

Summary/Abstract

Name of Applicant: RenewCO2 Inc
Principal Investigator: Peter Shepard
Project Title: Integrated electrocatalytic conversion of CO2 from bio-ethanol emissions into carbon-negative chemicals

Project Objectives: The objective of the project is to conduct a feasibility study for converting waste CO_2 from bioethanol production to a value-added plastics monomer with RenewCO$_2$'s electrochemical process to (i) reduce the carbon footprint of the biofuel by more than 70% compared with gasoline and (ii) achieve a cost-competitive Minimum Fuel selling Price (MFSP). The proposed integrated system will be based on a Generation 1 Corn Ethanol Plant and will utilize the current CO_2 waste gas as a feedstock for the production of monoethylene glycol (MEG) via RenewCO$_2$'s electrochemical process. Further, a rigorous techno-economic analysis and lifecycle GHG benefit analysis will validate the projections using real-world processes and provide a representative sample of replicable cases to catalyze widespread adoption.

As of 2019, the carbon intensity over the life cycle of 1st Generation corn ethanol was 45 gCO_{2e}/MJ or 1.33 ton CO_{2e}/ton ethanol. Utilization of the fermentation CO_2 (0.62 ton CO_{2e}/ton ethanol) has the potential to reduce up to 47% of the overall CO_2 emissions from ethanol production. The resulting ethanol would have a footprint of 24 gCO_{2eq}/MJ, a reduction of 76% in comparison with the emissions of gasoline (100.8 g$CO_{2/}$MJ). This potential 21 gCO_{2e}/MJ reduction in carbon footprint would far exceed the Topic 4a requirement of a 3.58 gCO_{2e}/MJ reduction. It could singlehandedly meet the target of at least a 70% reduction of greenhouse gas (GHG) emissions relative to gasoline.

Project Description: RenewCO$_2$ Inc. and teammates Strategic Analysis, Inc. (SA), Porcelli Consultants, and Ace Ethanol propose an 18-month contract with DOE-BETO to conduct a cost and life cycle analysis (LCA) for the electrochemical conversion of direct CO_2 emissions from ethanol fermentation to MEG to reduce the carbon intensity of the biofuel. This work builds on continued technical de-risking and engineering of RenewCO$_2$'s technology, over twenty years of SA's past extensive work for DOE and NREL on hydrogen polymer electrolyte membrane fuel cells and electrolyzers, Porcelli's lifetime experience in conceptual design of chemical processes, especially in ethylene glycol production, and Ace Ethanol's expertise innovating in bioethanol production.

This rigorous feasibility study will include a robust techno-economic analysis (TEA) using the Design for Manufacture and Assembly methodology to project the cost of the electrolyzer systems at multiple annual rates of manufacture for current and future technologies. The Balance of Plant systems, which Porcelli specializes in designing, will be modeled for OpEx and CapEx, energy consumption, and carbon footprint. The complete system's TEA and LCA will be modeled for different scenarios of capacity utilization, power source mix, and location. Every single facet of the proposed work has been conducted by SA in some form on past projects for the DOE. Thus, SA and the team would start the proposed project with an excellent baseline body of work and an established and proven analysis methodology.