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A combined LCA-TEA approach for assessing the impacts of deploying waste mineralization

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There is an increasing level of interest for utilising CO_2 to treat alkaline industrial wastes evolved during energy generation, chemical processes and construction projects. Industrial wastes often contain a high content of cations (e.g. Ca, Mg, Al and Fe) that can react with carbonate ions. This makes them particularly attractive for carbon mitigation and utilisation. Globally, about 200-300 Mt of CO_2 per annum could be utilised in treating such wastes [1].

To address this, the present study presents a combined techno-economic analysis (TEA) and lifecycle assessment (LCA) of a plant utilising fly ash and CO_2 captured from typical coal power generation plants. The carbonate produced has the potential of beneficial reuse as synthetic aggregate. In addition to serving as a sink for CO_2, this synthetic aggregate has the potential co-benefits of providing profits and preventing CO_2 emissions associated with mining aggregate [2,3]. Since the investment in unproven ventures carries high risk, techno-economic analyses of up-and-coming technologies are essential to providing improved prediction of the associated expenditure and potential profits. Additionally, as the environmental benefits of novel concepts are an important criterion to guide and push future research and deployment, a comprehensive environmental assessment method is needed.

Production of waste-derived synthetic aggregates is most likely to depend on numerous factors including waste policy, economic prosperity, historic construction activity, availability of mineral resources, and construction practice. In view of these, the study deals with three different regional scenarios in order to reflect differences in market potential, economic frameworks and environmental incentives. Selection of regions was done based on economic, environmental and social factors such as GDP, energy sources and existing regulatory schemes.

Process modelling software (Aspen Plus) was utilised to organise the mass and energy streams and for each scenario, both TEA and LCA indicators were calculated, interpreted and assessed on a comparative and multi-criteria basis. Overall, a holistic approach was developed to investigate the sustainability of synthetic aggregate production routes.

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