VII. Photovoltaics

PCB design, realization and characterization of local DC-DC convertor for smart configurable PV modules

It is well known that photovoltaic (PV) modules yield a lower energy in the field than what could be expected from their rated power, indicated as "Watt-peak (Wp)". The latter is measured under so-called "standard test conditions" but in climates like Western Europe, these are rarely met. In fact, the main energy yield losses (kWh/kWp) in these climates, can be attributed to a reduced illumination resulting in lower current, and non-uniform illumination conditions (shading, clouds, soiling, ...) leading to current mismatch in the serially connected cells inside the module. In order to maximize the power production of PV modules working under non-uniform illumination conditions, we are building advanced "smart" PV modules able to dynamically establish different non-series topologies. We want to build such configurable module demonstrators with specific topologies to test our research concepts, and to validate them by experimentally evaluating the Energy yield gain they allow for when working under non-uniform and dynamic irradiation and shading conditions. We also want to compare them with respect to standard state-of-the-art serially connected topologies. Currently, we are mainly interested in designing, prototyping and testing local DC/DC converters to finalize the first smart PV module demonstrator. The circuit design is innovative because voltages up to 10V input and 30V output, and current levels up to 15-20A have to be sustained while strongly minimizing cost and achieving acceptable losses and efficiency. And that is not achieved yet in commercial module and strong convertors. The MSc activity will firstly focus on PCB-level realization, characterization and testing of a switched-capacitors circuit concept which has already been simulated at imec. But now we want to build it in hardware. Later on, the MSc will also deal with the exploration of novel cost-effective inductor-based converter topologies. The entire project will have a clear impact on relevant aspects of the future photo-voltaic energy landscape. It combines mostly practical skills with a more in-depth analysis of the obtained results. The MSc activities will be co-guided with colleagues from the Ghent University and the MSc activities will mainly take place at their location. Considering the variety of challenges to be addressed, it is important for us to have a candidate who already has previous hands-on experience with electrical measurements and convertor characterization. A strong background in the domains of power electronics, preferably applied to photovoltaic sources, and control is desirable. However, given that we work on this with a team, the specific focus of the MSc subgoals within the topic can be adapted to some extent to the interest of the applicant.

Type of project: Thesis or internship project, or combination of both

Degree: Master in Engineering Technology or Master in Engineering majoring in electrotechnics/electrical engineering, energy

Responsible scientist(s):
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Advanced thin film solar cell architectures

The field of photovoltaics (PV) is composed of thin film (TF) and silicon (Si) solar cells, where TF solar cells have a rather simple cell structure, while the typical Si solar cell design is more complex as it is optically and electrically optimized. Standard TF solar cell devices are grown layer by layer on a rigid or flexible substrate. For example for copper indium gallium (di)sulfide or (di)selenide (Cu(In,Ga)(S,Se)2 = CIGS(e)) solar cells: First a molybdenum (Mo) rear contact is deposited, then the
– typically 2.5 to 3.0 µm thick – CIGS(e) absorber layer, followed by a CdS buffer layer, and completed by an i-ZnO/ZnO:Al window layer. The typical Si solar cell design is more advanced, as it includes concepts to improve front and rear surface passivation, and optical confinement, as is the case for the passivated emitter and rear solar