

# Carbon Capture and Conversion for Mobile Sources

NETL Carbon Management Meeting

08/08/2024

Caitlin Bien

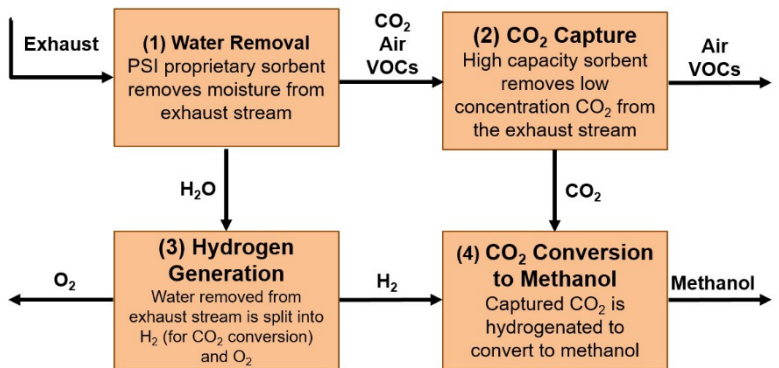
**Disclaimer:** This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

# Carbon Capture and Conversion for Mobile Sources

VG-2024-328-1

## Program Overview

Develop and optimize an energy efficient, regenerative CO<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> for downstream methanol fuel production

## Proposed Technical Approach

1. Demonstrate synthesis of water and CO<sub>2</sub> capture sorbents with **high adsorption capacities** on a 0.1 kg per batch scale.
2. Demonstrate **methanol production** from captured CO<sub>2</sub> with a yield rate of 50 mg/g<sub>cat</sub> · 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

Work Tasks	Weeks After Contract Start									
	4	8	12	16	20	24	28	32	36	40
1. Sorbent Production and CO <sub>2</sub> Sorption	█									
2. CO <sub>2</sub> Conversion to Methanol			█							
3. Development of a COUGAR prototype				█						
4. TEA for Phase II and Commercialization								█		
5. Management, Briefings and Reporting	█									
● Kickoff Meeting ▲ Report ★ Final Report		●			▲				▲	★

### 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.

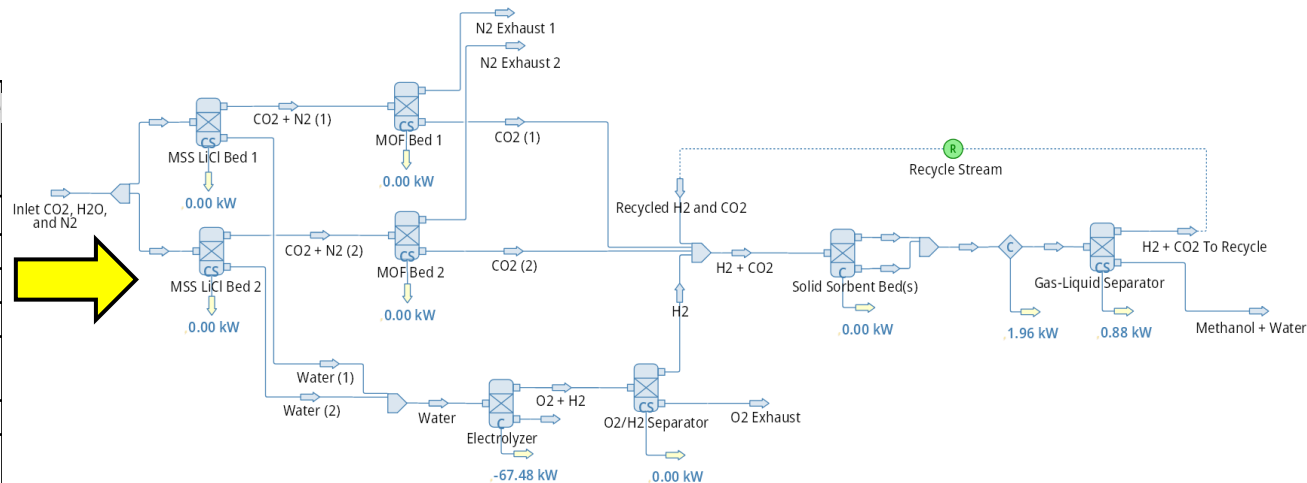
# Application and Technical Approach

- 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 <sub>2</sub> uptake (mmol g <sup>-1</sup> )* @ 5 mbar
<b>PSI Sorbent</b>		<b>2.5</b>
SIFSIX-3-Cu	MOF	2.3
NbOFFIVE-1-Ni		2
13X	Zeolite	1.7
PPN-6- CH <sub>2</sub> DETA	Porous polymer	2.5
NaOH	Salt	0.04-0.05
MEA	Amine	1.8-2.95
DEA		

## System Design





Physical Sciences Inc.

# PSI's Mobile Carbon Capture System

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

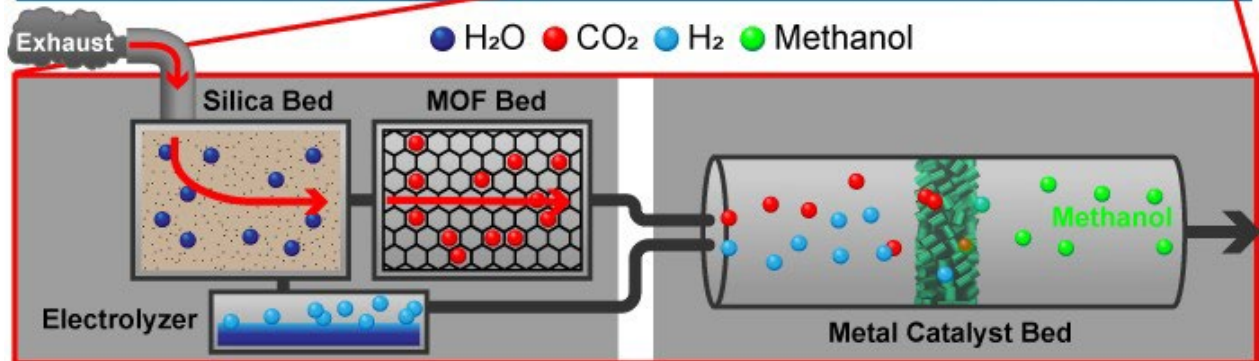
VG-2024-328-3

✓ Energy Efficient   ✓ Green Fuel   ✓ Synergistic sorbent performance   ✓ Coupling carbon capture & conversion

CO <sub>2</sub> Capture Capacity	0.1 g/g
Product	Methanol
Methanol Yield	50 mg/g <sub>cat</sub> *h
Size	75 m <sup>3</sup>
Weight	8000 kgs
Power	9 MW

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



L-6809

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