# Carbon Capture and Conversion for Mobile Sources

NETL Carbon Management Meeting

08/08/2024

Caitlin Bien

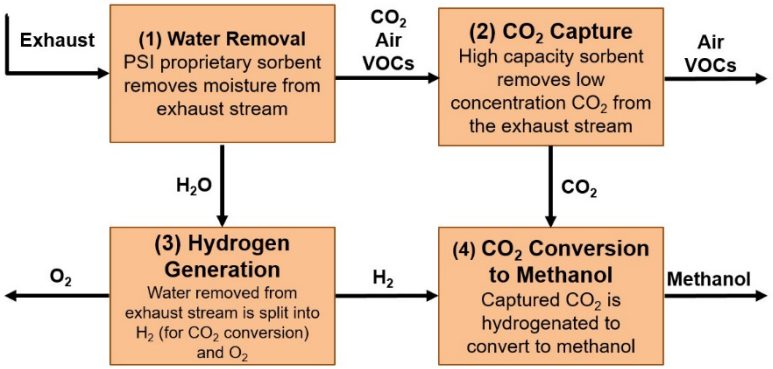
# Carbon Capture and Conversion for Mobile Sources

Physical Sciences Inc.

VG-2024-328-1

## Program Overview

Develop and optimize an energy efficient, regenerative $CO_2$ capture and conversion-to-fuel system from mobile exhaust streams.




**Starting TRL: 1-2 Projected Phase I End TRL: 3**

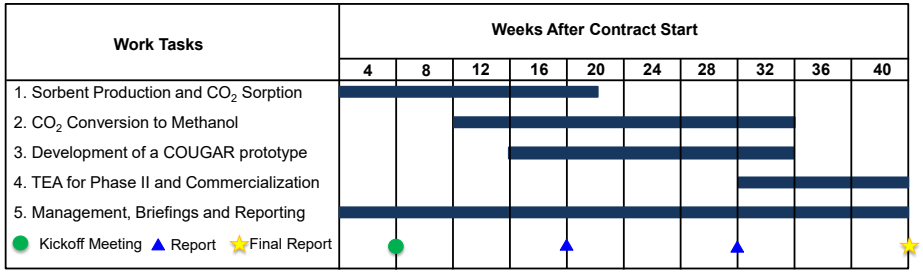
## Operational Capability

- **Technology** –process to capture and upgrade $CO_2$ from merchant marine vessels
- **Solution** – synergistic, two-stage sorbent system made using the combination of a modified silica and sorbent
- **Application** – Modular system housed in two shipping containers that can be adapted for other modes such as rail and trucks
- **Performance Improvements** – Utilize the captured $CO_2$ for downstream methanol fuel production

## Proposed Technical Approach

1. Demonstrate synthesis of water and $CO_2$ capture sorbents with **high adsorption capacities** on a 0.1 kg per batch scale.
2. Demonstrate **methanol production** from captured $CO_2$ with a yield rate of 50 $mg/g_{cat}{\cdot}h$.
3. **Design a subscale (1/200 scale) prototype** for the capture, storage and transformation. Create a detailed piping and instrumentation diagram for construction in Phase II.
4. Develop a **techno-economic model** that identifies key economic drivers to be used as the basis for development of process scale-up and further development in Phase II and beyond

## Phase I Work Plan




**Key Personnel**

**Dr. Caitlin Bien:** Principal Investigator
**Dr. Luisa Posada:** Lead Chemist
**Dr. David Gamliel:** Technical Reviewer
**Mr. Nicholas Skovran:** Lead Chemical Engineer

Our multidisciplinary team consists of chemical and mechanical engineers, and chemists who bring together the expertise needed to execute on this multifaceted project.

# Application and Technical Approach

Physical Sciences Inc.

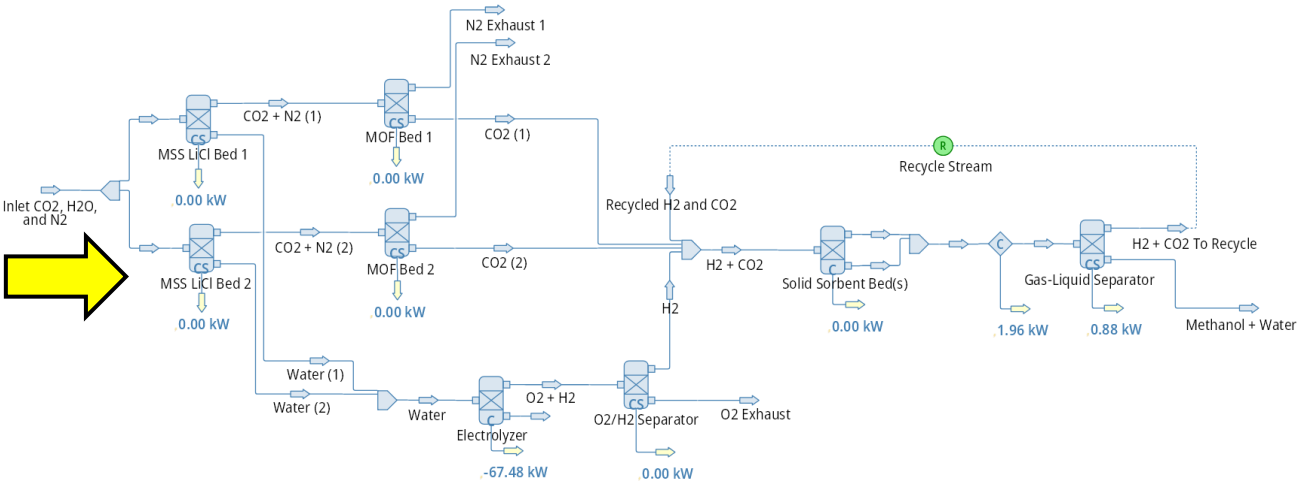
VG-2024-328-2

- **Goal:** develop, test, and commercialize a novel, compact sorbent system for mobile carbon capture, storage and fuel production applications
  - The process can be utilized for reduction of emissions from other mobile point sources such as rail transport, heavy trucking, and cruise ships
  - The technology demonstrates the potential to produce materials of significant importance to the US economy at a low cost, while reducing the environmental footprint associated with fossil fuel combustion

## Sorbent Development

| Adsorbate | Adsorbate Classification | $CO_2$ uptake (mmol $g^{-1}$)* @ 5 mbar |
|---|---|---|
| **PSI Sorbent** | | **2.5** |
| SIFSIX-3-Cu | MOF | 2.3 |
| NbOFFIVE-1-Ni | | 2 |
| 13X | Zeolite | 1.7 |
| PPN-6- $CH_2$DETA | Porous polymer | 2.5 |
| NaOH | Salt | 0.04-0.05 |
| MEA | Amine | 1.8-2.95 |
| DEA | | |

## System Design

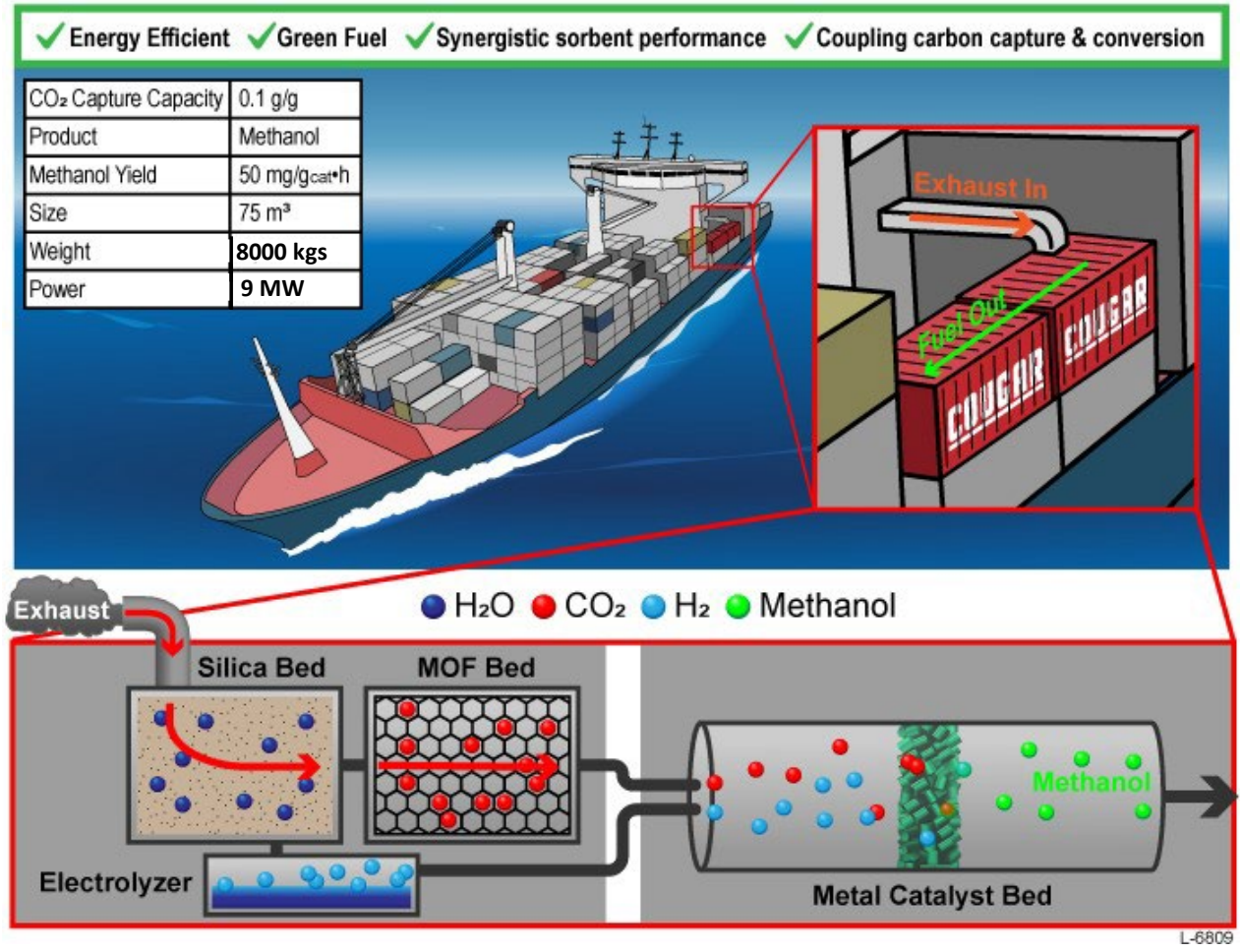


# PSI's Mobile Carbon Capture System

Physical Sciences Inc.

VG-2024-328-3

**Physical Sciences Inc. (PSI) will develop the Carbon Capture for Generation of Renewable Fuel (COUGAR) system**




The transportation sector currently accounts for a significant (24 %) portion of emissions, and is therefore an important focus of decarbonization efforts

The sale of 50 COUGAR units corresponds to an estimated potential revenue of ~ $185 M

**Capability to be provided:** A regenerative sorbent and catalyst system to upcycle the captured carbon dioxide from mobile point sources to valuable fuel.