Insight: Solar Power Generation Systems (Photovoltaic)

Recognizing the Risk

According to the Rocky Mountain Institute (RMI), wind and solar projects are on track to account for more than a third of the world's electricity by 2030. Additionally, exponential sector growth means wind and solar projects are predicted to generate at least 33% of global electricity, up from around 12% now, leading to a fall in fossil fuel-powered generation and cheaper power, the RMI report showed.

Photovoltaic (PV) installations range in size from private homes to large utility-scale installations that connect directly to the electrical transmission system. Other large megawatt PV installations include a substation transformer to step voltage up to transmission levels or include a battery energy storage system (BESS) to store energy when the sun is not shining.

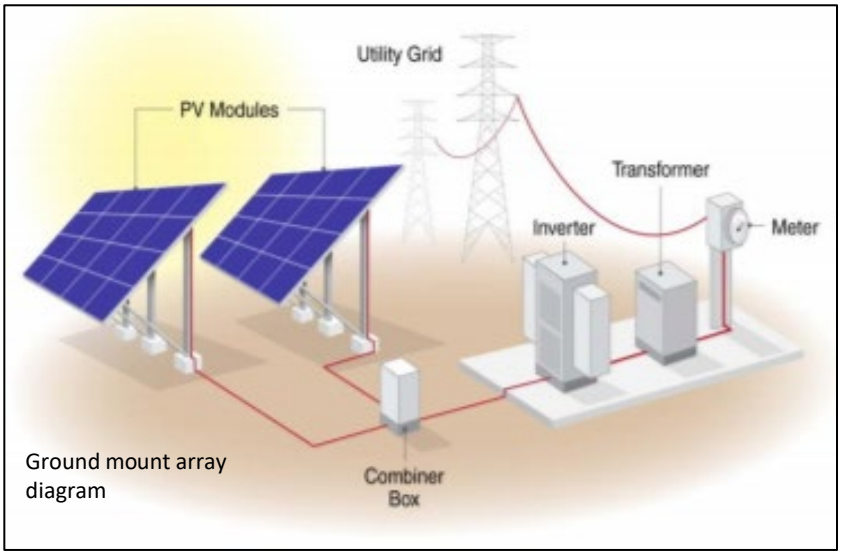
Risks associated with these installations vary depending on the type, size, and location including: extreme weather (wind, hail, lightning, wildfire, floods and tornado), snow loading, fire, panel failure/degradation, electrical faults, breakdown of the racking systems and poor installation practices.

Wind and hail are considered to be the main causes of damage to a solar installation. An inadequate design could cause panels to become dislodged and possibly airborne, which may lead to additional damage.

Poor or improper installation can include broken panels that render the system incapable of reaching peak efficiency or electrical issues that may lead to electrical faults and possibly fires.

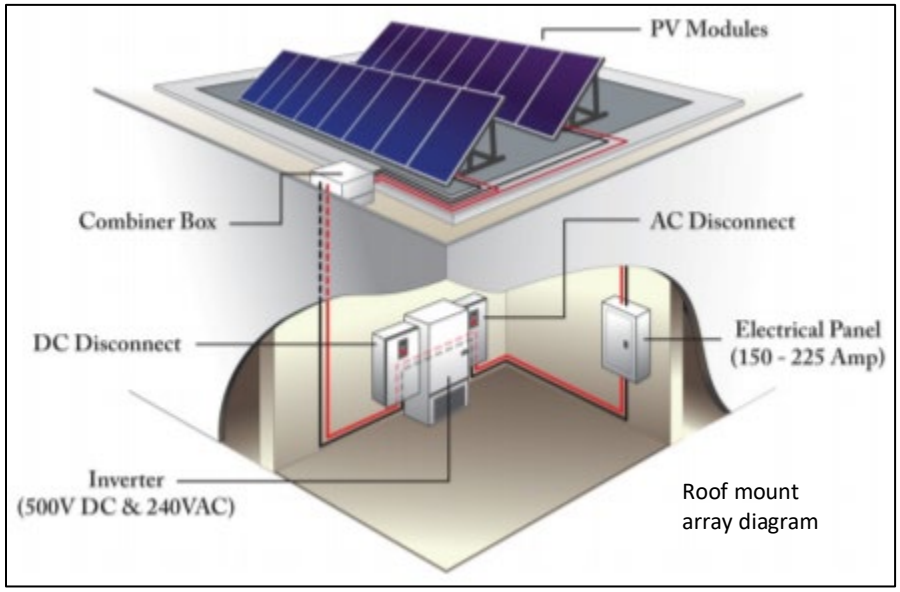
PV Solar Installations

PV solar installations consist of PV modules, inverters, disconnect switches, support structures, tracking systems, cables, and depending on the design, batteries and step-up transformer.



Ground mount array diagram

- PV modules are the most basic piece of equipment of solar systems. The terms solar panel, solar module, PV panel, PV module are often used interchangeably when discussing solar installations. PV cells are a semiconductor that converts solar energy into Direct Current (DC) via the photovoltaic effect. Cells are grouped together to form a PV module. Depending on the design and size of the solar installation the PV modules are linked together to form PV arrays. These can be installed as a free-standing structure or installed on rooftops among other locations.
- Inverters are utilized to convert the PV module output voltage from DC to AC to supply power to the AC loads.
- Disconnect switches are installed to isolate the PV modules from the downstream loads to protect personnel and equipment from electrical faults and during routine maintenance.
- DC cables are used to connect the PV modules to the inverters and AC cables connect the output of the inverters to the downstream loads.
- Support structures are used to hold and properly align the PV modules. These can be free-standing or installed on rooftops. Some structures also utilize tracking systems to provide more efficiency by following the sun throughout the day. These may also provide the ability to position the PV modules into a “storage” configuration in the case of a weather event to limit the damage by wind or hail.



Source for both images: NREL

Controlling the Hazard

Damages caused by wind and hail can be minimized by performing a natural catastrophe review for the geographic location and designing around these hazards. Such designs may include additional supports or ballasts to counteract the expected wind speeds and automatic stowing features that will align the panels in the best configuration in the event of a hailstorm to minimize impacts. Rooftop installations should be secured to the building to withstand expected wind speeds.

There are many solar panel manufacturers worldwide but not all solar panels are equal. Research should be done to determine the quality and design standards that each manufacturer adheres to prior to purchasing.

Improper installation can be easily addressed by utilizing qualified technicians for the installation and performing a thorough inspection prior to placing the system into service. Technicians that are not familiar with solar installations may inadvertently damage panels during installation simply by roughly handling the panels or even walking on them during installation. In some cases, panels may be damaged during delivery.

Electrical connections and wiring are another example of poor design or improper installation. These areas should also be inspected to look for broken connections which could eventually introduce water and cause hot spots which will lead to an electrical fault and possibly fire. Cables routed without proper protection may eventually lead to insulation being worn or cut.

Having an adequate inspection, testing, and maintenance program is crucial to help identify deficiencies that can be corrected before a failure occurs. If internal personnel are not qualified a third-party inspector may be necessary.

Infrared inspections should be performed on a routine basis to look for hot spots on panels, connections, cables, inverters, and all other electrical equipment. These inspections have helped many PV module owners and inspectors identify deficiencies and even broken or degraded panels that are not operating to peak efficiency.

Conclusion

Solar energy generation is a large part of renewable energy. With proper design, correct installation by qualified technicians and a thorough maintenance, testing, and inspection most of these hazards can be mitigated.

Resources / Standards

IEEE 1262 Recommended practice for Qualification of Photovoltaic Modules

IEC 61730-1 & -2 / UL 1703 Photovoltaic (PV) Module Safety Qualification

IEC 61215 Crystalline silicon terrestrial photovoltaic modules – Design qualification and type approval

IEC 61646 Thin-film terrestrial photovoltaic modules – Design qualification and approval

NFPA 70 National Electric Code

*While NFPA documents are the global standard used by AIG, international equivalents may be acceptable.

For more information, contact your local AIG Risk Engineer.