Project Summary

Applicant: University of Connecticut

Project title: Preservation and Arrested Anaerobic Digestion of Farmed Seaweeds into Sustainable Aviation Fuel

Project Participants:
PI: Mingyu Qiao, Assistant Professor of Innovation and Entrepreneurship, Department of Nutritional Sciences, University of Connecticut (UConn)
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Background: The US northeast coast is focusing on scalable seaweed farming, particularly sugar kelp (cold-water) and Gracilaria (warm-water). Seaweeds offer significant potential as renewable feedstocks for low-carbon chemicals and fuels, despite challenges like high salt content and antimicrobial compounds. The Department of Energy's Bioenergy Technologies Office (DoE BETO) aims to produce 3 billion gallons per year of sustainable aviation fuel (SAF) by 2030, achieving a 50% reduction in life cycle greenhouse gas (GHG) emissions. By 2050, the goal is to meet 100% of the projected 35 billion gallons of aviation jet fuel demand with SAF.

Previous Efforts and Knowledge Gaps: DOE-funded projects have explored SAF production from seaweeds using hydrothermal liquefaction (HTL). However, HTL's high energy demand and GHG emissions limit its adoption. There is a gap in understanding the maximum GHG reduction potential of SAF from seaweeds using alternative methods.

Project Goal: This project aims to develop a biological-based system for on-site SAF production from near-shore farmed seaweeds in the northeast coastal region, targeting over a 50% reduction in well-to-wake GHG emissions compared to fossil-based aviation fuel.

Innovations and Specific Goals: 1) Seaweed Preservation: Establish conditions for preserving farmed seaweeds for year-round operation. 2) AAD System Development: Create a controlled Arrested Anaerobic Digestion (AAD) system with membrane-based in-situ VFA recovery, doubling VFA production compared to commercial food waste AD systems while halving energy consumption. 3) Modular Fuel Upgrading: Integrate a modular catalytic fuel upgrading system to determine optimal blending ratios of seaweed-VFA-SAF into fossil jet fuel. 4)TEA and LCA: Perform techno-economic and life cycle analyses to establish the minimum blend ratio and selling price required to achieve over 50% GHG reduction.

Impact: This project will provide data to evaluate the potential of farmed seaweeds for SAF production, informing future R&D. Success will accelerate DoE BETO's goals, develop supply chains, and decarbonize the chemical industry. It will also support rural economies by converting seaweed to jet fuel with minimal chemical and energy use, promising significant environmental and economic benefits.