FIRETRACE™ International

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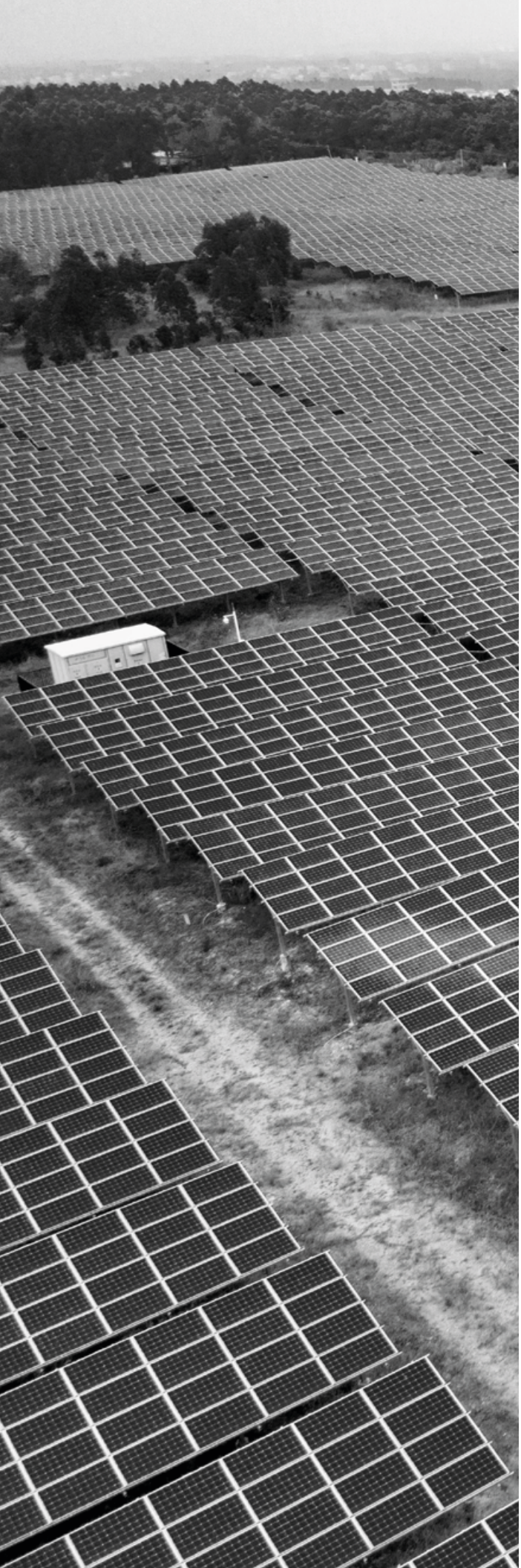
HIDDEN DANGER

Why solar farm fire risk could be greater than you think



Summary

The solar industry is potentially underestimating the risk of fire at solar farms.

Why? It's partly because there is a shortage of data on solar farm fires, and partly because research into the issue has given rise to suspicions that fires at solar farms have been under-reported.

This report will look at the solar fire data that is available and analyse what conclusions can be drawn from that data.

In addition, the report will look at:

- The factors that make a fire at a solar farm more likely
- The possible root causes of solar-related fires, and
- The PV components most likely to cause solar farm fires

Finally, the report will also explore what steps you can take to reduce the risk of solar farm fires.

What is certain is that solar farm fire risk is an issue that the solar industry needs to take more seriously. This is particularly the case when you consider how rapidly the global solar industry is expanding.

Data from the International Energy Agency (IEA) – which was published in the IEA Photovoltaic Power Systems Programme's 'Snapshot of Global PV Markets 2022' report – showed that the world's total cumulative installed PV capacity increased 23% in 2021 to 942GW.[1]

With the number of solar installations growing fast – amid concerns that instances of solar fires are being under-reported – now is the time for action to be taken to minimize solar farm fire risk.

1 https://iea-pvps.org/snapshot-reports/snapshot-2022/

How significant is solar fire risk?

There is a severe lack of data on the prevalence of solar farm fires.

Indeed, some studies have concluded that there is a high likelihood that instances of solar farm fires are under-reported.

A study by the UK's BRE National Solar Centre – which was entitled 'Fire and Solar PV Systems – Investigations and Evidence' and detailed an investigatigation into a total of 80 potential PV-related fire incidents – led to the finding that researchers "strongly suspect a degree of under-reporting, especially amongst solar farms and domestic thermal events that were resolved by a solar installer/ maintenance engineer."[2]

With regard to the data that is actually available, the US Department of Energy's Solar Energy Technologies Office has cited a study conducted by European testing and certification company TÜV Rheinland – entitled 'Assessing Fire Risks in Photovoltaic Systems and Developing Safety Concepts for Risk Minimization' – which found that, in approximately half of 430 cases of fire or heat damage in PV systems, the PV system itself was considered the "cause or probable cause."[3]

Meanwhile, the study carried out by the BRE National Solar Centre found that more than a quarter of fires involving solar systems were caused by the photovoltaics and those fires were all "serious fires", meaning fires that were "difficult to extinguish and spread beyond the area of origin."

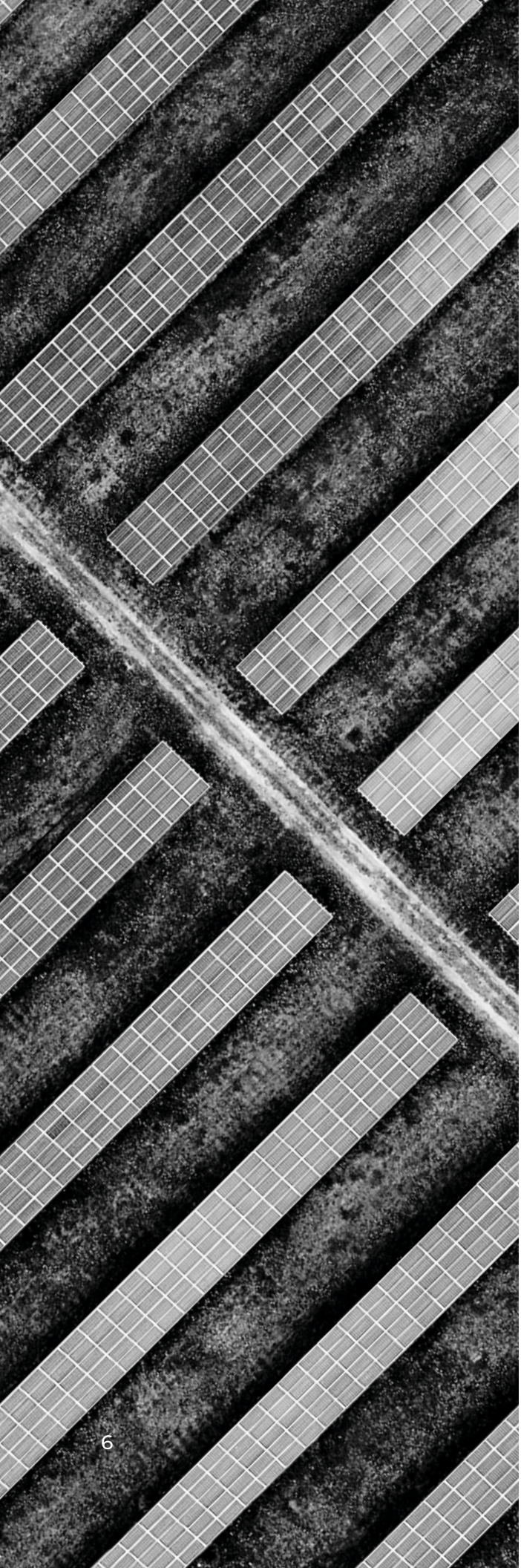
2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/786882/Fires_and_solar_PV_systems-Investigations_Evidence_Issue_2.9.pdf

3 https://www.energy.gov/sites/default/files/2018/10/f56/PV%20Fire%20Safety%20Fire%20Guideline_Translation_V04%2020180614_FINAL.pdf

However, as already indicated, the BRE National Solar Centre study did emphasize that the full extent of solar fire risk may have been concealed. Specifically, it highlighted how, in one instance during the course of the study, researchers were “denied access to one site by the insurance company’s loss adjuster.”

As a result, we cannot rule out the possibility that solar farm fire risk, and occurrences of solar farm fires, may be more prevalent than the available data suggests.

There is a high likelihood that instances of solar farm fires are under-reported.



What statistics are available?

Despite the challenges in obtaining data that provides a comprehensive picture of the extent of solar fires and the prevalence of solar fire risks, there are a number of studies that have attempted to gain an insight into the issue.

For example, one data set released by the US Fire Administration (USFA) found that instances of solar system fires more than doubled during the period 2015 to 2018.

The USFA reportedly does not track fires from solar installations, instead filing them under the 'other' category for causes. In the aforementioned instance, the USFA data was only made available following a specific request from an executive at a solar maintenance company.

The USFA data that was obtained showed that there were 56 solar system fires recorded in 2018, up from 25 in 2015.[4] A third of the fires that were recorded by USFA during the period 2015 to 2018 occurred in California, Arizona and Nevada.

However, while the number of fires recorded by the USFA more than doubled between 2015 and 2018, the number of solar installations in the US increased at a similar rate during the same period – from less than 30,000MWdc to more than 60,000MWdc, according to Solar Energy Industries Association research data – which suggests solar fire risk may not actually be increasing.[5]

Yet, in contrast, data from Australia indicates that the opposite is true – that is, solar fire risk is, in fact, increasing exponentially.

Statistics from the Australian PV Institute show that PV installations in the country increased from around 7.3GW in January 2018 to more than 20.7GW in December 2020.[6] However, while the increase in PV installations in Australia during the period was less than three-fold, data from Fire and Rescue New South Wales (NSW) showed that there was a six-fold increase in the number of solar fires attended by firefighters in the period 2018 to 2020, according to reports.[7] In 2020, Fire and Rescue (NSW) attended 139 solar fires, compared to 22 in 2018.

4 https://onedrive.live.com/?authkey=%21ADZAYZw3zBKJ%5F1k&id=C8BE25A716873030%216383&cid=C8BE25A716873030

5 https://www.seia.org/solar-industry-research-data

6 https://pv-map.apvi.org.au/analyses

7 https://www.smh.com.au/national/nsw/the-irony-s-not-lost-on-me-solar-panel-safety-device-led-to-500-per-cent-rise-in-rooftop-fires-20210129-p56xtp.html

What are the risk factors?

There are three possible root causes for solar farm fires, according to the BRE National Solar Study Report.

They are:

- an error in the system design
- a faulty product (a design or quality issue)
- poor installation practice

The report said DC isolators were found to present the greatest fire risk. Around 30 percent of the incidents recorded in the study were caused by DC isolator malfunctions.

A number of the incidents in question involved ingress of water into DC isolators, all with upward-facing cable glands, the BRE study said. The study also concluded that there was evidence of fires originating within DC isolators with "poor contact design" – that is, originally being designed for AC operation and being re-designated as DC-rated by the manufacturer – and with incorrect internal wiring.

The BRE report said there were three separate issues with DC isolators:

1. **Poorly designed or constructed products**
   Models originally designed for AC are "unlikely to be reliable over the life of a PV system."

2. **Incorrectly specified DC isolators**
   Isolators that are underrated for the current or voltage of the PV strings connected, for example.

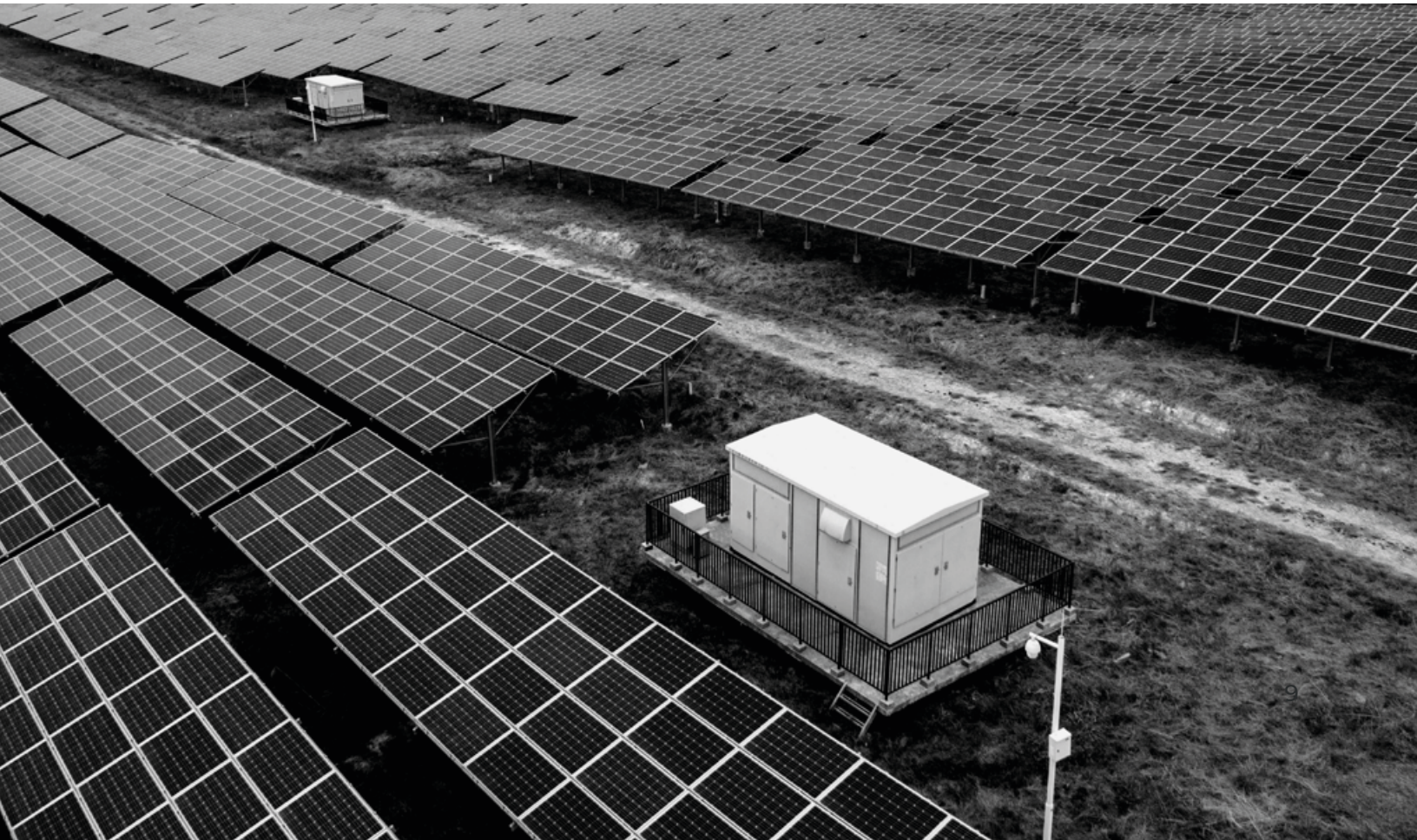
3. **Poor installation practice**
   The BRE report said this category accounted for the "majority of DC isolator failures leading to fires or thermal events." Poor installation frequently caused ingress of water into the isolator casing causing arcing.

Meanwhile, DC connectors are the second most likely PV component to cause a fire.

DC circuits connect the PV modules together, increasing the voltage in a similar way to connecting batteries in series. Parallel strings of PV modules increase the current. The DC circuits are fed back to the inverter, sometimes via a DC isolator.

The metal contacts of DC connectors tend to remain connected by frictional forces, even when the supporting plastic body has been burnt off, the BRE report said. Therefore, any DC connectors that have been subject to arcing should be suspected as a likely source of ignition.

DC isolators were found to present the greatest fire risk.



Inverters: How they cause fires

A number of fires start in inverters, which form the most complex part of a PV system and manage the power that flows through them. Though they have sensors and other safety features, there have been incidents of solar fires logged as initiating in an inverter, according to the BRE report.

The BRE has also highlighted how the use of "faulty inverters" has resulted in solar-related fires.[8] In 2020, there were reports of firefighters called to extinguish a fire in the central inverters of the Ullum photovolataic park – owned by energy company Genneia – in Argentina. In this incident, a number of inverters had caught fire, with firefighters taking an hour and a half to extinguish the blaze.[9]

Meanwhile, an article published by the Solar Power World website highlighted how "electrical abuse" was one of "three main abuse factors" that can send a battery into thermal runaway [meaning a situation where the heat generated within a battery exceeds the amount of heat that is dissipated to its surroundings]. The article added: "Electrical abuse happens during overcharging, undercharging or shorts from the inverter."[10]

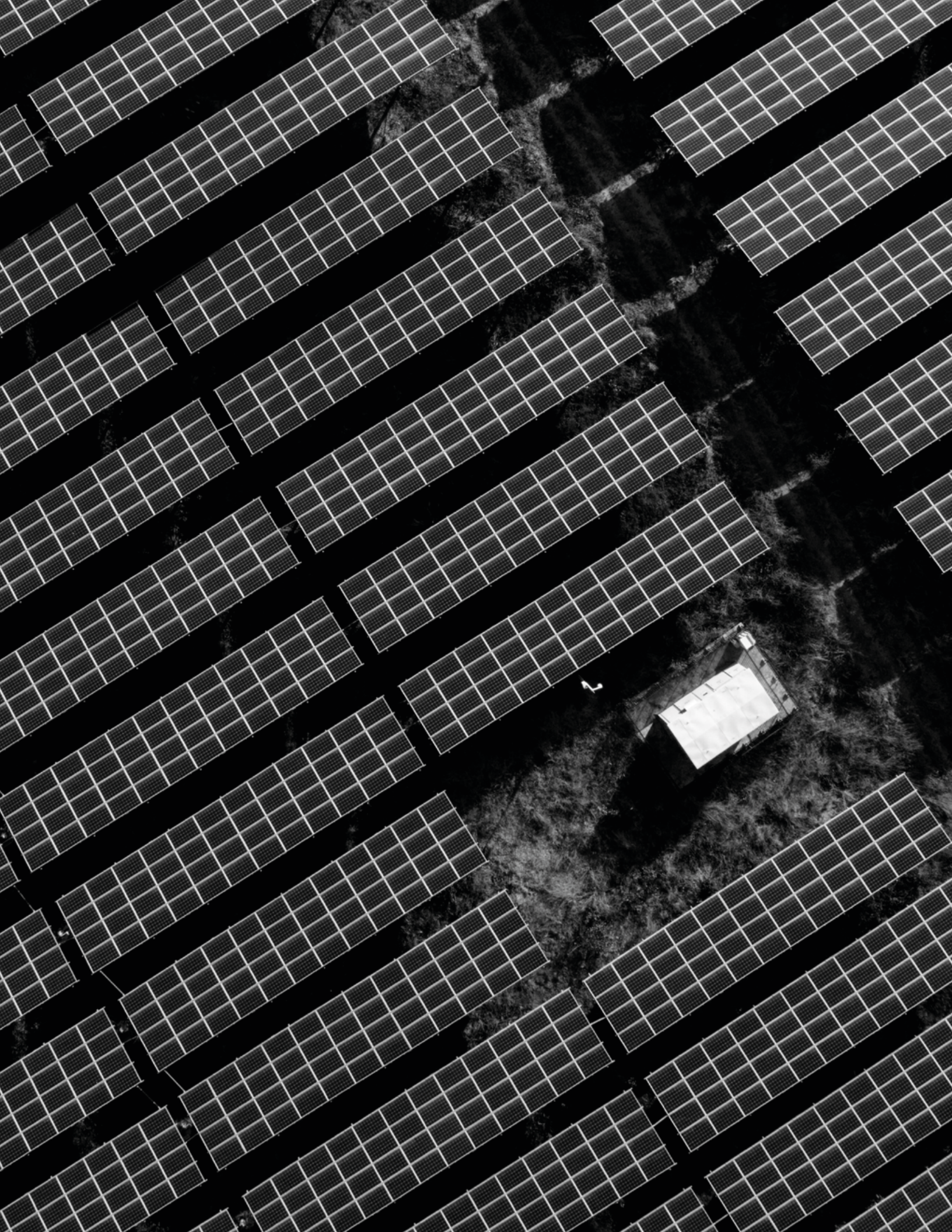
What causes fires in inverters? According to photovoltaic system distributor Solarity, inverters are combustible due to their polymer content.[11] Solarity has also highlighted how, during and after a solar fire, the PV system can potentially produce liquid, solid or smoke emissions and firefighters responding to the incident "could be exposed with dangerous levels of metals such as lead (c-Si) or cadmium and selenium."

8 https://www.bre.co.uk/page.jsp?id=3211

9 https://www.pv-magazine.com/2020/10/21/fire-accident-at-argentinian-solar-parks-central-inverters/

10 https://www.solarpowerworldonline.com/2020/02/just-how-concerned-should-the-solar-industry-be-about-battery-fires/

11 https://solarity.cz/blog/fire-hazards-and-mitigation-in-photovoltaic-systems/#



How can the risk of solar fires be reduced?

Even if quality assurance measures have been implemented for solar systems, it is difficult to completely eradicate the risk of fire.

The TÜV Rheinland study concluded that “despite quality assurance measures, overheating or electric arcs cannot be ruled out 100%.”

So what steps can be taken to minimise the risk of solar farm fires?

Recommendations made in the TÜV Rheinland study included:

1. **Ensure solar systems are regularly tested by independent third parties**
2. **Incorporate additional safety components everywhere possible**
3. **Create standardized quality assurance measures**
4. **Ensure defective or prematurely aged components are promptly replaced**

The report added that electric arc detectors can also reduce risks. However, it also said that it was vital that the electric arc detector remains fully functional over a very long period of time, if possible during the entire service life of the PV system, without itself causing any faults in the system. The report continued: “Protective measures such as an integrated self-test could be helpful here.”

In addition, an electric arc detector is “moreover useful only if it can be assumed to reliably detect electric arcs”, the TÜV Rheinland report concluded.

It added: “Electric arcs in modules produce different noise patterns than those in serial terminals. Different cable lengths greatly differ in their dampening of electric arc signatures. Interference from inverters, switching transients, or coupled radio signals can mask or overlay the noise coming from the electric arc. Only very robust detection algorithms tested on different systems can ensure real added utility here.”

Solar farm operators could also consider addressing the issue of fire risk by incorporating fire suppression systems, for example.

Conclusion

The risk of fires at solar farms is potentially being underestimated due to under-reporting and a lack of available data.

However, a number of studies have indicated that solar fires are on the increase. One US study found that solar system fires had tripled over a three-year period, while data from Australia showed that there had been a six-fold increase in the period 2018 to 2020.

Hence, there is an urgent need for the solar industry to address the issue of fire risk, particularly with data showing that global cumulative installed PV capacity increased by around a quarter in 2021.

Studies have shown that there are three root causes for photovoltaic fires – they are: an error in the system design; a faulty product (a design or quality issue); or poor installation practice.

The photovoltaic component that presents the greatest fire risk are DC isolators, which cause around a third of solar fire incidents.

However, DC connectors and inverters can also pose significant fire risks.

It's difficult to completely eradicate the risk of fire at solar farms, but there are a number of key steps you can take to minimize the risk.

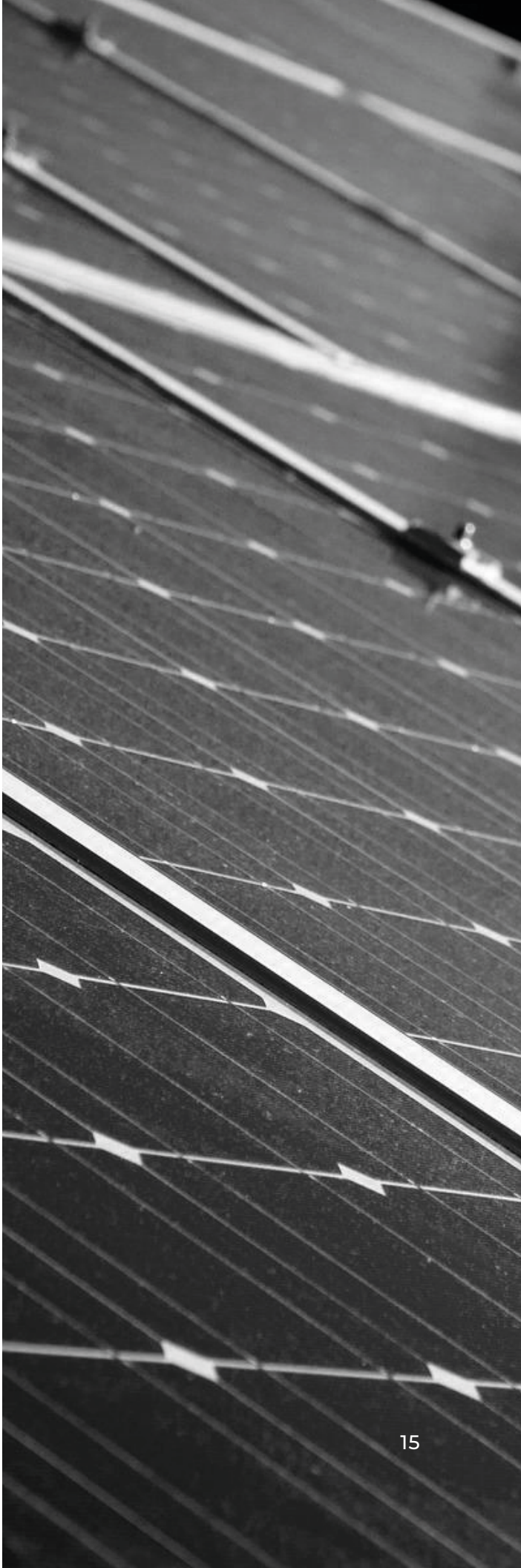
These steps include having solar systems regularly tested by independent third parties and incorporating additional safety components, such as fire suppression systems.

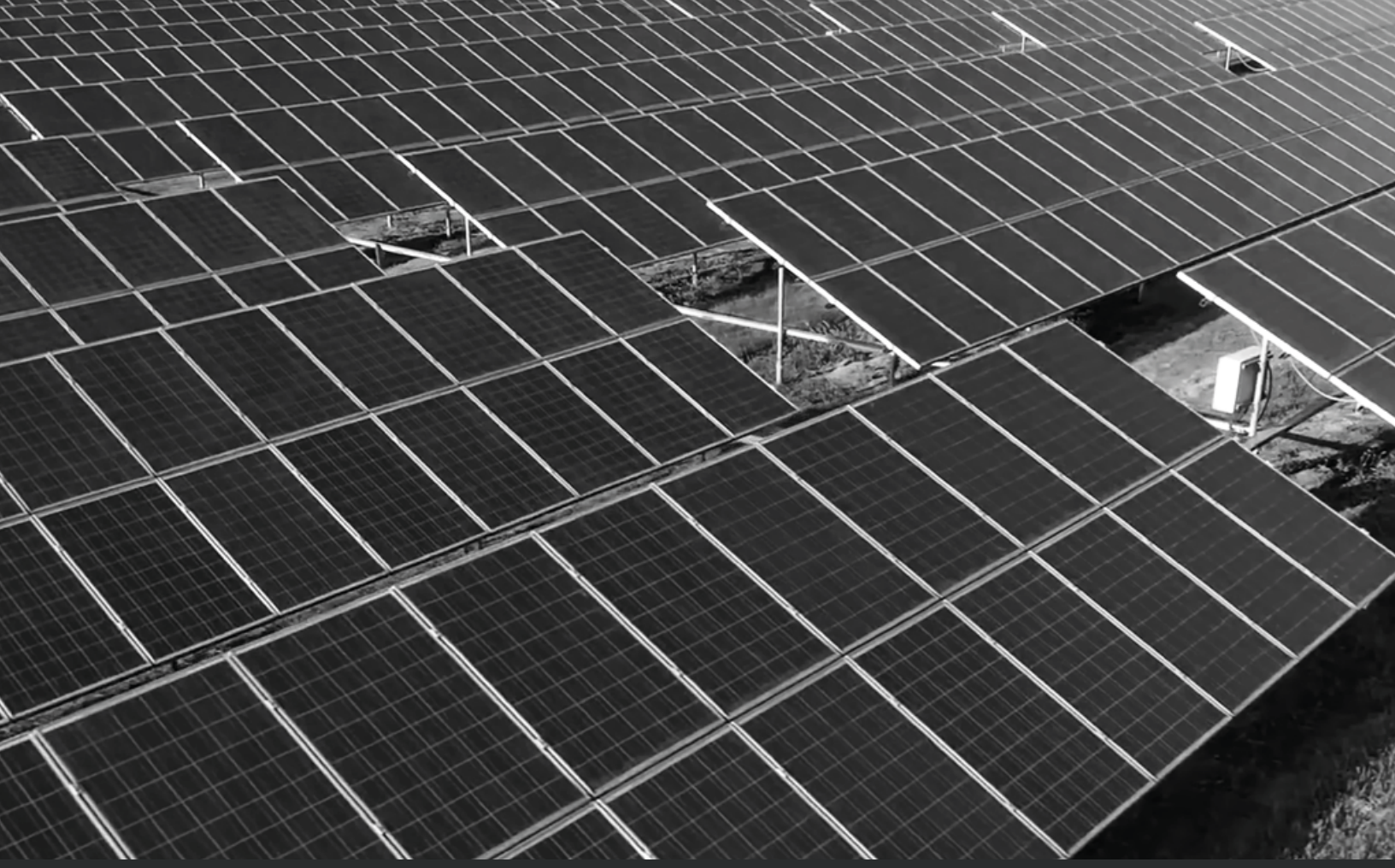
With the number of PV installations dramatically increasing around the world, taking these steps will be vital in order to reduce fire risk.

Would you like to talk about the risks in this report? How about your approach to fire risk in your portfolio?

Get in touch with the Firetrace team today.

www.firetrace.com/contact





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