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PROJECT SUMMARY

Continuous Catalytic Hydrothermal Liquefaction of *Saccharina latissima* for High Energy Density Biocrude

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The proposed research addresses the '**Topic Area 1: Conversion of Seaweeds to Low-Carbon Fuels and Bioproducts'** and plans to develop a low-cost continuous Catalytic Hydrothermal Liquefaction (CHTL) process (TRL2→4) capable of handling corrosive feedstock to demonstrate optimum conversion of polysaccharides in the brown seaweed, **Saccharina *latissima* (sugar kelp) into a low carbon, stable and high-energy density (>35 MJ/kg) bio-oil/biocrude precursor (yield >45 wt.%)** for sustainable aviation fuel (SAF). To further improve feasibility and sustainability, we propose to explore i) storage and pretreatment methods to preserve the polysaccharides while simultaneously reduce ash/salt content and ii) low-cost coatings for the CHTL reactor system to endure the corrosive reaction conditions associated with continuous, thermally efficient, high throughput reactor operation. *The overarching aim of our process development effort is to generate a blueprint for continuous CHTL processing of sugar kelp applicable to a farm-algal biorefinery model with >60% reduction in GHG emission (petroleum crude baseline)*. The proposed approach addresses current **knowledge gaps** in 1) energy effective kelp storage preserving polysaccharides, 2) high salt/ash management of HTL feedstock, 3) biocrude stability and calorific value, 4) continuous hydrothermal processability to obtain high energy biocrude, and 5) reactor corrosion issues to address feasibility of biocrude production at higher TRL. *The project will demonstrate 500 hours or 3 weeks of continuous oil production from sugar kelp using CHTL reactor system fabricated from low-cost 304H steel with a corrosion resistant coating and demonstrate economic and environmental impacts through TEA and LCA while considering SAF pathway.*

The global biofuel market is forecasted to grow at a CAGR of 6.2% and reach $225.9 Billion in 2028. The Sustainable Aviation Fuel (SAF) Grand Challenge Roadmap of 2022 by the U.S. DOE states that at least 18% of biomass feedstock for SAF will need to come from algae. Seaweed could be a great resource to generate renewable oil precursor that can be processed via HEFA process for the SAF production. The global seaweed market is expected to reach $12.1 billion in 2030 growing at a CAGR of 2.3%. The team proposes key innovations to realize maximum production of oil biocrude from sugar kelp, which include i) pretreatment to reduce salinity and ash to obtain CHTL conversion ready feedstock, ii) proprietary corrosion resistant coating by GEV, compatible with low-cost stainless steel reactor vessel and able to withstand salinity/harsh environment, and iii) continuous CHTL system utilizing a core-shell novel zeolite catalyst to maximize high energy density oil production with minimum residue. This DOE grant will create opportunities in STEM education and careers for students from diverse communities and enable stakeholders to create energy equity policies for renewable fuel generation from sugar kelp using HTL technologies. An algae based biorefinery will generate affordable renewable energy and have a positive impact on local kelp businesses.