

# Application of MCDA for ranking the social sustainability performance of alternative CCU technologies

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*Abstract*— Carbon Capture and Utilization (CCU) technologies capture CO<sub>2</sub> waste emissions and utilize them to generate new products (e.g., fuels, chemicals and materials) with various environmental, economic and social opportunities. CCU has an important role in a circular economy by changing waste emissions to a valuable resource. Moreover, following the ambitious goals developed in the Paris agreement, CCU can be considered as a potential basic unit for a wider climate change mitigation plan. However, as most of the CCU technologies are in the R&D stage, their technical and economic viability are examined with very little attention to the social aspects. Furthermore, there is only a limited perception of how companies understand the relevance of social performance concerns and what indicators they identify as specifically applicable in decision making. Therefore, in a first study we identified the social indicators that are of highest importance according to European CCU experts. To determine the relative importance of these indicators, we used a modified technique for order preference by similarity to ideal solutions (TOPSIS) method. The social indicators that were taken into account were based on the suggested list by UNEP/SETAC (2009). Accordingly, three relevant stakeholder's groups (workers, consumers and local community) are considered as the main social impact categories throughout the life cycle phases of CCUs. The results for the indicator set covers the following issues: regarding the workers group: i) Fair Salary, ii) Health and Safety, iii) Equal Opportunities/Discrimination; for the consumer group: i) End of Life Responsibility, ii) Transparency, iii) Health and Safety; and for the local community group: i) Safe and Healthy Living Conditions, ii) Secure Living Conditions and iii) Local Employment<sup>2</sup>.

In this study we will add to this work and literature by using Multi-Criteria Decision Making Analysis (MCDA) methods to assess various CCU alternatives based on the ranked social indicators. For this we select 4 (Belgian) case studies to compare the social sustainability of different CCU end products (i.e. monomers and polymers, calcium carbonate, bio-ethanol, and methanol fuels) using TOPSIS and fuzzy TOPSIS set approaches. To do so, 4 technical and managerial experts from each company are invited to a face to face interview and are asked to fill in the questionnaires developed according to the expert-based set of social indicators identified in the previous step of the analysis. Furthermore, a sensitivity analysis is performed to show how the weighting applied to each indicator affects the assessment of different alternatives. The results of our study enable companies to pay more attentions to the most important social areas when implementing CCU

technologies. The proposed method can be a useful decision making tool for policymakers to develop more effective policies and decide on priorities in the support of CCU technologies from a social perspective.

*Keywords*— CO<sub>2</sub> emissions, TOPSIS, Multi-Criteria Decision Making, Social indicator, Sustainability assessment.

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