Global Cement and Concrete Association

CONCRETE FUTURE

Cement & Concrete Industry Net Zero Action & Progress Report 2026/27

An update of global action and progress of the GCCA and its member companies – as we advance on our net zero journey.



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Foreword



Cement and concrete are essential to modern life. They underpin the homes that protect us, the schools and hospitals that serve us, the transport networks that connect us, and the infrastructure that delivers clean water and renewable energy. As the global population grows and urbanises, our materials will remain vital to human development and to building communities that are sustainable and resilient to our changing climate.

Our responsibility is clear. Through the GCCA 2050 Net Zero Roadmap, our sector has set out and committed to a credible pathway to produce net zero concrete by 2050. And our members are making progress against every lever. You will see throughout this report many excellent examples of the collective action across the world to deliver a decarbonised industry: from alternative fuels, supplementary cementitious materials and novel binders, to deep decarbonisation technologies such as CCUS, and innovations that improve how we use and produce cement and concrete.

Despite our progress, our message remains clear. We cannot achieve the scale of transformation we seek to achieve alone. We require governments, the investment community, customers, academics, and the wider built environment value chain to act with us. Regulations and incentives must be created to set the market conditions needed for lower-carbon cement and concrete. Better waste management and greater use of alternative fuels in cement kilns to recycling, circular economy policies, low-carbon procurement, funding schemes as well as a transportation and storage infrastructure for CCUS, carbon pricing, and government led lead markets are all essential.

In addition to climate mitigation, consideration must also be given to climate adaptation and resilience. As the world's climate changes, our material will be ever more crucial in helping society build resilience to heat, flooding, fire, and other extreme weather events. A decarbonised cement and concrete industry will support sustainable adaptation to the impacts already underway.

The opportunity before us is significant: to decarbonise an essential material and use it to build a safer, stronger and more sustainable future. We invite all our partners to join us on this mission.

Dominik von Achten
GCCA President
CEO, Heidelberg Materials

> The opportunity before us is significant: to decarbonise an essential material and use it to build a safer, stronger and more sustainable future."



Five years on from the launch of the GCCA 2050 Net Zero Roadmap, our industry's commitment remains firm. Across our membership, companies are investing, innovating and acting across every available lever to deliver net zero concrete.

This report shows that progress: reduction of fossil-fuel use, developing blended cements and new binders, optimising concrete mixes, improving material efficiency and advancing carbon capture. And our latest GNR figures show that these collective efforts have contributed to a 25% reduction in CO_2 emissions since 1990.

But action is not yet happening at the scale or speed required. The central challenge is no longer simply technological; it is whether the right policy frameworks will unlock investment, remove barriers and create viable markets for lower-carbon cement and concrete.

The years to 2030 are critical. Proven solutions, including lower clinker factors, co-processing, renewable energy, material efficiency and greater circularity, must be deployed much more widely, while carbon capture moves rapidly towards commercial scale.

Industry is ready to accelerate, but it cannot deliver this transition alone. In too many countries, outdated standards restrict lower-carbon products, procurement fails to reward carbon performance, valuable resources are discarded, and CCUS projects lack enabling infrastructure, timely permitting and access to finance.

Governments therefore have a decisive role. We need clear, stable and long-term policies that give companies and investors confidence to act. Standards must enable innovation. Public procurement must build demand for demonstrably lower-carbon materials. Waste and circular economy policies must support co-processing and alternative materials. Effective carbon pricing, targeted finance and shared CCUS infrastructure are also essential.

These frameworks must reflect different national circumstances and support an inclusive global transition, including access to finance, technology and capacity-building for emerging and developing economies.

Our members continue to act, innovate and deliver. Now policymakers, investors and customers must match that commitment. With the right policies and partnerships, we can turn ambition into implementation and deliver net zero concrete for a sustainable and resilient world.

Thomas Guillot
Chief Executive, GCCA

> Waste and circular economy policies must support co-processing and alternative materials. Effective carbon pricing, targeted finance and shared CCUS infrastructure are also essential."

Our mission

Concrete future: building a Net Zero world



Executive summary

Concrete is fundamental to modern life. It provides the homes, schools, hospitals, transport networks, water systems and energy infrastructure on which societies depend. As populations grow and climate impacts intensify, it will remain essential to development and to building safer, more sustainable and resilient communities.

Meeting that demand while rapidly reducing emissions is a defining challenge. Through the GCCA 2050 Net Zero Roadmap, the global cement and concrete industry has committed to delivering net zero concrete by 2050. This report shows how companies are turning that commitment into action.

Progress is underway across the full life cycle. The industry is reducing fossil fuel use; increasing alternative fuels and raw materials; lowering clinker content; developing blended cements, new binders and lower-carbon concrete; improving energy, material and design efficiency; expanding renewable electricity; advancing reuse and recycling; and investing in carbon capture, utilisation and storage. Innovation programmes, country roadmaps, transparent measurement and global collaboration are helping proven solutions scale and new technologies reach commercial deployment.

Decarbonising this essential material will also support a more sustainable and climate-resilient world. Concrete enables durable, adaptable and energy-efficient buildings; clean energy and low-carbon transport infrastructure; protection against flooding, fire, heat and other hazards; and circular solutions that conserve resources and reduce waste.

Yet industry action alone cannot deliver change at the required scale and speed. Governments and policymakers must establish clear, stable frameworks that make lower-carbon solutions commercially viable. Standards and building codes must enable innovation; procurement must reward verified carbon performance; and circular economy policies must unlock responsible co-processing, reuse and recycling. Effective carbon pricing, faster permitting, targeted finance and shared transport and storage infrastructure are essential to accelerate CCUS.

The wider value chain must act too. Architects, engineers, developers, contractors, customers, investors, researchers and standards bodies all shape how materials are designed, specified, financed, produced and used. Stronger collaboration will remove barriers, share risk and reward whole-life carbon performance.

The net zero transition is both an urgent responsibility and a major opportunity. The cement and concrete industry is acting and is ready to accelerate. With aligned policy, investment and value-chain leadership, we can deliver net zero concrete and use it to build a sustainable, resilient and prosperous future for all.

The essential role of concrete and the need to decarbonise

Concrete is a key enabler of a resilient and sustainable built environment.

Concrete (and its key binding ingredient of cement) is the backbone of modern society. It is the essential building material that lays the foundation for everything from homes, schools, offices, and transport networks to critical infrastructure – all of which are and will continue to be crucial to global development. As our world's population grows and increasingly urbanises, concrete will be fundamental in providing society with the foundations of what it needs to grow and prosper.

Concrete's inherent properties – its durability, resilience to climate-related and natural disasters, cost-effectiveness and widespread availability and versatility – are the reasons why it is the second most used material on the planet after water. Without it, much of the modern world would not exist as we know it – and much of what is still required to achieve sustainable development could not be built.

UN Sustainable Development Goals UNOPS, a UN agency, published a report which identified that the built environment supports society in reaching 92% of the 169 targets in the 17 UN SDGs. This 92% figure derives from consideration of all parts of the built environment: infrastructure (water, waste, energy, transport and digital communications), buildings and facilities. Concrete is fundamental to these assets hence concrete is key to delivering the vast majority of the UN Sustainable Development Goals.

Our Net Zero Mission

Accounting for approximately 7% of the world's carbon emissions, the global cement and concrete sector collectively committed to reaching net zero by 2050, as set out in our 2050 Net Zero roadmap. The GCCA and its members account for the majority of global cement production capacity outside of China, as well as a growing number of leading Chinese manufacturers, all of which have committed to reducing and ultimately eliminating CO_2 emissions in concrete through seven key levers. Since the launch of the roadmap in 2021, progress has been strong but there is much work still to do.

The journey towards decarbonisation is complex and requires continued collaboration. Achieving our goals will depend not only on innovation and dedication within the industry but also on active support and partnership from all stakeholders and policymakers across the built environment to set the market conditions and regulatory frameworks to enable us to achieve our goals.

> Concrete's inherent properties – its durability, resilience to climate related and natural disasters, cost effectiveness and widespread availability and versatility – are the reasons why it is the second most used material on the planet after water.

Five key megatrends shaping our future

A new report by Oxford Economics for the GCCA highlights the critical role cement and concrete will play in meeting the world's growing need for housing and infrastructure, while supporting more resilient and sustainable societies.

01

People, cities & development pressure

Population growth and urbanisation intensify demand for housing, transport, utilities and social infrastructure.

02

Climate transition & resilience

Renewables, grids, electrification, water systems and adaptation assets raise the performance demands placed on infrastructure.

03

Digitalisation & high-tech infrastructure

AI, data centres and advanced manufacturing create demand for energy-intensive, highly serviced facilities.

04

Infrastructure gaps & housing deficit

Addressing infrastructure gaps will require a major programme of construction, renewal and upgrading, from replacing ageing assets in advanced economies to expanding basic services in emerging markets.

05

Sovereignty & strategic resilience

Governments are investing in domestic capacity, strategic industries, defence-related assets and reconstruction capability.



Global construction activity is forecast to rise by more than 70% by 2050, reaching US$16.6 trillion, driven by population growth and urbanisation, infrastructure and housing deficits, climate adaptation, strategic resilience and growing demand for high-tech infrastructure.

A world of rising physical demand

The report identifies five established and emerging megatrends that are increasing demand for housing, infrastructure and essential services.

Population growth and urbanisation are increasing demand for transport, energy, water, sanitation and social infrastructure. Emerging and developing economies will account for a significant share of new construction to accommodate urban growth and address infrastructure deficits, while advanced economies will focus more on modernising and adapting ageing assets.

The low-carbon transition requires major investment in renewable energy, electricity grids, transport and industrial infrastructure. Buildings and infrastructure must also adapt to rising temperatures, flooding, sea-level rises, drought, wildfire and stronger storms.

Geopolitical change is renewing demand for domestic industrial capacity, secure supply chains, defence infrastructure and reconstruction capability. AI, data centres and advanced manufacturing also require high-specification facilities with reliable energy, water and transport networks.

Concrete's enabling role

As demand for infrastructure grows, the cement and concrete industry has a vital role to play: its scalability, durability and local availability will help societies develop, adapt and become more resilient, while accelerating progress towards net zero.

Concrete must therefore be viewed as both indispensable to the built environment and part of the transition towards net zero. Its future role will depend on the industry combining scale, affordability and local availability with lower-emissions production, greater productivity and verified whole-life performance.

+2bn
increase in urban population by 2050 (representing 68% of total population).

$3.1tn
required investment in transition technologies to meet net zero 2050.

$16.6tn
in global construction activity by 2050 (+70% increase from 2025 levels).

$18tn
global infrastructure gap between 2016–40 when accounting for electricity and WASH SDG goals.

$6.9tn
required investment to enhance infrastructure resilience to climate change and align with climate goals.

+500%
increase in trade restrictive measures between 2015 and 2025.

Our Members

Our members, which represent the majority of the global cement industry volume outside of China, including some key Chinese manufacturers, operate in almost every country of the world.

We are committed to strong, decisive action across the value chain so that together we will reach net zero.

Our members

- Arkan (Emirates Steel)
- Asia Cement Corporation
- Breedon Group
- BUA Cement
- Buzzi
- Cementir Holding
- Cementos Argos
- Cementos Progreso
- CEMEX
- Cimenterie Nationale*
- Çimsa Cimento*
- City Cement
- CNBM
- CRH
- Dangote
- Fletcher Building Limited
- GCC
- Heidelberg Materials
- Hima Cement
- Holcim
- Huaxin Cement
- JSW Cement
- Kartuli Cement
- Limak Çimento
- Medcem Madencilik*
- Moctezuma
- Molins*
- Nesher Israel Cement Enterprises
- Norm Cement
- SCG Cement
- SCHWENK Zement*
- Siam City Cement
- Taiheiyo Cement Corporation
- TCC Group Holdings Co., Ltd
- TITAN Group
- UltraTech Cement
- UNACEM
- Vassiliko Cement
- Votorantim Cimentos
- Yura Cement

*Associate Members

Our national and regional association partners

- American Cement Association (ACA)
- APC – Morocco
- ASOCEM – Peru
- Associação Brasileira de Cimento Portland
- Association of Portland Cement Producers – Argentina (AFCP)
- Azerbaijan Cement Producers Association (ACPA)
- Betonhuis – Netherlands
- BIBM – Europe
- Cámara Nacional del Cemento (CANACEM) – Mexico
- Canadian Precast Concrete Institute
- Cement Association of Canada (CAC)
- Cement Concrete & Aggregates Australia (CCAA)
- Cement Europe
- Cement Industry Federation – Australia
- Cement Manufacturers Ireland (CMI)
- China Building Materials Foundation
- China Cement Association
- CMA – India
- Concrete New Zealand
- European Federation Concrete Admixtures (EFCA)
- European Ready Mixed Concrete Organisation (ERMCO)
- Federacion Iberoamericana del Hormigon Premezclado (FIHP) – LatAm
- Federacion Interamericana del Cemento (FICEM) – LatAm
- France Ciment
- Japan Cement Association
- Mineral Products Association (MPA) – United Kingdom
- National Ready Mixed Concrete Association (NRMCA) – USA
- Oficemen (Agrupación de Fabricantes de Cemento de España)
- South Indian Cement Manufacturers Association
- Thai Cement Manufacturers Association
- TURKCIMENTO (Turkish Cement Manufacturers Association)
- VDZ Technology GmbH – Germany

Net Zero Value Chain Partners

- ABB
- CDE
- CFLO World Limited
- KHD
- Master Builders
- Saint Gobain
- Schneider Electric
- Sinoma

India chapter members

- Sagar Cements Ltd
- My Home Industries

We are proud to work with a range of external organisations and partners, including:

- ACI and NEU
- AECOM
- Amazon
- Asian Development Bank
- American Concrete Institute
- The Biodiversity Consultancy
- Boston Consulting Group (BCG)
- Business for Nature
- BusinessGreen
- Build Change
- C40 Cities
- CCS Knowledge Center
- China Building Materials Federation (CBMF)
- Clean Air Task Force (CATF)
- Clean Energy Ministerial (CEM) CCUS Initiative
- CEM Industrial Deep Decarbonisation Initiative
- Climate Action
- Climate Club
- Climate Champions
- Climate Economist
- Climate Imperative
- The Climate Group
- ClimateWorks Foundation
- Concrete Transition Capital
- Confederation of Indian Industry
- Convention on Biological Diversity
- Decarb Connect North America
- European Bank for Reconstruction and Development (EBRD)
- EPFL
- European Climate Foundation
- European Roundtable on Climate Change and Sustainable Transition (ERCST)
- Federation International Beton
- FóS
- German International Development Agency
- Gensler
- GHG Protocol
- Global Alliance for Buildings and Construction (GABC)
- Global Industry Hub
- Global CCS Institute
- Habitat for Humanity
- ICLEI
- International CCS Knowledge Center
- International Chamber of Commerce
- International Code Council
- International Negotiating Committee on Plastic Pollution
- International Energy Agency (IEA) and IEA GHG
- International Emissions Trading Association (IETA)
- International Finance Corporation (IFC)
- International Fire Safety Standards Coalition
- Intergovernmental Panel on Climate Change (IPCC)
- LBR&A Arquitectos
- LeadIT
- Ministry of Foreign Affairs of Denmark
- Mission Possible Partnership – Industrial Transition Accelerator
- MSP – End Open Waste Burning
- Net Zero Banking Alliance
- OECD
- OGCI
- Race to Zero
- RILEM
- RMI
- SBTI
- Sequoia Foundation
- SINTEF
- Switch Asia
- TEN Arquitectos
- The Energy and Resources Institute (TERI)
- The iMasons Climate Accord
- United Cities and Local Governments of Africa (UCLGA)
- UN Secretary General and Climate Action team
- UNEP-UN Environment Programme
- UNEP Global Mercury Partnership and UNEP Global Mercury Cement Partnership
- UNIDO – UN Industrial Development Organisation
- Economic and Social Commission for Asia and the Pacific (UN ESCAP)
- UN Office for Disaster Risk Reduction (UNDRR)
- Global Champions Office
- UNCTCN
- Urban Land Institute
- The World Business Council for Sustainable Development (WBCSD)
- We Mean Business Coalition
- World Economic Forum
- World Green Building Council
- WorldSteel

The role of international collaboration

International collaboration remains fundamental to achieving our mission. Cement and concrete are global industries facing a global decarbonisation challenge, and no single company, country or technology can deliver net zero alone.

But this is also one of the most significant opportunities of our time, and through working with international and multilateral organisations, climate initiatives, financial institutions, philanthropies, NGOs and other stakeholders, we can turn global ambition into practical action.

We value the partnerships we have built across the ecosystem over many years. These collaborations enable us to align policy approaches, create consistent market signals for low-carbon cement and concrete, accelerate the deployment of decarbonisation solutions, unlock funding and investment, and provide platforms for knowledge sharing and capacity building.

Through our continued collaboration, we can accelerate progress towards net zero while supporting sustainable development and resilient infrastructure around the world.





Above: **Climate weeks in London & New York**

COP and Climate Weeks

Working with a range of UN bodies and initiatives, we continue to ensure our industry is represented and continues to play a leadership role at the climate COPs and the most important climate gatherings.

We were proud to sign the Belém Declaration on Global Green Industrialization at COP30 in Belém, demonstrating our commitment to accelerating the transition to net zero through international cooperation. We also welcome the opportunity to support its delivery mechanism, the Global Green Industrialization Agenda (GGIA), a UNIDO-hosted platform launching at COP31 in Türkiye to coordinate global action on industrial decarbonisation, clean technology deployment and green industrial development. GCCA will leverage this platform to advocate for stronger international coordination on cement and concrete decarbonisation priorities.

Our COP31 programme in Antalya is closely aligned with the COP's overarching objective of moving from ambition to implementation, as well as key themes including green industrialisation, zero waste, resilient cities and the built environment.

This year, we hosted our first event at London Climate Action Week, which continues to grow in influence and reach. Together with our partners LeadIT, Mission Possible Partnership, Concrete Transition Capital and the Breakthrough Agenda, we convened stakeholders from across the value chain, including the building sector, hyperscalers, start-ups, investors and international organisations, to discuss scaling demand for low-carbon cement and concrete, accelerating decarbonisation in the Global South, and unlocking finance and innovation. We also launched our Innovandi Open Challenge 2026. (see page 29)

At Climate Week NYC, we continued the discussion on how international collaboration and strong partnerships can create the enabling conditions for our industry's decarbonisation. In partnership with LeadIT, we convened stakeholders from across the value chain to identify how global decarbonisation ambitions can be translated into effective action tailored to different national contexts.

"Decarbonising cement and concrete requires more than technology; it needs collaboration at every level. Industry leadership, ambitious government policies, and investment must work hand in hand to accelerate the deployment of low-carbon solutions.

At LeadIT, we believe that collaboration is fundamental to a just and equitable global industry transition and the GCCA has an important role in bringing stakeholders together around a common ambition. By strengthening international cooperation, sharing knowledge and creating the right conditions for investment and demand, we can turn net-zero commitments into real industrial transformation. Let's make it happen."



Per Andersson
Head of the Secretariat,
Leadership Group for Industry Transition (LeadIT)

Leadit
LEADERSHIP GROUP FOR INDUSTRY TRANSITION

The role of international collaboration
Continued

Cement and Concrete Breakthrough

Over the past year, the GCCA continued its role as the formal facilitator of the Cement and Concrete Breakthrough, working with its co-chairs, the Governments of Canada and the United Arab Emirates, and participating countries to promote aligned policy asks on supply side enablers (e.g. CCUS, SCMs) and demand side measures (e.g. low-carbon procurement). The GCCA produced policy papers setting out practical policy recommendations to accelerate the deployment of SCMs, alternative fuels and CCUS. They were accepted by Cement Breakthrough members and published as advocacy materials.

The Cement and Concrete Breakthrough continues to build momentum, with Ethiopia becoming the latest country to join, bringing the partnership to 14 countries.

At the invitation of Brazil's COP30 Presidency, the Breakthrough has taken on an even stronger coordinating role for global efforts to decarbonise heavy industries. A key milestone is the Plan to Accelerate Solutions (PAS), a three-year roadmap for cement and concrete bringing governments, industry, international organisations and finance behind four priority areas: definitions and standards, demand creation, collaboration and scale-up, and finance and investment. Progress is being made, but greater action is needed to translate commitments into deployment, particularly by strengthening demand for low-carbon cement and concrete, mobilising investment and expanding the project pipeline in developing economies.

"Concrete is essential to the homes, infrastructure, and major projects that underpin a strong and competitive economy. As global demand grows for cleaner construction solutions, Canada is driving innovation that both strengthens industry and reduces emissions. As co-chair of the Cement and Concrete Breakthrough, Canada is proud to work with the United Arab Emirates and the Global Cement and Concrete Association to advance practical solutions through the COP process. Together with governments, industry, and partners around the world, Canada is advancing innovative solutions that support a more competitive, resilient, and sustainable future."



The Honourable Mélanie Joly
Minister of Industry and Minister responsible for Canada Economic Development for Quebec Regions

Canada

Global Alliance for Buildings and Construction (GlobalABC)

As a proactive partner, the GCCA offers its cement and concrete industry expertise to GlobalABC initiatives to ensure cement and concrete solutions are smoothly incorporated into wider strategies and international climate frameworks for the building and construction sector. Through our work with GlobalABC we strengthened the standing of cement and concrete in the building and construction sector over the last couple of years. At the 2026 Sustainable Buildings and Construction Summit in Lausanne, low-carbon cement and concrete were recognised as essential contributors to reducing emissions from the built environment and accelerating the transition towards more sustainable construction.

At COP30 in Belém in 2025, the Intergovernmental Council for Buildings and Climate (ICBC), a high-level political framework coordinated by GlobalABC and bringing together more than 70 countries, introduced a series of initiatives for member countries to endorse. Once agreed, these initiatives demonstrate collective political support and provide a pathway towards implementation and progress tracking.

GCCA's Call for Action on Lower Carbon Cements and Supplementary Cementitious Materials (SCMs) was accepted as one of these initiatives and presented to ICBC members for endorsement. It promotes lower-carbon cements and greater use of SCMs as an immediately available way to reduce GHG emissions from new buildings. The initiative also seeks to raise awareness of the role of low-carbon construction materials in buildings decarbonisation and mobilise stakeholders across the built environment to advocate for the policies and market conditions needed to accelerate their uptake.

GlobalABC and GCCA also collaborate on the Blend Better Cement campaign, a ClimateWorks funded project to scale SCMs globally. Building on the ICBC Call to Action on SCMs, the project seeks to build global recognition of blended cements and SCMs as proven decarbonisation solutions. The campaign which was launched at Climate Week NYC will also support national policies and market frameworks that encourage lower-carbon cement uptake and will be a key advocacy platform.

"Decarbonising cement and concrete is essential to delivering a low-emission, resilient built environment. Many of the solutions we need already exist – the challenge now is to move from proven solutions to deployment at scale.

Increasing the use of supplementary cementitious materials (SCMs) and blended cements can reduce emissions from cement today, while sustainably sourced bio-based materials can further reduce the embodied emissions of the buildings and infrastructure we create.

The ICBC Country Action on Blended Lower Carbon Cements and SCMs to Reduce Clinker Content and GHG Emissions brings governments, industry and international partners together around the policies, standards, procurement practices and market conditions needed to accelerate this transition. With much of the infrastructure the world will need by 2050 still to be built, the choices we make about materials today will shape emissions for decades. Collaboration across the value chain is critical to turning ambition into implementation and delivering buildings and infrastructure that meet people's needs while advancing our climate goals."



Gulnara Roll
Head of GlobalABC Secretariat, United Nations Environment Programme

The role of international collaboration

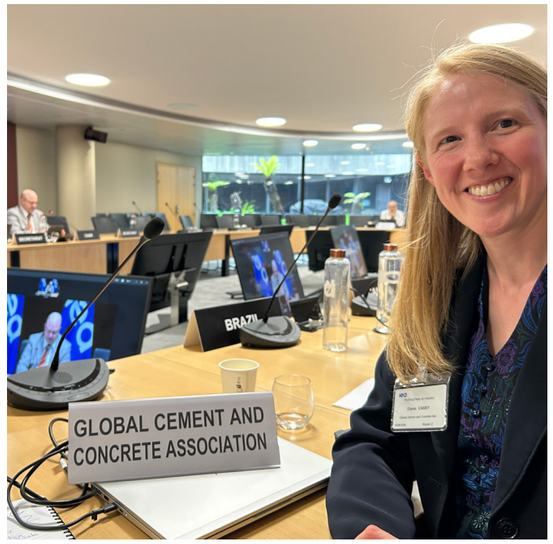
Continued

OECD and IEA

Our engagement with the IEA and OECD continues to strengthen, helping ensure the cement and concrete sector's priorities are reflected in influential international analysis and policy discussions. With the IEA, the GCCA has moved from being primarily a recipient of analysis to an active contributor, reviewing key publications, including work on co-processing, and contributing to discussions on the policies and technologies needed to accelerate cement decarbonisation.

Our collaboration with the OECD has similarly deepened, particularly on financing the transition, low-carbon procurement, co-processing and the policy frameworks needed to unlock investment.

Both organisations are also important partners through the Climate Club, where we continue to engage on demand creation, standards, finance and international approaches to industrial decarbonisation, helping align global policy work with the practical needs of our sector.



Above: **Dr. Diana Casey, Cement and ESG Director, GCCA at the IEA's Working Party on Industry (WPI) meeting (15 June 2026)**

"The transition to near-zero emission cement and concrete is ultimately an investment challenge as much as a technology challenge.

Governments need to create the conditions for innovation, investment and deployment, while enabling industry to develop economically competitive solutions. Sustained action and public-private collaboration will be critical to provide certainty, unlock investment and maintain momentum. At the OECD, we are bringing key stakeholders together and fostering international cooperation to further accelerate progress by sharing experience, mobilising finance and scaling solutions across markets."



Jaime de Bourbon de Parme
Environment Director,
OECD

UNIDO

Since signing our MoU in June 2024, UNIDO has become a key strategic partner for the GCCA. Our collaboration has focused on two critical enablers: access to finance and the development of enabling regulatory frameworks. On financing, we are working jointly to mobilise catalytic and concessional funding for cement decarbonisation projects, particularly in developing markets. On policy and regulation, we are actively contributing to shaping supportive environments for low-carbon investment. UNIDO's leadership in initiatives such as the Breakthrough Agenda (UNIDO is now taking charge of the broader Breakthrough leadership) and the Belém Declaration provide a strong platform for aligning governments and building regulatory confidence.

Together, we are also convening regional dialogues bringing policymakers, industry and stakeholders together to advance carbon frameworks and the action agenda. The cement and concrete sector are the first industry to undertake discussions of this kind at a regional level, and we were a key partner in UNIDO's regional dialogues held in Santiago, Chile, in May and Addis Ababa, Ethiopia, in July 2026.

The Santiago Dialogue focused on accelerating cement and concrete decarbonisation through stronger public-private collaboration, leading to the development of the Santiago Principles for the Decarbonisation of Cement and Concrete in Latin America and the Caribbean.

In Africa, the Addis Ababa Dialogue addressed how the continent can meet rapidly growing infrastructure demand while avoiding carbon lock-in, with discussions centred on solutions that are already available and can be scaled, including reducing the clinker content of cement through SCMs and LC3, improving material efficiency in construction, increasing the use of alternative fuels, strengthening measurement and reporting systems, and creating markets for low-carbon materials through standards, building codes and green public procurement.

Together, these dialogues create a platform for regional cooperation, knowledge exchange and partnership-building, helping to turn decarbonisation roadmaps into tangible projects and investment pipelines.

"Cement and concrete are crucial for building resilient and sustainable communities while enabling durable economic growth, as well as the transition of heavy industry as a whole to Net Zero.

The First Movers Coalition is working with the GCCA and partners across the value chain to strengthen private-sector demand for low-emissions materials. We are now extending this approach into urban systems, bringing together city governments, private-sector actors and finance to explore how intra-city procurement can help scale ambitious low-carbon construction solutions. The World Economic Forum looks forward to continuing its collaboration with the GCCA to support the cement and concrete sector's competitiveness while transitioning towards Net Zero."



Pedro Gómez
Senior Director, Industry Agenda,
World Economic Forum.

The role of international collaboration

Continued

Other strategic partnerships

Working with influential organisations across the world that can help us achieve our objectives on issues such as enabling policies, regulations and standards, financing and mechanisms is vital. This is why the GCCA was established. We have, alongside our members, positioned our industry as leaders with a seat at the top table. , and we will continue to leverage the additional reach and influence that these relationships provide.

At the GCCA CEO annual gathering in Madrid, we signed an MoU with the Global CCS Institute (GCCSI) to strengthen collaboration and accelerate the deployment of carbon capture and storage (CCS), a critical lever for achieving the cement sector's net zero ambitions. Its key objectives are to build awareness and understanding of CCS, share technical and policy expertise, strengthen advocacy for enabling regulatory frameworks, and support knowledge-sharing and project development. Through joint outreach, thought leadership, capacity building and stakeholder engagement, the partnership aims to help create the conditions needed to scale CCS across the sector.

As momentum builds, this is not the time to slow down. It is the time to accelerate our collective efforts to deliver on our commitments and scale the decarbonisation solutions that our industry is already implementing.



Above: **GCCA CEO annual gathering in Madrid**

"Decarbonising cement and concrete at the scale and pace required will demand a portfolio of solutions, and CCS is one of the few options capable of addressing the sector's unavoidable process emissions.

The technology is proven; the task now is to create the conditions for deployment at scale. That means durable policy, clear regulation, investable business models, access to shared CO_2 transport and storage infrastructure, and strong collaboration across industry, governments, finance and international organisations.

The partnership between GCCA and the Global CCS Institute is an important part of that effort. By sharing knowledge, aligning policy and industry needs, and learning from projects already operating and those moving into construction, we can help turn ambition into practical deployment and accelerate progress towards a net-zero cement and concrete sector."



Jarad Daniels
CEO, Global CCS Institute

GLOBAL CCS INSTITUTE



Our progress

CO_2 emissions*
25%
Reduction in net CO_2 emissions per tonne cementitious (1990 baseline).

Energy**
17%
Energy efficiency improvement (1990 baseline).

Fossil fuels
23%
Reduction in fossil fuel consumption (1990 baseline).

Every year we publish our latest industry GNR data. The GNR is a global database that collects (through a credited third party, PwC) and transparently publishes a set of key industry sustainability data. The data is collected according to the Cement CO_2 and Energy Protocol, and available data goes back to 1990 as a reference point so we are able to assess the progress that is underway.

The headline CO_2 intensity reduction of 25% since 1990 shows that progress is not only achievable but underway, but we acknowledge that there is a lot more to do and less time to achieve it. That is why we are calling on government and stakeholders to act now to help us move further and faster.

Outlined on the immediate next pages are the key enablers that can truly unlock the decarbonised and circular future which we are ready to deliver, but we need the right policies, investment and infrastructure support to make happen.

To find out more about the GNR visit **https://gccassociation.org/gnr/**

* Note 25% is a rounded figure – actual figure is 25.07%.
** Note 18% is a rounded figure – actual figure is 17.6%.

Our key policy requirements

We call on governments and policymakers to support us across these five key policy areas:

01
Supplementary Materials

Use of blended cements and Supplementary Cementitious Materials (SCMs) can be increased now through policies that ensure government procurement permits SCMs and the latest material standards are available. In the short-term, policies need to promote and enable access to relevant materials and establish government funding programmes to develop material standards, including performance based standards.

02
Carbon Pricing

An appropriate carbon price, as well as long-term predictability of the carbon price, allows companies to make the investments needed to reduce their CO_2. Policymakers must ensure that use of carbon pricing does not lead to distortions of competition between domestic producers and importers. The transition towards carbon neutral economies is dependent on the acceptance of carbon constraints and costs by all actors along economic value chains.

03
Carbon Capture, Use and Storage

Policy across all geographies is not yet strong enough to drive the number and scale of projects needed for cement manufacturing to be on track to meet net zero by 2050. Policy needs to address public financing, recognition of carbon removal, transport and storage infrastructure, access to decarbonised electricity, carbon pricing and demand for low-carbon product.

04
Waste Treatment in Cement Kilns

The right policies enable the industry to replace the majority of minerals with energy recovered from waste. In addition, recycling of mineral from waste is also achieved. And yet, globally less than 10% of energy needed in cement kilns comes from waste. Policies need to recognise and implement the fact that waste treatment in kilns is more sustainable than landfill and incineration.

05
Low Carbon Procurement

The demand side can drive supply side decarbonisation through low-carbon procurement. GCCA provides an EPD tool to calculate the carbon impact to compare with the definitions. Policymakers need to build on this foundational work with demand side pledges such as the Clean Energy Ministerial's Industrial Deep Decarbonisation Initiative.

For all policies visit www.gccassociation.org/gcca-policies/

Co-processing: transforming waste into purpose

Co-processing represents a huge opportunity for the cement and concrete industry and society.

Waste from human and industrial activity is estimated to account for 11.2 billion tonnes every year and managing this waste material is a growing challenge. In some parts of the world it is left in streets, sometimes openly burned, causing real hazards and problems for communities. It is also often dumped in rivers and ends up in our oceans, causing immense damage to the natural world.

Where waste and by-products cannot be managed technically or economically by prevention, reduction, reuse or recycling, the cement manufacturing process provides a more ecologically sustainable solution, compared to waste-to-energy, incineration, or landfill, thanks to the full energy recovery and material recycling.

Co-processing uses carefully selected waste to replace conventional fuels in high-temperature cement kilns. Its energy content is recovered, while its residual mineral content is incorporated into clinker, leaving no ash requiring disposal. It, therefore, complements prevention, reuse and recycling by providing a circular solution for waste that cannot otherwise be recycled, while reducing fossil fuel consumption, avoiding landfill and supporting lower CO_2 emissions.

The GCCA has developed a range of materials to build understanding of co-processing and strengthen policy support for its wider adoption. Centred on the message "transforming waste into purpose", co-processing is shown to be a practical, safe and scalable response to two connected challenges: managing society's non-recyclable waste and reducing the cement industry's reliance on fossil fuels.

Materials include a dedicated webpage, explanatory content, campaign films, social media materials, frequently asked questions and international case studies. A webinar and joint statement brought together leading industry and waste-management organisations to demonstrate the environmental and societal benefits of co-processing and call for stronger enabling policy.

Alongside public communications, the GCCA strengthened policy engagement through one-to-one stakeholder meetings and two advocacy workshops involving international organisations and multilateral institutions. This work addressed regulatory barriers, shared good practice and informed a Southeast Asia policy playbook and wider international work on scaling co-processing. The campaign received a positive response, with members rallying around the common narrative and using the materials in their own markets.

Our central call remains clear: governments should recognise co-processing within waste-management and circular-economy frameworks and establish transparent, effective regulations that enable its safe expansion. With supportive policy, this proven solution can help communities manage difficult waste streams, conserve resources and support the transition to a lower-carbon, more circular economy.





EPDs

Environmental Product Declarations

Environmental Product Declarations (EPDs) provide transparent, independently verified information on the environmental performance of products across their life cycle. For cement and concrete producers, they provide credible product-level data that can support low-carbon procurement, whole-life carbon assessment and more informed design decisions. As governments, developers and customers increasingly seek reliable environmental information, EPDs are becoming an important mechanism for demonstrating and accelerating progress towards net zero concrete.

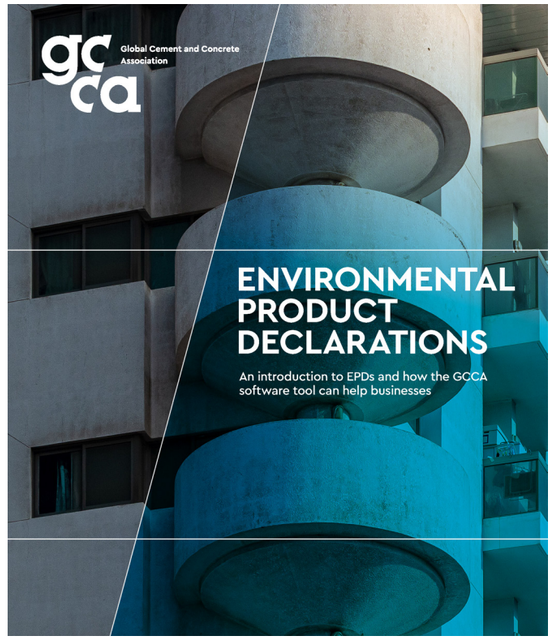
The GCCA EPD Tool enables cement, concrete and precast producers to prepare draft EPDs using a consistent, sector-specific methodology. Its pre-verified calculation model can reduce the time and cost associated with individual EPD verification, making environmental reporting more accessible and scalable. More than 1,000 users across over 90 organisations are already using the tool to prepare EPDs, helping to expand the availability of consistent and comparable environmental data across the industry.

A major milestone during the year was the launch of Version 6 of the GCCA EPD Tool. The upgrade introduced a new openLCA calculation engine and updated software architecture, alongside the latest GNR 2023 data, the new North American Product Category Rules for cement and additional functionality for the Australian market. These improvements strengthen the tool's technical foundation, broaden its regional application and provide a platform for future interoperability, automation and integration with other industry systems.

The next phase will focus on completing the remaining Version 6.1 developments, supporting user migration and strengthening the tool's assurance, governance and integration capabilities. The longer-term ambition is to develop the GCCA EPD Tool from a standalone calculation tool into trusted environmental product data infrastructure for the global cement and concrete sector. This will include exploring API and business-system integration, partnerships with EPD programme operators and regional organisations, and alignment with evolving standards and digital product information requirements.

> "As governments, developers and customers increasingly seek reliable environmental information, EPDs are becoming an important mechanism for demonstrating and accelerating progress towards net zero concrete."

> "More than 1,000 users across over 90 organisations are already using the tool to prepare EPDs, helping to expand the availability of consistent and comparable environmental data across the industry."



Finance & funding

Progress on international finance assistance and carbon market mechanisms.

Financial assistance represents a promising opportunity for our sector. The GCCA is collaborating with implementing agencies and local partners to design tailored strategies that maximise the effectiveness of financial assistance.

The Paris Agreement and subsequent COP decisions established a collective commitment by developed countries to mobilise at least USD 100 billion annually for climate action in developing economies, with an increasing focus on hard-to-abate sectors such as cement. Key funding mechanisms such as the International Climate Initiative (IKI), Mitigation Action Facility (MAF), Green Climate Fund (GCF) and Global Environment Facility (GEF), are mandated to channel these resources, often through accredited implementing partners such as UNIDO.

The GCCA is uniquely positioned to bridge this global financing landscape with the cement industry's concrete decarbonisation needs. Through its global and national roadmaps, the GCCA has already identified a robust pipeline of priority projects spanning strategy development, feasibility studies and large-scale asset deployment.

By working closely with donors, multilateral agencies, national governments, and national and regional partners such as FICEM and TCMA, the GCCA can convene government and industry stakeholders to structure programmes, align priorities, standardise methodologies, and develop investment-ready plans that de-risk projects and direct climate finance towards high-impact cement decarbonisation initiatives across the Global South. Flagship "lighthouse" projects and sustained dialogue with key donors will help strengthen long-term partnerships and scale impact.

Recently, the GCCA has advanced mechanisms designed to improve the commercial viability of very low-carbon cement and concrete investments. It has developed a robust Chain of Custody and Book & Claim framework, recognising that breakthrough technologies require stronger business incentives alongside high environmental integrity and broad industry participation.

Key achievements include building a shared understanding of Chain of Custody principles, publishing an initial high-integrity Rulebook, and engaging members, standard setters and external stakeholders. This work has established the GCCA as a leading global voice and encouraged greater openness to Chain of Custody and Book & Claim models. The GCCA is also developing a scalable governance and operating model, supported by a digital registry, with pilot implementation planned for the coming months.

Alongside this work, the GCCA is pursuing carbon-market opportunities to create additional revenue streams and narrow the cost gap for industrial decarbonisation. Priorities include developing internationally transferred mitigation outcomes under Article 6 of the Paris Agreement, particularly for scalable technologies such as calcined clay. Going forward, stronger standards, measurement, reporting and verification frameworks, and broader market recognition will be essential to make decarbonisation projects bankable and scalable.



Innovation

Innovation is fundamental to the cement and concrete industry's future. Many of the technologies needed to reach net zero need to be developed, nurtured and accelerated. It is therefore crucial to drive, support and advocate for innovation in the sector at all stages.

The GCCA, on behalf of the industry, runs three world-class innovation platforms under its Innovandi arm to accelerate and foster innovation.

Innovandi Global Cement and Concrete Research Network

Launched in 2020, the Innovandi Global Cement and Concrete Research Network (GCCRN) is a consortium which brings together academia (leading global institutions) and industry (cement and concrete manufacturers, admixture companies, equipment and technology suppliers) to collaborate on essential, actionable pre-competitive research, in areas such as clinker, calcined clays, concrete recycling, kiln electrification, CCUS and carbonation.

The network connects over 450 scientists in the field of cement and concrete, and the value of its research is worth approximately 10 million Euros per year (85 PhDs). It also directly funds around 1.2 million Euros per year in research solely focussed on reducing the CO_2 footprint of concrete. In 2025, the GCCRN also started postdoctoral scholarships for students outside the network. We have one postdoc student in the network and for 2026 the evaluations are ongoing.

Under the network, academic partners and industrial partners collaborate on research projects, of which there are over 85 currently being worked on and 2–3 new calls for proposals are in progress. The network meets at biannual (Spring Week and Autumn Week) meetings to present updates and results on their cutting-edge research and determine the direction for future projects.

All the core projects, partner projects and PhD researchers can be found on our website: gccassociation.org/innovandi-gccrn-projects/

Below: **Spring Week 2026 attendees**



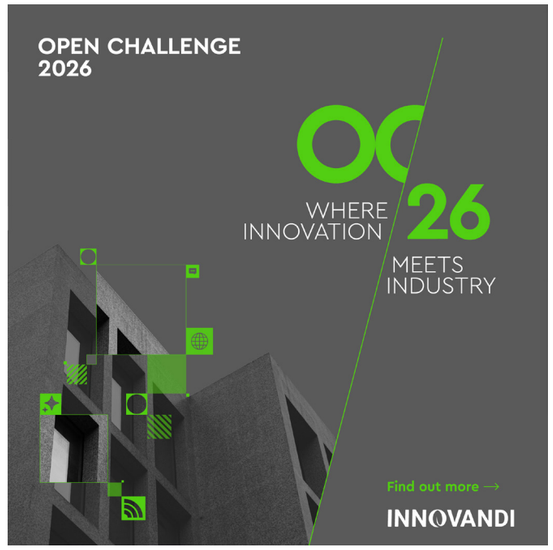
Innovandi Open Challenge

The Innovandi Open Challenge is a global programme which brings together tech start-ups and the world's leading cement and concrete companies to help accelerate the next wave of innovations in decarbonisation technologies. The programme sources the world's most exciting start-ups, and after a series of pitches it partners them with GCCA members to form consortia.

Selected start-ups gain unique access to plants and labs through this programme, as well as the expertise and infrastructure of nearly 50 members across the world to: move from ideas to prototype, pilot tests, proofs of concept, business cases. In other words, the programme will provide start-ups with the access they need to grow.

Over 400 start-ups have applied to Open Challenge since the start of the programme in 2021 and 15 successful consortia have been formed:

2026 saw the launch of our fifth Open Challenge, which focussed on AI for cement and concrete manufacturing. Over 60 start-ups applied for the Challenge and of those 20 start-ups were invited to pitch to member companies to form consortia.



Above: **Spring Week 2026 attendees**

Innovandi Entrepreneur Network

The Innovandi Entrepreneur Network is open to start-ups interested in collaborating to support our shared net zero mission. Membership provides a platform to access the Innovandi mentorship programme and network with peers and GCCA members, as well as access first-hand information on the Innovandi Open Challenge. Fifteen start-ups have joined since its launch in 2024, and have attended various webinars and events including the annual GCCA conference in Mexico in 2025.

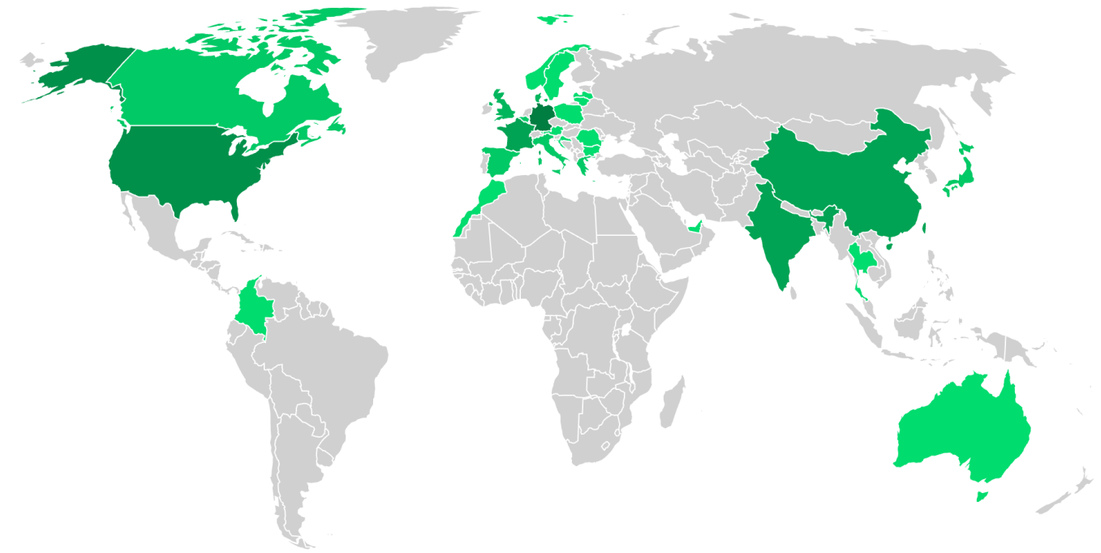
Green Cement Technology Tracker

Developed jointly by LeadIT and the Global Cement & Concrete Association (GCCA) in collaboration with the UN Climate Change High-Level Champions.

Scan the QR Code below to use the Green Cement Technology Tracker.

Where have Carbon Capture projects been announced?

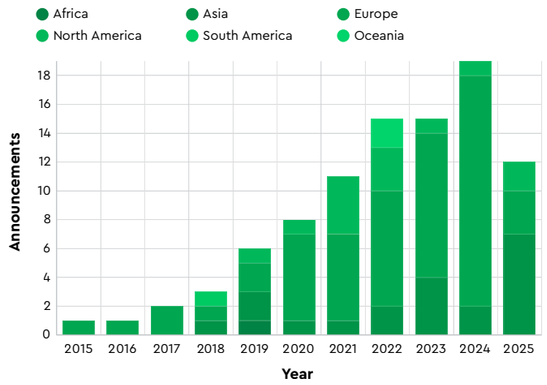
*Data retrieved on 3 November 2026.



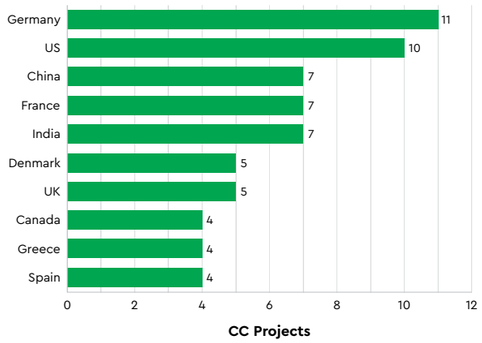
Amount of projects per country

0–11

Announcements over time

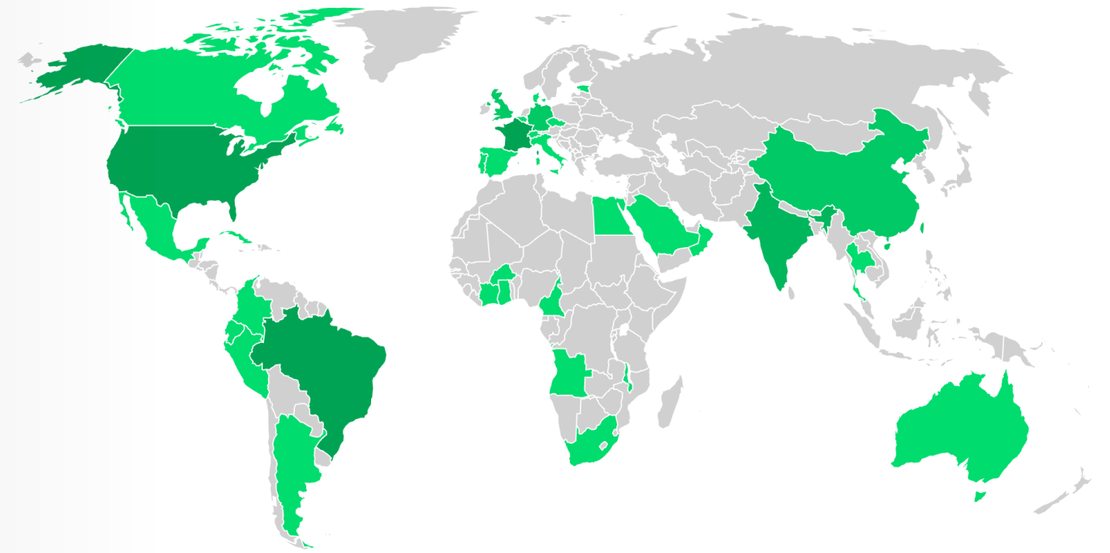


Top ten countries with the most CC projects



Where have Calcined Clay projects been announced?

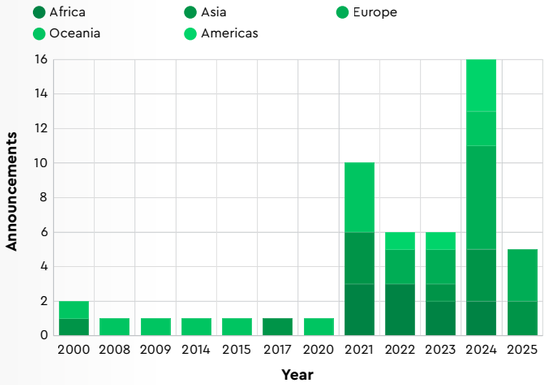
*Data retrieved on 3 November 2026.



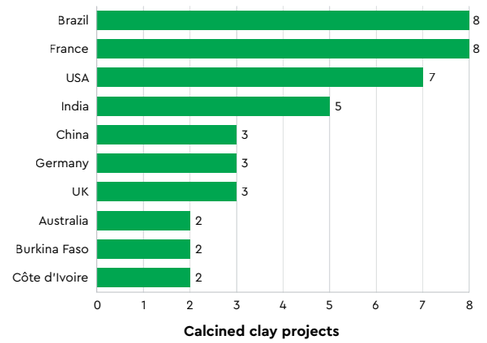
Amount of projects per country

0–8

Announcements over time



Top ten countries with the most Calcined Clay projects



Roadmap to Zero: Technology levers and policy enablers

The GCCA 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete, published in 2021, is the collective commitment of the world's leading cement and concrete companies to fully contribute to building the sustainable world of tomorrow.

The roadmap sets out a net zero pathway to help limit global warming to 1.5ºC. The sector is committed to producing net zero concrete by 2050 and is committed to acting now. Even prior to the roadmap publication, the industry had already made progress with proportionate reductions of CO_2 emissions in cement production of 20% from 1990 to 2020.

The roadmap highlights three milestones for 2030: application of carbon capture technology at industrial scale at 10 plants; 20% reduction in CO_2 per tonne of cement by 2030 from 2020; and a proportionate 25% reduction in CO_2 emissions per cubic metre of concrete.

The industry is on track to deliver CCUS technology at an industrial scale at 10 plants by 2030.

Tracking CO_2 reductions of 100% of global cement production is not currently possible. However, leading companies have been reporting plant level data for many years as part of GNR (see page 22). GNR is a good trend indicator of all committed players in the cement and concrete sector. Due to legal requirements, data reporting is delayed by two years, so the latest data available is from 2024. Four years into this decade, the reduction in CO_2 per tonne of cement is 4.4%, which represents a doubling of the annual carbon reduction rate over the previous decade, but further acceleration is required to meet the 2030 milestone.

GNR data is yet to be extended to concrete, although this is currently being implemented. It is reasonable to conclude that concrete progress is closely aligned to that of cement.

2030 Milestone: Carbon capture progress

Carbon capture technology is applied at industrial scale in

10 plants

to contribute to delivering net zero concrete.

2030 Milestone: CO_2 Reduction

(Compared with 2020 Baseline).

Cement

20%

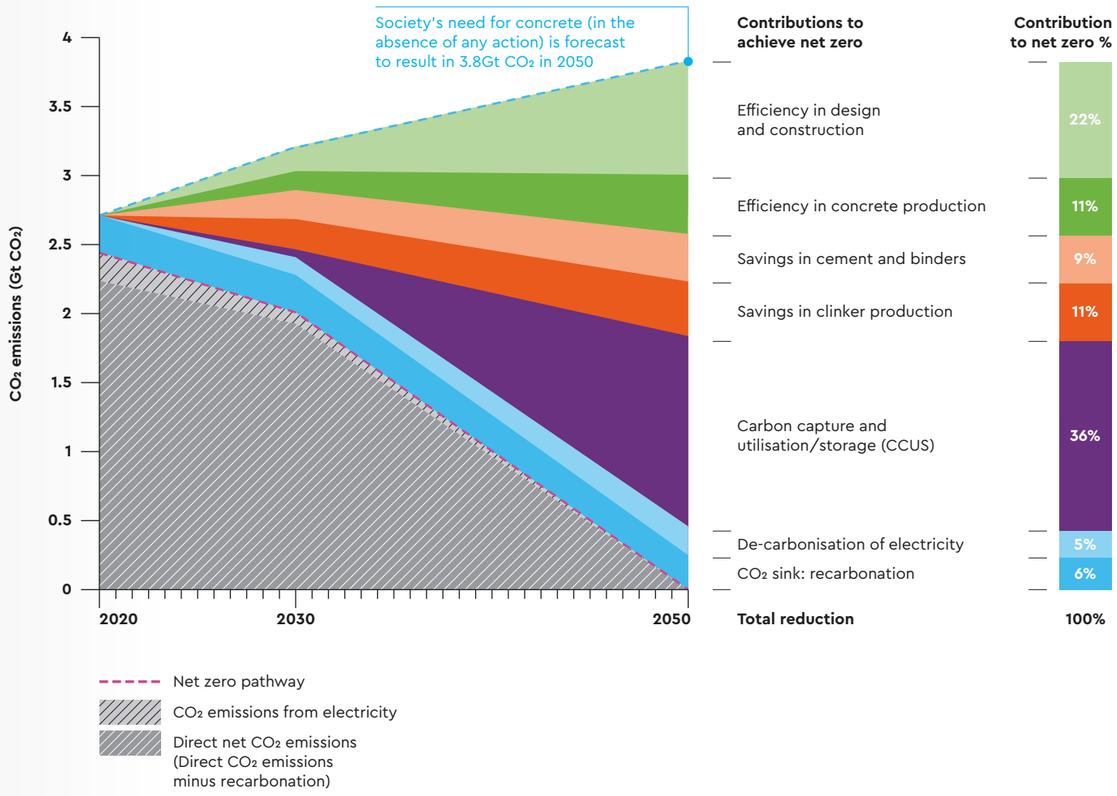
CO_2 reduction per tonne of cement by 2030.

Concrete

25%

CO_2 reduction per m³ of concrete by 2030.

The net zero pathway



The roadmap sets out the levers to achieve net zero across the whole lifecycle from cradle to grave. It also highlights that success requires the right policy support to be in place to shape demand for low carbon products (economic viability), enable a transition of the sector and make full use of circular economy opportunities, as well as supporting the development and implementation of innovations and key infrastructure.

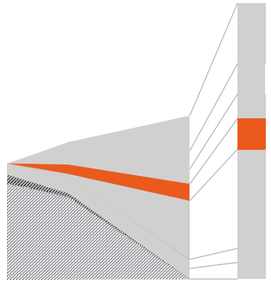
Total global CO_2 emissions from the sector in 2020 were in excess of 2.5Gt. Emissions are primarily direct CO_2 emissions which, in turn, are primarily from the decarbonation of limestone itself (approx. 60%) and combustion of the fuels used in the cement kiln and other plant processes (approx. 40%). Electricity used by the sector contributes further CO_2 emissions.

There are multiple levers that will be implemented to reduce CO_2 emissions at different stages of the whole life of cement and concrete. Our roadmap process evaluated the role that each of these levers will play to reach net zero.

The global average is presented in the graph above. Across the world, each lever will be implemented in accordance with local factors.

In the following pages, each lever will be described from the perspective of the technology and the required policies to enable the transition to happen. Where possible, indications of progress are reported.

Clinker



11%

contribution to Net Zero and 410Mt CO_2 emission savings in 2050.

Savings in Clinker production:

- savings from waste fuels ("alternative fuels")
- use of decarbonated raw materials
- thermal efficiency
- use of hydrogen as a fuel

During the clinker production stage, CO_2 reductions are possible through the use of waste materials ("alternative fuels") to replace fossil fuels, use of decarbonated raw materials, energy efficiency measures and innovations such as the use of hydrogen and kiln electrification.

Alternative fuels are derived from non-primary materials i.e. waste or by-products and can be biomass, fossil or mixed (fossil and biomass) alternative fuels. There are current examples of cement kilns operating with nearly 100% alternative fuels, which demonstrates the potential of this lever. The industry provides a waste management option that combines energy recovery with mineral recycling. It can treat waste from a range of sources that is otherwise non-reusable and non-recyclable, for example, municipal, agricultural, chemical and food production. The extremely high temperatures and residence times reached in cement kilns ensure that these are managed in a safe and environmentally sound way.

On average, globally, alternative fuel use is forecast to increase from 6% in 2020 to 22% and 43% by 2030 and 2050 respectively. The leading companies have significantly higher use of alternative fuels than these global production averages. GNR data for 2020 and 2024 respectively shows an increase from 19% to 25%. This increase is in line with the forecast increase across total production.

Use of decarbonated raw materials to replace some of the limestone in the kiln reduces the total emissions from decarbonation of the limestone. By definition the decarbonated materials, such as the fine material from recycled concrete and crystalline slag, do not emit CO_2 when heated because they have already had the CO_2 removed. Globally this is forecast to provide a 2% reduction in total emissions from the sector.

Thermal energy efficiency measures are already widely implemented across the globe through deployment of existing state-of-the-art technologies in new cement plants and retrofitting existing facilities. With many newer energy efficient cement plants in emerging economies, this is an area where these regions have already made good progress. It is to be noted that with an increase in the use of alternative fuels, there can be a decrease in thermal energy efficiency.

Innovations such as the use of hydrogen and kiln electrification are forecast to play a small role from 2040, providing 10% of energy needs by 2050. The Innovandi Global Cement and Concrete Industry Research Network (GCCRN) has a core project "Meta-analysis on the use of electric energy for cement production" and a partner project on use of hydrogen in cement kilns. For more information and article references on GCCRN Projects/ Clinker Production **gccassociation.org/innovandi-gccrn-projects/**

> There are current examples of cement kilns operating with nearly 100% alternative fuels, which demonstrates the potential of this lever.

Policy enablers

In the context of clinker production, the policy support that can have the most significant and most immediate decarbonisation, and broader sustainability benefit, relates to enabling treatment of waste in cement kilns.

To increase the use of alternative fuels requires the implementation of policies that allow access to suitable waste and secondary material streams, such as biowaste, by reducing the landfilling of waste that can be co-processed in cement kilns. Policies must also encourage the segregation of waste streams to improve resource flow and ensure streamlined environmental permit-issuing processes for cement plants. There also must be a level playing field in the access and use of biomass across all sectors of the economy.

To aid in this policy development, countries should require and implement monitoring and accounting of the share of materials which are effectively recycled through co-processing as part of their recycling targets. It is also recommended that there is a formal recognition of the simultaneous energy recovery and mineral recycling characteristics of 'co-processing' in waste policy frameworks. At international level, this should be through the addition of a dedicated code (R15) for co-processing under Annex IV of the Basel Convention.

Alongside the above policies, there should be strong regulatory measures, including permit issuance and compliance procedures to ensure implementation of Best Available Technologies (BAT) when implementing co-processing in the cement industry.



Çimsa Alternative fuels and hydrogen

Scaling alternative fuels and hydrogen technologies to reduce fossil-fuel use in clinker production. Read more on p62



Cementos Argos Cartagena co-processing

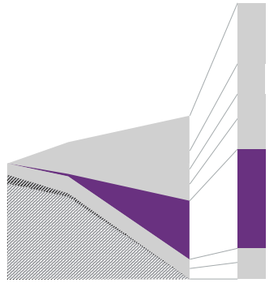
Replacing fossil fuels with waste-derived alternative fuels at the Cartagena cement plant. Read more on p59



Dangote Waste heat recovery

Recovering heat from cement production to generate electricity and improve the energy efficiency of clinker production. Read more on p73

Carbon Capture Utilisation and Storage (CCUS)



36%

contribution to Net Zero and 1,370Mt CO_2 emission savings in 2050.

Savings in CCUS:

- carbon capture at cement plants

CCUS is a critical lever to decarbonise cement and concrete because, unlike other sectors, switching to renewable energy is not sufficient to deliver decarbonisation. This is because the CO_2 emissions from the cement sector are not only due to energy use. Two thirds of the CO_2 emitted is from the calcination of limestone. Whilst there is work on alternatives to clinker (see Cement and Binders on p38), the scale of demand for buildings and infrastructure can only be met by Portland clinker cements.

The contribution of carbon capture and utilisation/storage to decarbonisation is forecast to become significant beyond 2030 when commercial viability and the necessary infrastructure have been established. Good progress has already been made this decade from fundamental studies of CO_2 storage sites through to the first industrial scale facility opening in Norway.

The GCCA Net Zero Roadmap set a milestone of 10 plants having applied carbon capture technology at an industrial scale by 2030. Publicly announced projects are collated and made available on the GCCA/LeadIT green cement technology tracker. In October 2026, of the 95 projects, 43 of them are commercial scale (>0.1 million tonnes captured), and 29 of these are reported as due to be commissioned in 2030 or before, and on average will capture 1 million tonnes CO_2 per year.

Also of note are the different technologies across a number of regions. Among the 40 projects (demonstration and commercial) to be completed by end of 2030, 5 different specific carbon capture technologies are being applied.

Storage and Utilisation

Once captured, the CO_2 will be permanently stored primarily in geological storage or utilised. If utilised, this may be within the cement and concrete industry or by other industries. Utilisation of captured CO_2 within the cement and concrete industry includes injection into wet concrete, curing of hardened concrete and in the manufacturing of aggregates from waste products. Further commercial development and expansion of these uses of captured CO_2 is under way. Fundamental research is also ongoing, including that by the Innovandi Global Cement and Concrete Research Network (GCCRN).

Relevant projects and references can be found in both the CCUS and Recarbonation/Recycling sections of the GCCRN online library. Innovandi GCCRN projects can be found at **gccassociation.org/innovandi/gccrn/**

> “The contribution of carbon capture and utilisation/storage to decarbonisation is forecast to become significant beyond 2030 when commercial viability and the necessary infrastructure have been established."

Policy enablers

Policy levers need to be extended across the world to drive the number and scale of CCUS projects that are needed for cement manufacturing to be on track to meet net zero by 2050.

Policy support in Europe, the USA and Canada has enabled the industry to be on track for its 2030 target of 10 plants at an industrial scale. However, further policy development is required to enable a robust business case for the essential deployment from 2030. And this policy landscape needs to be in place by the middle years of this decade to ensure the necessary ramp up in carbon capture from 2030.

Policies are required to support the development of CCUS technologies through financial, infrastructural, and regulatory measures. Policies must also foster innovation and demand for carbon-neutral solutions.

The key policy asks are:

- Use appropriate carbon pricing mechanisms to create a level playing field on carbon costs, and avoid carbon leakage through adequate carbon pricing mechanisms.
- Integrate CCUS in public financing mechanisms that cover, in particular, the initial investments and early operational abatement costs to allow for an investable business case.
- Provide fair recognition of all carbon removal measures, both where the CO_2 is ultimately stored or used in products, either by acknowledging them as part of regional/national emissions trading systems or by developing tailored accounting rules. Include negative emissions savings through the use of CCUS combined with biomass fuels in the accounting rules.
- Provide transport infrastructure and storage to move captured carbon to where it can be used or stored. In particular, speed up permitting processes to allow for the construction of carbon storage facilities. In addition, the infrastructure needs to be regulated in such a way that dispersed sites are not disadvantaged when it comes to access and costs.
- Provide reliable access to sufficient and competitively priced decarbonised energy.
- Establish public-private partnerships to speed-up CCUS developments, including shared investment in CO_2 transport and storage networks.
- Support R&D including for new uses in other sectors of CO_2 captured by the cement and concrete industry.
- Enable the integration of CO_2 performance in public procurement, building standards and construction codes alongside traditional criteria to create the demand for carbon-neutral products.



Heidelberg Materials Padeswood CCS

Deploying industrial-scale carbon capture to address hard-to-abate process emissions at the Padeswood cement works. Read more on p77



SCG VPSA carbon capture

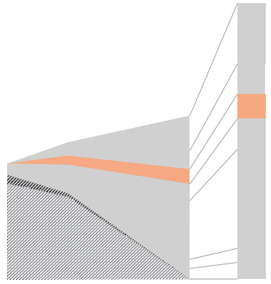
Developing carbon capture technology to separate CO_2 from cement production for subsequent use. Read more on p93



Holcim CaptureLab

Provides a dedicated industrial testing platform at Holcim's Martres-Tolosane cement plant to develop, test and scale carbon capture technologies under real-world operating conditions. Read more on p83

Cement and Binders



9%

contribution to Net Zero and 350Mt CO_2 emission savings in 2050.

Savings in Cement and Binders:

- Portland clinker cement substitution (also expressed through clinker binder ratio)
- alternatives to Portland clinker cements

At the cement plant or the concrete plant, fly ash, ggbs, ground limestone and other materials, known as Supplementary Cementitious Materials (SCMs) can be added to Portland clinker cement to deliver concretes with reduced CO_2 emissions whilst maintaining required performance. In some applications the concrete performance is enhanced.

Availability of suitable materials around the world varies now, and will into the future. For example, fly ash comes from coal fired power stations and ggbs from the steel industry's blast furnaces and these industries are also transitioning. In coming decades there will be increased use of ground limestone and calcined clays to both compensate for reduced supply of fly ash and ggbs, and further reduce the Portland clinker to binder ratio. Progress in production of calcined clay can be seen on p29.

Whilst availability of SCMs can be a limitation for reducing the clinker binder ratio, client acceptance is a current barrier in fully exploiting this lever in some developed and emerging economies.

On average globally, the clinker binder ratio in 2020 was estimated as 0.63. It is projected to reduce to 0.58 and 0.52 by 2030 and 2050 respectively. Regional and even country variations are inevitable due to differing SCM availability and market requirements.

GNR data is available for use of SCMs in the cement manufacturing process with a parameter known as the clinker to cementitious ratio. This is higher than the clinker to binder ratio because it does not account for SCMs added in the concrete plant. GNR has shown a progression from 0.78 down to 0.75 in clinker to cementitious ratio from 2020 to 2024 respectively.

Alternatives to Portland clinker cements

Alternatives to Portland clinker cements have been the subject of much research but their impact is not forecast to be significant primarily because of a fundamental lack of availability of raw materials at the scale required. Furthermore, they also come with CO_2 emissions (about half of common cements). On average globally, it is forecast that alternatives to Portland clinker cements will be 1% and 5% of cement in 2030 and 2050 respectively and in 2050 will contribute a 0.5% reduction in overall CO_2 emissions.

To speed up the progress on novel cements, the GCCA 2023 and 2025 Innovandi Open Challenge focussed on new materials and ingredients for low-carbon concrete. Over 120 start-ups were sourced, out of which 32 start-ups were invited to pitch to our members resulting in 8 successful consortiums formed between start-ups and GCCA member companies. For more information visit:
gccassociation.org/innovandi/openchallenge2023/
gccassociation.org/innovandi/openchallenge2025/

> "In the coming decades there will be increased use of ground limestone and calcined clays to further reduce the Portland clinker to binder ratio."

Policy enablers

Specific policies are required to unlock the full circular economy potential and prioritise the use of, and improve access to, waste and by-products as supplementary cementitious materials.

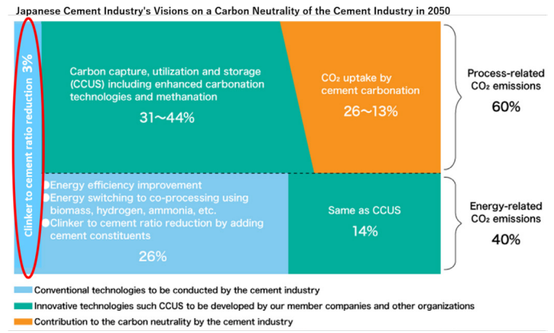
Use of blended cements and SCMs can be increased in the immediate term through governments and policymakers doing the following:

- Ensure necessary support for review, approval and publication of standards to ensure latest standards are available.
- Ensure cement, concrete, design and construction codes and standards, and building regulations where applicable, are aligned and congruent. For example, construction codes must refer and default to latest available material standards.
- Ensure government and its agencies take the lead in public projects by specifying low-carbon cements and concrete, through use of blended cements and SCMs, while taking into account the whole life carbon and performance of projects. We recommend major government agencies responsible for construction are asked to review specifications to ensure they permit the use of blended cements, SCMs and latest material standards.
- Promote formal construction and more industrialised uses of cement, understanding that they offer a better scenario to leverage a more efficient, safe, and optimised use of SCMs.
- Provide policy measures that encourage, incentivise and train clients and specifiers to use low-carbon cement and concrete, through use of blended cements and SCMs, in construction projects, based on a whole life carbon and performance assessment.
- Enable access and avoid barriers to sourcing SCMs both from overseas and domestically. Whilst taking into account the transport carbon impacts, no blanket prevention of importation should be introduced. Domestically, regulations should enable access to materials that are valuable for input into the cement/concrete value chain.
- Establish government funding programmes to support development of material standards that will widen and accelerate the use of SCMs and blended cement.
- Establish government funding programmes for product development and innovation for new SCMs.
- Establish government funding programmes for development of test methods to enable more performance-based approaches firstly for known constituents and then for new, alternative constituents.



CRH Supplementary cementitious materials

Turning industrial by-products into supplementary cementitious materials that reduce the clinker content of cement and concrete. Read more on p72



Japan Cement Association Clinker-to-cement ratio

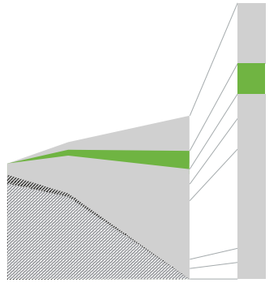
Supporting revised cement standards that allow a higher proportion of non-clinker constituents in cement. Read more on p85



Limak LC3 and calcined clay

Developing limestone calcined clay cement to reduce clinker use and the carbon footprint of cement. Read more on p88

Concrete



11%

11% contribution to Net Zero and 430Mt CO_2 emission savings in 2050.

Efficiency in Concrete production:

- continue to industrialise manufacturing
- optimised mix design
- optimisation of constituents
- quality control

In terms of concrete production, industrialisation is the most significant specific decarbonisation lever. Moving from small project site batching of concrete using bagged cement to industrialised processes offers significant CO_2 emissions savings because of the adherence to mix specifications and quality control.

In some emerging economies such as India, the vast majority of concrete production is currently on project sites and the continued growth in industrialised production offers the prospect of significant savings in cement use. For some countries in which bagged cements have a relatively high use of SCMs, and bulk cements do not, then greater industrialisation may have the perverse effect of increasing clinker binder ratios. This should be guarded against by raising awareness of the benefit of blended cements and SCMs.

More broadly, the utilisation of admixtures and improved processing of aggregates are good opportunities for CO_2 emissions savings in concrete production through the more efficient use of binders. These savings have already been implemented by parts of the industry, but broader and deeper application will deliver further savings.

On average globally, the optimisation of concrete production in terms of binder utilisation is forecast to lead to binder demand reductions of 5% and 14% in 2030 and 2050 respectively, compared with 2020.

The GNR data collection and reporting for cement production is being extended to include concrete production. A pilot data collection has been conducted and refined reporting guidelines are now being more broadly rolled out. To maximise global coverage of the concrete industry, which is local by nature, the plan is to work with national concrete association partners so that their data collection is aligned to facilitate aggregation and reporting of global trends.

> “Concrete is the essential material for delivering progress and building the resilient and sustainable communities our world needs.”

Policy enablers

Changes to standards and public procurement policies are necessary to accelerate the adoption of low carbon concrete products. Low carbon concrete products arise from carbon reduction measures along the value chain, and so these procurement policies are also important for the decarbonisation of clinker and cement and enabling CCUS.

Low carbon procurement policies will stimulate demand for low carbon and near zero carbon cement and concrete products. Policies should recognise the following:

- Low carbon procurement of products should be based on comparison of products with the same functional performance using recognised EPDs.
- Targets for reduction compared with current CO_2 performance should be:
  - stretching to deliver demand signal wanted by manufacturers and challenging enough to be credible drivers
  - realistic to ensure customers can find suppliers
  - congruent with GCCA global roadmap taking into account national opportunities/challenges, or national roadmaps where they exist.



GCC AI concrete mix optimisation
Using artificial intelligence and real-time data to optimise concrete mixes and improve production efficiency. Read more on p75

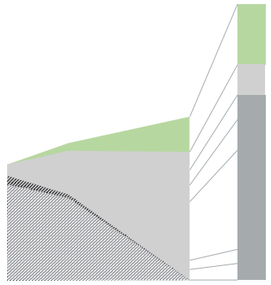


Taiheiyo Cement Shirasucrete
Using volcanic material as a cementitious component to produce durable concrete with reduced embodied carbon. Read more on p95



Votorantim Cimentos Córdoba flagship concrete plant
Combining lower-carbon cement, optimised mixes, circular practices and renewable electricity at a ready-mix concrete plant. Read more on p113

Design and Construction



22%

22% contribution to Net Zero and 840Mt CO_2 emission savings in 2050.

Efficiency in Design and Construction:

- client brief to designers to enable optimisation
- design optimisation
- construction site efficiencies
- re-use and lifetime extension

The project team of architect, engineer, contractor, project manager and quantity surveyor, together with the client (or their representative) have important roles to play to help decarbonise the whole life of cement and concrete.

They are responsible for:

- Material specification: specification with CO_2 as a criteria results in lower CO_2 solutions. Either lower carbon mixes with same performance requirements, or higher strength mixes with higher per unit volume carbon footprint outweighed by volume savings.
- Material procurement: low carbon procurement is a key enabler for the industry to decarbonise production. (See Concrete on p40)
- Efficiency in design and construction of elements and whole projects: This can be achieved by applying many specific levers. These levers are able to be applied with current standards and regulations.

The primary means of unlocking design levers is ensuring that the reduction of CO_2 emissions becomes a design parameter in addition to the current parameters of cost, time, quality and specific project client requirements.

Across all projects globally, the CO_2 emissions reductions achievable through design and construction levers is forecast as 7% and 22% in 2030 and 2050 respectively.

Policy enablers

The Clean Energy Ministerial Industrial Deep Decarbonisation Initiative calls on governments to commit to low carbon procurement of projects. Level two of their pledge includes: "Starting no later than 2030, conduct whole project life cycle assessments for all public construction projects, and, by 2050, achieve net-zero emissions in all public construction projects."

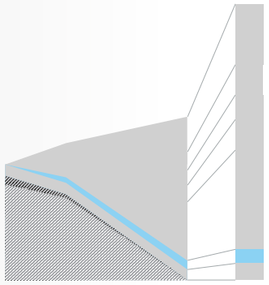
Adoption of this pledge, implementation as soon as practical, and extension to privately funded construction will facilitate the realisation of the potential design and construction decarbonisation savings.

Concrete design and construction can be optimised to reduce CO_2 impact, but there are often systemic barriers and practical constraints preventing this potential from being realised. For example:

- demands on speed of construction meaning low carbon mixes are less economical
- fragmented value chains meaning the possibility and responsibility to reduce CO_2 is spread across different actors with diverging incentives
- the pace of change in revision of standards and building codes which (justifiably) prioritise avoiding risk

Policy enablers are required to tackle (non-regulatory) systemic barriers to enable the optimisation of concrete design and construction and prioritisation of CO_2 performance alongside other objectives at the procurement, design and construction stages.

Decarbonisation of Electricity



5%

contribution to Net Zero and 190Mt CO_2 emission savings in 2050.

Savings in Decarbonisation of Electricity:

- decarbonisation of electricity used at both cement plants and in concrete production

Demand for electricity from the cement sector will increase as we move towards 2030 in line with increased total production, and as we move towards 2050 primarily due to electricity demand of carbon capture. This increase in demand is countered by the decarbonisation of electricity production. Decarbonisation of electricity across the globe over the coming decades will result in emissions from the generation of electricity used in cement and concrete production to reduce to zero.

The IEA reported in October 2024 that clean energy transitions have accelerated rapidly in recent years, but need to move much faster to meet climate goals. In 2023, renewables provided 30% of global electricity supply. (1)

> "In 2023 renewables provided 30% of global electricity supply (1)."

Policy enablers

The cement and concrete sector are not alone in calling for policies to boost the supply, distribution, availability and affordability of renewable energy.

There remains a gap between the stated policies scenario and the net-zero emissions scenario for the energy sector generally and electricity in particular. Read more in IEA report (1).

1. IEA, World Energy Outlook 2024, www.iea.org/reports/world-energy-outlook-2024



UltraTech 100% green-energy-powered Kukurdih unit

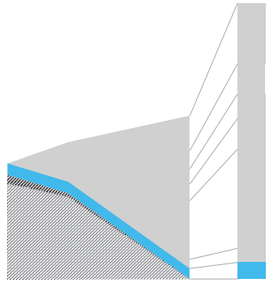
UltraTech's Kukurdih Cement Works has met 100% of its electricity requirement through green energy every month since April 2026, using renewable power and waste heat recovery. Read more on p107



Cemex Poland Renewable electricity programme

Cemex is combining off-site renewable electricity supply with more than 14 MWp of new on-site solar installations across cement and concrete plants in Poland. Its Statkraft agreement is expected to cover around 30% of annual energy needs. Read more on p60

Recarbonation



6%

6% contribution to Net Zero and 240Mt CO_2 emission savings in 2050.

Savings in Recarbonation:

- natural uptake of CO_2 in concrete over whole life – a carbon sink

Recarbonation is a natural process of CO_2 uptake by concrete. It has been well understood by engineers and has been incorporated into engineering standards for decades. In addition, to being recognised in the IPCC 2006 Guidelines for GHG Inventories, It has most recently been highlighted in the IPCC 6th assessment report published in August 2021.

In the GCCA roadmap, tier 1 of the IVL methodology has been used. This permits a 20% value for recarbonation to be adopted, with this being applied to the theoretical maximum carbonation possible for a tonne of clinker (525kg CO_2/tonne). This is a lower bound conservative value within the IVL methodology.

From 2020 to 2050, the clinker binder ratio decreases (see Cement and Binders on p38). The reduced clinker per m3 of concrete, and total clinker volume globally results in a slight decrease in recarbonation over the coming decades.

This forecast is intentionally conservative because it was the first global roadmap to include recarbonation and work is still progressing on a more detailed evaluation of recarbonation and efforts to enhance recarbonation through active exposure of crushed concrete to CO_2 at end of life.

Policy enablers

Policies should recognise the natural CO_2 uptake in concrete over its lifetime as a permanent CO_2 sink. They should facilitate access to concrete demolition waste to enable the industry to maximise CO_2 uptake through enhanced recarbonation. Evaluation and reporting of carbon uptake should be part of national greenhouse gas accounting and in project/product lifecycle analysis.



Asia Cement/Yatung Carbon mineralisation of returned concrete
Mineralising CO_2 in returned concrete to produce recycled aggregate for use in new concrete. Read more on p51

1. www.ivl.se/projekt/co2-concrete-uptake/calculation-models.html

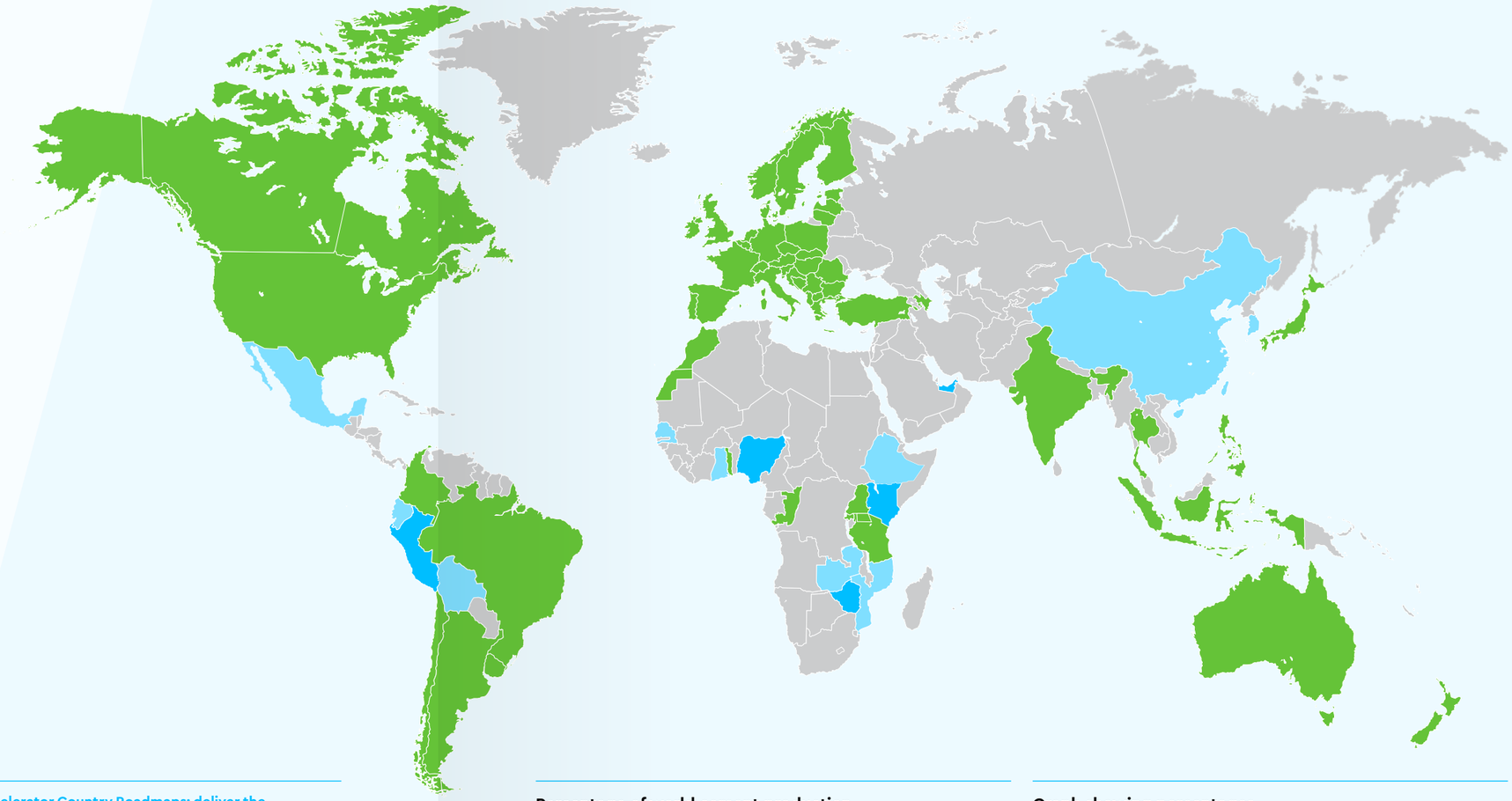
Country Roadmaps

We call on governments and policymakers to support us across these five key policy areas:

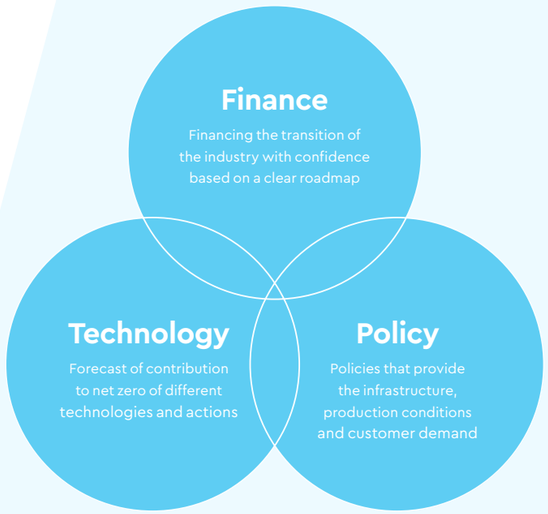
The GCCA Net Zero Country Roadmap Accelerator Programme helps national cement and concrete industries develop their own roadmaps in line with the GCCA's 2050 Net Zero Global Roadmap that was developed with ECRA and published in October 2021. The GCCA provides the methodology and ongoing support for the national industry to drive, deliver and thereby own their national roadmap.

The GCCA, with the support of ECRA, ensures that there is a consistency in application of the methodology and provides expertise including transferring experience from one country to another. The Net Zero Roadmap Accelerator aims for each country, to:

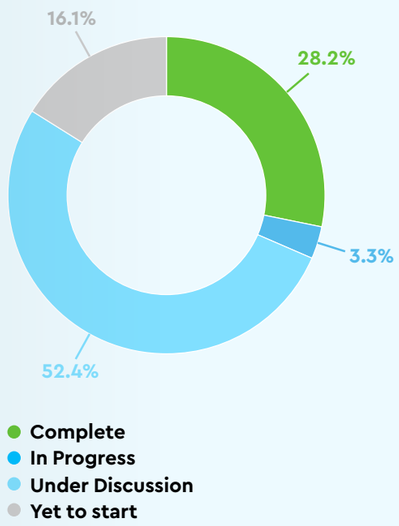
- Convene all stakeholders across the whole life of cement and concrete to increase the understanding of the roles that each can play to deliver decarbonisation
- Identify the contributing technologies and actions to decarbonise by 2050
- Describe the enabling policies
- Bridge the dialogue between policymakers and the industry towards policy engagement to facilitate the implementation of decarbonisation actions
- Capture the attention of the financial institutions to finance sustainable projects
- Help our members progress on their decarbonisation transition through a credible industry technology roadmap, enabling policies and financing



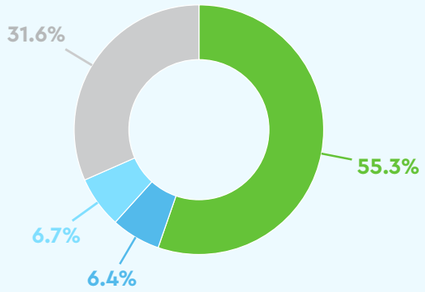
Below: **Net Zero Accelerator Country Roadmaps: deliver the technology forecasts and policy enablers that underpin increased financing of the transition to net zero**



Percentage of world cement production covered by roadmaps



Graph showing percentages (excluding China)





ACTION & PROGRESS

GCCA Member Action

Our members are demonstrating climate action today, with projects that exemplify CO_2 reductions across the world.

The following pages highlight some of the standout projects that are taking place across our members and association partners today.

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ABCP | SNIC

Official Launch of the Brazilian Cement Industry Net Zero Roadmap at COP30

The national cement industry reached a milestone with the official presentation of the Brazilian Cement Industry Net Zero Roadmap on the stage of COP30, setting key guidelines for sector decarbonisation by 2050.

Coordinated by ABCP and SNIC in partnership with GCCA, the initiative expanded its governance to include Brazil's Ministry of Development, Industry, Trade and Services (MDIC), UNIDO, and the E+ Energy Transition Institute.

Strategic Alignment & International Cooperation

This strategic alliance strengthens the sustainability ecosystem by linking the Net Zero Roadmap directly to major industrial transition and financing fronts. The initiative aligns with the federal government's National Strategy for Industrial Decarbonisation (ENDI) and connects with the ID Hub—a platform co-led by MDIC and the UK Government to mobilize transition investments for hard-to-abate sectors. It also articulates with German cooperation (GIZ – IKI/INDUZ), as well as UNIDO initiatives, fostering new research, technological innovations and decarbonisation projects nationwide.

Nature-based Solutions & Carbon Removals

Furthermore, the roadmap incorporates the pioneering Nature-based Solutions (NbS) strategy as a viable mechanism for carbon removal, fully aligned with the regional vision of the Inter-American Cement Federation (FICEM), while leveraging Brazil's vast forestry and ecological potential. To advance this agenda, Brazil hosted a technical mission from FICEM, bringing together regional leaders and experts to structure nature-based carbon removal pathways. By combining ecosystem restoration, biomass integration, and natural sequestration with industrial innovation, the regional cement industry positions itself at the forefront of holistic climate solutions.







Top & Middle: **Roadmap Presentation at COP30**
Bottom: **Mission NbS in Brazil (FICEM delegation at ABCP)**

Asia Cement Corporation

Asia Cement's carbon capture and utilization (CCU) technology mineralizes CO_2 using calcium oxide-rich waste materials, producing carbon-negative aggregate for reuse in concrete.

Asia Cement has developed a carbon capture and utilization (CCU) technology, launching the High-Efficiency Carbon Mineralization Project in 2023 and completing system construction in early 2025. It uses waste concrete and calcium-rich materials from the steel industry, including desulfurization slag, basic oxygen furnace slag, and reducing slag. These materials are prepared as a slurry and treated in a high-gravity reactor, where high-speed rotation enhances mass transfer with CO_2 and enabling the CO_2 to react with calcium oxide in the materials and form stable calcium carbonate, recarbonating and storing the CO_2 emitted from the cement plant flue gas.

Objectives & Benefits

The project plans to progressively scale up CO_2 capture and utilization, targeting 18,000 tonnes of CO_2e captured per year by 2030 and 36,000 tonnes of CO_2e per year by 2035. The resulting carbon-negative aggregates will be supplied to downstream ready-mixed concrete producers for the manufacture of low-carbon concrete. Through CCU technology, the project aims to advance a circular carbon economy and support Asia Cement's net-zero transition.

Key Metrics

Asia Cement has completed laboratory-scale system setup and parameter optimization, achieving carbon uptake of up to approximately 0.2 tCO_2 per metric tonne of material. When the carbonated material replaces 10% of the fine aggregate in concrete, the 28-day compressive strength is comparable to that of the control mix. The process is estimated to fix approximately 13 kg CO_2 per cubic metre of concrete, demonstrating potential for low-carbon construction-material applications. A field-scale pilot test is planned for 2026.



Above: **High-Gravity Carbonation System**

36,000t

The project aims to gradually expand CO_2 capture and utilization, reaching 18,000 tonnes of CO_2e annually by 2030 and 36,000 tonnes annually by 2035.

Asia Cement Corporation

Continued

Asia Cement converts end-of-life wind turbine blades into alternative raw materials and fuels by developing Taiwan's first cement kiln co-processing technology for waste wind turbine blades, successfully addressing the disposal challenge arising from renewable energy development.

Asia Cement, in collaboration with the Resource Circulation Administration, Ministry of Environment (RECA), and the Industrial Technology Research Institute (ITRI), developed a cement kiln co-processing technology for end-of-life wind turbine blades. Made from glass-fibre-reinforced polymer (GFRP) composites, wind turbine blades are strong and corrosion-resistant but difficult to manage after decommissioning. Through the high-temperature cement kiln process, approximately 60% of the non-combustible components can substitute for natural raw materials such as clay and limestone, while the remaining approximately 40% resin fraction, which has calorific value, can be used as an alternative fuel, reducing coal use and supporting resource circulation.

Objectives & Benefits

Asia Cement's cement kiln co-processing technology for end-of-life wind turbine blades is expected to process a total of 2,800 metric tonnes by 2028 and has an annual treatment capacity of up to 36,000 metric tonnes. The technology can help address Taiwan's need to recycle end-of-life wind turbine blades, with annual waste generation projected to exceed 10,000 metric tonnes from 2050 onward.

Key Metrics

The technology has successfully processed approximately 42 metric tonnes of end-of-life blades from onshore wind turbines, equivalent to blades from about two wind turbine generator units, with an estimated carbon reduction benefit of approximately 37 tCO_2e. The results demonstrate the potential of the cement industry to co-process end-of-life composite materials and provide a feasible circular solution for decommissioned renewable energy equipment.



Above: **Cement Kiln Co-processing Technology for End-of-Life Wind Turbine Blades**

2,800 tons

2,800 metric tonnes of end-of-life wind turbine blades expected to be processed by 2028.



Cement Kiln Refrigerant Destruction Technology

Asia Cement has successfully developed Taiwan's first cement kiln-based refrigerant destruction technology, helping destroy refrigerants that deplete the ozone layer and have high global warming potential (GWP).

Case study

Asia Cement leverages the "3T" characteristics (high temperature, long residence time, and strong turbulence) of its cement kiln and, in collaboration with the Ministry of Environment (MOENV) and the Industrial Technology Research Institute (ITRI), has developed Taiwan's first cement kiln process for refrigerant destruction. High-pressure liquid refrigerants are first converted into gas, then fed into the cement kiln for high-temperature decomposition after stable metering. By preventing the release of regulated refrigerants, the technology helps reduce impacts on the ozone layer and climate.

Objectives & Benefits

In 2026, Asia Cement plans to collaborate again with ITRI to destroy approximately 3.5 tonnes of smuggled refrigerants seized by customs. Based on the refrigerant types and their respective global warming potentials (GWPs), the project is estimated to reduce emissions by approximately 4,350 tCO_2e. Going forward, Asia Cement will continue to support the treatment of such materials, deepen the practical application of this technology, and leverage cement kilns as a means of helping government address environmental challenges, thereby expanding the project's carbon-reduction benefits.

Key Metrics

Between 2022 and 2025, the project helped destroy 66.6 tonnes of smuggled refrigerants seized by customs, including R-12, R-22, R-141b, and R-408A. Based on their GWPs, this quantity is estimated to represent approximately 538,000 tCO_2e of avoided potential emissions. The results demonstrate the potential of cement kilns for treating special wastes and provide a new environmental management application for high-temperature destruction technology.

> “In 2026, Asia Cement plans to collaborate again with ITRI to destroy approximately 3.5 tonnes of smuggled refrigerants seized by customs."

Above: **Cement Kiln Refrigerant Destruction Technology**

Asia Cement Corporation

Continued

Utilize CarbonCure's carbon mineralization technology to enhance concrete strength, optimize cementitious material content, and continuously reduce the embodied carbon footprint of concrete products.

Yatung Ready Mixed Concrete, an important subsidiary of Asia Cement Corporation primarily responsible for the ready-mixed concrete business, has adopted carbon mineralization technology by implementing CarbonCure Technology from Canada in the ready-mixed concrete production process at its Taichung plant. Through a series of batch validation tests, CarbonCure's carbon mineralization technology has demonstrated that 4000 psi concrete can achieve the same 28-day compressive strength as the original mix design (without cement reduction) while reducing cement consumption by 5 kg/m³ and injecting 0.2 kg of CO_2 per cubic meter during production.

Objectives & Benefits

Between 2026 and 2027, Yatung Ready Mixed Concrete plans to expand the deployment of CarbonCure Technology to five additional production plants across Taiwan, enabling the production of a greater volume of carbon-mineralized concrete. In the next phase, the company also plans to collaborate with Taiwan's high-tech manufacturing sector to utilize captured CO_2 from industrial carbon capture systems, further promoting carbon utilization and circular carbon management.

In addition, Yatung Ready Mixed Concrete is working jointly with CarbonCure Technology to apply CO_2 injection technology to the recycled water system of ready-mixed concrete plants. This project represents the first pilot system of its kind in Asia. Based on Taiwan's typical recycled water solids content of approximately 20%, each metric ton of recycled water is estimated to have a carbon mineralization potential of 50–100 kg of CO_2. This innovative technology is expected to significantly enhance the contribution of ready-mixed concrete plants to Carbon Capture, Utilization, and Storage (CCUS) while further advancing the industry's low-carbon transformation.

Key Metrics

From January to April 2026, Yatung Ready Mixed Concrete produced 37,610 m³ of concrete incorporating CarbonCure's carbon mineralization technology. The process permanently mineralized 11,389 kg of captured CO_2 while delivering a total carbon reduction benefit exceeding 160 metric tons of CO_2e.





Above: **Implement CarbonCure Technology to Reduce Cementitious Material Content**

11,389 kg

11,839 kg of captured CO_2 permanently mineralised while delivering a total carbon reduction benefit exceeding 160 metric tons of CO_2e.

Yatung Ready Mixed Concrete has developed a dry processing technology that converts returned ready-mixed concrete into a calcium hydroxide-rich material. By injecting CO_2 captured from high-tech manufacturing facilities, the material undergoes carbon mineralization, permanently sequestering the CO_2. The resulting carbon-negative aggregates are then reused in the production of new ready-mixed concrete, establishing a closed-loop circular system for concrete materials and carbon.

The ready-mixed concrete industry in Taiwan generates approximately 3–5% returned concrete each year due to factors such as demand forecasting errors, extended transportation times, on-site quality issues, and concrete remaining in pumping pipelines. Traditionally, these returned materials are processed through recycling water and aggregate separation systems at ready-mixed concrete plants. While the recovered sand and coarse aggregates can be reused in concrete production, the fine cementitious sludge suspended in the recycling water must be dewatered and disposed of in landfills, resulting in environmental impacts and increased production costs.

To address this challenge, Yatung Ready Mixed Concrete has developed an innovative dry processing technology that directly converts fresh returned concrete into dry aggregate materials. The processed material is then treated in a planetary mixer, where CO_2 captured from other industries is injected to induce carbon mineralization. This process transforms the returned concrete into a composite material consisting of sand, coarse aggregate, and cementitious limestone powder. After screening, the coarse and fine fractions are recycled back into the production of new ready-mixed concrete.

Objectives & Benefits

The fine aggregate–cementitious limestone powder composite produced through this process has a CO_2 sequestration capacity of approximately 50–80 kg of CO_2 per metric ton. This technology not only eliminates the need for landfill disposal of cementitious sludge, thereby reducing environmental pollution, but also creates a new carbon sequestration pathway for ready-mixed concrete plants. Furthermore, it has enabled Yatung Ready Mixed Concrete to develop low-carbon concrete with up to a 70% reduction in embodied carbon emissions, supporting the transition toward a circular, carbon-negative concrete industry.

Key Metrics

Leveraging its patented dry processing technology for returned concrete, Yatung Ready Mixed Concrete transforms returned concrete into carbon-negative aggregates while permanently mineralizing 50–80 kg of CO_2 per metric ton of recycled fine material. This innovative technology not only eliminates returned concrete disposal challenges but also enables the production of concrete with up to a 70% reduction in embodied carbon emissions, achieving an embodied carbon footprint of less than 100 kg CO_2e/m³ for 4000 psi concrete.

Below: **Carbon Mineralization of Returned Concrete**





CCAA

CCAA has developed and released the CCAA Australian Adoption of the Global Cement and Concrete Association Global Ratings for Low Carbon and Near Zero Concrete

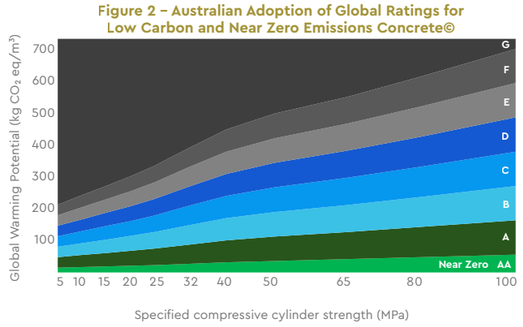
CCAA has localised the GCCA AA-G global concrete ratings for Australia, extending coverage to 5–100 MPa and launching the model through a national industry online seminar (December 2025) to support transparent, EPD-based lower-carbon procurement.

Case study

CCAA developed the Australian Adoption of the GCCA Global Ratings for Low Carbon and Near Zero Concrete to give Australia a clear, credible, and globally aligned framework for comparing the upfront embodied carbon of concrete. The model directly adopts the GCCA bands for 20–50 MPa concrete and extends them to locally relevant strength grades from 5 to 100 MPa, while retaining the eight AA-G performance bands. Ratings are determined using cradle-to-gate (A1-A3) Global Warming Potential data and are designed to be used with third-party verified Environmental Product Declarations.

The framework is intended to improve transparency, simplify product comparison and strengthen demand for lower-carbon concrete through design, specification, and procurement. Key metrics include 11 strength grades, eight carbon bands and a 5–100 MPa application range. The intended outcome is measurable market uptake and progressive movement of concrete mixes into lower-carbon bands. CCAA launched the adoption through an online seminar featuring representatives from CCAA, GCCA, and CCAA member representatives supported by a public guide, presentation, and recording.

Figure 2 – Australian Adoption of Global Ratings for Low Carbon and Near Zero Emissions Concrete©



Above: **The AA-G ratings across the extended 5–100 MPa strength range. Cement Concrete & Aggregates Australia (2025).**

5–100 MPa

5–100 MPa coverage extending the GCCA core range of 20–50 MPa.

8

Performance bands
AA (near zero) through G.

11

Strength grades
5, 10, 15, 20, 25, 32, 40, 50, 65, 80 and 100 MPa.

CEMENT CONCRETE & AGGREGATES AUSTRALIA

CCAA has developed practical guidance and worked examples to help project teams consistently apply the Australian AA-G concrete carbon ratings using verified EPD data, performance requirements and local supply conditions.

Case study

Following the December 2025 release of the Australian adoption of the GCCA Global Ratings for Low Carbon and Near Zero Concrete, CCAA developed an Interpretation and Application Guide to support appropriate & consistent use of the ratings in Australian projects. The Guide moves the initiative from establishing a national classification framework to practical implementation in planning, design, specification and procurement. It sets out five key principles covering early supplier engagement, performance requirements, geographic variability, proportionate procurement integration and verified EPD data. The rating system is a core enabler for delivery of the Australian Industry Decarbonisation Facilitation Plan.

The Guide provides a six-step process from defining requirements and indicative targets through to supplier engagement, AA-G banding, option comparison and documentation. An addendum includes three worked examples – a Sydney CBD multi-storey building, a regional Victorian homebuilder and a major bridge project – showing how appropriate targets vary by application and local conditions. The intended outcome is greater confidence and consistency in applying the CCAA Australian Adoption and enabling progressively lower-carbon concrete solutions.

6 steps

A 6-step practical process with requirements and targets through to documentation.

5

Key application principles
Engagement, performance, geography, procurement and EPD verification.

3

Worked case studies
Multi-storey, regional residential and major infrastructure.



Case Study 1 — Sydney CBD multi-storey building

Low-rise metro build - 32 MPa, 40 MPa and 50 MPa concrete across different elements.

Scenario:

The builder of a multi-storey project in Sydney is getting ready to tender the concrete supply and wants to utilise the CCAA Low Carbon Ratings in the project specification. The build consists of 4 main concrete element types:

32MPa – Footings, Slab on Grade

40MPa – Columns and Walls

50MPa – Columns, Core Walls

40MPa – Post tensioned suspended slabs

From recently completed similar projects the builder and consultant have some embodied carbon data for similar mixes. They plot these EPD values for each concrete type against the CCAA Low Carbon Concrete Ratings graph (figure 2) and table (table 2) to determine the CCAA Rating Band that applies for each concrete element.

Determining Rating Bands and Setting Targets

Element	Strength Grade (MPa)	GWP A1-A3 (kg CO_2e/m^3)	CCAA Rating Band	Review	Specified Maximum CCAA Rating Band
32MPa Footings, Slab on Grade	32	Not Available	-	As no previous data was available the consultant reviews the Low Carbon Materials Hub and notes the median value for 32MPa NSW EPDs is 250kg CO_2e/m^3 which is band D in the CCAA ratings. As these elements are basic N-Class concrete and comprise a significant volume of the project the builder decides to specify band D as maximum.	D
40MPa Columns, Walls	40	320	E	LCMH 40MPa for NSW EPDs shows median value of 297kg CO_2e/m^3 which is band D in the CCAA ratings. These elements have no special performance requirements and last project the concrete was only just into band E, so the builder decides to specify band D as maximum.	D
50MPa Columns, Cor Walls	50	370	E	LCMH 50MPa for NSW EPDs shows median value of 337kg CO_2e/m^3 which is band D in the CCAA ratings. While a key component of the build these elements have no special performance requirements, so the builder decides to specify band D as maximum.	D
40MPa PT Slab (22MPa@3days)	40	350	E	LCMH 40MPa for NSW EPDs shows median value of 297kg CO_2e/m^3 which is band D in the CCAA ratings. These elements require high early strength which is critical to the project schedule. The builder decides to specify band E as the maximum for these elements as they know the suppliers generally use higher cement contents to achieve early strengths compared to regular 40MPa concrete.	E

Above: **The AA-G ratings across the extended 5–100 MPa strength range. Cement Concrete & Aggregates Australia (2025).**

Cementos Argos

Advancing Construction Through Concrete Innovation

Cementos Argos is transforming construction in Colombia through industrialized systems and lower-carbon concrete solutions that enhance productivity, optimize resource use, and accelerate decarbonisation.

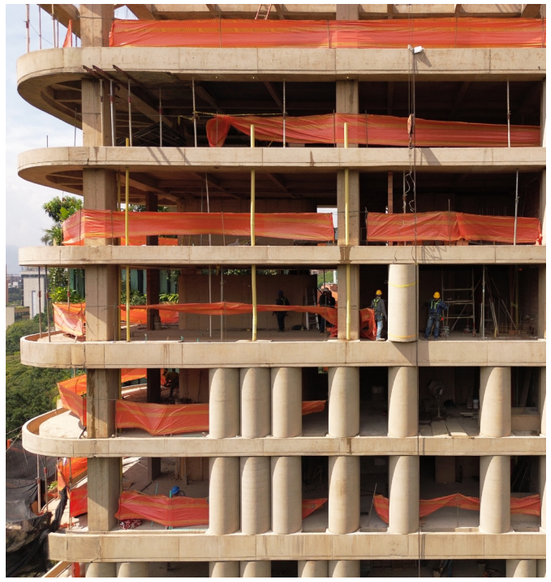
Case study

Cementos Argos Modular Solutions is helping transform construction practices in Colombia through industrialized concrete systems that improve productivity, construction quality, safety, and resource efficiency. The portfolio includes adaptable modular solutions, high-performance structural connections validated for Colombia's seismic conditions, and high-quality finishes that simplify on-site activities, optimize resource use, and support more efficient construction processes.

Despite a challenging construction market, the business continued expanding in 2025, achieving sales of more than 11,000m² of modular concrete elements and construction services, with 10 specialized products commercially active and 29 projects executed nationwide.

The initiative is complemented by Argos' development of lower-carbon concrete solutions. During 2025, the company commercialized 333 new concrete product references, representing 23.3% of all references sold. Lower-carbon concrete mixtures were used in projects covering 112,840m², contributing to an estimated 23,200 tonnes of CO_2 emissions avoided during the year.

By combining industrialized construction systems with lower-carbon concrete technologies, Argos is demonstrating how innovation can simultaneously improve productivity, optimize resource use, and support the cement and concrete industry's net-zero roadmap.





Top: **Modular Solutions Living23 Project**
Bottom: **Modular Solutions Andarrios Project**





Above: **Cartagena Plant Coprocessing**

From waste to energy: scaling co-processing at Cartagena plant

Despite the challenges of Colombia's developing waste recovery ecosystem, Cementos Argos increased thermal substitution at its Cartagena plant by 43% year-on-year in the first half of 2026, demonstrating the potential to scale co-processing in emerging markets.

Case study

At its Cartagena plant in Colombia, Cementos Argos is demonstrating how co-processing can accelerate alternative fuel adoption while supporting circular waste management in a market where waste recovery ecosystems are still developing.

While alternative fuel substitution rates achieved in more mature waste recovery markets are significantly higher, progress in Colombia takes place under different regulatory, infrastructure, and economic conditions. Limited incentives for waste recovery make growth dependent on sustained investment, strong partnerships, and reliable waste supply chains.

Against this backdrop, Cartagena's experience demonstrates the potential for co-processing to advance even in emerging waste recovery markets. During the first half of 2026, the plant recovered energy from more than 18,300 tonnes of waste. This achievement enabled the plant to reach an accumulated thermal substitution rate of 11.3%, representing a 43% increase compared with the same first semester in 2025. In March, the plant recorded its strongest performance, processing approximately 4,400 tonnes of waste and achieving a 15% substitution rate.

Beyond reducing fossil fuel use, co-processing addresses a broader challenge shared across many regions where we operate: responsible waste management. Building on these results, Argos aims to expand partnerships and sourcing networks to increase residual material recovery, strengthen circularity, create shared value, and accelerate climate ambitions.

ARGOS

Cemex

Scaling Renewable Electricity Across Cemex Poland's Operations

Through partnerships with Statkraft and EDP Energia Polska, Cemex Poland is increasing the use of renewable electricity across its operations, from off-site supply to on-site solar generation.

Cemex Poland is expanding its use of renewable electricity through long-term partnerships with Statkraft and EDP Energia Polska. Since January 2025, Statkraft has been providing renewable electricity to Cemex Poland's cement and ready-mix plants under an eight-year agreement, expected to cover around 30% of annual energy needs through electricity generated by Polish wind and photovoltaic farms.

Alongside this, Cemex is expanding on-site solar generation with EDP Energia Polska under a 15-year agreement, building solar installations with a total capacity of more than 14 MWp. These will be implemented at Cemex's cement plants in Chełm, Rudniki and Gdynia, as well as its concrete plants in Mysłowice, Warsaw Annopol, Lublin, Szczecin and Gdańsk, adding to an existing solar farm at its Pruszków ready-mix plant.

Together, these initiatives help diversify Cemex's energy sources across its operations in Poland, while supporting its long-term strategy to decarbonise its operations and achieve carbon neutrality by 2050.

Cemex Mexico: Profitable Decarbonisation Through Clinker Factor Optimization

Through systematic clinker-factor optimization, admixture deployment, and process governance, Cemex Mexico has achieved one of the company's strongest clinker-factor reductions, reaching levels below our 2030 target of 65%, positioning the operation as a company benchmark. The initiative combines laboratory testing, industrial trials, economic validation, and digital monitoring tools to maximize clinker substitution while maintaining cement quality and performance. The approach reduces both CO_2 emissions and production costs, demonstrating that decarbonisation at scale is both sustainable and profitable.

Cemex Mexico deployed a structured clinker-factor optimization program built on three complementary fronts. First, admixture optimization: quality enhancers enabled higher clinker substitution with SCMs and fillers such as pozzolans, slags, and limestone, delivering a major boost in bagged cements, with work ongoing in structural cements. Second, process optimization: fine-tuning cement fineness and clinker chemistry maximized reactivity while maintaining optimal clinker and cement production. Third, standards advocacy, Mexico is actively promoting a shift in national cement standards from composition-based to performance-based approaches, adapting regulations to align with these standards while optimizing the clinker factor.

The initiative combines laboratory testing, industrial trials, economic validation, and digital monitoring tools to maximize clinker substitution while maintaining quality and performance. Throughout every change, cement performance is consistently guaranteed, ensuring full compliance with customer requirements, all supported by aligned efforts across operations, ready-mix, admixtures, and commercial teams, the latter playing a key role in driving greater market adoption and consumption of blended cements.

The results are tangible. Mexico closed 2025 already below our 2030 target of 65% clinker factor and has kept it on a downward path throughout 2026, delivering increasingly better results. The payoff: less clinker per ton, lower CO_2 intensity, and reduced production costs, proving that decarbonisation is both smart and profitable.



Distributed Solar Projects for CEDIs

A portfolio of distributed solar projects across 10 distribution centers (CEDIs) is being deployed under a 10-year PPA, providing over 2.0 MWp of installed capacity with no upfront CAPEX while delivering long-term energy cost savings and supporting Cemex's decarbonisation strategy.

Objectives & Benefits

This portfolio of distributed solar projects was developed to provide clean, reliable, and cost-competitive electricity to multiple distribution centers through a 10-year Power Purchase Agreement (PPA). Under the agreement, the developer finances, owns, operates, and maintains the solar systems, allowing Cemex to benefit from renewable energy with no upfront CAPEX. Electricity tariffs are fixed throughout the contract (subject only to annual inflation adjustments) and guaranteed to remain at least 5% below the applicable utility tariff, providing long-term cost certainty.

Key Metrics

The portfolio comprises 11 CEDIs with approximately 3,362 solar panels and a combined installed capacity of about 2.0 MWp. At the time of reporting, seven sites had completed installation while the remaining projects were progressing through construction and grid interconnection. The initiative is expected to deliver long-term electricity cost savings while increasing the share of renewable electricity, strengthening energy resilience, and supporting the company's decarbonisation goals.



Above: **Cemex Tejeria, Mexico**

> The initiative is expected to deliver long-term electricity cost savings while increasing the share of renewable electricity."

Çimsa



Çimsa is scaling alternative fuels and low-carbon energy solutions to reduce fossil fuel use in cement production, strengthening co-processing infrastructure and advancing hydrogen technologies.

Knowledge and experience are shared across operations in Türkiye, Spain, Ireland and US, supporting solutions tailored to different production conditions. In 2025, Çimsa achieved an average thermal substitution rate of 28%, progressing towards its 2030 target of 40%.

At the Buñol Plant in Spain, the thermal substitution rate reached 30% despite the demanding conditions of white clinker production. Planned green hydrogen use is expected to increase alternative fuel use to approximately 48% and reduce annual CO_2 emissions by around 30,000 tonnes.

At Mannok in Ireland, the annual thermal substitution rate increased from 55% in 2024 to 68% in 2025, reaching up to 75% daily and performing above EU average levels. FUELFLEX® Pyrolyzer technology and JETFLEX® burner systems enable refuse-derived fuels to replace fossil fuels during precalcination and inside the kiln. As a result, annual coal consumption decreased by approximately 104,000 tonnes, avoiding around 98,000 tonnes of CO_2 emissions.



Top: **Preheater From Ground Level Çimsa-Mannok Plant**
Bottom: **Control Room Çimsa-Mannok Plant**

98 $ktCO_2$

Around 98,000 tonnes of CO_2 emissions avoided after annual coal consumption decreased by approximately 104,000 tonnes.



Pictured: **The Çimsa Mannok Cement Factory**

CNBM – Sinoma Int'l

Digital and Intelligent Solutions for Zero Carbon Emissions in the Cement Industry.

In the cement industry's journey towards zero carbon emissions, the core challenge lies in how to apply alternative fuels and raw materials on a large scale while ensuring the stability, efficiency of the production process and high quality of products. The 10,000 t/d intelligent production line of Jidong Cement in Tongchuan, constructed under the EPC contract by Sinoma International , has established five major intelligent systems covering full-process material management, quality control, production execution, operation and maintenance support, and production decision-making. Leveraging remarkable technological innovation achievements and practical effects, the production line has increased production stability by 20%, reduced energy consumption by 2%, and cut annual carbon emissions by 11,000 tons.





Top: **Jidong Cement in Tongchuan**
Bottom: **Central control room photo**

11,000t

fewer carbon emissions annually

CNBM | sinoma



Currently, the long-term operation indicators of this plant are outstanding: the comprehensive coal consumption per unit of clinker is less than 91 kgce/t, the comprehensive electricity consumption per unit of clinker is less than 45 kW·h/t, and the carbon emission intensity of clinker is less than 0.8 tCO_2/t clinker. Relying on its outstanding capabilities in the fields of intelligent manufacturing and green production, the plant has successively won honorary titles such as "National Demonstration Plant for Intelligent Manufacturing", "National Excellent-level Intelligent Plant" and "National Green Plant".



Top: **Jidong Cement factory area**
Bottom: **Smart Operations Center**

20%

increase in production stability

Net zero in cement production

Alternative fuels and raw materials

Technical pathways for zero carbon emissions

Alternative fuels


Waste tyres


Waste textiles


Biomass fuel

Alternative raw materials


Calcium carbide slag

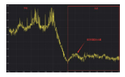

Gangue

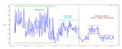

Desulfurized gypsum

Sixty percent of carbon emissions in the cement production process come from process emissions, and 30% from energy-related emissions. Energy substitution and raw material substitution are the core of achieving zero carbon emissions in cement plants.

Challenges of Zero Carbon Emissions

01 High volatility leads to poor control stability





02 A high content of harmful components leads to a decline in product quality





Alternative fuels have complex sources, with significant fluctuations in their calorific value, moisture content, and chemical composition (especially chlorine and sulfur content). This poses great difficulties for the stable combustion of kilns and the control of clinker quality.

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Continued



Challenges and Solutions in Zero-Carbon Plant Construction

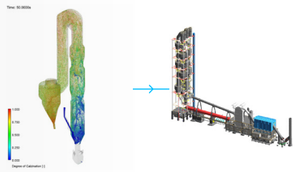
Sixty percent of carbon emissions in the cement production process come from process emissions, and 30% from energy-related emissions. Therefore, energy substitution and raw material substitution are the core approaches to achieving zero carbon emissions in cement plants.

Alternative fuels have complex sources, and their calorific value, moisture content, and chemical composition (especially chlorine and sulfur content) fluctuate significantly. This poses great difficulties for the stable combustion of kilns and the control of clinker quality. The traditional regulation method relying on manual experience will be unsustainable, as it is highly prone to triggering chain fluctuations in process, equipment operation, and product quality.

This is precisely where the core value of digital intelligence lies. The full-lifecycle intelligent equipment operation and maintenance system, full-process quality closed-loop control system, and intelligent decision-making system based on mechanism simulation and big data analysis built by the Tongchuan plant point out the way forward for us.

> Sixty percent of carbon emissions in the cement production process come from process emissions, and 30% from energy-related emissions. Therefore, energy substitution and raw material substitution are the core approaches to achieving zero carbon emissions in cement plants.

Digital design and mechanism simulation



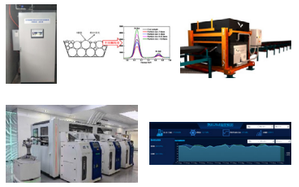
Intelligent optimization and decision analysis



Online monitoring of equipment status



Online quality inspection and closed-loop control



Through mechanism simulation and digital twin technology, and with the help of big data and AI expert systems, historical production line data, simulation data, and real-time production data are integrated to train an AI-optimized control model capable of handling high-dimensional and nonlinear problems. Under complex disturbances, it can automatically find the optimal balance among factory output, quality, energy consumption, and emissions, facilitating the construction of zero-carbon factories.

Built on **an intelligent operation and maintenance system** and a **full-process quality closed loop,** it minimizes unplanned equipment shutdowns and abnormal fluctuations caused by alternative fuels/raw materials through online equipment monitoring, fault diagnosis, and predictive maintenance. Meanwhile, it leverages online analyzers, intelligent laboratories, and quality prediction models to monitor in real time the full-process quality changes from mines to cement.

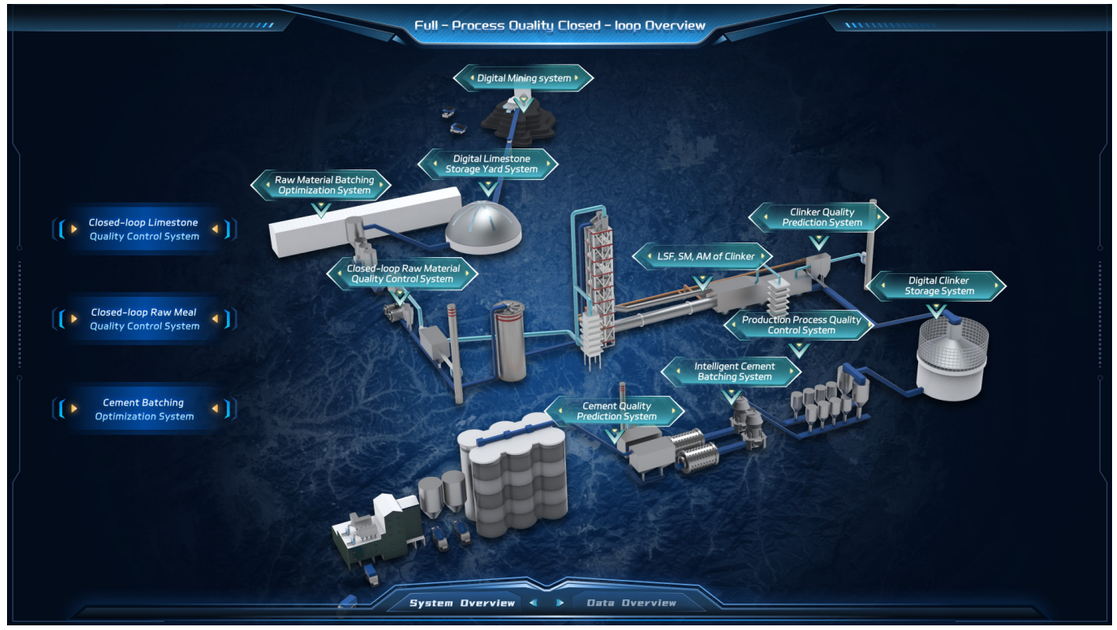
Intelligent equipment operation and maintenance, along with quality closed-loop control, form the cornerstone for the large-scale application of alternative fuels and raw materials. Through online equipment monitoring, fault diagnosis, and predictive maintenance, unplanned equipment shutdowns and abnormal fluctuations caused by alternative fuels/ raw materials are minimized. This ensures that the physical foundation (equipment) remains in a reliable state even under complex operating conditions. Utilizing online analyzers, intelligent laboratories, and quality prediction models, a full-process quality closed-loop control system is established to monitor real-time quality changes across the entire process from mining to cement production.

With the guarantee of this cornerstone, mechanism simulation and digital twin technologies are employed, along with big data and AI expert systems, to integrate historical production line data, simulation data, and real-time production data. This integration is used to train AI-optimized control models capable of handling high-dimensional and non-linear scenarios. Under complex disturbances, these models can automatically find the optimal balance among plant output, quality, energy consumption, and emissions, facilitating the construction of zero-carbon plants.

> Utilizing online analyzers, intelligent laboratories, and quality prediction models, a full-process quality closed-loop control system is established to monitor real-time quality changes across the entire process from mining to cement production."

CNBM – Sinoma Int'l

Continued



Multi-model Collaborative Intelligent Quality Closed-loop Control System for Cement Plants.

To address persistent challenges in cement production, such as difficulties in raw material quality control, inefficient mine-plant coordination, and ineffective dynamic process adjustment, an intelligent closed-loop quality control system covering the "mine–raw meal–clinker" process has been developed by SINOMA INTERNATIONAL. Moving beyond the traditional "grid drilling and manual sampling" approach, the system innovatively integrates IoT (Internet of Things) and UAV (Unmanned Aerial Vehicle) into an automatic drilling-sampling-analysis system for mining operations. It enables simultaneous sampling during drilling, rapid sample transfer and automated analysis, supporting dynamic updates of the mine's three-dimensional grade model.

A multi-model intelligent collaborative closed-loop control system has been developed, which implements an intelligent blending strategy featuring "instant deviation correction + cumulative compensation". This shifts raw meal batching from an "experience-driven" to a "data-driven" approach. By deeply integrating real-time mine quality data with the plant's raw meal batching system, cross-process collaborative optimization-from mining planning and ore blending schemes to raw meal proportioning-has been achieved.

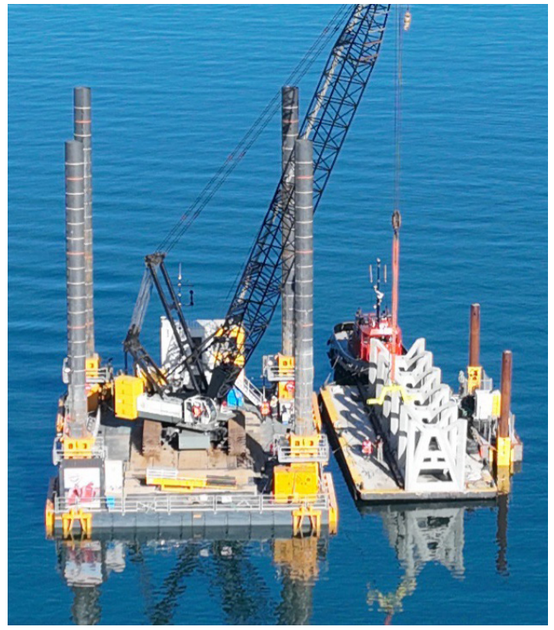
The AI-based intelligent quality control system for the full cement clinker production process have been applied in multiple cement production lines, including those at Luoyang Huanghe Tongli, Hunan Shaofeng Southern Cement, and Jidong Cement Tongchuan. As a result, the mine quality data feedback cycle has been shortened from several days to within two hours. In particular, at Luoyang Huanghe Tongli, the fluctuation of CaO content in incoming limestone has been reduced from ±2% to within ±0.5%, and the stability of raw meal out of the mill has improved by 20–30% compared to conventional technologies. Benefiting from the stabilized raw meal achieved by the intelligent closed-loop quality control system, the stability of clinker kiln operation conditions and clinker strength has been enhanced. Consequently, the standard coal consumption per ton of clinker has decreased by approximately 1 kg, and the overall clinker mix proportion in the final cement product has been reduced by 1%. Taking a cement clinker production line with an annual capacity of 1.5 million tons as an example, these improvements translate to an annual reduction of approximately 1,750 tons in raw coal consumption, a decrease of 15,000 tons in clinker consumption, a reduction in carbon emissions of 15,700 tons, and an increase in carbon trading revenue of €1.256 million.

Concrete NZ

Te Ara Tupua: Building Climate-Resilient Coastal Infrastructure with Low-Carbon Concrete

The Ngauranga to Petone (Ngā Ūranga ki Pito-One) section of Te Ara Tupua in Wellington (Te Whanganui-a-Tara), New Zealand, demonstrates how innovative concrete solutions can simultaneously reduce embodied carbon, enhance biodiversity and deliver resilient infrastructure critical to the regional transport network.

The Ngauranga to Petone (Ngā Ūranga ki Pito-One) section of Te Ara Tupua in Wellington (Te Whanganui-a-Tara), New Zealand, demonstrates how the cement and concrete industry can advance decarbonisation while delivering resilient infrastructure that supports long-term economic growth. Constructed along one of the region's most strategically important transport corridors, the project protects State Highway 2 and the Hutt Valley rail line, while creating a 4.5 km shared walking and cycling pathway expected to carry more than 2,100 active transport trips each weekday by 2030.



Above: **Concrete reef units, also referred to as 'Pyramids', were designed and positioned to mitigate the loss of rocky reef habitat from building the pathway.**

"Concrete tide pools and the engineered reef units also create new marine habitats, demonstrating that resilient infrastructure can actively enhance biodiversity rather than simply minimise environmental impact. "

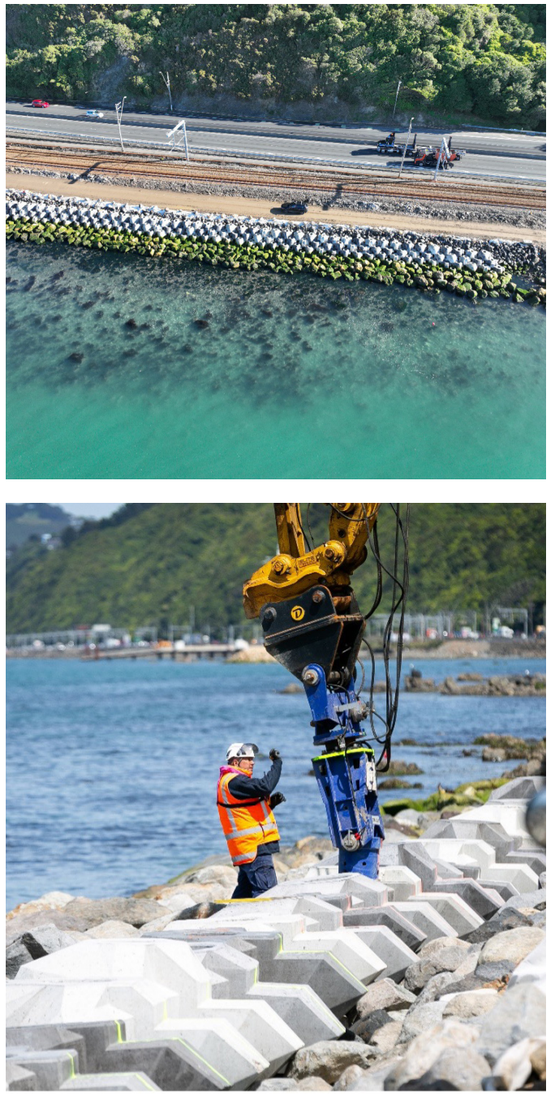
concretenz BUILDING RESILIENCE

Concrete NZ

Continued

The project showcases multiple pathways to lower-carbon construction. Concrete producers developed bespoke high-performance mixes for challenging marine conditions, while locally manufactured XBlocPlus® coastal protection units optimised material use and installation efficiency. Reef enhancement structures incorporated 560 m^3 of low-carbon concrete containing 30% fly ash as a cement replacement, reducing clinker demand while delivering the durability required for an aggressive coastal environment. Concrete tide pools and the engineered reef units also create new marine habitats, demonstrating that resilient infrastructure can actively enhance biodiversity rather than simply minimise environmental impact.

Concrete NZ member companies Higgins Concrete, Firth Industries and Preco Precast Concrete supplied and manufactured key project elements using New Zealand expertise and production capability. By combining efficient design, lower-carbon concrete, local manufacturing and infrastructure built for a long service life, Te Ara Tupua demonstrates how all stages of the concrete value chain can contribute to net zero while strengthening economic resilience and providing a model for sustainable coastal infrastructure worldwide.



Top: **Ngauranga to Petone (Ngā Ūranga Ki Pito-One) also includes concrete tide pools along the pathway and on the two small offshore habitats.**

Bottom: **XBlocPlus® units are positioned along the Ngauranga to Petone (Ngā Ūranga ki Pito-One) section of Te Ara Tupua.**

Pictured: **Ngauranga to Petone (Ngā Ūranga to Pito-One) section used XBlocPlus® units. Iwi cultural design lead Len Hetet created the bespoke ecological pattern, named Te Ripowai, which is grounded in the cultural narrative of Te Ara Tupua.**

CRH





Turning industrial by-products into lower-carbon construction materials

CRH is accelerating the transition to next-generation cement and concrete through increased use of supplementary cementitious materials (SCMs). One of the seven levers in the GCCA's Net Zero Roadmap, "Savings in Cement and Binders" involves the use of materials with cementitious properties including fly ash and Ground Granulated Blast-furnace Slag (GGBS) to reduce the proportion of clinker-based material in cements and concretes. This can significantly lower the carbon intensity of concrete while maintaining the performance and durability required for modern construction.

In 2025, CRH strengthened its leadership in this area when it acquired Eco Material Technologies (Eco Material), the leading supplier of SCMs in North America. Eco Material partners with leading electric utilities to process and recycle approximately 10 million tonnes of fly ash, synthetic gypsum and other materials from the power generation industry annually. Together with Ash Grove, CRH's existing cementitious business in North America, the addition of Eco Material significantly enhances the company's ability to develop and supply lower-carbon cement and concrete solutions at scale in the North American market.

By combining SCMs such as fly ash, slag, calcined clay and pozzolans with traditional clinker-based cements, CRH is reducing its clinker-to-binder ratio while providing enhanced cementitious products that support the development of resilient concrete used in a wide range of construction projects, from major infrastructure projects to complex industrial buildings.

Because SCMs can help maintain and – in some cases, enhance – the strength and durability required for modern construction, they provide a practical and economical pathway to producing lower-carbon cement and concrete with strong performance and resistance to chemical and water ingress.

By turning industrial by-products into high-value construction materials, CRH is also supporting greater circularity and increasing the supply of lower-carbon solutions for projects across North America.

As demand for the materials needed to build and modernize essential infrastructure in North America grows, SCMs will play an important role in reducing emissions from cement and concrete at scale.

Dangote



Dangote Cement Plc plans to decarbonise its cement production process by generating low-carbon electricity through the installation of waste heat recovery systems.

Following the launch of the Dangote Cement Plc (DCP) decarbonisation roadmap, alternative fuels utilisation, improvements in energy efficiency processes and technology, installation of kiln and cement mill optimisers and use of supplementary cementitious materials, have largely driven the 6.5% reduction in carbon intensity recorded in 2025, from a 2021 base year.

One of the plans to attain the DCP projected 20% reduction in Scope 1 and 2 CO_2 emissions by 2030, include savings in clinker production through the installation of waste heat recovery systems (WHRS) in its integrated plants. This involves recovering hot exhaust gases from the preheater and clinker cooler, during clinker production, to generate low carbon electricity for use. The project will be piloted in two of DCP's integrated plants which is expected to generate over 125,000 MWh of low-carbon electricity annually, with carbon savings of over 87,000 tCO_2 per year.

The roll out of this technology will significantly contribute to DCP's decarbonistion ambition. It will reduce CO_2 emissions associated with power generation and consumption and improve overall plant energy efficiency and stability. Beyond emissions reduction, WHRS will enhance DCP's operational resilience by reducing energy costs and ensure energy security by reducing dependence on fossil-fuel-based captive power generation and grid electricity.

87 $ktCO_2$

in carbon savings expected each year from the project's pilot across two DCP integrated plants.

Above: **DCP Cement plant**

GCC

Advancing calcined clay as an SCM to reduce clinker content and carbon emissions while maintaining cement performance.

Reducing clinker content is a key strategy for lowering the carbon footprint of cement. As part of our efforts to advance the GCCA Net Zero Roadmap, GCC is evaluating the use of calcined clay as a supplementary cementitious material (SCM) to formulate a lower-carbon cement solution.

We have developed new cement formulations incorporating calcined clay and validated performance through laboratory and semi-industrial scale trials.

Testing has focused on mortar and concrete performance, including strength and workability, to validate that this new cement formulation meets quality and performance requirements.

Semi-industrial scale production trials have delivered positive results, maintaining good workability during concrete placement and demonstrating strong early-age performance, with no visible cracking observed during initial testing. Ongoing work is focused on confirming long-term strength and durability while supporting future commercial-scale implementation. GCC continues to optimize these formulations to achieve the best balance between clinker reduction, product performance, and scalability, advancing calcined clay as a practical solution to reduce the carbon footprint while meeting customer and market expectations.



> Reducing clinker content is a key strategy for lowering the carbon footprint of cement."



AI-powered concrete mix optimization to reduce cement consumption and lower the carbon footprint of ready-mix concrete.

Process variability can lead to conservative mix designs and higher cement consumption than necessary. As part of our innovation and decarbonisation strategy, we are piloting an AI-based solution that uses real-time data from sensors installed on mixer trucks to predict concrete slump during transportation and delivery. By providing continuous visibility into concrete behaviour, the technology enables optimized water adjustments, reduces process variability, and improves quality control, supporting more efficient concrete production.

By leveraging improved process visibility and control provided by the technology, the pilot aims to reduce process uncertainty and minimize the cement overdesign often used to compensate for operational variability. Through improved control of the water-to-cement ratio and more consistent concrete properties, we aim to reduce cement content by 1–2% without compromising quality, performance, or compliance with specifications. Because cement production is a large contributor to embodied CO_2 emissions in concrete, enabling a more efficient use of cement offers a practical pathway to reducing the carbon footprint of our products. The pilot will evaluate the scalability of advanced digital technologies in our dry batch operations and identify opportunities to expand data-driven solutions across GCC's concrete network in support of the GCCA Net Zero Roadmap.

> By leveraging improved process visibility and control provided by the technology, the pilot aims to reduce process uncertainty and minimize the cement overdesign often used to compensate for operational variability."



Image: **Heidelberg Materials' Padeswood cement plant, UK**

Heidelberg Materials

Padeswood CCS: Scaling carbon capture with evoZero

Heidelberg Materials is advancing construction of its Padeswood CCS project in north Wales. Following the company's pioneering Brevik CCS project, Padeswood is designed to capture around 95% of CO_2 emissions from the existing cement works – approximately 800,000 tonnes annually. By addressing process emissions that are difficult to eliminate through efficiency measures or fuel switching, Padeswood will be a meaningful step for the UK cement sector's transition to Net Zero.

During the groundwork phase in Summer 2026, more than 60,000 tonnes of aggregate were placed to establish working areas, with more than 600 concrete piles installed for a retaining wall. The construction workforce of around 80 people per day is expected to double until the end of 2026. The project is also applying evoZero carbon captured near-zero cement, produced using CCS at Heidelberg Materials' Brevik plant in Norway, wherever possible in the facility's construction. This links deployed CCS technology with the infrastructure needed to scale it.

800 $ktCO_2$

800,000 tonnes of CO_2 to be captured annually with more than 600 concrete piles installed as part of a retaining wall. The project is also using evoZero.

> By addressing process emissions that are difficult to eliminate through efficiency measures or fuel switching, Padeswood will be a meaningful step for the UK cement sector's transition to Net Zero.

Heidelberg Materials
Continued



Airvault: A step change in efficiency and decarbonisation

In spring 2026, Heidelberg Materials commissioned a new dry-process kiln line at its Airvault cement plant in France, replacing two semi-dry clinker lines with a modern pre-calciner system. With an annual clinker capacity of 1.25 million tonnes, the modernisation is backed by an investment of more than €350 million and is designed to improve energy and production efficiency while reducing emissions.

Once fully implemented, almost 90% of the plant's energy demand is expected to be met with alternative fuels. Electricity consumption per tonne of cement is expected to fall by around 10%, while lower clinker content is expected to contribute to an almost 30% reduction in the carbon footprint of cement produced at the site compared with previous production. The project also creates a platform for the future use of calcined clay, enabling further clinker substitution, and has secured EU Innovation Fund support for the planned Airvault$GOCO_2$ CCUS project. Together, these measures combine energy efficiency, alternative fuels, clinker substitution and CCUS to advance Airvault's decarbonisation roadmap.



Above: **Airvault cement plant, France**

~90%

almost 90% of the Airvault plant's energy demand is expected to be met with alternative fuels.

Closing the loop with ReConcrete and CEMLOOP XL

ReConcrete is a Heidelberg Materials technology designed to address two challenges at once: CO_2 emissions from clinker calcination and the consumption of natural aggregates in concrete production. It combines selective mechanical separation of waste concrete with enforced CO_2 mineralisation of the recovered cement fraction. The process enables closed-loop concrete recycling, permanently mineralises CO_2, and produces a reactive supplementary cementitious material (SCM) that can partially replace clinker. First-of-their-kind industrial-scale plants for selective separation and enforced carbonation were commissioned in Poland in 2024–2025, completing the core technology development phase.

Heidelberg Materials is now moving towards commercial scale through CEMLOOP XL, a joint project with Etex, co-funded by the EU LIFE Programme. As part of the project, fibre-cement waste will be converted into a secondary raw material for use in cement production. The recycled fibre-cement powder will then be carbonated using CO_2 generated by cement production. The resulting material has cement-like properties and can partially replace clinker in the production of low-carbon cement.





Above: **Heidelberg Materials' cement plant, Górażdże, Poland**

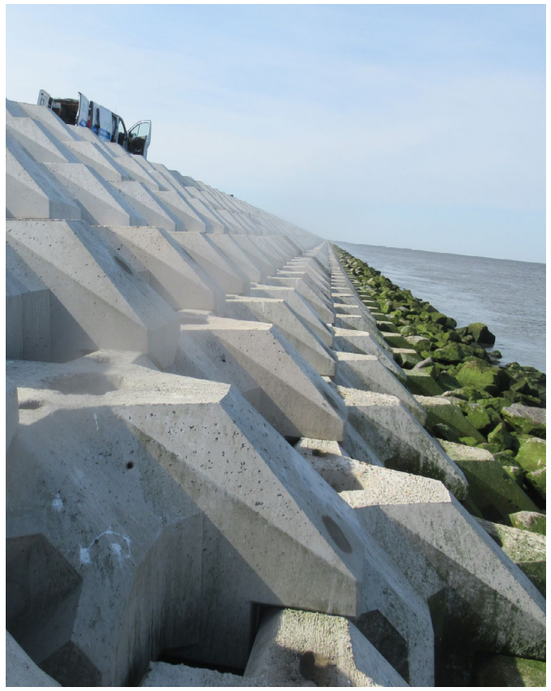
> The process enables closed-loop concrete recycling, permanently mineralises CO_2, and produces a reactive supplementary cementitious material (SCM) that can partially replace clinker.

Heidelberg Materials
Continued

Levvel-blocs: Testing lower-carbon coastal protection

As part of a pilot project, Heidelberg Materials Benelux is testing specially designed concrete blocks for breakwaters and coastal protection. The blocks are produced with a lower-carbon binder based on carbonated recycled concrete paste (cRCP) and calcined clay. By combining recycled concrete-derived material with calcined clay, the pilot explores clinker substitution and the circular use of construction materials while supporting climate adaptation.

The first blocks were placed in a marine test field near Amsterdam a few months ago, initiating a long-term exposure trial in a demanding coastal environment. Their resilience and durability will be monitored over time to assess performance under wave action and marine exposure. The results will help determine the suitability of this lower-carbon concrete solution for future coastal protection applications. The pilot therefore connects industrial decarbonisation with climate adaptation: it aims to reduce the carbon intensity of concrete while developing durable infrastructure to protect coastal areas from wave impacts.



Above: **Coastal protection blocks**

> By combining recycled concrete-derived material with calcined clay, the pilot explores clinker substitution and the circular use of construction materials while supporting climate adaptation."

From waste to resource: Heidelberg Materials strengthens alternative fuels supply in Egypt

In October 2026, Heidelberg Materials Egypt secured a strategic stake in ZeroCarbon, an Egyptian waste-management and alternative-fuels company, to expand local supplies of refuse-derived fuel (RDF) and biomass. The partnership builds on ZeroCarbon's planned new RDF facility and upgrades to existing sites across Egypt, increasing the production and availability of quality-controlled waste-derived fuels for cement manufacturing. This will help replace conventional fossil fuels, strengthen the resilience of Heidelberg Materials' North African operations and contribute to reducing local carbon emissions.
The partnership will also support the development of supplementary cementitious materials (SCMs) and alternative raw materials, enabling lower clinker use and further CO_2 reductions. By diverting suitable waste fractions from landfill and using biogenic materials where available, the initiative combines decarbonisation with circular resource management. It demonstrates how Heidelberg Materials' Strategy 2030 can be implemented through locally tailored partnerships that bring together international cement expertise and Egyptian waste-management capabilities. The investment builds on existing activities in Egypt, including alternative fuels, waste heat recovery and lower-carbon building solutions.



Above: **Partnering on waste-derived fuels in Egypt**

> By diverting suitable waste fractions from landfill and using biogenic materials where available, the initiative combines decarbonisation with circular resource management."

Holcim

Climate Resilience and Adaptation in Morocco with Holcim's permeable concrete

The renovation of Morocco's busiest highway rest station using Holcim's Hydromedia permeable concrete demonstrates exceptional climate adaptation and sustainable construction practices by simultaneously managing stormwater, reducing local air pollution, and recycling demolition materials.

To meet ambitious sustainability objectives and build climate resilience, Vivo Energy partnered with Holcim to renovate Morocco's busiest highway rest station using Hydromedia concrete. This permeable material delivers dual environmental benefits. First, it prevents surface flooding by rapidly absorbing an average of 500 to 600 liters of water per square meter every minute. This technology efficiently manages stormwater and can facilitate urban cooling in densely populated environments through natural evapotranspiration.

Second, infused with patented activated charcoal technology, the concrete actively purifies the air by capturing and safely neutralizing up to 70% of harmful vehicle pollutants in its immediate surroundings, including nitrogen oxides and VOCs. Furthermore, the project advanced resource efficiency and circularity by utilizing Holcim's ECOCycle circular technology to recycle the site's old construction demolition materials into new circular cement.

By integrating these quantifiable environmental benefits, the project successfully earned the High Quality Environmental (HQE) "Excellent" label, becoming the first site in Africa to achieve this prestigious certification.





Maximizing Efficiency in Concrete Production with AAC

Ytong Autoclaved Aerated Concrete (AAC) blocks revolutionize production efficiency by utilizing an innovative manufacturing process that drastically minimizes raw material consumption and lowers embodied energy.

The primary objective of Ytong Autoclaved Aerated Concrete (AAC) is to maximize production efficiency and minimize the embodied energy of building materials. Ytong AAC transforms traditional manufacturing through an autoclaving process that creates a cellular structure consisting of up to 80% air. This remarkable volume efficiency drastically reduces the primary raw materials required.

The quantifiable benefits of this streamlined production are substantial. Manufacturing AAC blocks demands up to 15.5 times less energy than traditional pressed bricks, utilizing only 3.6 gigajoules per 100 square meters of wall compared to 62 gigajoules. Additionally, their ultra-lightweight composition cuts transportation energy by roughly 75%. On-site, these precision-engineered blocks improve productivity by reducing installation time and labor by up to 50%.

These combined production and operational efficiencies make Ytong an essential tool for sustainable and efficient construction, as demonstrated during the refurbishment of Oslo's City Hall Passage. There, AAC blocks empowered contractors to meet BREEAM NOR "Excellent" standards. By optimizing resources from manufacturing to assembly, Ytong AAC exemplifies low-carbon concrete innovation.

Left: **Morocco Hydromedi**
Above: **Concrete efficiency with AAC**



Scaling Carbon-Storing Concrete

The deployment of Paebbl Rebond in a global retailer's logistics facility in Germany demonstrates the carbon sink potential of concrete by replacing traditional cement with a mineralized, carbon-storing supplementary material.

To validate concrete's potential as a permanent carbon sink, Holcim partnered with general contractor Goldbeck and startup Paebbl to deliver Germany's first commercial-scale industrial floor slab using carbon-storing ready-mix concrete. The primary objective was to seamlessly integrate Paebbl Rebond—a supplementary cementitious material (SCM) created by accelerating natural CO_2 mineralization—into standard construction workflows without compromising structural performance.

The benefits of this technology are significant. Rather than emitting carbon during production, this innovative process actively turns captured CO_2 into a stable mineral powder, permanently locking it within the built environment. Applied across a 420-square-meter logistics facility floor, the project successfully replaced 15% of traditional cement with this carbon-storing SCM. This achieved highly favourable metrics, delivering a 13% reduction in embodied carbon and lowering the mix to 200 kg CO_2e per cubic meter from a 228 kg CO_2e baseline. Crucially, the final concrete met the stringent C30/37 strength specification with identical workability and no delays to the construction schedule, proving that decarbonised, carbon-storing concrete can be rapidly deployed at scale.

Advancing CCUS with CaptureLab

The launch of CaptureLab at Holcim's Martres-Tolosane plant in France establishes the cement industry's first dedicated carbon capture test platform, accelerating the deployment of CCUS technologies by bridging the gap between innovative research and full-scale industrial application.

To accelerate the decarbonisation of cement production and validate carbon capture, utilization, and storage (CCUS) technologies, Holcim launched CaptureLab at its plant in Martres-Tolosane, France. The primary objective of this 2,500-square-meter facility is to act as a high-tech "plug-and-play" hub where engineers and partners can test, refine, and scale next-generation carbon capture solutions under real-world industrial conditions. Notably, Air Liquide is the first partner to pilot their proprietary capture technology at this facility.

The operational benefits of this open-innovation platform are numerous. By simulating everyday cement plant operations – such as modifying fuel mixes or raw meal compositions – the lab actively de-risks new technologies before full-scale industrial implementation. CaptureLab delivers impressive quantifiable outcomes, operating with a capacity to treat and capture between 5 and 30 tons of CO_2 per day. A key performance metric is its advanced purification capability: the facility successfully refines typical industrial flue gas into a professional-grade stream that is at least 99.7% pure CO_2. By removing trace elements down to parts-per-million specifications, the captured carbon is guaranteed to be safe for transport, second-life utilization, or permanent geological storage, bringing the industry closer to producing near-zero cement.



Top left: **CO_2 Sink, South Germany**
Above: **Holcim CaptureLab CCUS, Martres-Tolosane plant, France**

Holcim
Continued



Decarbonizing Cement Production with Floating Solar Energy

The inauguration of Europe's largest floating solar plant at Holcim's cement facility in Obourg, Belgium demonstrates exceptional decarbonisation of industrial electricity by generating 30 GWh of renewable energy annually for direct site consumption.

To advance the decarbonisation of electricity in heavy industry, Holcim partnered with TotalEnergies to launch Europe's largest floating solar plant at its Obourg facility in Belgium. The primary objective was to generate clean energy on-site without consuming valuable space, which was achieved by transforming a flooded former chalk quarry into a hub for renewable energy.

The environmental benefits of this approach are multifaceted. By installing 55,000 solar panels on a repurposed industrial water body, the project unlocked massive capacity while protecting local biodiversity and avoiding the use of terrestrial land. Quantifiable outcomes showcase the scale of this efficiency. The 31 MW installation produces 30 GWh of renewable electricity annually, all of which is consumed directly by the cement plant. By 2030, this array will cover up to 15% of the new GO4ZERO CCS project's power needs, equivalent to the energy usage of 8,500 homes. Furthermore, this floating installation avoids the emission of 110,000 metric tons of CO_2 over its operational lifetime. By substituting fossil-fuel dependency with dedicated clean electricity, this project sets a new benchmark for sustainably powering cement production.



55,000

solar panels installed on a repurposed industrial water body, unlocking massive capacity while protecting local biodiversity and avoiding the use of terrestrial land.

Above: **Floating solar energy Holcim**

JCA

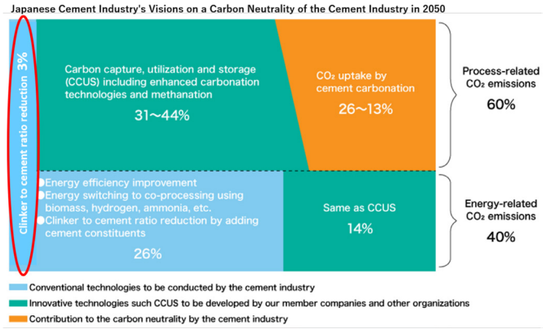
Development of Cement PCR

The Japanese cement industry completed and published a cement PCR that complies with ISO and EN standards in May 2026. JCA plans to develop its own EPD based on this PCR.



Reduction of the clinker-to-cement ratio

On March 23, 2026, the Japanese Industrial standard (JIS) for cement was revised to increase the maximum allowable addition for the minor additional constituent in an ordinary Portland cement from 5% by weight to 10%. The reduction of the clinker-to-cement ratio is positioned as one of the key measures to achieve our ambition to achieve a carbon neutrality by 2050.



一般社団法人
セメント協会

JSW

Accelerating Net Zero Through Renewable Energy Expansion

As part of its commitment to achieving net-zero emissions, JSW Cement is steadily expanding its clean energy portfolio across its manufacturing operations. During FY2025-FY2026, and continuing into FY2027, the company increased its use of low-carbon electricity through a combination of long-term renewable energy power purchase agreements (PPAs) and the optimization of captive clean energy assets, including Waste Heat Recovery Systems (WHRS).

This strategic initiative is aimed at reducing dependence on fossil fuel-based grid electricity, lowering Scope 2 greenhouse gas emissions, and enhancing long-term energy resilience. By progressively integrating clean energy into its operations, JSW Cement has successfully supported business growth while limiting the associated increase in carbon emissions and maintaining operational reliability. Over the last five years, the share of clean energy (renewable energy and WHRS combined) in the company's power mix has increased significantly, from 3.6% in FY2022 to 24% in FY2026, further risen to 36% in H1 FY2027, reflecting its accelerated transition towards low-carbon cement production.

Focusing specifically on renewable energy, JSW Cement added approximately 7.8 MW of solar capacity through PPAs during FY2026, taking its total renewable energy portfolio to approximately 35 MW, contributing almost 12% of total power requirement. The company plans to further scale up its solar and wind power portfolio to nearly 150 MW over the next two to three years, supporting its ambition to achieve a 60% clean energy share by 2030. In Q1 FY2027, renewable energy accounted for 18% of the company's total electricity consumption.

The initiative is directly aligned with the Global Cement and Concrete Association (GCCA) Net Zero Roadmap lever on Decarbonisation of Electricity and is expected to reduce Scope 2 emissions intensity from the current 27 kg CO_2 per tonne of cementitious material to below 20 kg CO_2 per tonne by 2028. Beyond carbon reduction, the expansion of renewable energy capacity is expected to strengthen energy security, improve resilience against power market volatility, and deliver greater long-term cost stability.

JSW Cement
The Leaders' Choice







Top & Middle: **Solar farm**
Bottom: **Wind Power**

Limak



The Turkish Cement Industry's First and Only Operational Hydrogen & Oxygen Project to Boost Alternative Fuel Utilization

Starting in June 2024, Limak Cement, in collaboration with Air Liquide, launched a series of hydrogen and oxygen trials at its Ankara Cement Plant to demonstrate the de-fossilization of clinker production using hydrogen combined with a high-biogenic-content alternative fuel mix.

- June 2024 – Phase 1: First-of-its-kind trial in the Turkish cement sector, demonstrating the use of a hydrogen-blended fuel mix in the calciner and achieving full thermal substitution of fossil fuels with high-biogenic alternative fuels.
- February 2025 – Phase 2: Demonstrated the use of hydrogen and oxygen in the calciner and the required scale of an on-site Electrolyzer, achieving full thermal substitution with improved thermal efficiency and productivity.
- May 2026 – Phase 3: Hydrogen and oxygen were injected into the kiln main burner to further increase fossil fuel substitution using a high-biogenic-content mix of RDF and biomass.

These trials represent a step-by-step pathway toward the de-fossilization of clinker production, combining hydrogen, oxygen, RDF, and biomass while maintaining plant performance.

By combining oxy-combustion with optimized hydrogen use, we demonstrated that clinker production can achieve full thermal substitution with high biogenic alternative fuels without compromising kiln performance.

Once deployed permanently, this solution could avoid approximately 160,000 tons of CO_2 emissions for this plant annually.

> “Building on the advanced infrastructure we have developed through all these efforts, our first 1 MW on-site AEM Electrolyzer is now operational at Limak Anka for field testing and is expected to reach full-scale operation by the end of the year."

Limak Cement now must say new things

Above: **Limak's Ankara cement plant, Turkiye**

Limak
Continued



The Turkish Cement Industry's First and Only Operational Calcined Clay – LC3 Production

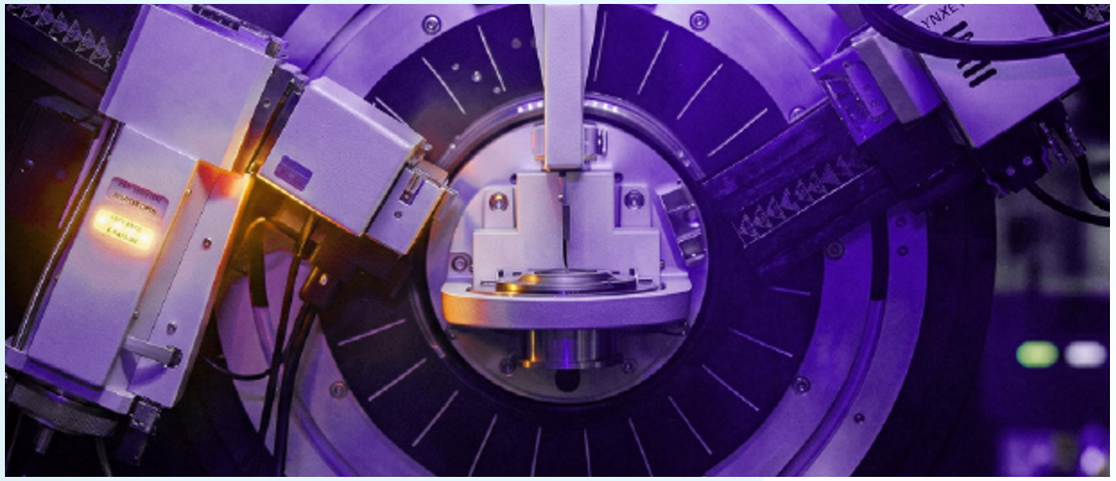
Limak Cement has developed and industrially implemented LC3 (Limestone Calcined Clay Cement) technology as part of its decarbonisation strategy to significantly reduce the carbon footprint of cement while maintaining the mechanical performance and durability required for structural applications. The project focuses on reducing clinker content through the incorporation of locally available clay and limestone, enabling a substantial reduction in the overall CO_2 footprint of cement without compromising product quality. Extensive laboratory characterization, raw material investigations, pilot-scale production trials, and industrial validation were carried out to optimize clinker chemistry and supplementary cementitious material (SCM) utilization.

Since April 2026, LC3 production has been implemented at the Trakya plant using a dedicated rotary kiln calcination system with a production capacity of approximately 1,600 tones per day.

In addition to reducing the carbon footprint of cement, the project promotes the use of locally available raw materials, improves resource efficiency, and provides a scalable pathway to produce low-carbon cement that supports the transition toward more sustainable construction.



"Through the commercialization of its LC3 product portfolio, Limak Cement has achieved a yearly saving of 125 000 tons of CO_2."



A New Patent for the Global Cement Industry: Boron-Activated Cement for Energy-Efficient, Low-Carbon Production

Limak Cement has developed a patented boron-activated cement technology to improve production efficiency while reducing the environmental impact of cement manufacturing. The technology utilizes boron-based activation to enhance clinker reactivity, enabling higher mechanical performance with lower energy demand during production. The patented technology has been successfully implemented in cement production without requiring significant modifications to existing manufacturing infrastructure. The optimization of the cement formulation has resulted in improved production efficiency while maintaining compliance with applicable quality standards and performance requirements.

Industrial implementation has demonstrated a 6% reduction in specific heat consumption, contributing to lower fuel demand and improved process efficiency. In addition, the optimized cement formulation has achieved an overall 10% reduction in CO_2 emissions per ton of cement compared with the conventional reference product. Beyond lowering the carbon footprint of cement production, the patented boron-activated technology supports more efficient use of natural resources, enhances manufacturing sustainability, and provides a practical, scalable solution for reducing emissions while maintaining product quality and operational reliability.



-6%

Industrial implementation has demonstrated a 6% reduction in specific heat consumption.

Limak
Continued



Expanding Renewable Energy Capacity for Self-Consumption at Full Speed

In 2025, Limak Cement took a significant step toward reducing its Scope 2 emissions by accelerating the transition to renewable electricity. A 36 MW solar power project investment was started during 2025 and 28.4 MW was commissioned, while the company's solar projects began contributing to its electricity consumption in the final quarter of the year. Additionally, 52 MWp of new capacity is currently under construction. These investments represent an important milestone in Limak Cement's decarbonisation roadmap and supports its longer-term ambition to meet 53% of its total electricity demand from solar energy by 2030, increasing this share to more than 90% by 2050.



> The commissioned 28.4 MW solar energy project will produce 47 000 MW yearly. This will reduce our Scope 2 emissions with 20 000 tons of CO_2 per year."

Molins

Decarbonizing clinker production through raw material substitution, process efficiency and alternative fuels

Molins' Sant Vicenç dels Horts plant (Barcelona) is implementing an integrated decarbonisation strategy combining decarbonised raw materials, alternative fuels, process optimisation and renewable hydrogen. Together, these measures will reduce CO_2 emissions from Portland clinker production by 5.8%, while significantly cutting the consumption of limestone and petcoke.

Case study

Molins Sant Vicenç dels Horts plant in Barcelona is implementing a comprehensive approach to reduce CO_2 emissions from Portland clinker production, targeting its two main sources: limestone decarbonation and fossil fuel use.

The project brings together four complementary measures. First, Molins is incorporating decarbonated calcareous slag into the raw meal, replacing part of the limestone and reducing emissions generated during calcination. Second, the plant is increasing the use of alternative fuels, including refuse-derived fuel (RDF) and wood, to replace petcoke. Third, fluorite and gypsum are being incorporated as fluxes/mineralisers in the raw meal to accelerate kiln reactions, reducing the energy and petcoke required to produce clinker. Finally, the project includes the generation of renewable hydrogen to enable higher usage of alternative kiln fuel and thus achieving further reducing petcoke consumption.

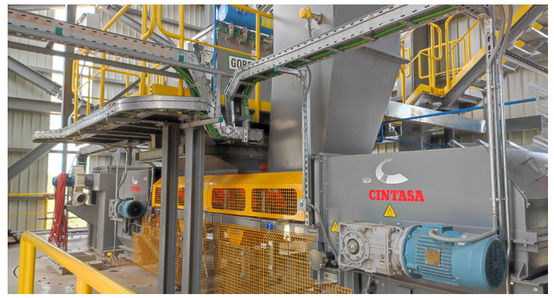
The objectives are reducing limestone consumption by 1.5% and petcoke consumption by 29%, bringing clinker emissions down to 678 kilos of CO_2 per tonne of clinker and saving 45,890 tonnes of CO_2 emissions (with reference to yearly production of 2022).

This project demonstrates the effectiveness of Molins' approach to progressively decarbonizing clinker production.

Molins

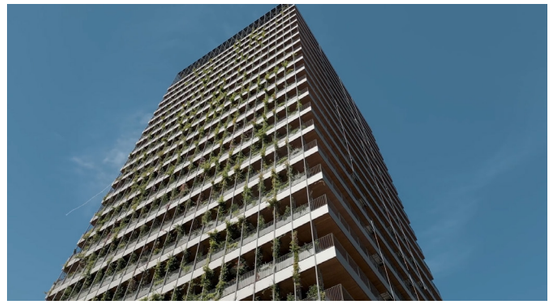






Above: **Decarbonisation at SVH**

Molins
Continued



Decarbonising construction starts at the design stage

Tower One – Porta Diagonal, a 25-storey, nearly 100-metre-high tower in the Barcelona metropolitan area, demonstrates how integrating structural optimisation and lower-carbon materials from the design stage can help reduce the embodied carbon of high-rise construction.

Case study

Tower One – Porta Diagonal, a 25-storey, nearly 100-metre-high tower in the Barcelona metropolitan area, incorporated two complementary strategies to reduce emissions from the design stage: optimising the structure to use materials more efficiently and selecting materials with a lower carbon footprint.

The project was developed through data analysis and the assessment of different design and material alternatives, with the engineering firm bis and Molins working together. Responsible for the structural calculations, bis, optimised the design and quantified the associated impacts, while Molins supplied low-carbon concrete made with Susterra cement for most of the structure.

Susterra is Molins' range of solutions that groups products with sustainability attributes. In this case, the cement reduces its carbon footprint through lower clinker content and the use of alternative fuels, resulting in emissions up to 29% lower than Type II cements and 41.5% lower than Type I cements.

The combination of both strategies has reduced emissions by 710 tonnes of CO_2e compared with a more conventional structure.

The project demonstrates how integrating design and material selection decisions from the early stages, together with collaboration between engineering and industry, can reduce emissions from construction.





Above: **Tower One Barcelona**

710 tCO_2

a reduction of 710 tonnes of CO_2e compared with more conventional structures.

SCG

A Game-Changing Low-Carbon Innovation

SCG has developed and demonstrated Thailand's first pilot-scale carbon capture system for the cement industry designed and built by Thai researchers and engineers. The project applies Vacuum Pressure Swing Adsorption (VPSA) technology to capture carbon dioxide directly from cement plant flue gas, using an innovative adsorbent made from zeolite blended with locally sourced natural clay.

The field-scale system is designed to capture 100–500 kilograms of CO_2 per day at a purity of more than 80%. The captured CO_2 will be utilized in concrete curing, where it can be permanently mineralized within concrete products, supporting the development of high-quality, low-carbon construction materials. By integrating carbon capture and utilization within the cement and concrete value chain, the project demonstrates a circular approach to carbon management and provides a practical platform for scaling the technology toward larger industrial applications.

The project is currently undergoing process optimization to maximize capture capacity, energy efficiency, operational reliability and cost competitiveness. As part of SCG's broader Net Zero Cement & Concrete 2050 vision, this Thai-developed VPSA platform complements clinker reduction, alternative fuels, renewable energy and other CCUS solutions on the pathway toward near-zero cement production.
It also contributes to the GCCA Net Zero Roadmap by demonstrating how locally sourced materials, home-grown innovation and field-scale deployment can accelerate the decarbonisation of the cement industry in Thailand and across Southeast Asia.





Above: **Reserch and innovation Center, Saraburi, Thailand**

100–500kg

100–500 kilograms of CO_2 captured per day at a purity of more than 80%.

SCG
Continued

Case of One Bangkok, Thailand

SCG is advancing the real-world application of Limestone Calcined Clay Cement (LC3) at One Bangkok, one of "Thailand's largest holistically integrated district and a premier green smart city in the heart of Bangkok." The project marks an important step in moving LC3 from technology development into practical construction use.

LC3 reduces the need for conventional clinker by incorporating calcined clay and limestone into the cement system. This helps lower the carbon intensity of cement production while maintaining the performance required for structural concrete. SCG reports that its LC3-based low-carbon cement can reduce greenhouse gas emissions by approximately 30% compared with conventional Portland cement, depending on the product and application.

At One Bangkok, LC3 cement has been applied in concrete for the project's parking building, providing a real demonstration of how lower-carbon cement can be integrated into a major urban development. SCG has also identified its use of calcined clay in cement production as a first for Thailand and ASEAN, reinforcing the significance of the project as a regional reference for clinker substitution and low-carbon construction.

The One Bangkok mobile application shows that LC3 is not only a promising decarbonisation technology, but also a practical solution that can be deployed in real construction projects. As urban development continues to expand across Southeast Asia, applications such as this can help accelerate the transition toward lower-embodied-carbon buildings and infrastructure.

> The project marks an important step in moving LC3 from technology development into practical construction use."







Above: **One Bangkok, Bangkok, Thailand**

Taiheiyo Cement

Taiheiyo Cement supports Yakushima Town's Zero Carbon Island Initiative through Shirasucrete, a low-carbon and durable concrete incorporating finely ground volcanic glass powder produced from locally sourced shirasu.

Taiheiyo Cement is promoting Shirasucrete, a low-carbon and durable concrete incorporating finely ground volcanic glass powder produced from locally sourced shirasu. Shirasucrete contributes to reducing clinker consumption and associated CO_2 emissions while supporting long-term infrastructure durability through improved resistance to chloride penetration and enhanced long-term strength.

Yakushima Island, a UNESCO World Natural Heritage site, is one of the regions closest to achieving carbon neutrality, where almost all electricity is supplied by hydropower generated from its abundant water resources and rich natural environment. Yakushima Town has declared its Zero Carbon Island Initiative and is promoting activities aimed at achieving carbon neutrality. To support these efforts, the company has entered into a comprehensive cooperation agreement with Yakushima Town and Yakushima Denko.

Under the agreement, the partners are collaborating on initiatives related to renewable energy utilization, disaster resilience, infrastructure longevity and the reduction of CO_2 emissions from construction materials.

In 2025, Shirasucrete was used in the construction of an EV fast-charging station at a supermarket operated by an affiliated company on Yakushima Island. The material was applied to the EV charger shelter, rest area columns and wheel-stop blocks. The use of Shirasucrete in these components reduced CO_2 emissions by up to 50% compared with conventional concrete.

This project was implemented as part of the efforts supporting Yakushima Town's Zero Carbon Island Initiative. Taiheiyo Cement will continue to support decarbonisation of cement and concrete industry by promoting awareness and wider application of Shirasucrete and other group technologies.

TAIHEIYO CEMENT



Above: **EV fast-charging station, Yakushima Island, Japan**

50%

a 50% reduction in CO_2 emissions through the use of Shirasucrete instead of conventional concrete.

TCC Group Holdings Co., Ltd

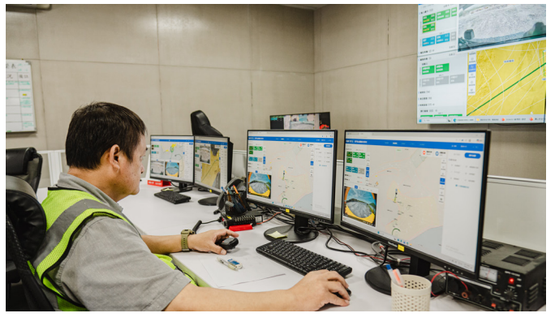
Autonomous Electric Haulage: Removing Diesel from the Quarry Cycle

Quarry haulage is one of the few places where a cement producer still burns diesel at scale inside its own boundary, and it is where recruitment is hardest: the average age of TCC Group Holdings' experienced haulage personnel is around 50, with almost no replacement intake. Between 2020 and 2025 the company addressed both at once, taking the full load-haul-dump-park-charge cycle unmanned and battery-electric at three limestone quarries — Jurong and Yingde in China, Heping in Taiwan.

Forty-four autonomous electric trucks are now in service: 14 at Jurong, 18 at Yingde and 12 at Heping. Developed with CiDi, the system was re-specified at each site rather than replicated: Heping, fogbound for a third of the year, carries twice the millimetre-wave radar of the mainland sites. Third-party assessment by the National Institute of Metrology, China placed unmanned productivity at 1.04 times manned diesel operation, and Jurong has recorded no haulage accidents since November 2022.

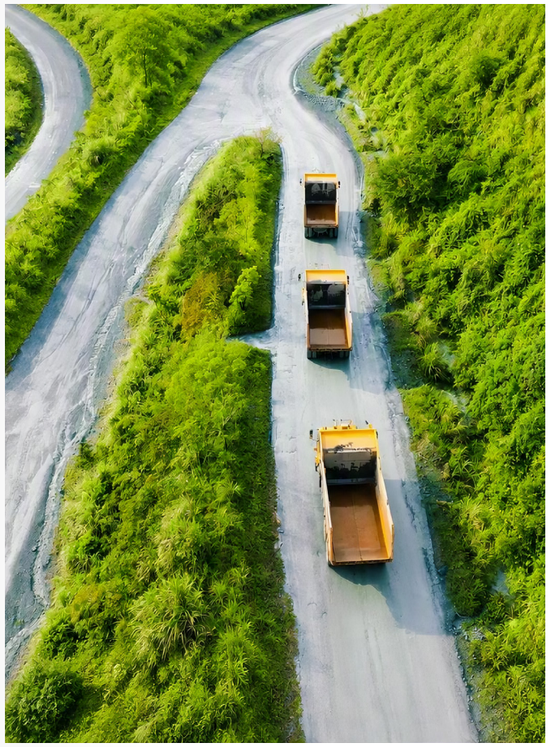
Where the haul road has grade, the descent becomes an energy source. At Yingde, whose 1500m haul road averages 6.5%, the traction motor is the primary retarder in place of friction brakes, and a single loaded descent returns 114kWh to the battery — around 43% of the gross traction energy a cycle draws.





Top: **Close-up of the truck sensor installation — LiDAR, millimeter-wave radar and camera positions.** *Courtesy of TCC Group Holdings*
Bottom: **A former mining truck driver, now a central control operator, dispatching the autonomous fleet.** *Courtesy of TCC Group Holdings*

> "At Yingde a single loaded descent returns 114kWh to the battery, around 43% of the gross traction energy a haulage cycle draws — turning the grade that makes quarrying difficult into part of the energy supply."



Above: **Autonomous electric mining trucks on the haul road at TCC's Heping quarry, Hualien, Taiwan.** *Courtesy of TCC Group Holdings*
Figures, Right: **The deployment in numbers, across the three quarries.** *Courtesy of TCC Group Holdings*

Jurong has avoided 5,433t of CO_2 to date; Yingde is projected to avoid 30,982t over five years and Heping avoids 848t a year. Five-year returns are 29.94% at Jurong and 25.08% at Yingde, on a boundary that includes the private 5G network, charging infrastructure and grid connection. TCC is now evaluating on-site solar and storage so the fleet runs on renewable electricity.

At Heping all 14 mine truck drivers were retained: five to haul road maintenance, four to central control, three to power and charging logistics, two to fleet preparation. Their route knowledge — segment speed profiles, loading approach geometry, weather-conditional behaviour — was captured as rules in the planner before the first truck ran unmanned.

44

autonomous electric trucks in service across three quarries.

1.04x

productivity against manned diesel haulage, third-party verified.

43%

of traction energy returned to the battery on a loaded descent.

TCC GROUP HOLDINGS

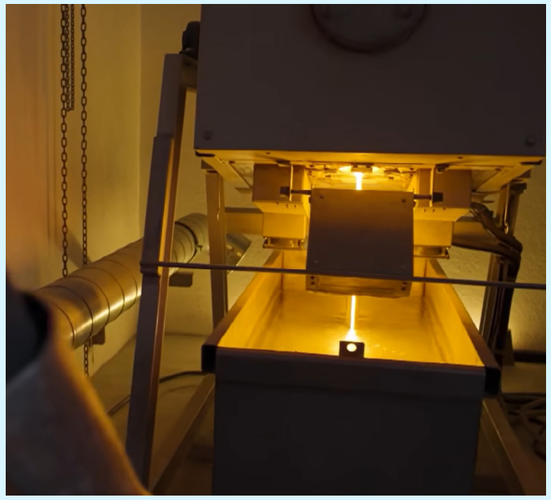
TCC Group Holdings Co., Ltd

Continued

Clinker: X-Clinker, an Electrified Melting Route to Low-Carbon Hydraulic Binder

The GCCA roadmap places kiln electrification and hydrogen late in the sequence — a small role from 2040, around 10% of energy needs by 2050. CIMPOR, the Portuguese subsidiary of TCC Group Holdings, is bringing that lever forward. With Instituto Superior Técnico in Lisbon it has developed X-Clinker: a hydraulic material made not by calcining limestone in a kiln, but by melting the feed electrically. The technology is patented in the United States, Europe and Brazil.

Two things follow. First, the feed no longer has to be limestone. Industrial by-products and construction and demolition waste can be melted in full, so much of the process CO_2 from decarbonating limestone never arises. The reduction is close to 400kg CO_2 per tonne of clinker, some 48% against conventional OPC clinker; with renewable electricity it falls to 350kg CO_2e per tonne.

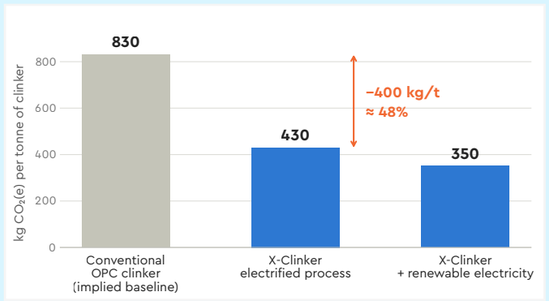




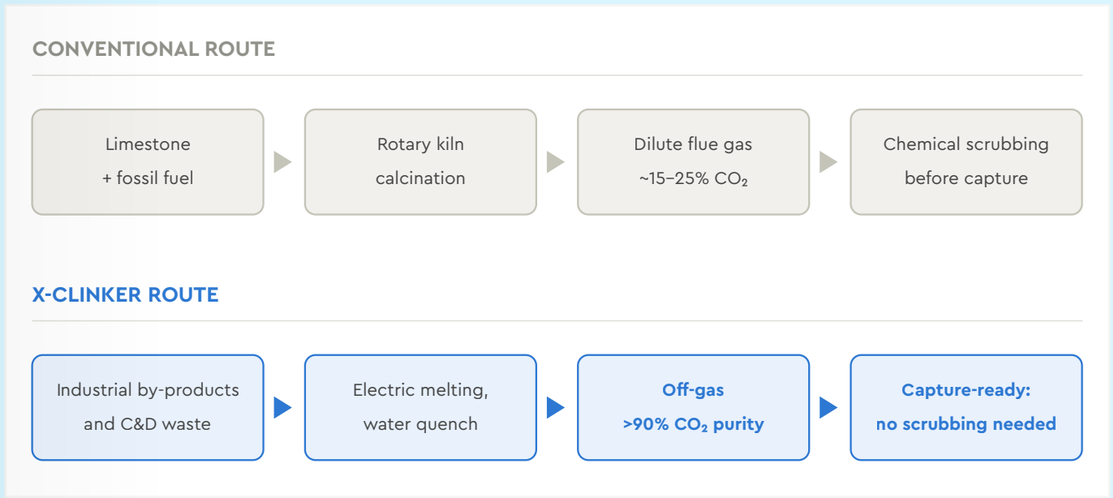
Above: **Tapping the melt at CIMPOR's central laboratory in Alhandra. The 10kg-a-day electric tilting furnace discharges straight into a water bath, where the charge quenches to a glassy granulate.** *Courtesy of CIMPOR / TCC Group Holdings*

Left: **X-Clinker after quenching: a glassy granulate, before being ground in the same way as conventional clinker.** *Courtesy of CIMPOR / TCC Group Holdings*

Below: **CO_2 per tonne of clinker: conventional OPC against the X-Clinker electrified route.** *Courtesy of CIMPOR / TCC Group Holdings*



> Melting rather than calcining removes most of the process CO_2 and concentrates what remains: an off-gas above 90% CO_2, against 15 to 25% from a conventional kiln, arrives at the capture plant already fit for purpose."



Second, the off-gas changes character. Because electric melting does not dilute the stream with combustion products, the gas released during high-temperature treatment carries a CO_2 purity above 90%, against roughly 15–25% for kiln flue gas. That removes most of the chemical scrubbing needed ahead of capture and lowers the front-end cost of CCUS — the largest lever in the GCCA roadmap.

At Alhandra the melt is tapped from a 10kg-a-day electric tilting furnace in the central laboratory and water-quenched to a glassy granulate. X-Clinker remains at development stage and has not entered commercial production. A fully electrified five-tonne-a-day pilot is under construction with an equipment maker, due in 2027 and intended to take the technology to TRL 7–8 — the basis for a possible plant of 300 to 400 tonnes a day. Since 2024 a three-year programme with IETcc, part of Spain's national research council, is pursuing a European Technical Assessment for the EU market.

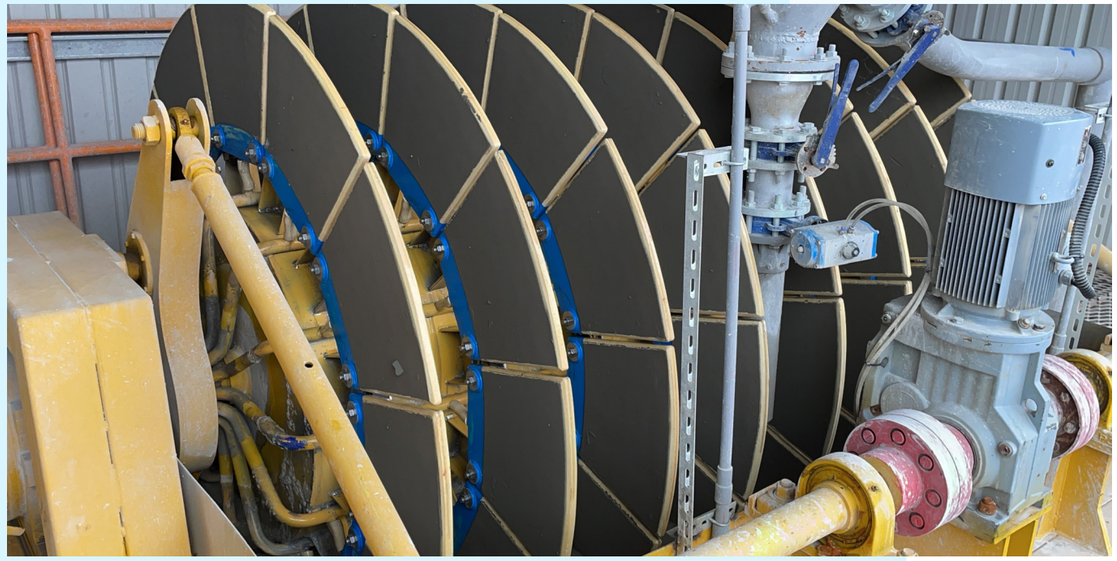


Figures, Top: **The electrified route produces a capture-ready off-gas, removing the pre-treatment step.** *Courtesy of CIMPOR / TCC Group Holdings*

Above: **CIMPOR's Alhandra plant on the Tagus estuary, north of Lisbon, where the pilot installation is being built.** *Courtesy of CIMPOR / TCC Group Holdings*

TCC Group Holdings Co., Ltd

Continued



Concrete Production: Carbonating Ready-Mix Plant Slurry into a Closed-Loop CO_2 Sink

Every ready-mixed concrete plant generates a calcium-rich process slurry from washing mixers, trucks and batching equipment. It carries unhydrated cement, ground granulated blast-furnace slag, fly ash and admixtures together with the calcium hydroxide formed on hydration, and it is strongly alkaline — pH 13.2 as measured at TCC's plants.

TCC Group Holdings is developing a route that treats the slurry as a feedstock. Solids are separated on ceramic-disc filters; the fresh slurry is then contacted with CO_2, converting calcium hydroxide into stable calcium carbonate. Laboratory work used bottled CO_2 at 99% concentration as a proxy for an industrial flue-gas stream, at ambient temperature and atmospheric pressure with controlled mechanical agitation to optimise gas–liquid–solid contact. Carbonation was verified by loss-on-ignition testing, tracking mass loss at 300°C for free water, 550°C for portlandite decomposition and 900°C for carbonate decomposition; carbonated samples show mass loss transferring from the portlandite step to the carbonate step.

> One kilogramme of fresh ready-mix slurry fixes 0.10 to 0.18kg of CO_2 as stable calcium carbonate, while pH falls from 13.2 to 8.3 — mineral carbon storage and water recovery in a single step."

pH 13.2

measured in fresh process slurry at TCC's plants.

Above: **Ceramic-disc filtration separating solids from wash water at a TCC ready-mixed concrete plant.** *Courtesy of TCC Group Holdings*



Above: **Residual slurry recovered after ceramic-plate separation,** *Courtesy of TCC Group Holdings*

Slurry sampled at TCC's Taoyuan ready-mixed concrete plant fixes 0.10 to 0.18kg CO_2 per kg of fresh slurry, equivalent to 10 to 18% on a dry-solids basis, while pH falls from 13.2 to 8.3. For a plant generating some 5,000 tonnes of dry slurry a year, that is a storage potential of roughly 500 to 900 tonnes of CO_2 annually. The single step stores carbon permanently in mineral form and returns the process water to a pH at which it can be recirculated within the plant.

Laboratory verification was completed in 2025. TCC has positioned the route as a 2035 milestone in its concrete decarbonisation roadmap, for the point at which mix-design optimisation alone approaches its practical limit and further reduction has to come from circularity and carbon storage. Plant-scale trials will explore direct integration with industrial CO_2 captured on site.

ALKALINITY (pH)

13.2 → 8.3

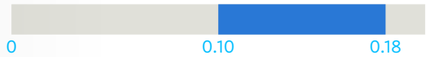
untreated slurry — after carbonation

Calcium hydroxide converted to stable calcium carbonate

CARBON FIXATION

0.10 – 0.18

kg CO_2 per kg of fresh slurry



Equivalent to 10–18% on a dry-solids basis

Above: **Carbonation test results: CO_2 fixation and the change in slurry alkalinity.** *Courtesy of TCC Group Holdings*

500–900t

500–900 tonnes of potential CO_2 storage annually for a plant generating approximately 5,000 tonnes of dry slurry a year.

TCC Group Holdings Co., Ltd

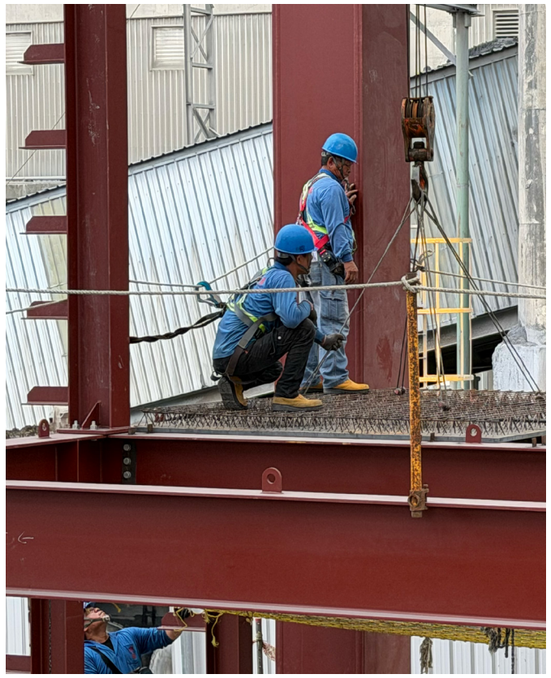
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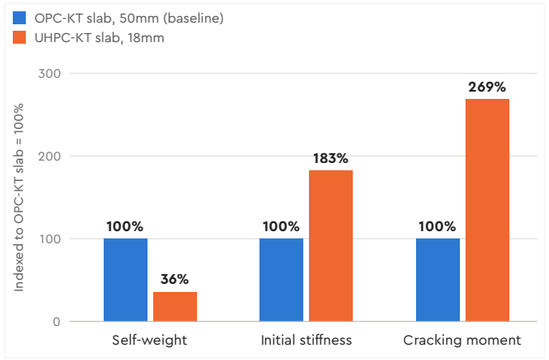
Design and Construction: Cutting Slab Depth by Two-Thirds with UHPC Precast Half-Slabs

Precast composite half-slabs with lattice girders — KT slabs — move rebar fixing, formwork, casting and curing off the site and into a factory. The constraint is depth: in ordinary Portland cement concrete the panel must be at least 50mm to carry construction-stage loading. That depth makes each panel heavy, caps the area lifted as one unit, and drives transport and craneage.

TCC Group Holdings has developed a UHPC version at 18mm — a 64% reduction in section depth. Eighteen panels were tested at Taiwan's National Center for Research on Earthquake Engineering against a 50mm OPC-KT control. Self-weight fell to 36% of the baseline while initial stiffness rose to 183% and the cracking moment to 269%: lighter and stiffer at once, when the half-slab acts as participating formwork and is most exposed.

> A 64% reduction in section depth, delivering 1.8 times the initial stiffness and 2.7 times the cracking moment of the 50mm ordinary Portland cement panel it replaces."





Top: **Setting a UHPC-KT panel onto the steel frame at TCC's Heping plant, Hualien.** *Courtesy of TCC Group Holdings*

Figures, above: **Test results: an 18mm UHPC-KT slab against a 50mm OPC-KT control, indexed to the control.** *Courtesy of TCC Group Holdings*



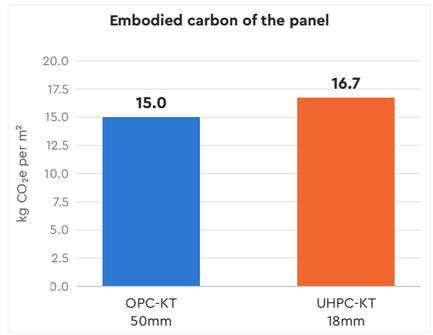


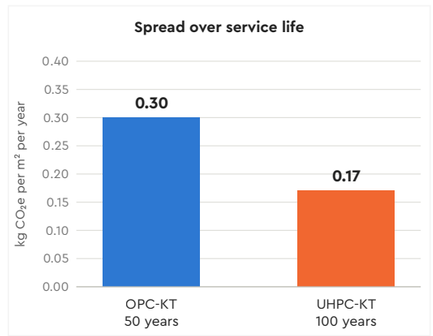
The binder uses TCC's own IL limestone cement with ground granulated blast-furnace slag, and 2% by volume of 13mm steel fibre. An ISO 14067 assessment puts the mix at 927kg CO_2e/m^3, against roughly 300 for ordinary concrete; cutting the section by 64% narrows that gap without closing it, and per square metre the panel still carries slightly more embodied carbon than the one it replaces. The case rests on service life. A Life-365 model run by the Taiwan Construction Research Institute on measured chloride diffusion puts UHPC beyond 100 years against 50, halving the annual figure and avoiding one replacement cycle.

The first application floors the stone-powder grinding mill extension at TCC's Heping plant in Hualien: 45m². On a first use the designer specified 27mm rather than 18mm; laying the panels and pouring the topping took three days. The system is now in the TCC ARC building (staff-residence), under construction since May 2026.

Above: **A UHPC-KT panel is lifted for delivery. Each panel is 2.5 by 3 metres.** *Courtesy of TCC Group Holdings*

Top right: **Panels in place, with reinforcement laid over the lattice girders ahead of the topping pour. The 45m² deck was laid and poured in three days.** *Courtesy of TCC Group Holdings*





Precast panel only; lattice girders and structural topping excluded. UHPC mix at 927kg CO_2e/m^3 (ISO 14067, Heping UHPC plant); ordinary concrete taken at 300kg CO_2e/m^3.

Figures, above: **The panel costs slightly more carbon to make and lasts twice as long.** *Courtesy of TCC Group Holdings*

TCMA

From Roadmap to Action: Thailand's Cement Decarbonisation Journey

Thailand is translating its 2050 Net Zero Cement and Concrete Roadmap into action through collective commitment from TCMA members, government agencies and international partners. Building on the Thailand Chapter developed in alignment with the GCCA 2050 Roadmap, the "Decarbonisation of the Cement and Concrete Sectors in Thailand" project was announced at the GCCA CEO Gathering and Leaders Conference in Bangkok in 2024, supported by CAD 8 million from the Government of Canada through Environment and Climate Change Canada (ECCC) and facilitated by the United Nations Industrial Development Organization (UNIDO).

The project advances five workstreams covering policy and action planning, innovation, investment and commercialization, standards and practices, and cooperation and knowledge sharing. TCMA serves as the industry platform, mobilizing members and connecting stakeholders across the value chain to support implementation.

A key tangible outcome is the deployment of Canada's Mobile Carbon Capture Unit (MCCU), to be piloted across TCMA member cement plants through the Saraburi Sandbox. The pilot is intended to generate real-world evidence, strengthen local capabilities and build readiness for future large-scale CCUS deployment.

The initiative demonstrates how industry commitment, international collaboration, technology and finance can move decarbonisation from roadmap to implementation and create the enabling conditions for scale-up.



Above: **Missing Caption**

> Thailand is progressing from roadmap to action by mobilizing industry, government and international partners to advance decarbonisation solutions, accelerate its pathway to Net Zero and strengthen the long-term competitiveness of the cement and concrete industry."

TITAN



Accelerating decarbonisation in TITAN's Turkish operations through renewable energy and low-carbon construction materials

TITAN is strengthening its decarbonisation journey in Türkiye by combining renewable energy deployment through a large-scale solar power project and investment in low-carbon construction materials, demonstrating an integrated approach to reducing the carbon footprint of its operations and products.

As part of the acquisition of Traçim Çimento, located in the greater Istanbul market, one of the most dynamic cement markets of Türkiye, TITAN signed an agreement with Caba Energy Group for a joint venture in a 100 MW solar power project. The project, currently under construction, is expected to provide renewable electricity capacity to support the Group's operations and contribute to reducing emissions associated with energy consumption. In parallel, TITAN has invested in the Vezirhan pozzolana quarry in East Marmara, Türkiye, to secure access to alternative raw materials for low-carbon construction products. Together, these initiatives demonstrate TITAN's integrated approach to decarbonisation by combining cleaner energy sources with innovative solutions that reduce the carbon intensity of cement and concrete.



Next-Generation Alternative Cementitious Materials (ACMs) – Accelerating low-carbon cement innovation

TITAN is accelerating the development and commercialization of next-generation Alternative Cementitious Materials (ACMs) as a key lever in its decarbonisation roadmap, combining innovation, strategic partnerships, and circular economy solutions to develop lower-carbon products.

TITAN has established a strategic partnership with Thyssenkrupp Polysius to deploy the innovative meca® clay technology, which activates alternative materials to partially replace clinker while maintaining cement performance. The technology will be piloted at the TITAN Centre for Advanced Technologies (PATH) in Patras, Greece, with the ambition to produce cement with a clinker-to-cement ratio below 40%, compared with approximately 93% for Ordinary Portland Cement.

Additional initiatives include recycling ponded fly ash through ST Equipment & Technology's (STET) proprietary separation technology, enabling the production of cementitious materials with significantly reduced CO_2 profiles. In 2025, TITAN announced a first of its kind project to process up to 300,000 tonnes per year of harvested coal ash using STET's proprietary process at the Fiddler's Ferry power station in Warrington, UK.

Also, through its TITAN Venture activities, TITAN has partnered with Carbon Upcycling to pilot carbon utilization technologies and explore the production of local, low-carbon cementitious materials using available feedstocks from selected TITAN sites.

Left: **TITAN Traçim's Vize cement Plant in Kırklareli, Türkiye**
Right: **ST Equipment & Technology's installation**

TITAN
Continued

IFESTOS: Advancing one of Europe's largest industrial carbon capture projects

IFESTOS, TITAN's pioneering carbon capture project at the Kamari integrated cement plant near Athens, Greece, is one of Europe's largest industrial decarbonisation initiatives and a cornerstone of TITAN's roadmap to net-zero concrete by 2050. The project involves the deployment of an industrial-scale carbon capture facility, with captured CO_2 transported to an adjacent port for liquefaction and subsequent shipment to a permanent geological storage site. Once operational, IFESTOS is expected to capture significant amounts of CO_2 from cement production, enabling the production of near-zero carbon cement to support the growing demand for sustainable construction solutions in Greece and beyond.

During 2025, IFESTOS advanced into a new phase of development, with key milestones achieved across permitting, infrastructure planning, and stakeholder engagement. The project obtained an environmental permit for pre combustion in Kamari, and was designated as a Strategic Investment by the Greek State, eligible for permit fast-tracking. Additionally, the project signed a connection terms agreement with the Hellenic Transmission System Operator to ensure the necessary infrastructure to supply IFESTOS' energy requirements will be in place. In parallel, TITAN continued advancing collaboration across the CCS value chain.

The EU Innovation Fund will support TITAN's project with a grant of €234 million.



Above: **Illustration of the planned IFESTOS carbon capture facilities at TITAN's Kamari cement plant near Athens**

€234m

The EU Innovation Fund will support TITAN's project with a grant of €234 million.

UltraTech



> "Nearly a third of UltraTech's 76 manufacturing units in India have maintained green energy utilisation above 50% of their electricity requirement."

UltraTech achieves major decarbonisation milestone with its first 100% green energy powered integrated unit

UltraTech Cement Limited, the world's largest cement company excluding China, has reached a new decarbonisation milestone, with its integrated cement manufacturing unit Kukurdih Cement Works located in Chhattisgarh meeting 100% of its electricity requirement through green energy every month since April 2026.

Commissioned in 2024, Kukurdih Cement Works, with an installed grey cement capacity of 3.3 million tonnes per annum, has reached this milestone through a combination of renewable power sourcing and Waste Heat Recovery Systems (WHRS), which together now cover the plant's entire electricity requirement without compromising operational reliability.

Since April 2026, nearly a third of UltraTech's 76 manufacturing units in India have maintained green energy utilisation above 50% of their electricity requirement. Five of these, including the Kukurdih unit, have exceeded 95% green energy utilisation. UltraTech is also progressively deploying Battery Energy Storage Systems (BESS) across its network to support deeper integration of renewable energy.

As of Q1FY27, the Company's captive green energy capacity stood at 1,897 MW, comprising 1,463 MW of renewable capacity (solar, wind and hybrid) and 434 MW of WHRS capacity. Under its RE100 commitment, UltraTech is committed to increasing the share of green power in its total power mix to 85% by 2030 and 100% by 2050.

Votorantim Cimentos

Salto Chlorine By-Pass Project

The Salto Chlorine By-Pass Project enables significantly higher alternative fuel utilization, reducing fossil fuel consumption and CO_2 emissions.

Case study

The Salto Chlorine By-Pass Project was implemented to overcome operational constraints associated with chlorine accumulation in clinker production, a key factor limiting the use of alternative fuels in cement kilns. The project introduced a dedicated chlorine by-pass system capable of extracting chlorine-rich gases from the process and recovering materials for reuse in cement manufacturing, enhancing both operational efficiency and resource circularity.

In parallel, upgrades to the kiln draft system increased exhaust-gas handling capacity, improving process stability, and creating the conditions necessary to significantly increase alternative fuel consumption. As a result, the Salto plant can now achieve thermal substitution rates of up to 50%, substantially reducing its reliance on fossil fuels while lowering associated greenhouse gas emissions. Beyond the environmental benefits, the project has strengthened kiln reliability and operational resilience, allowing the plant to operate more efficiently while supporting Votorantim Cimentos' long-term decarbonisation roadmap. By converting a process limitation into a sustainability opportunity, the project demonstrates how technological innovation can accelerate the transition to lower-carbon cement production without compromising operational performance.



Above: **Fábrica Salto de Pirapora, Brazil**

Up to 50%

thermal substitution rate now achievable at the Salto plant, reducing reliance on fossil fuels and associated greenhouse gas emissions.

VOTORANTIM cimentos

NYSDOT Bridge Replacement

Votorantim Cimentos' St. Marys Cement and United Materials collaborated to provide low-carbon cement and concrete solutions for the replacement of a nearly 100-year-old bridge in New York.

Case study

St. Marys Cement and United Materials partnered to deliver more than 3,800 cubic meters of low-carbon concrete for the replacement of the nearly 100-year-old U.S. Route 20 (Transit Road) Bridge over Cazenovia Creek in New York. The project met both NYSDOT Performance Engineered Mix (PEM) requirements and New York State Buy Clean Concrete (Green NY) guidelines while supporting the state's sustainability goals.

Approximately 2,200 cubic meters of mass concrete were used for the bridge's 24 metre piers, incorporating BlentureTM IS and 45% additional CemplusTM for a total slag content of about 60%. This high slag content reduced heat generation during curing, helping meet strict thermal control requirements and minimizing the risk of thermal cracking. Another 1,900 cubic meters of High-Performance Internal Curing (HPIC) concrete was supplied for the bridge deck, using blended silica fume (Type IP) cement with slag cement, silica fume, and lightweight fine aggregate to improve durability, strength, and service life.

Blended cements and supplementary cementitious materials significantly reduced embodied carbon while maintaining required performance. St Marys Cement BlentureTM IS lowers CO_2 emissions in the cement by 30%, while Type IP cement reduces emissions by 15% compared to ACA industry-average for Portland cement.

blenture

united materials

st marys cement







Top: **United Materials Bridge Replacement project| Two truck-mounted concrete pumps pouring bridge deck | 24-meters-tall mass concrete bridge piers**

Middle: **United Materials ready-mix truck onsite**

Bottom: **Winter service**

Votorantim Cimentos

Continued

Wind Energy Brazil

The Cajuína Project expands Votorantim Cimentos' renewable energy portfolio through a strategic partnership with Auren, adding 55 MW average of wind power and increasing renewable electricity participation to more than 90% in Brazil.

Case study

The Cajuína Project is a strategic renewable energy partnership between Votorantim Cimentos and Auren designed to accelerate the company's energy transition and strengthen the resilience of its electricity supply in Brazil. Structured through a long-term power purchase agreement and self-production model, the project adds 55 MW average of wind energy to Votorantim Cimentos' energy portfolio, providing a reliable source of competitive renewable electricity for industrial operations.

The initiative plays a significant role in the company's decarbonisation strategy by increasing the share of renewable electricity in its Brazilian operations above 90%, one of the highest levels in the sector. By securing long-term access to wind power, the project reduces exposure to electricity market volatility while helping mitigate indirect greenhouse gas emissions associated with energy consumption. The partnership also supports energy security, portfolio diversification, and cost competitiveness over the long term. The project represents an important milestone in Votorantim Cimentos' commitment to sustainable growth, demonstrating how strategic partnerships can simultaneously deliver environmental, operational, and economic value.

55 MW

The Cajuína Project adds 55 MW average of wind energy to Votorantim Cimentos' energy portfolio.

> "The initiative plays a significant role in the company's decarbonisation strategy by increasing the share of renewable electricity in its Brazilian operations above 90%, one of the highest levels in the sector."



Pictured: **The Cajuina Project, Brazil**

Votorantim Cimentos

Continued

Scaling Low-Carbon Building Solutions in Galicia

Votorantim Cimentos has expanded the availability of Anhivel® THERMIO®+ (anhydrite mortars) in Galicia, enabling more energy-efficient radiant heating and cooling systems that can improve thermal performance, comfort and building energy savings.

Case study

Votorantim Cimentos has commissioned a new anhydrite mortar production line at its A Coruña plant, expanding the availability of Anhivel® THERMIO®+ solutions in Galicia and strengthening the adoption of more energy-efficient building systems.

Developed by Votorantim Cimentos in collaboration with Anhydritec®, THERMIO®+ is a high thermal conductivity mortar specifically designed for radiant heating and cooling applications. The technology is engineered to maximize heat transfer between the installation and the occupied space, improving the performance of underfloor systems while enhancing occupant comfort.

Compared with conventional solutions, THERMIO®+ can deliver up to a 30% increase in the thermal emission coefficient and up to 80% higher thermal diffusivity, enabling faster system response times and a more immediate comfort experience. The improved thermal efficiency can also generate energy savings of up to 18% on heating costs.

By commissioning its third anhydrite mortar facility in Galicia, Votorantim is increasing regional access to advanced construction solutions that combine performance, energy efficiency and circular economy principles, demonstrating how innovative building materials can contribute to lower operational energy demand across the built environment.



30%

Up to 30% increase in thermal emission coefficient.

80%

Up to 80% higher thermal diffusivity.

18%

Up to 18% in savings on heating costs generated.

Votorantim Cimentos' low carbon RMX Flagship Plant in Andalucia

The Blenture flagship ready-mix concrete plant showcases how low-carbon cement, optimized mix designs, renewable electricity and circular economy practices can be combined to reduce the carbon footprint of concrete production.

Case study

Votorantim Cimentos presented its low-carbon RMX Flagship Plant in Córdoba (Andalucia); the plant is a best-in-class for lower-emission ready-mix concrete. The model combines lower-carbon cement (under the brand Blenture), optimized cement dosage, and photovoltaic generation. The project roadmap also includes returned-concrete recycling through additives. Key actions include maximizing Blenture cement use, installation of a specific silo for R32,5 cement dosing in non-structural concrete, and installation of a self consumption solar park in the vicinity of the plant.

The location of the plant was strategically selected; the city of Córdoba is a provincial capital with access to a strong potential market and the potential to supply emblematic projects. The flagship concept is built around the Blenture® brand value proposition, which integrates lower-carbon cement, lower-carbon ready-mix concrete, optimized mix designs, circular economy practices and renewable energy solutions into a single market offering. The Córdoba flagship plant serves as a practical demonstration of how the Blenture can bring lower-carbon construction solutions to market in a ready-to-use format.



Above: **Votorantim Cimentos' RMX Plant, Córdoba, Spain**

Up to 5%

Third silo for CEM 32.5: up to 5% planned reduction in $CO2/m^3$ in the flagship action plan.

50%

Photovoltaic installation supplying 50% of the plant's electricity consumption.

Votorantim Cimentos
Continued

Votorantim Cimentos' new waste management plant in Galicia

The waste management plant, located in Galicia, is a strategic investment that expands Votorantim Cimentos' alternative fuel capacity pre-treatment, strengthens vertical integration across the waste-to-energy value chain and supports the transition away from fossil fuels in cement manufacturing while providing a productive end-use for non-recyclable industrial waste that would otherwise be landfilled.

Case study

The waste management plant is a project designed to classify and shred non-hazardous industrial waste to produce recovered fuel for cement manufacturing. The validated project material identifies plastics, rubber, cardboard and wood as target waste streams, supplied by authorized waste managers in Galicia.

The objective is to give a second life to materials that would otherwise be sent to landfill and to strengthen the supply of alternative fuels for VCE's northern cement operations, supporting circular economy objectives and reducing reliance on fossil fuels.

The technical project was designed with a maximum throughput of almost 150 kt of RDF per year, including main-burner-quality fuel. In Q1 2026, the project was given a green light by the Administration successfully obtaining the Integrated Environmental Authorization for its execution. Works started in March 2026.

50%

Main-burner-quality RDF:
50% of designed volume.

150,000kt

tonnes of RDF per year — approximate maximum capacity.

Biomass use in Türkiye towards our Net Zero target

Votorantim Cimentos is expanding the use of biomass as an alternative fuel in Türkiye, building on the successful implementation at Yozgat and Hasanoğlan to reduce fossil fuel use and support its net zero pathway.

Case study

Decarbonisation stands at the heart of Votorantim Cimentos' 2030 Sustainability Commitments and is a top priority for the company. A cornerstone of this decarbonisation strategy is co-processing waste and biomass for use as alternative fuels, reducing reliance on fossil fuels while supporting circular economy objectives.

As part of this journey, Votorantim Cimentos has led the way in adopting biomass as an alternative fuel in Türkiye, leveraging the rich agricultural resources of Central and Eastern Anatolia. Following the successful implementation of a biomass feeding system at the Yozgat Plant, the company is now extending this initiative to other plants across Türkiye.

As a next step, Votorantim Cimentos installed a biomass feeding system at the Hasanoğlan Plant. The initiative enables the use of biomass in both the calciner and the main burner, contributing to a reduction of approximately 35 kg of CO_2 emissions per ton of cementitious material and supporting progress towards the company's Net Zero target.



Above: **Votorantim Cimentos' Hasanoğlan Plant, Türkiye**

Sanford Dam Auxiliary Spillway

The Sanford Dam Auxiliary Spillway renovation used 13,760 cubic meters of low-carbon roller-compacted concrete (RCC) providing durability and thermal control in a large-scale mass concrete application.

Case study

The Sanford Dam Auxiliary Spillway renovation in Sanford, Michigan in collaboration with Fisher Contracting Company demonstrates how innovative concrete technology can support both accelerated construction and sustainability goals. The 366 -meter-long spillway, featuring stepped sections up to 7 meters high, required approximately 13,760 cubic meters of roller-compacted concrete (RCC) to be placed within a six-week schedule.

To meet demanding performance requirements, the project team developed a high-performance RCC mix containing a total of 208 kg/m³ of cementitious material, consisting of St. Marys cement 60% CemplusTM and 40% Portland-Limestone cement (Type IL). This optimized blend significantly reduced the heat of hydration, helping maintain required core-to-surface temperature differentials for this mass concrete application while achieving the 24-hour initial set time needed for rapid construction.

Despite its low cementitious content, the mix delivered the strength, durability, and long-term performance required for critical infrastructure. The combination of RCC construction methods, high slag cement replacement levels, and Type IL cement enabled efficient placement, effective thermal control all while reducing embodied carbon.

st marys cement







Top: **Sanford Dam**
Middle: **The 366-meter-long spillway**
Bottom: **Stepped sections reaching 7 meters high**

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