Control number: 1908-1563

Applicant: Colorado State University, Ft. Collins, CO

Project Title: Integrating an Industrial Source and Commercial Algae Farm with Innovative CO_2 Transfer Membrane and Improved Strain Technologies

Principal Investigator: Prof. Kenneth F. Reardon (CSU)

Team: Prof. Graham Peers, Prof. David Dandy, Prof. Travis Bailey (CSU), Dr. Lieve M. Laurens, Dr. Deanne Sammond, Ryan Davis (NREL), Dr. Rebecca L. White (Qualitas Health), Chris Keogan (New Belgium Brewing)

Project Objectives: The overall goal of this project is to demonstrate increased carbon utilization efficiency (CUE) and areal productivity through enhanced delivery of inorganic carbon and improved strains of *Nannochloropsis oceanica* capable of higher rates of bicarbonate update and metabolism. The use of enzymatic membrane technology to transfer CO_2 from a gas to water as bicarbonate, designing the delivery locations in an open raceway pond (ORP) with a detailed mathematical model, and employing on-line optical CO_2 monitoring to ensure that delivery rates are matched to consumption will enable us to achieve the FOA goal of increasing CUE by 25% over the Qualitas Health baseline level of 55% to a target of 69%, demonstrated in small ORPs located at the Qualitas Health facility at Imperial, TX. At the same time, the development of variants of *N. oceanica* with higher bicarbonate uptake rates will enable us to demonstrate a 20% increase in areal productivity in small ORPs. The improved productivity and biomass yields derived from both strain improvement and carbon delivery system development will be conceptually integrated in a fuel production process that is based on the NREL-developed combined algal processing pathway. The cost savings derived from progress made in this project, if successful, will be captured in yearly state of technology assessments of the integrated system performance at small scale deployment and contribute to BETO's multi-year program plan (MYPP) outyear targets and mapped onto a path towards $3/GGE by FY2022.

Potential Project Impact: The novelty and advantages of the approach presented below lie in the parallel effort focused solely on the development of a novel carbonic anhydrase enzyme containing hydrogel membrane unit that will be tested at a commercial brewery site and deployed at a large-scale algae farm. Engineering and selecting strains of the native alga *N. oceanica* to more effectively assimilate higher concentrations of bicarbonate delivered to the growth media will increase areal biomass productivity to levels where we expect the algae production levels to become economical. The innovations in known pathway engineering will allow this project team to achieve the yield and cost targets that set the technology development up for future commercial development of algae bioenergy development.

This proposal leverages prior DOE funding to NREL and CSU members in the areas of strain improvement, protein design and engineering, membrane technology development and process integration. The work proposed here is outside the scope of those projects. Successful achievement of the project milestones will accelerate technical progress toward the 2022 areal productivity goals and will help drive down the cost of algal biofuel production. With Qualitas Health and New Belgium Brewing as partners, we are in a position to meet technical targets, and translate these into pilot and demonstration scale deployment