

Addressing Firefighter safety around solar PV systems



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In the early years of the solar industry, when there was very little awareness of system issues outside of the industry, installers developed a habit of increasing voltages to simplify installation. As rooftop solar becomes more common throughout the world, new considerations for standard installation practices have been developed to address the needs of fire service personnel.

Codes and standards address fire safety of electrical systems; they have evolved over time to address new technologies and improve existing codes as more field experience develops. But these same codes and standards do not yet address the standard procedures the fire service use to suppress fires involving PV (photovoltaic) systems.

Safety hazards such as high-voltage electrical shock or slippery solar modules present dangers for first responders and, in particular, firefighters battling a blaze who may be unfamiliar with PV systems.

The institution of standardized or regulated safety procedures has been slow because, until recently, problems associated with rooftop systems have been deemed relatively benign. Then, on June 22, 2009, firefighters responded to a blaze in Bursstadt, Germany, which occurred on a portion of a 5MW commercial rooftop PV system. The fire was controlled and contained to a small portion of the overall system; however this blaze rekindled the discussion on system designs and firefighter procedures to ensure the overall safety of first responders and improve their ability to successfully extinguish fires in buildings with PV systems.

When approaching a burning building, firefighters are on the lookout for unusual situations

requiring special safety procedures that help them address the situation in a calm and collected manner. When rooftop PV systems are involved, challenges arise for which firefighters may not be ready. The first is figuring out whether the location has a rooftop PV installation; second is attempting to extrapolate how that installation might be wired. Is it through the roof and down into the building? Isolated to the roof? Are there system components located elsewhere in the house, and where could the DC wiring be located?

In some cases involving large buildings—or fires with thick, heavy smoke—firefighters may be unable to determine whether there's a PV system on the roof in the first place, forcing them to enter the building blind. Without proper training, this could be very dangerous and, with the growing use of renewable energy on homes and businesses, proper training for the emergency response community is essential—particularly in areas where PV systems are highly concentrated.

One idea suggested by fire prevention experts is to modify existing central or regional mapping systems, where addresses of buildings with PV systems can be available to emergency responders. This type of system is already being used in Dusseldorf, Germany, and by the German Federal Network Agency (FNA). Including system registration in the requirements for certification would greatly aid firefighters in their ability to accurately assess the danger of a situation.

After firefighters have identified that a PV system is present, they must be wary of the multitude of problems that could arise, compromising the safety of themselves and the crew, such as:

- Electrical shock through water conduction or contact with system components.
- Inhalation of toxic gases, caused by the inability to vent (cut a hole in the roof of) the building because they may hit the PV array or its wiring.
- Falling debris from the aluminum racking giving way.
- Flying glass debris from bursting PV modules.
- Dead loading on a compromised structure and tripping on conduits.

To deal with these challenges, some fire departments have developed new safety procedures, introduced PV safety workshops into their training and worked with solar industry professionals to create a guideline for PV installations that provide setbacks and signage to help address fire service needs. Main points that members of the fire service should consider are:

1. When a PV system is present, communication is essential for fire service safety and proper fire suppression.
2. Solar modules do not generate electricity at night, and the lighting apparatus used by the fire service does not produce enough light to generate a dangerous amount of electricity. During overhaul—which might occur during the daytime—loose wiring attached to modules may present a hazard.
3. Covering the PV modules with foam or salvage covers may not shut the array down to a safe level. This is not a recommended practice.
4. PV modules do not store energy; however, it may take a few moments for the power in them to reduce to zero. Inverters have

- capacitors, which will hold electricity for longer than a few minutes.
- When exposed to sunlight, the PV modules are generating electricity. The electricity will flow through all attached conduit.
 - Do not cut, break, chop or walk on PV modules or conduit.

So what can firefighters do? These are real situations and concerns, which have moved to the forefront as the popularity of PV systems has grown, and are now part of PV system safety discussions within the industry and the fire service.

Some fire service personnel have created YouTube (bit.ly/c8gXoT) training videos and hosted workshops to raise awareness for fire service professionals. The California Department of Forestry and Fire Protection (CalFire)—in conjunction with local fire officials, building officials and representatives from the solar industry—developed a “Solar Photovoltaic Installation Guideline” (bit.ly/KlsBB) that discusses rooftop solar PV as it relates to building occupant and emergency responder safety. This document then goes on to make clear and logical suggestions to create solar installations that do not obstruct the ability of firefighters to save lives—or put their own in danger. This guideline has been submitted to the International Code Council for adoption into regulation.

The CalFire Installation Guideline recommends creating pathways and allowing for easier access to the roof by setting solar modules anywhere from 1.5 ft to 3 ft from edges and ridges (depending on the roof type), and from 4 ft to 8 ft for commercial-scale buildings. This setback rule would provide a clear and structurally sound pathway to walk on should firefighters need to vent toxic fumes and smoke.

Seems reasonable, doesn't it?

So reasonable, in fact, that the Oregon Building Codes Division has recommended implementing a similar requirement; aiming to have a 3-ft wide path from the eave to the ridge—the highest point—to allow firefighters safe access to the roof. It also recommends access be provided at the ridge with a 1-ft path when a PV system is installed on one side of the ridge, along with a total of 3 ft when a PV system is installed on both sides of a ridge. Although 3 ft of space is deemed a little excessive by some, the need for rooftop pathways and space to cut ventilation holes is necessary.

It is important to also think about what these new regulations will do to the viability and uptake of solar in the residential market. Roofs on residential homes are already being stuffed to the brim to fit even just 3 kW onto them; by removing the space required to meet with these safety protocols, residential capabilities will significantly decrease, making the economics of it all much less appealing.

According to Matthew Paiss, fire captain with the San Jose fire department and contributor to the CALFire PV Installation Guideline, solar installers in California have reported a 30-40% decrease in interest in installing rooftop PV when system owners must comply with a setback rule. Perhaps, then, manufacturers need to find a way to create smaller solar systems, or systems that do not pose as high a risk of electrocution.

Knowing how to respond appropriately to a fire situation where there is a PV system is very important and, today, there are many ways to address PV system safety: everything from ensuring your system is installed to meet all electrical safety codes to having all of the required detection and safety mechanisms in place. New system designs and technologies are being developed every day to decrease risk to firefighters and system owners in emergency situations, as well as work to prevent fires from starting in the first place.

Many different technological solutions are being proposed to address system safety, but they all have one thing in common: limit firefighter contact with live electrical components to within the extra-low-voltage (ELV) band. This is because the International Electrotechnical Commission (IEC) has determined that the ELV voltage level provides sufficient protection from electric shock to anyone coming into contact with such a circuit.

In the context of PV, the upper ELV voltage limit is defined by systems not exceeding 120vDC. Solutions are now available to create a system that keeps the combined, individual voltage to within the ELV band while achieving the same efficiencies as high-voltage systems. These systems are tested and proved to work effectively for close to the same cost as installing a traditional high-voltage system, only with more design flexibility and greater revenue return.

Inverters supporting ELV system architecture already in the market include SMA's 1100LV, Solar-Wind-Technik's DMI 900, any module-scale inverter such as Enphase micro-inverters and Sustainable Energy's Sunergy inverter. Micro-inverters offer a fully distributed power generation option where a separate micro-inverter is connected to each solar module in the system, and delivers the energy from its own module to the AC grid independently. In this case, the parallel integration is accomplished exclusively in the AC circuit. The other solutions deliver the same benefits at a lower cost and in a familiar form factor by connecting the modules in parallel on the input of a high power inverter; as high as 5kW in the case of Sunergy.

To further increase safety for firefighters, the inverter should be placed as close to the array as possible, which considerably decreases the amount of live DC wire in the systems, instead running AC circuits through the building. The California Department of Forestry and Fire Protection states in its “Solar Photovoltaic Installation Guideline”:

“... Conduit runs between subarrays and to DC combiner boxes should use design guidelines that minimize total amount of conduit on the roof by taking the shortest path from the array to the DC combiner box. The DC combiner boxes are to be located such that conduit runs are minimized in the pathways between arrays...”

Accordingly, Sustainable Energy recommends its Sunergy inverter be installed on the roof—preferably on the back of the racking system—or as close to the array as possible. This method will improve system yield, increase system safety and allow for confident installation and maintenance by any electrician.

Firefighters' are open and receptive to the development and increase of rooftop PV systems as part of the solution to our climate and energy security challenges; however, concerns remain for the safety of their crews and others. It is important that firefighters, the solar industry and municipalities work together to develop the safest and most effective solutions for dealing with rooftop installations as photovoltaic systems become more common in the urban landscape. **EB**

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