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. Lina Khaddour (Email: L.Khaddour@napier.ac.uk)
- 2ND SUPERVISOR: Prof. Sam Hart

Subject Group: Built environment

Research Areas: Architecture, Building & Planning

Project Title: Development of comprehensive multi-residential building retrofit, using archetype, cost-optimal and net-zero approach

Project description:

Purpose:

Scotland's existing housing sector contributes 6.3 million tones of CO2 annually, accounting for

approximately 13% of the nation's emissions. Edinburgh and its partners in the ESESCR (Edinburgh and Southeast Scotland City Region) face major challenges being committed to an 80% reduction in carbon emissions by 2050, with housing accounting for 27% of total current emissions. To meet its 2045 net zero target, Scotland will have to upgrade and retrofit approximately 2.6 million homes;

potentially 113,000 homes each year. Hence, this demand is challenged by shortages and skills gap identified in Highland and Islands and particularly in southeast Scotland. These multiple pressures of growing housing demand, an ageing workforce, skills shortage and an ageing population mean that smarter archetyping methods, to increase the rate of multi-residential buildings retrofit solutions, are needed throughout Scotland.

The developed comprehensive multi-residential building retrofit, using archetype, cost-optimal and net-zero approach will be applied to existing housing stock in the Scotland climate zones. This will stimulate the retrofit market productivity and increase the pace of retrofitting. This project will produce digital twins for a suite of standardised multi-residential building archetypes with whole life performance specifications that allows innovation of housing retrofitting to be scaled up to levels that meet Scotland's housing demand and a significant step towards the 2045 Net Zero Carbon targets as well as the City of Edinburgh Council plans to be carbon neutral city by 2030.

Aim and objectives:

The aim of the PhD project is for a candidate to investigate the route to efficient multi-residential building retrofit productivity through a blend of archetype, whole life cost and net zero approach of homes aiming to achieve net-zero criteria by 2050 through imposed targets set in Scotland. This project will address the multiple pressures of growing existing housing retrofitting demand, ageing workforce and skills shortage by using archetyping smart methods to increase the rate of retrofitting solutions. Archetyping will specifically help to accelerate the uptake in Scotland multi-residential building retrofit providing a satisfactory compromise between accuracy and speed of simulation. There are three main objectives:

1. Evaluate the key archetypes within the multi-residential building stock in Scotland using Building Information Management BIM in aid of the standardised retrofitting scenarios;
2. Assess the representativeness of archetypes, testing and checking suitability in relation to costing and net zero targets for current state retrofitting scenarios;
3. Develop comprehensive model combining energy signatures and building energy simulations using archetype, cost-optimal and net-zero approach.

Expected outcomes:

Developing low-carbon multi-residential building retrofit approach requires an integrated approach to capture the aggregated impact of new energy efficiency policies and measures. This approach will combine energy signatures and building energy simulations of various measures in order to

evaluate their potential outcomes in terms of energy savings and emissions reductions. Therefore, a

methodology calibrated engineering models combined with building energy simulation tools will enable reliable simulations to be derived with this PhD and published for the wider benefit of the UK construction industry.

This project will demonstrate innovation in the public, construction and academic sectors and will act as a platform for greater use of more advanced multi-residential building methods in the Scottish Government's Affordable Housing Supply Programme. It is expected that this model will be replicable and increasingly be adopted by the wider housing market.

References:

[1] Climate Change Committee

[2] Environmental Audit Committee

[3] Panagiotidou, M., Aye, L., & Rismanchi, B. (2021). Optimisation of multi-residential building retrofit, cost-optimal and net-zero emission targets. Energy and buildings, 252, 111385.

[4] Lopes, J., Oliveira, R. A., Banaitiene, N., & Banaitis, A. (2021). A staged approach for energy retrofitting an old service building: A cost-optimal assessment. Energies, 14(21), 6929.

[5] Zhang, H. (2021). Energy retrofit evaluation in residential construction: a life cycle thinking approach (Doctoral dissertation, University of British Columbia).

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Built Environment subject i.e. Civil / Structural Engineering; construction management; Architectural Technology; Sustainable Built Environment or equivalent

Subject knowledge:

The candidate should have fundamental knowledge of sustainability, sustainable building technologies and the built environment.

Essential attributes:

- Knowledge of retrofitting
- Capable of collecting and analysing data sets and undertaking complex predictive modelling
- Competent communicator capable of engaging with industry and external stakeholders
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:

- supply chain management
- Risk management
- LCA
- LCC