CALIFORNIA ENERGY COMMISSION
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Main website: www.energy.ca.gov
CEC-057 (Revised 1/20)

Notice of Final Conclusions
Town of Truckee Petition for Exemption from the Solar Photovoltaic Requirements
Docket No. 19-BSTD-12

Purpose

California Energy Commission (CEC) staff has reviewed a petition submitted by the Town of Truckee requesting that the CEC exempt building sites that have a high snow load from the *2019 Building Energy Efficiency Standards* (2019 Energy Code) solar photovoltaic (PV) requirements. The Town of Truckee petition requests exemption for building sites with a ground snow load above 223 pounds per square foot (lbs/ft^2).

On August 20, 2020, staff posted a *Notice of Preliminary Conclusions and Public Comment Period* and solicited comments on staff's review of the *Town of Truckee Petition*. A total of twelve comments were submitted to the CEC docket.

This final notice revises the preliminary conclusions to incorporate the comments that were received. Staff will be seeking approval on this item at the Commission business meeting scheduled on February 10, 2021.

The petition, all comments and related documents are available for download on the CEC's docket website at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-BSTD-12.

Background

On May 9, 2018, the CEC adopted the 2019 Energy Code, which includes new PV requirements for all newly constructed low-rise residential buildings in Title 24, Part 6, §150.1(c)14. "Low-rise residential buildings" are defined as single-family houses, duplexes, and townhomes, as well as multifamily buildings that are three stories or fewer. These requirements, along with the rest of the 2019 Energy Code, went into effect January 1, 2020.

The Administrative Regulations of the California Building Standards Commission (CBSC) (Title 24, Part 1, §1-313) include provisions under which any local government agency, firm, or member of the public may petition the CBSC for the proposal, adoption,

amendment, or repeal of any building standard or administrative regulation in Title 24 of the California Code of Regulations. The CBSC may refer received petitions to the state agency having specific jurisdiction for the subject of the adopted building standard. A state agency receiving a petition referred by the CBSC shall process the petition and report decisions made by the agency back to the CBSC.

Town of Truckee Petition

On February 11, 2020, the Town of Truckee and the local Building Working Group (hereinafter referred to as the "Town of Truckee") submitted a petition to the CBSC requesting an exemption from the 2019 Energy Code PV requirements for building sites where high snow loads make compliance with the PV requirements "routinely impossible or onerous." Member jurisdictions of the Building Working Group consist of the Town of Truckee, Town of Mammoth Lakes, Nevada County, Sierra County, Mono County, and Placer County. The CBSC forwarded this petition to the CEC to consider.

The petition includes:

- Completed Form DGS BSC-30, Title 24 Petition
- Cover letter that summarizes the petition
- Analysis paper prepared by the Tahoe Truckee Engineers Association (TTEA)

The petition states that many building sites located in the Sierra Nevada mountain range have building design snow loads that are greater than what PV panels are rated to withstand. The Town of Truckee believes that requiring the installation of PV panels that are not rated for the design roof snow load conflicts with California Building Code §1604 General Design Requirements. Its petition states that substantial damage to the PV system could result, warranties would likely be voided, and replacement would not be cost-effective.

The petition requests that building sites with a ground snow load above 223 lbs/ft^2 be exempt from the PV requirements. This proposal was based on a snow load analysis conducted within the framework of the *American Society of Civil Engineers (ASCE) Standard 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (Standard 7-16), as discussed in the analysis paper prepared by TTEA. The Town of Truckee concluded that the highest-rated PV panels available have a design load rating of 125 lbs/ft^2. The 223 lbs/ft^2 ground snow load threshold was back-calculated by using this panel design load and making generalized assumptions for the variables that are to be considered in the Standard 7-16 snow load method.

Building sites located in some parts of the Sierra Nevada mountain range can have ground snow loads higher than 500 lbs/ft^2. The Town of Truckee acknowledges that design snow loads depend on the characteristics of the building and the building site (site-specific) and need to be determined by a design professional. The Town of Truckee proposes establishing a uniform exemption criterion that would rule out solar PV without requiring that a design professional conduct a project-specific design. The

Town of Truckee also requested that the exemption be effective until PV panels with higher load ratings become available for its jurisdictions.

Staff Review of Building Standards Code (Title 24) Requirements

The 2019 Energy Code (Title 24, Part 6), §150.1(c)14, requires that "*all low-rise residential buildings shall have a photovoltaic (PV) system … with annual electrical output equal to or greater than the dwelling's annual electrical usage.*"

The 2019 California Building Code (CBC, Title 24, Part 2) includes the following requirements:

- §1604.1 requires that "*building, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design … as permitted by the applicable material chapters and referenced standards.*"
- §1608.1 requires that "*design snow loads shall be determined in accordance with Chapter 7 of ASCE 7 …*" ([*ASCE] Standard 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures*)
- §1510.7.2.1 requires that "*Supports and attachments of photovoltaic panels to the roof structure, the panels, modules and components shall be designed for applied loads per this code and shall comply with industry standards determined applicable by the enforcement agency."*

The 2019 California Residential Code (CRC, Title 24, Part 2.5), §R324.4, requires that "*rooftop-mounted photovoltaic panel systems shall be designed to structurally support the system and withstand the applicable gravity loads in accordance with Chapter 3."*

In addition, the 2019 CBC, §1.1.7.3 has the following provision: "*Conflicts. When the requirements of this code conflicts with the requirements of any other part of the California Building Standards Code, the most restrictive requirements shall prevail.*"

Staff finds that in some cases PV panels cannot be installed to withstand the snow load conditions in high-snow-load areas. Whether this finding is true for a building depends on the site-specific characteristics of the PV panels, the roof, and the conditions at the building site. PV panels can be installed to be more resilient to snow loads, for example, through the use of three-rail mounting systems, and roofs can be designed and PV installation locations on the roof can be chosen to enable PV panels to meet snow load requirements when they otherwise would not.

When there exists a conflict between the Energy Code PV requirements and the CBC and the CRC snow load requirements, the CBC and CRC code requirements prevail as the more restrictive standards. Therefore, if local conditions (including site-specific characteristics) do not allow the installation of PV systems that comply with the CBC and the CRC snow load requirements, the CBC and CRC preclude installation of PV panels. Conversely, when the specific characteristics of the PV panels and the roof, including the roof design and PV location on the roof, can be chosen to enable the PV

system to meet the snow load requirements, then the 2019 Energy Code PV requirements prevail, and PV installation is required. The local enforcement agency is responsible for making this determination.

Staff concludes that all pertinent code requirements of the 2019 Energy Code, the CBC, and the CRC simultaneously should be met in as many newly constructed, low-rise residential buildings as are feasible and achievable.

American Society of Civil Engineers Standard 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures

Standard 7-16 includes structural design methods used for determining types of loads such as dead, live, soil, flood, tsunami, snow, rain, atmospheric ice, earthquake, and wind. Snow loads are covered in Chapter 7. For the purpose of determining snow loads on PV panels, the same method for determining roof snow loads are used. In areas that have higher than nominal ground snow loads, CBC §1608.2 requires that ground snow loads for each of the building sites in the area be based on case studies approved by the local jurisdiction, using an extreme values statistical analysis of the snow data in the vicinity of the site, with a two percent annual probability of being exceeded (50-year mean reoccurrence interval).

Standard 7-16 uses this ground snow load along with other site-specific variables to determine the flat and sloped roof snow load that roof structures must be designed to withstand. Standard 7-16 uses the following equations to calculate roof snow loads:

Equation 7.3-1: Flat Roof Snow Load, p_f

$$p_f = 0.7 * C_e * C_t * I_s * p_g$$

C_e =exposure factor (*Standard 7-16, Table 7.3-1*)
C_t = thermal factor (*Standard 7-16, Table 7.3-2*)
I_s = importance factor (*Standard 7-16, Table 1.5-2*)
p_g = ground snow load (*determined by local jurisdiction*)

Equation 7.4-1: Sloped Roof Snow Load, p_s

$$p_s = C_s * p_f$$

C_s = roof slope factor (*Standard 7-16, Figure 7.4-1*)
p_f = flat roof snow load (*as calculated from Equation 7.3-1*)

The design load rating of the PV panels must be equal to or greater than the sloped roof snow load (p_s). The design load rating of a PV panel is determined by dividing the panel manufacturer's maximum load test rating for the panel and mounting hardware, by a safety factor of 1.5.

These are the base equations to calculate the snow load on PV panels. Standard 7-16 includes substantial design considerations that go beyond these equations, such as accounting for snow drifts, partial loading, unbalanced snow loads, ice dams, and sliding snow safety.

Staff Analysis

The Town of Truckee petition requests that the enforcement agency not be obligated to enforce the installation of a PV system when the design load rating is lower than the roof snow load calculated through the Standard 7-16 equations 7.3-1 and 7.4-1. To achieve this, the Town of Truckee proposed a threshold criterion whereby PV systems would not be required for sites having a ground snow load of greater than 223 lbs/ft^2, based on general assumptions for the variables used in the Standard 7-16 equations.

Staff finds that applicable most-favorable values should be used for each variable in the Standard 7-16 equations for establishing a threshold (that is, maximum) ground snow load criteria, above which PV panels would be found to always fail to meet structural requirements. Doing otherwise risks establishing a threshold that ignores conditions where PV panels would be capable of meeting snow load structural requirements based on site-specific conditions. Staff finds that the thermal factor and the importance factor assumed by the Town of Truckee represent applicable, most favorable, values.

The Town of Truckee used a maximum design load rating of 125 lbs/ft^2 for the PV panel in its calculation, based on its understanding of the panels available in the marketplace. Staff finds that PV panels should be expected to be robustly designed and installed to address high snow load conditions, including PV panels installed with three-rail support and mounting hardware. Staff finds that the 125 lbs/ft^2 design load rating identified by Town of Truckee appears consistent with the best available panels (and therefore represents applicable, most favorable values) and seeks public input on the availability of PV panels with higher manufacturer load ratings to ensure that such products are properly recognized.

The Town of Truckee assumed a roof pitch of 7-on-12 (roof slope of 30.26 degrees), a non-slippery surface, and a partially exposed upwind condition. Staff finds that newly constructed homes in snow areas can often have roof pitches greater than 7-on-12. In some circumstances, PV panels would appropriately be considered slippery surfaces[1] that more readily shed snow, provided there are otherwise no obstructions on the roof.

PV panels installed on the roof can also have either fully exposed or partially exposed upwind conditions, dependent upon the site. In the Standard 7-16 method, the roof slope, surface slipperiness, and upwind exposure conditions affect snow load calculations; snow load calculation results can differ by more than 100 percent,

1 Standard 7-16 includes the following definition: SLIPPERY SURFACE: Membranes with a smooth surface, for example, glass, metal, or rubber. Membranes with an embedded aggregate or mineral granule surface are not considered a slippery surface.

depending on these variables. When site-specific roof slopes, surface slipperiness, and exposure conditions exist that make PV systems capable of meeting structural requirements, those characteristics should be used in the analysis. Building- and site-specific values for these characteristics represent applicable, most favorable values that need to be used in the threshold analysis.

Staff Recommendation

Staff developed Table 1 based on the Standard 7-16 method. Staff used the following values for the variables in the Standard 7-16 equations:

- C_t = thermal factor = 1.0 (see Table 7.3.2) — same as Town of Truckee
- I_s = importance factor = 0.8 (see Table 1.5-2 — Risk Category I) — same as Town of Truckee
- C_e = exposure factor = 0.9 fully exposed; 1.0 partially exposed (see Table 7.3.1)
- C_s = slope factor = 0.0 to 1.0 (see Figure 7.4-1, Graph 7-2a — dashed line for unobstructed slippery surfaces, solid line for all other surfaces)

Table 1 allows a look-up for the maximum ground snow loads for the roof slope, upwind exposure condition, and surface slipperiness category applicable to the specific building and site in question. The maximum ground snow loads for those site conditions were back-calculated using the Standard 7-16 equations in the same manner as the threshold proposed in the Town of Truckee's petition.

Standard 7-16 section 7.4 states "snow loads acting on a sloping surface shall be assumed to act on the horizontal projection of that surface." The snow load is assumed to act in a vertical (plumb) direction; that snow load is not subjected perpendicular the PV panels. On the other hand, PV panels are tested and rated by laying panels flat and applying a load, meaning the load is perpendicular to the surface of the panel. To compare the tested and rated load tolerance of the panels to the snow loads determined through the equations of Standard 7-16, Table 1 applies the cosine of the angle for the roof slope to determine the maximum ground snow loads. (See docketed comments of Louis "Rocky" Woods, PE., TN# 234933).

Table 1 is intended to be used as a first step to quickly determine whether installation of PV panels will not be able to comply with snow load structural requirements. To make that determination, the local enforcement agency would request from the permit applicant the roof slope, surface type, and upwind exposure condition of the roof area where the PV would be best suited for the newly constructed low-rise residential building, and use Table 1 to find the calculated maximum ground snow load for that PV installation. If the ground snow load approved by the Town of Truckee for that building site is greater than the maximum ground snow load determined using Table 1, then the PV panels would be determined to not be able to comply with snow load structural requirements. In this case, the local enforcement agency would not need to enforce the installation of a PV system at that building site.

If the ground snow load approved by the Town of Truckee is less than the maximum ground snow load found in Table 1, then the PV panels would initially be determined to be able to meet the snow load structural requirements. A registered design professional would at that point prepare all structural documentation for the project, demonstrating to the local enforcement agency's satisfaction whether all requirements of Standard 7-16, the CBC, and the CRC are met.

Table 1 is developed based on PV panels and mounting hardware with a designed load rating of 125 lb/ft^2, consistent with the assumptions of the Town of Truckee petition. This value will need to be updated if PV panels with higher load ratings became available on the market.

Table 1 does not account for the down-slope, in-plane component of snow load. This places both shear forces on all fasteners and components and potentially a moment force that will act to pry the mounts off the roof, bend L-feet and standoffs, and put stress on fasteners. Where mounting hardware is specified by panel manufacturers, all proprietary components should be rated for the in-plane component of the snow load. In the absence of ratings from the manufacturer, the registered design professional must demonstrate that the components can carry the load, including safety factors.

Table 1: Maximum Ground Snow Loads

Maximum Ground Snow Loads based on Panel Rating, p_g (lb/ft^2)				
Roof Slope	Fully Exposed Site		Partially Exposed Site	
(°)	Unobstructed Slippery Surfaces	All Other Surfaces	Unobstructed Slippery Surfaces	All Other Surfaces
0	248	248	223	223
5	249	249	224	224
10	273	252	246	227
15	303	257	273	231
20	343	264	309	238
25	395	274	356	246
30	465	286	419	258
35	562	346	506	311
40	701	432	631	389
45	912	561	821	505
50	1,254	772	1,128	695
55	1,873	1,153	1,686	1,038
60	3,223	1,984	2,901	1,786
65	7,625	4,695	6,863	4,225
≥70	No Maximum	No Maximum	No Maximum	No Maximum

Note: Grey areas are maximum ground snow loads that exceed snow levels reported in the petition.

Conclusions

Staff concludes that PV systems that cannot comply with the CBC and the CRC snow load structural requirements should not be installed or required to be installed per the 2019 Energy Code (Title 24, Part 6), §150.1(c)14. However, building permit applicants should address issues under its control, to the extent possible, to meet snow load structural requirements. These include the specific characteristics of the PV panels and the method of installation, the slope and design of the roof, and the location of PV panels on the roof. Steps that can be taken to meet snow load structural requirements include, but are not limited to:

1) Using three-rail mounting or other installation practices that would make PV panels resilient to roof snow loads.
2) Choosing roof slopes and PV panel locations that maximize the roof slope and allow the PV system to qualify as unobstructed slippery surfaces.
3) Modifying roof designs, roof locations, or PV panel mounting to avoid issues, such as unnecessary snow accumulation or snow sliding off the roof to undesirable locations on the site.

Table 1 may be used as a first step to determine whether installation of a PV system will not be able to comply with snow load structural requirements due to PV panel ratings. This determination should not be made if changes are possible in accordance with the above paragraph that would enable the PV system to meet snow load and structural requirements at the site.

Table 1 should not be used to guide the design of, or perform the Standard 7-16 calculations for, PV systems. Pertinent design requirements go beyond what is covered in Table 1, therefore ground snow loads within Table 1 maximum values may still present structural issues or conflict due to other reasons. A registered design professional would need to make this determination.

Simultaneous compliance with the pertinent code requirements of the 2019 Energy Code, the CBC, and the CRC should be accomplished in as many newly constructed low-rise residential buildings as are feasible and achievable.

Local enforcement agencies should take care to ensure that practical approaches are taken to design homes that facilitate the installation of solar panels where possible. Designers may be inclined to offer designs which make the solar panels impractical to save money and construction complication, rather than doing a best effort to adapt designs to the conditions and the solar panel requirement. Experienced designers in snow country have demonstrated that PV systems can be successfully installed with due attention to all Standard 7-16 requirements. Designers who do not have experience in snow country, may potentially lack specific snow load knowledge and are at risk of specifying systems that have a higher probability of failure. Local enforcement agencies are encouraged to provide effective technical assistance to designers to ensure that designs of roofs and PV systems are modified as practical to meet the demanding

conditions in snow country. (See docketed comments of Ben Woodard, TN# 234856; Anne-Flore Dwyer, TN# 234846; and Mark Dickson, TN# 234845)

Recent extreme weather events and raging wildfires up and down the state demonstrate that the consequences of climate change are upon us. Properly installed PV systems represent an important opportunity for achieving state and local climate change goals for reducing greenhouse gas (GHG) emissions. This holds true for suitable PV installations in snow country. (See docketed comments of Jan Zabriskie, TN# 234853)

Staff also recommends that the CEC consider adopting amendments in the 2022 Energy Code to be consistent with these conclusions.

Staff wishes to recognize and strongly appreciates the expert technical advice and tutelage provided on the Town of Truckee petition by Diane Gould, Supervising Structural Engineer, California Division of the State Architect.

Public Comments

This item will be presented at the February 10, 2021 business meeting. Business meeting agendas are available 10 days before the date of the meeting and will be posted on the CEC's business meeting webpage at https://www.energy.ca.gov/proceedings/business-meetings. The agenda will include direction on how to participate and provide oral comments.

If you wish to submit a written comment, please submit them using the e-commenting feature on the CEC's webpage at https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=19-BSTD-12. Written comments must be submitted prior to the business meeting.

A full name, email address, comment title, and either a comment or an attached document (.doc, .docx, or .pdf format) is mandatory. After a challenge response test used by the system to ensure that responses are generated by a human user and not a computer, click on the "Agree & Submit Your Comment" button to submit the comment to the CEC's Docket Unit.

You are encouraged to use the electronic filing system described above to submit comments. If you are unable or do not wish to submit electronically, a paper copy of your comments, including the docket number 19-BSTD-12 and indicating "Town of Truckee Petition for Exemption from the Solar PV Requirements" may be sent to:

Docket Unit
California Energy Commission
Docket No. 19-BSTD-12
1516 9th Street, MS-4
Sacramento, CA 95814

Or, email them to docket@energy.ca.gov

Please note that your e-comments, emails, written letters, any attachments, and associated contact information (for example, address, phone number, and email address) become part of the viewable public record. Additionally, this information may become available via internet search engines.

Public Advisor and Other Commission Contacts

The CEC Public Advisor's Office provides the public assistance in participating in CEC proceedings. For information on how to participate in this proceeding, or to request language services or other reasonable accommodations, please contact the Public Advisor, Noemi O. Gallardo at publicadvisor@energy.ca.gov, or by phone at (916) 654-4489 or toll free at (800) 822-6228. Requests for language services and reasonable accommodations should be made at least five days in advance. The CEC will work diligently to accommodate late requests.

Please direct all news media inquiries to the Media and Public Communications Office at (916) 654-4989, or by email at mediaoffice@energy.ca.gov.

If you have questions on the subject matter of this notice, please contact Cheng Moua at (916) 651-3004, or by email at cheng.moua@energy.ca.gov.

The proposal and supporting materials can be downloaded at https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=19-BSTD-12.