Study Committee D1

Materials and Emerging Test Techniques

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Power generation by unhealthy photovoltaic modules

R. RAIMUNDO[1], A. COELHO[2], R. MARTINS[2], I. CATARINO[1]

[1]NOVA School of Science and Technology, [2]EDP Labelec

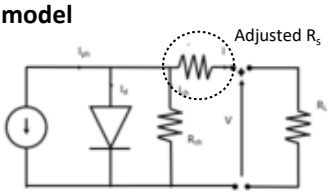
Motivation

- A photovoltaic module can **deteriorate over time** due to the environmental conditions, manufacturing, transport, and installation process.
- This degradation can lead to a **decrease in the performance**, resulting in a variation in energy production.
- For this reason, it is **important to study the defects of photovoltaic modules**, in order to minimize energy loss and ensure greater use and efficiency of this energy source.
- One of these defects is the presence of **hotspots**, which can be detected through a non-destructive test called **infrared thermography**.
- This article aims to relate the level of severity of a **hotspot anomaly** with its impact on the **energy production** of a PV module
- This analysis intends to develop a model to help PV asset management, helping to estimate and evaluate the impact of hotspots defects.

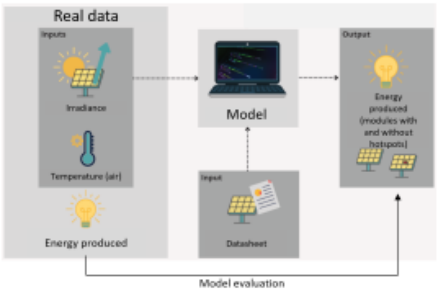
Method/Approach

- A model that describes the electrical behaviour of a healthy photovoltaic module - **1 diode and 5 parameters** - was **adapted** in order to build tool suitable to evaluate the energy production of PV modules with **hotspots**.
- **Real data** was used to validate the model – 2 years

The model



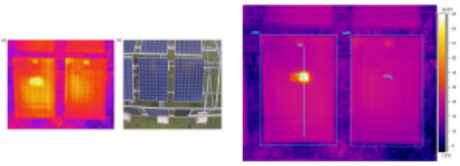
The workflow



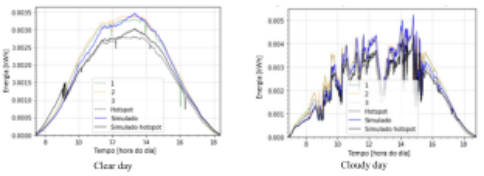
Experimental setup/Results

- Test installation

- Hotspot characterization



- Model results – energy produced on clear and cloudy day



Discussion/Conclusion

- In the validation of data referring to the **healthy module**, it was found that the average error between the modeling of the photovoltaic module and the experimental data is always **less than 10%**.
- For the **module with hotspot**, the developed model allowed to obtain results with an error of **less than 17.5%**. The model presents a worse performance for this type of modules because it is a less consolidated model.
- In 2017 and 2018 there was a loss of energy production for the module with hotspot (whose temperature difference between the healthy region and the region that has the defect is about 13ºC **)** of 92.8 kWh, which corresponds to a **loss of 9.4%,** relative to a healthy module.
- With this work, a decision-aid tool for the management of photovoltaic energy production systems was developed, enhancing **and quantifying the importance of the thermographic inspection** of this type assets.
- As future work, the model can be further developed using a more significant sample of data from modules with hotspots, allowing a deeper understanding of the impact of defect severity on energy production.