



Pilot-Scale Demonstration of MOF Sorbents: Bridging Materials Innovation and Industrial Carbon Capture

8th Post Combustion Capture Conference (PCCC-8)

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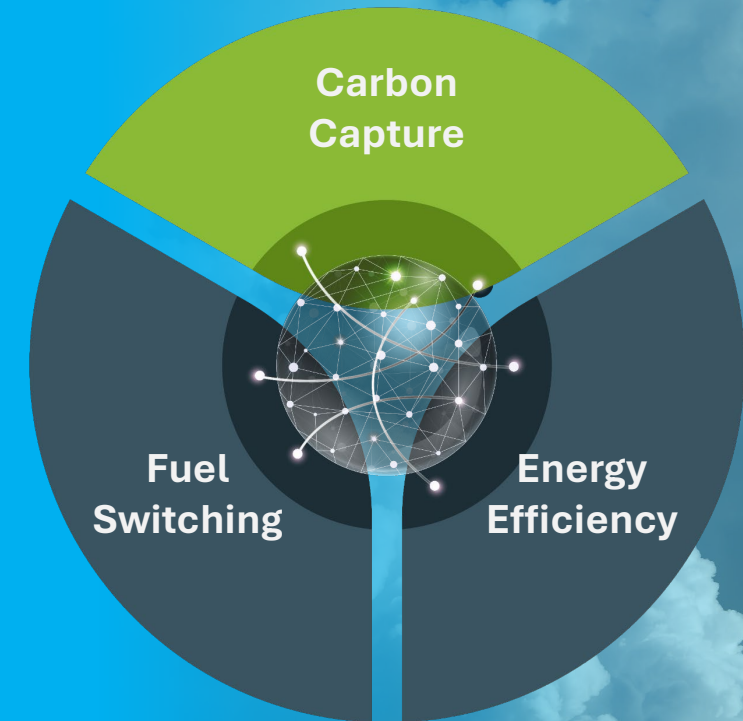
Carbon Capture



The Paris Agreement's long-term temperature goal is to keep the rise in the mean global temperature well below 2 °C above pre-industrial levels, while pursuing efforts to limit it to 1.5 °C. Emissions need to be cut 43% by 2030, but are still rising



CO₂ is the primary greenhouse gas emitted through human activities accounting for more than ¾ of all GHG emissions



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Carbon dioxide removal is necessary to achieve net zero CO₂ and GHG emissions both globally and nationally

Pioneering a CCS Paradigm Shift



Carbon Capture is now deemed essential

A necessity to meet global decarbonisation targets



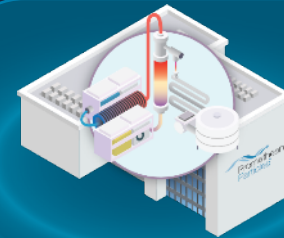
Incumbent technology has limitations

Amine-based systems burdened with energy penalties, footprint restrictions, EHS concerns



MOFs have shown a lot of promise

Exciting materials but have been constrained due to lack of scale, prohibitive costs

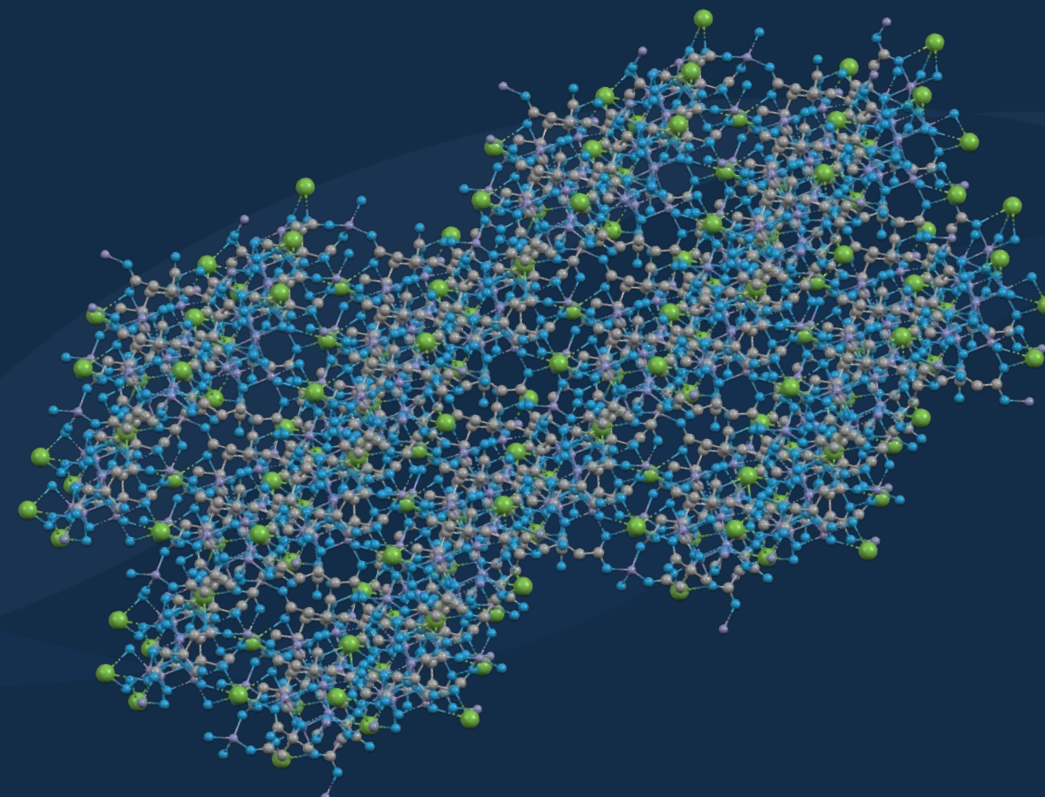


Promethean's Tech Unleashes MOFs' Potential

Overcomes historical barriers, uniquely enabling industrial scale, cost-effective MOFs

Metal-Organic Frameworks

- Metal-organic frameworks (MOFs) are highly porous, structured materials
- Act like molecular “sieves” that selectively trap target molecules
- Offer highest known uptake capacities
- Desorption energies are much lower than amine solvents → lower regeneration cost
- Exhibit high thermal and chemical stabilities, tuneable selectivity, and recyclability
- Industrial adoption historically constrained due to a perceived lack of scale and exorbitant costs and pricing



Promethean Particles: Who We Are

- A UK-based industrial-scale manufacturer of high quality and cost-effective MOFs, using our proprietary continuous flow reactor technology
- Strong portfolio of patents and know-how in reactor design and large-scale MOF processing
- Developing MOFs to support the energy transition, with focus areas including:
 - Carbon capture and biogas upgrading
 - Water harvesting
 - Gas storage
- World's largest* MOF manufacturing facility, based in Nottingham, UK with integrated R&D and production capabilities
- Producing different MOFs at scale and collaborating with EPCs and technology developers, enabling MOF deployment



*Based on Promethean estimations from published talks, papers, etc.

Promethean's Mission

To unleash the **game-changing potential of MOFs** in the fight against climate change through our proprietary continuous-flow manufacturing processes



**Industrial
Scale**



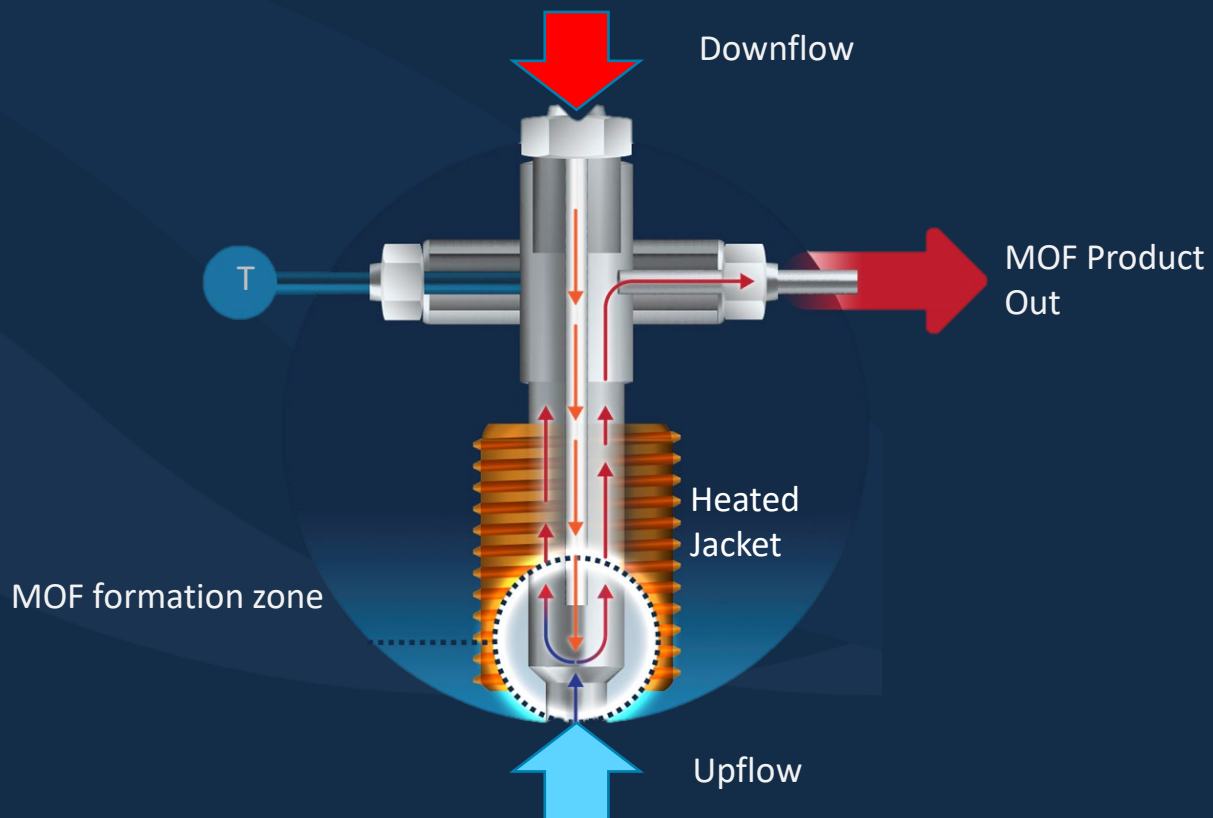
**High
Quality**



**Cost
Effective**

**Promethean's
Proprietary Reactor
Technology**

Promethean Manufacturing Process



- Proprietary continuous flow manufacturing allows instantaneous adjustment of key process parameters
- Superior MOF quality – “Not all MOFs are created equally”
- Patented reactor designs, new patent application(s), >15 years know-how IP

CONTINUOUS SYNTHESIS OVERCOMES THE HISTORIC CAPACITY AND COST ISSUES THAT HAVE HELD MOFs BACK

Project MONET

- MOF-based Negative Emissions Technology
- Carbon Capture demonstration project funded by the UK Department for Energy Security and Net Zero (DESNZ) under the Call 2 of the CCUS Innovation 2.0 competition
- Key objectives:
 - To scale Promethean's MOF for carbon capture and shape the material for deployment
 - Trial Promethean's MOF in prototype capture unit at a UK power station (design target: 0.5-1.0 tonne CO₂ per day)

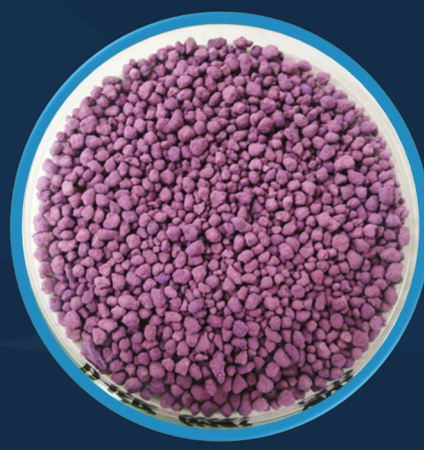


MOF Scaleup without Compromise

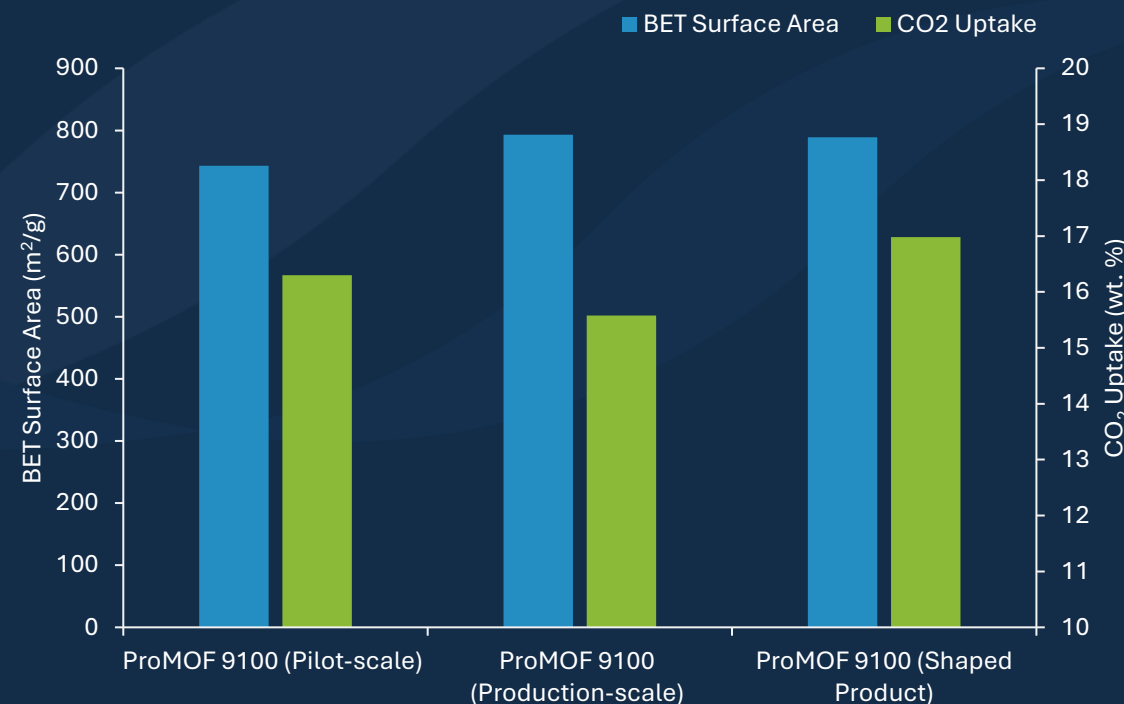
- ProMOF® 9100 (UTSA-16 type structure) successfully scaled to >100 kg with consistent quality and retained performance
- Materials shaped into industrially relevant forms



Powdered ProMOF 9100



Shaped ProMOF 9100



From Lab to Pilot: MOFs in Industrial Conditions

- Pilot trial of MOF-based carbon capture system using industrial flue gas – providing essential insights for next generation CCS
- Proof of concept: MOFs demonstrated stable performance and material integrity after flue gas exposure



Promethean's pilot-scale carbon capture rig loaded with 50 kg of MOF



Learnings from MONET

- Proved MOFs can operate in a pilot rig under industrial flue gas
- Key gaps identified:
 - Humid flue gas → water uptake competes with CO₂
 - Regeneration challenges due to rig design → prevented reliable cycling testing
- Demonstrated that MOF scale-up is solved, but their behaviour in real flue gas needs deeper understanding
- Highlighted the need for:
 - Controlled and systematic testing
 - Collaboration with EPCs and technology developers for full system-level validation

Bridging the Gaps: VPSA Testing

- Next step after MONET is systematic performance evaluation of MOFs (bridging between lab and pilot)
- Fully automated multi-bed vacuum pressure swing adsorption (VPSA) system for solid sorbent testing in carbon capture applications
- Supports a wide range of material volumes, enabling both bench and pilot-scale evaluation
- Generates insights to guide the design and operation of the “heart” of a CCS system
- Accelerating development and validation of next-generation sorbents under realistic operating conditions and diverse feed compositions



Summary

- CCS needs a portfolio of solutions – no single technology is enough
- MOFs are an exciting next-generation sorbents with high selectivity, tuneability and energy efficiency
- Promethean is focused on delivering industrial-scale, high-quality and cost-effective MOFs – bridging lab innovation and commercial readiness
- Demonstration projects (like MONET) are essential to validate performance and identify scale-up challenges
- Our VPSA system can generate critical performance data to support deployment and integration by engineering partners and technology developers
- Keen to collaborate with partners across CCUS value chain to advance MOF-based carbon capture technology – *please reach out!*

Thank You for Listening!

Any Questions?

- Follow our LinkedIn page and website for more information and company updates
 - [linkedin.com/company/promethean-particles](https://www.linkedin.com/company/promethean-particles)
 - [prometheanparticles.co.uk](https://www.prometheanparticles.co.uk)

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- Download our white paper discussing the factors that determine the industrial viability of MOFs for Carbon Capture

