Applicant: North Carolina State University (NCSU)

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Project Title: Sargassum and Wood Waste for Aviation Fuel and Graphite (SWAG)

Project Objective: The objective of this project is to develop a technology for the production of sustainable aviation fuel (SAF) and graphite for lithium-ion battery (LIB) using wood waste and Sargassum, which are increasingly problematic in the southeastern US and Caribbean territories.

Project Description: This project will merge NREL's highly robust biomass fractionation and fermentation technology and NCSU's highly innovative graphitization technology to convert two waste streams into SAF and battery-grade graphite. In this project, we will develop the SWAG technology by (a) demonstrating synergistic anaerobic ensilage of wood waste and Sargassum blends to mitigate seasonal production of the feedstocks, (b) optimizing pretreatment conditions to release carbohydrates that can be fermented to the SAF precursor (e.g. ethanol), (c) developing a novel catalytic graphitization process with a catalyst recycle strategy to convert residual solids into battery-grade graphite, (d) conducting an economic analysis to demonstrate a pathway to low-cost SAF and graphite production with a reduction in SAF GHG of >70%, (e) integrating all the above with a siting study to provide a scale-up pathway in a region that is impacted by climate change and often underrepresented in economic development, and (f) stimulating underserved students' interest in career pathways in the bioeconomy.

Methods to be Employed: The SWAG team will collect waste wood and Sargassum from Puerto Rico, which will be blended and either processed directly or ensiled to evaluate synergetic conversion. The blends will undergo pretreatment, enzymatic hydrolysis, and solid/liquid separation to produce a hydrolysate rich in soluble carbohydrates and a solid residue rich in lignin. The hydrolysate will be fermented to ethanol, which is a precursor for SAF via existing alcohol-to-jet pathways. The solids will be converted to battery-grade graphite using Fe-based catalyst and will be tested in standard electrochemical experiments. The project scope includes extensive economic and life-cycle analysis to guide process modifications explored during the project with a focus on the selling price and greenhouse gas emission of SAF and graphite. In addition to these technical aspects, the team will create high school lab activities, NCSU/NREL visitation programs, and other initiatives for high school students and teachers from underrepresented areas.

Potential Project Impact: Battery-grade graphite is largely imported, is either mined or synthesized from petroleum feeds, and is processed with severe environmental burdens. Development of a lower impact, cost-effective process for producing graphite for battery applications from renewable domestic waste streams has the potential to impact the market for electric vehicles and grid electrical storage, thereby boosting the US bioeconomy. If all of the Sargassum is used at a 25% blend ratio (75% wood waste), it could produce up to 78 million gallons of SAF, enough to meet 2.6% of the Biden Administration's goal of 3 billion gallons of SAF per year by 2030. Similarly, it is estimated that the proposed process could produce up to 61,000 tons of graphite per year, which is roughly 3.4% of the current global synthetic graphite production (~1.8 million tons). In addition to these technical aspects, the active collaborations will have environmental and social equity impacts by mitigating waste streams on coastal communities, creating new jobs, and helping to meet energy independence goals, particularly in PR.