PV systems can be quickly and easily checked for hotspots with thermal imaging. However, for large and inaccessible facilities even this technique is time-consuming. Using a remote-controlled drone for aerial thermography the measurement is flexible and efficient.

The drone system

The drone is composed of a multicopter with flight control and camera equipment from a thermal imaging camera and a compact camera. The cameras are stabilized and aligned with a gimbal, which is adjusted by remote control. The video signal is sent to a monitor on the remote control so that the pilot knows what the cameras are recording. Image 1 shows the complete drone, ready for takeoff.

Image 1: BFH’s IR-multicopter drone

The special feature of the system is the thermography camera that records a full-radiometric infrared video at 30 frames per second. A video instead of a picture facilitates the evaluation of the data. Reflections and other irregularities can be immediately recognized that way.

The IR camera consists of a miniature lightweight PC and an IR sensor. The used camera is manufactured by OPTRIS, a German company, and weighs 380 grams. Image 2 shows the OPTRIS PI400 LightWeight IR-camera system.

Image 2: IR-camera system Source: OPTRIS

Another advantage is the price. The entire drone system including accessories costs about the same as a comparable stand-alone thermal imaging camera.

Application

For the measurements best weather conditions are required not only for the operation of the drone, but also for thermal imaging inspection of a PV system. In the infrared imaging, temperature irregularities are immediately visible and distinguishable (Image 3, bright spots).

Several flaws can be recognized:
• Strings that are not in operation
• Substrings bridged by bypass diodes
• Individual cells with various defects (which could cause a fire)
• Smaller areas than the cell size

Cell fractures can be seen as bright spots in image 3. This facility was victim of vandalism.

A Module with a cell fracture and a faulty soldering – these are the most frequent defects in PV modules – was measured and it has a power loss of about 20% (Image 4).

Image 4: Characteristic of a defective module

Remarkable is the amount of time it takes to IR-map solar power plants. For a facility the size of 560kW a flying time of about 15 minutes is required. Especially for large systems, the time difference to manual checking is wide. For systems difficult to access, the advantage of the drone is its flexibility. It must be made no further efforts to reach a photovoltaic roof system, for example.

Future Efforts

The drone system will be used for checking the Facilities of Berne University of Applied Sciences and tested at further PV technologies under various conditions. Together with Gebäudeversicherung Bern GVB we will train installers and users. This helps to improve solar power production and avoids fire hazard.

In 2015, flights on special terms are feasible.

BFH PVLab sponsored by: