



Maintaining PV systems with advanced AI software

PVision, a young AI startup based in Stuttgart, Germany, has developed innovative software that enables electricians to inspect photovoltaic systems for damage using drones and AI analysis. In this article, we take a closer look at the challenges faced by the industry in maintaining these systems.

PV systems are susceptible to various damage that can significantly limit their performance. Modules are particularly vulnerable to aging and weather conditions, which can lead to issues such as hotspots, diode malfunctions, and many more failures. Damage can also occur in connectors and inverters. PV systems should therefore be inspected and maintained by experts at regular intervals in order to detect damage at an early stage and rectify faults quickly.

Historically, identifying damage to PV systems primarily occurred during the billing process, due to reduced yield values. The search for errors involved tedious manual efforts. More recently, monitoring software has been employed to analyse data from the inverters. This allows the data from the inverter to be visualised and various data to be evaluated. It is used by electricians and private plant owners.

So-called micro inverters are also occasionally used. These can record data at

module level, but are very expensive to purchase and install, which makes their use unprofitable. Nevertheless, monitoring software falls short in pinpointing faults at module level. While it supports with recognising the presence of a fault, it lacks the capability to specify its exact location.

Monitoring through various software or reading data from the inverter allows for performance evaluation, often detecting major issues. Subsequently, electricians need to manually inspect each module in the string to identify defective ones. Traditional maintenance is time consuming and expensive, but with a thermal camera, these damages become visible and analysable through software.

PVision provides electricians with software to identify faulty modules quickly and easily in real-time using drones and AI analysis. The system involves flying a drone over the installation, capturing thermal images. These images are then analysed directly on the drone's remote control for anomalies.

The history of PVision is characterised by pioneering spirit, experimentation, and a clear vision to revolutionise the maintenance of PV systems through innovative technologies.

Subsequently, a report is generated with all essential information and the data is transmitted to the web interface, where the data of the analysis can be evaluated in detail.

The drone is very easy to operate and flies completely autonomously. The drone comes from one of the largest drone manufacturers in the world with very sophisticated software. You can program the route in advance, the drone then takes the pictures independently, and lands again afterwards. There is a one-day onboarding session for users of the software, during which the operation of the drone and the analysis software is explained and any questions that arise can be asked.

The web interface displays all results and provides various analyses, including performance loss per anomaly and location, as well as the financial impact of the damages. Reports can be customised in structure and

appearance to suit individual needs. Following this, it is possible to create repair quotes and optimise the maintenance process. Especially in the absence of detailed plans, drone images can accurately identify defective modules, irrespective of string plans.

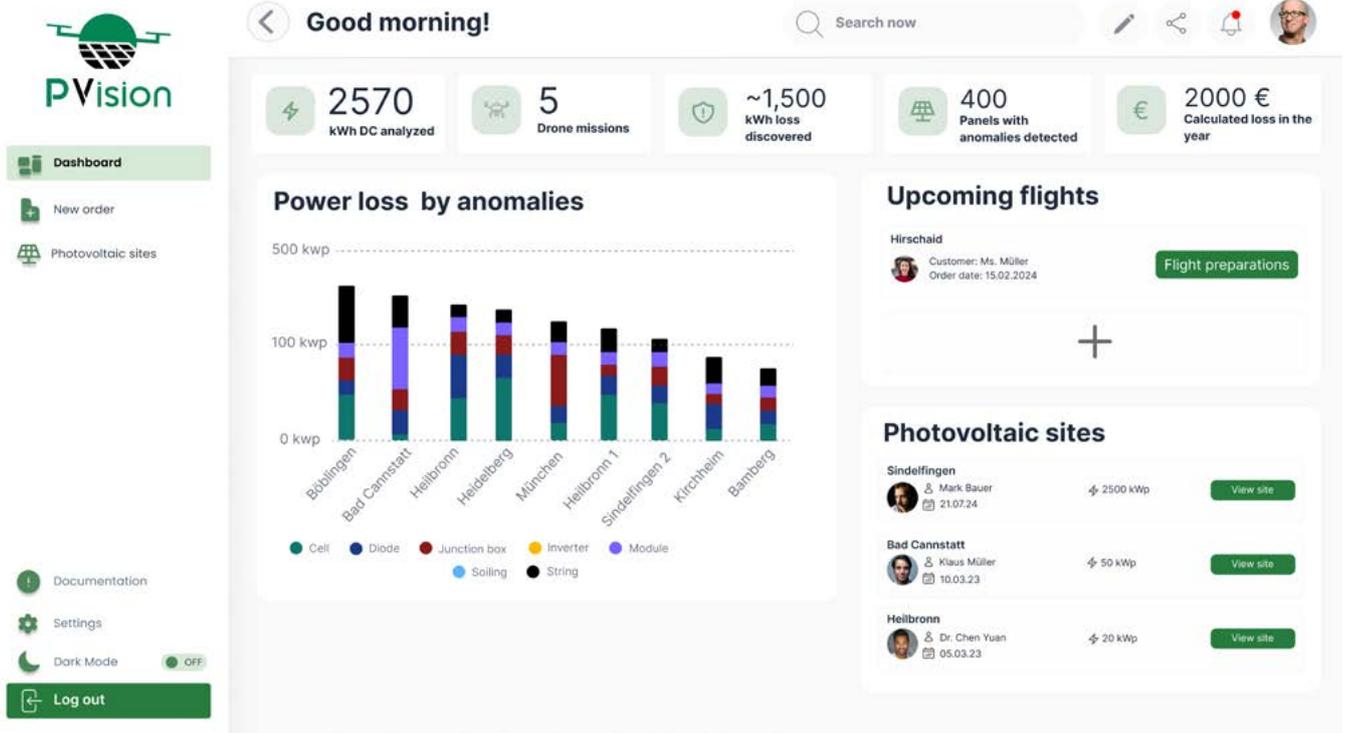
PVision's AI software employs an exceptionally resource-efficient algorithm for image analysis, allowing real-time evaluation of images on the drone's remote control. Subsequently, an automated report is generated, available through a web application.

The technological innovation combines drone technology, thermal cameras, and advanced AI. On-site real-time analysis enables precise damage identification, with automated bounding boxes drawn on thermal images, allowing for accurate classification and evaluation of damages.

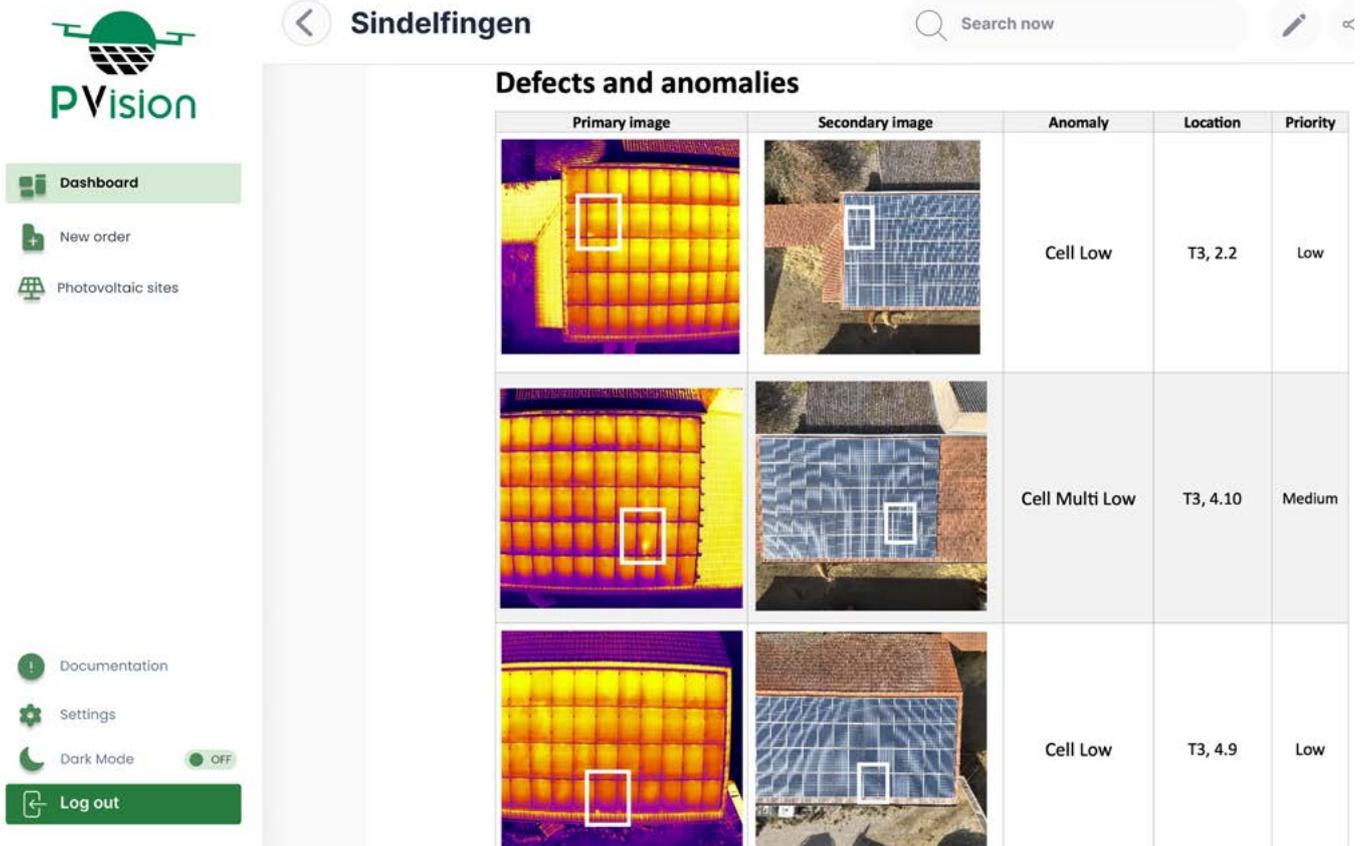
In assessing individual damages, the temperature difference between the identified faulty spot and the functioning neighbouring cells is crucial. Minimal differences may not require replacement, but higher temperature discrepancies indicate a more sensible replacement.

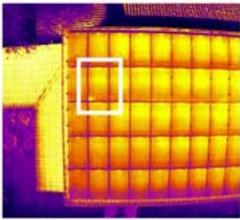
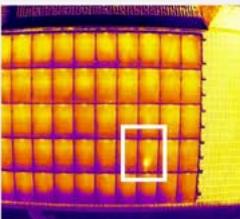
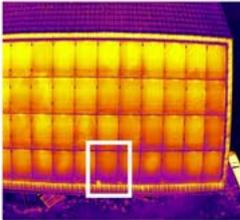
PVision's web application offers comprehensive evaluations and comparisons for different recording years, enabling scrutiny of the PV system's development over its entire lifecycle. The exchange of panels can be documented, and emerging warranty claims can be tracked and processed more easily.

Their innovative solution brings significant benefits to installers and operators of photovoltaic systems. The accelerated analysis and quote generation significantly reduce time requirements, facilitating a quick response



Example report of a photovoltaic system from the PVision software, with image damage category, location and severity of the damage



Primary image	Secondary image	Anomaly	Location	Priority
		Cell Low	T3, 2.2	Low
		Cell Multi Low	T3, 4.10	Medium
		Cell Low	T3, 4.9	Low

Dashboard overview of the PVision software with overview of power loss, upcoming flights and photovoltaic plants

to potential damage. Automated reports not only enhance documentation but also lay the foundation for well-informed decisions regarding repairs and warranty claims.

The company currently supported by a grant program from the German Ministry of Economics called EXIST and has already won several startup awards. Through this, PVision has an initial 6 digits funding to make the technology accessible to the market. In 2023 about 300 startups applied for this funding and we are one of the few who received it. The intention of the program is to support startups from the university and research environment that have a high innovative content and can have a good impact on society. Simultaneously, these projects should have the potential to become economically viable. The company is also part of several accelerators and communities where we get continuous support in software development, understanding its customers and much more.

PVision has successfully analysed over 60,000 modules with its software, uncovering a substantial number of damages. A compelling example is the case of a customer from Bavaria, who owns a 1.71 MWp PV system with approximately 6,000 modules.

The inspection revealed a staggering 349 modules with anomalies, including

84 with diode malfunctions and 25 with the critical 'MultiHotspot' error. Individual module damages negatively impacted the entire string, leading to approximately 2.5% power losses and an annual loss of 175 MWh. This corresponds to the annual electricity consumption of approximately 35 four-person households.

These figures emphasise the importance of regular and preventive maintenance of photovoltaic systems. The quick repair was possible due to the customer's reserve modules.

PVision was founded by a team of passionate enthusiasts who have always been fascinated by drones and renewable energy. The company's journey began with experiments and trials, exploring the potential of using a thermal imaging camera to detect damages on PV modules. Inspired by this idea, it invested in a professional drone equipped with a thermal imaging camera.

Initial flights were conducted by Markus Bäuerlein, who manually analysed the captured images. This laborious and time-consuming method quickly became a catalyst for change. Concurrently, Jonas Lackmann worked on his bachelor's thesis on AI image processing. The realisation that damage detection could be implemented through software marked the inception of our technological vision.

The initiative gained momentum when Kai Ritter joined the team to develop a sustainable solution from the initial idea. Together, they took the leap and applied for a funding program from the Federal Ministry for Economic Affairs and Energy. After a few months, they received the awaited approval, providing support for a year to work on our groundbreaking project.

Currently, the company is in an intensive phase, further developing the software through numerous customer projects and tailoring it specifically to meet our customers' needs. The history of PVision is characterised by pioneering spirit, experimentation, and a clear vision to revolutionise the maintenance of PV systems through innovative technologies. In the future, the aim is to combine its analysis software with related services, such as cleaning and maintenance.

The successful collaboration with solar technicians and system operators reaffirms the solution's success. In the future, more operators and installers of PV systems are expected to benefit, particularly those with systems above 50 kWp.

For more information or potential partnerships, we are at your disposal. Feel free to contact us at: kai.ritter@photovoltaikvision.de or visit us at Intersolar in Munich.

[photovoltaikvision.de/](https://www.photovoltaikvision.de/)