



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 Inji Kenawy (Email: I.Kenawy@napier.ac.uk)
- 2ND SUPERVISOR:

Subject Group: Built Environment

Research Areas: Architecture, Building & Planning

Project Title: Digitally twinned rating systems for low energy housing in Scotland.

Project description:

This PhD Project aims to develop innovative 'digitally twinned' rating systems for low energy housing in Scotland. Energy efficiency is becoming a pressing issue that must be addressed in current and future housing developments. This is mainly resulting from the global climate and environmental challenges facing the world. Various low-energy solutions, certificates, and building standards have been developed to solve this issue. Among the well-established and known certificates and rating systems for low-energy buildings, are the Building Research Establishment Environmental Assessment Method (BREEAM), Passive House (PH), the Leadership in Energy and Environmental Design (LEEDS), and the Association for Environment Conscious Building (AECB). Passive House benefits have been well-established not only in energy consumption but also in relation to occupants' evaluation (Pitts, 2017). Occupants' usage is another vital determinant of energy performance for houses. The performance gap results from the difference between the actual building performance and the calculated one, which is mostly by users' behaviours. However, the research also shows how the profits associated with low-energy buildings are underrated by the public. Therefore,

linking Building Information Modelling (BIM) with low-energy design software (Cemesova, 2015), and using it to evaluate Net Zero energy buildings for existing buildings has been endorsed (Kaewunruen et al, 2019). It's also noted that low-energy buildings have been more attractive to businesses and large houses rather than social housing developments.

This project focuses on the suitability of the different low-energy building systems for Scotland's new and retrofit housing developments and their possibilities to be associated with digital technologies such as BIM and/or digital twin. The outputs of the project contribute to guiding the development of the current building regulations. Case studies will be selected as part of the research journey. The main objectives of the research are to include:

1. Reviewing and evaluating the different low energy systems, certificates, and standards for new development and retrofit projects.
2. Testing the possibility of using BIM and/or Digital twin with selected low-energy systems.
3. Developing a framework that could be used in new social housing and retrofit developments.

If you're interested in energy efficiency, housing development, retrofit projects, BIM, digital twins and building regulations the supervisory team is looking forward to reading your application.

Keywords: Low energy buildings, Passive House (Passivhaus), BIM, digital twin, Energy Efficiency, AECB, BREEAM, LEEDS, building regulations, Building rating systems.

References:

- [1] Pitts, A., 2017, Passive House and Low Energy Buildings: Barriers and Opportunities for Future Development within UK Practice, *Sustainability*, 9 (2), p. 272, <https://doi.org/10.3390/su9020272>
- [2] Cemesova, A.; Hopfe, C.J.; Mcleod, R.S. PassivBIM: Enhancing interoperability between BIM and low energy design software. *Autom. Constr.* 2015, 57, 17–32.
- [3] Kaewunruen, S., Rungskunroch, P, and Welsh, J., 2019, A Digital-Twin Evaluation of Net Zero Energy Building for Existing Buildings, *Sustainability* 11(1), p. 159; <https://doi.org/10.3390/su11010159>

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Architecture, Built Environment, Urban Development

Subject knowledge:

- Urban Studies and
- Sustainable Cities

Essential attributes:

- Environmental Design, Built environment studies, BIM and digital twin, academic writing, research methods, critical analysis.