

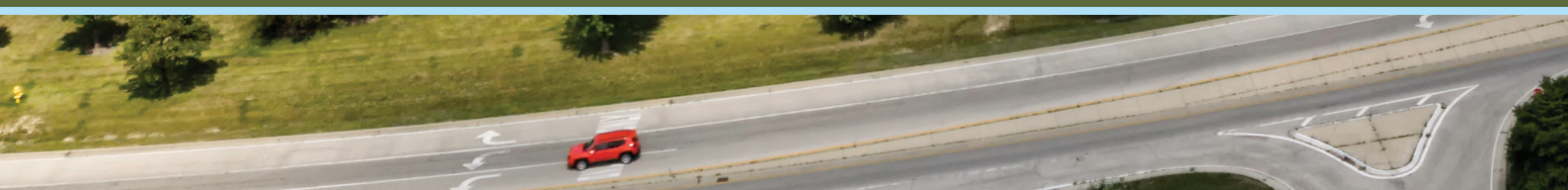
From Carbon Targets **To Concrete Reality**



Justin Dickey, Cemex US, explores how early-stage collaboration and the use of blended cements and supplementary cementitious materials are enabling lower-carbon concrete for hyperscale data centre construction.

The expansion of AI is creating one of North America's most active construction sectors. While the digital economy is often discussed in terms of software and data streams, its infrastructure depends on a massive physical footprint. Behind every hyperscale data centre is a substantial investment in power distribution, cooling systems, connectivity, and structural concrete.

For the cement and concrete industry, this growth represents more than a shift in



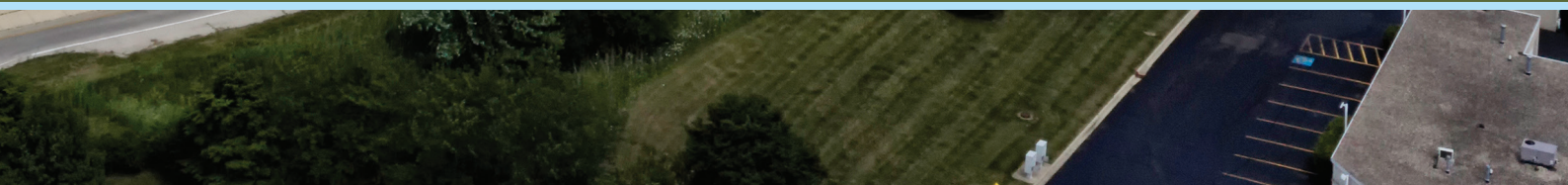


material volume. Many of the technology companies leading data centre development have established specific corporate commitments to reduce embodied carbon across their portfolios. As a result, discussions regarding cement composition, environmental product declarations (EPDs), and regional material availability are entering project planning much earlier than has historically been the case.

Cemex is increasingly seeing owners engage directly with material producers during the

early design phases. Rather than treating concrete simply as a downstream commodity, developers want to understand what level of global warming potential (GWP) reduction is practically achievable within a specific market, and how those material decisions might influence mixture performance, cost, and the construction schedule.

Supporting this market requires managing two connected operational challenges: maintaining the rapid delivery schedules required by hyperscale construction timelines



while identifying predictable pathways to lower the carbon intensity of the concrete supplied.

Shifting toward early-stage collaboration

The traditional construction procurement sequence can place multiple layers between the owner and the material producer. Typically, an owner establishes project requirements, the design team translates those requirements into structural specifications, the general contractor bids the project, and the ready-mix producer is engaged at the end of the chain to supply a conforming product.



Aerial view of a hyperscale data centre campus with supporting power and cooling infrastructure.



A crane lowers a tilt-up concrete wall panel into position during data centre construction.



A large-scale data centre campus comprises multiple facilities and supporting infrastructure.

While this linear process works for standard projects, it becomes inefficient when managing specific embodied-carbon targets. Carbon optimisation cannot easily be treated as a product substitution made shortly before construction begins. By the time a concrete specification is locked and the project schedule is established, many practical material options may no longer be logistically or technically viable.

This is why data centre developers are increasingly participating in early material selection. Many hyperscale owners now utilise dedicated engineering and sustainability teams to evaluate cement types, supplementary cementitious material (SCM) replacement levels, and product-specific environmental data well ahead of procurement.

From a producer's perspective, early engagement allows for a more comprehensive technical discussion. It provides the runway to outline which materials are available in a given market, how those materials can be combined to reduce GWP while maintaining required performance, and what performance trade-offs may accompany those choices. Crucially, it provides the necessary time to evaluate alternative binders, confirm regional supply chains, and conduct laboratory and field trials before full-scale production begins.

The intent is not for the material producer to dictate the project's sustainability goals, but rather to help translate corporate carbon objectives into a constructible mixture that can be reliably manufactured, transported, and placed under actual field conditions.

Balancing global targets with regional supply constraints

Although an owner's corporate sustainability objectives are typically standardised across a national or global portfolio, cement and concrete supply chains remain highly regional.

Ready-mix concrete must be produced within a practical transit distance of the job site to ensure workability and performance. Furthermore, the availability of cement types and SCMs is strictly governed by local manufacturing capabilities, terminal networks, transport logistics, and existing market demand. Aggregate characteristics also vary significantly by source, directly impacting water demand, chemical admixture response, and total cementitious content.

Consequently, a carbon-reduction strategy that proves successful in one market may be considerably more difficult to implement in another. A project framework designed for Atlanta cannot automatically be applied to a project in Phoenix or Reno. One region may

have consistent, cost-effective access to slag or fly ash, while another may rely more heavily on portland-limestone cement (PLC), natural pozzolans, or intensive aggregate optimisation. Local climates and regional construction practices also dictate specific setting times, early strength development, and finishing requirements that must be respected.

Regional benchmarks and EPDs reflect the baseline materials and industrial practices already established within a specific market. A uniform percentage-reduction mandate may appear consistent on paper, but the technical pathway to achieve it will vary by location. Owners must therefore maintain a distinction between a common carbon objective and a uniform material recipe, allowing producers the flexibility to optimise mixtures based on local infrastructure and material realities.

Leveraging scalable, existing technologies

A significant portion of the public conversation around cement decarbonisation centres on emerging technologies, such as carbon capture, utilisation, and storage (CCUS), novel alternative binders, and completely new manufacturing processes. While these innovations are critical



Crews construct the concrete foundation and structural frame of a large data centre facility.



Multiple phases of construction take place across an expansive data centre campus.

to the industry's long-term transition, hyperscale data centres are actively being designed and constructed now. Project teams cannot rely entirely on technologies that have not yet achieved broad commercial scale or regulatory acceptance.

The industry currently possesses several proven tools that can reduce embodied carbon immediately:

- ▶ Blended cements. Utilising formulations like portland-limestone cement to lower clinker content while maintaining standard structural performance.
- ▶ SCM utilisation. Replacing a portion of traditional portland cement with fly ash, slag, or calcined clays.
- ▶ Aggregate optimisation. Engineering particle size distribution to improve packing density and minimise water and paste demand.
- ▶ Chemical admixtures. Deploying advanced water reducers and performance enhancers to maintain workability while optimising total cementitious content.

The engineering challenge lies in balancing these tools within a reliable production system. For instance, high SCM replacement levels can extend setting times and slow early strength gain while also potentially extending conventional psi acceptance ages. On fast-tracked data centre projects with tight, repetitive slab-placement cycles, these delays can disrupt the construction schedule if not properly managed. A binder formulation that performs well in a controlled laboratory must still prove compatible with local aggregates, admixtures, and batching equipment under field conditions.

Implementing these solutions also requires operational adjustments at the ready-mix plant. Introducing alternative materials often requires dedicated storage silos, revised handling procedures, and updated quality-control protocols. Plant personnel must be trained to manage these variables consistently, and contractors frequently require comprehensive field mock-ups to gain confidence in the handling and finishing characteristics of a modified mixture before major structural pours begin.

Evaluating system-wide SCM availability

Fly ash and slag have supported clinker reduction efforts for decades, but they are not available in unlimited quantities. The ongoing retirement of coal-fired power generation plants has structurally reduced the production of fresh fly ash in many North American markets. While harvested ash from legacy economic stockpiles represents a significant alternative resource, reclaiming and processing it requires substantial capital

investment and time to develop. Similarly, slag availability remains constrained by regional steel production, import terminal capacity, and demand across the broader concrete market, including infrastructure, commercial, and industrial construction. As demand for lower-carbon concrete grows within the hyperscale market, it raises an important system-level consideration. A specific project may successfully lower its reported embodied carbon by securing a high volume of a constrained local SCM. However, if that material is simply diverted away from an adjacent project that must then use standard portland cement, the net regional carbon reduction is not increased.

To achieve meaningful, widespread decarbonisation, the industry must expand the qualified cementitious material supply base. Natural pozzolans, ground glass, and calcined clays represent important pathways forward, but their adoption depends on consistent production volumes, technical qualification, and dependable distribution networks. The scale of the data centre market can help accelerate this transition; large developers can provide the predictable, long-term demand signals needed to justify producer investment in these emerging material supply chains.

Analysing the economics of material optimisation

It is occasionally assumed that lower-carbon concrete mixtures should inherently cost less because certain SCMs were historically priced below portland cement. In the current market, this assumption no longer applies. Elevated demand, extended transportation distances, specialised chemical admixture packages, and the capital expenditure required for plant storage modifications mean that lower-carbon concrete formulations can carry a cost premium.

Evaluating the economic case requires looking beyond the line-item cost of the concrete package in isolation. Hyperscale data centres are highly capital-intensive facilities where the primary expenditures are driven by advanced computing equipment, specialised cooling systems, and electrical infrastructure.

While structural concrete represents a modest percentage of the total capital investment, cement-related decisions impact a significant portion of the project's upfront embodied carbon. When viewed from an asset-lifecycle perspective, optimising the concrete mixture can offer a practical, cost-effective carbon mitigation strategy relative to the overall facility cost.

Rather than treating carbon reduction as a rigid pass-or-fail metric, project teams should evaluate cost, carbon intensity, technical risk, and schedule impact concurrently. This balanced analysis allows owners to determine where material investments

yield the most reliable performance and carbon returns.

Operational execution at scale: a Houston case study

A Houston AI-ready data centre project provides a practical example of how these considerations come together. The project required approximately 45 000 yd³ of concrete, with some placements pumped through roughly 400 ft of delivery system.

The challenge was not limited to one material or performance requirement. The team needed to develop a concrete system that could be produced consistently while supporting pumping, placement, strength development, and long-term performance across a large volume of work.

Early coordination allowed the project team to evaluate the cementitious materials, aggregate grading, fibres, and chemical admixtures as one complete system. Rather than making isolated product substitutions, the team considered how each material decision would affect production and field performance.

The broader lesson is that lower-carbon and performance objectives are most effective when they are addressed early and validated under actual project conditions. For large data centre projects, early collaboration can help convert broad owner requirements into a concrete mixture that can be reliably produced, transported, and placed.

Conclusion: turning ambition into implementation

The digital economy may be driven by computational capacity, but its build-out remains dependent on physical industrial materials and regional supply chains. For the cement and concrete industry, the growth of the hyperscale market provides a clear opportunity to demonstrate that industrial-scale sustainability can be executed under rigorous commercial conditions.

The technical tools required to lower embodied carbon are already available. The primary challenge is coordination and execution across the value chain. Producers must provide transparent information regarding regional supply limitations, designers must author flexible, performance-based specifications that permit local optimisation, contractors must participate in early testing to build field confidence, and owners must engage the supply chain early enough for producers to plan and respond.

The ultimate value the material industry can offer to the technology sector is not merely supplying increased volume but helping turn corporate carbon goals into predictable, constructible, and economically viable reality. ■