Safety Risks & Solutions in PV Systems for North America

White Paper

Introduction

In traditional photovoltaic (PV) systems, high DC voltages are present and pose risks to installers, maintenance personnel and firefighters. In addition, the possibility of electrical arcs, which can result in a fire, creates a threat to people working or living in the vicinity of a PV system. Safety mechanisms required by the National Electric Code (NEC) and Electrical Safety Authority (ESA) are not sufficient to remove all risks and ensure a safe working environment. The SolarEdge system provides a level of safety beyond that required by code.

This document details the safety risks inherent to traditional PV systems and the SolarEdge safety mechanisms which overcome these risks.

Traditional systems

Installation Safety

PV modules typically have an output voltage of 30-60V. Connecting several of these modules serially in a string creates a high voltage which can be dangerous to installers during system installation. Traditional string inverters cannot reduce this DC voltage even if they are turned off.

Maintenance and Firefighting Safety

Once modules are connected in a string, the voltage can reach up to 600Vdc (residential and commercial systems) or up to 1000Vdc (commercial systems). After connecting the strings to an inverter the PV system will operate at these high voltages. Installers, maintenance personnel or firefighters who need to work on or near the system are exposed to these high voltages. Shutting down the main circuit breaker will shut down traditional string inverters but will not shut down the DC voltage, which will remain high as long as the sun is out.

Several safety measures can be employed in these cases, but none of them remove the high voltages:

1. Shutdown functions in traditional inverters merely interrupt current flow while voltages remain dangerously high.

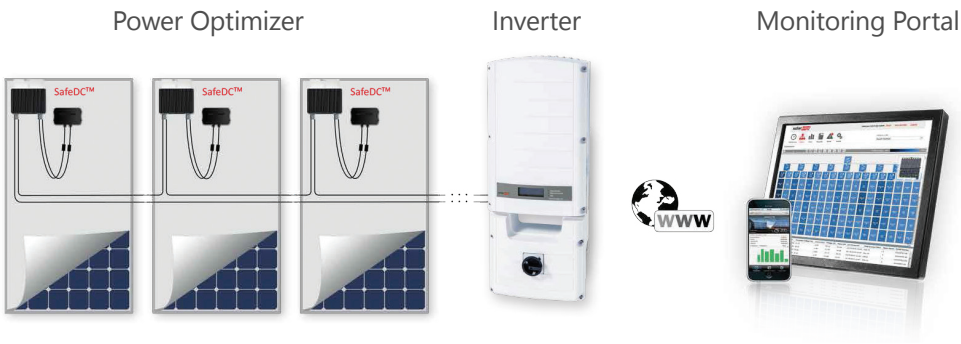
2. Automatic DC breakers located on the inverter cannot disconnect the voltage at the modules (only at the inverter), adding cost without decreasing the risk.

3. PV module covering (during firefighting):

   a. Spray Foam – this approach has proven to be ineffective because the foam evaporates or slides off the modules before the fire is extinguished.

   b. Covering the module with an opaque material – this approach requires the firefighters to climb onto the burning roof, risking electrocution.

SafeDC™ = Shutdown, arc detection & termination at the module-level



Arc Prevention

When connecters and/or cables in a PV system are improperly connected or are damaged, the electric current may pass through the air, causing an electric arc. Arcs generate heat which can cause fires and they also pose a risk of electrocution to those working near them. As PV systems age and connectors and cables degrade, the risk for electric arcs, while still low, increases. UL/CSA safety requirements pertaining to arcs are being put into place, but they require only the ability to terminate an arc through inverter shut down, not the ability to prevent its occurrence. This means that the associated risks of electrocution and fire are not eliminated.

The SolarEdge solution

The SolarEdge system consists of power optimizers connected to each module, a PV inverter and module-level monitoring. In addition, SolarEdge systems have a built-in safety feature, Safe DCTM, which eliminates safety risks during installation, maintenance and firefighting.

The SolarEdge SafeDC™ does the following:

1. Automatic shut-down of PV arrays during emergency shut-down.
2. Lowers and maintains the voltage in all DC conductors below 50V.

Installation Safety

When the SolarEdge power optimizers are not connected to an operating SolarEdge inverter, they each limit their output to a safe voltage of 1V. This means that during installation, long strings of power optimizers can be connected without creating a high DC voltage. For example if 19 power optimizers are connected in series, the string voltage will be 19V.

Maintenance and Firefighting Safety

Once the strings are connected to the SolarEdge inverter and the PV system is operating, the system operates at a fixed DC voltage of 350V (single phase non-HD-Wave inverters), 380V/400V (single phase HD-Wave inverters) or up to 425V to ground (three phase inverters).

For maintenance or firefighting purposes, shutting down the AC power will automatically reduce the DC voltage to 1V per power optimizer. This can be done in one of several methods:

1. Shutting down the main AC breaker
2. Turning the inverter ON/OFF switch to OFF
3. Turning the AC/DC Safety Switch to OFF
4. Pressing the Firefighter Gateway switch (available if gateway is installed; SolarEdge systems have full safety capabilities also if Firefighter Gateway is not installed)

Arc Prevention

In addition to the built in safety features of the SolarEdge system, SolarEdge inverters are UL1699B certified, providing NEC 2011 690.11 compliance[1].

Conclusion

High DC voltages created by PV arrays can be dangerous if not adequately controlled. Traditional string and central inverters have a limited ability to control DC string voltage and therefore pose a risk to those living or working near an array. The SolarEdge system, with its built-in SafeDCTM mechanism and arc prevention capabilities, is the best solution to ensure complete safety for PV installers, maintenance personnel and firefighters.

[1)] Refer to the SolarEdge inverter datasheets for details on specific model compliance.