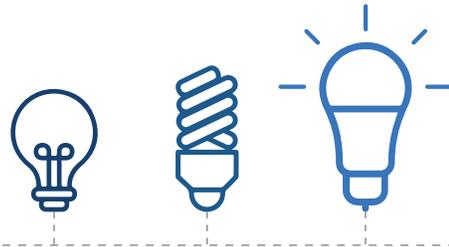


# Solar Photovoltaic Systems



## When do the Standards Apply?

The 2019 Building Energy Efficiency Standards (Energy Code) has solar photovoltaic (PV) system requirements for all newly constructed low-rise residential buildings. These requirements do not apply to additions or alterations to existing buildings. For example, an existing unconditioned building (like a garage) that is converted to an accessory dwelling unit (ADU) is considered an addition and not subject to the PV system requirements. Unconditioned buildings are also not subject to the PV system requirements.

The 2019 Energy Code defines a low-rise residential building as:

“A building, other than a hotel/motel, that is occupancy group: R-2, multifamily, with three habitable stories or less; or R-3, single family; or U-building, located on a residential site.”

## How Much PV System Generation is Required?

Generally, the installed PV system must be big enough to offset the electricity use of the proposed building as if it was a mixed-fuel building. A mixed-fuel building assumes a natural gas furnace, water heater, stove, and clothes dryer. This means electric heat pump space heating and water heating loads, and electric appliances will not affect the minimum PV system size requirement.

The climate zone of a building will affect the cooling demand of the building and, as a result, the PV system size. The conditioned floor area of a building will also affect the cooling demand, as well as possible plug loads. For multifamily buildings, the number of dwelling units will affect the expected number of occupants and energy demand.

### *Prescriptive Compliance*

[Section 150.1\(c\)14 of the 2019 Energy Code](#) has a calculation that determines the minimum PV system size based on three key factors:

1. The climate zone of the building
2. The conditioned floor area of the dwelling(s) being served by the PV system
3. The number of dwelling units of the building

### *Performance Compliance*

The minimum PV system size requirement will be based largely on the factors described above. Adding a battery can reduce the required PV system size, for instance. For more on the 2019 Energy Code compliance credit for batteries and related requirements, see [Reference Joint Appendix JA12 of the 2019 Reference Appendices](#).

Additionally, increasing the energy efficiency of a building (e.g. efficient space cooling and increased insulation) will decrease the electricity consumption



of that building and, as a result, decrease the required PV system size. The inverse is not true, however. Increasing PV system size cannot be traded for decreased building energy efficiency.

### Why is the Minimum PV System Size Based on a Mixed-Fuel Building?

The primary reason the minimum PV system size is based on mixed-fuel building is to not discourage all-electric buildings. There were concerns about increasing the required PV system size for all-electric buildings during the rulemaking of the 2019 Energy Code and the negative impacts this size increase could have on the construction of all-electric buildings.

### Are There Exceptions?

Yes. Two exceptions exist to exempt buildings completely from the PV system requirements.

The first is for scenarios where the effective annual solar access of the roof of a building is restricted to less than 80 contiguous square feet because of shading by objects outside the dwelling. These objects could include existing trees, hills, or adjacent structures. For a list of programs that can help with determining the solar access of a building, visit the California Energy Commission's [solar assessment tools page](#).

The second exception is for buildings that were destroyed as a result of a disaster in an area in which a state of emergency was proclaimed by the Governor of California. This exception applies only to areas in which a state of emergency was proclaimed by the Governor before January 1, 2020.

To read the bill in its entirety, see [Assembly Bill 178](#) (AB178, Dahle, Chapter 259, Statutes of 2019).

There are other exceptions that allow the required PV system size to be reduced based on the number of stories, location, and other factors of a building. For more on the PV system size reduction allowances, see [Section 7.2.2 of Chapter 7 of the 2019 Residential Compliance Manual](#).

### Does the PV System Have to be Installed on the Roof of the Building?

No. The PV system requirements and exceptions are based on the system being installed on the roof of the building. However, the system can be ground-mounted or installed on other structures on the lot.

### How do the Solar-Ready Requirements Apply?

The solar-ready requirements of the 2019 Energy Code do not apply to buildings that have PV systems installed. If a newly constructed low-rise residential building is exempt from the PV system requirements and does not install a PV system, then the solar-ready requirements may apply. [See Section 110.10 of the 2019 Energy Code for more detail](#).

### More PV System Questions?

If you have more questions about the 2019 Energy Code's PV system requirements for low-rise residential buildings, see the Energy Commission's frequently asked questions on this topic [here](#).



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**Gavin Newsom**

Chair  
**David Hochschild**

Vice Chair  
**Janea A. Scott, J.D.**

Commissioners  
**Karen Douglas, J.D.**  
**J. Andrew McAllister, Ph.D.**  
**Patricia Monahan**

Executive Director  
**Drew Bohan**

September 2020

**Photovoltaic Requirements.** All low-rise residential buildings shall have a photovoltaic (PV) system meeting the minimum qualification requirements as specified in Joint Appendix JA11, with annual electrical output equal to or greater than the dwelling's annual electrical usage as determined by Equation 150.1-C:

EQUATION 150.1-C ANNUAL PHOTOVOLTAIC ELECTRICAL OUTPUT

$$\text{kWPV} = (\text{CFA} \times \text{A}) / 1000 + (\text{NDwell} \times \text{B})$$

WHERE:

kWPV = kWdc size of the PV system

CFA = Conditioned floor area

NDwell = Number of dwelling units

A = Adjustment factor from Table 150.1-C

B = Dwelling adjustment factor from Table 150.1-C

**EXCEPTION 1** to Section 150.1(c)14: No PV system is required if the effective annual solar access is restricted to less than 80 contiguous square feet by shading from existing permanent natural or manmade barriers external to the dwelling, including but not limited to trees, hills, and adjacent structures. The effective annual solar access shall be 70 percent or greater of the output of an unshaded PV array on an annual basis.

**EXCEPTION 2** to Section 150.1(c)14: In climate zone 15, the PV system size shall be the smaller of a size that can be accommodated by the effective annual solar access or a PV system size required by the Equation 150.1-C, but no less than 1.5 Watt DC per square foot of conditioned floor area.

**EXCEPTION 3** to Section 150.1(c)14: In all climate zones, for dwelling units with two habitable stories, the PV system size shall be the smaller of a size that can be accommodated by the effective annual solar access or a PV system size required by the Equation 150.1-C, but no less than 1.0 Watt DC per square foot of conditioned floor area

**EXCEPTION 4** to Section 150.1(c)14: In all climate zones, for low-rise residential dwellings with three habitable stories and single family dwellings with three or more habitable stories, the PV system size shall be the smaller of a size that can be accommodated by the effective annual solar access or the PV system size required by the Equation 150.1-C, but no less than 0.8 Watt DC per square foot of conditioned floor area.

**EXCEPTION 5** to Section 150.1(c)14: For a dwelling unit plan that is approved by the planning department prior to January 1, 2020 with available solar ready zone between 80 and 200 square feet, the PV system size is limited to the lesser of the size that can be accommodated by the effective annual solar access or the size that is required by the Equation 150.1-C.

**EXCEPTION 6** to Section 150.1(c)14: PV system sizes from Equation 150.1-C may be reduced by 25 percent if installed in conjunction with a battery storage system. The battery storage system shall meet the qualification requirements specified in Joint Appendix JA12 and have a minimum capacity of 7.5 kWh

# SOLAR SHADING ANALYSIS REPORT EXAMPLE

**Customer**  
Firstname Lastname

**Designer**  
Firstname Lastname

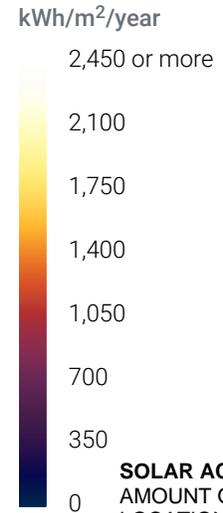
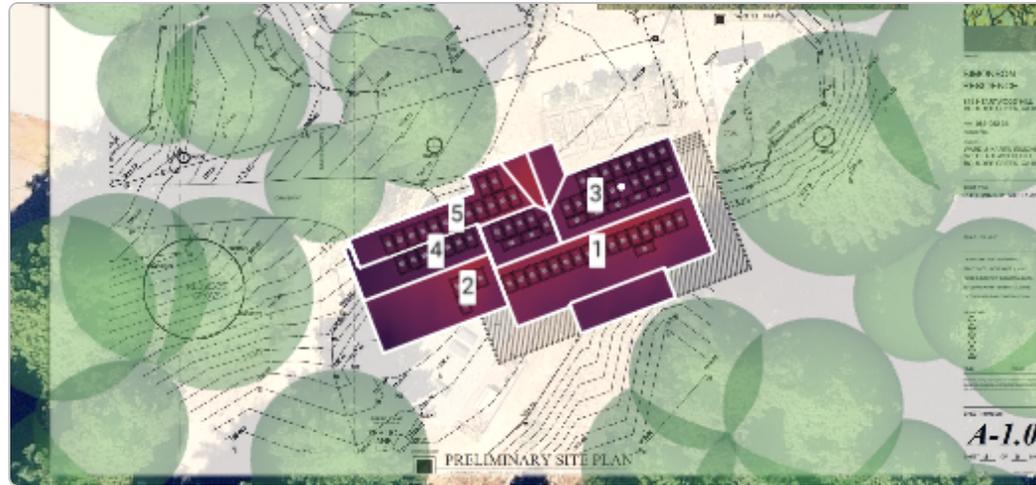
**Organization**  
Organization Name

**Address**  
123 Address St  
City, ST ZZZZZ

**Coordinates**  
(XX.XXXXX / XX.XXXXX)

**Date**  
MM/DD/YYYY

## Annual irradiance



**SOLAR ACCESS** - THE AMOUNT OF SUN A LOCATION RECEIVES IN A GIVEN YEAR

**TOF - TILT AND ORIENTATION FACTOR**

## Summary

Array	Panel Count	Azimuth (deg.)	Pitch (deg.)	Annual TOF (%)	Annual Solar Access (%)	Annual TSRF (%)
1	17	159	26	98	43	42
2	4	159	26	98	44	43
3	29	339	26	65	51	33
4	7	339	26	65	43	28
5	14	339	9	81	47	38
<b>Weighted average by panel count</b>	-	-	-	-	47.2	36.3

**TSRF - TOTAL SOLAR RESOURCE FRACTION: <70 FOR EXEMPTION**

## Monthly solar access (%) across arrays

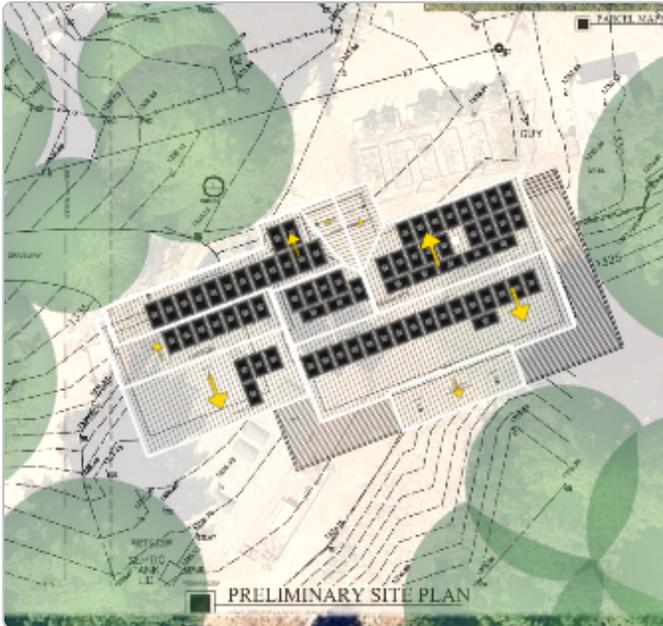
Array	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	26	29	35	46	55	60	58	50	38	30	25	24
2	31	30	32	43	60	61	62	50	33	30	31	28
3	39	38	43	48	60	57	60	52	46	38	37	41
4	31	29	34	45	50	50	51	46	37	26	28	32
5	28	27	41	48	56	56	58	50	44	29	28	30

Customer  
Firstname Lastname  
Address  
123 Address St  
City, ST ZZZZZ

Designer  
Firstname Lastname  
Coordinates  
(XX.XXXXX / XX.XXXXX)

Organization  
Organization Name  
Date  
MM/DD/YYYY

Zoomed out satellite view



3D model



3D model with LIDAR overlay  35 ft



**Customer**  
Firstname Lastname

**Designer**  
Firstname Lastname

**Organization**  
Organization Name

**Address**  
123 Address St  
City, ST ZZZZZ

**Coordinates**  
(XX.XXXXX / XX.XXXXX)

**Date**  
MM/DD/YYYY

Street view and corresponding 3D model



I, **Firstname Lastname**, certify that I have generated this shading report to the best of my abilities, and I believe its contents to be accurate.