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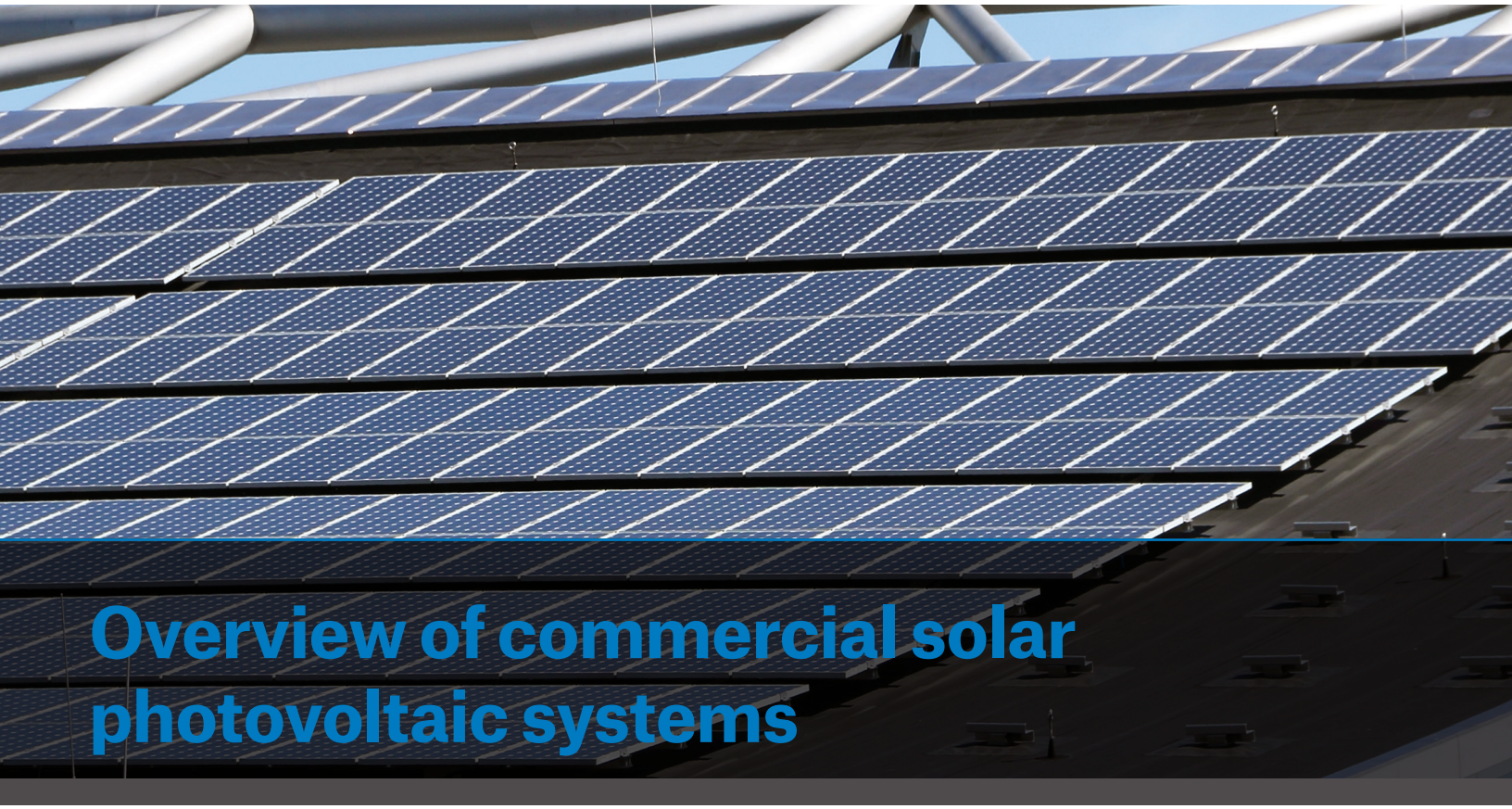

Overview of commercial solar photovoltaic systems

HSB, a Munich Re company, is a technology-driven company built on a foundation of specialty insurance, engineering and technology, all working together to drive innovation in a modern world.

This guide provides a baseline background of solar photovoltaic (PV) technology, as well as major system components and configuration. This overview pertains primarily to commercial solar PV installations used to supplement a building's electrical loads.

Introduction to solar technology

There are two types of solar technologies found on commercial buildings:

1. Solar thermal — heating of water for direct use or hot water space heating.

2. Photovoltaic (PV) — electrochemical reaction that uses sunlight to produce electricity.

A solar PV system utilizes several key components; they are, solar panels, racks and a mounting system, inverters, and the electrical balance of plant (BOP), which includes cabling, combiner boxes, disconnects, and rapid shutdown devices. Larger installations may also have a transformer(s) to convert the inverter's voltage to the utility distribution voltage. Some installations may also use single or dual axis tracking to follow the sun and increase energy production of the array. Tracking systems are primarily utilized on ground mounted

installations. Commercial applications may be roof or ground based systems and typically have a capacity of 40 kW to 1 MW, with an average size being 200 to 270 kW.

Solar panels, or modules, are the heart of any PV system. Fundamentally, individual cells are packaged into modules and they convert the solar energy into direct current (DC) electricity. Amongst several PV panel technologies, crystalline silicon is the most common. The combined power rating of all the panels is referred to as the kW-DC or kW_{Peak} value of the system.

There are two common racking types for roof mounted systems.

1. Ballasted rack systems — These systems are weighed down by heavy material, usually concrete blocks, to keep them in a fixed position. Ballasted systems are typically placed on flat or very low pitch roofs and require no roof penetrations.

2. Penetrating rack systems — These systems are attached through the roof membrane to the structural members of the building. Penetrating rack systems are lighter than ballasted ones.

Inverters are the brains of any solar PV system. They regulate and convert the DC output of many modules into alternating current (AC) at a voltage that is useful for the end-user.

There are two types of inverters used in commercial systems: string inverters and microinverters. String inverters receive the power output from hundreds to thousands of solar panels; they range from 5 to 100 kW. Microinverters are placed on the back of modules and receive the power output from one to three modules; they are sized to the modules' power rating and are used on commercial projects up to ~1 MW. The combined power rating of all the inverters is referred to as the kW-AC value of the system. It is common for the kW-AC rating to be lower than the kW-DC rating, by a ratio of up to 1.6 DC:AC.

Solar PV systems are either grid connected or stand alone. Grid connected systems are designed to operate in parallel with grid supplied electricity, allowing the customer to operate even when the solar system is not producing power. However, a grid tied solar system cannot operate without the grid, unless additional equipment is installed to specifically allow stand alone operation. Grid connected systems can also feed all or part of their produced power directly to the grid; these systems may also have a net metering arrangement. A simple way to think of net metering is with a meter than can spin forwards (consuming energy from the grid) and backwards (sending energy to the grid). For example, if a building uses 7.5 kWh and the PV system generates 10 kWh in a day, the building would have a positive credit of 2.5 kWh for that day. The vast majority of systems on commercial buildings are grid connected. Stand alone systems are designed to operate independently of the electric utility grid and will usually incorporate a battery bank.

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