Sustainability Assessment under Uncertainty and Risk Attribution of CO_2 Utilization Technologies utilizing Naïve Bayes Classifier

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The potential benefits and sustainability of CO_2 utilization technologies must be assessed via a holistic evaluation that involves some form of technoeconomic analysis (TEA) and CO_2 life cycle assessments (LCA). However, the current state-of-art largely fails to address the uncertainty problem in the evaluation procedure. We propose a simultaneous uncertainty-accounted assessment framework with risk attribution for a more realistic evaluation of CO_2 utilization technologies. In particular, we utilize independent Bayes classifier which is a commonly used machine learning algorithm to perform a numerical risk assessment of the CO_2 utilization technology with respect to input parameters. The advantage of this approach is that it is able to identify which technology aspects most critically contribute to the technology's ability to meet the sustainability criteria while accounting for uncertainties. We applied this framework to evaluate a biocrude production process from microalgal biomass. Results show that water content in wet biomass (52% of risk) and upstream cultivation parameters (28% if risk) were most critical factors after 100,000 Monte Carlo simulations.