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: Stathis Tingas (Email: E.Tingas@napier.ac.uk)
- 2ND SUPERVISOR: Neil Urquhart, Firdaus Muhammad-Sukki

Subject Group: Engineering & mathematics

Research Areas: Mathematics, Mathematical Modelling, Applied Mathematics, Biological Sciences, Computational Biology

Project Title: Modelling and optimisation of infrastructure for the decarbonisation of transport in rural areas

Project description:

The decarbonisation of the transport sector (primarily through electrification) has become one of the priorities of most advanced economies nowadays, including the UK, in the fight against climate change. This transformation is usually supported by national legislation that aims to facilitate the transition to more environmentally friendly technologies. For instance, the UK has recently mandated the ban on all new petrol and diesel car sales by 2030. Similar initiatives were undertaken by other countries like the Sweden, Norway, Denmark, Austria, Japan, Italy and many others.

In 2021, 18.6% of the new car registrations in the UK were plug-in EVs (BEVs and PHEVs), a significant increase from 2020 when only 10.7% of the new car registrations were related to plug-in EVs. Yet, in 2022, the share of new plug-in sales has been 20.6%, a negligible increase compared to the previous year. Hydrogen fuel cell electric vehicles (FCEVs) are perceived as an alternative to BEVs and PHEVs, albeit their retail prices are still inaccessible to most buyers. Yet, it is expected that FCEVs will be an important part of the decarbonisation process and will eventually take a considerable part of the market share.

A necessary condition for the effective adoption of BEVs, PHEVs and FCEVs is the availability and accessibility to the required infrastructure, i.e., charging/refuelling stations. The UK EV infrastructure strategy has a provision that more than 300,000 charging points will be available by 2030. The available technologies for such stations currently can vary a lot hence the decision on the appropriate type is not straightforward. In addition to that, the exact location for the installation of a charging point is usually the result of an optimisation process where parameters such as the potential available users, safety, accessibility, land use, visibility, surrounding street network, traffic flow and many others are factored.

Optimisation approaches have been studied extensively in urban setups, however, there is limited understanding on the required approaches and appropriate technologies (e.g., types of charging stations, charging vs H2 refuelling stations, etc) to be used in rural setups, where the demands and the available solutions will be widely different. This becomes of paramount importance for countries like Scotland that are predominantly rural; with a population density 70 people per km2, 91% of Scotland's population lives in communities, which make up only 2.3% of Scotland's total land area.

The objective of this work will be to develop appropriate models for establishing networks of charging and/or refuelling stations appropriate for rural areas, using evolutionary and machine learning algorithms. These models will need consider among others, the requirements of the distribution network (centralised vs decentralised), the possible revenue, the available public transport, the convenience of the users, the renewable energy sources, the local geography and others.

References:

[1] 1. Kchaou-Boujelben, M. (2021). Charging station location problem: A comprehensive review on models and solution approaches. Transportation Research Part C: Emerging Technologies, 132, 103376.

[2] 2. Gupta, R. S., Tyagi, A., & Anand, S. (2021). Optimal allocation of electric vehicles charging infrastructure, policies and future trends. Journal of Energy Storage, 43, 103291.

[3] 3. Metais, M. O., Jouini, O., Perez, Y., Berrada, J., & Suomalainen, E. (2022). Too much or not enough? Planning electric vehicle charging infrastructure: A review of modeling options. Renewable and Sustainable Energy Reviews, 153, 111719.

[4] 4. Ahmad, F., Iqbal, A., Ashraf, I., & Marzband, M. (2022). Optimal location of electric vehicle charging station and its impact on distribution network: A review. Energy Reports, 8, 2314-2333.

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Electrical Engineering, Mechanical Engineering, orCivil Engineering

Subject knowledge:

- Optimisation approaches

Essential attributes:

- Experience of fundamental modelling of complex systems
- Competent in programming and using MATLAB.
- Knowledge of features and requirements of basic infrastructure for electric vehicles of all types.
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:

- Knowledge of/Experience in using machine learning and/or evolutionary algorithms.
- Experience in undertaking independent research.
- A completed or near completion MSc in a relevant subject area.