

Early-stage sustainability evaluation and analysis of Carbon-to-X Technologies

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Alongside an energy revolution, there is an increasing global need to decarbonize the chemical productions industry. To this end, substitution of existing chemical production processes with carbon utilizing technologies (carbon-to-x, C2X) has been proposed, utilizing CO₂ as feedstock. The success of C2X requires large-scale deployment with renewable energy. On the other hand, most C2X technologies are nascent and are characterized by low technology readiness levels (TRLs). Thus, there is a need to identify promising and sustainable C2X technologies despite the lack of established domain knowledgebase so that R&D resources can be efficiently allocated toward the development of technologies that are likely to have the most marked effect on chemical decarbonization. To this end, we propose several methodological techniques and evaluation methods to identify promising early-stage C2X technologies. We also highlight the importance of uncertainty and how sustainability evaluations such as CO₂ life cycle analyses and technoeconomic assessments can be conducted while accounting for endogenous and exogenous uncertainties.