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

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply

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: Development of solar concentrator for hydrogen production in solar thermochemical water-splitting cycle

Project description:

The UK has set an ambitious commitment of achieving net zero by 2050. Low carbon hydrogen is expected to play a vital role in the next few decades. The UK Hydrogen Strategy, published in August 2021, outlined a comprehensive roadmap for the development of a thriving UK hydrogen economy over the coming decade. Similarly, the British Energy Security Strategy published in April 2022 indicated that the UK government doubled the UK's hydrogen production ambition to up to 10GW, by 2030 which clearly placed the UK at the forefront of the global hydrogen economy.

Green hydrogen production can be generated from solar photovoltaic (PV) and electrolysis but these routes have some disadvantages; (i) Electricity is already an energy carrier, and transformation into another energy carrier, hydrogen, is, in principle, flawed, and (ii) the efficiency of commercial solar PV is relatively low, mono-crystalline cells have a solar energy conversion efficiency of approximately

21%. Production of hydrogen using the current best processes for water electrolysis has an efficiency of ~70%.

Solar thermochemical water-splitting cycles (TWSCs) use high-temperature solar heat to drive a series of reactions producing hydrogen with oxygen as a by-product. The project here aims at developing a novel concentrated solar energy to be utilised in hydrogen production through the TWSCs at much higher efficiency. By incorporating this solar concentrator plus thermal energy storage to feed the TWSC, there is an opportunity to lower the hydrogen cost production making the technology more commercially viable in the future.

References:

[1] A. Alamoudi, S. M. Saaduddin, A. B. Munir, F. Muhammad-Sukki, et al., "Using static concentrator technology to achieve global energy goal", Sustainability, vol. 11,pp. 3056:1–22, 2019.

[2] W. Q. Wang, Y. Qiu, M. J. Li et al., "Optical efficiency improvement of solar power tower by employing and optimizing novel fin-like receivers", Energy Conversion and Management, vol. 184, pp. 219-234, 2019.

[3] D. Freier, F. Muhammad-Sukki, S. H. Abu-Bakar et al. "Annual prediction output of an RADTIRC-PV module," Energies, vol. 11, no. 3, pp. 544:1-20, 2018.

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.