Solartechnik Stiens uses FLIR thermal imaging cameras to make sure their solar panels operate properly

'We compared several suppliers and FLIR came out as the winner'

The FLIR T335 thermal imaging camera: light, compact and easy to use.

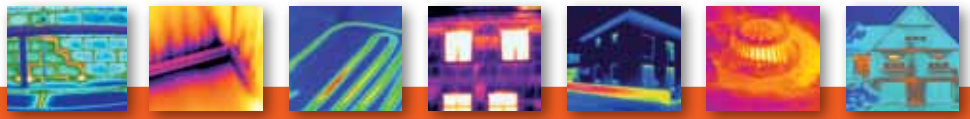
Fossil fuel reserves dwindle, the prices for coal and gas rise to new heights and many people look to the sun for a renewable power source. To make sure that the solar panels they deliver perform well, Solartechnik Stiens uses a thermal imaging camera from FLIR to look for flaws.

"As solar cells turn sunlight into electricity they also produce heat", explains Benjamin Kimpel, Servicetechnician at Solartechnik Stiens. "But ineffective cells produce much more heat than the cells that do work effectively so the ineffective cells clearly show up as a hot spot on a thermal image. That's what we're looking for."

Benjamin Kimpel, Servicetechnician at Solartechnik Stiens.

Solartechnik Stiens is a relatively new company. Founded in 2004 it has grown from the two employees it had at the day it was founded to its current number of employees of 55. Their main office building in Kaufungen, which was opened in 2008, has a 46kWp solar system on the roof. The upper half of the building constantly follows the course of the sun. Every 10 minutes the upper story of the office building moves almost imperceptibly. It turns 180° from sunrise to sunset, directing the solar panels toward the sun throughout the sunshine hours, thus making optimum use of the power of the sun.

Every 10 minutes the upper story of the main office building of Solartechnik Stiens in Kaufungen moves almost imperceptibly, directing the solar panels on the roof toward the sun.



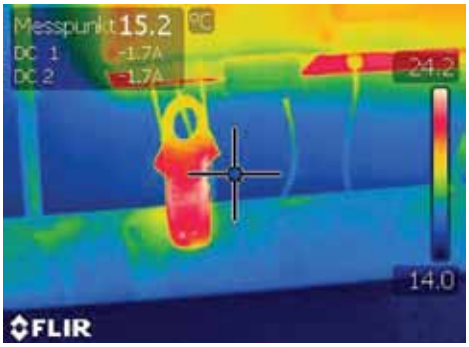
The FLIR T335 thermal imaging camera is available with several different interchangeable lenses.

FLIR T335 thermal imaging camera: usability is key

To prevent defected solar panels being delivered to their clients, Solartechnik Stiens has acquired a FLIR T335 thermal imaging camera, which they can use to check panels before delivery. Like all the FLIR T-Series thermal imaging cameras the FLIR T335 is very practical. The FLIR T-Series of portable thermal imaging cameras takes ergonomics, weight and ease-of-use to a new level. Usability is key: the engineers of FLIR Systems have translated user feedback on comfort and clarity into a series of comprehensive and innovative features.

The FLIR T335 thermal imaging camera has an uncooled microbolometer detector that produces crisp thermal images with a resolution of 320 x 240 pixels. It can accurately measure temperatures from -20°C to +650°C at a thermal accuracy of less than 50 mK. "The quality of the images the FLIR T335 thermal imaging camera produces is remarkable, but even more important for our application is the practical design", explains Mr. Kimpel. "Especially the fact that it is lightweight and that it has a tiltable lens unit makes it the ideal tool for fieldwork, checking already installed solar panels for flaws."

These inverters convert the direct current from the solar panels to alternating current.



FLIR MeterLink technology allows the measurement data collected with the clamp meter to be transferred via Bluetooth and combined with the thermal image.

Ineffective solar cells

Thermal cameras are an ideal tool to check solar panels for bad cells, according to Mr. Kimpel. "If a solar cell produces less electricity, it usually produces more heat than the other cells. That means that you can very easily spot such ineffective cells with a thermal camera."

The cause for solar cell inefficiency usually lies in the uniformity of the semi-conductor material that is used, for most solar panels this semi-conductor is silicon. The multicrystalline silicon wafers used in most solar cells can be very prone to develop these non-uniformities either during the production process or later on. If a solar cell has a higher concentration of these non-uniformities it produces less electricity and more heat than others, dragging the performance of the entire panel down.

Defects may render an entire panel useless

For the conversion to alternating current a certain amount of electric current is needed, so if inefficient cells drag the electricity production of the entire panel below this critical threshold the entire panel can be rendered completely useless.

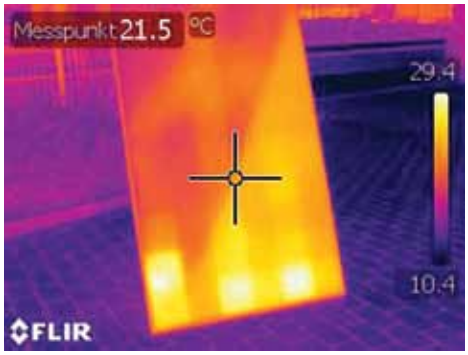
But there are many other possible causes for a solar panel's performing poorly like broken cells, broken glass, water leakage, broken soldering points, defective sub strings, defective bypass diodes, delamination of the semi-conductor material, defective connectors, to name just a few. Whatever the cause may be, thermal imaging cameras help the operator to find out where the cause is located and often it even indicates what the cause might be. In all of the possible scenarios a thermal camera can play an important part in finding out what's wrong.

These solar panels that are mounted on poles can be scanned from the back to minimize reflection.

Identifying defects

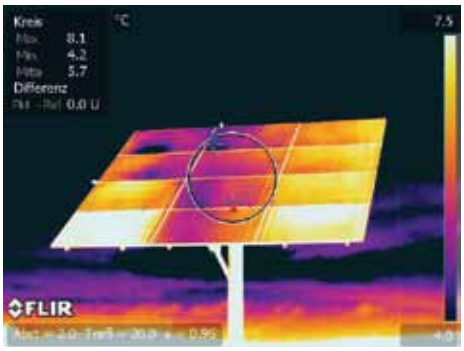
"We want to prevent such defective solar panels from reaching our clients", explains Mr. Kimpel. "And we also want to be able to monitor their performance after they are installed." Identifying these defects requires efficient, cost effective test and measurement methods for characterizing a cell's performance and its electronic structure. "We invited several different suppliers to demonstrate their thermal imaging cameras and FLIR proved to have the best product for our application. We set up a test situation with an operating solar panel and we wanted to see which thermal imaging camera would spot the hot spot first."

At the test FLIR Area Distribution Manager Michael Mende and FLIR products distributor Heiner Röder of Roeder Measuring Systems introduced Mr. Kimpel to the FLIR T335



A test with a solar panel in the parking lot of Solar-technik Stiens shows that the hot spots can quite easily be seen on the thermal image, even from the front.

Viewing angle recommended (green) and to be avoided (red) during thermographic inspections.

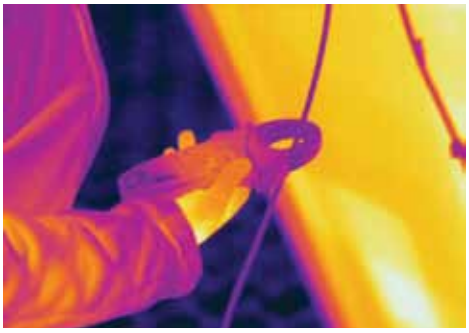


The hot spots on this thermal image taken from the front of the solar panel might seem to indicate that a multitude of cells are working inefficiently.

thermal imaging camera. "Not only does the FLIR T335 thermal imaging camera combine an ergonomic design with excellent image quality, it also achieved the best result in our comparative test by finding the hot spot long before the others did. That's why we decided to buy the FLIR T335 thermal imaging camera."

Choosing your angle

But Mr. Kimpel did not just choose the FLIR T335 for the camera quality, ergonomic design and its useful features: "The training we receive from FLIR Systems is just as important", explains Mr. Kimpel. Although all FLIR thermal imaging cameras are designed for easy operation, there is a lot more to thermal imaging than just knowing how to handle the camera. "When you use the thermal imaging camera to look at solar panels from the front side then you have to be very careful not to jump to false conclusions due to reflection."



The amount of electricity the panel produces can quite easily be measured with the clamp meter. The measurement data are combined with the thermal image with the help of FLIR MeterLink technology.

According to FLIR Area Distribution Manager Michael Mende the viewing angle should be chosen carefully to avoid misinterpretation of thermal images due to heat emitted by surrounding objects that are reflected in the glass. "Pointing the thermal imaging camera at the solar panel perpendicularly would provide the best result, because emissivity is at its highest when the angle is perpendicular, and decreases with an increasing angle, but in the case of a perpendicular angle the reflection of the camera and the operator might be seen in the thermal image. Therefore a viewing angle of 5–60° (where 0° is perpendicular) is seen as a good compromise."

An even better way to solve this problem, according to Michael Mende, is to avoid reflection altogether...

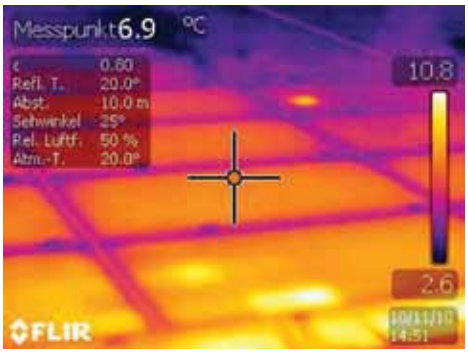
Looking at the opposite side

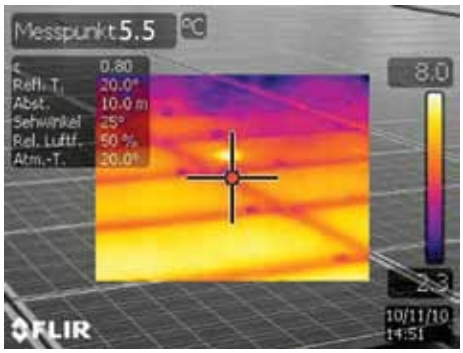
The best way to solve this problem is to avoid reflection altogether. "It's not always an option in solar panels that have been installed on a roof, but with the solar panels on the parking lot of Solartechnik Stiens that are mounted on poles it is possible to take a thermal imaging camera and point it at the back of the solar panel. The back of the panel doesn't reflect thermal radiation as much, so you can more accurately measure the temperature of the solar panel."

Inspection from the back shows no hot spots, the hot spots in the previous thermal image taken from the front were caused by reflection.

MeterLink

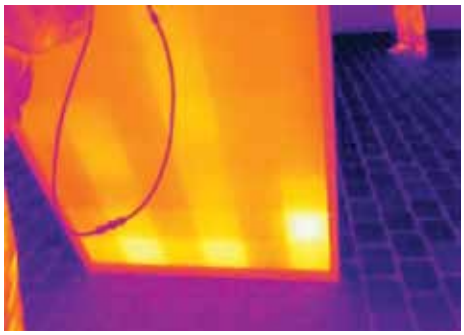
Along with the FLIR T335 thermal imaging camera Solartechnik Stiens also bought

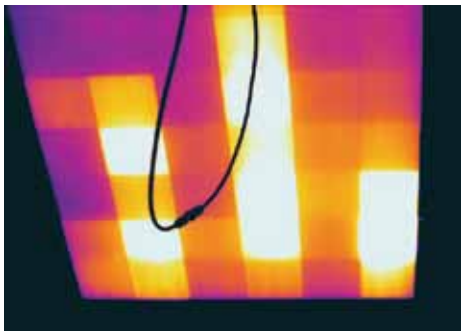




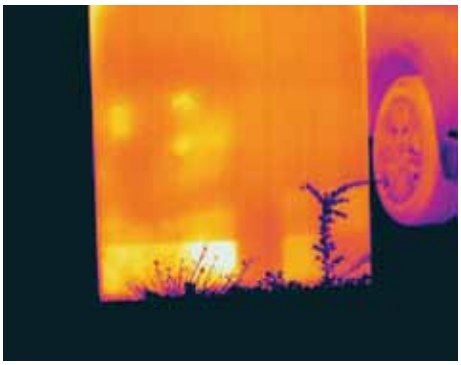
The Picture-in-Picture feature allows the user to overlay the thermal image directly over the corresponding visible image. At the push of a button the user can simply move, resize, and reshape thermal images inside the visual image.

The FLIR T-Series of portable thermal imaging cameras takes ergonomics, weight and ease-of-use to a new level.

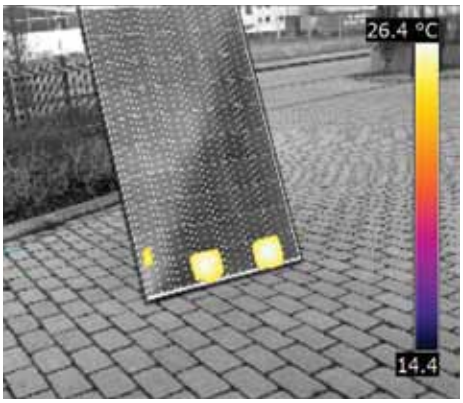




These images taken from the back of the same solar panel show much less reflection than the front, making the temperature measurements much more accurate.



These hot spots seem to indicate inefficient solar cells, but closer inspection shows that several of the hot spots are caused by the reflected warmth of people standing in front of the panel.



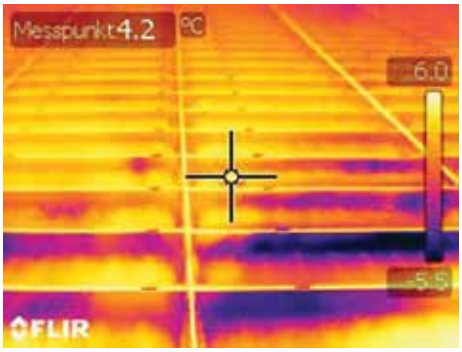
In this Thermal Fusion recording only the hot spots on the thermal image are shown.

an Extech clamp meter, because it can be connected to the FLIR T335 thermal imaging camera through a MeterLink connection. FLIR MeterLink technology simplifies the work in electrical or building inspections by making it possible to transfer the measurement data of the clamp meter via Bluetooth to the FLIR thermal imaging camera. This saves time and eliminates the risk of erroneous records or notes. "Before we could connect the FLIR T335 thermal imaging camera with the clamp meter via MeterLink we had to manually write down the measurement values of the clamp meter in our notebook. With FLIR MeterLink that information is automatically combined in one report."

Fusion and Picture-in-Picture

Another useful feature of the FLIR T335 thermal imaging camera is the possibility to combine a visual image with a thermal image. The FLIR T335 thermal imaging camera has two different methods: Thermal Fusion and Picture-in-Picture.

These two features of the FLIR T335 make it easy to create compelling reports and communicate trouble spots to colleagues or clients. The Picture-in-Picture feature allows the user to overlay the thermal image directly over the corresponding visible image taken with the integrated 3.1 megapixel photo camera. This functionality combines the benefits of both the infrared image and visual picture at the push of a button. The user can simply move, resize, and reshape thermal images inside the visual image.
The FLIR Fusion technology takes the integration of the visible photo and thermal image one step further. It allows certain temperature ranges of the thermal image to be super-imposed over the visual image, for instance by showing only the hot spots.



This thermal image quite clearly shows that reflection can pose a problem when monitoring solar panels: the thermal imaging camera records the reflected thermal image of the cloud instead of measuring the temperature of the panel itself.

"The Picture-in-Picture and Thermal Fusion features are very useful to quickly communicate to colleagues or clients where the inefficient solar cells are located, for some people find it difficult to see what part of the solar panel they're looking at if all they have to go on is the thermal image."

FLIR QuickReport

For compiling reports Mr. Kimpel uses FLIR QuickReport. "It's quite simple and very easy to use", explains Mr. Kimpel. FLIR QuickReport, allows users to organize and analyze the radiometric images from their thermal imaging cameras and present them in a report in just three easy steps.

Not only does the software allow the user to change the color palette and the temperature contrast to bring out the smallest details, it also incorporates the measurement data received from the Extech clamp meter through the MeterLink connection in the report.

"The FLIR T335 really helps us to ensure that all our solar panels meet the stringent quality criteria for which Solartechniek Stiens is renowned", concludes Mr. Kimpel.

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