



Thermo diagnosis of photovoltaic power plants

The worldwide increased knowledge of the environment and the risk of exhausting non-recoverable energy sources is a reason that various methods of using alternative resources have been sought. Solar energy is an inexhaustible source which, thanks to the programmes for the support of the construction of solar power plants is most often used. The need for problem-free operation of such a power plant is high-quality assembly, as well as regular maintenance and inspection of all panels. A fast, cheap and reliable method where it is possible to check the quality of a large area of solar panels is thermo diagnostics using the Workswell WIRIS thermal imaging system attached to the drone.

Outline of the issue

Each panel usually consists of 36 to 96 crystalline silicon cells that work on the photovoltaic effect principle. This is a very simple principle which, however, is influenced in practice by a large number of disturbing circumstances that can occur in production and use. During production and then during the installation and operation of photo voltaic power plants, defects can occur that affect the service life or restricts the performance of the panels. The most well-known material defect is the so-called swirl defect, which is caused by the injection of oxygen admixtures into the material during the production of silicon ingots.



Photovoltaic power plant



Process defects are defects caused by poor construction and incorrect use of the panels. For the user, this may concern mechanical damage from careless use (scratches, cracked or broken cell) or the covering of surface

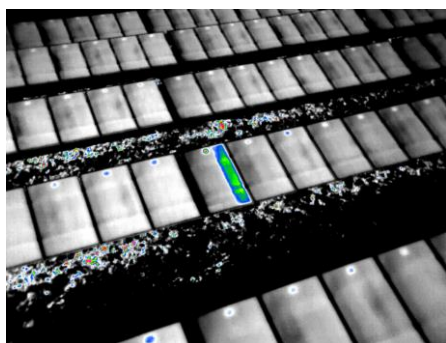
areas with dirt resulting in insufficient maintenance. There is often a break in the integrity of individual layers of the panel caused either by the effects of internal tensions in the cell or by dispersion of the dirt into the silicon material during the manufacturing process.

Most of the mentioned defects result in the occurrence of hot places, known as hot spots. This is where there is an increased recombination of electrons and holes. Energy released during this process is radiated into the space as heat. These spots report excessive heating and the thermal difference

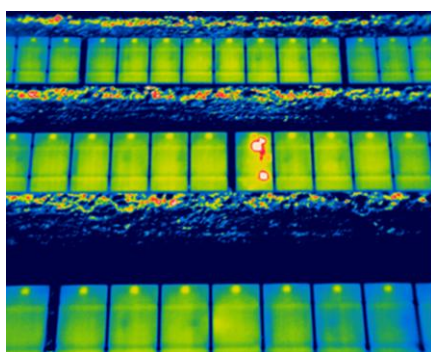
compared with good cells can be higher than 50°C. This often leads to irreversible damage to the defective cell, as well as to the whole panel. Inspection of individual photo voltaic cells is usually a difficult task. Either the panels are located at a high height on the roofs of buildings, or the area is large and a visual inspection is both time and financially demanding. The omission of regular inspection once a year (detailed inspection a minimum of 1x per 4 years) can have fatal consequences in the form of fire.

Use of thermal cameras during the diagnostics of photo voltaic panels

The ideal solution to this problem is the application of thermal camera systems because the hot spots are significantly reflected on the thermal image (termogram) by contract colouring towards the surrounding. In most cases it is not possible or safe to approach the panels with a thermal camera either in the case that the panels are located on sloped roofs or cases where passing between the panels is prevented by



various obstacles (plants, roughness of the terrain ...). For these reasons, an elegant and efficient solution is the fixation of the Workswell WIRIS on the drone.



A thermal image of the FVE power plant with failure detected (hot spots) produced using the Workswell WIRIS system

Technical construction of such measurement requires experience of controlling the drone with thermography. Therefore, the pilot of the drone is always present while the thermo diagnostician who controls the camera system, instructs the pilot on which panel it is necessary to focus when the problem is detected and stores images for later analysis.

A compelling reason to use a thermo camera from the air is the fact that a thermal anomaly is recommended to be detected at a viewing angle of 70° up to

almost 90° related to the surface of the panel. Due to this requirement, it is excluded the use of handheld thermal cameras; on the contrary, a drone with a thermal camera fixed on the controllable gimbal easily fulfils this condition. A limiting factor during the measurement of values may only be the hydro-meteorological conditions that can significantly influence the measurement precision. An ambient temperature of 25°C during measurement is ideal with a sunshine intensity of 1,000 W/m², and a few clouds. In this case, the output of the panels is sufficiently high enough to reflect all detected types of defects.

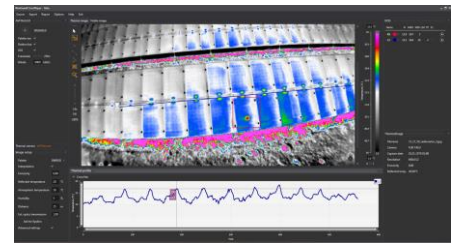


Advantages of the Workswell WIRIS system

The Workswell WIRIS system is a light, compact camera set for the visible spectrum, thermal imaging camera and control elements that enable the user to quickly check a large area of the whole power plant. During the flight, it is possible to monitor live images, to produce a fully radiometric record or sequence the images of the whole flight. Records can be then analysed by the Workswell CorePlayer software, which has advanced measuring functions and the option to easily and quickly produce reports.

The Workswell WIRIS system enables to remotely switch regimes and, for example, to define alarm statuses when selecting the contract colour in the thermogram to highlight places with a temperature exceeding the expected limit. The hot points "light up" on the thermogram and on first sight it is possible to identify and focus on these during a detailed inspection. The visible

identification of warmer places is supported by the option to set a manual scope for the temperature scale. Individual colours in the selected pallet show the same temperature, which is not automatically changed by a change in the temperature of the monitored area as is the case with simpler systems.



View of the operator's screen. When in use, the Workswell WIRIS system provides the same comfort level as existing manual thermal cameras. All parameters can be set for measuring, including emissivity and reflected temperature. The high sensitivity of the system is achieved by manually setting the range of temperatures.

Summary



Workswell WIRIS system on the drone

Aerial thermal imaging systems can be uniquely recommended for any inspection of FVE systems after assembly but before collection from the supplier, as well as during regular inspections that ensure that the user has maximum efficiency for gathering energy and minimum costs for repairs. The speed of the thermal camera inspection compared with a common inspection is several times higher, as well as is its reliability. This measuring method is also the cheapest method of identifying defects on panels. Today, thermograms are a standard feature in claim reports and are accepted by companies as proof when reporting defects.