NEBRASKA CENTER
FOR ENERGY SCIENCES RESEARCH

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Project Title.
Enhanced CO_2 transport for high-efficiency biological carbon capture and biofuel fermentation

Abstract.
The transition to a sustainable bioeconomy requires converting up to one billion tons of captured and waste carbon in the form of CO_2, biomass, and biosyngas to biogas (methane) and other transportation fuels annually. Methanoarchaea, a promising platform to generate renewable methane and bioisoprene fuels from CO_2 and waste carbon, can further enhance yield and efficiencies through metabolic engineering and synthetic biology. Here, we propose to design novel enzymes, bioreactors, and *Methanosarcina* cells to optimize CO_2 conversion selectivity to biogas and bioisoprene. We will use computational modeling and a high-throughput enzyme engineering screen to design and select for novel enzyme variants to enhance the capabilities of microbial cells to produce isoprene, which can be used as fuel or chemical precursor. We will also explore embedding biocatalysts in soft materials for the design and development of robust gas-liquid contactors. If successful, the project's enzymes, materials, and engineered cells are expected to improve carbon capture technologies and enable sustainable biofuel and biomanufacturing in various applications, including for (ethanol) fermentation and biomedical uses. When combined, the novel bioreactors, strains, and enzymes produced have the potential to make a significant impact on converting captured and waste carbon for sustainable aviation and transportation fuel, decarbonizing heavy industry, and reducing greenhouse gas emissions.