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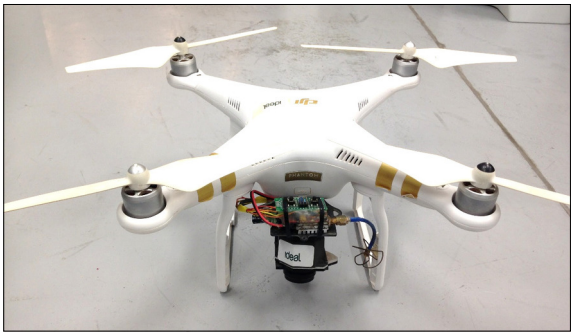
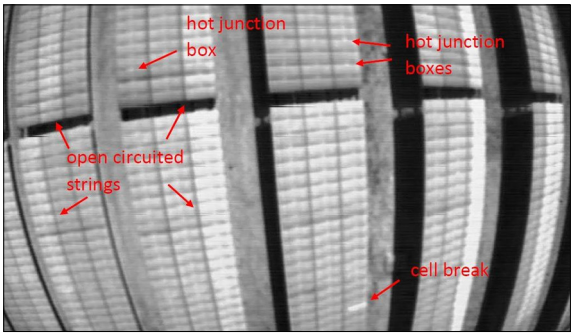
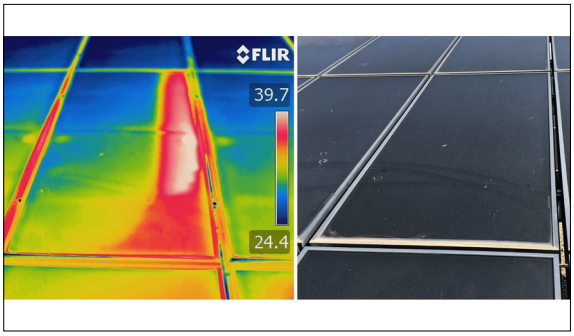
Infrared Imaging of Thin Film PV Plants Using Aerial Inspection



Drone equipped with infrared camera used in the aIRT measurements



Infrared image taken by the drone from 20 m altitude shows different faults in the PV plant in Tubarão



Infrared image (left) taken by the handheld camera shows a hot spot caused by broken cells (right)

Introduction: The photovoltaic (PV) market has been growing exponentially in the past years and so has the share of PV in the electricity grid. PV plants have become a subject of big investments. In order to guarantee the stability of the electricity grid and the rentability of the investment, the reliability of a PV plant is of high importance. This requires a well-functioning O&M, including an inspection method to detect faults in the plant. A fast and flexible inspection method is the aerial infrared thermography (aIRT), where an infrared camera is mounted on a drone to detect the heat producing faults. There is a lot of research in the field of aIRT of crystalline silicon (c-Si) PV but only very little of thin film.
This thesis investigates the aIRT inspection of thin film PV plants and attempts to answer questions like: How practical is aIRT to detect faults in thin film PV plants? Which faults can be detected and which not? How do the procedure and results differ from aIRT of c-Si PV?

Procedure / Result: In order to answer these questions, aIRT measurements were carried out on an R&D PV plant in Tubarão, a city in the state of Santa Catarina in the south of Brazil, as well as at the laboratory of Fotovoltaica UFSC in Florianopolis, also in Santa Catarina. Additional data were used from aIRT measurements of a 37 MWp thin film PV plant in the northeast of Brazil. A drone equipped with an infrared (IR) camera, a handheld IR camera, a digital camera and other measuring devices were used during the measurements on these three sites.

Result: This thesis showed that the aIRT inspection is a fast and practical method to find faults in thin film PV plants. The following faults are detectable by aIRT from 20 m altitude: open strings, short circuits, bypassed modules, glass breaks (if in superstrate configuration), cell breaks (if break leads to hot spot), hot junction boxes and bad solderings
Other faults are not detectable by aIRT, namely: glass breaks (if in substrate configuration) and cell breaks (if break doesn't lead to hot spot)
The inspection of a 1 MWp thin film PV plant of 1.4 hectares takes 12 minutes and the analysis of the recorded videos around 30 minutes. If the flights are performed in higher altitudes, the inspection time reduces significantly (3.5 min in 50 m altitude) but some faults become undetectable. An angle of view of 90° to the surface of the module is recommended for a good detectability of the faults. However, some faults were better visible from different angles because of reflections occurring during the measurements.
The comparison of aIRT of thin film and c-Si PV showed that the procedure and time of the inspection are the same for the two technologies. Only the higher reflexivity of the thin film modules increase the importance of clear sky conditions during the inspection. The detected faults are mainly the same in both technologies, just the shapes of the hot spots differ because of the different shapes of the cells.