WHITE PAPER

Understanding CALCIMA's Report on Achieving Net Zero Concrete in California

An easy-to-read summary of CALCIMA's roadmap for decarbonizing the concrete industry.

Introduction

The California Construction & Industrial Materials Association (CALCIMA) is a trade association that represents the vast majority of concrete manufactured in the state.

It recently produced a roadmap to achieving net zero concrete in California by 2045 and outlined policy recommendations to help drive progress. And while the focus is on California, the recommendations and roadmap align with broader national and international efforts to decarbonize the industry.

Table of Contents

9 Policy Recommendations

1. Advocate for **performance-based concrete specifications**, allowing producers the flexibility to innovate with new technologies and create low carbon mix designs.
2. Introduce **incentives to lower the costs** of new low-carbon concrete technologies like CarbonCure.
3. Offer public support for industry investments in **decarbonizing production infrastructure**.
4. **Boost market demand for low carbon concrete** with high Supplementary Cementitious Materials (SCMs) or other technologies through incentives and education.
5. **Support infrastructure upgrades** at batch plants to facilitate greater use of low carbon innovations.
6. Develop partnerships to **form circular supply chains** incorporating demolished concrete or recycled material from washwater, enhancing recarbonation.
7. Adjust construction regulations to **maximize concrete's recarbonation potential**.
8. **Establish public-private research** and development collaborations for sourcing alternative raw materials.
9. Strengthen **collaboration between concrete producers and stakeholders** to optimize projects' environmental impact.

Decarbonizing the Concrete Industry

To attain net zero concrete in California, a flexible strategy is essential, considering challenges like existing regulations, limited raw material supplies, and the unique dynamics of the industry.

Like CarbonCure, CALCIMA recognizes there is no silver bullet to decarbonizing the concrete industry. Reflecting this, it recommends a comprehensive approach involving all stakeholders in the cement-concrete-construction value chain and identifies five pathways to decarbonization.

5 Pathways to Decarbonization

- **Pathway 1:** Implement Performance-Based Specifications
- **Pathway 2:** Use Less GHG Intense Raw Materials
  - 2.1: Expand the Use of Lower Carbon Cements
  - 2.2: Expand the Use of SCMs
- **Pathway 3:** Optimize Design, Reduce Waste, & Increase Circularity
  - 3.1: Optimize Concrete Use
  - 3.2: Increase Circularity
- **Pathway 4:** Increasing the GHG Efficiency of Concrete Operations
  - 4.1: Automate Concrete Manufacturing Operations
  - 4.2: Decrease Emissions from Transportation
- **Pathway 5:** Increase the Recarbonation — or CO_2 Uptake — Potential of Concrete

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Pathway 1: Implement Performance-Based Specifications

The Challenge

Current concrete specification standards are prescriptive and don't align with greenhouse gas (GHG) reduction goals.

If a concrete producer can offer a concrete mix with a lower carbon footprint that meets performance needs, they often can't supply it unless the specifications are changed. This restricts concrete producers from minimizing carbon footprints and discourages innovation.

The Opportunity

Transitioning to performance-based specifications can provide more flexibility for producers to design low-carbon products and innovate further. This transition will also enhance other decarbonization pathways, such as using low-carbon cement or optimizing mix designs.

Potential Barrier to Progress

The shift to performance-based specifications requires collaboration with various stakeholders, especially as the industry is risk-averse to new methods. The main concern for customers is the predictability of the concrete's performance.

Even if low carbon concrete can meet standard performance criteria, stakeholders may prioritize known, safe, and quick solutions.

Education and open communication between all parties are essential for this transition.

CarbonCure Supports Performance-Based Specifications

Concrete specifiers — architects, engineers, consultants — play the most important role in embodied carbon reduction and removal: encouraging the inclusion of low carbon technologies like CarbonCure in their specifications.

Learn More

Pathway 2: Use Less GHG Intense Raw Materials

Concrete's carbon footprint comes primarily from the ingredients used to make it, particularly cement. As such, achieving net zero concrete relies on a combination of (1) utilizing lower carbon cements; and (2) utilizing SCMs.

2.1: Expand the Use of Lower Carbon Cements

The Challenge

Cement, despite making up a small volume of concrete, is responsible for roughly 90% of concrete's embodied emissions.

The major issue in decarbonizing cement arises from process emissions, which result from the chemical reaction that converts limestone to cement, accounting for about two-thirds of all emissions from cement manufacturing.

The Opportunity

There is already a marked shift toward the adoption of lower carbon cement, with the California cement industry mapping out a roadmap for net zero by 2045.

Additionally, the introduction of Portland Limestone Cement, which can reduce carbon footprint by up to 10%, represents a promising development in this direction.

Potential Barrier to Progress

Decarbonizing cement, especially the unavoidable process emissions, can only be done through carbon capture, utilization, and storage (CCUS) which is expensive and hasn't been fully industrialized for the cement sector.

Additionally, a lack of education and promotion leads to a preference for traditional concrete, and without substantial public funding or other incentives, low carbon cement may be cost-prohibitive in the near term.

2.2: Expand the Use of SCMs

The Challenge

SCMs (Supplementary Cementitious Materials) provide an avenue for reducing the carbon footprint of concrete by replacing emissions-intensive cement with less emissions-intensive raw materials. The major challenge lies in the shrinking availability of widely-used SCMs, such as fly ash and GGBS, due to shifts in global industries.

The Opportunity

SCMs can significantly decrease the embodied carbon in concrete, with the added advantage of maintaining the specified performance characteristics. For instance, fly ash can theoretically replace up to 50% of cement, while GGBS can replace up to 70%. Silica fume, on the other hand, enhances strength and porosity of the concrete.

Furthermore, alternative raw materials like natural pozzolans and calcined clays have great potential.

Chemical admixtures, like superplasticizers and accelerators, can be used with SCMs to achieve optimal performance, further reducing the cement requirement.

To reach carbon neutrality by 2050, an SCM blending rate of at least 25% across all concrete produced will be vital.

Potential Barrier to Progress

Availability: The global supply of popular SCMs is dwindling and expected to decline by 16% by 2050, creating a gap between supply and demand.

Admixture Cost: Admixtures like superplasticizers can be expensive, making them less feasible for smaller-scale projects, despite their long-term benefits.

Infrastructure Constraints: Most concrete batch plants have limited storage capacity for SCMs, with the capital cost for adding storage being significant.

Research, Development, & Deployment: While naturally occurring SCMs present a solution to the SCM supply challenge, there are barriers like heavy regulatory requirements and high costs in establishing new supply chains.

Strength Development Requirements: Current standards for concrete strength development discourage SCM substitution, despite the fact that SCMs can offer similar or even better performance at later maturity stages. Adjustments to these standards could promote greater SCM use.

Cement Reduction is the Most Important Lever in Lowering Concrete's GHG Emissions

Cement — the key ingredient that gives concrete its strength — is also one of the largest emitters of CO_2 in the built environment. Cement represents more than three times the CO_2 emissions of civil aviation. In typical mixes listed by the NRMCA industry-standard EPD, cement contributes about 80% of the total GWP score.

The most significant contribution we can make to decrease the Global Warming Potential (GWP) of concrete lies in minimizing its cement content.

This can be achieved by optimizing the mixture composition, incorporating alternative binders, and leveraging sustainable additives and innovative solutions like CarbonCure.

Pathway 3: Optimize Design, Reduce Waste, & Increase Circularity

The concrete industry can reduce industry-wide emissions by: (1) optimizing concrete use; and (2) increasing industry-wide circularity.

3.1: Optimize Concrete Use

The Challenge

Concrete overdesign and unnecessary waste are leading to an increase in carbon emissions.

While the California concrete industry has limited control over design and construction, it bears an oversized portion of the environmental impact.

About 5% of delivered concrete goes unused. Reducing this through better logistics and supply management would drastically cut industry emissions. The industry can work closely with customers to offer solutions that meet performance objectives while lowering emissions.

The Opportunity

While producers don't control design practices, they can act as educators. By guiding customers on the GHG implications of various designs and encouraging efficient use of concrete, potential emissions reductions of up to 30% by 2050 are feasible.

Potential Barrier to Progress

The main obstacle is the industry's limited ability to directly influence wider construction and design practices.

Overcoming this requires multi-stakeholder collaboration, involving architects, engineers, contractors, and policymakers to make effective changes in design and construction methods.

3.2: Increase Circularity

The Challenge

The concrete industry is tasked with adopting sustainable practices to integrate itself into a circular economy. The overarching issue is the proper reuse of waste or demolished concrete without increasing its carbon footprint.

The Opportunity

Recycling and downcycling are essential for reducing GHG emissions and promoting circularity.

Recycling: New technologies like smart crushing and CarbonCure Reclaimed Water can enable cement to be reused in fresh concrete, reducing embodied emissions.

Downcycling: Although some concrete can't be recycled for the same use, it can be utilized as a base or aggregate in subsequent structures. This reduces emissions from aggregate extraction and transportation.

Potential Barrier to Progress

Cost, logistics, and performance are all barriers to the adoption of new technologies for recycling and downcycling. However, the main barrier is simply awareness of the available solutions.

CarbonCure's Circular Solutions

Embracing circularity, CarbonCure's innovations not only optimize cement usage but also champion the reuse of reclaimed water and recycled aggregate.

- **CarbonCure Reclaimed Water** technology stabilizes cement solids so they can be reused as virgin materials, ensuring consistent results.
- **CarbonCure Recycled Aggregate** is a new technology that uses CO_2 to enhance the quality of aggregate from demolished buildings or excess concrete, transforming what was once downcycled or discarded into a valuable resource.

"For over 30 years, the concrete industry has been challenged to find an effective solution for reclaimed water. Because CarbonCure standardizes and stabilizes the cementitious fines in the reclaimed water, we get repeatable, consistent results that allow us to gain maximum value from the cementitious fines in terms of strength. It almost acts as a supplementary cementitious material."

Stephen Hay,
General Manager, Trio Ready-Mix

Pathway 4: Increasing the GHG Efficiency of Concrete Operations

Up to 10% of the total embodied emissions in concrete are associated with manufacturing — primarily indirect emissions from electricity use — and transportation. The industry can reduce emissions stemming from these activities through two primary levers: (1) automating concrete manufacturing operations and (2) decreasing transportation emissions.

4.1: Automate Concrete Manufacturing Operations

The Challenge

The California concrete industry is on the path to electrifying its operations and enhancing energy efficiency, but the variety in the size and sophistication of companies can lead to varying impacts and outcomes.

The Opportunity

While California is aiming for net-zero electricity generation, the concrete industry can further reduce emissions by enhancing energy efficiency.

By investing in automation and optimizing raw material procurement, they can achieve better GHG performance.

Enhanced monitoring can also facilitate the creation of environmental product declarations without third-party verifications.

Potential Barrier to Progress

The diverse nature of the state's concrete industry means automated batching might not be beneficial or feasible for all. Larger plants tend to benefit more from automation, but the investment might not justify the benefits for smaller operations. Retrofitting plants with new technology could lead to operational challenges like production shutdowns, which might offset the benefits.

4.2: Decrease Emissions from Transportation

The Challenge

The concrete industry in California needs to address the substantial share of emissions that come from transporting raw materials to batch plants and concrete to job sites.

The Opportunity

Transitioning to zero- or low-emissions energy sources for transportation could bring these emissions to zero by 2045. There are multiple fuel and technology options to achieve this, such as Renewable Natural Gas, electricity, and renewable diesel. The recent regulation by the California Air Resources Board for zero-emissions commercial fleets by 2045 is expected to accelerate the transition.

Potential Barrier to Progress

Several barriers hinder the move to alternative fuels for fleet decarbonization:

Cost: Switching to low carbon fuels like Renewable Natural Gas and renewable diesel is currently uneconomical.

Availability: Scaling production of these fuels is a challenge, as increased demand for feedstocks leads to competition among producers.

Technical and Raw Material Limitations: Electrifying heavy-duty vehicles, such as concrete mixers, comes with issues like limited operational range and battery size constraints. The industry will need significant financial and policy support to overcome these barriers.

Pathway 5: Increase the Recarbonation — or CO_2 Uptake — Potential of Concrete

5.1: Automate Concrete Manufacturing Operations

The Challenge

Recarbonation, the natural or technology-assisted absorption of CO_2 by concrete structures, has not been fully accounted for in its potential to mitigate emissions.

The Opportunity

The concrete industry can optimize the recarbonation potential of concrete using technologies like CarbonCure that inject CO_2 into the concrete during the mixing process, where it mineralizes and is permanently stored.

Potential Barrier to Progress

Increasing the carbonation potential of concrete is largely contingent on architects and engineers, who might not prioritize it in their specifications. The current regulatory framework doesn't recognize or credit CO_2 sequestered through recarbonation, making carbon neutrality goals harder to achieve.

CarbonCure introduces recycled CO_2 into fresh concrete to reduce its carbon footprint without compromising performance.

Once injected, the CO_2 undergoes a mineralization process and becomes permanently embedded in the concrete, resulting in carbon emissions savings and improved compressive strength. It also has the added benefit of reducing the amount of cement that is used in concrete, which further reduces emissions.

Read the CALCIMA Report Achieving Net Zero Concrete in California: Pathways, Opportunities, & Barriers for full details.