Summary for Public Release

Applicant: University of Virginia (UVA)

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Area of Interest: Subtopic Area 5a: Renewable Natural Gas (R&D)

Project Title: Low Temperature CO_2 Methanation for Biogas-to-Renewable Natural Gas Conversion via Advanced Ni-Based Catalysts

Objective: This proposal aims to develop a low temperature thermocatalytic CO_2 methanation process to directly convert CO_2 in biogas to CH_4, producing pipeline quality renewable natural gas (RNG). We specifically plan to create a highly active, durable and selective Ni-based CO_2 methanation catalyst that allows the reaction unit to operate at low temperature. Success of this innovation will advance the state of the art in catalyst materials for biogas-to-RNG conversion processes with improved energy efficiency, operational cost and carbon management.

Description: Our strategy to advance the performance of catalytic CO_2 methanation involves the development of Ni-based bimetallic nanoparticles with precisely controlled sizes, compositions and nanoparticle-support interactions with the optimization of reaction process conditions. We will: 1) enhance the activity through control over the size of Ni nanoparticles and the nanoparticle-support interactions, 2) improve the stability and sulfur resistance through the modulation of Ni bimetallic nanoparticles, 3) optimize the process operation conditions (pressure, temperature and regeneration) through scale-up studies and industrial reactor tests, and 4) guide technical advancements towards effective cost targets and environmental benefits by an integrated techno-economic (TEA) and life cycle (LCA) analysis.

Impact: This work will improve biogas-to-RNG technology by increasing RNG yields to utilize >95% of biogas carbon and eliminating the need for CO_2 separation. It will also provide a biogas industry-oriented guidance involving catalyst performance evaluation, reactor and process modeling, and TEA/LCA. Moreover, it will lead to improvements in the productivity and stability of CO_2 methanation catalysts by increasing our understanding of the fundamental science and the applied engineering, significantly impacting other technologies beyond the biogas sector (e.g., carbon capture mechanisms, purification of process gasses, mobile fuel cells).

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