

CARBONCURE™
SIMPLY BETTER CONCRETE

Strong & Green:

Using CO₂ to
improve ready mix
performance and
sustainability

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CarbonCure Technologies



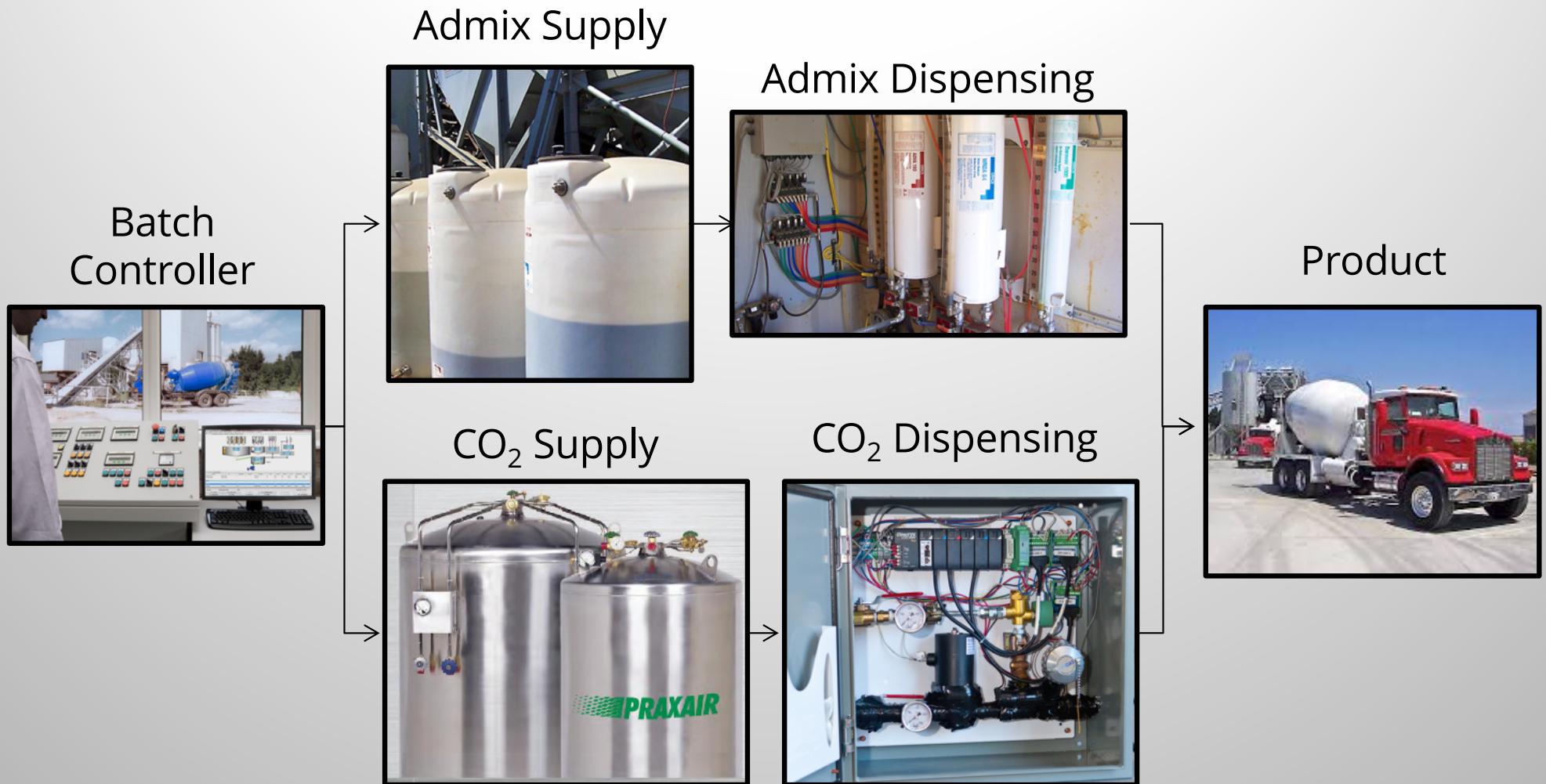
What is CARBONCURE™ ?

SIMPLY BETTER CONCRETE



CarbonCure is a technology installed in ready mix concrete plants. The technology injects CO₂ into fresh concrete in order to improve its strength and allow concrete producers to **optimize their mix designs** and **realize cost savings** while **growing their business** within the green design community.

How it works: Admixture analogy

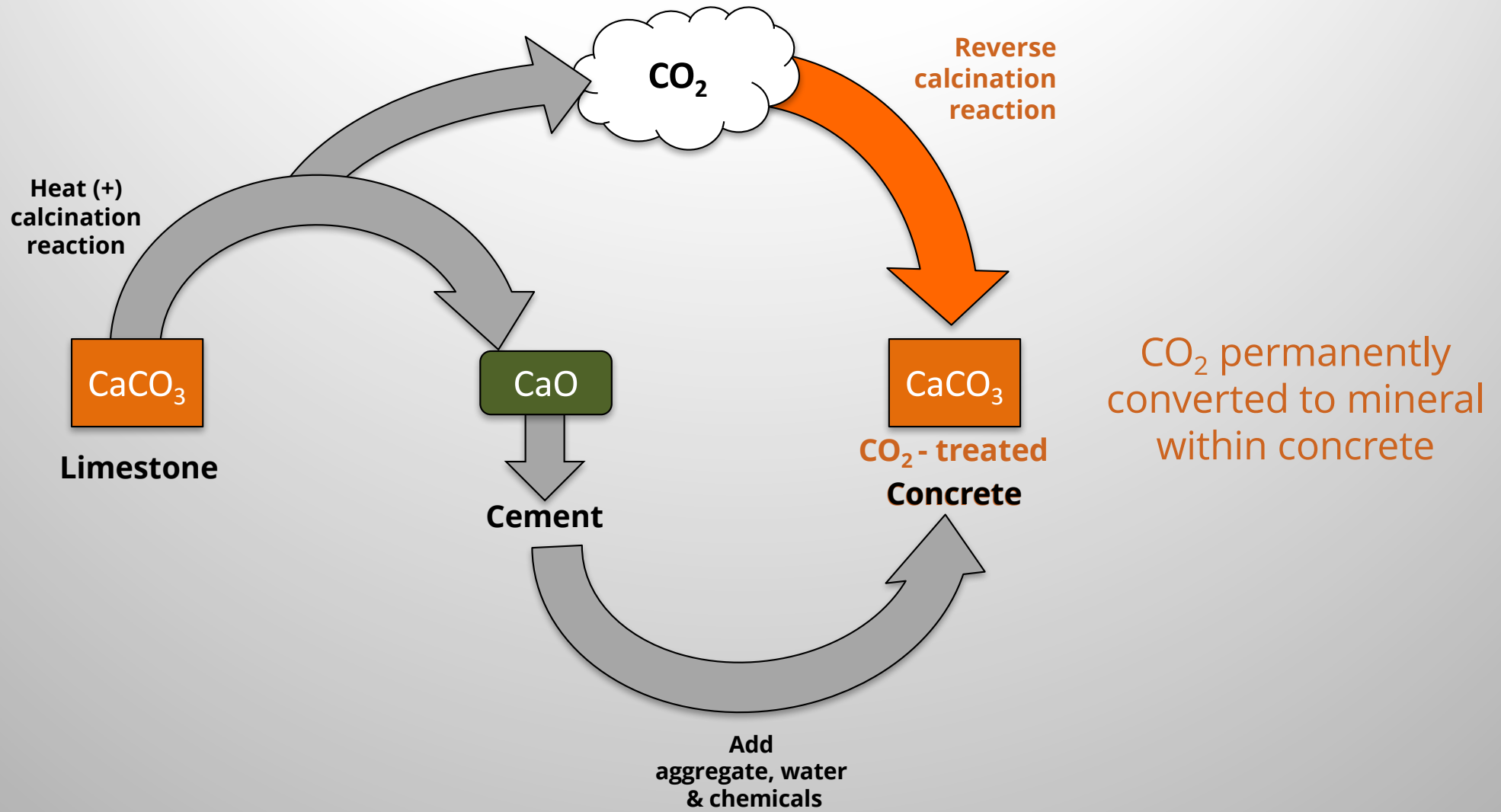


CO₂ Supply

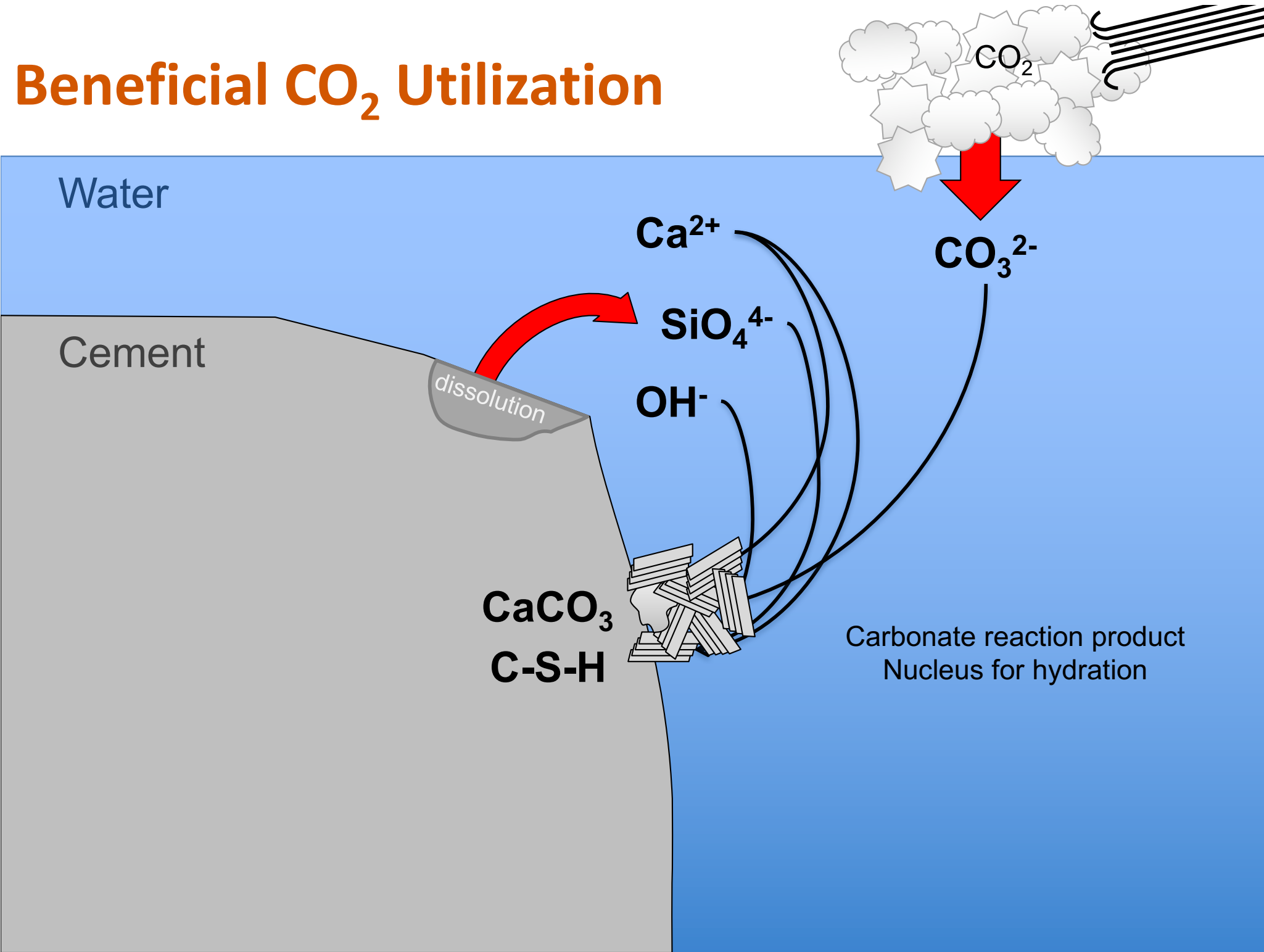
1. CO₂ is collected as a byproduct from large emitters, such as cement, fertilizer and power plants
2. Suppliers such as Praxair, Air Liquide and Linde purify the gas
3. Liquid CO₂ is delivered to the concrete plant
4. CO₂ cost is typically \$0.15 - \$0.30 USD / lb



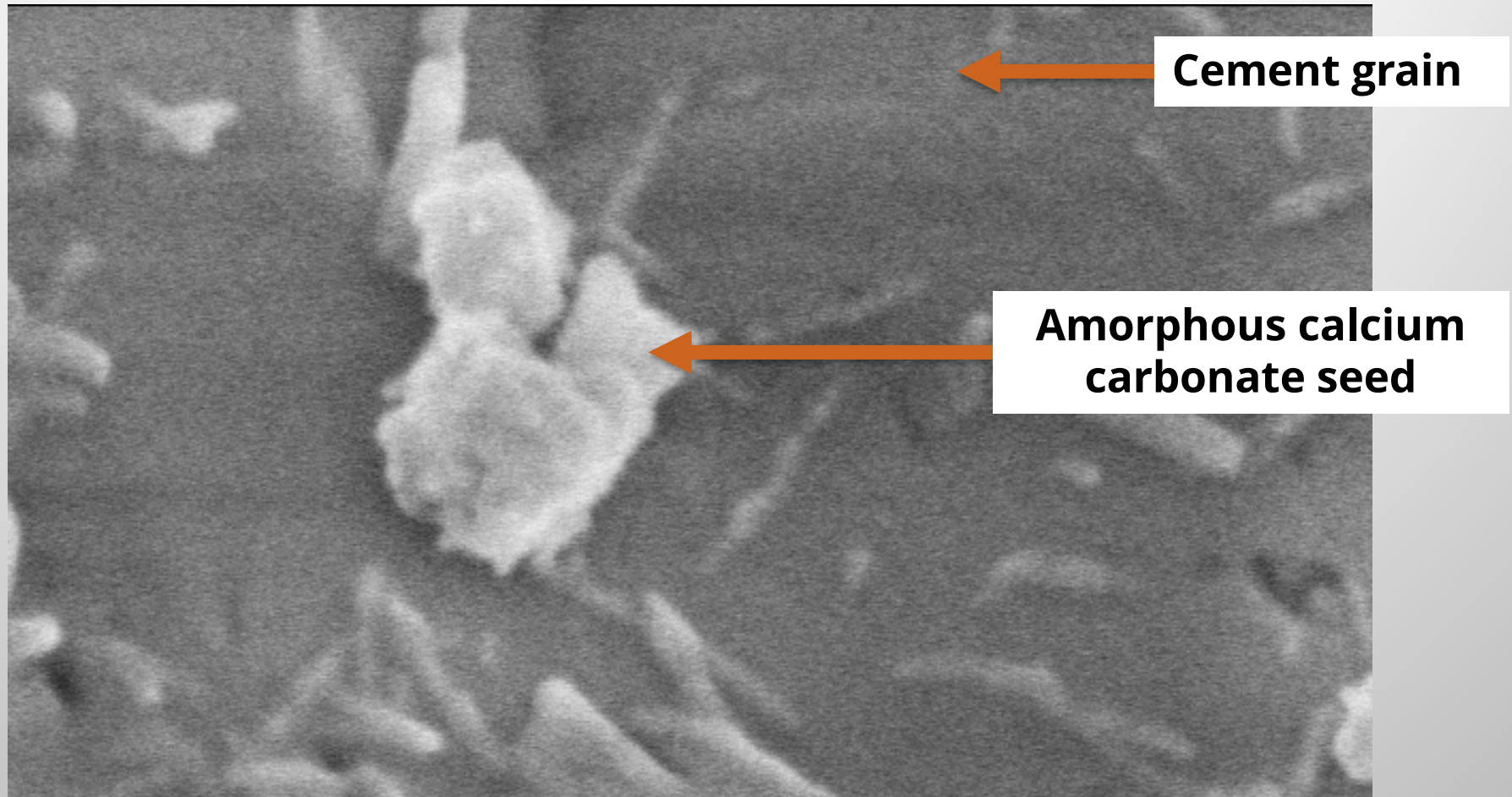
Converting CO₂ gas to a solid mineral



Beneficial CO₂ Utilization



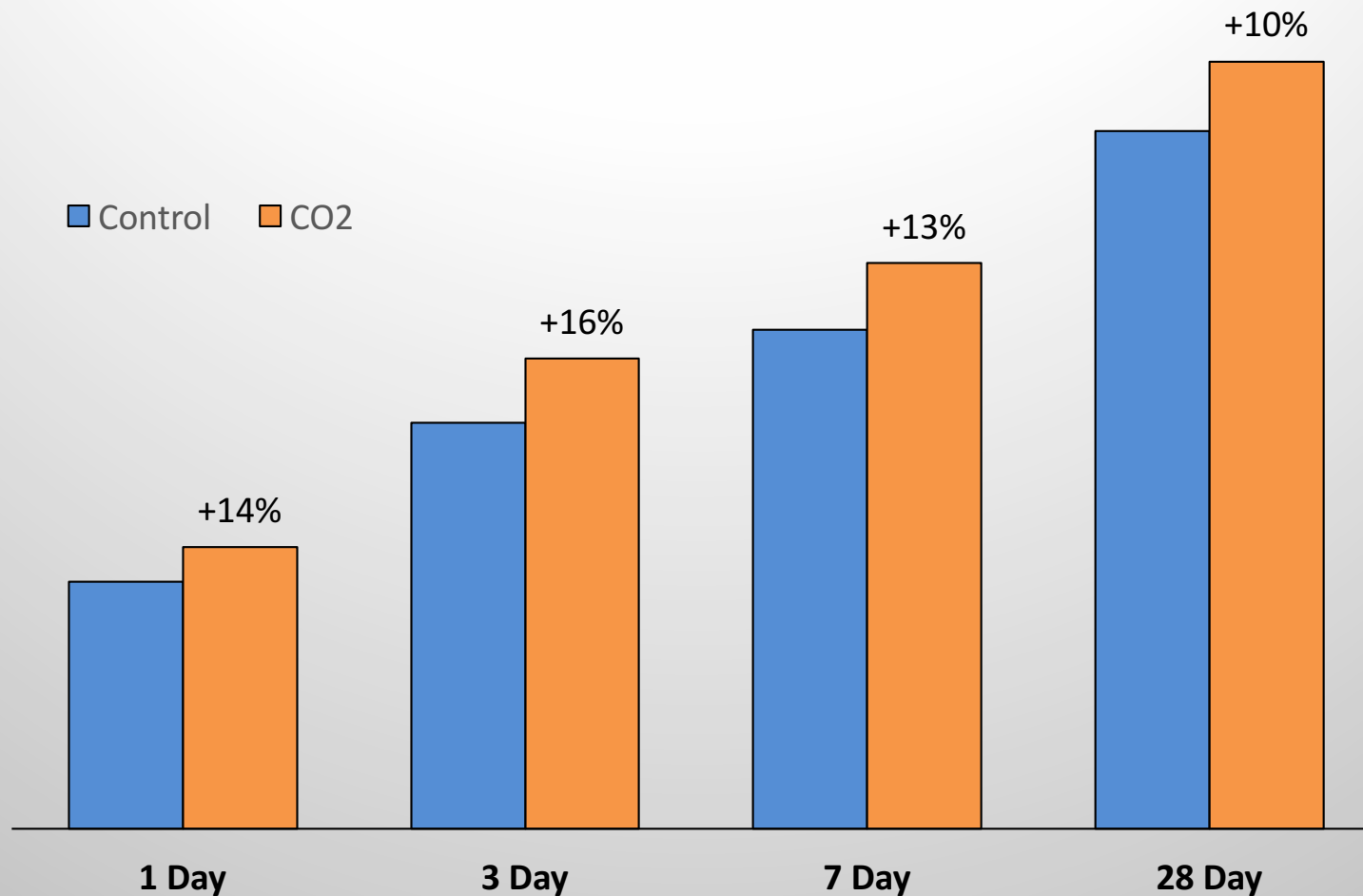
Carbonation Reaction Product Microstructure



Carbonation reaction creates nano calcium carbonate particles that act as nucleation sites for the hydration process

IRC 2.0kV 4.0mm x200k SE(M) 12/7/2015 200nm

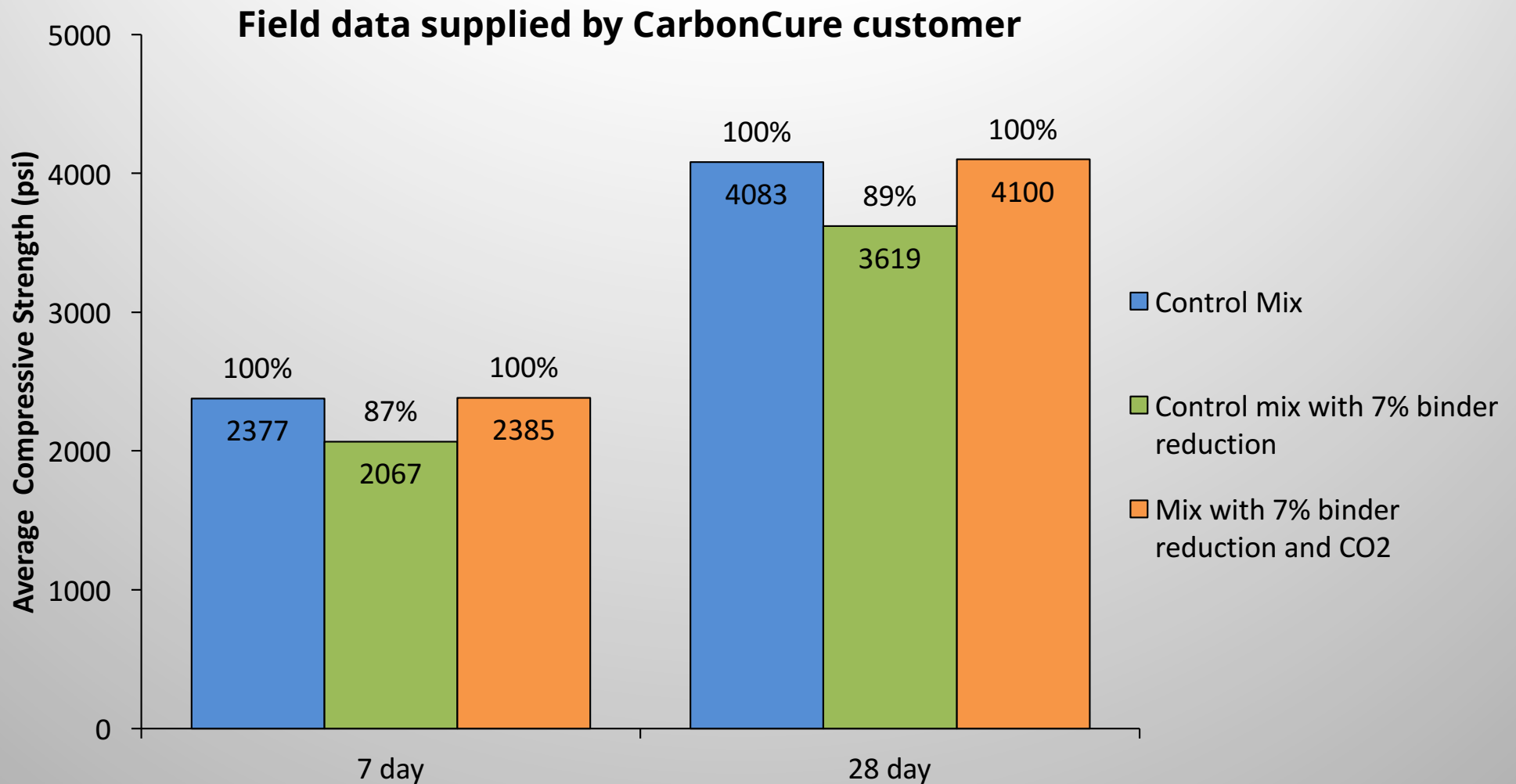
Compressive Strength Effects – Industrial Trial Average Results



- Industrial trial results from 84 batches at 13 locations
- Average strength improvement of 10 - 16% across 1 through 28 days
- Dose optimization not necessarily achieved

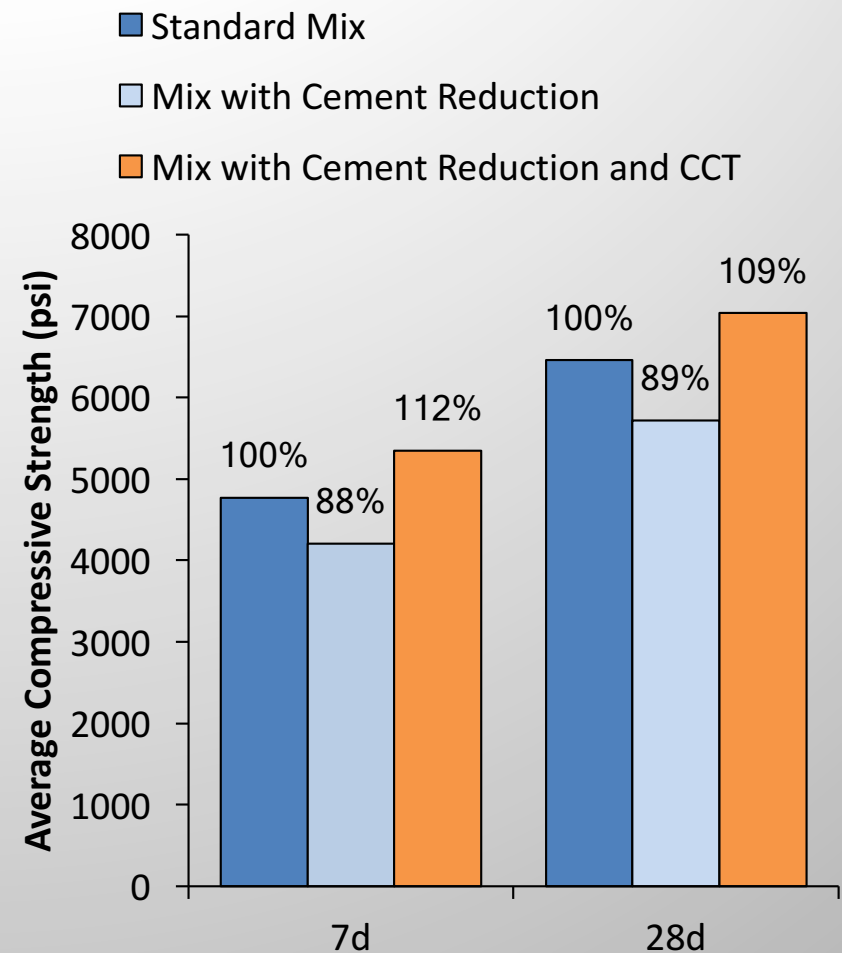
Indication: Mix optimization

CarbonCure's technology may enable producers to reach strength requirements with reduced cement content



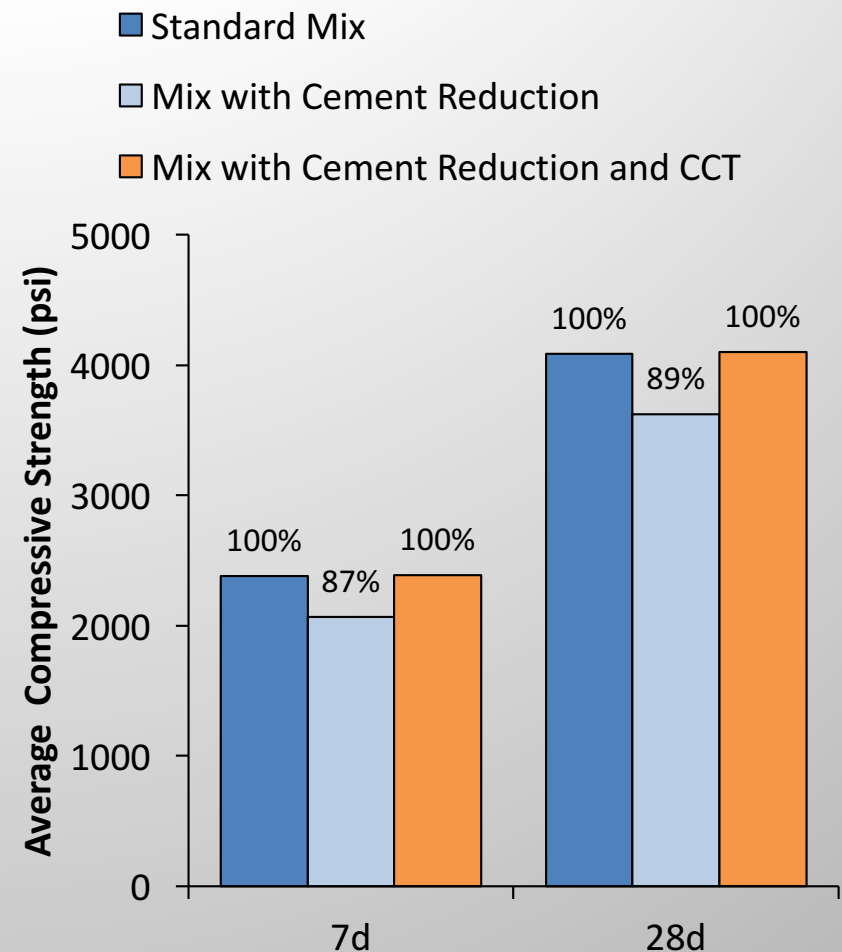
Calgary – Cement Reduction

- High performance mix
 - Most requested mix
- Optimum dosage identified as 1.5 oz/cwt
- Strength was improved even with a 5% cement replacement
- Assessment on-going



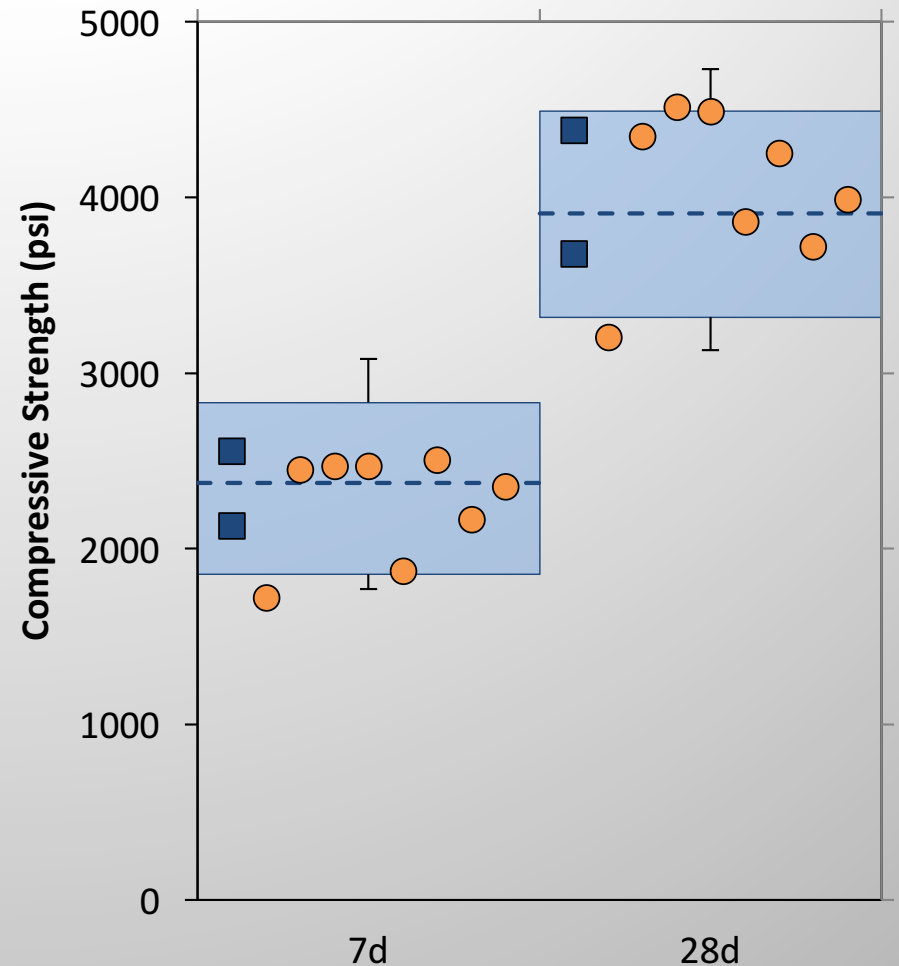
Atlanta – Cement Reduction

- 3000 psi design strength
 - Majority of annual production
- Producer demonstrated that strength was reduced when binder was reduced but CO₂ addition compensated.
- Total binder reduction 7%
- Mix adjustment was rolled out to other mix designs and applications



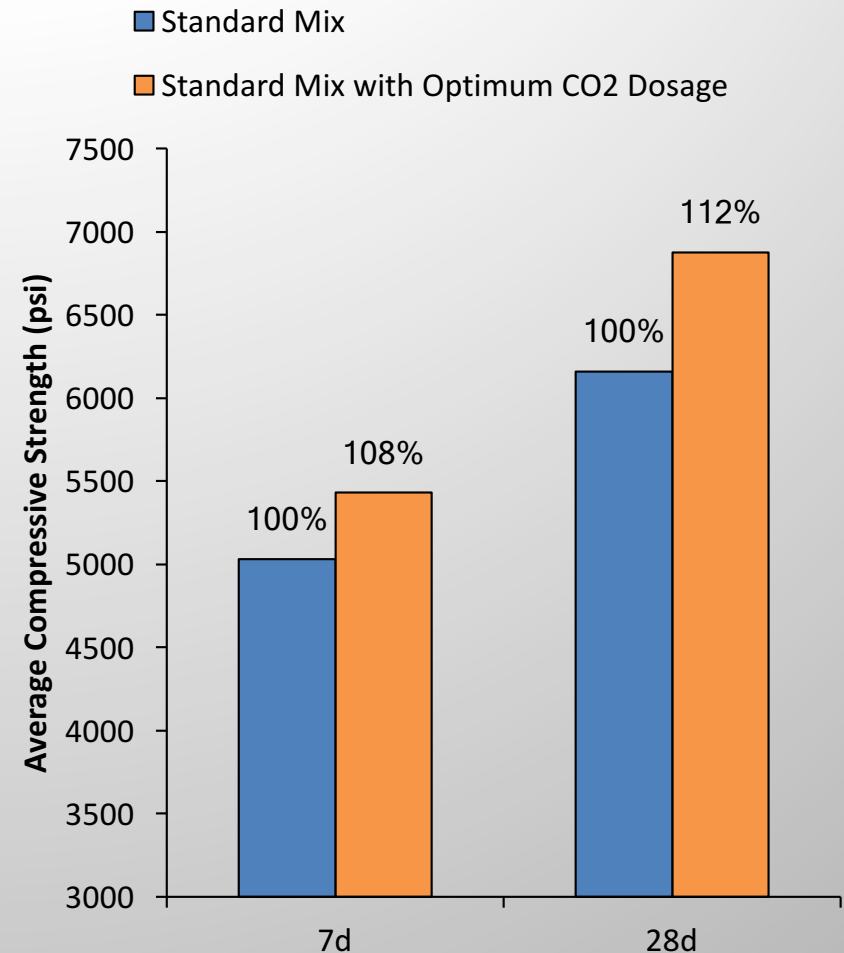
Atlanta – Extended Production

- Results of extended production and testing
- 3000 psi mix design
 - 50% cement
 - 25% Class F fly ash
 - 25% slag
- Cement reduced in the CO2 batches
 - Average cut 5.7%
 - 16 lbs/yd³ or 11 kg/m³
- No change in strength compared to historical and day-of controls



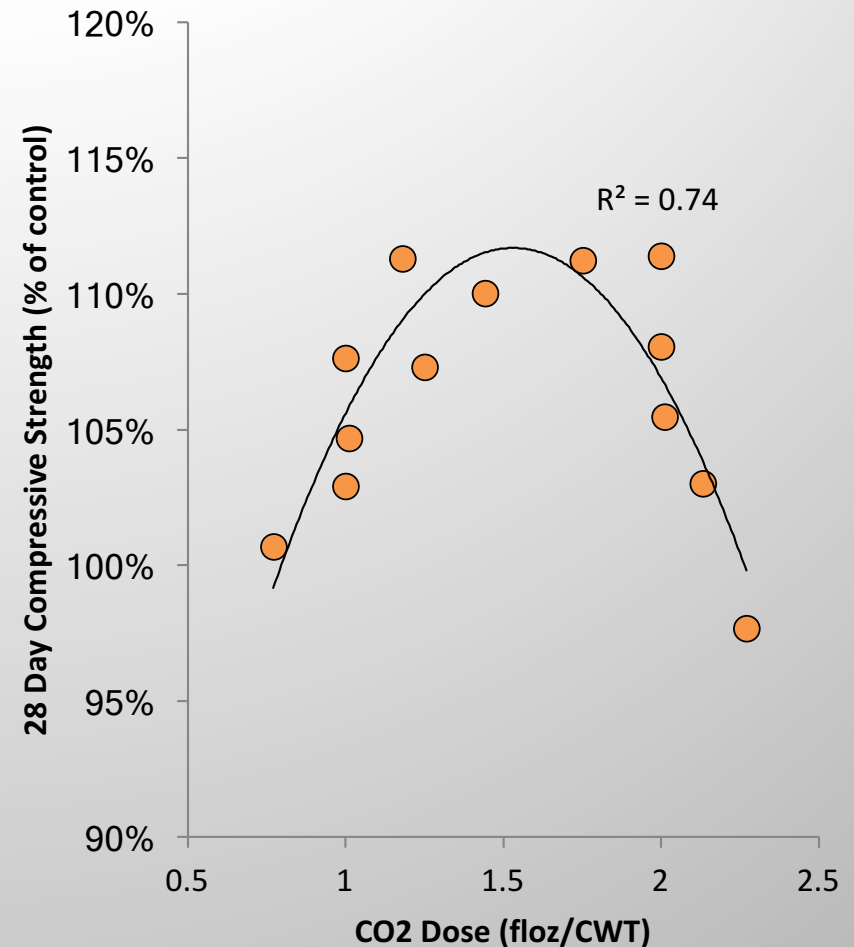
Chicago – Optimum Identification

- 4000 psi mix
- Optimum dosage identified and a ~10% strength improvement realized at 7 & 28 days
- Recommendation of 5% cement replacement in conjunction with CO2 use



Charlotte – Optimum CO₂ Dose Identification Through Typical Dosage Ramp

- Dosage response from commissioning
- Three mix design
- Fresh properties in range of normal variation
- Optimum dosage at 1.5 floz/cwt leading to 10% strength improvement
- Cement replacement of 5% is recommended



Early-stage carbonation effects on concrete

No measurable effect on:

- Workability/slump
- Air content
- Density
- pH
- Durability
- Freeze-thaw performance
- Color
- Texture
- Finishing



Case Study: Ambassadors Garage



**Halifax, Nova Scotia - 1,200 yards concrete
No effect on fresh properties or finishability**



Economic benefit

CarbonCure helps concrete producers realize significant material cost savings **and** sell to the growing green building market...

Which means that being greener **can** be good for the bottom line!

Will you profit from the trend?

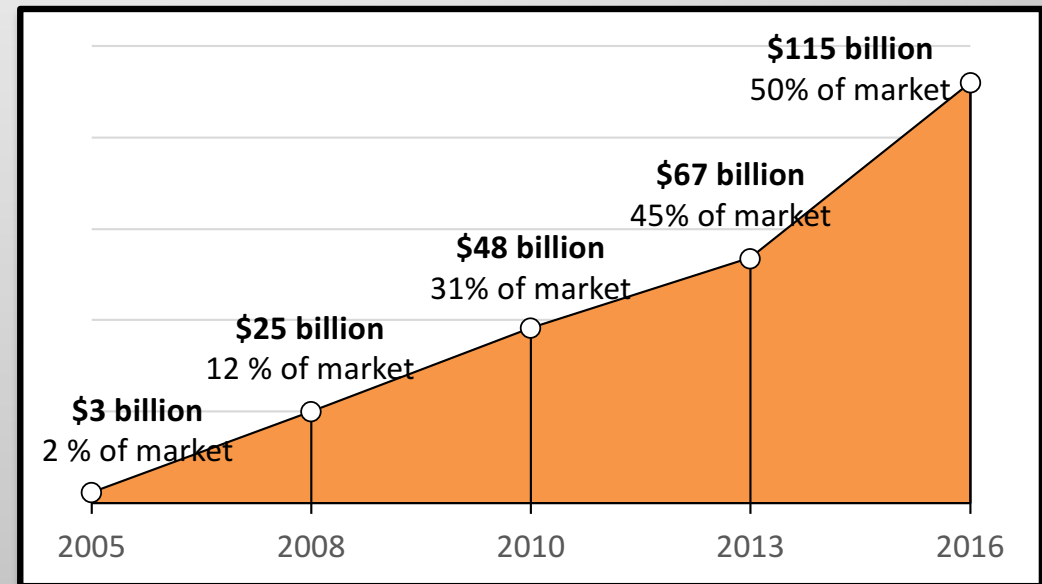
Average Return on Investment

HIGH 70+ cents per yard

MED 50 cents per yard

LOW 30 cents per yard

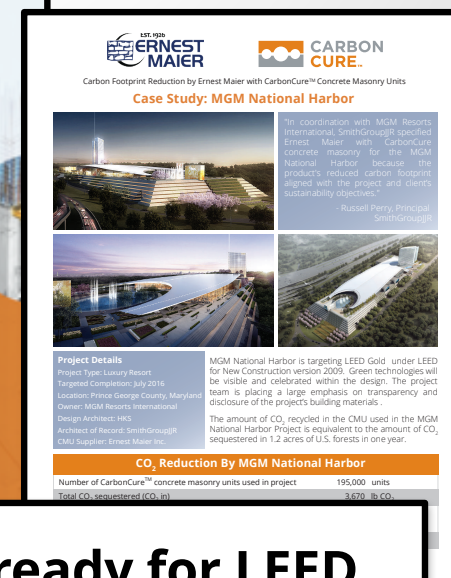
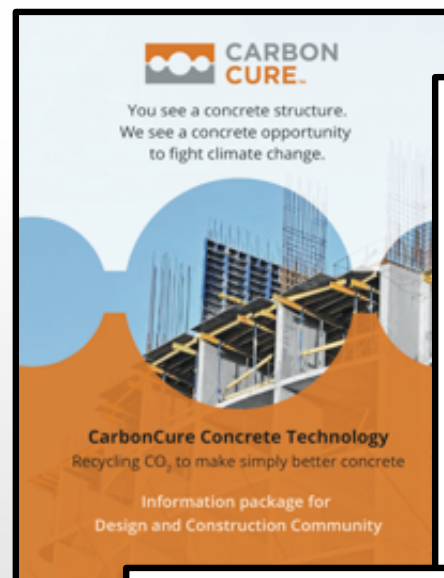
**Commercial Green Building
Market Size (\$ billions)**



Marketing & green building consulting services

Marketing and Sales Services

- Flyers & brochures
- AIA presentations
- Press releases
- Web content
- LEED documentation
- Sales training
- In-person meetings with architects, engineers, contractors and specifiers
- Green building & LEED strategy



Are you ready for LEED version 4?

Concrete's ability to contribute to LEED points is changing significantly in 2016. CarbonCure helps concrete products contribute toward further LEED points.

Spec development: Creating new business

