57] May 2022 SFM Meeting
[58] See generally C-46 and C-10 occupational analyses

[59] C-46 Occupational Analyses, p. 10
[60] UC Berkeley Report, p. 47
[61] CCR § 832.46
[62] CEC Art. 100
[63] CEC Arts. 690 and 706; CFC, §§ 1204, et seq., 1206, et seq.
[64] UC Berkeley Report, p. 17
[65] UC Berkeley Report, p. 17; see also definition of photovoltaic system in CEC, Arts. 100 and 690, CRC § 202
[66] CEC § 690.1
[67] UC Berkeley Report, p. 74 (emphasis added)
[68] UC Berkeley Report, p. 11
[69] May 2022 SME Meeting
[70] May 2022 SME Meeting
[71] May 2022 SME Meeting
[72] May 2022 SME Meeting
[73] Definitions of panel board, single-phase and three-phase power. Craftsman's Illustrated Dictionary of Construction Terms. Frane, James T. Craftsman Book Company. 1994. Pgs. 236, 319, and 356-357
[74] National Fire Protection Association (NFPA) § 70 (2020) (National Electric Code), Section 706.2, ESS definition.
[75] C-10 Occupational Analysis, p. 30-34
[76] May 2022 SME Meeting
[77] October 2019 CALSSA Letter, p. 15
[78] October 2019 CALSSA Letter, p. 15
[79] October 2019 CALSSA Letter, p. 14
[80] October 2019 CALSSA Letter, p. 14
[81] Ardani, Kristen, et al. "Installed Cost Benchmarks and Deployment Barriers for Residential Solar Photovoltaics with Energy Storage: Q1 2016." National Renewable Energy Laboratory, Rocky Mountain Institute, U.S. Department of Energy. February 2017. P. 13. https://www.nrel.gov/docs/fy17osti/67474.pdf
[82] U.S. Energy Information Administration. Commercial Buildings Energy Consumption Survey. December 2016. https://www.eia.gov/consumption/commercial/data/2012/c&e/cfm/pba4.php
[83] UC Berkeley Report, p. 32 (average of Self-Generation Incentive Program (SGIP) data (2015-2020) and utility interconnection data (2020))
[84] UC Berkely Report, p. 25 (Tables 1 & 2), 31 (finding that a 5 kW / 20 kWh size restriction for C-46 contractors "would basically maintain the status quo"), 32 (Table 5)
[85] C-46 Occupational Analysis, p. 9, finding "C-46 respondents to the occupational analysis survey for the last C-46 examination development showed that 73% of C-46 contractors work was on residential projects, and 21% on commercial projects." Similarly, SGIP data from 2015-2020 showed that C-46 contractors performed 7% of residential installations and a "negligible" percentage (reported as 0%) of commercial installations. (UC Berkeley Report, p. 26.)
[86] UC Berkeley Report, p. 20
[87] UC Berkeley Report, p. 61

[88] UC Berkeley Report, p. 32 (the average of Self-Generation Incentive Program (SGIP) data (2015-2020) and utility interconnection data (2020))
[89] UC Berkeley Report, p. 32 (the average of Self-Generation Incentive Program (SGIP) data (2015-2020) and utility interconnection data (2020))
[90] UC Berkeley Report, p. 25 (2015-2020 SGIP data for the 5.2 kw and 2020 interconnection data for the 6.6 kw)
[91] UC Berkeley Report, p. 32 (either 5.1 kw or 6.6 kw, according to SGIP data between 2015-2020, or 2020 interconnection data respectively, with a combined average of 5.85 kw)
[92] UC Berkeley Report, p. 32 (either 8.4 kw or 16.3 kw, according to SGIP data between 2015-2020, or 2020 interconnection data respectively)
[93] UC Berkeley raw data table, "2015-2021_Weekly Statewide Report_04_12_2021(posted 04_12_21)(SUMMARY4-30-21) 11.30.21"; 2015-onward tab, average of column I (kWh), sorted by C-46, no other license
[94] UC Berkeley raw data table, "2020 Interconnections"; Sheet 6, sorted by C-46 no A, B, or C-10, average of column K, (kWh)
[95] This was extrapolated from a review of the 556 battery energy storage systems on the California Energy Commission solar equipment list for compliance with CEC's Building Efficiency Standards and participation in utility programs (https://solarequipment.energy.ca.gov/Home/EnergyStorage). The average kw power of all 556 systems was 25.85 and the average kWh for all 566 was 69.9, or 2.7 times the kw amount. This was the average for all systems, but the relationship between kw and kWh for the two most common batteries on the residential market was lower. For the Tesla Powerwall, its 13.5 kWh storage capacity was a factor of 2.3 times its 5.8 kw power, and for the LG RESU, its 9.8 kWh storage capacity was a factor of 1.96 times its 5 kw power.
[96] CRC § 327.5; CFC § 1206.11
[97] CFC § 1206.11.4
[98] Ease of compliance and enforcement was among the rationale that IBEW-NECA proposed as a reason to select a kWh threshold. See p. 11 of January 2022 IBEW-NECA Letter
[99] CRC § R327.5, CFC § 1206.1 and Table 1206.1 (Lithium-ion), CFC § 1206.11.4, and Office of the State Fire Marshal, Code Interpretation 21-004, Electrical Energy Storage Systems, March 30, 2022, p. 1.
[100] CFC § 1206.1 and Table 1206.1
[101] CRC § 1.1.3
[102] CFC § 1206.11
[103] CRC § R327.5, CFC § 1206.11.4
[104] CRC § R327.5, CFC § 1206.11.4, and Office of the State Fire Marshal, Code Interpretation 21-004, Electrical Energy Storage Systems, March 30, 2022, p. 1.
[105] May 2022 SFM Meeting; Office of the State Fire Marshal, Code Interpretation 21-004, Electrical Energy Storage Systems, March 30, 2022, p. 1.
[106] CRC § R327.5, CFC § 1206.11.4
[107] CRC § R327.5, CFC § 1206.11.4
[108] CFC § 1206.5.1
[109] January 2022 IBEW-NECA Letter, p. 5 and February 2022 CALSSA Letter, p. 1

[110] CRC § R327.5, CFC § 1206.11.4, in which case CFC §§ 1206.1 through 1206.9 would apply.
[111] CFC § 1206.1.5
[112] U.S. Department of Energy. Energy Storage System Guide for Compliance with Safety Codes and Standards. June 2016. P. 2.2-2.3 https://www.energy.gov/sites/prod/files/2016/08/f33/Energy%20Storage%20System%20Guide%20for%20Compliance%20with%20Safety%20Codes%20and%20Standards%202016.pdf
[113] CEC § 90.1 (A)
[114] CFC § 1.1.2
[115] B & P Code §§ 7090, 7109
[116] November 2021 CALSSA Letter
[117] July 13, 2021 SGIP Handbook, pp. 66-67.
[118] California Public Utilities Commission Decision 16-01-44, Conclusion of Law ¶ 28.
[119] UC Berkeley Report, p. 96
[120] UC Berkeley Report, p. 96
[121] UC Berkeley Report, p. 96