Development of high value bioproducts and enhancement of direct-air capture efficiency with a marine algae biofuel production system

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Our team brings together world leaders in algae cultivation, inorganic carbon chemistry, advanced membrane development and technoeconomic analysis (TEA) and life cycle assessment (LCA) to demonstrate increased algal productivities, enhanced algae biomass value and cost-competitive utilization of direct air capture (DAC) technology to support algae growth. In this project, this team will address the DOE EERE FOA #DE-FOA-0002203 Topic #3: Algae Bioproducts and CO_2 Direct-Air-Capture Efficiency, which has three major goals – (1) increasing the revenue of the algae biomass while ensuring that the fuel specifications are met, (2) increasing productivity over baseline levels while using carbon supplied by DAC and (3) increasing the percentage of carbon supplied by DAC while still reducing the costs associated with supplying CO_2. To address these diverse goals, our team has designed a series of tests that together will accomplish each of the components of the FOA. Specifically, this project's overarching goals are to (1) enhance growth and productivity of algae through cultivation system design and operation improvements, (2) increase the market value of post-fuel algae biomass residuals by assessing alternative high value products (i.e. collagen, whey protein substitute and EPA/DHA) and (3) demonstrate direct air capture as a source of CO_2 for algae cultivation. In the initial phase, these three objectives will be assessed individually, but tied together in the final period to demonstrate integrated system design. Each component of the project will be grounded in an iterative TEA/LCA analysis to quantitatively demonstrate the improvements in the economics and environmental impacts of each successive modification. By the end of the project, the team will have (1) identified at least one strain each that co-produces collagen precursors or whey protein replacement without harming other performance parameters (2) demonstrated DAC of CO_2 and conversion to other forms of stable dissolved inorganic carbon that algae can use with equal or greater efficiency than standard CO_2 bubbling, (3) demonstrated enhancements to algal productivity through a combination of stocking density optimization or O_2 degassing (through pond design modification approaches) and (4) calculated improved economics and environmental assessment in a geospatial context using this combination of technologies. This project will leverage the demonstrated capital and intellectual/operational resources of this team and allow it to achieve common objectives with the DOE in the broad application of algal biofuels and also advance the goals of the broader algae and bio-economy community.