School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Funding and application details

Funding status: Self funded students only

Application instructions:
Detailed instructions are available at https://blogs.napier.ac.uk/scebe-research/available-phd-student-projects/

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:

- DIRECTOR OF STUDY: Dr Firdaus Muhammad Sukki (Email: F.MuhammadSukki@napier.ac.uk)
- 2ND SUPERVISOR: Dr Nazmi Sellami

Subject Group: Engineering & mathematics

Research Areas: Energy Technologies

Project Title: Non-Imaging Cheap Highly Efficient solar concentrator for building integrated photovoltaic (PV) system - (NICHE-PV)

Project description:

Solar photovoltaic (PV), which is one of the technologies that harness solar energy by converting the sunlight directly into electricity, grew by more than 100 folds from 2000 to 2013. However, more needs to be done to ensure that renewable technologies, especially solar PV, are more widely adopted in order to reduce climate change. One of the problems that surround the PV technology is its high cost of implementation and the largest proportion of the cost (approximately 45%) was due to the expensive PV material used in the fabrication of the module. It is argued that by reducing the usage of PV material in a PV module, it is possible to

achieve a cheaper PV system; which could further attract more consumers into opting and installing this technology.

A possible way to reduce the amount of expensive PV material and therefore the cost of the PV modules and the PV systems is by using a solar concentrator. This is a device (mainly constructed from a low cost refractive and/or reflective material) that focuses the solar radiation from a large entrance aperture area into a smaller exit aperture where a solar cell is attached. This allows the system to generate a similar or higher electrical output than a conventional PV system, while at the same time using only a fraction of the PV material.

The NICHE-PV project proposed here is aim at developing a second generation concentrator for use in building integration. The concentrator will be different from existing alternatives in its novel design. It should be capable of providing larger gains than existing optics, making the design more compact, lighter and/or cheaper. This project not only involves the creation of a new alternative design to traditional solar PV panels, but a design that is also cheaper, easy to mass manufacture, and appealing to the market. The proposed project has several objectives that need to be addressed to ensure that this product can be commercialized and is available into the market. These objectives include: (1) To carry out simulation on the performance in selected environment; (2) To fabricate and assemble a small and large prototype of the panel; (3) To carry out experimental validation indoor and outdoor; (4) To identify the best manufacturing, assembly and integration technique; (5) To evaluate the cost analysis and market analysis for implementation in selected countries, and (6) To perform experimental prototype for interfacing the proposed PV system with a typical islanded load/microgrid.

References:

[1] D. Freier Raine, F. Muhammad-Sukki, R. Ramirez-Iniguez, T. Jafry, and C. Gamio, “Indoor performance analysis of genetically optimized circular rotational square hyperboloid (GOCRSH) concentrator”, Solar Energy, vol. 221, pp. 445-455, 2021.

[2] F. Muhammad-Sukki, H. Farooq, S. H. Abu-Bakar, J. A. Ardila-Rey, N. Sellami, C. Kilpatrick, M N. Muhtazaruddin, N. A. Bani and M. Zulkipli, “Modelling of a static concentrating photovoltaic: Simulation and experimental validation”, Applied Sciences, vol. 11, no. 9, pp: 3894:1-19, 2021.

[3] S. Foster, F. Muhammad-Sukki, R. Ramirez-Iniguez, D. Freier, J. Deciga-Gusi, S. H. Abu-Bakar, N. A. Bani, A. B. Munir, A. Abubakar Mas’ud and J. A. Ardila-Rey, “Assessment of the RACPC performance under diffuse radiation for use in BIPV system” Applied Sciences, vol. 10, no. 10, pp. 3552:1-11, 2020

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in relevant discipline such Electrical & Electronics Engineering, Mechanical Engineering, Renewable Energy, or Materials Science.

Subject knowledge:

- An MSc in a relevant subject is highly desirable with a good fundamental knowledge of chemistry, opto-electronics and heat transfer.

Essential attributes:

- Experience of fundamental engineering, particularly in chemistry, opto-electronics and heat transfer.
- Competent in programming language, e.g. MATLAB/Simulink.
- Knowledge of CFD is advantageous.
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management.

Desirable attributes:

- Have a knowledge in ray-tracing software such as ZEMAX, APEX or COMSOL.