Bandweaver

SenseTek

Case Study

Bandweaver's Linear Heat Detection (LHD) System Photovoltaic (PV) Array Monitoring

The Scenario

In the past decade, solar energy has gained significant prominence worldwide as an emission-free and sustainable energy source. It has progressively become both economically viable and reliable. Nevertheless, faults in photovoltaic (PV) panels – such as faulty wiring, connector failures, combiner box malfunctions, and plugs prone to overheating or ignition, pose substantial fire risks to industrial facilities and commercial properties.

Excessive heating of photovoltaic cabling and associated electrical components presents a serious risk to the operational safety and efficiency of PV systems. Overheating can cause insulation breakdown, connector failures, and increased electrical resistance, which may trigger short circuits and fire hazards. PV arrays installed on the rooftops of critical infrastructure represent a unique fire hazard that demands detailed attention. Given the indispensable role of these facilities, any fire-related incident could cause severe operational disruptions and occupational hazards.

Due to the rooftop placement and the distributed, complex circuitry of photovoltaic cabling, discrete fire detection devices and traditional sensing technologies are ineffective in detecting fire threats originating from PV arrays. Continuous detection along the entire length of the PV wiring layout is therefore essential. Implementing Bandweaver's advanced Linear Heat Detection (LHD) system, compliant with the EN54 Part 22 standard for fire detection systems, can mitigate fire hazards related to PV wiring and ensure uninterrupted, secure infrastructure functionality.

During 2023, an established technical solutions integrator sought a state-of-the-art fire detection and monitoring system to safeguard a high-value operational facility in the Netherlands. The principal goal was to reduce fire-related threats originating from rooftop solar PV modules, which posed a risk of undetected fire propagation potentially jeopardising the facility's critical operations.

Client Requirements

The end user required an advanced fire detection system capable of comprehensive monitoring across all areas susceptible to electrical overheating associated with the rooftop solar PV infrastructure. The system needed to accommodate the dispersed layout of the PV components distributed across the open rooftop surface. Due to this complex and spatially distributed configuration, conventional fire detection methods, such as point-type sensors, were deemed unsuitable.

Furthermore, the end user specified the need for site zoning, wherein each designated zone comprises multiple PV panel groups. Each group, consisting of four photovoltaic modules, required individual monitoring, with alarm data communicated to a third-party platform via the Modbus TCP/IP protocol. Early detection of temperature anomalies, such as thermal hotspots, was a critical requirement to enable proactive intervention prior to fire development.

Figure.1: Photovoltaic Array

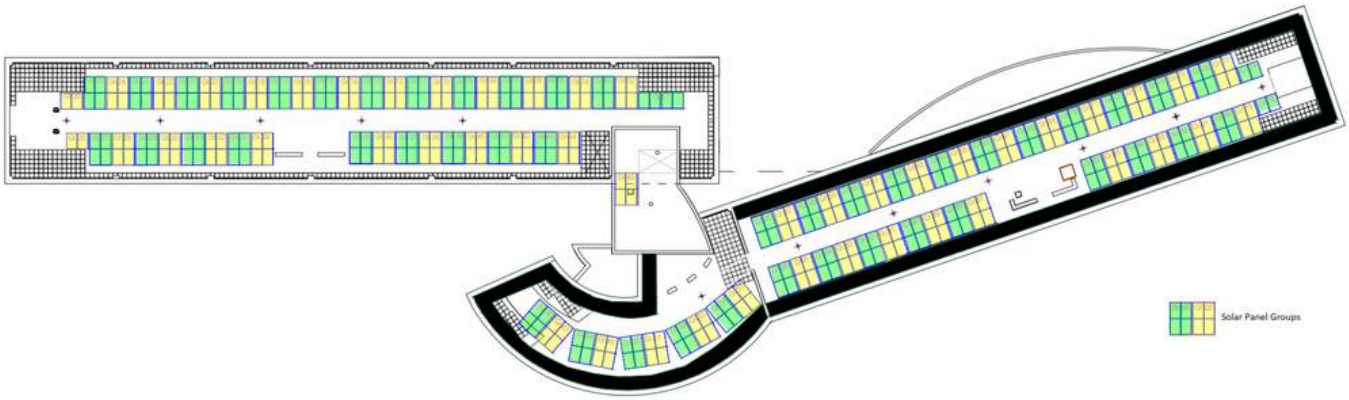

Figure.2: Photovoltaic Array Rooftop Layout

What Did We Do?

SenseTek B.V., Bandweaver's authorised distributor in the Netherlands, possessed prior collaboration experience with the technical solutions integrator and was engaged for this project. The proposed technical solution was required to demonstrate the capability to detect overheating behind PV cable wiring before receiving approval.

SenseTek B.V. thoroughly analysed the end-user's fire detection requirements and supplied Bandweaver's fiber optic-based Linear Heat Detection (LHD) system, the FireLaser DTS. The provided FireLaser model included two optical channels, each capable of monitoring up to two kilometres. The two optical channels were configured in a pseudo-loop (redundant loop) arrangement. One channel was coupled to an optical fiber core at the near end of the cable, while the second channel was linked to the other fiber core at the far end, which was routed back to the DTS controller. Although each channel operated in single-ended mode, this setup functionally established a closed-loop path by utilising both fiber cores in opposite directions within the same cable. This configuration provided inherent cut resilience, enabling uninterrupted monitoring even in the event of a single-point cable cut or sabotage.

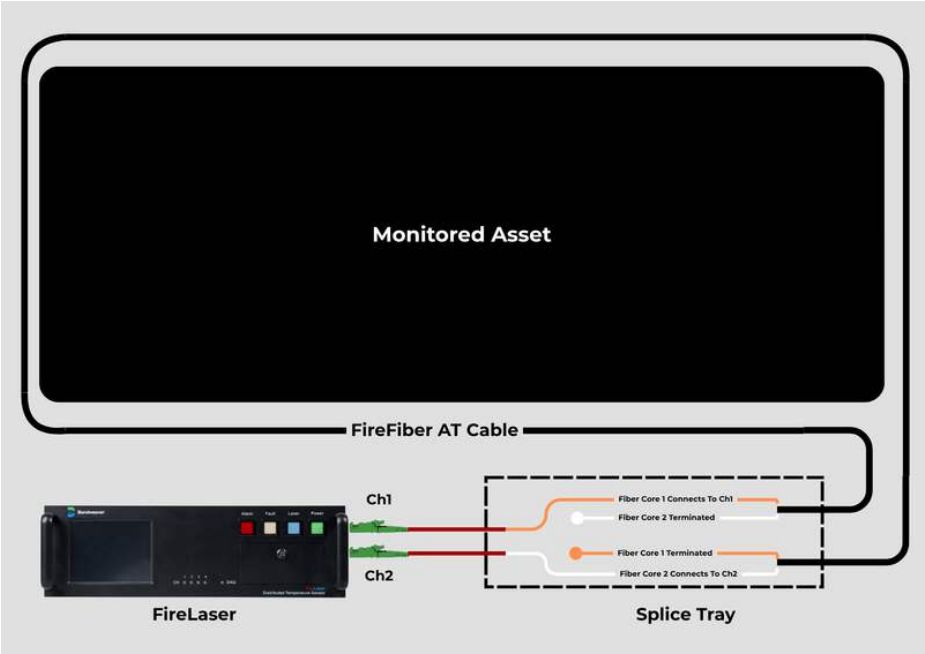

Figure 3 – Pseudo-loop (Redundant loop) Configuration

The FireLaser DTS monitoring system, along with the splice tray containing the fusion splice connections, was housed in a wall-mounted cabinet to ensure protection and accessibility. This cabinet was positioned adjacent to the photovoltaic inverter. A wall-mounted EN54-4 compliant power supply unit (PSU) was installed beneath the FireLaser cabinet to provide regulated DC power to the DTS system. Directly below the PSU, the fire panel was integrated with the FireLaser system via the available fault and alarm relay outputs.

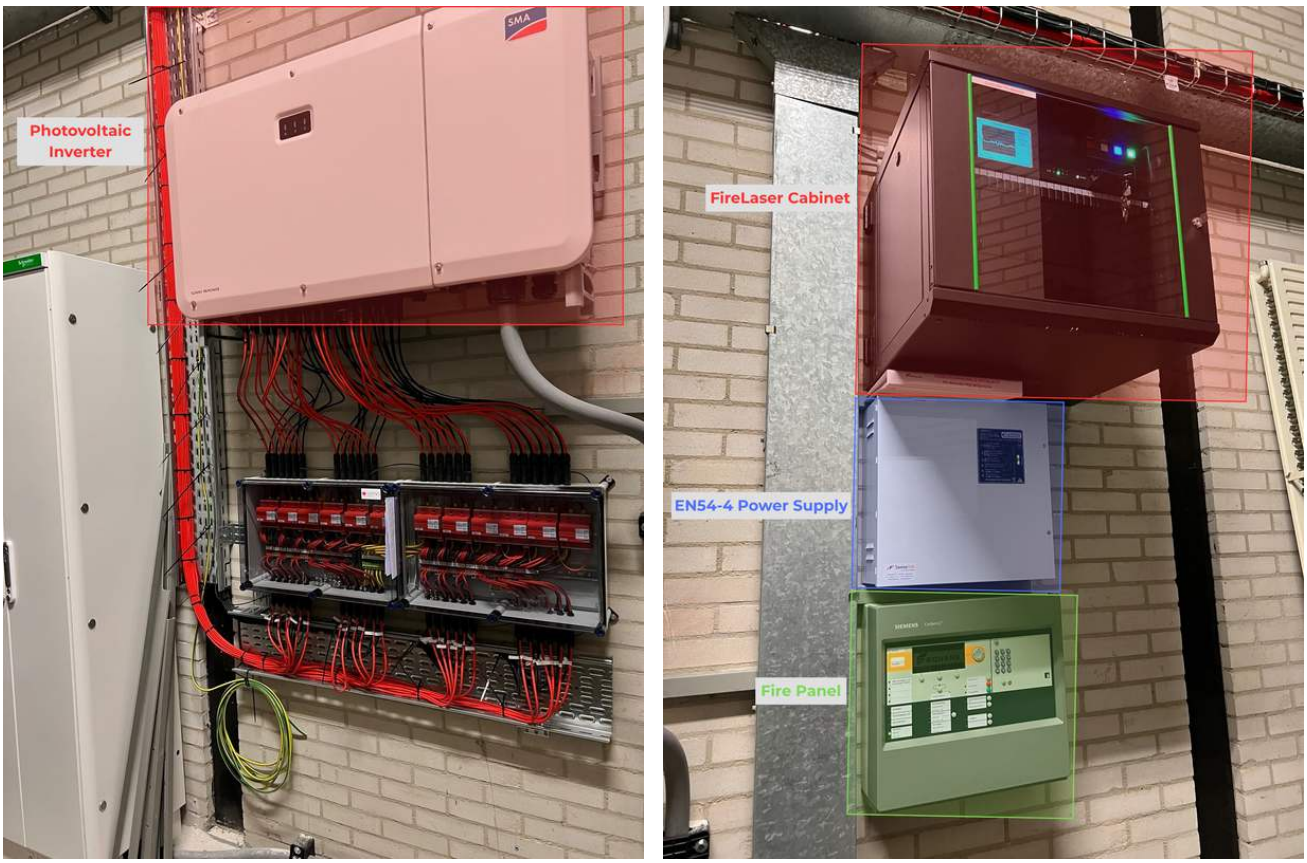

Figure 4 – FireLaser Installation

The fiber-optic sensing cable utilised in this application was Bandweaver's FireFiber AT (Armoured Tube) model. The cable comprises dual fiber cores as standard and is purpose-built to be lightweight and flexible, with an external diameter of approximately 3.3 mm. This design facilitates straightforward installation and is optimised for rapid thermal response applications. The cable construction incorporates stainless steel braid and aramid yarn reinforcements to enhance mechanical robustness, coupled with a stainless steel spring tube that provides superior crush resistance and flexibility while reducing the likelihood of fiber kinking.

The FireFiber AT cable was strategically positioned in close proximity to identified high-risk fire zones. It was routed in parallel with the PV cabling infrastructure, spanning the rear side of each photovoltaic module and covering the inverter connector points. The cable was secured to the PV wiring using UV-resistant cable ties suitable for outdoor installations. The total length of the monitored optical fiber cable extended to approximately 1,900 meters.

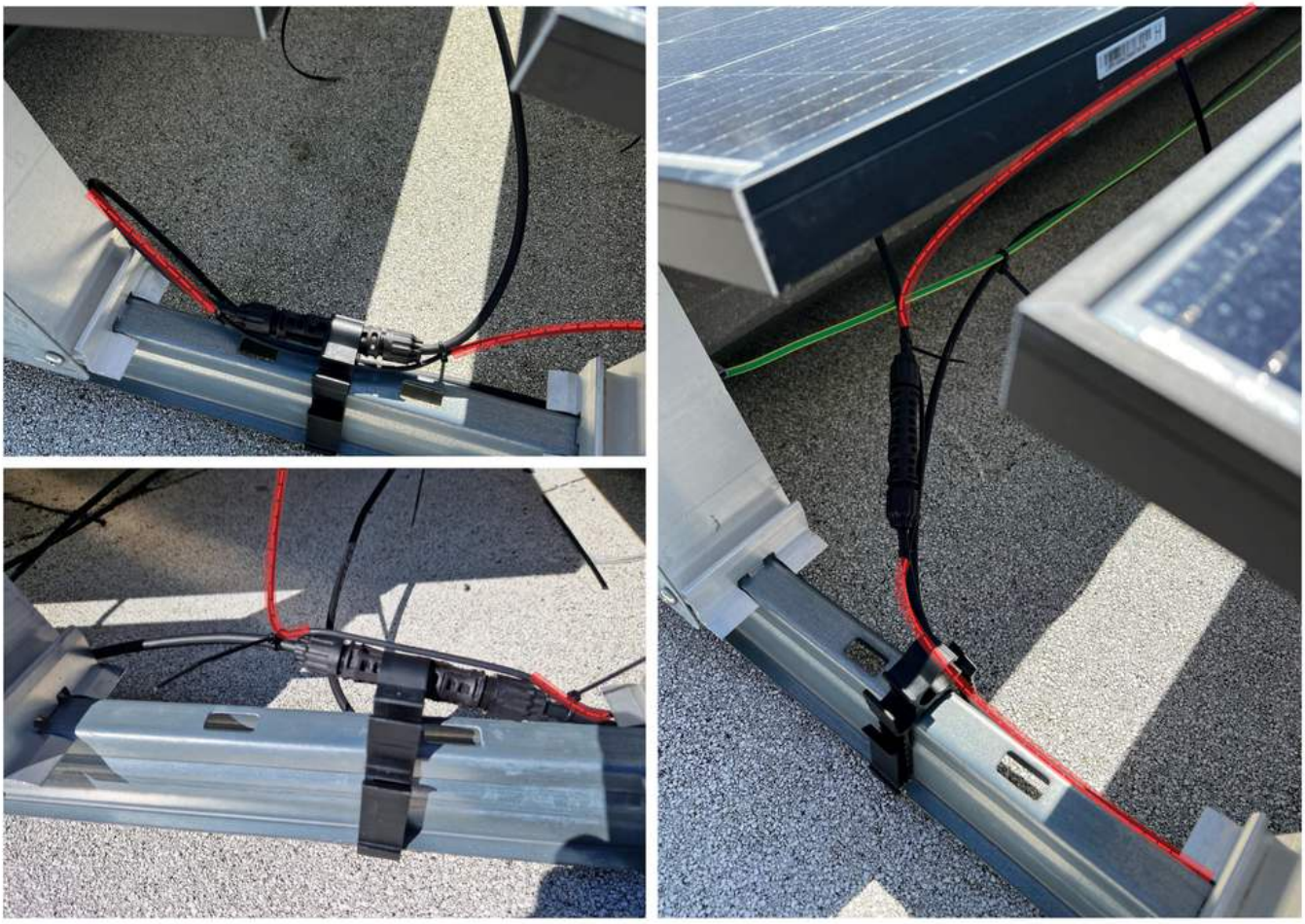

Figure 5 – FireFiber AT Cable Installation (shown as dashed lines)

The rooftop PV system was segmented into eight main fire detection zones. The zone numbering was assigned in accordance with the physical routing of the FireFiber AT cable. Each main detection zone corresponded to a specific section of the PV array and was further subdivided into sub-zones to provide precise identification of alarm origin and location for the end user.

Two distinct alarm temperature thresholds were programmed into the system: 80°C and 85°C.

- The 80°C threshold was allocated to cable runs mounted directly on the PV array infrastructure, where early detection of overheating is critical.
- The 85°C threshold was assigned to cable segments primarily routed along the rooftop surface, where a slightly higher trigger point was acceptable.

The alarm zoning configuration was designed to ensure prompt detection of potential fire sources originating from the PV array, allowing for rapid intervention.

A total of 34 alarm zones were defined within the FireLaser DTS system. Alarm zones grouped under the same main detection zone were configured with the same relay index to ensure consistent alarm signalling. Additionally, the PV inverter area was configured as a separate zone to provide dedicated monitoring.

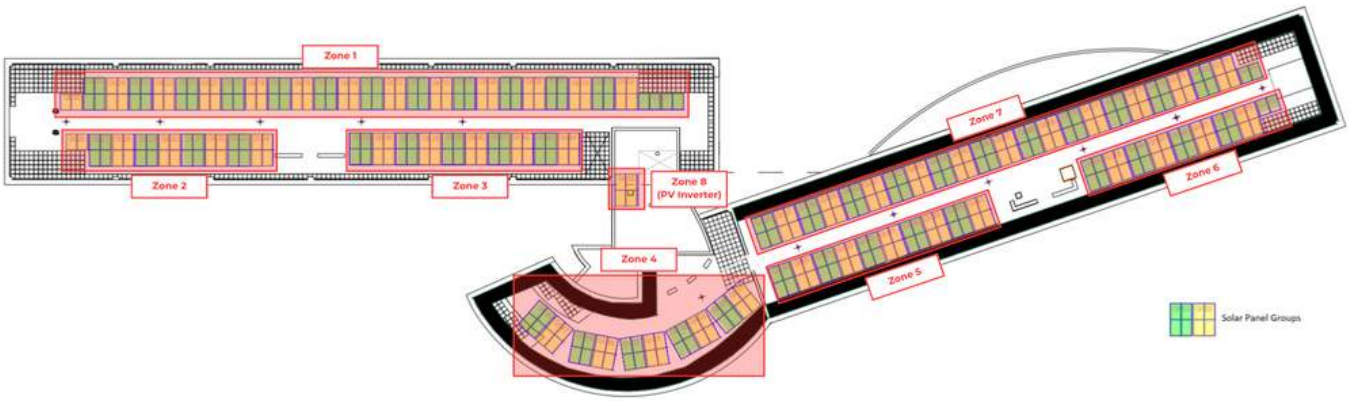

Figure 6 – Zoning Schematic

In the event of an alarm, the relay associated with the specific fire zone is activated and displayed on the end user's fire panel. Additionally, the FireLaser DTS system is integrated with a third-party platform via the Modbus TCP/IP protocol.

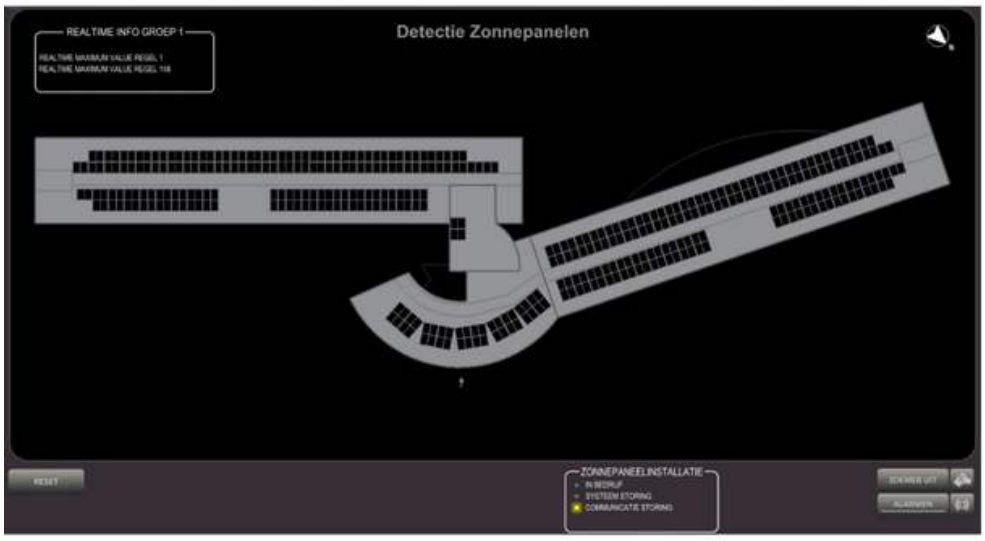

Figure 7 – Third-Party Platform Integrated with FireLaser via Modbus TCP/IP

Benefits To the Client

The end user aimed to protect their critical facility from fire risks associated with the rooftop photovoltaic array. The Bandweaver LHD system met this requirement effectively, successfully detecting an overheating condition near the PV inverter caused by an improperly inserted connector. Some of the other key benefits and advantages to the end user include:

- **Early detection** of even a small fire: Bandweaver LHD systems are approved to operate with a measurement time of 5 seconds, which is considerably quicker than the alternatives. With the smart alarms (including rate of rise and deviation alarms), the system can detect fires at a very early level without risk of false alarms.
- **Complete Coverage:** The distributed nature of the fiber optic system provides measurements every 1 m along the length of the cable, providing complete and continuous coverage with no blind spots or gaps in the protection.
- **Reliable and robust system:** The system was configured in a loop configuration, which means that there is a level of redundancy even if the cable is damaged. Also, it is not affected by any dust, particulates, or moisture in the air. For example, the electrically based system is affected adversely by moisture.
- **Low Cost of Ownership:** Fiber optic cables are completely passive and have no moving parts, they are non-corrosive and immune to electromagnetic interference and typically have lifetimes of more than 30 years and so carry a very low cost of ownership and no maintenance.

About Bandweaver Technologies

With an installed base of over 60,000 km and 8,000 systems installed worldwide, Bandweaver's vision is to be the first choice for integrated distributed fiber optic sensing solutions across the globe. Since 2002, Bandweaver has been committed to delivering reliable, innovative, client-centric, and value-added products and services via a dedicated and talented team of people.

Bandweaver manufactures and distributes advanced fiber optic monitoring sensors and integrated technologies, enabling customers to monitor, secure, and keep personnel and critical assets safe.

With quality and excellence as fundamental elements of Bandweaver's portfolio, the business is continuously developing its range of technologies, including Distributed Temperature Sensors (DTS), Distributed Acoustic Sensors (DAS), and integrated smart intelligent software solutions. Bandweaver provides solutions for security, fire, power, and pipelines.

For further information, please contact our global team at info@bandweaver.com