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 Carolina Costa Pereira (Email: c.costapereira@napier.ac.uk)
- 2ND SUPERVISOR: Dr Nazmi Sellami

Subject Group: Engineering & Mathematics

Research Areas: Mechanical Engineering, Chemical Engineering, Energy Technologies, Nanotechnology, Thermodynamics

Project Title: Photo-thermal composite Phase Change Materials for Photovoltaic and Thermal Hybrid Applications

Project description:

The UK government is committed to reaching Net Zero greenhouse gas emissions by 2050. Due to the global economic landscape and energy market, the pathway towards "Net Zero" must be accelerated to release the economic pressure on households and businesses. Among the strategies, increasing the solar capacity is vital for the goal of sustainable net-zero buildings, particularly on domestic and commercial rooftops. One priority is to increase the efficiency of existing technologies, such as photovoltaic (PV) and explore how to design and install a combination of technologies, such as rooftop PV-thermal (PV/T), battery and thermal storage.

Photovoltaic (PV) is becoming the low-cost option for electricity generation (IEA, 2022). PV panels convert approximately 20% of incident solar radiation

into electricity, and a significant part is lost, either reflected or through thermalization. This waste heat is limiting the efficiency and lifetime of the PV systems. Therefore, further efforts are required to increase their lifetime and efficiency, decreasing the cost and waste of energy. Hybrid Photovoltaic/Thermal (PV/T) technology can improve overall efficiency by more than 80% by effectively controlling the PV cell temperature and delivering renewable combined heat and power (CHP). Recent studies demonstrate that integrating phase change materials (PCMs) into PV/T systems as passive cooling or heat storage media improves system performance. However, it is necessary to develop thermal response and heat transfer in PCMs and their optimum integration into PV/T systems.

This project aims to design and develop prototype PV/T systems integrating composite PCMs with enhanced photo-thermal properties as thermal storage and passive cooling. The project will involve energy materials research to increase the photo-thermal conversation efficiency of PCMs using carbon-based and metal-oxides-based additives. Different configuration concepts of PV/T systems will be evaluated, such as air, fluid, and heat pipes, to propose a new conceptual high-performance PV/T system. Such high-performance PV/T will promote the broader utilization of solar energy, supporting the “Net-Zero" targets towards the decarbonization of heating.

The innovation potential of this project can directly contribute to two sustainable development goals: climate action and affordable and clean energy and the proposed project is aligned with the principles of responsible innovation to generate a positive impact on society ethically and responsibly.

References:

D'Oliveira, E. J., Costa Pereira, S. C., Groulx, D., & Azimov, U. (2022). Thermophysical properties of Nano-enhanced phase change materials for domestic heating applications. Journal of Energy Storage, 46, 103794.

Arshad, A., Iqrar, S. A., Costa Pereira, S. C., Shahzad, M. W., Nawaz, K., & Worek, W. (2023). Cooling performance of an active-passive hybrid composite phase change material (HcPCM) finned heat sink: Constant operating mode. International Journal of Heat and Mass Transfer, 207, 123973.

Candidate characteristics

Education:

A first degree (a minimum 2:1) in Mechanical Engineering, Energy Engineering, Material Science and Engineering, Chemical Engineering

Subject knowledge:

This project will require an interest in holistic engineering challenges, including material science, thermodynamics and heat transfer, optical physics, design, CFD and experimental work.

Essential attributes:

- Self-motivated
- Hard working
- Self-directed
- Active learner
- Enthusiastic and passionate
- Good communication and interpersonal skills.

Desirable attributes:

- Knowledge of Computational Fluid Dynamics (CFD) and MATLAB