THE FARADAY INSTITUTION Modelling

MULTI-SCALE MODELLING

Environmental impact assessment comparing LIB and NIB material extraction and processing

Project Description

The significantly increasing demand for lithium-ion batteries (LIBs) for EV and grid storage applications puts pressure on critical raw materials such as lithium, cobalt and graphite. Development of "beyond-lithium" technologies such as sodium-ion/Na-ion batteries (NIBs) has been hailed as being a cheaper alternative to lithium-ion batteries (LIBs), because sodium is cheap, abundant and geographically evenly distributed. However, no in-depth analysis, comparing the economic and environmental gains/losses between mining and recycling of Li and Na and their impact on the overall life cycle cost and sustainability, has been done to confirm this. To truly compare the two battery types, a lifecycle assessment (LCA) of both needs to be performed in a consistent manner, comparing the environmental impacts of all processes involved in extracting, processing, manufacturing, using and recycling or disposing of both NIBs and LIBs. In this work, the student will focus on the early lifecycle stages of materials sourcing and processing and will assess the impacts of all processes required for mining and materials processing of both LIBs and NIBs. We want this project to answer the question of whether, in terms of the early lifecycle stages, replacing LIBs with NIBs is worthwhile, looking into the following sub-questions:

- What are the environmental gains/losses of the Li mining and refinement processes?
- What are the environmental gains/losses of the Na mining and refinement processes?
- What are the lessons learned for both materials?
- What are the environmental "clean-up" requirements for the materials extraction and processing stages of both NIBs and LIBs?

Project Objectives

- Using process flowcharts, which we will supply and are also available in the literature, compare and assess the environmental impacts involved to extract Li vs Na.
- Put the data and calculations into a spreadsheet model which is well structured and can be easily adjusted, as required (particularly considering that the model could be used to analyse extraction processes for other minerals, too).
- Draw comparisons and conclusions from the data.

Learning Objectives

- Understanding of the working principle of batteries and applications
- Obtaining insights into the battery value chain, associated challenges and key solutions
- Development of techno-economic models tailored towards engineering problems
- Understanding of materials extraction and processing for LIBs and NIBs

Funding

A salary of £9.50/hour across the UK or £10.85/hour in London will be provided. This will be determined by the working address of the appointee, not the university's location. The internship is a full-time role for 8 weeks beginning in June-early July. The funding is provided by The Faraday Institution.

Eligibility

In order to be eligible for the Faraday Institution's FUSE funding, you will need to:

- Be a fully registered student at a UK university; and
- Not be in your final year of undergraduate study.

This project can be executed entirely remotely.

To apply:

Please send your CV and a brief cover letter to j.edge@imperial.ac.uk and llander@ic.ac.uk by **30th April 2021**.

The criteria for selection will be:

Essential: a clear rationale for applying for the position and how it fits with the candidate's career goals.

Essential: evidence of interest and motivation for the research area.

Essential: familiarity with Excel spreadsheets.

Essential: ability to document work done and flexibility to discuss slides on ongoing results of the project with the supervisor weekly and update the supervisor promptly on any challenges faced.

Desirable: some experience in a high level programming language, preferably Python or MATLAB.

Imperial College London is committed to providing a supportive and considerate community, based on diversity, mutual respect and a commitment to excellence. Imperial College London was a founder member of the Athena Swan Charter, which recognises and celebrates good employment practice undertaken to address gender equality in higher education and research. Imperial College London received the institutional Silver award in 2012 and the Department of Mechanical Engineering at Imperial College London was recently awarded an Athena Swan Bronze Award.