High pH/High Alkalinity Cultivation for Direct Atmospheric Air Capture and Algae Bioproducts

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Abstract: For algal biofuels to replace fossil fuels, it is imperative that cultivation systems are not constrained by the proximate availability of flue gas or other high concentration CO_2 sources or the energy and infrastructure burden to deliver CO_2 over long distances. This project will build on our significant prior experience of cultivating algae in high pH and high alkalinity (Hp+HA) environments with enhanced Direct Air Capture (DAC) to produce fuels and high value products. Even though we have demonstrated, with our Hp+HA adapted algal strain, productivities comparable to those achieved otherwise only with high concentration CO_2 sources, our productivities can be higher but the regeneration of the Hp+HA cultivation medium in the presence of atmospheric air is becoming the rate limiting step. Thus, in order to sustainably obtain high average algal biomass productivities this project focuses on research and development activities to develop and demonstrate improvements in reactor design and overall facility operation to enable high efficiency re-carbonization of high pH, but bicarbonate-depleted growth medium using atmospheric CO_2. To improve overall economics further, we are also developing cultivation-based strategies (nutrient and microbiome control) to optimize biomass productivities, quality and culture stability. The resulting biomass will be suitable for fuel and algae-based material production for applications in automotive, packaging and energy storage.

If successful, this work will increase biomass productivity by 40% along with a >20% increase of DAC CO_2 delivered and utilized by the algae over our current Hp+HA cultivation baseline. Biomass quality is expected to be stable due to stable cultivation conditions at high pH values and suitable for a broad range of applications in the future.

This work will effectively eliminate the high costs associated with CO_2 supply as well as the need for co-location of algae production facilities with CO_2 point sources such as powerplants or cement plants, and thus result in more flexible siting of algae production facilities. Improved reactor and facility designs combined with no-costs for CO_2 supply as well as more flexible and economical siting, investment and operational strategies will make algal production facilities more competitive.