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Title: Systematic Characterization of Variability in MSW Streams to Identify Critical Material Attributes for Fuel Production

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Project Description: The proposed study targets understanding the characteristics critical to turning low-cost, abundant municipal solid waste (MSW) into conversion-ready feedstocks for producing biofuels through gasification and solid-state anaerobic digestion (SS-AD) as targeted thermal and biological conversion technologies with final Fischer–Tropsch (F-T) processing to liquid hydrocarbon fuels. In alignment with the AOI in Subtopic 1a, this project will build a comprehensive MSW characteristic database using standardized methods to provide nationwide geographic mapping information to inform conversion readiness of MSW feedstocks for fuel production. The proposed technology advancement will bring significant impact to the biofuel industry by offering an alternative feedstock sources to conventional gasification and anaerobic digestion by valorizing MSW. The proposed technology delivers MSW sampling and characterization standard operating procedures (SOPs) as well as mathematical, statistical, and machine learning models capable of producing spatially and temporally representative MSW information specifically tailored for downstream conversion technologies. The innovative characteristic technologies will benefit the US biofuel industry by developing a characterization SOP plan for developing an economically competitive MSW feedstock for the liquid fuel market.

Objectives: To quantify the MSW characteristics to convert this valuable feedstock to renewable fuel using thermochemical (gasification) conversion or biological (anaerobic digestion) conversion with final processing using F-T to liquid hydrocarbons. The project will accomplish six objectives: 1) Initial verification of current state-of-the-art of MSW characterization; 2) Assess the magnitude, range, and frequency distribution of MSW attributes across operational scales of geographic, temporal, and supply chains; 3) Characterize MSW using physical, chemical, and biological approaches; 4) Evaluate the impact of the critical material attributes (CMAs) and critical quality attributes (CQAs) on downstream fuel yields; 5) Develop a machine learning model using geographic data with energy yields and characterization; and 6) Determine resiliency, economic impact, and market comparison of each energy pathway via techno-economic assessment (TEA) and life cycle assessment (LCA) of CO_2 emissions for each pathway.

Potential Impact: Our proposed research innovatively fills knowledge gaps by: 1) establishing and validating a suit of standard MSW sampling and characterization methods with QA/QC specifically tailored for provision of feedstocks ready for gasification and SS-AD conversion processes; 2) These characterization procedures will be applied across a wide geographic and seasonal range to prove their accuracy and representativeness; 3) The characterization study will cover enough detail for comprehensive understanding of the physical, chemical, biological characteristics of MSW critical to the targeted conversion technologies; 4) The CMAs and CQAs of MSW will be identified via lab testing and modeling of MSW to fuel conversion; 5) Statistical and machine learning models will be developed and calibrated with the MSW characteristics and extended for a MSW characterization mapping tool that can be utilized by the biofuel conversion industry across the US, with TEA and LCA of the MSW to liquid fuel processes.