

PV Rooftop Safety

Top 10 Safety Concerns



**What if one of your biggest
safety risks wasn't IN your
business...but on TOP of it?**

Rooftop Solar's Unspoken Truth: Fires and Safety Risks Are Uncomfortably Common

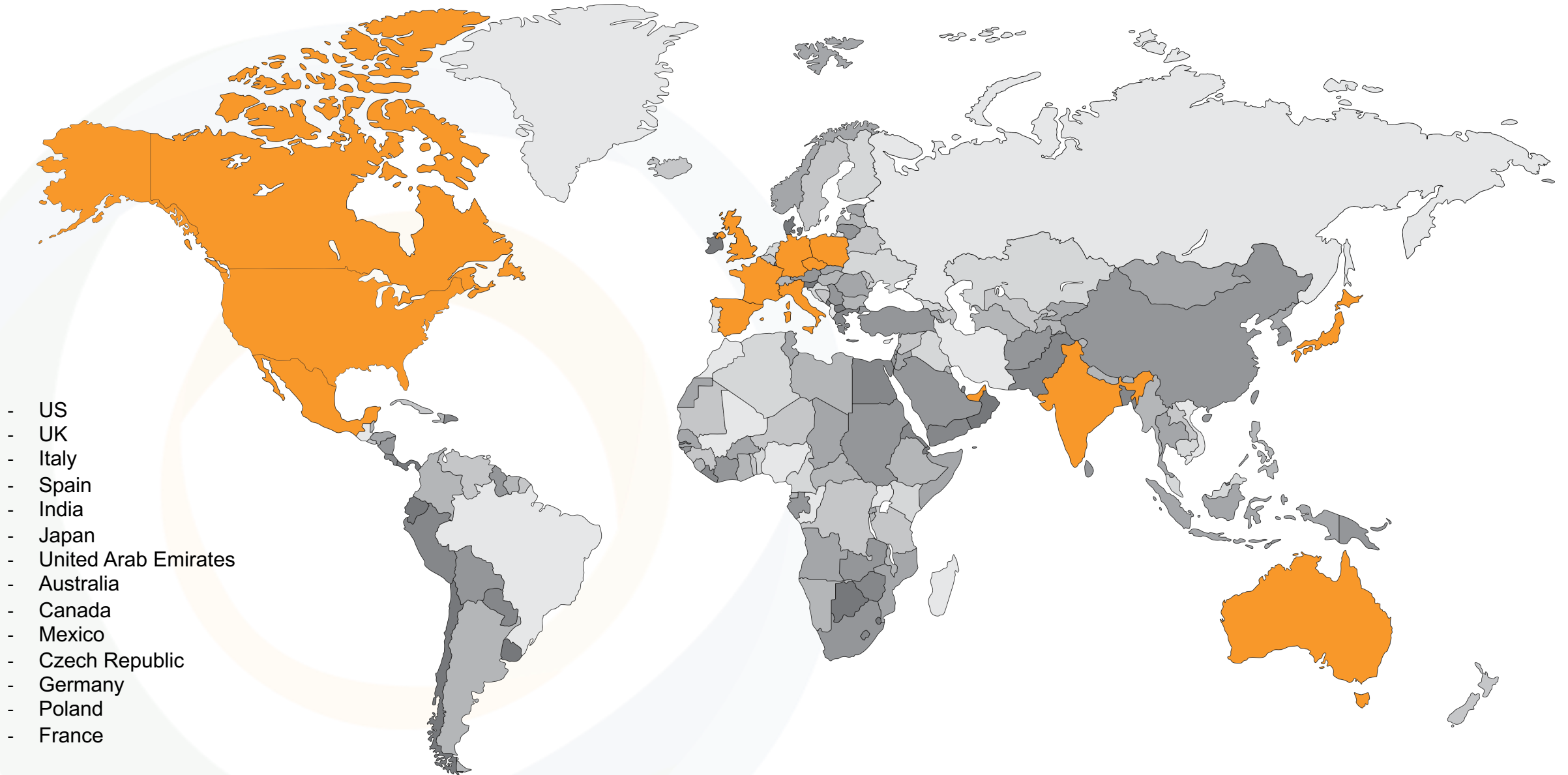
600

CEA has performed over 600 rooftop PV safety audits

97%

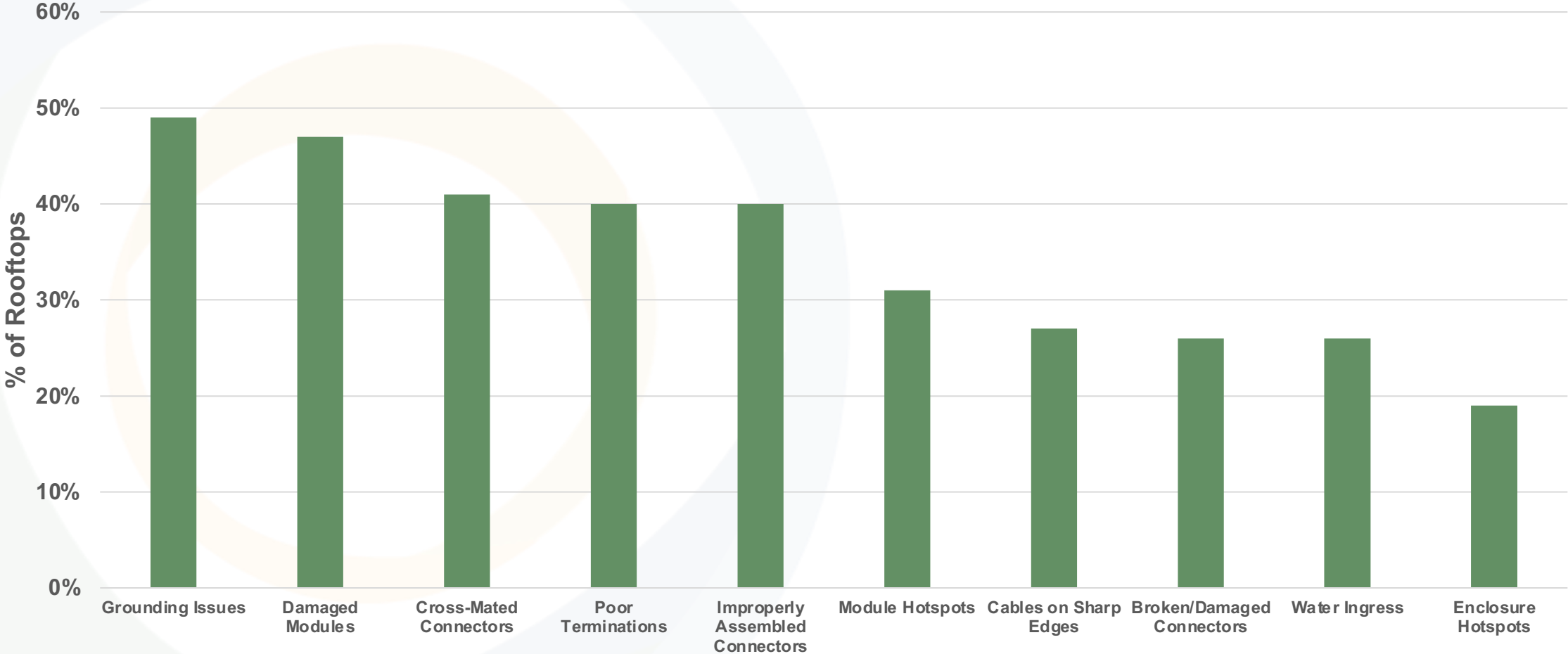
97% of audited systems had major safety concerns

Locations of performed rooftop safety inspections



Following Over 600 Detailed Safety Audits, CEA Identified the Most Common Safety Problems

Top Ten PV Safety Concerns
based on safety audits performed by CEA



49% Of Sites Have **GROUNDING ISSUES**

Why/How Does It Happen

- 1) Some designs are simply incorrect
- 2) In other instances, the installation crew does not follow the installation plan
- 3) Additionally, the installation quality control personnel can overlook grounding issues
- 4) Ultimately, moisture/water intrusion results in problems with grounding

Impact

- 1) Hazardous equipment current leakage
- 2) Increased maintenance and system down time from inverter faults
- 3) Safety risk for onsite personnel

Examples

The prevalence of different module frame, racking, and inverter grounding designs complicates this issue and makes it easier for problems to get missed during design or installation. CEA typically finds grounding problems in the following areas:

- At the inverter or equipment pad

Between PV array blocks and module rows, where short conduit runs are needed

On extended conduits runs, which require additional grounding straps

47% Of Sites Have **DAMAGED MODULES**

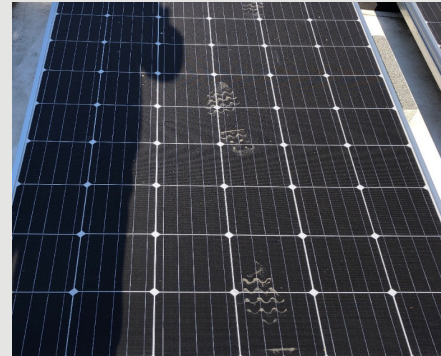
Why/How Does It Happen

- 1) Incorrect installation or cleaning methods, including walking on modules
- 2) Extreme weather like hail or wind
- 3) Electrical short circuits in the module, leading to thermal events
- 4) Heavy soiling or grease on the modules affecting performance

Impact

- 1) Microcracking and soiling causing module underperformance
- 2) Electrical fault
- 3) Shock hazard
- 4) Fire safety risk

Examples



41% Of Sites Have CROSS-MATED CONNECTORS

Why/How Does It Happen

- 1) Incorrect understanding of UL listed connector pairings
- 2) Incorrect installation techniques
- 3) Undertrained installation technicians
- 4) Improper field made connectors which don't match the module connector

Impact

- 1) Water intrusion and corrosion
- 2) Arcing in connector housing, potentially leading to a fire

Examples



40% Of Sites Have POOR TERMINATIONS

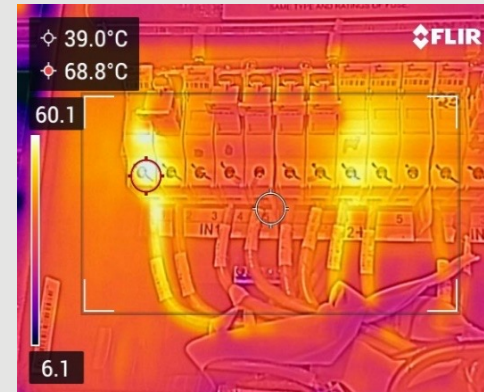
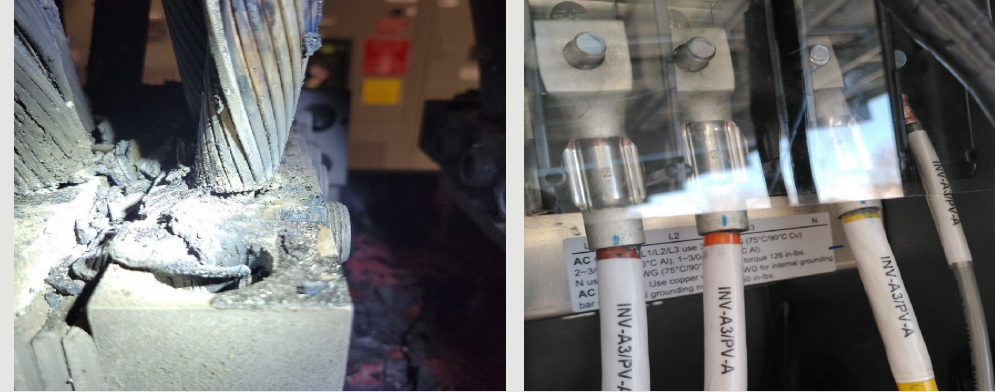
Why/How Does It Happen

- 1) Untrained or inattentive technicians using improper installation techniques (i.e. wrong crimp, wrong die, poor wire stripping and/or trimming)
- 2) Faulty terminal block or faulty workmanship that results in faulty equipment

Impact

- 1) Potential for terminations to arc to one another or to arc to wire clippings within the inverter housing
- 2) Increased heat at the terminal causing safety and longevity concerns

Examples



40% Of Sites Have IMPROPERLY ASSEMBLED CONNECTORS

Why/How Does It Happen

- 1) Untrained workforce and/or improper or nonexistent installation standards can lead to a wide variety of problems, including improper wire trimming, improper crimping, wrong gland size, improper torque on connector backnut, obstruction such as electrical tape preventing a watertight seal, etc.
- 2) Impossible to identify during visual inspection. Diagnosis requires thermal imaging or destructive testing.

Impact

- 1) Extreme thermal signatures cause safety and reliability issues
- 2) Potential melting causes increased concern for a thermal event

Examples



31% Of Sites Have **MODULE HOTSPOTS**

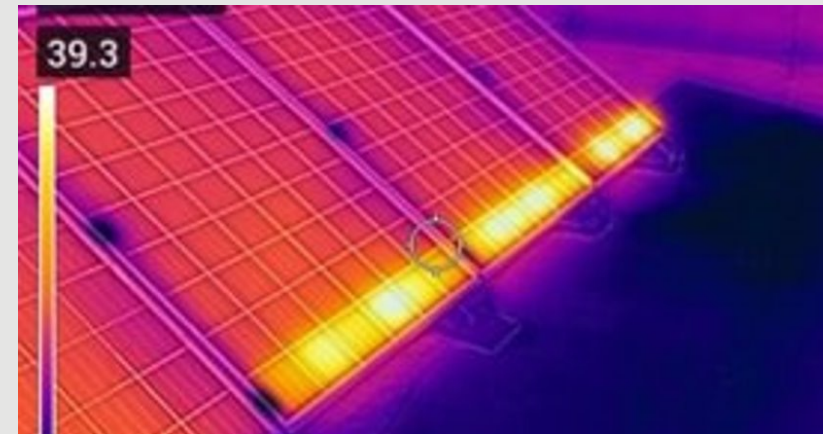
Why/How Does It Happen

- 1) Module shading, which can lead to diode failure
- 2) Module soiling for an extended period, which can cause a cell hotspot
- 3) Manufacturing defects
- 4) Module damage during shipping/installation

Impact

- 1) Voltage mismatch between modules, causing string underperformance
- 2) Hot spots that get so hot they can ignite nearby organic material
- 3) Potential for backsheet melting, increasing the potential for arcing

Examples



27% Of Sites Have **CABLES ON SHARP EDGES**

Why/How Does It Happen

- 1) Inexperienced or undertrained technicians incorrectly install cables resting on sharp edges.
- 2) Through thermal expansion/contraction from changing temperatures and seasons the sharp edge slowly cuts through the cable insulation.

Impact

- 1) Once the conductor is exposed a short circuit can develop, often leading to an electrical fire.
- 2) Depending on several factors, the short circuit may not be immediately interrupted, potentially allowing the fire to spread to other components.

Examples



26% Of Sites Have **BROKEN/DAMAGED CONNECTORS**

Why/How Does It Happen

- 1) Untrained workforce
- 2) Improper or nonexistent installation standards, which can lead to improper wire trimming, improper crimping, wrong gland size, etc
- 3) Prolonged weather exposure (sunlight, water, etc.)

Impact

- 1) Corrosion of connector pins which leads to performance and reliability risks
- 2) Electrical faults from water pooling
- 3) Conductors may become exposed over time, leading to short circuit and fire risk

Examples



26% Of Sites Have WATER INGRESS

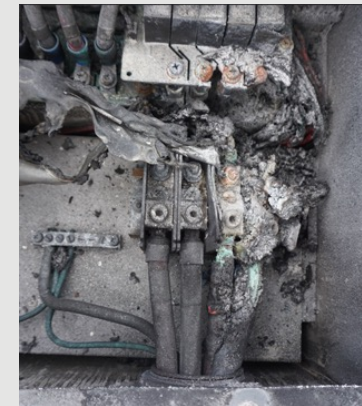
Why/How Does It Happen

- 1) Improperly installed equipment covers may not properly prevent water intrusion.
- 2) Missing or damaged conduit seals allow water to enter enclosures.
- 3) Missing weep holes do not allow intruded water to exit enclosures.

Impact

- 1) Electrical failures and potential thermal events caused by compromised component protection or the creation of unintended electrical paths

Examples



19% Of Sites Have ENCLOSURE HOTSPOTS

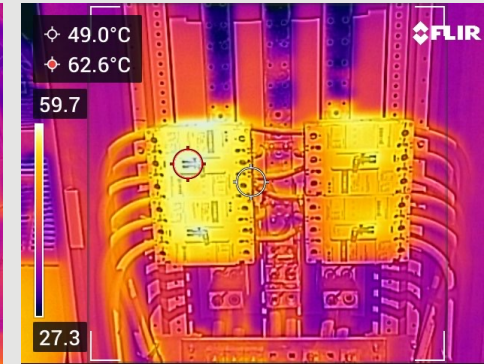
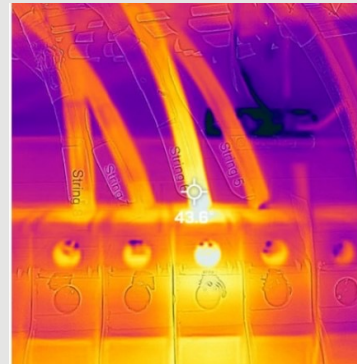
Why/How Does It Happen

- 1) Improper or nonexistent installation standards
- 2) Improperly installed conductor terminations
- 3) Overcurrent or other unsafe system operations
- 4) Faulty fuses

Impact

- 1) Potential for thermal events
- 2) Degradation of production quality
- 3) Increased heat at the terminal causing safety and longevity concerns
- 4) Increased risk for component breakdown and electrical failure

Examples



Need Help?

CEA is uniquely capable of **identifying** your fire risk and **advising a remediation** strategy.



Focus on most critical and common risks



Identify and mitigate risks across your system



Collaborate with supply chain partners

Act today to identify these systemic risks to stop fires from happening in the first place



For more information

info@cea3.com

<https://www.cea3.com/commercial-rooftop-solar-safety>

The information herein has been prepared by Clean Energy Associates, LLC (“CEA”) solely on a confidential basis and for the exclusive use of recipient, and should not be copied or otherwise distributed, in whole or in part, to any other person without the prior written consent of CEA. No representation, warranty or undertaking, express or implied, is made as to, and no reliance should be placed on, the fairness, accuracy, completeness or correctness of the information or the opinions contained herein. The information herein is under no circumstances intended to be construed as legal, business, investment or tax advice. Neither CEA or any of its affiliates, advisors or representatives will be liable (in negligence or otherwise), directly or indirectly, for any loss howsoever arising from or caused by the understanding and/or any use of this document.