

SOLARGRADE
BY HELIOVOLTA

THE SOLARGRADE PV HEALTH REPORT

FIRST EDITION

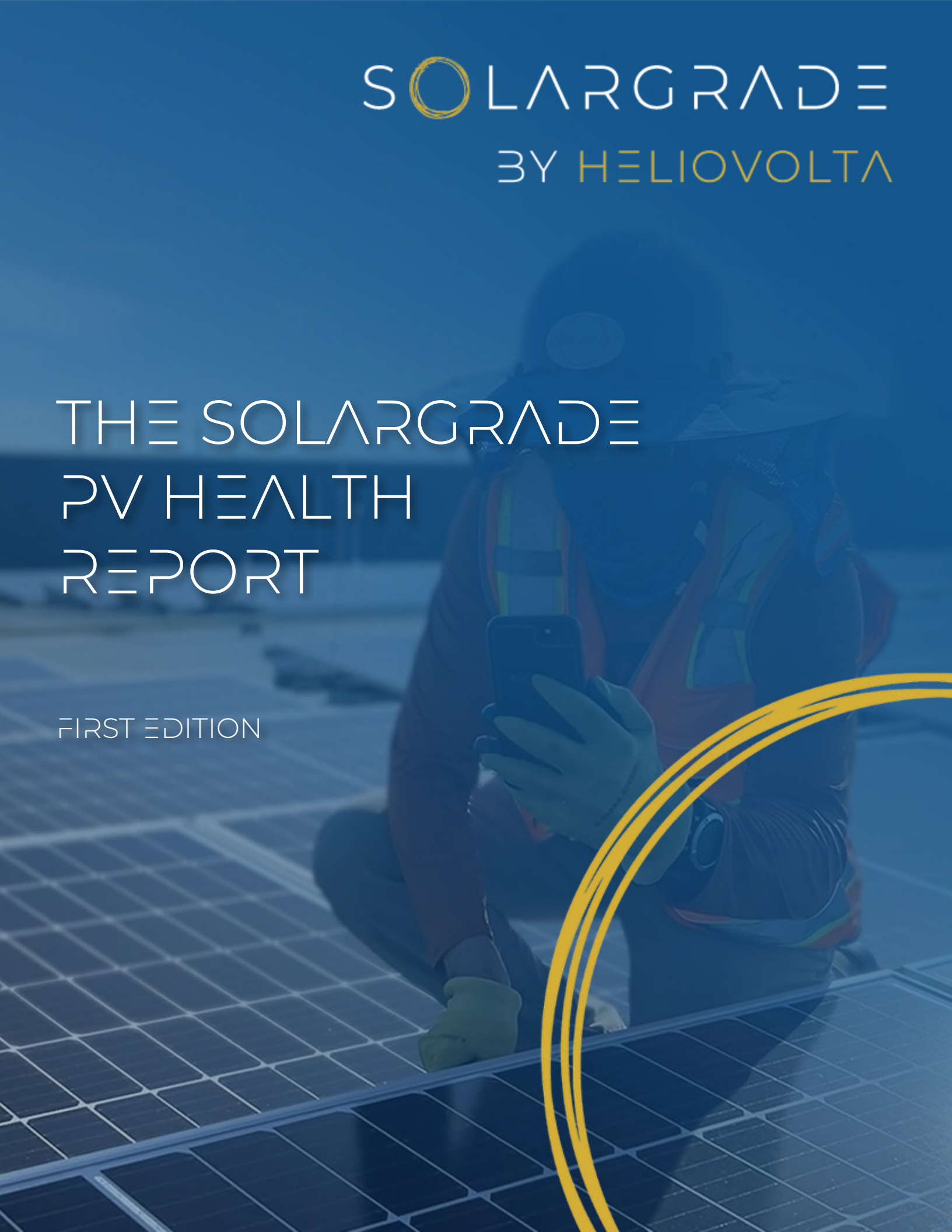


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INTRODUCTION

The HelioVolta team has assessed the health of hundreds of distributed generation (DG) PV systems as an independent provider of third-party inspection and quality control services. Our clients span Fortune 50 companies, asset owner-operators, investment firms, and insurers.

Our collective field experience demonstrates that solar asset safety and underperformance events are almost always caused by workmanship errors, poor O&M, and equipment flaws that go unaddressed and escalate into serious failures. Renewable energy assets are fundamentally safe and reliable, but only when they are installed correctly and properly maintained.

We are sharing the findings from our PV system health assessments in this white paper, our first **SolarGrade PV Health Report**. It represents the first comprehensive report on solar PV safety and reliability that leverages from-the-ground-up field data that is only available via on-site visual and thermal inspections.

As the global solar market prepares for a new phase of unprecedented growth, we urge the broader industry to uphold high standards for EPC and O&M fieldwork because they are critical for PV system safety and reliability.

With that in mind, our inaugural **SolarGrade PV Health Report** aims to answer two fundamental questions:

1. **What are the most common issues in DG solar assets?**
2. **How can DG project stakeholders avoid issues and ensure that solar assets operate reliably over time?**

We hope the data in this report drives the deployment of safe and reliable solar assets in the U.S. and around the world.



David Penalva and James Nagel
Co-founders of HelioVolta and SolarGrade

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METHODOLOGY

The image features a hand wearing a green work glove holding a black smartphone. The hand is positioned over a grid of solar panels, which are visible in the background. The entire scene is overlaid with a semi-transparent blue filter. A yellow graphic element, consisting of three curved lines forming a partial circle, is located in the bottom right corner. The text 'SOLARGRADE BY HELIOVOLTA' is at the top, and 'METHODOLOGY' is centered over the hand and phone.

FIELDWORK WITH SOLARGRADE

Inspections analyzed for this report were conducted and documented with **SolarGrade**, HelioVolta's cloud-based fieldwork management platform.



A Standardized Field Inspection Dataset

- The SolarGrade platform standardizes fieldwork processes for accuracy and consistency across different teams and workers.
- All issues documented in SolarGrade are categorized in the same way with the same criteria, so issue volumes and severity are comparable from project to project.
- Automated reporting within SolarGrade streamlines large-scale analyses of field inspection data.

Assessing PV Health with Over 60,000 Data Points

This report analyzes more than 60,000 data points and insights from hundreds of HelioVolta's PV system health assessments at DG solar projects in the U.S. and Puerto Rico:

- 73% of the projects are located on commercial rooftops, 25% are ground-mounted, and 2% are carports.
- Projects ranged in size from 100 kW to 350 MW, with a mean of 90 MW and a median of 500 kW.


DEFINING PV SYSTEM ISSUES

The issues analyzed in this report were documented and segmented into four levels of severity within SolarGrade.

1. Negligible

Issue does not present a risk to personnel or site safety and may be corrected during scheduled O&M.




 *PV module delamination and snailtrails are negligible: they are unlikely to create near-term safety issues when hotspots are not present.*

2. Minor

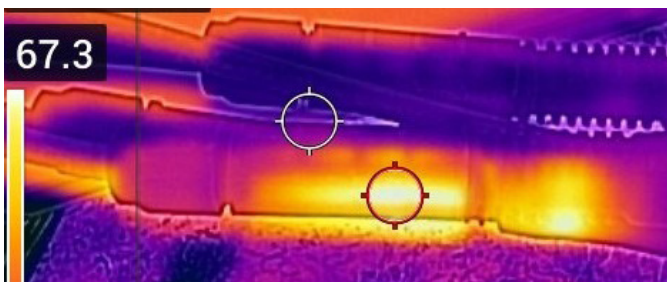
Issue does not present an immediate risk to personnel or site safety and should be corrected during scheduled O&M visits.




 *The bend radius on this connector's leads is too high. This is a minor issue: it can cause damage over time but does not present an immediate risk.*

3. Major

Issue presents an immediate risk to personnel or site safety and must be corrected as soon as possible.




 *Overheating connectors are major issues at minimum because they can cause fires. Severe overheating is categorized as a critical issue.*

4. Critical

Issue presents an urgent risk to personnel or site safety. The system must be de-energized and corrective action is immediately required.



 *Melted equipment and signs of thermal events are critical issues: a severe failure has occurred in this module and others in the array may be vulnerable.*

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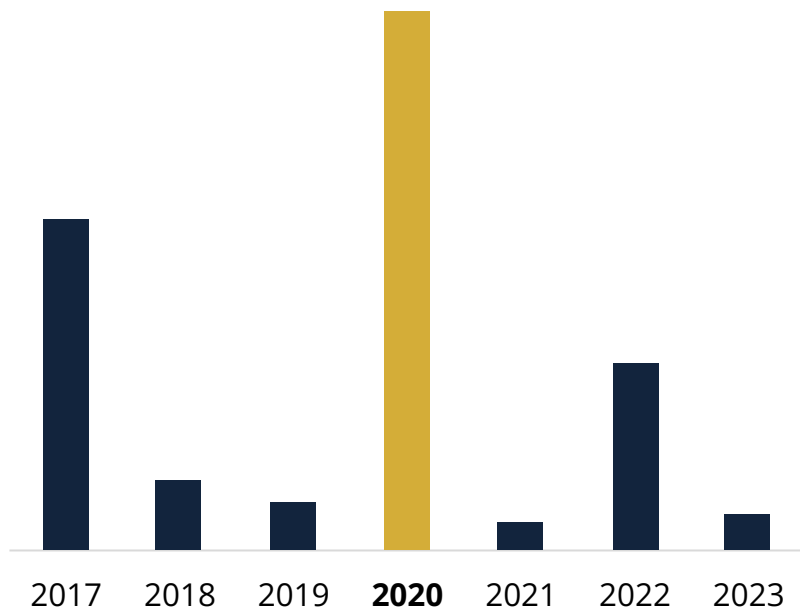
FINDINGS



2020 WAS A DIFFICULT YEAR

Systems commissioned in the year **2020** have the **most issues** across our dataset.

ISSUE VOLUME BY YEAR OF SYSTEM COMMISSIONING



2020 was marked by pandemic lockdowns and profound disruptions in the PV module and balance-of-systems supply chains.

Workers were likely rushed to commence construction: the Investment Tax Credit (ITC) was scheduled to step down at the end of 2020. It was ultimately extended in December 2020.

Data was normalized to account for variability in the number of inspections conducted by year commissioned.

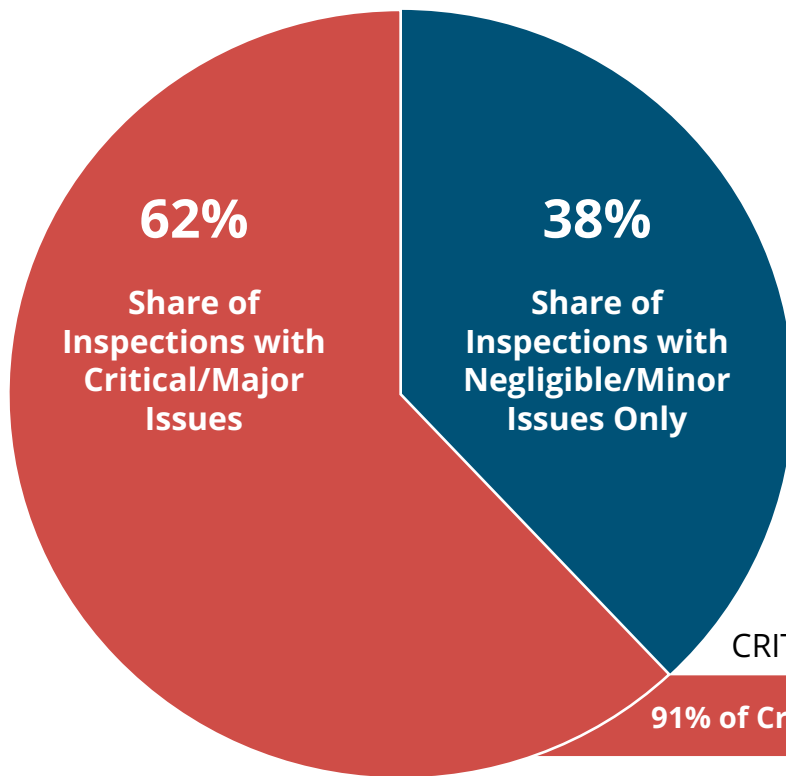
WHAT YOU SHOULD KNOW

Work quality decreases when workers are stressed or rushed. Installation issues also increase when specified equipment is unavailable.

SAFETY RISKS ARE COMMON

62% of inspections found **safety issues** that require urgent correction.

SHARE OF ISSUES BY SEVERITY



Every inspection identified at least one issue, and a majority of inspections uncovered critical and/or major issues that present immediate risks to the project site and personnel. 91% of all critical/major issues are located in the DC distribution section of the system.

The remaining critical/major issues relate to PV modules, inverters and overall site condition.

CRITICAL/MAJOR ISSUES BY PV SYSTEM SECTION

91% of Critical/Major Issues are in DC Distribution

PV Modules: 5%
Inverters: 3%
Site Condition: 1%

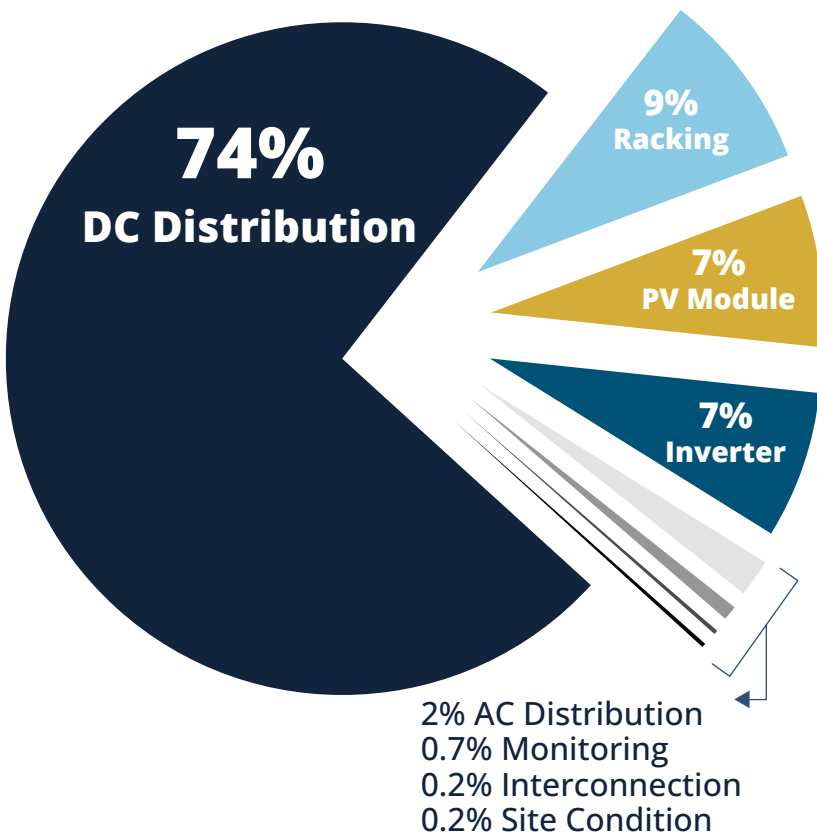
WHAT YOU SHOULD KNOW

Issues can be fixed before they become hazardous. Periodic inspections and proactive O&M — especially in the DC distribution section of PV systems — are critical to safe and reliable operations.

DC DISTRIBUTION HAS THE MOST ISSUES

74% of all issues were located in the **DC Distribution** section of PV systems.

SHARE OF ISSUES BY PV SYSTEM SECTION



Inverters often appear to cause PV system problems: they are usually the primary source of energy yield data and error messages when PV systems trip and shut down.

Yet, on-the-ground data reveals that inverters are rarely the root cause of downtime. In most cases, inverters trip because they detect underlying issues located within the DC Distribution section.

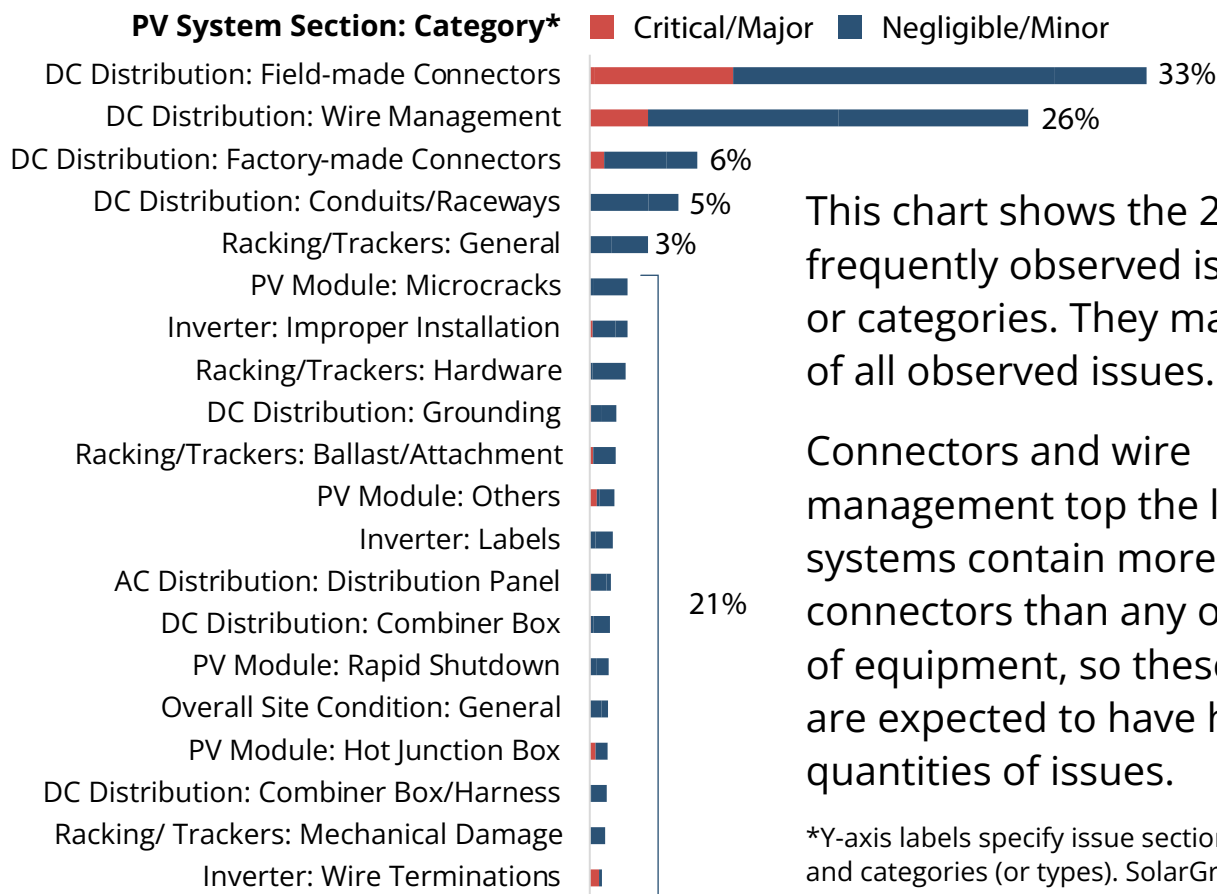
WHAT YOU SHOULD KNOW

DC Distribution issues are more likely to present safety risks than issues in any other section of the system.

DRILLING DOWN ON THE ISSUES

59% of all issues are related to **field-made connectors and wire management** in DC Distribution.

TOP 20 MOST COMMON ISSUE TYPES BY VOLUME AND SEVERITY



This chart shows the 20 most frequently observed issue types, or categories. They make up 94% of all observed issues.

Connectors and wire management top the list. PV systems contain more wires and connectors than any other piece of equipment, so these categories are expected to have higher quantities of issues.

*Y-axis labels specify issue sections (or locations) and categories (or types). SolarGrade's automated interactive and PDF reports use this structure.

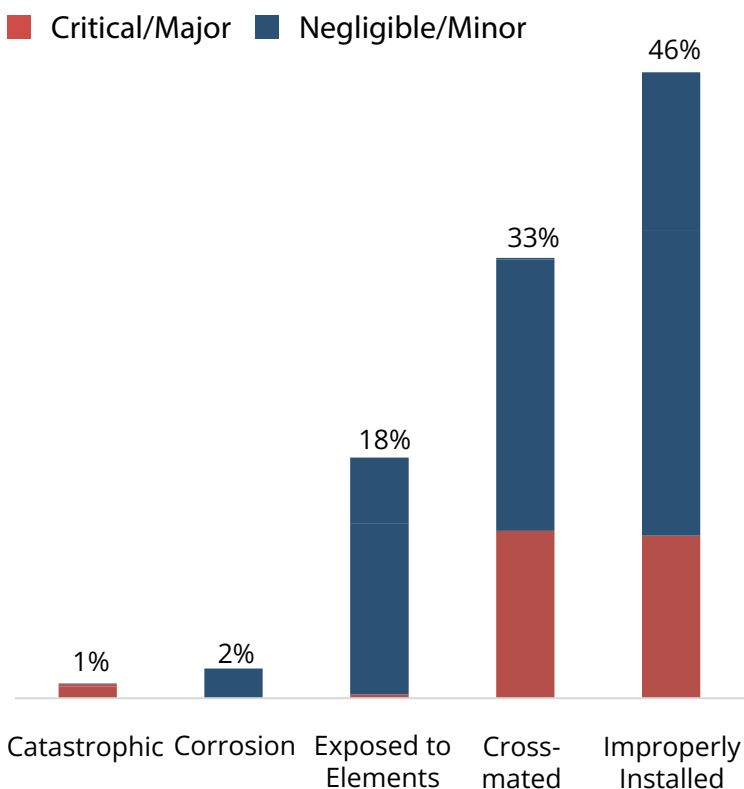
WHAT YOU SHOULD KNOW

The most frequently observed issues are related to field-made connectors and wire management. Installer error is typically the root cause for these categories of issue — not defective equipment.

CHALLENGES WITH FIELD-MADE CONNECTORS

79% of all field-made connector issues are caused by either **improper installation or cross-mating** of incompatible parts.

FIELD-MADE CONNECTOR ISSUES BY VOLUME



Field-made connectors are the most issue-prone components of PV systems. Identifying and remediating compromised field-made connectors is critical to safety: they can trigger PV system fires by overheating and by creating arc and ground fault conditions.

Improving connector installation training and inspection protocols is the best way to prevent safety events at DG solar projects.

Learn more in our [Ultimate Safety Guide for Solar Connectors >>](#)

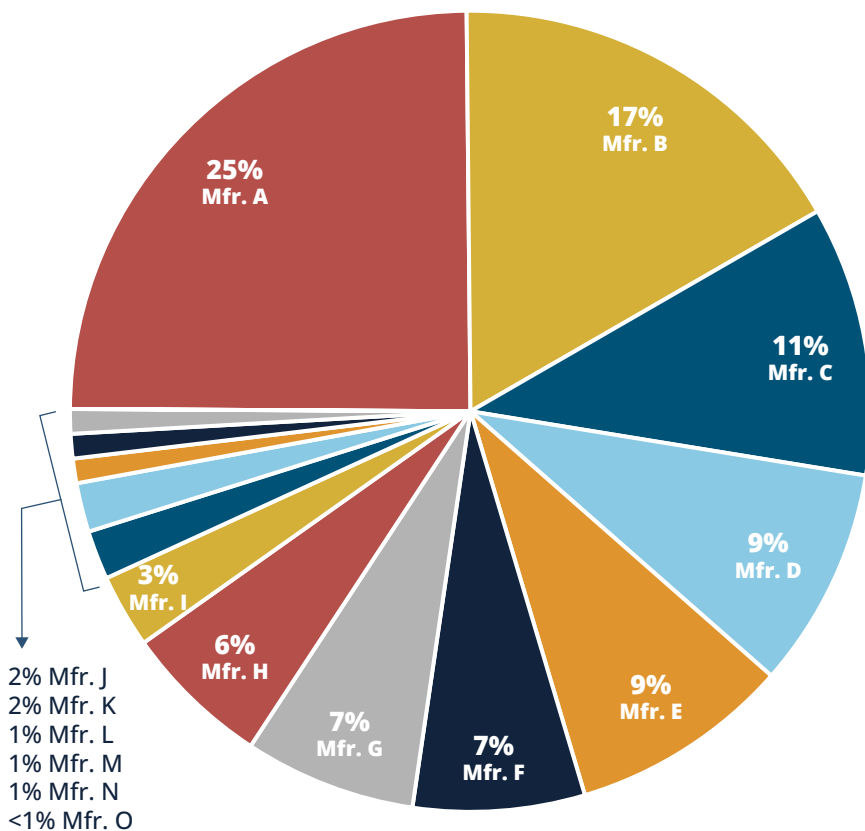
WHAT YOU SHOULD KNOW

Connector installation is a precise process that varies by manufacturer, and regulations have been slow to adapt to technical advances. Improper installation is a serious issue: it can result in overheating and trigger PV system fires.

INVERTER BRAND MATTERS

25% of all inverter issues came from **one manufacturer.**

SHARE OF INVERTER ISSUES BY MANUFACTURER



The number of inverter issues varied by manufacturer. Only three brands generated over half of all inverter issues. A total of 15 manufacturers were analyzed, and the data was weighted.

Weighting the data prioritizes major/critical issues that affect site safety (i.e., overheating), while de-emphasizing minor/negligible issues (i.e., improper labeling).

Analysis of the raw, unweighted data is more stark: Mfr. A generated 37% of all issues.

Data was normalized by number of inspections per manufacturer and weighted by issue severity as follows: 10x for critical, 5x for major 3x for minor and 1x for negligible.

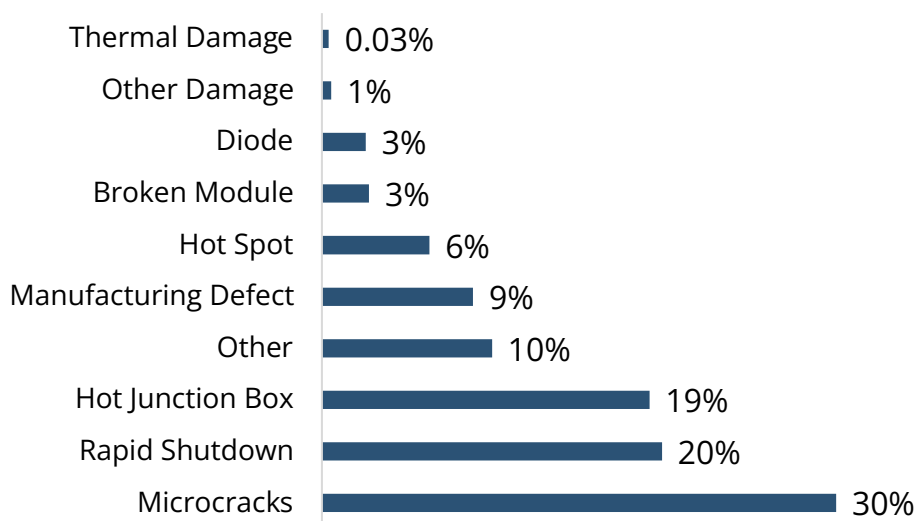
WHAT YOU SHOULD KNOW

Some inverter manufacturers are more vulnerable to issues than others. Potential root causes are complex installation processes, poor manufacturing QA/QC, and upstream supply chain challenges.

TOP ISSUES IN PV MODULES

Microcracks and **rapid shutdown devices** (RSDs) are the most common PV module issue categories.

PV MODULE ISSUE CATEGORIES BY VOLUME



Microcracks, or cell-level cracks and damage in PV modules, are the dominant issue category for PV modules. They restrict the flow of current, thus reducing energy yield and potentially creating hotspots over time. The microcracks observed by HelioVolta are so severe that they are visible in plain sight without EL imaging.

While RSDs are separate devices, they are included here because they are attached to PV modules and inspected at the same time. RSDs are a relatively new component in PV systems and developed in response to National Electric Code requirements. RSDs increase the number of connections in PV systems, thus creating more potential failure points.

Learn more about RSD issues in the field in the [SolarGrade Blog >>](#)

WHAT YOU SHOULD KNOW

Microcracks and rapid shutdown devices are the most common issue types in the PV module section of PV systems. Both issue types can create safety incidents over time.

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NEXT STEPS



ACHIEVING PV SYSTEM HEALTH

The first **SolarGrade PV Health Report** demonstrates that solar project stakeholders should take action to ensure their assets are operating safely and reliably: severe and critical issues that present risks to personnel and site safety are common. Taking action to identify and correct issues in the field is vital, especially as installed solar capacity expands.

The HelioVolta team recommends the following best practices:

- 1. Require Robust Installer Training**
DC distribution issues related to connectors and wire management are the most common problems at project sites. With better training protocols, the vast majority of these issues could be avoided.
- 2. Conduct QA/QC Inspections at Commissioning**
Assessing EPC workmanship through QA/QC inspections early in a project's lifecycle helps ensure that latent issues are corrected before catastrophic failures occur.
- 3. Require Inspections During O&M Visits 2x/Year**
Periodically walking project sites to assess PV system health ensures that signs of latent component failure and accelerated degradation are identified early.
- 4. Standardize Inspection Processes**
Make sure inspectors know what to look for in PV system health assessments by providing standardized, accessible, and easy-to-use guidelines. The SolarGrade platform comes with pre-written templates and issue descriptions.
- 5. Track Issue Resolution**
Do not allow issues to get lost in the shuffle of PDF reports, spreadsheets, and clunky manual checklists. The SolarGrade platform allows field technicians to quickly find problems on the ground, and asset managers can dynamically track issue resolution in the cloud

ABOUT SOLARGRADE

SolarGrade is a cloud-based software platform that empowers field teams to build, operate, and manage the world's safest, most reliable, and high-performing solar and energy storage assets.

It features: **pre-built, customizable workflows** that standardize on-site processes and procedures so that field teams can quickly identify problems; **pre-written issue descriptions** that improve field documentation and enable accurate, **automated reporting**; and **geo-referenced issue-tracking** that reduces time-on-site for future service calls.



LEARN MORE

SolarGrade is the only software that revolutionizes renewable energy fieldwork so that today's green infrastructure can reliably meet the energy needs of the future.

SOLARFAX AND SOLARTWIN



SolarFax and **SolarTwin** are new products within the SolarGrade platform. SolarFax is an analytics tool that pairs system-level energy yield and performance data with SolarGrade health assessments. SolarFax reports provide a complete view of PV system health, safety, performance, and reliability. SolarTwin utilizes data from SolarFax to generate digital representations of physical PV assets.

ABOUT HELIOVOLTA



HelioVolta is a trusted provider of independent inspection and technical field services for renewable energy projects and energy storage systems. We specialize in assessing the health and quality of solar and energy storage installations from system construction through long-term operations. [Click here](#) to learn more about our services.

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