Summary for Public Release

Applicant: Vertimass LLC, Irvine, California, USA
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Project Title: Production of renewable cycloalkanes from ethanol for blending with jet fuel to enhance energy density and material compatibility and reduce particulate emissions

The Vertimass alcohol-to-jet approach is regarded as the lowest cost renewable jet fuel process. In this proposal, our team will enhance the product by increasing specific energy and reducing emissions for blending with jet while meeting fit-for-purpose specifications. Vertimass LLC was awarded an exclusive license to novel catalyst developed by Oak Ridge National Laboratory for conversion of ethanol and other alcohols into gasoline, diesel, and jet fuel blendstocks compatible with the current transportation fuel infrastructure and offering the option to coproduce chemical building blocks BTEX (benzene, toluene, ethylbenzene, and xylenes). This unique process offers important advantages that include 1) single step bolt-on conversion, 2) no hydrogen addition, 3) high liquid product yields with virtually complete ethanol use, 4) reaction at atmospheric pressure and 275-350°C, 5) robust catalyst, 6) replacement of molecular sieves and potentially rectification through ability to use 5-100% ethanol concentrations, 7) potential to debottleneck ethanol production, 8) flexibility to respond to changing markets, 9) low CAPEX and OPEX, 10) lower plant energy demand, and 11) reduced process water. Greatly aided by DOE BioEnergy Technology Office (BETO) funding, Vertimass successfully scaled up this technology by a factor of 300 from ORNL laboratory to commercial readiness while reducing conversion costs 15x. These new fuels offer greenhouse gas (GHG) reductions of up to 95% compared to petroleum equivalents and greater than 100% for coproduction of chemicals that sequester carbon. An invited paper recently submitted to PNAS through leadership by Professor Lee Lynd at Dartmouth College shows that feeding vapor from ethanol fermentation broths to the catalyst can realize hydrocarbon fuel equivalent energy content costs similar to that for removing water from ethanol.

Through this proposed project, Vertimass seeks to increase cycloalkane content to enhance jet fuel blending by providing 1) fit-for-purpose properties now provided by aromatics in jet fuel (minimum jet fuel aromatics 8% wt, maximum 25%, and average 16-18%), 2) increased fuel energy density, and 3) lower emissions (particularly particulates) by aromatics. The project results could have a major impact on renewable jet fuel production and emissions and be complementary to renewable Alcohol-to-Jet and Fischer-Tropsch processes that produce little to none of the aromatics currently required in jet fuel. Vertimass intends to partner with 1) TechnipFMC to process cellulosic ethanol and fusel oils in the established Vertimass system and apply TechnipFMC technology for hydrogenation of cycloolefins to cycloalkanes, 2) University of Dayton Research Institute (UDRI) to meet o-ring swelling and other fit-for-purpose requirements and emissions reductions of these new fuels, 3) University of California Riverside to improve the catalyst and define process conditions to increase cycloalkane content, and 4) Sandia National Laboratories to provide cellulosic fusel alcohols for exploratory determination of its potential beneficial fuel properties from the Vertimass reaction system.

Commercializing this novel technology for converting cellulosic biomass derived alcohols to renewable jet fuel blendstocks with significantly lower GHG and PM emissions and high specific energy compared to conventional jet fuel would be a giant step in sustainably fueling aircraft. BETO funding will accelerate worldwide acceptance and scale-up of the technology to realize vital goals of reduced GHG and particulate emissions, and enhanced renewable energy use.