A Life Cycle Assessment of Potential Pathways to Increase Sustainable Aviation Fuel Yields Through CO_2 Upgrading Co-located with Corn Ethanol Production

Stephen McCord, Sam Talsma, Jessey Bouchard, Victor Gordillo Zavaleta, Volker Sick

Abstract

Alcohol-to-jet (ATJ) upcycling of ethanol to sustainable aviation fuel (SAF) is an attractive pathway that can improve the environmental impact of SAF production. While ultimately the production of ethanol from carbon dioxide will be necessary to cover the market demands for SAF, the technology deployment can be accelerated by using bioethanol for the up conversion and also capturing the carbon dioxide from the fermentation plants to convert that to additional ethanol in a parallel effort. The life cycle impacts of both components for SAF production were analyzed and the assessment highlights critical steps for improvements and needs for further development. In the long-term, moving away from corn-based bioethanol as a feedstock is indicated to reduce negative environmental impacts. CO_2 to SAF pathways that were examined include CO_2 conversion to ethanol using a fermentation process and subsequent upcycling to SAF. A second option is reverse water gas shift to produce syn gas for Fischer-Tropsch synthesis to SAF. The use of solid oxide electrolysis of CO_2 to CO provides quantifiable benefits. A more desirable product mix might favor the alcohol-to-jet upcycling route starting with CO_2 over Fischer-Tropsch synthesis. Overall, the conversion of CO_2 to SAF can substantially reduce the CO_{2e} footprint of SAF compared to using bioethanol upcycling.

Keywords: sustainable aviation fuel, life cycle impact analysis, solid oxide CO_2 electrolysis, alcohol-to-jet upcycling, Fischer-Tropsch synthesis