Project Summary for DE-FOA-0001908

Applicant: Georgia Tech Research Corporation

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Project Title: **Direct Air Capture of CO_2 and Delivery to Photobioreactors for Algal Biofuel Production**

The objective of this project is to develop a process that extracts carbon dioxide (CO_2) from the ambient air (direct air capture, or DAC), concentrates it, and delivers it to photobioreactors (PBRs) for the growth of algae to produce advanced biofuels. The use of CO_2 captured from the air to provide the carbon building blocks for algae growth and biofuel production offers enhanced flexibility for siting of algal biofuel installations, and presents the added advantage of reduced carbon footprint. This program brings together four organizations that provide specific expertise to the project. Georgia Tech brings to the team substantial experience in DAC materials and technologies as well as life-cycle assessments (LCAs) applied to biofuel production. Global Thermostat's DAC technologies provide the most capital efficient approach to DAC known today, based on a unique combination of rapidly cycled, low pressure drop air/sorbent contactors coupled with CO_2-adsorbing materials specifically designed for DAC applications. Algenol Biotech's biofuel technology produces high yields and relies on patented PBRs and proprietary downstream separation techniques for low-cost, low carbon footprint biofuel production that includes ethanol produced by cyanobacteria. The National Renewable Energy Laboratory (NREL) will play a critical role offering expertise in process modeling, techno-economic analysis (TEA) and life cycle analysis (LCA).

In the first phase of research, a mobile, skid-mounted DAC system capable of producing a stream of ~98.5% CO_2 at a production rate suitable for PBR integration. In the process model, this stream of CO_2 will be blended with simulated effluent from a combined heat and power (CHP) reactor to a concentration of 12-15%, where the DAC unit provides at least 20% of the combined CO_2, for delivery to a PBR. Detailed TEAs and LCAs will be developed for the separate DAC and PBR processes and these will be used to suggest modes of operation for integration of the two systems. In the next phase, integration of the DAC system with PBRs will be accomplished, along with development of oxidation-resistant sorbents optimized for DAC processes will be completed. Using initial data from the DAC system, TEAs and LCAs will be used to determine the CO_2 and energy requirements for the integrated system including the CHP. In the final phase of work, optimization of the integrated DAC-PBR system and development low thermal mass sorbents tailored for integration with the PBR will be done. System design, analysis, and operation will be iterative, allowing realistic testing conditions and process modeling and analysis to influence adsorption/desorption process conditions. A final TEA and LCA for various operating configurations will be produced.

A fully successful project will produce (i) data and knowledge regarding reduction in algal biofuel costs and carbon intensity by using 20% or more of CO_2 fed to algal biomass from DAC and (ii) innovations in DAC process design that lower the cost CO_2 collection from air by developing a PBR-specific DAC technology that utilizes improved sorbents and less intense operating conditions.