

Riding the Flux: CO₂ Utilisation in Diverse Operating Environments – From Seaside to Inland & Europe to Canada (and back!)

**NIM Webinar Beyond Capture:
CO₂ Mineralisation and Carbon Circularity for a Net-Zero Industry**

21 April, 2026

Dr.ssa Kun V. TIAN

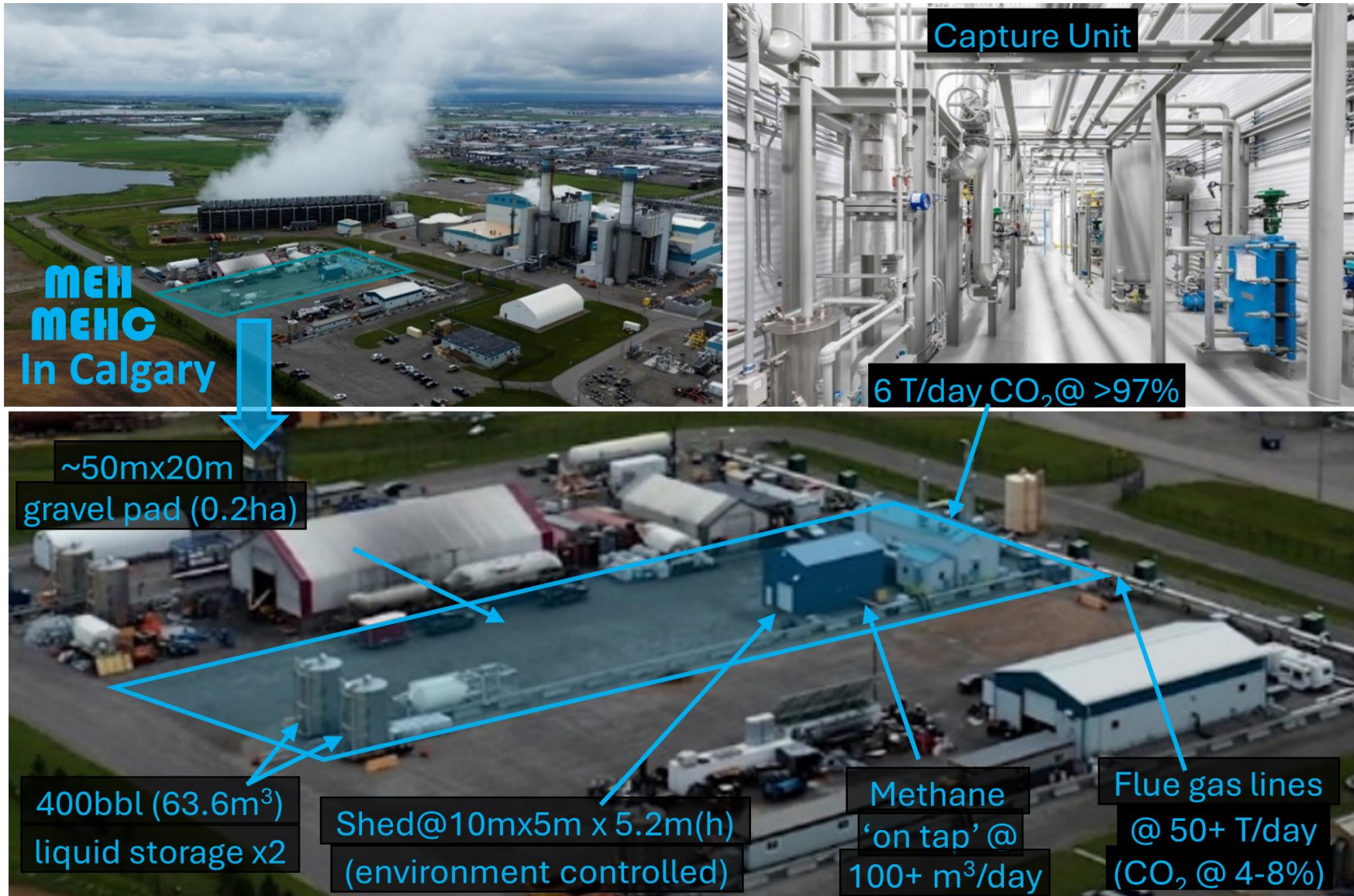
MEH - Mesoscale Engineering Halcyon, Rome, Italy

MEHC - Mesoscale Energy Halcyon Canada, Toronto/Calgary, Canada

Where we are at.

MEH-Canada / MEH Italy Pilot, Calgary, Alberta, Canada

Daily: 25-50+ T flue gas // 6 T CO₂@>97% // 100+m³ methane



CCU Mineralisation Unit – Brine Based Technology

Flux Tolerant Mineral Carbonation – via the ‘GSD’ method



- Flue gas fluxes:
4-8% CO₂ (~5% avg.)
- Brine:
T_f = -27.5 °C ✓👍
* Can operate during winter
- Brine-flux (liquid):
Ca: 0.5-1.05 mol_[crystallization]
Mg: 0.2-1.0 mol
Na, K, Sr: 0.01-0.1 mol
Other: trace – 0.01
- Brine Sediment:
(from supersaturation)
Ca: High (from supersaturation)
Mg: Moderate-High

Alberta – Inland and Environmental Flux (T°, P, Humidity, etc)

Ex: This week (20-29 Apr)

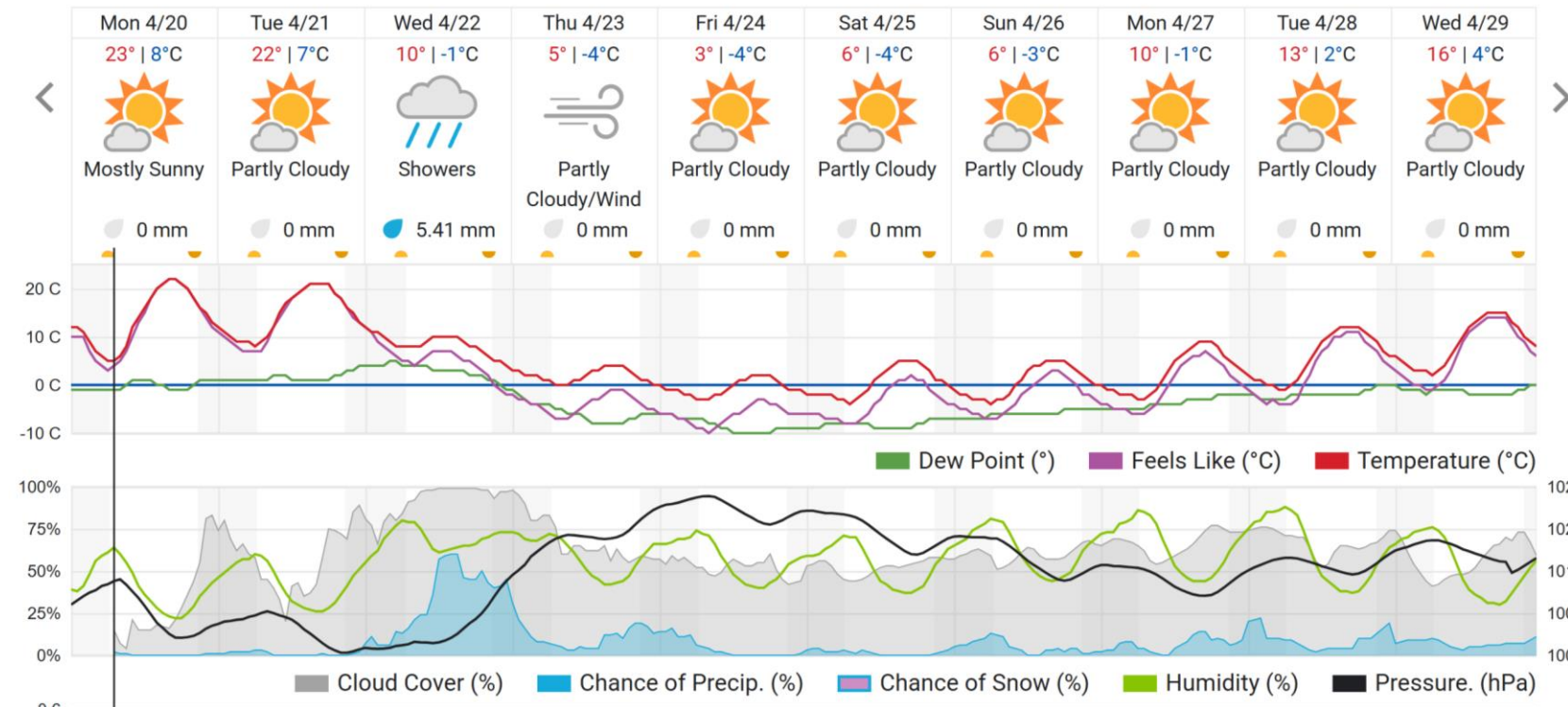
Elev 318 m, 51.04 °N, 114.05 °W

Calgary, Alberta, Canada 10-Day Weather Forecast ★ 🏠

☀️ 5° RAMSAY STATION | CHANGE ▾

TODAY HOURLY **10-DAY** CALENDAR HISTORY WUNDERMAP

⚙️ Customize



Temperature
 $\Delta \sim 27+^{\circ} \text{C}$

Pressure
 $\Delta \sim 0.3 \text{kPa}$

Seasonal Fluxes – Throughout the year

51.1 °N, 113.98 °W
Calgary, Alberta, Canada Weather History ★ 🏠
6° CALGARY INTL AIRPORT STATION | CHANGE ▼

TODAY HOURLY 10-DAY CALENDAR **HISTORY** WUNDERMAP

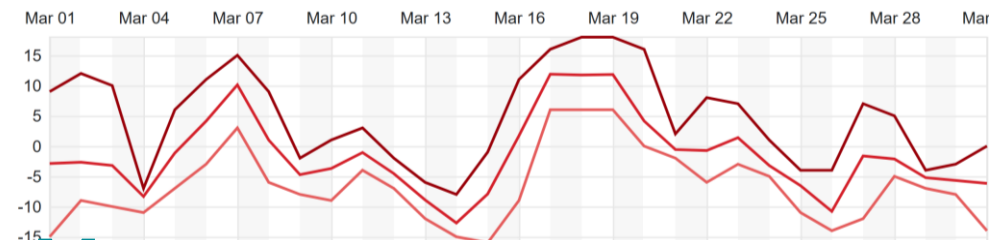
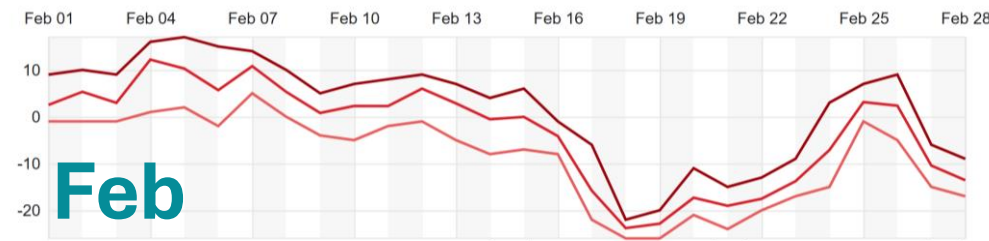
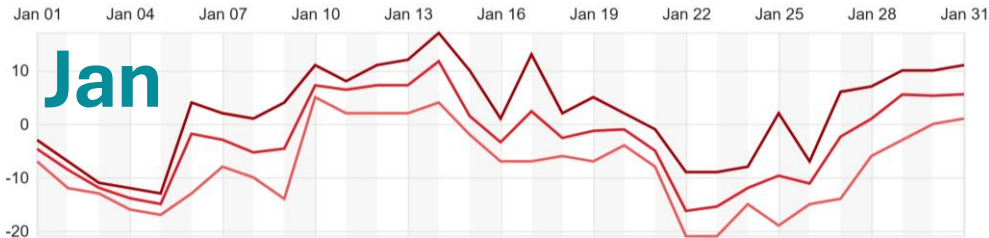
Daily Weekly **Monthly**

January ▼

2026 ▼

View

$\Delta \sim 25-40+^{\circ} \text{C}$

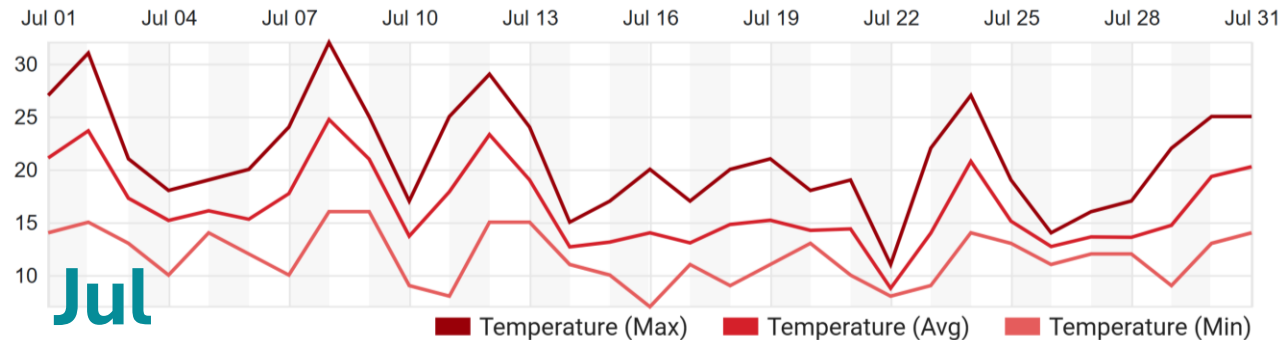


Even in Summer

July ▼

2025 ▼

View



- Diurnal (daily) and seasonal fluxes significantly change conditions (esp. for brines)
 - MEH/MEHC optimize processes to take advantage of this:
- Cold: ($\uparrow \text{CO}_2$ dissolution, \uparrow precipitation)
- Warm: (\uparrow rate, \downarrow hydrated phases).

**How it all works.
&
Where it all goes.**

MEH/MEHC Utilisation (daily): via 'GSD' method – valid in Italy and Alberta !

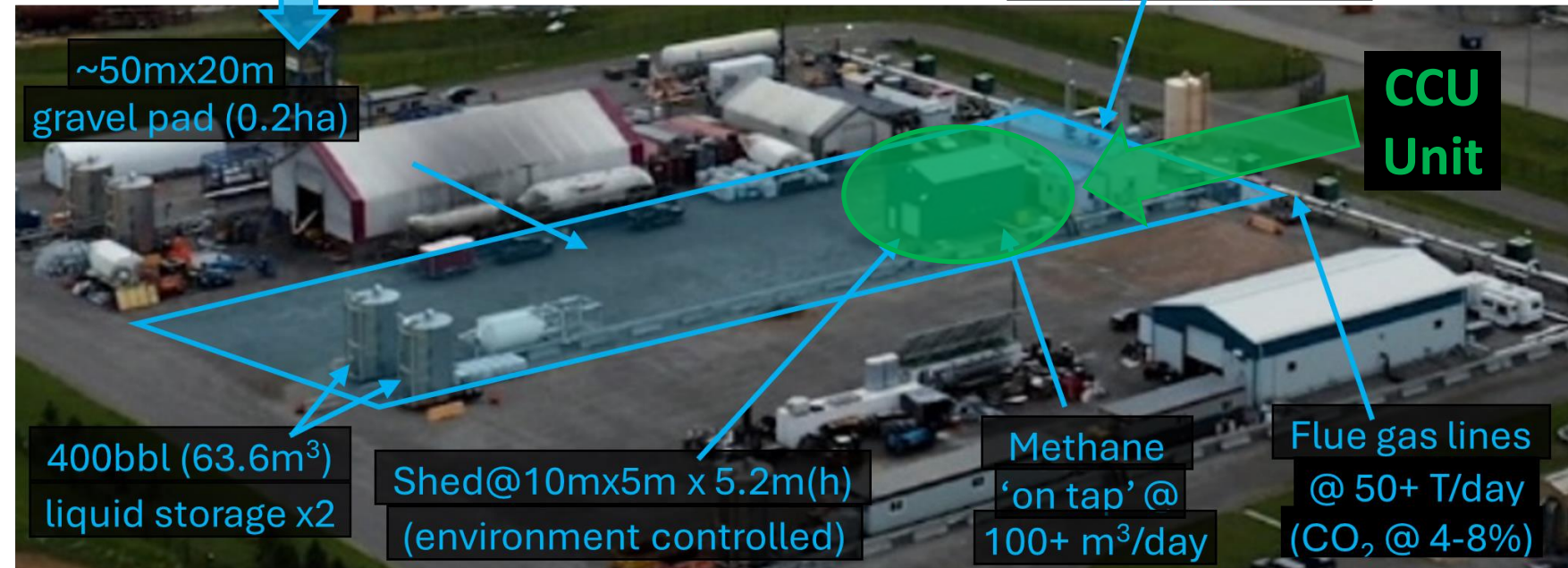
UP To: Flue Gas @ 25-50+ T / CO2 (>97%) @ 6 T // Brine @ 24-36m³



Villeneuve, Alberta

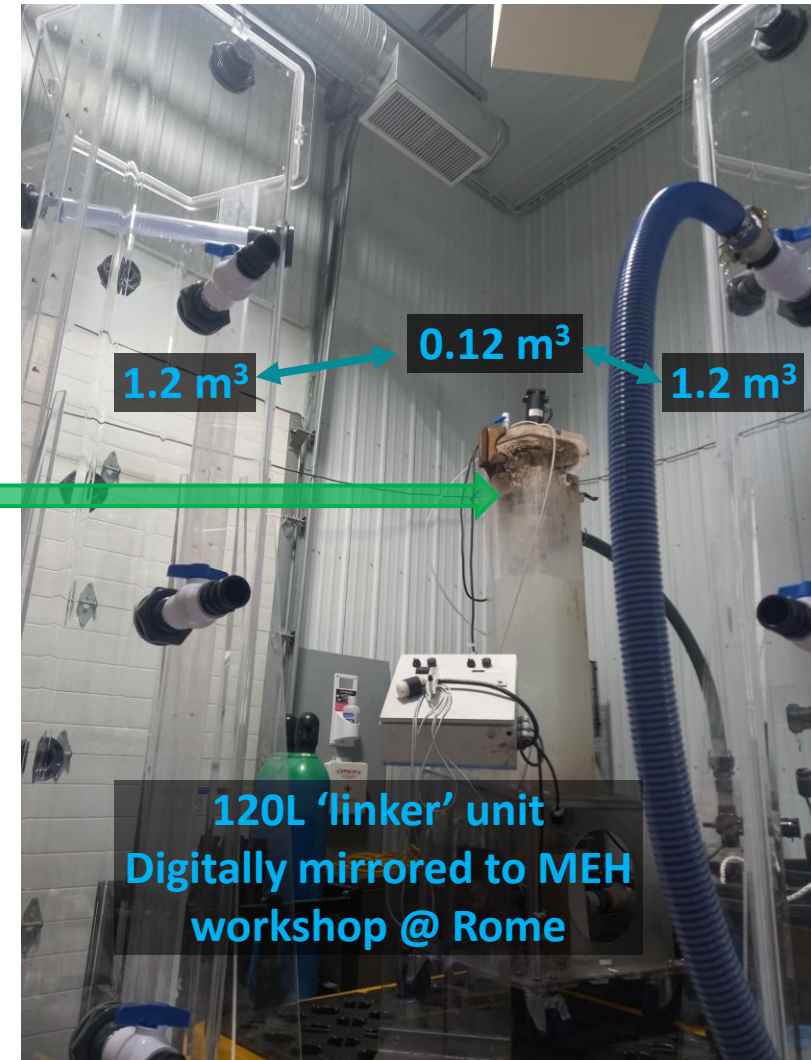
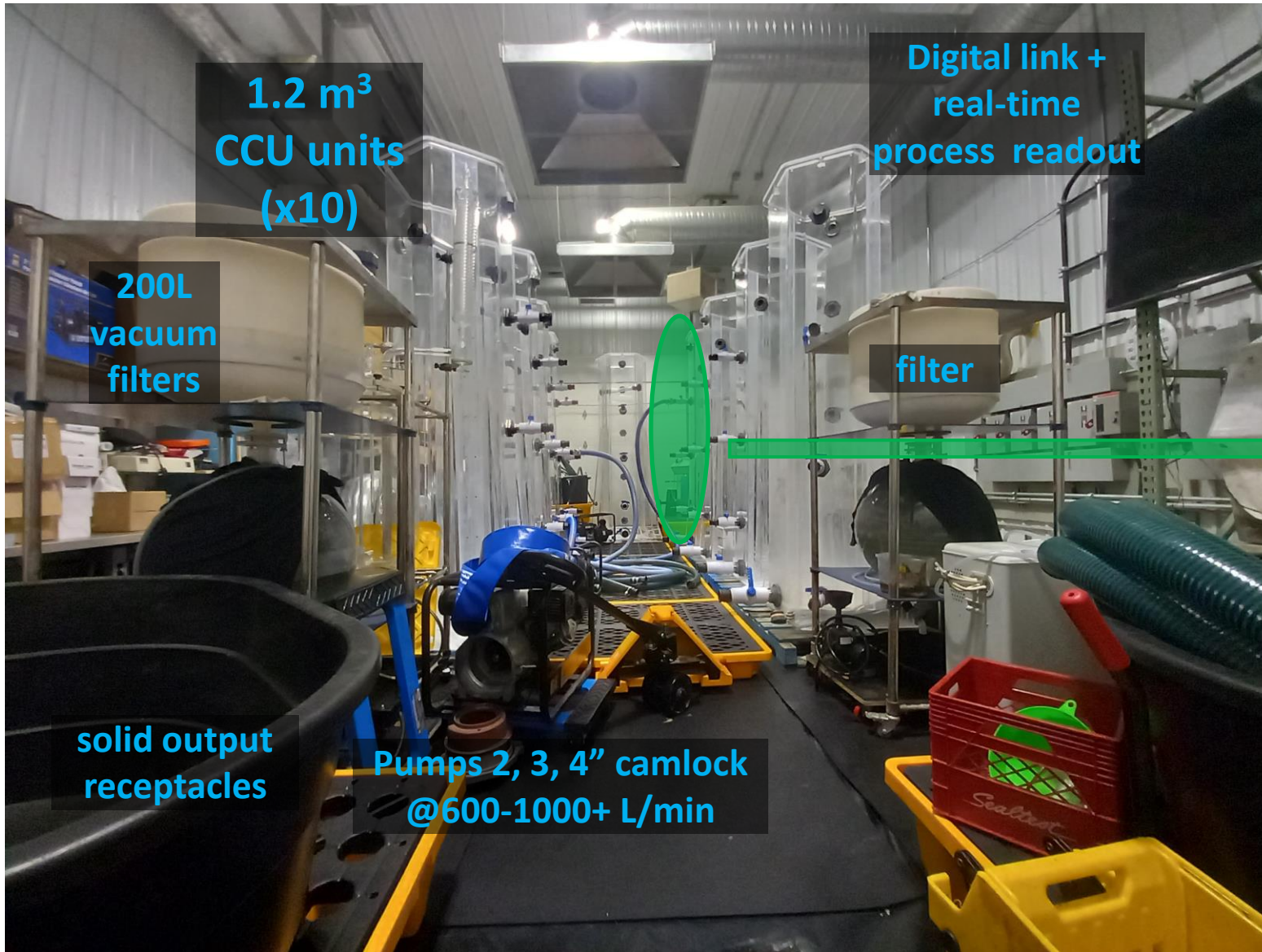


Natural Brines for Drilling,
Capping, Completion

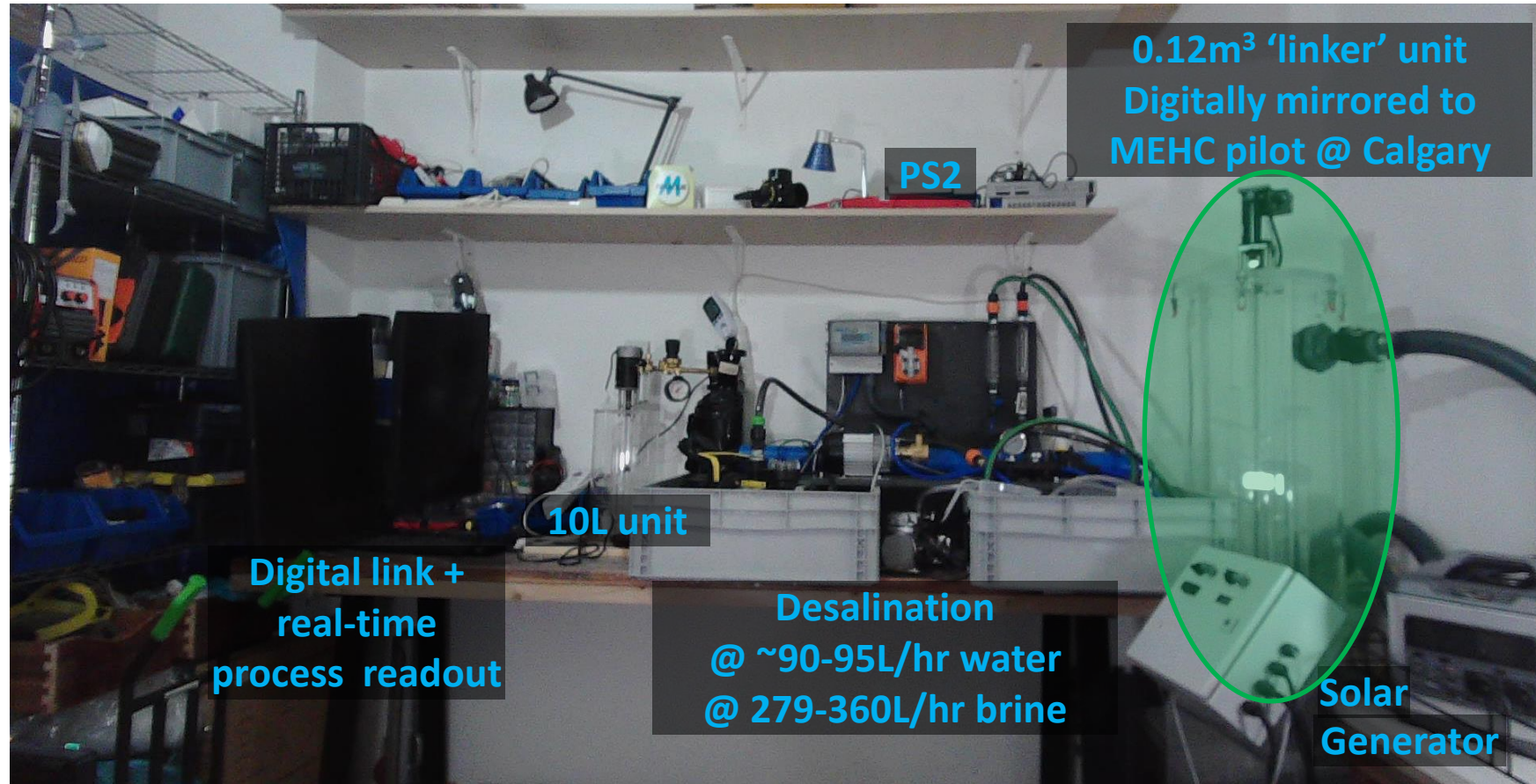


CCU Mineralisation Unit - Environment Controlled

CO₂@6T/day + Brine@18-36m³/day → ~11-14T Ca/Mg-Carbonate slurry/day (~50%dry)



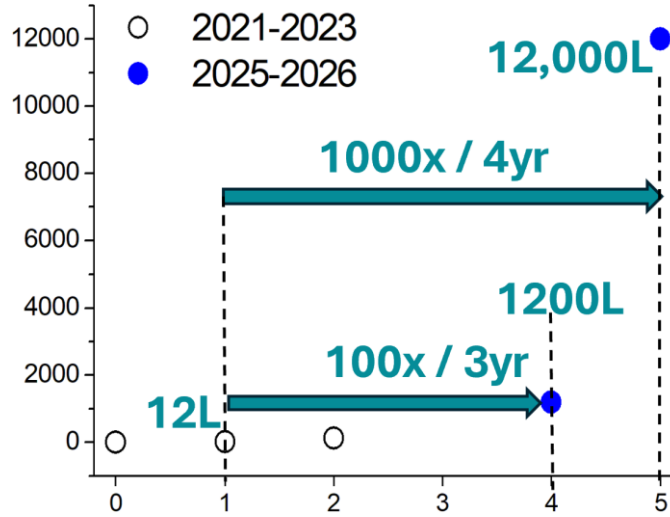
Alberta Brines – Used in Oil&Gas as Drilling, Capping, Completion Fluids



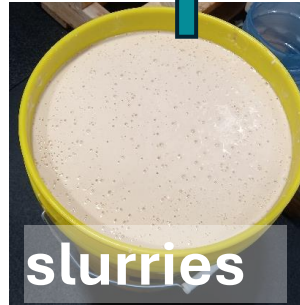
**Workshop, MEH Italy, Roma, Italy
Dimensioned to 20-foot Container**

Where it all goes – 2021-2026 → 2026-2030

Completed ('21-'26)

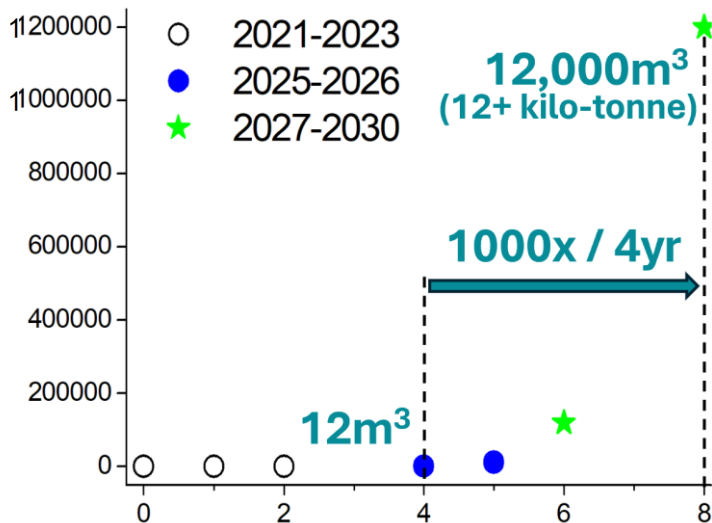


Road Stabilisation + Dust Control @>175kT/yr
(mining, logging, dams, agriculture)

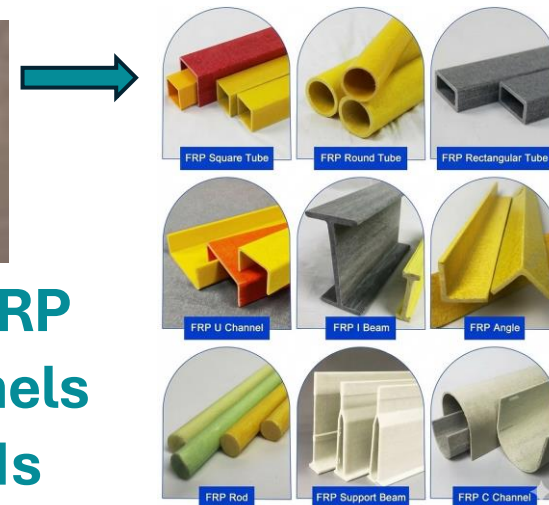


Current Clients - Downstream End-Users

Predicted ('26-'30)



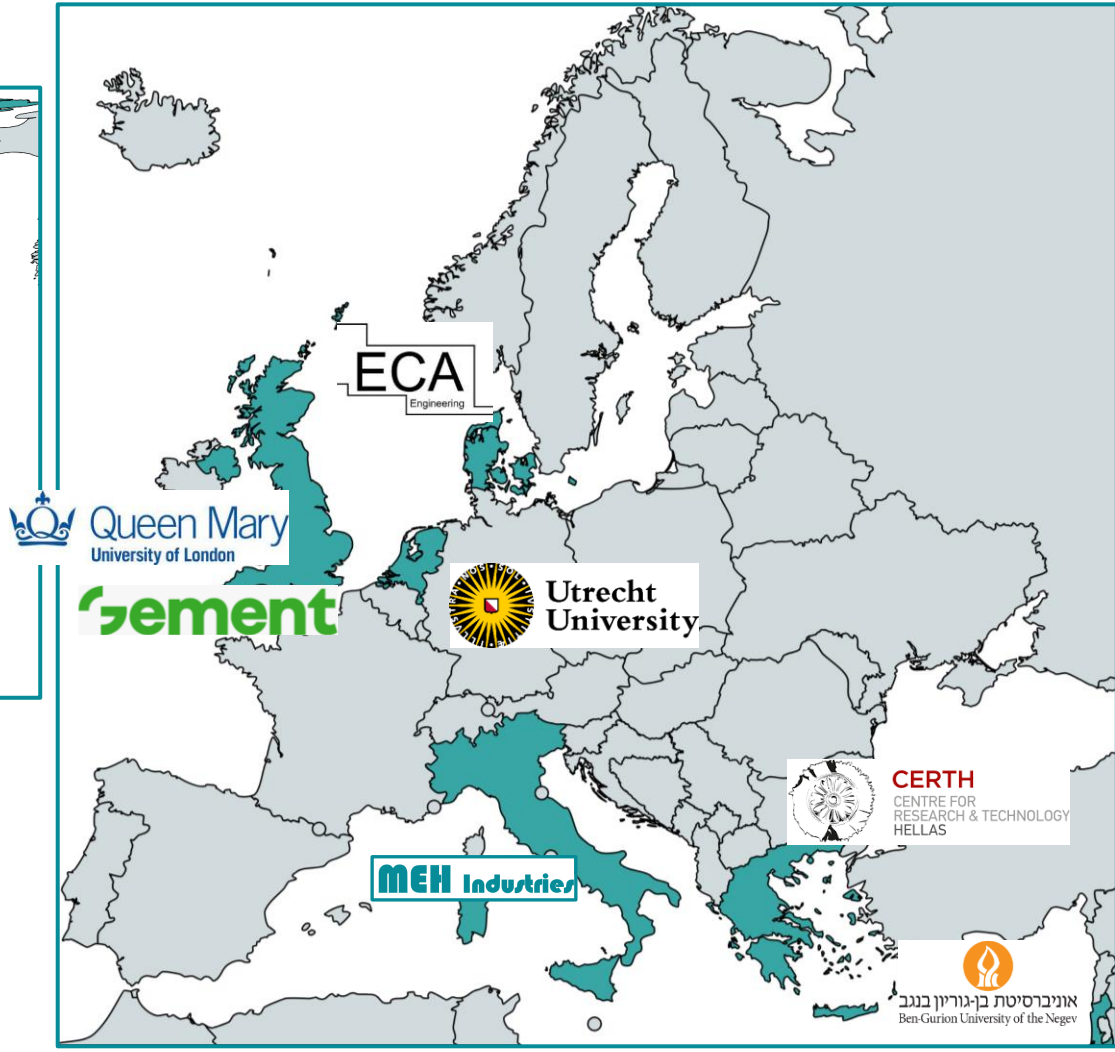
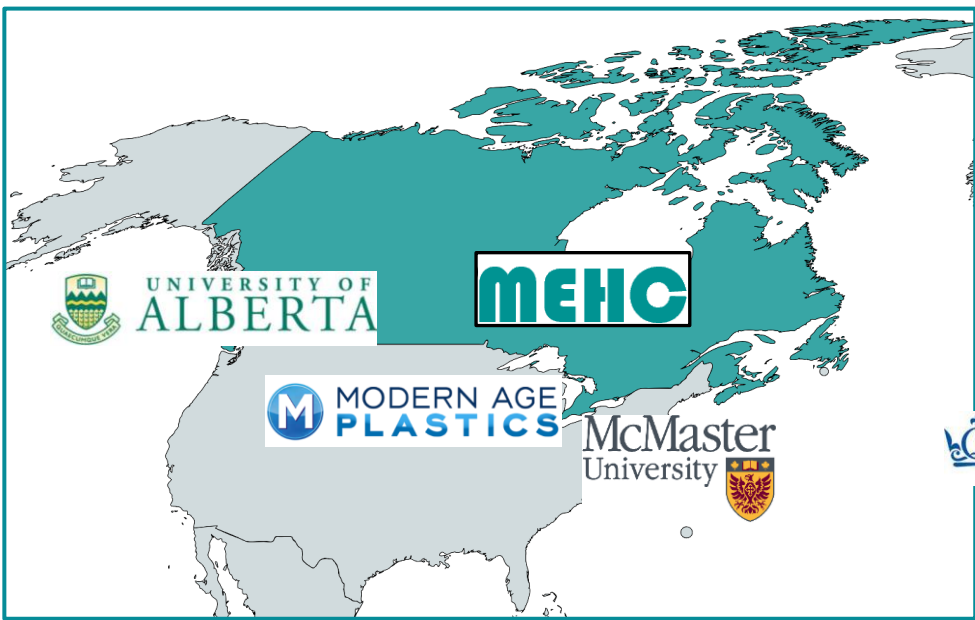
FRP/CFRP/GFRP
Structures, Panels
Process Skids



Pathway to Today History

BUCK\$\$\$ Consortium (2023-26): 13 partners, 7 countries (IT, GR, IS, DK, NL, UK, CA)

-7 Academic, 6 Industrial – 7 female leads, 9 Cultures



2023-2026
Funded by:
GSRI (GR)
MoE (IL)
EUDP (DK)



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BUCK\$\$\$ workshop, Rome, Italy



CETP workshop, Leipzig, Germany



Scale-Up (8→12L) + Optimised Unit Dimensions & Shape CCU Continued @ STP (ambient conditions, non-forcing)

Brine
+ 'Sauce'

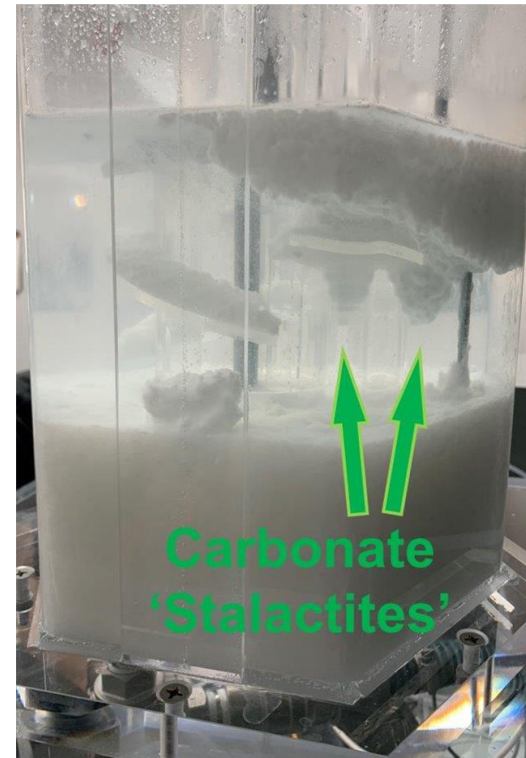
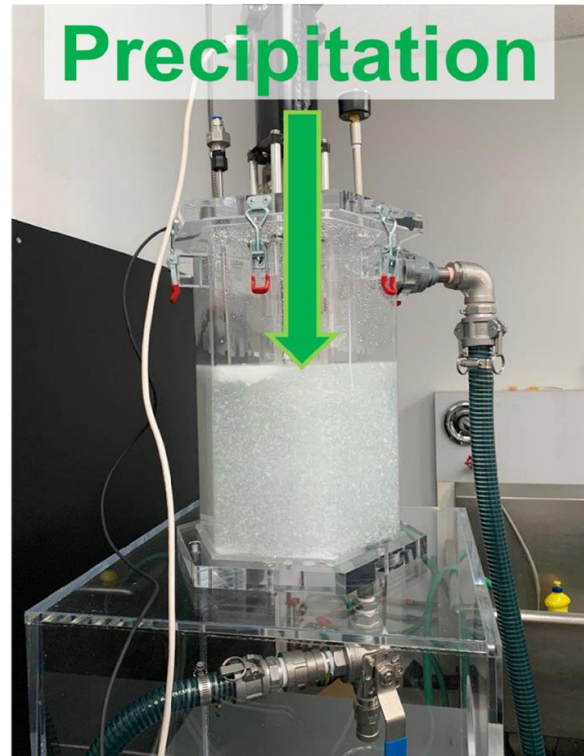
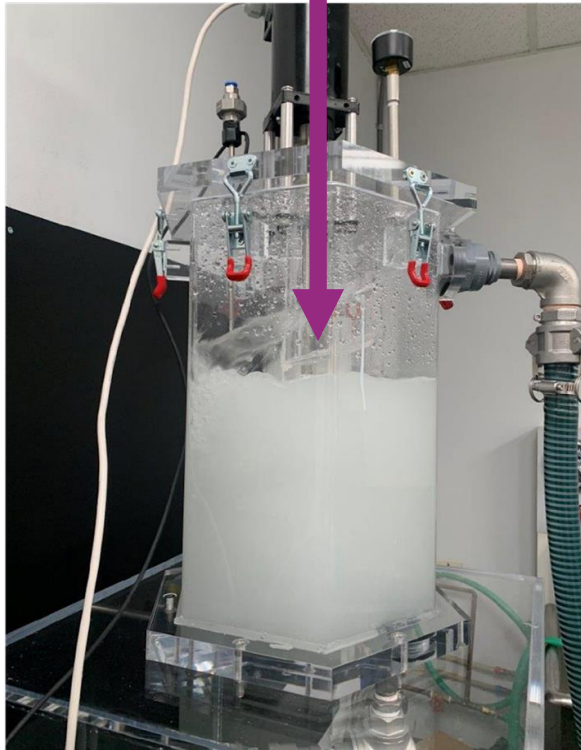


Add CO₂



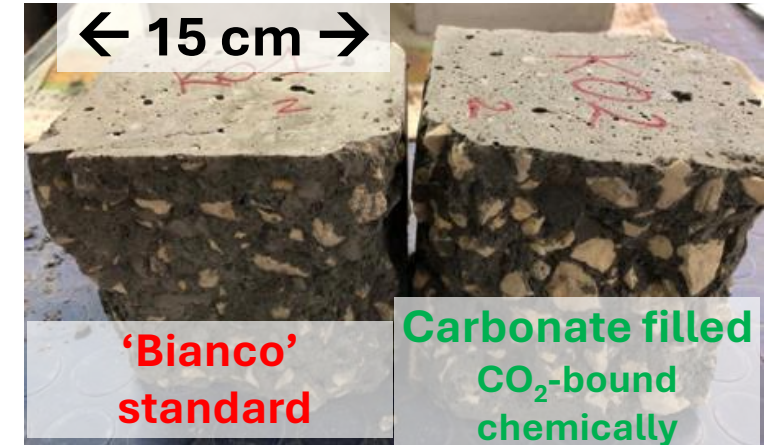
Precipitation

Mimicks natural
mineralisation



Product In Action – Technology In Operating Environments

Our 'greened' Concrete w/superior durability & lower permeability



*Lowered amount / omission of hydrocarbon 'plasticisers'

Lowest Estimates

350 kT/yr brine

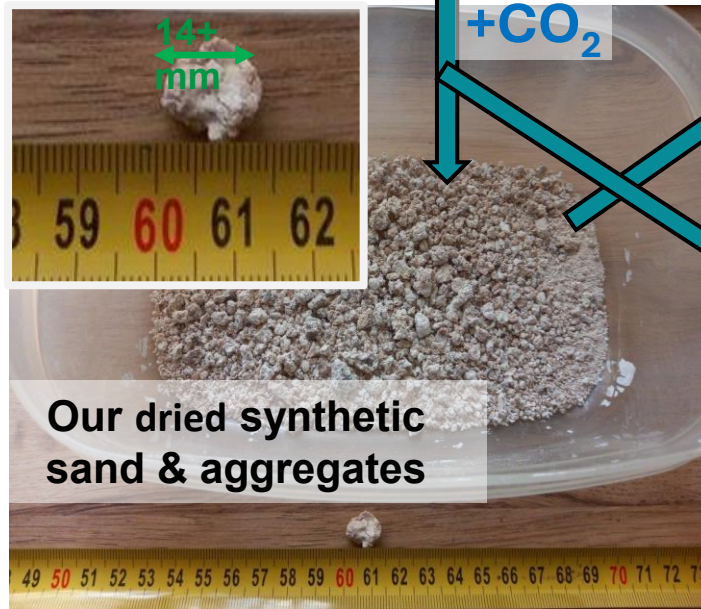
@10% ~ 35 kT carbonates

35 kT * 50 €/T = 1.75M €

@10% ~3.5 kT/yr CO₂ fixed

@1 locale

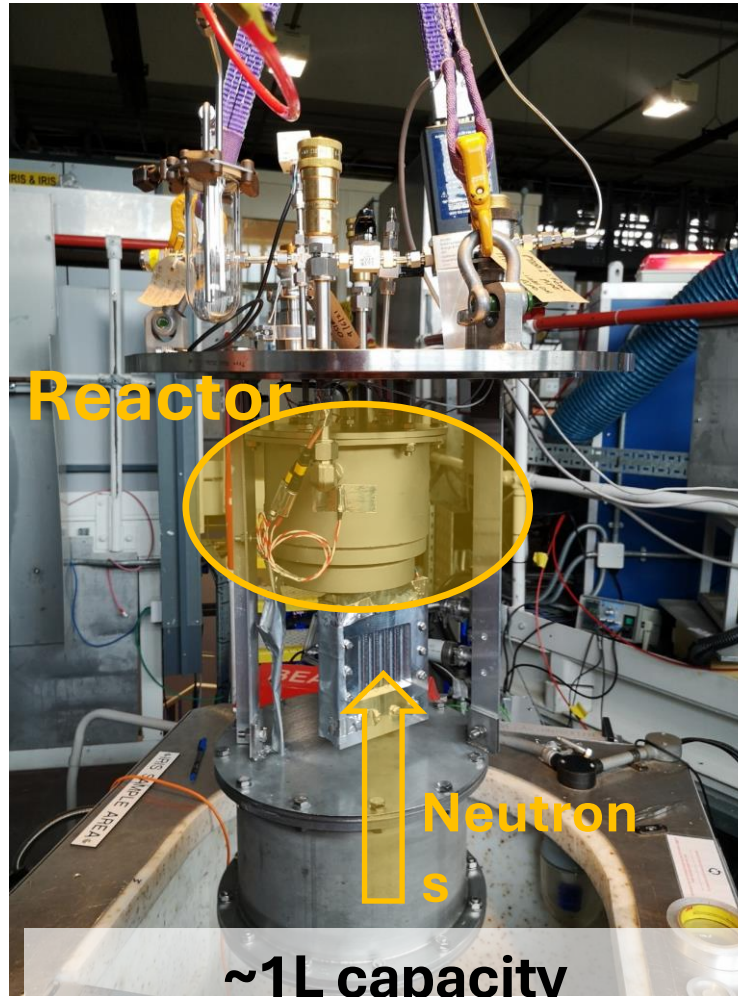
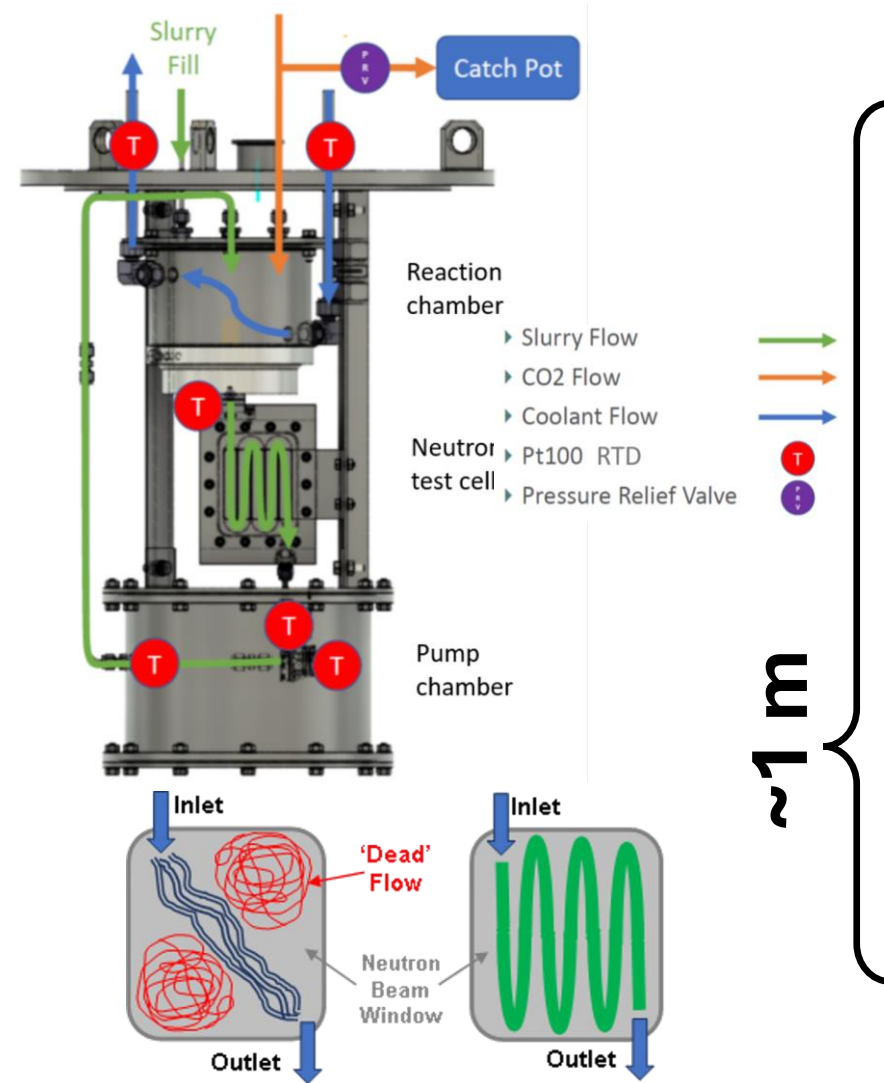
*50 €/T = as filler (sand, aggregates, etc)



MEH Industries

CCU Processes in Real-Time - Neutron Scattering *in-situ*

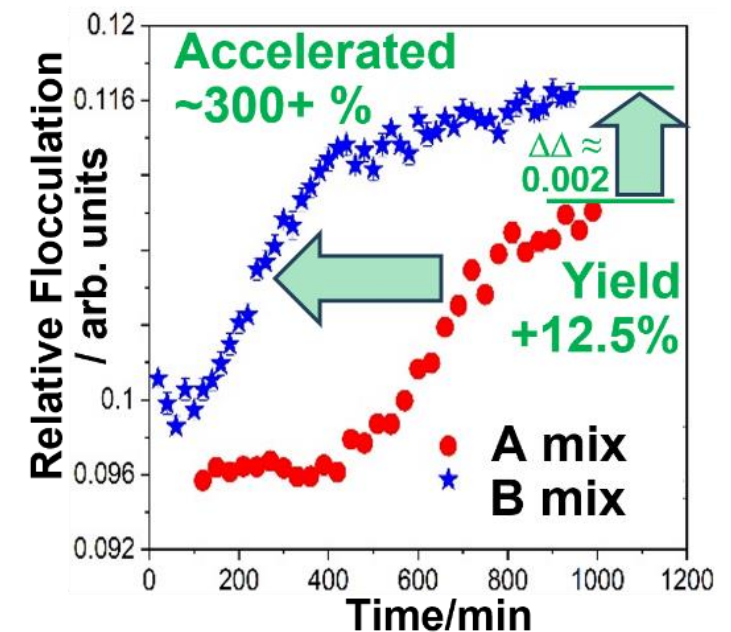
Non-Destructive Characterisation @ kg scale (w/partners @ QMUL, London, UK)



~1L capacity
~25kg + 10kg cover plate



CO₂ Mineralisation / Time

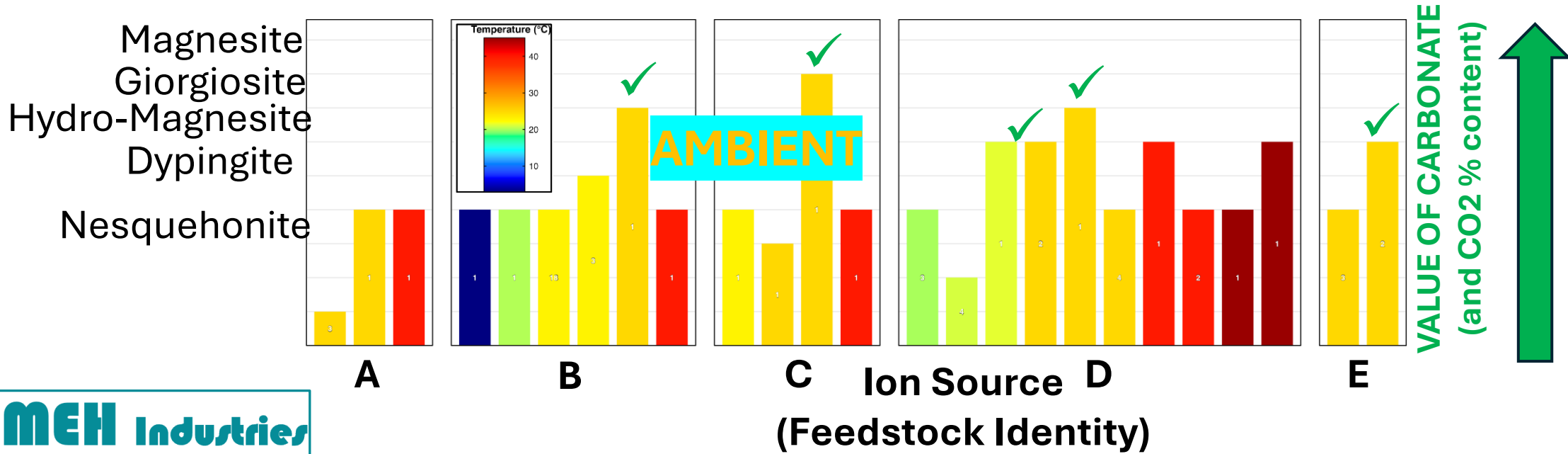


Rational optimization of carbonate type + yield + efficacy

Optimised Through Machine-learning + non-destructive testing

- Carbonates of differing 'desirability' (CO2%, solubility, hardness)
- CO2% NOT only measure of 'good'**
- We generate hydromagnesite and giorgiosite at/below STP (~50-100kg/hr)
- Ion-sources + conditions + process technology key to product utility

Carbonate	Formula	%CO2 w/w	Density	H ₂ O Solubility
Magnesite	MgCO ₃	52.2	3.0	Very Low
Giorgiosite	Mg ₅ (CO ₃) ₄ (OH) ₂ •5H ₂ O	36.3	~2.17	Very Low
Lansfordite	MgCO ₃ •5H ₂ O	25.2	~1.7	Moderate
Hydromagnesite	Mg ₅ (CO ₃) ₄ (OH) ₂ •4H ₂ O	37.6	~2.18	Very Low
Artinite	Mg ₅ (CO ₃) ₄ (OH) ₂ •4(H ₂ O)	22.4	2.0	
Dypingite	Mg ₅ (CO ₃) ₄ (OH) ₂ •5(H ₂ O)	36.3	2.2	Very Low
Nesquehonite	Mg(HCO ₃)(OH)•2(H ₂ O)	31.8	~1.8	Very Low
Brucite	Mg(OH) ₂	0.0	~2.4	Very Low



Acknowledgements

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- U. Alberta, Edmonton (CA), for support
- UBC, Vancouver (CA), for support

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