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Solar Photovoltaic and Battery Energy Storage Systems

Solar Photovoltaic and Battery Energy Storage Systems Overview

Chapter 7 describes the compliance requirements for solar photovoltaic systems (PV), battery energy storage systems (BESS), and solar and energy storage system readiness for newly constructed single-family residential buildings.

The prescriptive Solar PV requirement sets the standard design budget for the performance compliance method. To comply with the prescriptive requirements, all newly constructed single-family buildings must have a Solar PV installed unless the building qualifies for an exception specified in Section 150.1(c)14. Homes that qualify for an exception to not be required to comply with the PV system requirements are still subject to mandatory measures for solar readiness. The intent of the solar readiness requirement is to reserve a penetration-free and shade-free portion of the roof for the potential future installation of a solar energy system, plan for a pathway for connecting the components of the system, and install a main electrical service panel that will enable a future system.

Installation of a battery energy storage system is a compliance option, and this chapter describes the qualification requirements for this compliance option. New single-family homes have mandatory requirements for being ready for the future installation of BESS if one is not installed. The BESS ready requirements ensure that electrical infrastructure is in place and sized appropriately for the potential future installation of battery energy storage system.

For information about solar water heating system requirements, please see Chapter 5.

What's New for 2025

Mandatory measures (Section 150.0(s))

- Revise BESS ready requirements to apply only for all newly constructed single-family buildings with one or two dwelling units that have electrical service greater than 125 amps.
- Clarify that BESS ready requirements do not apply if a BESS is installed .

Prescriptive and Performance Compliance (150.1(c)14)

- Introduce solar access roof area (SARA) multipliers that are used for steep-sloped and low-sloped roofs to determine the Solar PV size in kW for a given square foot area of SARA roof space.

Prescriptive Requirements for Photovoltaic System

Photovoltaic System Size

To comply with the prescriptive requirements, all newly constructed single-family buildings are required to have a Solar PV system installed unless the building qualifies for an exception. The minimum qualifying size of the Solar PV system is based on the conditioned floor area (CFA) and the number of dwelling units as specified by the following equation.

$$RRRRRRRRRRRRRRR\ kkkk_{PPPP} = \frac{(CCCCCC \times CC)}{1000} + (NN_{DDDD} \times BB)$$

WHERE:

kW_{PV} = kWdc size of the Solar PV

CFA = Conditioned floor area

N_{DU} = Number of dwelling units

A = CFA adjustment factor from Table 7- 1: CFA and Dwelling Adjustment

B = Dwelling unit adjustment factor from Table 7- 1: CFA and Dwelling Adjustment

Table 7- 1: CFA and Dwelling Adjustment

Climate Zone	Factor A – CFA Adjustment Factor	Factor B - Dwelling Units Adjustment Factor
1	0.793	1.27
2	0.621	1.22
3	0.628	1.12
4	0.586	1.21
5	0.585	1.06
6	0.594	1.23
7	0.572	1.15
8	0.586	1.37
9	0.613	1.36
10	0.627	1.41
11	0.836	1.44
12	0.613	1.40
13	0.894	1.51
14	0.741	1.26
15	1.56	1.47
16	0.59	1.22

Example 7-1: Prescriptive Requirements for Solar PV for two different Climate Zones

Question:

How do I calculate the size of the required Solar PV system for a 2,000 sq ft single family home in Climate Zone 10? How do I compare the results to the same home in Climate Zone 15?

Answer:

$$\text{CZ10 } kkkk_{pppp} = \frac{2{,}000\ ssRRssss\ \times 0.627}{1000} + 1 \times 1.41$$

$$kkkk_{pppp} = 2.66\ kkkk$$

$$\text{CZ15 } kkkk_{pppp} = \frac{2{,}000\ ssRRssss\ \times 1.56}{1000} + 1 \times 1.47$$

$$kkkk_{pppp} = 4.59\ kkkk$$

In this example, we see the effects of the Adjustment factor "A" and the Dwelling Unit Factor "B". The A Factor for climate zone 15 is over twice the A Factor for climate zone 10. As a result, the Solar PV system size required for the home in climate zone 15 is larger than the identical single family home in climate zone 10. The B Factor has a larger impact as the number of dwelling units increases, such as for multifamily buildings.

Exceptions to Solar PV Requirements

Solar Access Roof Area (SARA) is the roof area that has ample annual solar access and is available for installation of solar PV. It includes the area of the building's roof, covered parking areas, carports, and all other newly constructed structures that are capable of structurally supporting a Solar PV as specified by Title 24, Part 2, Section 1511.2.

SARA does not include any roof area with less than 70 percent annual solar access. Annual solar access is the ratio of solar insolation including shading divided by the solar insolation without shading.

SARA also excludes any roof area that is not available due to state building code requirements, such as HVAC equipment setback and access (on low sloped roofs only) and fire setback and access pathways for Solar PV. Occupied roof areas are also specifically excluded from SARA but must be defined consistent with California Building Code (CBC) Section 503.1.4.

Some local building codes or ordinances require the roof to be used for specific purposes, such as for "living roofs." Areas of the roof that are required to be used for specific purposes can be removed from the SARA if the CEC's Executive Director has approved the SARA removal for the specific local code/ordinance. The enforcement agency must apply to the CEC for that approval.

Fire Code Regulations Applying to Residential Solar PV

Under regulations developed by the Office of the State Fire Marshal, the 2025 version of Parts 2, 2.5, and 9 of Title 24 include requirements for the installation of rooftop solar photovoltaic systems. These regulations cover the marking, location of DC conductors, and access and pathways for photovoltaic systems. They apply to residential and nonresidential buildings

regulated by all Parts of Title 24, California Building Standards Code. Provided below is a brief summary of the fire code requirements for residential buildings.

Solar PV arrays shall not have dimensions in either axis greater than 150 feet. To provide adequate firefighter access, residential buildings shall provide two pathways from the lowest roof edge to the ridge, which are not less than 36 inches wide, for each roof plane with a photovoltaic array. Solar PV arrays shall not be located higher than 18 inches or 36 inches below the ridge depending on the roof area covered by the Solar PV array. Builders shall refer directly to the relevant sections of the California Residential Code (Title 24, Part 2.5, Sections R324.3, and R324.6) for requirements. The California Department of Forestry and Fire Protection – Office of the State Fire Marshal (CAL FIRE-OSFM), local fire departments (FD), and the solar photovoltaic industry developed a Solar Photovoltaic Installation Guideline to increase public safety for all structures equipped with solar photovoltaic systems. The intent of this guideline is to provide the solar PV industry with information that will aid in designing, building, and installing Solar PV to meet the objectives of both the solar PV industry and the requirements set forth in the California Fire Code.

The entire Solar Photovoltaic Installation Guideline can be accessed at

http://opr.ca.gov/docs/20190226-Solar_Permitting_Guidebook_4th_Edition.pdf.

Solar Access Roof Area

The Solar PV size requirement for a home is normally established by Equation 150.1-C (see Equation 7.1 above). However, when there is limited Solar Access Roof Area (SARA), the Solar PV size requirement may be reduced based on the SARA determined for the home. Once the SARA is determined, it is multiplied by 18 W/sq ft for steep-sloped roofs or by 14 W/sq ft for low-sloped roofs to determine the SARA-based Solar PV requirement. The lower of the two Solar PV calculation methods (SARA and Equation 150.1-C) shall determine the size of Solar PV required for the home.

There are five allowable exceptions to the prescriptive Solar PV requirements as shown below.

Exception 1: For steep slope roofs, SARA shall not consider roof areas with a northernly azimuth that lies between 300 degrees and 90 degrees from true north. Whenever any individual roof area has a SARA that is less than 80 contiguous square feet, no PV system is required for that individual roof area.

Exception 2: No Solar PV is required when the minimum Solar PV is less than 1.8 kWdc for the home as calculated by the prescriptive equation or the SARA-based calculation.

Exception 3: If the building is in an area that receives large amounts of snow, and the enforcement agency determines it isn't possible for the Solar PV system, including panels, modules, components, supports, and attachments to the roof structure, to meet the snow load requirements of Ch. 7 in the American Society of Civil Engineers (ASCE) Standard 7- 16, no Solar PV is required.

Exception 4: For buildings that are approved by the local planning department prior to January 1, 2020 with mandatory conditions for approval:

- Shading from roof designs and configurations for steep-sloped roofs, which are required by the mandatory conditions for approval, shall be considered for determining the annual solar access.
- Roof areas, that are not allowed by the mandatory conditions for approval to have Solar PVs, shall not be excluded from the SARA.

Exception 5: Solar PV sizes determined using equation 150.1-C may be reduced by 25 percent if the Solar PV is installed in combination with a battery energy storage system. The battery energy storage system shall meet the qualification requirements specified in Joint Appendix JA12 and have a minimum compliance cycling capacity of 7.5 kWh as defined in Joint Appendix JA12. Manufacturers limit the amount of capacity that the battery can charge and discharge; this is called usable capacity. When commissioned, batteries can be set to establish a reserve level amount of the usable capacity that will be set and not be available for daily cycling for the purpose of load shifting, maximized solar self-utilization, and grid-harmonization. The remainder of the battery capacity that is commissioned to be available for daily cycling for compliance purposes is the compliance cycling capacity.

Example 7-2: Detached Building

Question:

Does a newly constructed building of U or R occupancy that does not contain dwelling units (like a pool house, rec room, or an art studio) on a residential lot need to meet the Solar PV requirements in Energy Code Section 150.1?

Answer:

Yes. A conditioned, newly constructed building classified as U building occupancy on a residential lot needs to meet the Solar PV requirements in Section 150.1(c)14 of the Energy Code. Using the prescriptive method, the annual Solar PV electrical output Equation 150.1-C allows for an input of zero for the number of dwelling units in this case.

Example 7-3

Question:

If a home that is located in Climate Zone 13 has a conditioned floor area of 1,410 sq ft and a SARA of 310 sq ft, what is the required Solar PV size?

Answer:

The SARA that is available is 310 sq ft and the SARA multiplier is 18 W/sq ft based on the slope of the roof. The Solar PV possible on this size roof is:

$$kkkk_{pppp} = 310\ ssRRssss \times 18\frac{kk}{ssRRssss} = 5{,}580kk$$

$$kkkk_{pppp} = 5.58\ kkkk$$

Next, calculate the prescriptively required Solar PV size using Equation 150.1-C:

$$kkkk_{pppp} = \frac{1{,}410\ ssRRssss\ \times 0.894}{1000} + 1 \times 1.510$$

$$kkkk_{pppp} = 2.77\ kkkk$$

The required Solar PV size is 2.77 kW because it's the smaller of the two calculations.

Example 7-4

Question:

Suppose that a mature tree exists in the front yard to the south of the SARA and a solar shading report shows that the square footage of roof space with at least 70% annual solar access is 133 sq ft, as shown below. Determine the required size of the Solar PV.

Answer:

The required Solar PV based on SARA is:

$$kkkk_{pppp} = 133\ ssRRssss \times 18\frac{kk}{ssRRssss} = 2{,}394kk$$

$$kkkk_{pppp} = 2.4\ kkkk$$

This value is lower than the prescriptive calculation of 2.77 kW using Equation 150.1-C. Therefore, the required size of the Solar PV is 2.4 kW. Note that if the solar shading report gave a usable SARA of < 80 square feet, no Solar PV would be required using Exception 1.

Joint Appendix 11 (JA11)

The installed Solar PV must meet the applicable requirements specified in JA11.

System Orientation

For prescriptive path compliance, a Solar PV with module pitches greater than 2:12, or 10 degrees, must be installed with an azimuth between 90 to 300 degrees measured clockwise from true north. Module pitches less than 10 degrees (low-slope) can be installed in any orientation since the azimuth of low-slope modules has an insignificant impact on array performance.

When using the performance approach, the array may be faced in any azimuth, including True north; however, the more the azimuth deviates from the optimum azimuth of south to southwest, the worse the system performs, resulting in a larger Solar PV size needed to achieve compliance. It is best to orient the panels as close to south to southwest as possible to maximize the system performance with the smallest Solar PV size.

To use the California Flexible Installation 1 (CFI1) simplified modeling option in the performance method, the Solar PV array must be installed with an azimuth range between 150 to 270 degrees from true north, with all modules at the same tilt as the roof for pitches up to 7:12. Solar PV arrays must have 98% annual solar access in order to use the CFI1 or CFI2 method; if the location of the Solar PV array(s) cannot meet the 98 annual solar access criteria, then the detailed method must be used. The detailed method uses the actual azimuth, tilt, and annual solar access for simulating energy production.

When the CFI2 option is selected in the performance calculation, the Solar PV array must be installed with an azimuth range between 105 and 300 degrees from true north, with all modules at the same tilt as the roof for pitches up to 7:12. Note, when selecting CFI2, the performance of the proposed system is reduced by approximately 10 percent.

Shading

Shading from obstructions must be limited to meet the prescriptive requirements. For prescriptive compliance and for performance compliance using CFI1 or CFI2, if the Solar PV does not qualify for Exception 1 described above, then the weighted average annual solar access by panel count shall be at least 98 percent. Any obstruction located north of the array does not need to be considered. Obstructions include the following:

- Any vent, chimney, architectural feature, mechanical equipment, or other obstruction that is on the roof or any other part of the building.
- Any part of the neighboring terrain.
- Any tree that is mature at the time of installation of the Solar PV.
- Any tree that is planted on the building lot or neighboring lots or planned to be planted as part of landscaping for the building. (The expected shading shall be based on the mature height of the tree.)
- Any existing neighboring building or structure.
- Any planned neighboring building or structure that is known to the applicant or building owner.
- Any telephone or other utility pole that is closer than 30 feet from the nearest point of the array.

Example 7-5: Shading

Question:

What would be the impact of shading on the Solar PV sizing requirement?

Answer:

Prescriptively, the weighted average annual solar access as measured by an approved solar assessment tool must be at least 98 percent by panel count. Under the performance path, there is no minimum requirement for annual solar access, however the increase in shading (lower annual solar access) will necessitate a larger Solar PV size to meet the same long-term system cost (LSC) budget as a smaller unshaded Solar PV.

Solar Access Verification

A solar assessment tool that is approved by the Executive Director must be used to demonstrate the shading conditions of the Solar PV or when claiming an exception based on limited amount of solar access. The list of solar assessment tools that have been approved by the Energy Commission for use as specified in JA11.4.1 are provided at the Energy Commission website, https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/solar-assessment-tools.

The installer must also provide documentation that demonstrates the actual shading condition of the installed Solar PV using an approved solar assessment tool. Documentation includes satellite, drone, or other digital images used in the solar assessment that clearly show that the installed system matches the system modeled by the solar assessment tool.

Remote Monitoring Capability

All Solar PV systems are required, as specified in JA11.5.1, to have a web portal and a mobile device application that enables the building owner, manager or occupants to monitor the performance of their Solar PV to identify, report and correct performance issues with the panels, inverters, shading and other issues that may impact the performance of the Solar PV. At a minimum, the occupants must have access to the following information:

JA11.5.1 Remote Monitoring Capability

The Solar PV shall have a web-based portal and a mobile device application that at a minimum

provide the building owner, manager, or dwelling occupants access to the following information:

(a) The nominal kW rating of the Solar PV.

(b) Number of Solar PV modules and the nominal watt rating of each module.

(c) Hourly (or 15-minute interval), daily, monthly, and annual kWh production in numeric and graphic formats.

(d) Running total of daily kWh production.

(e) Daily kW peak power production.

(f) Current kW production of the entire Solar PV.

Example 7-6: Remote Monitoring

Question:

How do I implement monitoring to meet section JA11.5.1 including the current reading?
Answer:

There are multiple options. Many inverters can connect to the homeowner's internet, through ethernet and/or wireless connection. Others use independent cellular connections. For cellular, the data should be updated to the monitoring portal periodically as allowed by the cellular plan.

Additional Requirements

In addition to the requirements above, the Solar PV must also meet the following requirements in JA11:

- Interconnection Requirements: All inverters in the Solar PV must comply with the CPUC Electric Tariff Rule 21, which governs CPUC-jurisdictional interconnections for all net energy metering (NEM) and net billing tariff (NBT) customers. Rule 21 requires that inverters have certain capabilities to ensure proper operation of the electrical grid as renewables are interconnected. Information about the CPUC's Rule 21 can be found at: https://www.cpuc.ca.gov/rule21/ .
- Certificates and Availability: The Solar PV installer shall certify on the Certificate of Installation that all provisions of JA11 are met and provide a solar assessment report meeting one of the following conditions:
    - A satellite, drone, or other digital image used in the solar assessment report must be created and dated after the Solar PV is installed.

- If the satellite, drone, or other digital image used in the solar assessment report is dated before the Solar PV is installed, additional on-site pictures must be attached to clearly show that the installed system matches the system modeled in the solar assessment report.

The Certificate of Installation shall be available on the building site for inspections.

Enforcement Agency Responsibilities: The local enforcement agency shall verify that the Certificate of Installation is valid complete and correct, and uploaded into an Energy Commission approved registry.

Performance Approach Compliance for Photovoltaic System

Energy Budget Calculation

The computer performance approach allows for the modeling of the Solar PV performance by considering Solar PV size, climate, panel azimuths and tilts, inverter efficiency, and shading characteristics. The standard design Solar PV size is determined by the modeled annual electrical consumption of the mixed-fuel proposed design building, regardless of the actual fuel type of the proposed design building. The performance method allows for modeling different Solar PV sizes, solar thermal systems, more energy efficiency measures, battery storage system and other demand response measures.

Substituting Solar PV for building energy efficiency measures is not possible because Solar PV has no impact on the Efficiency LSC compliance metric. However, a more efficient building design can enable a building to comply using a smaller solar system. Given the substantial value of Solar PVs, it's unlikely to design a home where a Solar PV is not required.

Example 7-7: Efficiency Tradeoff

Question:

Does the performance path allow tradeoffs between a Solar PV that is coupled with a battery storage system and energy efficiency measures? How about a standalone battery storage system?

Answer:

When the Solar PV is coupled with at least a 5 kWh compliance cycling capacity battery storage system, the performance path will allow a portion of the available credit to be used for efficiency measure tradeoffs; this is a modest credit that can be used to achieve compliance in buildings that have marginal difficulty achieving compliance. No compliance credit can be used for efficiency measure tradeoffs when a standalone battery energy storage system is installed.

Example 7-8: Solar Thermal System

Question:

Does a solar thermal water heating system still qualify for compliance credit in the performance path?

Answer:

Yes, although a solar water heating system cannot serve as a substitution for the prescriptively required Solar PV, it can still be installed for optional compliance credit in the performance

path. Solar water heating systems are modeled along with the remainder of water heating and distribution systems as part of the Efficiency LSC compliance, and can be used for efficiency measures tradeoff, or installing a smaller Solar PV. The requirements for solar thermal water heating systems are described in Chapter 5, Water Heating Requirements.

Community Shared Solar Electric Generation and Storage Systems

Photovoltaic System Size

The 2019 Energy Code first allowed the possibility for the requirement for photovoltaics on the site of the residential building to be fully or partially offset by Community Shared Solar Electric Generation. Community Shared Solar Electric Generation means solar electric generation, battery storage or other renewable electric generation that is provided as part of a community or neighborhood program that is approved to share the generation resources it develops with individual homes to demonstrate compliance with the Energy Code. Also, batteries installed in combination with photovoltaics on the building site can be fully or partially offset by Community Shared Battery Storage Systems. Community Shared Solar Electric Generation Systems and Community Shared Battery Storage Systems could be installed in combination or separately. Such systems are hereinafter referred to just as Community Solar Electric Generation Systems.

Entities who wish to serve as administrators of a proposed Community Solar Electric Generation System must apply to the Energy Commission for approval. The application process involves demonstrating compliance with all of the requirements specified in Section 10-115 of the Energy Code. If approved, Energy Commission approved compliance software will be modified to enable users to take compliance credit for buildings served by that Energy Commission approved Community Solar Electric Generation System.

Any entity may apply to serve as administrator of a proposed Community Shared Solar Electric Generation System, including but not limited to utilities, builders, solar companies, or local governments. The administrator is responsible for ensuring that the criteria for approval are met throughout (at least) a twenty-year period for each building that participates in the Community Solar Electric Generation System. The administrator is accountable to builders, building owners, enforcement agencies, the Energy Commission, and other parties who relied on these systems for offset of full or partial compliance with the Energy Code. Records demonstrating compliance with the criteria must be maintained over that period, with access to those records provided to any entity approved by the Energy Commission.

Enforcement Agency

The Community Shared Solar Electric Generation System must exist and be available for enforcement agency review early in the permitting process, and shall not delay the enforcement agency review and approval of the building that it will serve. All documentation required to demonstrate compliance for the building and the compliance offset from the Community Shared Solar Electric Generation System shall be completed and submitted to the enforcement agency with the permit application. The enforcement agency must have

facilitated access to the Community Shared Solar Generation System to verify the validity and accuracy of compliance documentation.

Energy Performance and Minimum Community Shared Solar PV and Battery Storage Size

Energy Commission approved compliance software must be used to show that the energy performance of the building's share of the Community Shared Solar Electric Generation System is equal to or greater than the partial or full offset claimed for the solar electric generation and batteries, which would otherwise be required for the building to comply with the Energy Code.

The compliance software will determine a minimum kW size that represents the portion of the community solar resource dedicated to the building, based on the characteristics of the Community Shared Solar Electric Generation System resources, including Solar PV component performance characteristics, azimuth and tilt, inverter type, and fixed or tracking panel mounting.

Participating Building Energy Savings and Bill Reduction Benefits

A specific share of the Community Shared Solar Generation System, determined to comply with the energy performance requirement discussed above, must be dedicated on an ongoing basis to the building. The energy savings benefits dedicated to the building shall be provided in one of the following ways:

1. Actual reductions in the energy consumption of the building;
2. Energy reduction credits that will result in virtual reductions in the building's energy consumption that is subject to energy bill payments; or
3. Payments to the building that will have an equivalent effect as energy bill reductions.

For all three options mentioned above, the reduction in energy bills resulting from the share of the Community Shared Solar Generation System dedicated to the building shall be greater than the cost that is charged to the building to obtain that share of the Community Shared Solar Generation System.

Durability, Participation, and Building Opt-Out

Durability. The Community Shared Solar Generation System must be designed and installed to provide the energy savings benefits to the participating building for a period not less than 20 years.

Participation and Opt-out. Buildings using community shared solar and/or battery storage systems to comply with Section 150.1(a)3 must participate in the Community Shared Solar Generation System for at least 20 years, regardless of who owns or occupies the building, unless the building owner discontinues participation in the Community Shared Solar Generation System and causes installation and interconnection of an on-site solar electric generation system that meets or exceeds the requirements of the Energy Code, which were in effect at the time that the builder applied for the original building permit for the participating building.

Compliance Documentation. The Administrator shall maintain record(s) of the compliance documentation that determined the requirements for the on-site solar electric generation system and/or battery storage system to comply with the standards in effect at the time the builder applied for the original building permit, and which establishes participants' obligations to meet the Opt-Out Requirements.

Additionality

The Community Shared Solar Generation System must provide the benefits exclusively to the participating building. Those benefits shall in no way be made available or attributed to any other building or purpose. Renewable Energy Credits that are unbundled from the Community Shared Solar Electric Generation System do not meet this additionality requirement.

The participating building(s) shall be served primarily by renewable resources developed specifically for the community solar electric generation system.

Other renewable resources may be used for each participating building if the building is permitted before the renewable resources developed for the program start operating, or after they cease operating.

For each renewable resource developed to serve participating buildings, bundled Renewable Energy Credits (RECs), which satisfy the criteria of Portfolio Content Category 1, shall be retired and tracked in the Western Renewable Energy Generation Information System (WREGIS) on behalf of program participants to ensure they will not be allocated to or used for any other mandatory or voluntary renewable electricity program requirement or claim.

Excess generation from renewable resources may be used to serve other loads but must be isolated from the generation serving participating buildings. This is not considered a violation of Section 10-115(a)5C, the Additionality requirement above.

Location

The community shared solar electric generation system must be located on a distribution system of the load serving entity providing service to the participating buildings. The distribution system shall have an electrical voltage less than 100kV.

Size

The community shared solar electric generation system must not be served by any individual source larger than 20 MW.

Example 7-9

Question:

To help entities that might want to apply to the Energy Commission for approval of a Community Shared Solar Energy Generation System, please provide examples of each of the three optional ways energy savings benefits could be provided to comply with Energy Performance and Minimum Community Shared Solar PV and Battery Storage Size.

Answer:

Examples would include:

- Actual reductions in the energy consumption of the building. This could be accomplished by locating the Solar PVs for several houses on a carport on common land in a subdivision, and direct wiring the unique Solar PV panels serving each house to an inverter that is located on the home's site. For homes served by utilities that are subject to compliance with Net Energy Metering or Net Billing requirements, the common land that is hosting the Solar PVs on the carport would have to be adjacent to (could be directly across a street) the houses that are being served by the Solar PV. All other requirements of Section 10-115 would have to be met.
- Utility energy reduction credits that will result in virtual reductions in the building's energy consumption that is subject to energy bill payments: This could be accomplished through a community shared solar program administered by a utility, for which a renewable resource is paid for through shares purchased for each home. Energy bill credits that reduce monthly electricity bills would be allocated based on the home's shares. All other requirements of Section 10-115 would have to be met.
- Payments to the building that will have an equivalent effect as energy bill reductions that would result from one of the two options above: This could be accomplished by builders installing Solar PVs on other properties they own to offset the compliance requirement for onsite Solar PVs on homes they build. The homes would pay for a share of the Solar PVs on the other properties. The builders would be obligated to make an ongoing cash payment to the homes for the home's share of the electricity generation achieved by the Solar PVs on the other properties. The share of the ownership of the Solar PVs on the other properties and the corresponding sharing of the electricity generation achieved by the Solar PVs on the other properties would not be accounted for through a utility system – the ownership share would not be paid to the utility and the payment for the share of the electricity generation achieved by the Solar PVs on the other properties would not be provided through a utility bill. The entire program would be administered by the builder for a 20-year period for each home. All other requirements of Section 10-115 would have to be met.

Example 7-10

Question:

Explain the cost requirements in the last sentence of the Participating Building Energy Savings and Bill Reduction Benefits section above regarding the reduction in energy bills resulting from the building's participation in the Community Shared Solar Generation System dedicated to the building being required to be greater than the cost that is charged to the building to participate in the Community Shared Solar Generation System.

Answer:

Regardless of the three options chosen above, it must be cost effective for the home to participate in a community shared solar electric generation system program. The participating home will pay for charges to participate in the program, and will receive either energy consumption reductions, energy bill credits, or cash payments for the electricity that is generated by the participating home's share of the community shared solar electric generation system resource. The value of the reductions, credits, or cash payments to the participating home must exceed the home's charges to participate in the program.

Battery Energy Storage System

The primary function of the battery energy storage system (BESS) is daily cycling for the purpose of load shifting, maximized solar self-utilization, and grid-harmonization.For the purpose of the Energy Code, grid harmonization is defined as strategies and measures that harmonize customer owned distributed energy resource assets with the grid to maximize self-utilization of solar PV array output, and limit grid exports to periods beneficial to the grid and the ratepayer. This is done by charging the battery from the Solar PV when there is limited electrical load at the building and excess Solar PV generation, that would otherwise be exported directly to the grid in midday when the grid already has plenty of utility-owned Solar PV, and the value of customer-owned generation has low value to the grid. By charging the battery with that excess Solar PV generation, the battery can load shift by discharging to the building load in the late afternoon and early evening hours, when there is much less utility-owned Solar PV generation available and loads at the house and on the grid are peaking for the day, and when the customer-owned generation has much higher value to the grid.BESS is available as a compliance credit in the performance compliance method, either coupled with an on-site Solar PV or as a standalone system if the building does not have on-site Solar PV due to an exception or being part of an Energy Commission approved community solar program. BESS is also a criterion of Exception 5 of the prescriptive Solar PV requirements in section 150.1(c). In all cases, the BESS must meet all applicable requirements in Joint Appendix JA12 and be self-certified to the Energy Commission by the manufacturer as a qualified product.

A Solar PV size can be specified with the performance approach based on a user-defined target LSC and a coupled BESS with an appropriate battery control strategy and compliance cycling capacity. This is a cost-effective strategy for meeting lower target LSCs, that may be required by reach codes, with a smaller, grid harmonized Solar PV. BESScontrol strategies are described below.

The list of qualified JA12 products can be found here, https://solarequipment.energy.ca.gov/Home/Index

For the Energy Code purposes, the JA12 compliant BESS must have Y(2025) in the JA12 column.

Minimum System Performance Requirements

JA12 specifies that the BESS must meet or exceed the following specifications for performance approach:

- Usable capacity of at least 5 kWh.
- Energy capacity retention of 70 percent of nameplate capacity after 4,000 cycles covered by a warranty, or 70 percent of nameplate capacity under a 10-year warranty.

And the following specifications for prescriptive approach:

- The single AC-to-AC charge-discharge cycle (round-trip) efficiency of the BESS must be at least 80 percent.

Controls Requirements

BESS that remain in backup mode indefinitely bring no grid benefits. The JA12 requirements are designed to ensure that the BESS remains in an active control mode and prevent the BESS

from remaining in the backup mode indefinitely. These requirements also enable the BESS to receive the latest firmware, software, control strategy, and other important updates.

The following requirements apply to all control strategies, including Basic Control, TOU Control, and Advanced Demand Flexibility Control, described in Controls Strategies below:

- The BESS shall have the capability of being remotely programmed to change the charge and discharge periods.
- During charging, when combined with an on-site solar photovoltaic system, the BESS shall first charge from an on-site photovoltaic system when the photovoltaic system production is greater than the on-site electrical load. The BESS also may charge from the grid during off-peak TOU hours of the day if allowed by the load serving entity. In anticipation of severe weather, Public Safety Power Shutoff events, or demand response signal, the BESS may charge from the grid at any time if allowed by the load serving entity.
- During discharge, the BESS shall be programmed to first meet the electrical load of the property. If during the discharge period the electrical load of the property is less than the maximum discharge rate, the BESS shall have the capability to discharge electricity into the grid upon receipt of a demand flexibility signal from the Load serving entity or a third-party aggregator.
- The BESS shall operate in one of the control strategies specified in Controls Strategies except during a power interruption, when it may switch to backup mode. If the BESS switches to backup power mode during a power interruption, upon restoration of power the BESS shall immediately revert to the previously programmed JA12 control strategy. The device must have the feature that would enable export to be built in at the time of installation. It can be in the off mode and be turned on later with a remote signal.
- At the time of inspection, the BESS shall be installed to meet one of the following control strategies. The BESS also shall have the capability to remotely switch to any of the control strategies.
- At the time of inspection, the BESS will be commissioned with a compliance cycling capacity that will be specified on the Certificate of Compliance. If at any time during operation, the capacity of the BESS that is available for daily cycling drops below the level of the compliance cycling capacity as a result of changes in the reserve level, the BESS shall automatically reset back to the compliance cycling capacity level after 72 hours. This reset requirement does not apply to reserve level changes that are controlled by a load serving entity or the California Independent System Operator, third-party aggregator, or manufacturer due to severe weather or Public Safety Power Shutoff events. At the conclusion of the severe weather or Public Safety Power Shutoff event, the BESS shall return to the compliance cycling capacity.

Control Strategies

JA12 includes four control strategies that are designed to encourage load shifting to harmonize the onsite PV system with the grid and deliver benefits to the environment, building owner and building occupants. Installation of battery energy storage systems increase self-utilization of PV array output, and reduce exports of excess generation to the grid. The installed BESS can follow any of the following control strategies. However, the compliance software will only simulate "Time of Use" control strategy.

Basic Control: When combined with an on-site Solar PV, to qualify for the Basic Control, the battery storage system shall be installed to only allow charging from an on-site Solar PV when the Solar PV production is greater than the on-site electrical load. The battery storage system shall discharge to the building load when the Solar PV production is less than the on-site electrical load.

Time-of-Use (TOU) Control: Designed to match load shifting with utility TOU rates. This control strategy generally results in a greater compliance credit than the Basic Control. When combined with an on-site Solar PV, BESS shall discharge during the highest priced TOU hours of the day. The operation schedule shall be preprogrammed from factory, updated remotely, or commissioned during the installation/commissioning of the system. At a minimum, the system shall be capable of programming three separate seasonal TOU schedules, such as spring, summer, and winter.

Advanced Demand Flexibility Control: Designed to bring the maximum value to the Solar PV generation by placing the charge/discharge functions of the BESS under the control of a load serving entity or a third-party aggregator. This control strategy allows discharging to the grid upon receiving a demand response signal from a grid operator. When combined with an on-site Solar PV, to qualify for the Advanced Demand Flexibility Control, the BESS shall be programmed by default as Basic Control or TOU control as described above. The BESS control shall meet the demand flexibility control requirements specified in Section 110.12(a). Additionally, the BESS shall have the capability to change the charging and discharging periods in response to signals from the local utility or a third-party aggregator

Controls for Separate Battery Systems: When installed separate from (not in combination with) an on-site solar photovoltaic system, including when the building is served by a community Solar PV, to qualify for the compliance credit, the battery storage system shall be programmed by default to:

- Start Charging from the grid during the lowest priced TOU hours of the day and start discharging during the highest priced TOU hours of the day, or
- Meet all the demand response control requirements specified in Section 110.12(a) and shall have the capability to change the charging and discharging periods in response to signals from the load serving entity or a third-party aggregator.

Alternative Control Approved by the Executive Director: The Executive Director may approve alternative control strategies that demonstrate equal or greater benefits to those strategies specified in JA12. To qualify for Alternative Control, the BESS shall be operated in a manner that increases self-utilization of the photovoltaic array output, responds to utility rates, responds to demand response signals, minimizes greenhouse gas emissions from buildings, and/or implements other strategies that achieve equal or greater benefits than those specified in JA12.2.3. The application to the Executive Director for the alternative control option shall be accompanied with clear and easy to implement algorithms for incorporation into the compliance software for compliance credit calculations.

Safety Requirements

The BESS shall be tested in accordance with the applicable requirements specified in UL 1973 and UL 9540. Inverters used with BESS shall be tested in accordance with the applicable requirements in UL 1741 and UL 1741 Supplement SA, or UL1741 Supplement SB.

Enforcement Agency

The local enforcement agency shall verify that all Certificate of Installations are valid. The BESS shall be verified as a model certified to the Energy Commission as qualified for credit as a BESS. In addition, the enforcement agency shall verify that the BESS is commissioned and operational with one of the controls specified in Controls Strategies above. The control strategy at system installation and commissioning and final inspection by the enforcement agency shall be the control strategy and the compliance cycling capacity that was specified in the Certificate of Compliance. The enforcement agency cannot enforce a particular control strategy after the BESS is installed and inspected. As a result, BESS can be operated with any JA12 control strategy, but the performance compliance software will only simulate time of use control strategy.

Certification Documentation Requirements

A specification sheet information showing usable capacity, compliance cycling capacity, roundtrip efficiency and an identification as a field assembled or integrated BESS shall be submitted to the Energy Commission for JA12 certification. In addition, a document showing the software operation of cycling control strategy, and a document or training materials describing the programming of the permanent 72 hour reset requirement during the commissioning of the BESS as specified in JA12.3.3.1(e) and JA12.3.3.1(e)(4), respectively shall be submitted to the Energy Commission for JA12 certification.

Fire Code Regulations Applying to Residential Battery Energy Storage Systems

Section 1207 of the California Fire Code (CFC) establishes requirements for energy storage systems. Requirements include that BESS shall be listed and labeled for use in accordance with UL 9540. Individual units shall be separated from each other by at least 3 feet except where smaller separation distances are documented to be adequate based on large-scale fire testing complying with Section 1206.1.5.

Allowable locations for BESS include:

- Detached garages and detached accessory structures.
- Attached garages meeting CFC requirements
- Outdoors or on the exterior side of exterior walls located not less than 3 feet (914 mm) from doors and windows directly entering the dwelling unit.
- 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

BESS shall not be installed in sleeping rooms, closets, spaces opening directly into sleeping rooms or habitable spaces of dwelling units.

Example 7-11: Battery Storage Credit

Question:

Can you explain the BESS credit requirements and how to comply with them?

Answer:

The performance path allows a compliance credit for:

- A BESS with a compliance cycling capacity of at least 5 kWh, with the capability to be programmed for a certain compliance cycling capacity, programmed for basic, time-of-use, or advanced demand flexibility control, and is coupled with a Solar PV, or
- A standalone BESS separate from on-site Solar PV with control requirements meeting JA12.3.3.2.4.

Compliance will allow a portion of available credit for a BESS combined with solar PV system to be used to meet the Efficiency LSC energy budget, with the rest of the credit being available for improving the Total LSC score. This "self-utilization" credit can be used to achieve compliance in buildings that are marginally out of compliance with the Efficiency LSC energy budget. The "self-utilization" credit is not available for stand-alone BESS.

BESS manufacturers must self-certify to the Commission that the BESS meets the requirements of JA12. These include minimum performance requirements, communication requirements, control requirements, safety requirements, and interconnection requirements, among others as mentioned in JA12.5, that must be complied with and certified to the Commission. The self-certification form may be downloaded from the Commission's website.

The following form must be used if a battery storage system or energy storage system is a system that has a single model number and contains both battery and inverter components:

https://www.energy.ca.gov/media/8219

For field assembled energy storage systems, the following form must be used:

https://www.energy.ca.gov/media/2247

Example 7-12: Battery Storage Credit

Question:

When batteries are used there is a loss of energy associated with round trip charging and discharging, resulting in lower generated kWh. Why does the Commission provide a compliance credit for a BESS that is coupled with a Solar PV if there is a loss of energy?

Answer:

BESS stores the Solar PV generated power in the middle of the day when the solar resources are generally plentiful and electricity prices are low. The systems then discharges the stored energy later in the day, during the peak hours when solar resources are diminished, and electricity prices are high. BESS have a limited charge/discharge (round trip efficiency) loss of 5 to 15 percent, depending on the type of battery and the inverter efficiencies. A compliance credit is available because of the major electricity cost differential between mid-day and peak-hours rates. This differential is greater than the battery charge/discharge loss.

To calculate the compliance credit of a BESS coupled with a Solar PV, the Energy Commission's compliance software, on an hourly basis, accounts for the Solar PV generation, losses, energy storage's compliance cycling capacity, charge and discharge rates, cost of electricity, house loads, and hourly exports. Similar calculations are also performed to calculate the benefits of storage for CO2 emissions.

Only BESS complying with JA12 requirements are eligible for compliance credit. The requirements ensure the BESS remains in a dynamic mode allowing residents to take advantage of variable electricity costs associated with charge and discharge periods

throughout the day. Static batteries that remain mostly in backup mode have little to no value for load shifting.

Example 7-13: Battery Storage TOU schedule

Question:

How will control requirement be enforced for customers that are not on a TOU schedule? How about customers on TOU rate but want to be in Basic Control?

Answer:

The BESS's cycling capacity must comply with JA12.3.3.1(e) whether the local utility does or does not currently have a TOU schedule. If the local utility currently does not have a TOU schedule, to comply with JA12.2.3, the BESS must perform a system check on 1 May and 1 November. A customer can set the control strategy to Basic Control if a TOU rate is not available for the customer. However, this strategy will reduce the benefits of the battery storage for both the customer and the grid, and therefore is not recommended. Load serving entities are expected to switch to TOU rates over time.

Solar Ready Overview

The solar-ready provisions are mandatory for single-family residences without a Solar PV located in subdivisions of 10 or more residences. Often, these residences do not have a Solar PV due to an exception to the prescriptive Solar PV requirements in Section 150.1(c)14.

Solar readiness requires that a portion of the roof or overhang of the building is reserved as a solar zone where solar panels can be installed in the future at the owner's discretion. The area must comply with access, pathway, ventilation, and spacing regulations specified in the California Residential Code (Title 24, Part 2.5, Section R324.3) and other local jurisdictional requirements.

The solar zone must also adhere to size and azimuth requirements (Section 110.10(b)1A - Section 110.10(b)2). It must be free from solar obstructions , such as vents, chimneys, architectural features and roof mounted equipment. The solar zone must be clearly indicated on construction documents, which must also include structural design loads of the roof. This documentation is required so that at the time of a future solar PV installation, the structural design loads of the roof at the time the building was permitted are know. The Energy Code does not require estimating the structural loads of possible future solar equipment. (Section 110.10(b)3 - (Section 110.10(b)4).

Also, all buildings that comply by designating a solar zone must indicate on construction documents a location reserved for inverters and metering equipment and a pathway reserved for routing of conduit from the solar zone plan for connecting a future Solar PV system. Alternatively, construction documents can indicate a pathway for routing of plumbing from the solar zone to a solar water-heating system (SWH) (Section 110.10(c)1, Section 110.10(c)2). In addition, the main electrical service panel shall have a minimum busbar rating of 200 amps, and shall have a reserved space to allow for the installation of a double pole circuit breaker for a future solar electric installation (Section 110.10(e)).

There are six allowable exceptions to the solar zone area requirements that reduce or remove the need to reserve a portion of the roof area as a solar zone. (Section 110.10(b)1A, Exception

1-6) These exceptions allow alternate efficiency measures instead of establishment of a solar zone, so the requirements for zone shading, azimuth, design load, interconnection pathways, owner documentation, and electric service panel do not apply.

California Fire Code Solar Access Requirements

Please see discussion in the Fire Code Regulations Applying to Residential Solar PV section.

Battery Energy Storage System Ready Overview

All newly constructed single-family residences with one or two dwelling units, which have electrical service greater than 125 amps, must be BESS ready to facilitate the future installation of a battery system. Dwelling units with 125 amp panels or less are not required to install electrical infrastructure to be battery ready. This may exclude smaller Accessory Dwelling Units (ADUs). BESS ready requirements do not apply if a BESS is actually installed. The following requirements must be met to be BESS ready:

1. Either a. or b. (or both) shall be provided:
   a. BESS ready interconnection equipment with a minimum backed-up capacity of 60 amps and a minimum of four BESS-supplied branch circuits specified in Section 150.0(s)2; or
   b. A dedicated 1" minimum raceway from the main service to a subpanel that supplies the branch circuits specified in Section 150.0(s)2. The subpanel must be labeled "Subpanel shall include all backed-up load circuits." All branch circuits are permitted to be supplied by the main service panel prior to the installation of a BESS.
2. A minimum of four branch circuits shall be identified and have their source of supply collocated at the subpanel specified in1.b. above to be supplied by the BESS. At least one circuit must supply the refrigerator. One lighting circuit must be located near the primary egress. At least one circuit shall supply a sleeping room receptacle outlet. Other circuits may serve any purpose.
3. The main panelboard shall have a minimum busbar rating of 225 amps.
4. Sufficient space shall be reserved to allow future installation of a system isolation equipment/transfer switch within 3 feet of the main panelboard. Raceways shall be installed between the panelboard and the system isolation equipment transfer switch location to allow the connection of a backup power source.

Compliance and Enforcement

When a building permit application is submitted to the enforcement agency, the applicant also submits plans and energy compliance documentation. This section describes the forms and procedures for documenting compliance with the solar ready requirements of the Energy Code. The following discussion is addressed to the designer preparing construction and compliance documents, and to the enforcement agency plan checkers who are examining those documents for compliance with the standards.

There are five certificate of installation forms associated with the low-rise residential solar photovoltaic system, battery storage systems and solar-ready requirements:

- The following forms are required for newly constructed single family residential projects to document that the solar and battery storage systems (where applicable) that were

installed to match the Certificate of Compliance (CF1R).CF2R-PVB-01-E: Certificate of Installation: Photovoltaic Systems

- CF2R-PVB-02-E: Certificate of Installation: Battery Storage Systems

The following forms are required for single family residential projects to document compliance with solar-ready requirements. Solar readiness compliance is required when a single family residential project is not required to install solar PV by meeting an exception.

- CF2R-SRA-01-E: Certificate of Installation: Solar Readiness

  This form documents what was installed to comply with the solar-ready requirements, including any equipment installed to qualify for one of the solar zone exceptions.
- CF2R-SRA-02-E: Certificate of Installation: Minimum Solar Zone Area Worksheet

  This form is required when buildings comply with the solar-ready requirement by including a solar zone.
- CF2R-STH-01-E: Certificate of Installation: Solar Water Heating System

  This form is required when a solar water- heating system is required to comply with the Energy Code. It would be required when solar readiness requirements are met by installing a solar water heating system .