

New Approaches to Carbon Capture

Canadian Fuels Association Innovation Forum

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Introduction



- Researcher at the University of Calgary
- Focused on developing new carbon capture materials
- CCUS startup founder

Overview

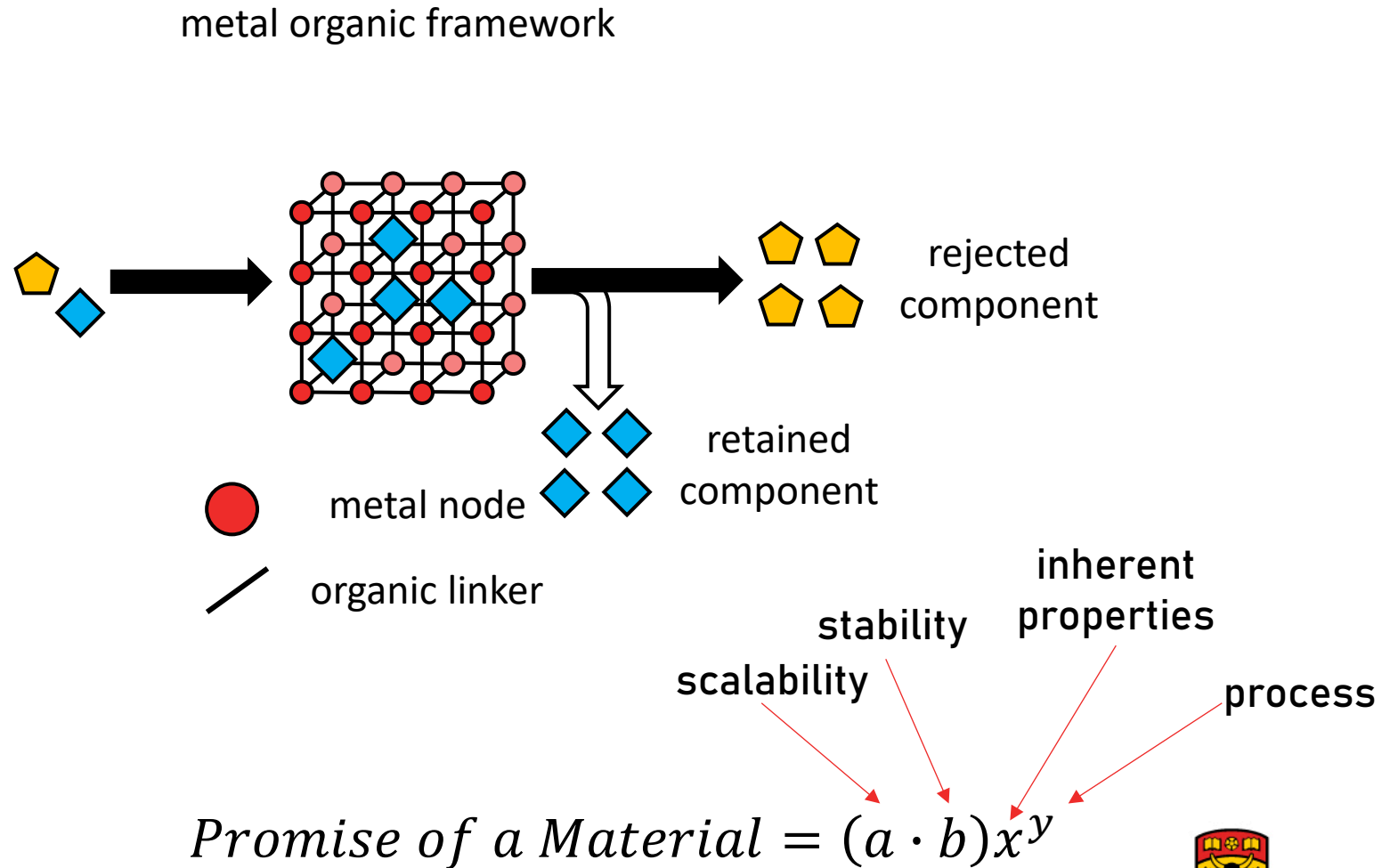
- Research Background
- Previous Success in Post-Combustion Carbon Capture
- Future Direction in Dilute Stream CO₂ Capture
- Integrating Research with Industry Needs



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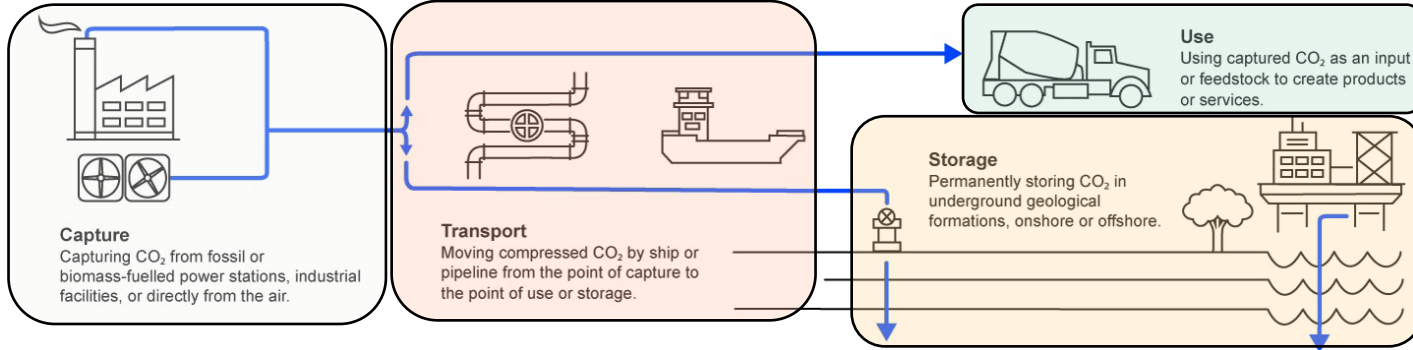
Introduction to Our Research

- Working in the Shimizu group
- Chemists by training, but work closely with engineers
- Strong focus on “useful” materials for separations
- Synthesize solid sorbents known as MOFs

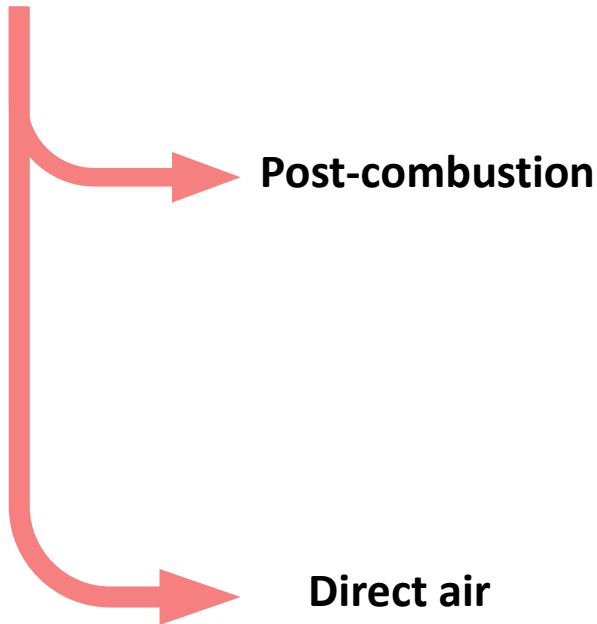


Carbon Capture Utilization and Storage

© International Energy Agency



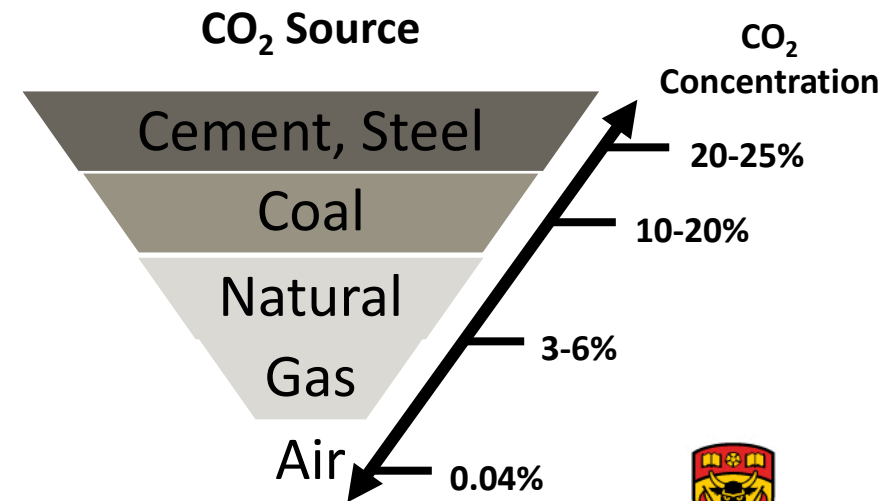
- Alberta Carbon Trunk Line
- Enhanced Oil Recovery/Value added chemicals
- Underground Injection



Post-combustion

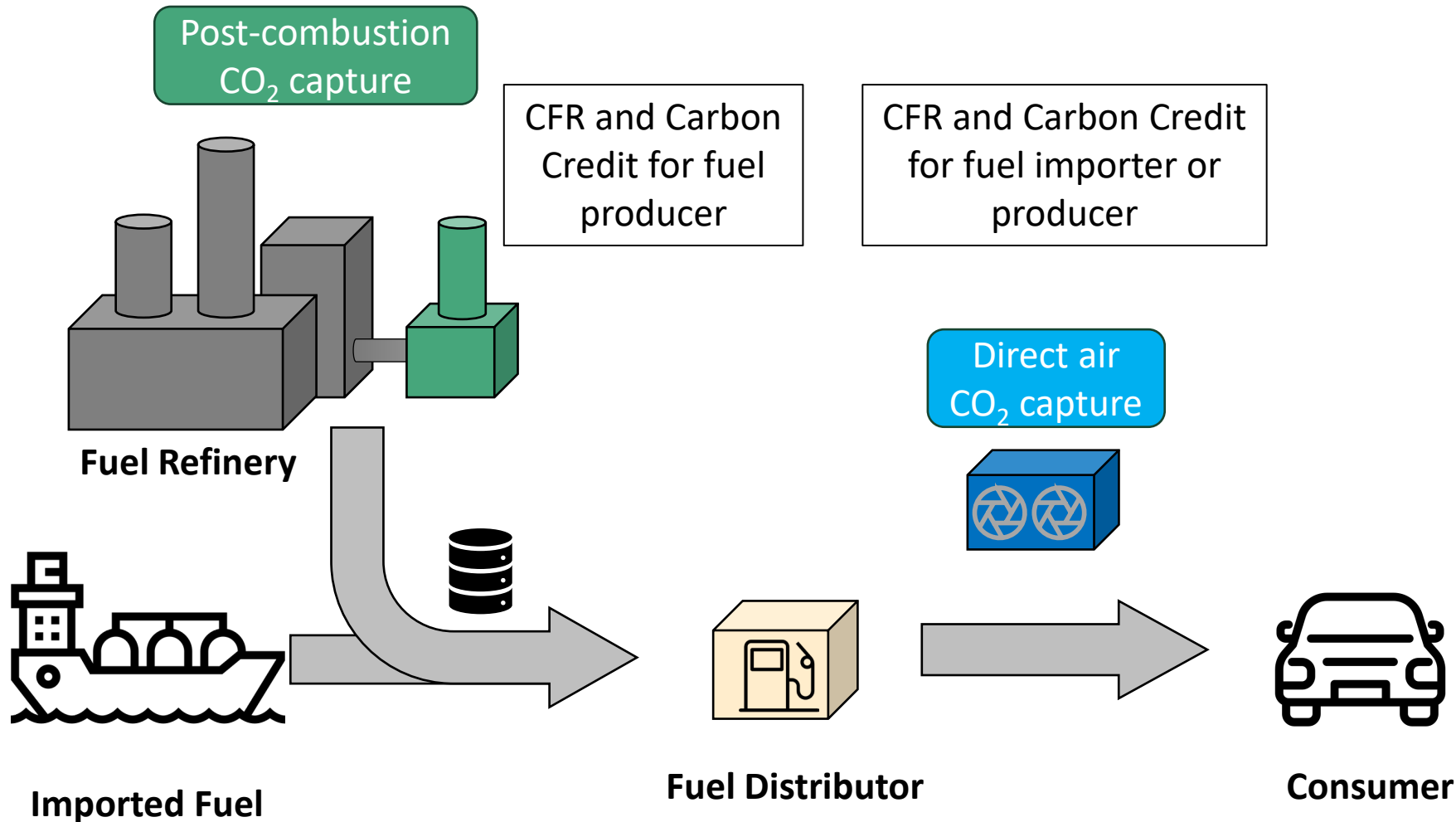
Direct air

+	-
high concentration CO ₂	presence of reactive impurities
readily accessible waste energy	higher temperature flue stream
lower energy process	requires interfacing with source
+	-
no reactive impurities	low CO ₂ concentrations
low temperature flue stream	needs independent energy source
flexible location for operation	higher energy process



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Carbon Capture and the Canadian Fuel Association



There are many ways to achieve compliance metrics, and carbon capture in Canada is one of them.

Post-combustion Carbon Capture

Historically, post-combustion capture of carbon dioxide has been performed using liquid amine systems.

- low chemical cost
- highly selective
- proven at large scales
- high regeneration energy
- higher turnover rate



Other Commercial Methods

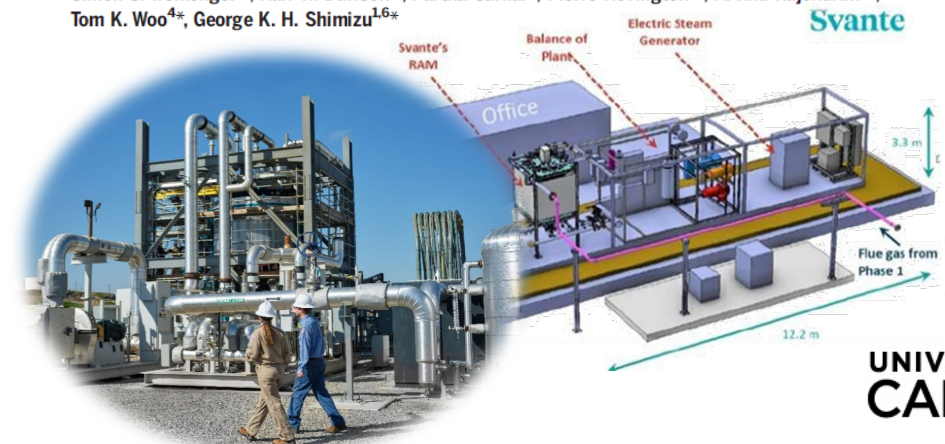
- Membrane Separation
- Cryogenic Distillation
- Chemical Looping
- Solid Adsorbents

RESEARCH ARTICLE

CARBON CAPTURE

A scalable metal-organic framework as a durable physisorbent for carbon dioxide capture

Jian-Bin Lin^{1†}, Tai T. T. Nguyen², Ramanathan Vaidhyanathan^{1,3}, Jake Burner⁴, Jared M. Taylor^{1,3}, Hana Durekova⁴, Farid Akhtar⁵, Roger K. Mah^{1,6}, Omid Ghaffari-Nik⁷, Stefan Marx⁸, Nicholas Fylstra¹, Simon S. Iremonger¹, Karl W. Dawson¹, Partha Sarkar², Pierre Hovington^{7*}, Arvind Rajendran^{2*}, Tom K. Woo^{4*}, George K. H. Shimizu^{1,6*}

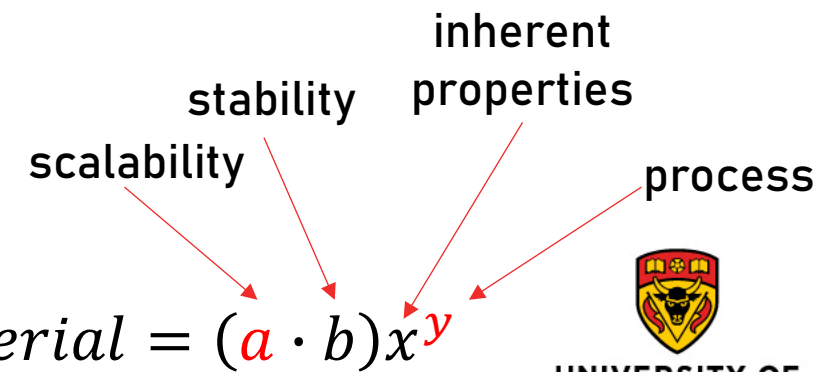
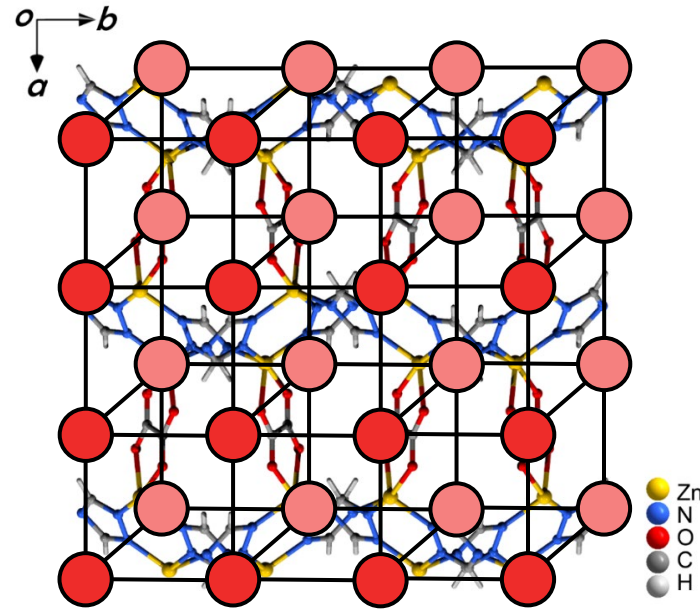


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CALF-20: A Benchtop to Application Success Story

Material Development Pathway

- Started at the milligram scale to understand the material properties
- Demonstrated promising properties for CO₂ removal
- Showed high stability after months long tests
- Made from inexpensive materials in the lab



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CALF-20: A Benchtop to Application Success Story

Industrial Partners

Process:
SVANTE inc.

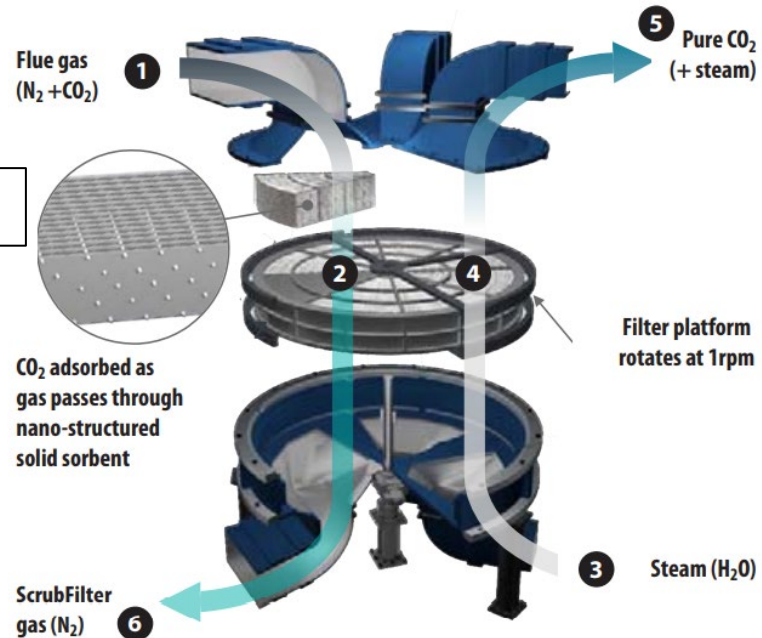
Scalability:
BASF



Omid Ghaffari-Nik



Pierre Hovington



Stefan Marx



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CALF-20: A Benchtop to Application Success Story

SVANTE

- 1 tonne/day capture demo at Lafarge Cement Plant in Vancouver
- 25 tonne/day demo at Chevron steam generator in Bakersfield

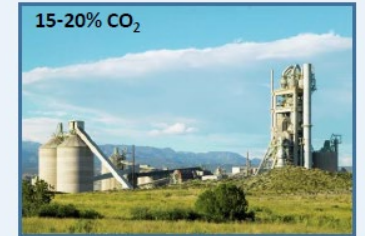
Other licenses

- *Two other licenses executed*
- *Two licenses being negotiated.*
- *Three licenses denied.*

Point-Source Capture (PSC) for Power Generation and Industrial Sectors



Power Plants



Cement Plants



Steel Plants



Hydrogen Plants

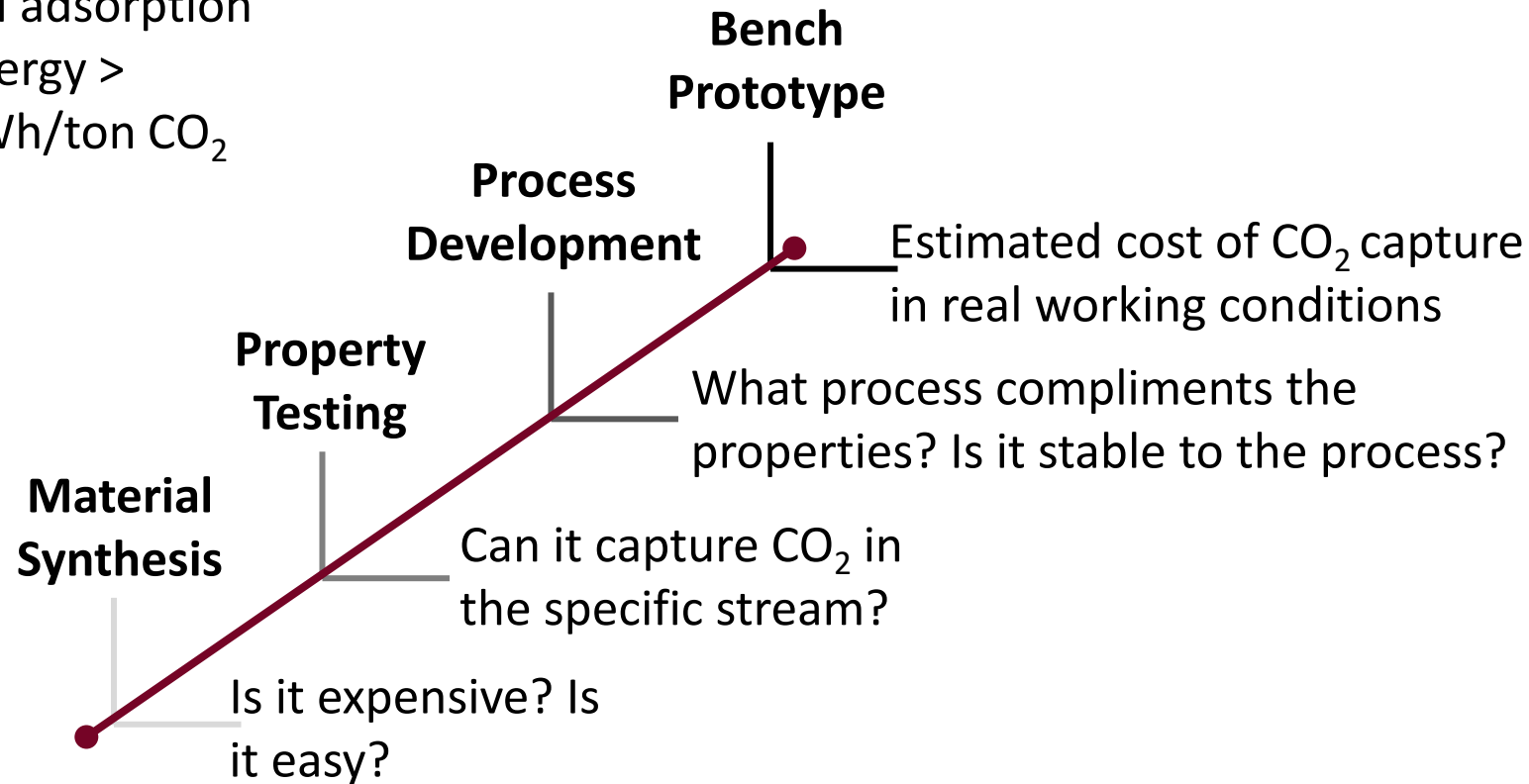
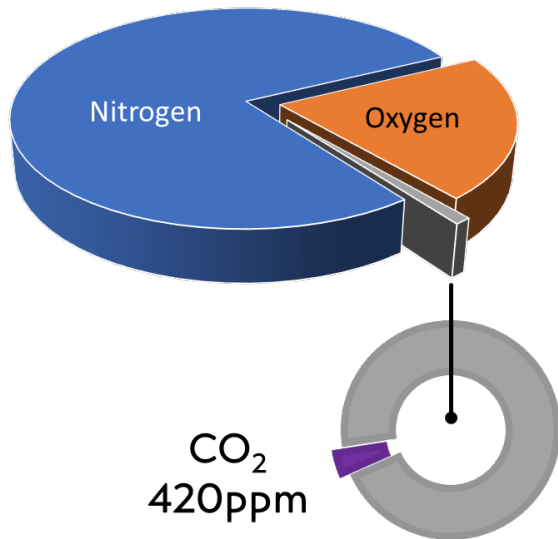
Bespoke solutions are critical.



Our new target: Direct Air Capture

- Carbon Engineering
- Climeworks
- Global Thermostat

Chemical adsorption
Energy >
2000kWh/ton CO₂



Direct Air Capture with CALF-423

- Novel physisorbent, like CALF-20
- Uniquely designed for a new desorption technique
- This gives a low energy cost (< 1/10th of commercial technologies)
- Highly stable under the operating conditions
- Technology Readiness Level 4-5



scalability stability inherent properties process

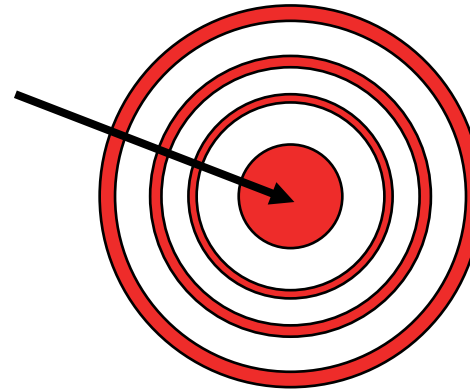
Promise of a Material = (a · b)x^y

- Space time yield upward of 200 tonne CO₂/tonne sorbent/year
- Capture energy of <200 kwh/tonne CO₂

Research to Industry Partnerships

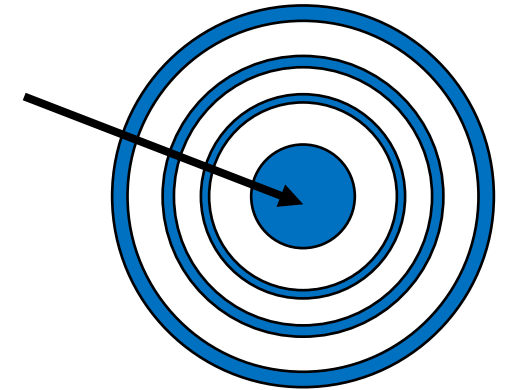
- A drop-in solution has a much lower entry barrier.
- Materials should be assessed under the process conditions more suitable for them and not other materials.
- More accessible process testing opportunities would help development.
- Duration of pilot is important

CALF-20



~ 10 years to pilot

CALF-423



~ 3 years to pilot

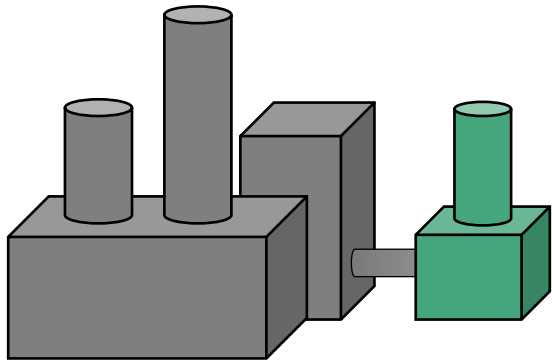
As researchers, we are looking for more information – how can we make a material which best fits YOUR situation.



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Our Carbon Capture Solutions

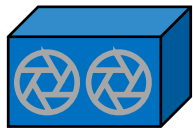
Post-combustion
CO₂ capture



Existent

- Control of CALF-20 IP
- Focus on post-combustion
- Direct interface with point source

Direct air
CO₂ capture



Chockstone

- Control of CALF-423 IP
- Focus on air capture
- Flexible deployment

We are always looking for new opportunities for new research applications and to find industrial partners

Thank you for your attention. Any questions?