Measurement Methods Improvement for Solar Cells under Spatial Conditions

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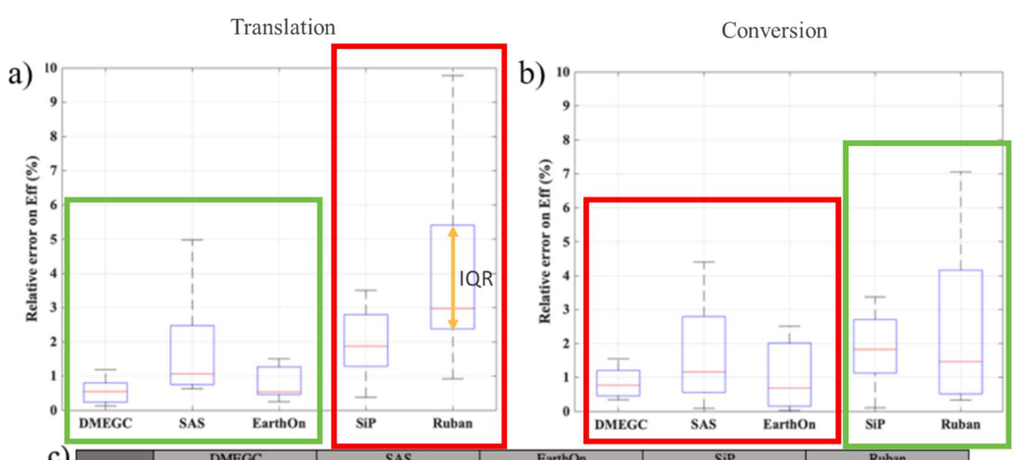
Assessment of solar cells (SC) characteristics indoor under standard conditions has been a challenge since the beginning of the industrialization of photovoltaic technologies. To do so, solar simulators that can extract the electrical characteristics of a cell under an illumination close to the sun's one are used. Because most solar simulators are designed for terrestrial applications, a given simulator does not necessarily have the optical and the calibration devices that allows the measurement under spatial conditions. The goal of this work is therefore to assess if there is a possible way to estimate the data (efficiency for instance) of cells under spatial conditions from the ones measured under terrestrial conditions and to evaluate the robustness of the found method experimentally.

In order to convert the characteristics of the SC under AM0 spectrum to the data under AM1.5 spectrum, two models were studied: the "conversion" model, and the "translation" model. The "conversion" model is based on the derivation of the diode equation for an ideal SC (shunt and serial resistances equal to 0). The principle is to take some quantities of interest in the I-V curve (short circuit current, open circuit voltage, fill factor and efficiency) and to convert each of them from their values under AM1.5 to their values under AM0 by using simple arithmetic relations (see fig 1) and spectral response measurements. The "translation" model differs from the first in that it does not only convert few points of the curve but also translate it point by point. The mathematical model to undertake the translation is taken from a publication of Cesar Dominguez [1] with parameter calculated with Suckow model [2].

For this study, a set of calibrated SC and five silicon different types of SC were used: SAS p-type Al-BSF (Back Surface Field), DMEGS p-type PERC (Passivated Emitter and Rear Cell), Earth On n-type PERT (Passivated Emitter Rear Totally Diffused), "Ruban Cells" made with glued interconnexion, and p-type solar cells irradiated. From the table below, it can be noticed that for the DMEGC, SAS and EarthOn cells, the translation model seems to give better results than the conversion, and conversely for the SiP and Ruban cells for which a difference of 1.5% between the two models can be denoted. This suggests that the translation model might perform better on good quality cells. Also, the analysis of the interquartile ranges shows that the dispersion of the errors is higher for the conversion model than for the translation. To find a distribution that describes properly the experimental, a kernel Density Estimation method is used [3]. Errors of 5.6 % and 3.9 % are found respectively for the translation and the conversion model with a 95 % confidence. For the moment, Both models can be used to get a first idea of the efficiency of SC under AM0 from data under AM1.5, and we have to perform measurements with a larger dataset.



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	DMEGC		SAS		EarthOn		SiP		Ruban	
	Translation	Conversion	Translation	Conversion	Translation	Conversion	Translation	Conversion	Translation	Conversion
Median (%)	0.55	0.77	1.06	1.16	0.54	0.68	1.87	1.83	2.97	1.46
IQR (%)	0.55	0.75	1.73	2.24	0.80	0.88	1.51	1.57	3.03	3.64

Fig 1: Relative errors on the efficiency with translation model (a) et conversion model (b).

References

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