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Public Comment on PV snow load limit

Additional submitted attachment is included below.

TTEA
Tahoe Truckee Engineer's Association
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Docket Unit
California Energy Commission Docket No. 19-BSTD-12
1516 9th Street, MS-4
Sacramento, CA 95814

Re: **Public Comment on Notice of Preliminary Conclusions and Public Comment Period re: Town of Truckee Petition for Exemption from the Solar Photovoltaic Requirements**

To the California Energy Commission:

The CEC staff recommendation considers solar panel capacity and out-of-plane loading on rails but does not address the other components of PV roof mount systems and additional snow related structural design issues. Thus, the Tahoe Truckee Engineer's Association's Structural Committee wants to express our concern that this oversight will lead to failures of newly installed PV systems if the staff guidelines are followed without modification. The snow loads allowed in much of Table 1 are simply too great to ensure survival of the systems on a roof under heavy snow load.

The purpose of the California Building Standards Code, including the California Building Code, California Residential Code, and the Building Energy Efficiency Standards, is to outline code standards for safe and energy efficient construction. The CEC staff recommendation, and particularly Table 1, will direct engineers to design systems which are risky and likely to fail in heavy snow years. This is in conflict with the fundamental purpose of building codes, which is to ensure that code conforming designs are 'safe'.

In the recent heavy winters of 2010-11 and 2016-17, our engineers witnessed numerous failures of PV systems and components, including mount failures, L-foot failures, panel frame failures, and failure of bolts and other connectors. Our members saw large portions of PV arrays swept off roofs and live wires exposed. We urge extreme caution in the design of PV roof mount systems in high snow areas. The staff recommendation is not conservative enough to prevent failure of PV arrays designed under its guidelines. If its recommendations are followed it will lead engineers, building officials and installers to design, approve and install PV roof mount systems that stand a high probability of failure in heavy snow years.

Although most PV panels carry a snow rating, which is typically between 75 and 125 psf, very few manufacturers have rated their rail or the other components of their PV systems for snow loads over p_s = 70 or 80 psf. Very few (if any) manufacturers have tested their components for in-plane loads applied at the panel surface and the resulting moment from such forces. Thus, engineers who design PV systems in areas where roof snow loads exceed the rail rating values often must use their own expertise to evaluate the rail, mounts, L-feet and other fasteners in the system for both the out-of-plane (normal) and in-plane forces on them. In heavy snow years, failures of the various components of roof mount PV systems have been quite common.

Another problem is that many engineers designing such systems do not live and work in snow country and due to lack of local knowledge are at great risk to specify systems that have a high probability of failure.

The Tahoe Truckee Engineer's Association and the local building departments in heavy snow regions readily support the energy goals of the 2019 energy code, however we recognize that complying with the PV mandate for new construction should be met with caution in high snow areas. Thus, we recommend more moderate snow load limits than those given in Table 1 for exemption to the 2019 Energy Code PV mandate. Our recommendations are generally in accordance with the Town of Truckee proposal.

In order to design safe PV systems which will not experience structural failure, the following additional issues need to be considered in design:

1) Elements of a roof mounted PV system shall be designed for the in-plane component of snow load acting at the face of the modules. This places both shear forces on all fasteners and components and a moment which will act to pry the mounts off the roof, bend L-feet and standoffs, and put significant stress on associated fasteners.

2) All proprietary components of the systems need to be rated for both the out-of-plane (normal) component of the snow load as well as the in-plane component of the snow load. In the absence of ratings from the manufacturer, the engineer must perform detailed calculations to show that the components are capable of carrying the load, including appropriate safety factors.

3) Rails must be designed for both out-of-plane (strong axis) snow loads & in-plane (weak axis) snow loads.

4) Beyond a simple calculation of p_s, the following must be considered and calculated when designing a roof mounted PV system subject to snow load: valley drift loads, wind drift loads, sliding snow on adjacent roof surfaces and snow creep (especially on low pitch roofs and near valleys).

5) Partially exposed sites need to be designed for lower maximum snow load capacity since the snow can accumulate throughout the winter and overload the array. Fully exposed sites can be designed for a little higher snow load capacity since snow on the array will tend to be blown off and will not typically accumulate as much.

6) Designing PV systems in situations where the PV array cannot slide freely is not recommended for higher snow loads, since the snow will slide or creep down from the upper part of the array and accumulate and overload the bottom part of the array.

7) Higher snow loads (p_g >300 psf) tend to have considerably more risk of failure regardless of the roof pitch. For example: failures occur due to drift loads, cornices building up and breaking off, large dynamic forces from sliding snow, large snow packs building up and creeping, roof snow bridging with ground snow and accumulating and overloading the roof and PV array on it.

8) In order to generate power, PV arrays must be able to have snow slide off them freely. However, such sliding could create a risk if it discharges onto an entry, walkway, deck, patio, driveway, lower roof, or neighboring property. Thus, some roofs may not have an area where a safe PV installation can be installed.

9) Regardless of the snow load on a given panel array, if snow is trapped below or between the panels or the rails, the snow can melt and re-freeze causing very large expansive forces on the PV system. This should be one of the major concerns of system designers. The potential for ice formation requires the system designer to address the overall "toughness" of the panels, not just their uniform pressure rating.

10) The architectural design can greatly affect the feasibility of successful installation of PV systems in snow country. It seems to be evident to all that the most favorable condition is the provision of a steep roof pitch which does not receive shedding snow from other roofs, and in which the eaves are adequately above the ground. However, this may not be favorable in some situations as shedding snow can be a safety hazard and can block egress windows and affect light and ventilation.

11) Placement of the PV array can also greatly affect the feasibility of a successful installation in snow country. Placement of the array at the ridge line of roofs (allowed for in our local ordinance) eliminates the forces from an uphill snowpack laterally loading the support system. However, there would need to be an adjacent roof plane to provide access for fire-fighting purposes.

We recommend these additional design issues be considered in the CEC staff recommendations.

In order to help prevent failures of PV roof mount systems, the Tahoe Truckee Engineer's Association recommends the following:

1) Modify Table 1 per the attached markup to show areas where the probability of failure is high. Installation of roof mounted PV systems should not be required where the snow load falls in the shaded area of the marked-up table or where the addition of valley load and drift loads will cause the roof snow loads to exceed the panel or other component capacities (See * footnote on Table 1 markup)

2) Before setting snow load limits and requiring PV systems for high snow loads, the CEC should check with manufacturers and make sure that there are at least two manufacturers who will rate all the components in their systems for the snow loads the CEC will require.

3) We recommend adding additional language clarifying that if the registered design professional successfully demonstrates that the roof snow load is greater than available solar panel load capacity, an exemption would be granted.

4) Allow the registered design professional to request and be granted an exemption of the PV requirement by the building official if their analysis shows that a system cannot be safely installed on a roof.

5) Allow an exemption for design or site safety issues. For example, if the roof has insufficient area where a PV array can be placed where it can slide freely, be away from valleys where snow build-up and/or creep could damage it, or where snow sliding off the array would cause risk to an entry, walkway, deck, patio, driveway, lower roof, windows and doors, or neighboring property.

As a final note, TTEA wishes to point out that since solar PV systems for high snow load installations require premium panels and a 3-rail system, as well as custom engineering, custom attachments, and potentially custom hardware, this will add to the overall cost of the system. As energy code requirements are based on cost effectiveness, it would seem that an analysis of the additional cost/snow load should be performed, and that this should be factored into the exemption. Perhaps options (other than solar PV) that make more sense for high snow load heating climates could be made available in the energy code.

TTEA's Structural Committee would also like to offer our assistance with any questions you may have regarding snow. Our members have vast experience with snow in the Sierra Nevada mountains and how it affects structures and PV solar systems. If you have any questions, please contact our committee chair, Rick Fitzgerald, P.E. at (775) 848-0053 or by email at rick@fnwengineers.com

Thank you very much for considering our recommendations.

Respectfully,

TTEA Structural Committee

Rick Fitzgerald, P.E. – Chair
Dennis Dodds, P.E.
Darcey Messner, P.E.
Paul Laudenschlager, P.E.
Donavan Rae, P.E.
David Hodder, S.E.
Eric Bacon, P.E.
Ron Mooiweer, P.E.
Jay Garbarino, P.E.
Doug Gadow, S.E.
Daryl Mills, P.E.
Brandon Brooks

Encl.

Fully exposed sites can be designed for a little higher snow capacity since snow on the array will tend to be blown off and will not typically accumulate as much.

Designing PV systems in situations where the PV array cannot slide freely is not recommended for higher snow loads, since the snow will slide on the upper part of the array and accumulate and overload the bottom part of the array.

MARKUPS BY THE TAHOE TRUCKEE ENGINEER'S ASSOCIATION STRUCTURAL COMMITTEE 9/15/20

Table 1: Maximum Ground Snow Loads

Maximum Ground Snow Loads for Snow Load Compliance (lbs/ft^2) * - Where applicable, the load must be reduced to account for the appropriate valley and/or drift load increase in snow load.				
Roof Slope	Upwind Fully Exposed Site		Upwind Partially Exposed Site	
(°)	Unobstructed Slippery Surfaces	All Other Surfaces	Unobstructed Slippery Surfaces	All Other Surfaces
0	248	248*	223	223*
5	248	248*	223	223*
10	269	248*	242	223*
15	293	248*	264	223*
20	322	248*	290	223*
25	358	248*	322	223*
30	403	248*	363	223*
35	461	283	415	255
40	537	331	484	298
45	645	397	580	357
50	806	496	725	446
55	1,075	661	967	595
60	1,612	992	1,451	893
65	3,223	1,984	2,900	1,786
≥70	No Maximum	No Maximum	No Maximum	No Maximum

Not Recommmended. Failures are likely. If designing and installing PV in these situations, local knowledge & significant experience is essential to prevent unsafe systems which might experience structural failure.

Higher snow load (Pg >300 psf) tend to have considerable more risk of failure regardless of the roof pitch. For example: failures occur due to drift loads, cornices building up and breaking off, large dynamic forces from sliding snow, large snow packs building up & creeping, roof snow bridging with ground snow, accumulating and overloading the roof.

Partially exposed sites need to be designed for lower maximum snow capacity since the snow can accumulate throughout the winter and overload the array.