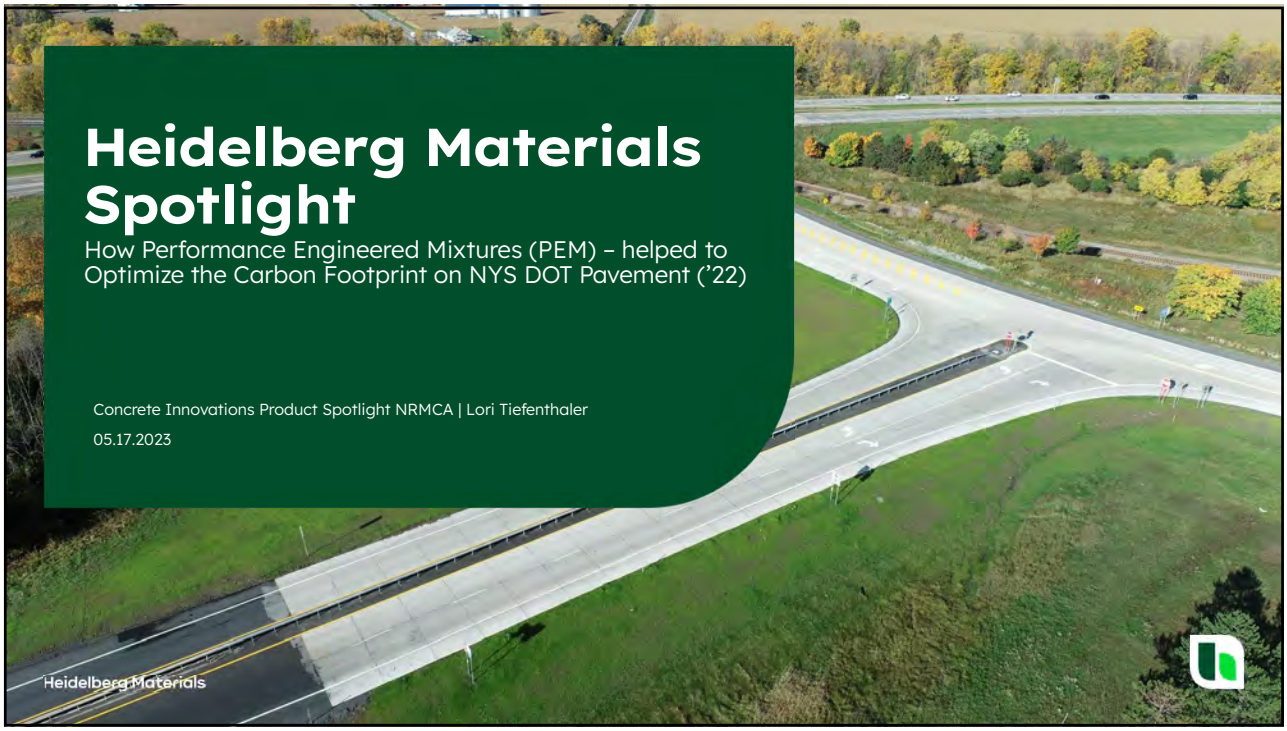


Heidelberg Materials North America

~9,000

employees
in 28 states and 6 provinces

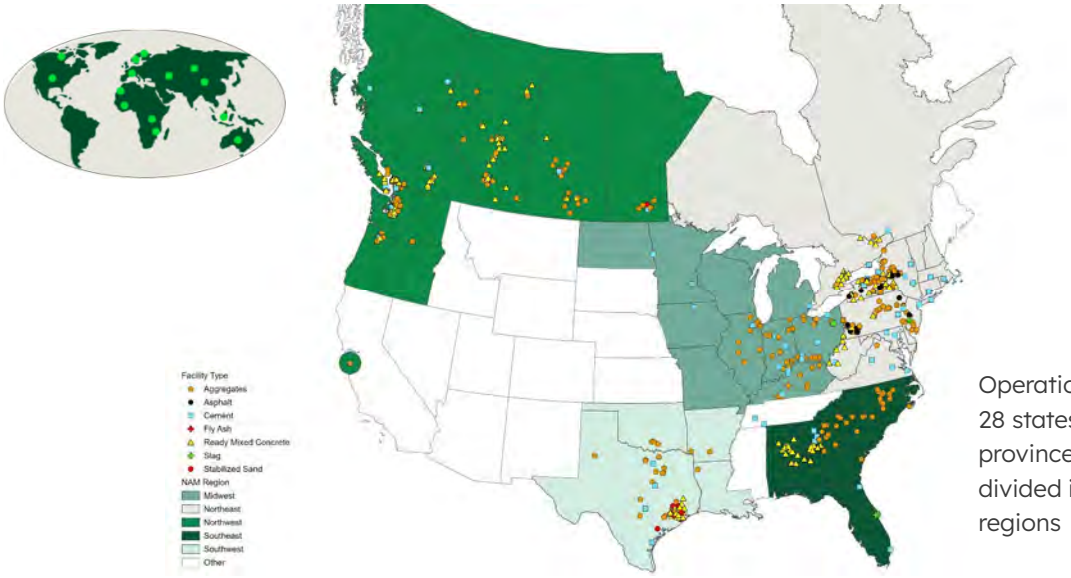
>450

manufacturing locations, distribution terminals and sales yards

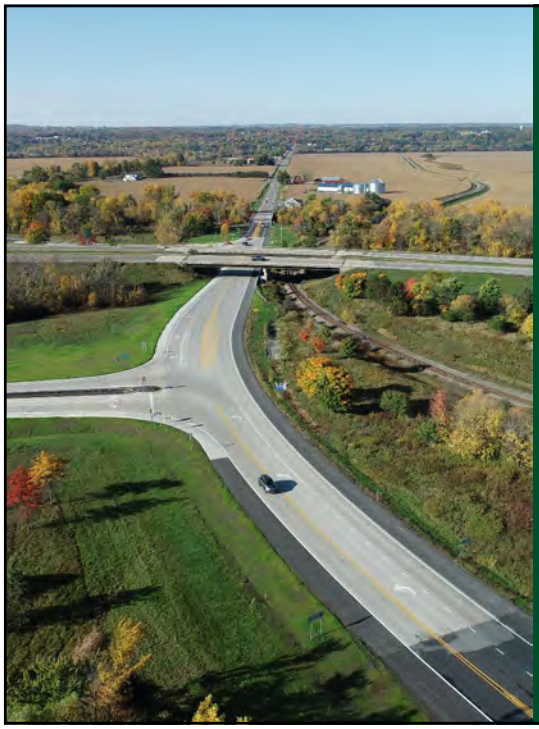
Leading positions in: cement, slag, fly ash, aggregates, and ready-mixed concrete

Heidelberg Materials is evolving our portfolio of products and services—providing the materials to build the future.

Heidelberg Materials geographic footprint



Operations in 28 states and 6 provinces divided into 5 regions



Agenda

1. Sustainability Demand
2. Concrete - Carbon Reduction Levers
3. Performance Engineered Mixtures (PEM) Case Study
4. Emerging Deep Carbon Cut Technology

1

Sustainability Demand

Current Buy Clean Procurement Policy Landscape

	Maximum GWP (kg CO2e)/m3	
Concrete Strength (psi) [1]	Portland Cement Concrete (PCC) including: Commercial Grade Concrete (CGC), Concrete Pavement, High-Performance Concrete (HPC)/Structural Concrete	Lightweight Concrete
2500	238	
3000	263	519
4000	318	575
5000	387	633
6000	411	
8000	489	

City of Portland (OR)

PANYNJ Proposed Carbon Limits		
PSI Range	lbs CO2e/cy	kg CO2e/m3
Flex Mixes	415	250
3000-6000	425	255
6001-8000	520	310
8000+	630	375

Port Authority of NYNJ

GSA IRA LEC Material Requirements

	GSA IRA Limits for Low Embodied Carbon Concrete - May 16, 2023 (EPD-Reported GWPa, in kilograms of carbon dioxide equivalent per cubic meter - kgCO2e/ m3)		
Specified concrete strength class (compressive strength [f'c] in pounds per square inch [PSI])	Top 20% Limit	Top 40% Limit	Better Than Average Limit
≤2499	228	261	277
3000	257	291	318
4000	284	326	352
5000	305	357	382
6000	319	374	407
≥7200	321	362	402

Add 30% to these numbers for GWP limits where high early strength[1] concrete mixes are required for technical reasons.

GSA

(U.S. General Services Administration)

Green Building Standards

International Code Council's 2012 International Green Construction Code (igCC)

Model Code

Mandatory

Commercial; Industrial; Mixed Use; Residential

New construction; Additions: alternations

Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings (ASHRAE 189.1)

Model Code

Mandatory

Commercial; Industrial; Mixed Use; Residential

New construction; Additions:

ICC 700-2012: 2012 National Green Building Standard (ICC 700)

Rating & Certification system

Voluntary

Mixed Used; Residential

New construction; Additions: alternations

Green Globes

Rating & Certification system

Voluntary

Mixed Used; Residential

New construction; Additions: Existing

Envision

Rating & Certification system

Voluntary

Civil infrastructure

US Green Building Council's Leadership in Energy and Environmental Design (LEED®)

Rating & Certification system

Voluntary

Mixed Used; Residential

New construction; Additions: Existing

The International Living Future Institute's Living Building Challenge , version 2.1

Certification system

Voluntary

Commercial; Industrial: Mixed use; Residential

All

2

Carbon Reduction Levers

How concrete got greener

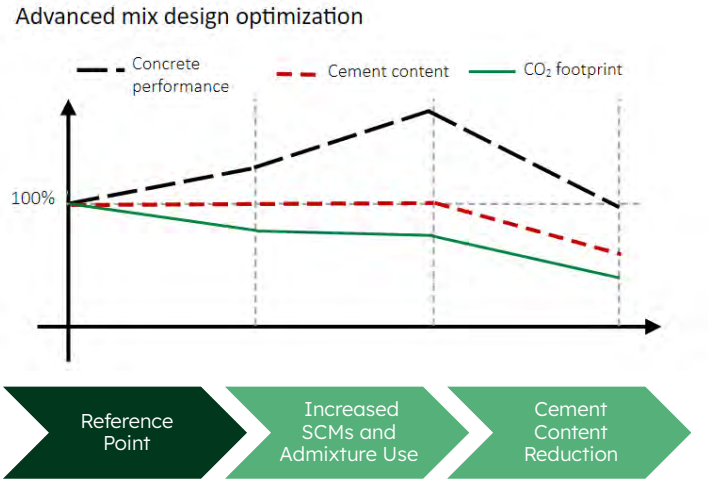
A Science-Based Approach to Lowering the Embodied Carbon of Concrete

Breaking down Concrete

Low carbon concretes can utilize a combination of carbon reduction levers to reduce overall CO2.

These include, but are not limited to:

- Aggregate gradations
- Admixtures
- Days to mature
- Secondary cementitious materials (SCMs)
- Cement type



Heidelberg Materials 05.17.2023 Concrete Innovation Product Spotlight | NRMCA | Pavement | Lori Tiefenthaler

3

Project Case Study

NYS DOT Project

Reconstruct Rt 408 at I-390 interchange

Cold Springs Construction

Heidelberg Materials (formerly Hanson) supplied the concrete

3700 Cubic Yards of Concrete

~13,300 Square Yards of 10” plain doweled pavement

Performance Engineered Mixture (PEM) Project

- First PEM in Western NY (3rd for NYS DOT)
- First PEM for Heidelberg Materials to supply concrete
- One of the first to use EcoCemPLC

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Performance Engineered Mixtures (PEM) - Framework

PEM Framework changes the focus from strength to durability:

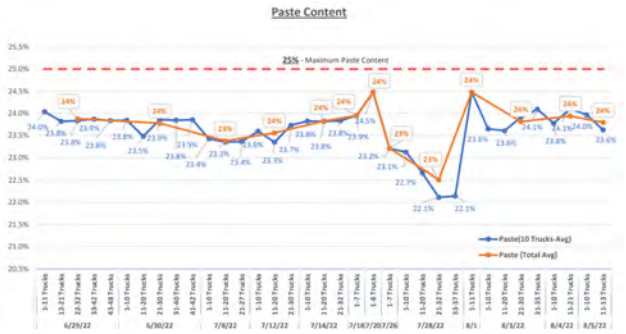
- Eliminates mandatory cement contents
- Paste content limit
- Combined aggregate gradation
- Surface resistivity requirement (SCM needed)
- Super Air Meter (SAM) & Box Test

NYS DOT - Reconstruct Rt 408 at I-390 interchange

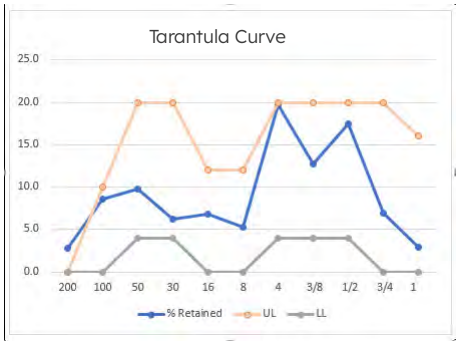
Properties	NYS DOT requirement	Average Field Results
28 day PSI	3000 psi (min)	4340 psi
56 day Surface Resistivity	16.5 kΩ/cm	21.3 kΩ/cm
Paste Content	25%	23.5-24%
w/c ratio	0.44	0.38-0.39

Each state agency is unique in the way it specifies concrete pavements; Table 2 in AASHTO R 101 gives agencies choices in the PEM properties and standard test methods to use

QA/QC Roles

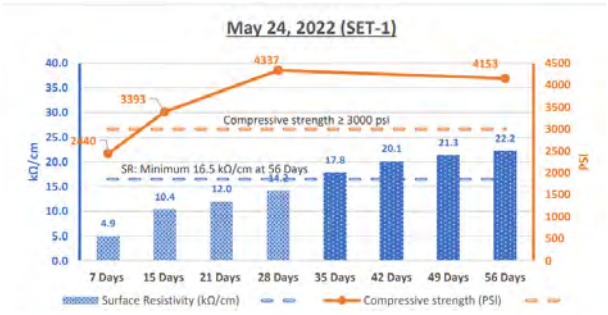


It may seem low, however for paving this paste content was plenty to finish well; the combine aggregate is a key contributor



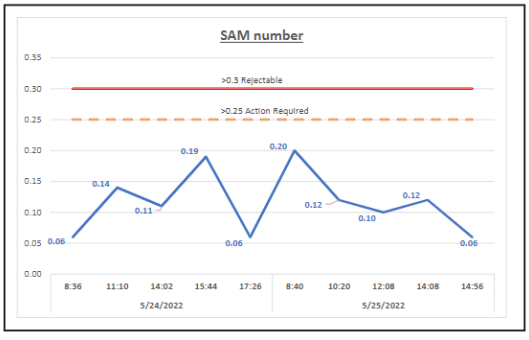
The box test was performed with lab mix and as the project got started and it was a good indicator the mix would work well with good edges

QA/QC Roles



Surface Resistivity is easy indicator of permeability

You will need an SCM to consume the CH



SAM is not a carbon reduction lever

Putting PEM to the Test

- Utilizing local batch plant
- Transport by belt to the dump truck
- Dump truck drove 15 min to job site
- Discharged to a spreader then paver

Project Results -

PEM mix design was forgiving for batching, delivery and placing

PEM intimidation factor relieved early

Minimal to no segregation during the transfer from truck mixer to open top haul unit to the material spreader to paver

Air, SAM, Slump was tested on site

The mixture maintained a nice edge profile, with minimal edge slump

Staff behind the paver complemented the mix

Saving over 270,000 kg CO2-eq

Carbon Footprint and PEM Reductions

87 kg CO2 per m3 reduced

272,658 kg CO2 saved, whole project

Environmental Impacts

Declared Product: PEM

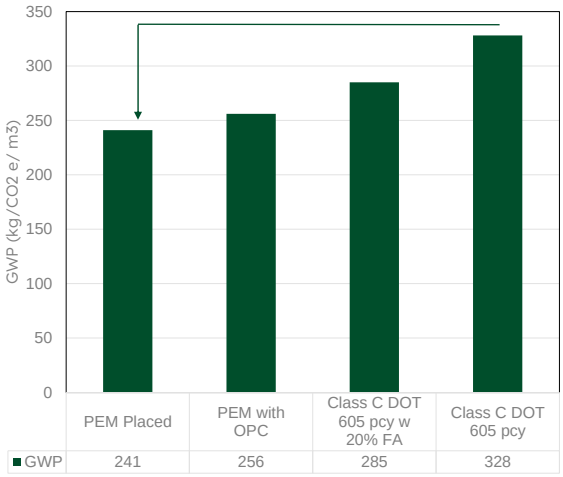
Description: PEM 3000 psi AE

Compressive Strength: 3000 psi @ 28 days

Declared Unit: 1 m3 of ready-mix concrete

		per m³
Global Warming Potential	kg CO2e	241.02
Ozone Depletion	kg CFC11e	8.13E-06
Acidification	kg SO2e	1.43
Eutrophication	kg Ne	0.22
SFP (Smog)	kg O3e	20.33
Abiotic depletion potential for fossil resources	MJ, NCV	633.76
Abiotic depletion potential for non-fossil mineral resources	kg Sbe	1.23E-04

Product Components:
BatchWater (ASTM C1602), Air Entrainer (ASTM C260), Crushed Coarse Aggregate (ASTM C33), Natural Fine Aggregate (ASTM C33), Water Reducer (ASTM C494), Portland Limestone Cement (ASTM C595), Fly Ash (ASTM C618)



ecocem™ PLC

Comparing to buy clean procurement

Specified concrete strength class (compressive strength [f'c] in pounds per square inch [PSI])	GSA IRA Limits for Low Embodied Carbon Concrete - May 16, 2023 (EPD-Reported GWPs, in kilograms of carbon dioxide equivalent per cubic meter - $kgCO_2e/m^3$)		
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Add 30% to these numbers for GWP limits where high early strength[1] concrete mixes are required for technical reasons.			

PEM mix design guideline for pavement

- Align with emerging low carbon procurement requirement
- By limiting paste content, SCM replacement
- Not all concrete are paving application
- GWP could change up and down due to distance to material sources and more EPDs for constitutes

PEM Resources

CPtechCenter.org

Performance-Engineered Mixtures (PEM) | National Concrete Pavement Technology Center (cptechcenter.org)

FHWA Mobile Concrete Technology Center (MCTC)

MCTC – equipment loan program

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With PEM approach, Concrete pavement is expected to perform better and last longer with a lower environmental impact.

Performance Engineered Concrete Paving Mixtures – Final Report Page 66

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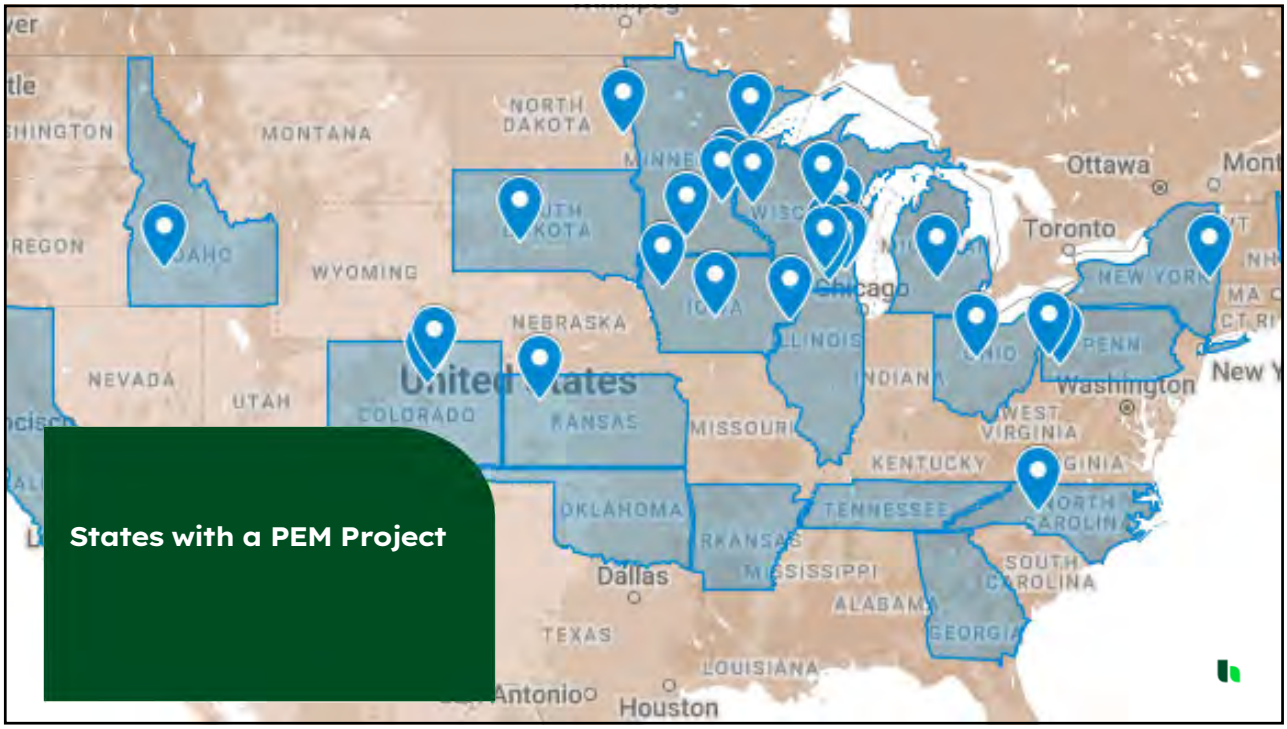


5

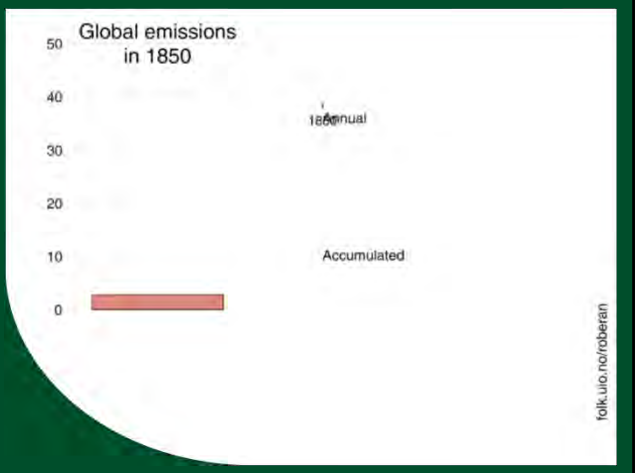
Emerging Deep Carbon Cut Technology

Carbon Budget and CCUS

Topline

The concept of a remaining carbon budget implies that, to stabilize global warming at any particular level, global emissions of CO2 need to be reduced to net zero levels at some point

IPCC



Ref: CICERO Center for International Climate Research, Robbie Andrew

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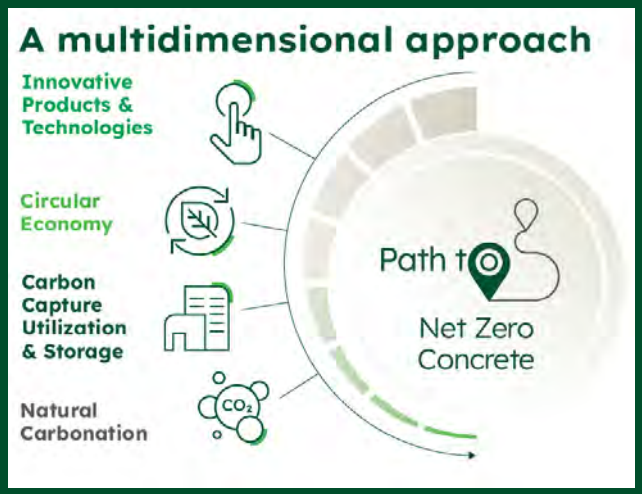
Leading the way to net zero concrete

Our North America Carbon Roadmap

- Innovative Products
  - Low Carbon Cements and Concrete Mixes
- Circular Economy
  - Use & incorporate reclaimed materials
    - Recycled Concrete Aggregate (RCA)
    - Supplementary Cementitious Materials (SCMs)
- Carbon Capture Utilization & Storage
  - Brevik Norway - world's first CCS plant in the cement sector deployed on industrial scale
  - Edmonton, to capture ~ 1-mil. tons CO_2/ year
- Natural Carbonation
  - Working for transparent uptake accounting



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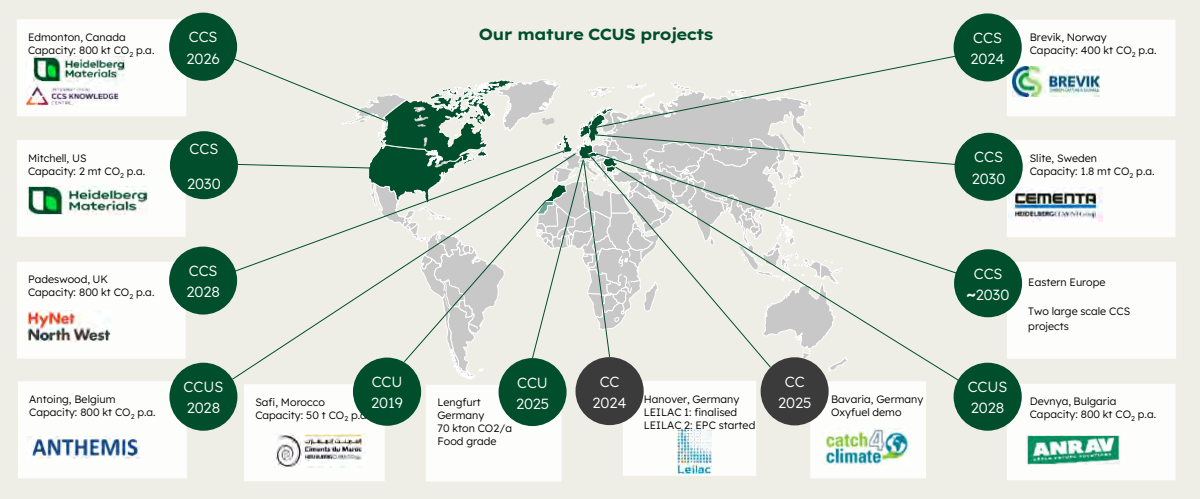
Building a more sustainable future

Driving CCUS with extensive and most advanced project portfolio in the sector



We target to cumulatively capture 10 Mt CO2 by 2030!

CCUS: Carbon capture, utilization, and storage

Questions?

Thank You.

Lori Tiefenthaler
Sr. Director of Marketing
Lori.Tiefenthaler@heidelbergmaterials.com

PEM – cptechcenter.org