TARGET Project Proposal Form – 2025 entry

First page not sent out in adverts

Project Title	Low-emission value chain for mineral processing facilities through renewable energy integration
University (where student will register)	University of Aberdeen
Which institution will the student be based at?	University of Aberdeen
Theme (Max. 2 selections)	Sustainability Strategy
Key words	Low-emission, renewables, value chain, mineral processing, geospatial
Please explain how the project fits within the NERC remit	While the focus of this project is on making the mineral sector more sustainable and low-emitting, the project further involves sufficient applications of geospatial tools in achieving these objectives. Thus, the key NERC themes (https://www.ukri.org/councils/nerc/guidance-for-applicants/how-to-submit-your-application/research-area-selection-in-je-s/) targeted by this project include "Pollution, waste and resources", "Survey and monitoring", and "Technology for environmental applications".
Supervisory team (including institution & email address)	**PI:** Dr. Lydia Sam University of Aberdeen; email: lydia.sam@abdn.ac.uk **Co-I:** Dr. Anshuman Bhardwaj University of Aberdeen; email: anshuman.bhardwaj@abdn.ac.uk **Co-I:** Dr Pablo Brito-Parada Imperial College London; email: p.brito-parada@imperial.ac.uk
Is the PhD suitable for part time study?	Yes, that's possible, but not preferable.

Low-emission value chain for mineral processing facilities through renewable energy integration

Lead supervisor: Dr. Lydia Sam, University of Aberdeen

Co-supervisors: Dr. Anshuman Bhardwaj, University of Aberdeen

Dr Pablo Brito-Parada, Imperial College London

Project Highlights:

- A workflow to assess renewable resource viability, and technoeconomic optimization model to assess the integration.
- Emissions benchmarking of mineral products via an energy audit that enables consequent energy efficiency enhancement.
- Framework development for low emission mineral value chain.

Overview:

Energy consumption in the mining and mineral processing sector plays a notable role in greenhouse gas emissions, contributing to 10% of global emissions as of 2018. This high percentage is primarily due to the energy-intensive characteristics of the mineral industry, which accounts for 38% of energy consumption within the industrial sector. As a result, energy expenditures represent 15-40% of operational costs across various mineral industries (Azadi et al., 2020). Research has shown that integrating renewable energy sources can lead to significant reductions in these costs (Haas et al., 2020). In the past decade, the levelized cost of electricity (LCOE) for solar and wind technologies has decreased considerably, surpassing that of fossil fuels and enhancing their feasibility (IRENA, 2022). Consequently, adopting renewable energy is advantageous for the industry, offering reductions in both energy expenses and emissions while simultaneously adding value to products.

This project intends to create an optimisation model that focuses on the technoeconomic aspects of incorporating wind and solar energy into mineral processing facilities, aiming to evaluate emission reductions in a post-integration context. Additionally, the research will establish a framework based on the findings, providing a strategic roadmap for developing a low-emission value chain in the industry. To assess the viability of renewable resource integration, a geographic information system (GIS) will be explored. An energy audit will be performed at a suitable facility to gather energy data and identify opportunities for improving efficiency. This audit will also set a baseline scenario for emissions per unit of mineral product, using Clean Development Mechanism (CDM) tools from the United Nations Framework Convention on Climate Change (UNFCCC) alongside Microsoft Excel. The design, modelling, and optimisation of the integration will further be carried out, followed by economic viability and sensitivity analysis to facilitate investment appraisals. An assessment of emission reductions will follow, quantifying the impact of the integration. Ultimately, the resulting framework will empower the mineral industry to lower energy costs and emissions, enhance production efficiency, and add product value, guiding the sector towards achieving net-zero emissions.

Figure 1: Heavy mining machinery with windmills in the background. Image taken from pexels.com (CC-0 license).

Key Research questions:

The project aims to answer the following research questions:

1. How does renewable energy integration affect operational costs in mineral processing facilities?
2. What methods can be employed to assess the viability of renewable energy sources in mining operations?
3. What are the potential emission reductions achievable through the adoption of solar and wind energy in the mineral industry?

Methodology:

Wind and solar potential modelling will be performed for a selected facility using available climatic and geospatial datasets. Furthermore, energy consumption data collection will be helpful in benchmarking current emissions using CDM tools of UNFCCC and delivering energy efficiency enhancement recommendations. Software tools will be utilised to design, model and optimise both single and hybrid integration systems. The economic model will be utilised to conduct an investment appraisal for the integration scenario and a sensitivity analysis to assess impact on system performance and economic output. A post-integration energy analysis will be conducted to measure emissions reduction by the project. Finally, a unifying framework will be developed, establishing a low-emission mineral value chain based on efficiency improvements and emission reductions.

Possible Timeline

Year 1: Completion of renewable resource assessment on a GIS platform to assess the renewable potential of a site. Collection of data such as energy consumption, operational hours, production volume and production process of each production line, and energy mix of the facility via questionnaires. Completion of emissions benchmarking (emissions per unit product) by utilising Clean Development Mechanism tools (Microsoft Excel) of United Nations Framework Convention on Climate Change. Literature review.

Year 2: Use the full year's energy consumption dataset from the site to develop load profile. Designing integration with component specifications, integration modelling and optimisation.

Year 3: Economic data collection of the region, investment appraisal by economic modelling, optimization and sensitivity analysis. Conduct emissions reduction analysis for post-integration scenario, development of low-emissions mineral value chain. Articles/thesis compilation.

Training and skills:

TARGET researchers will participate in a minimum of 40 days training over the 3.5 years of study composed of:

- an annual one-week workshop dedicated to their year group, and tailored to that cohort's needs in terms of skills development – *for the first three years of their study*;
- an annual all-TARGET workshop with cross-year interactions, advanced training and opportunities to specialise in particular areas – *all years of study*;
- a number of one-day workshops;
- additional online events and in-person workshops attached to relevant conferences.

In addition to the TARGET training, the PhD student will benefit from training delivered by the University of Aberdeen Postgraduate Research School (PGRS), including project management, scientific writing, and communicating science to a wider audience.

Partners and collaboration (including CASE):

The successful applicant will be supervised by an interdisciplinary team spanning environmental, geosciences, and engineering. The main supervisor will meet with the successful applicant on a biweekly basis and act as a mentor during the PhD process. The successful applicant will benefit from monthly meetings with the entire supervisor team. Regular exchange with co-supervisors (including TARGET partner from Imperial College London), and industry partner are central to the PhD experience. Regarding CASE partnership, while nothing is yet confirmed, we are in talks with OZ Minerals Limited, an Australian based mining company that operates in Australia and Brazil to produce copper, nickel, silver, iron and gold, crucial for energy transition. The company aims to provide scholarships for projects at five assets in Brazil to support sustainable development that leads the organization to become self-sustainable. The research project has the potential to provide the company with renewable viability assessment and technoeconomic optimization modelling resulting in technical specification and an investment appraisal.

Further reading:

Azadi, M., Northey, S.A., Ali, S.H. & Edraki, M. (2020) 'Transparency on greenhouse gas emissions from mining to enable climate change mitigation', Nature Geoscience, 13, pp. 100-104.

Haas, J., Moreno-Leiva, S., Junne, T., Chen, P.-J., Pamparana, G., Nowak, W., Kracht, W. & Ortiz, J.M. (2020) 'Copper mining: 100% solar electricity by 2030?', Applied Energy, 262, p. 114506.

International Renewable Energy Agency (IRENA) (2022) Renewable Power Generation Costs in 2021 [Online]. Available at: https://www.irena.org/publications/2022/Jul/Renewable-Power-Generation-Costs-in-2021 [Accessed 13 October 2024].

Zharan, K. & Bongaerts, J.C. (2017) 'Decision-making on the integration of renewable energy in the mining industry: A case studies analysis, a cost analysis and a SWOT analysis', Journal of Sustainable Mining, 16, pp. 162-170.

Further reading:

https://www.mckinsey.com/industries/metals-and-mining/our-insights/creating-the-zero-carbon-mine

Further details:

Please visit https://target.le.ac.uk/ for additional details on how to apply.

Contact the following for further details:

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