Algal Turf Scrubbers: Improving Carbon Utilization and Productivity (ATS: CUP)

Algal Turf Scrubber (ATS) systems are unique and robust algal cultivation systems that concurrently provide environmental services. Paired with contaminated waters, they derive carbon and other nutrients and thus do not rely on point source CO_2 and have been demonstrated to achieve very high carbon utilization efficiencies. The team has investigated the potential of ATS systems with a focus on productivity improvements, bioconversion of produced biomass, evaluation of environmental services, and understanding the sustainability of the system. This foundational research has identified critical areas for investment to improve ATS systems for biomass cultivation. The proposed work takes a three-pronged approach to improve the carbon utilization efficiency, productivity and biomass quality of the system: 1. Strain Selection, 2. Engineering Solutions, and 3. Systems Modeling. Strain selection includes selective seeding of the ATS system to support three objectives: carbon utilization efficiency, productivity improvement and reduction in ash content of the turf. These have been identified through techno-economic analysis as critical areas for investment, but none have previously prioritized. The engineering solutions of the proposal are to identify different technological solutions to improve the performance of ATS systems in terms of carbon utilization. This includes tailoring the operation to different contaminated waters, investigating the impact of hydrodynamical operational strategies, implementation of extended surface areas , and optimization of harvesting schedule. The experimental work is complemented with sustainability modeling, which includes techno-economic assessment and life cycle assessment including dynamic growth and hydrodynamic modeling. This modeling work will be directly integrated with the sustainability modeling with results used to strategically invest during the research program. The project includes system evaluation and optimization at lab scale with demonstration of performance at scale in outdoor trials to be completed at CSU and SNL. The strain selection component will improve the biomass quality through a reduction in ash and the targeting of a sustainable aviation fuel through one of two production pathways, lipid extraction or hydrothermal liquefaction (HTL). The novelty of the proposed system is the ability of the system to achieve higher than 100% carbon utilization efficiency as the systems naturally utilize atmospheric carbon without energy dedicated to the delivery of CO_2. The team assembled is multi-disciplinary and has the necessary expertise and experience working together.

Partners: The project will be lead at Colorado State University with support from Sandia National Laboratories, HydroMentia, and CZERO. Specific project personnel include: Jason Quinn, Jonah Greene, Kenneth Reardon – Colorado State University, Ryan W. Davis, Sungwhan Kim– Sandia National Laboratory, Mark J. Zivojnovich – HydroMentia, and Chris Turner-CZERO.